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RADIO-TV EXPERIMENTER

No. 569
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FALL
1960

37 Electronic Projects

- TRANSISTOR ANALYZER
- FREQ STANDARD
- 2-TUBE LW RCVR
- TUNNEL DIODE OSC
- VAN de GRAAFF GEN
- MUSIC-ANNUNCIATOR
- WIRELESS INTERCOM
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- MINIATURE TAPE RECORDER
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plans for this
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Fall 1960 Edition

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A Subsidiary of Davis Publications, Inc.

450 East Ohio Street **Chicago 11, Illinois**

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Associate Editor

Lynell A. Johnson
Editorial Assistant

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The Radio-TV Experimenter contains a selected few of the most popular electronics projects and radio and TV maintenance articles that have appeared in *Science and Mechanics Magazine*, plus a number of projects and helpful articles on the same subjects appearing for the first time.

Science and Mechanics Handbook Annual No. 6, 1960—No. 569

Advertising Offices: Chicago: 450 E. Ohio St., WH 4-0330; New York: 527 Madison Ave., PL 3-9377; Los Angeles: The Maurice A. Kimball Co., Inc., 2550 Beverly Blvd., DU 8-6178; San Francisco: The Maurice A. Kimball Co., 681 Market St., EX 2-3365.

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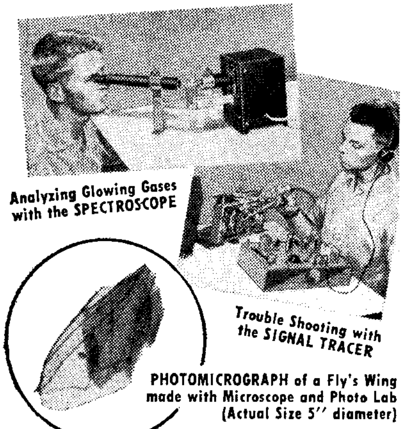

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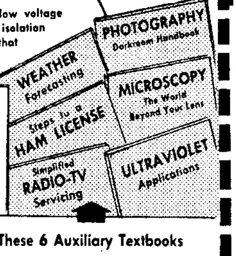

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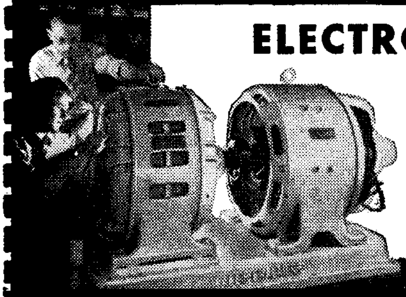


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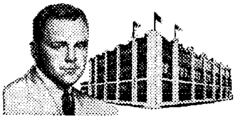

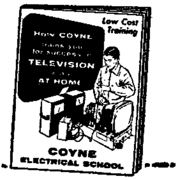
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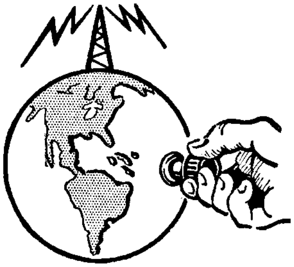

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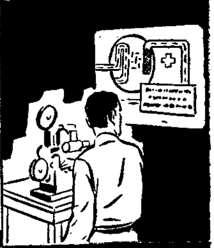

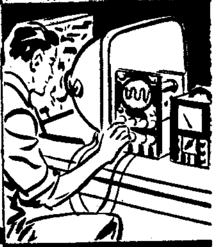

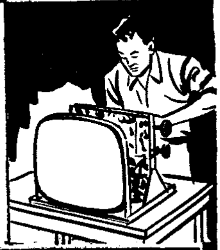

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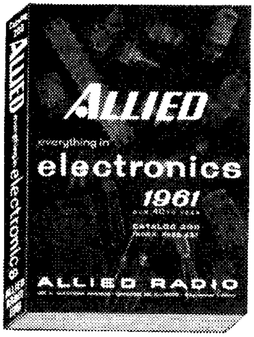

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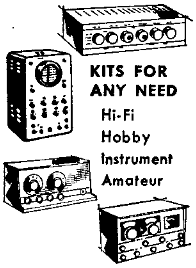

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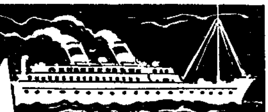

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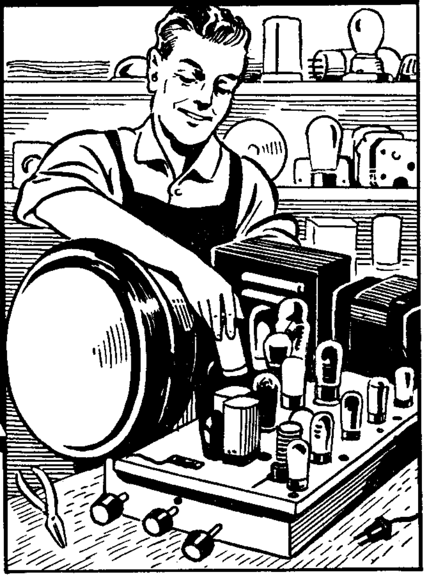

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3CF6
3CS6
3LF4
3Q4
3S4
3V4
4BQ7A
4BZ7
5AS8
5AT8
5AV8
5AW4
5BK7
5J6
5T8
5U4G
5U8
5V4G
5V6GT
5X8
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12BF6
12BH7
12BQ3
12BR7
12BY7
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12J5
12K7
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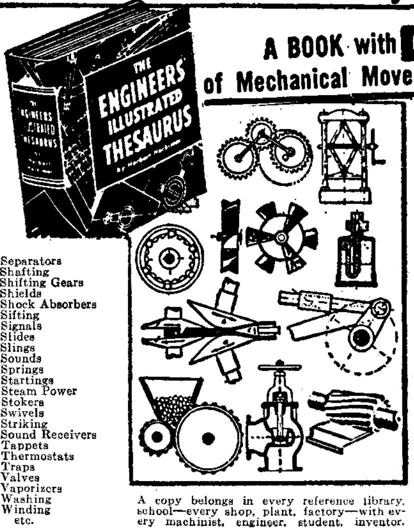

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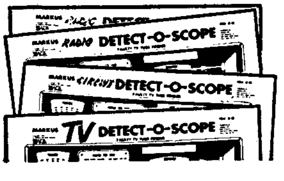

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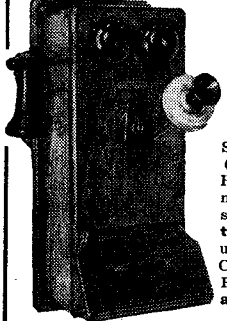

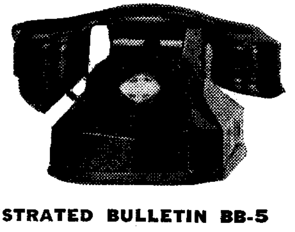


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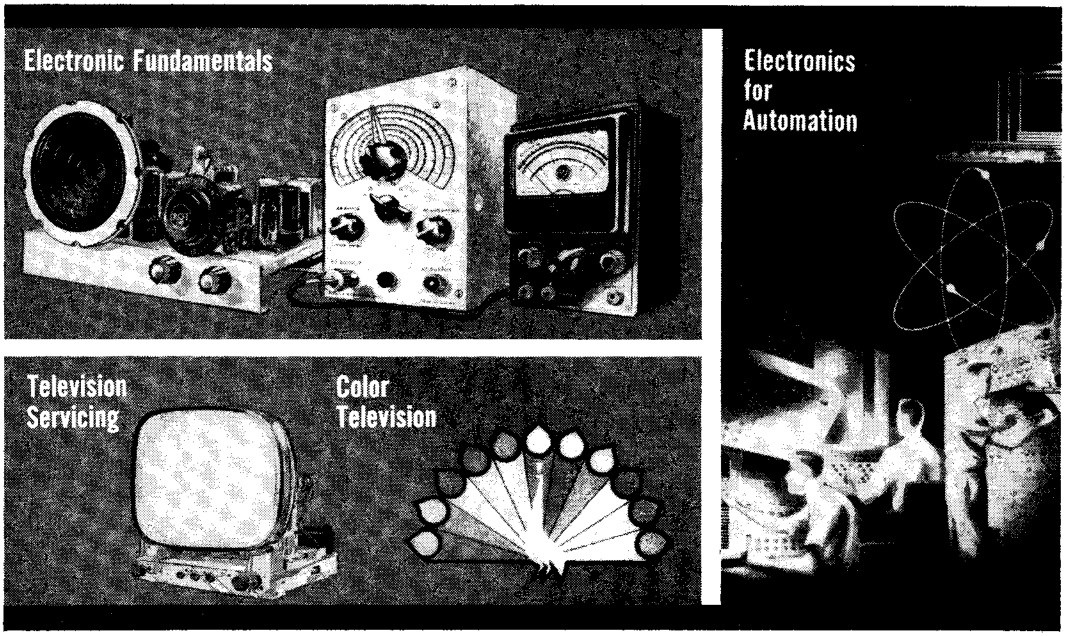
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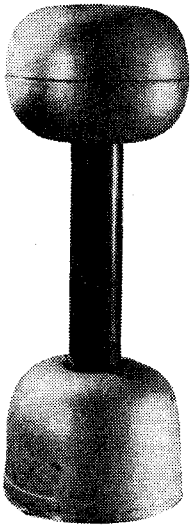

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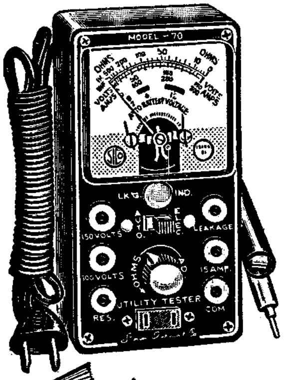

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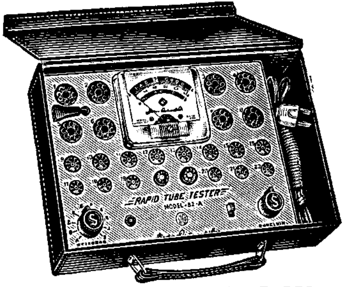

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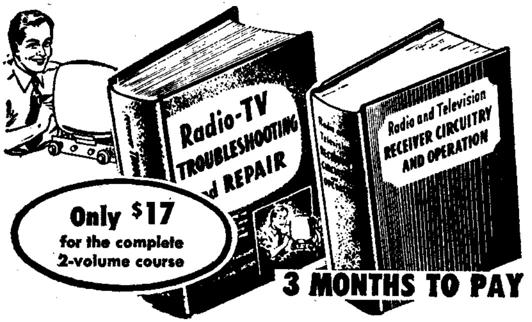

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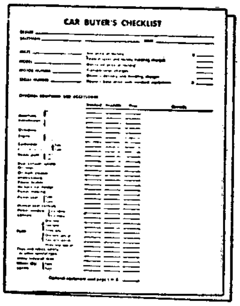

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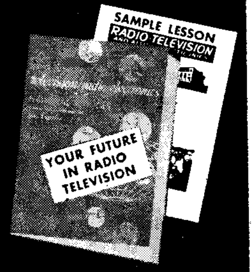

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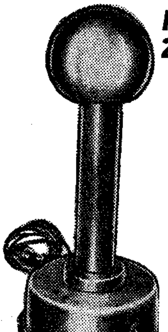


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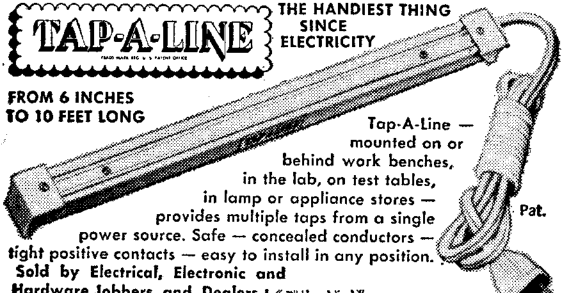
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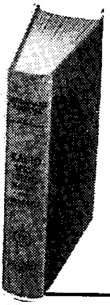

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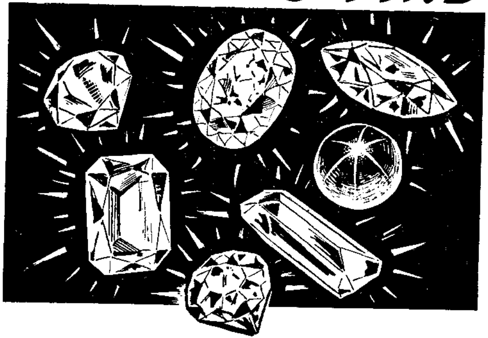

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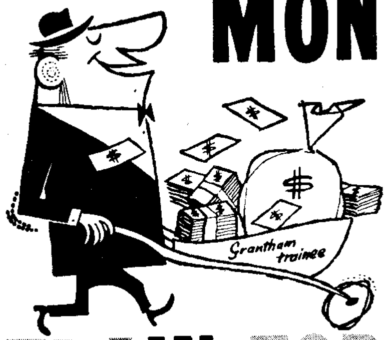
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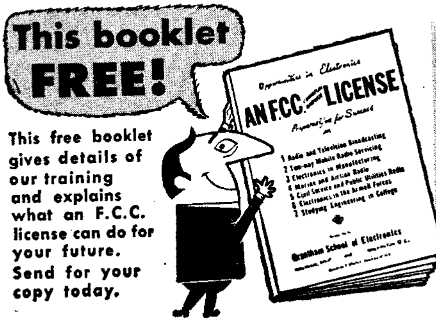
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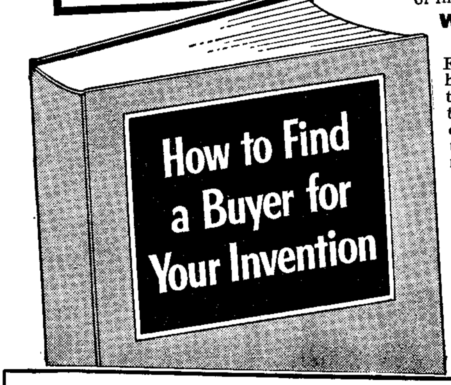
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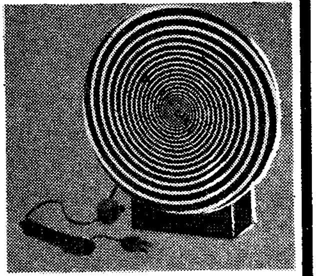

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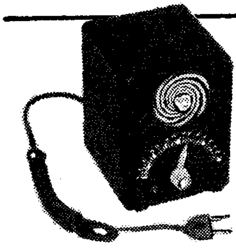

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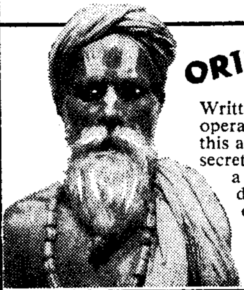

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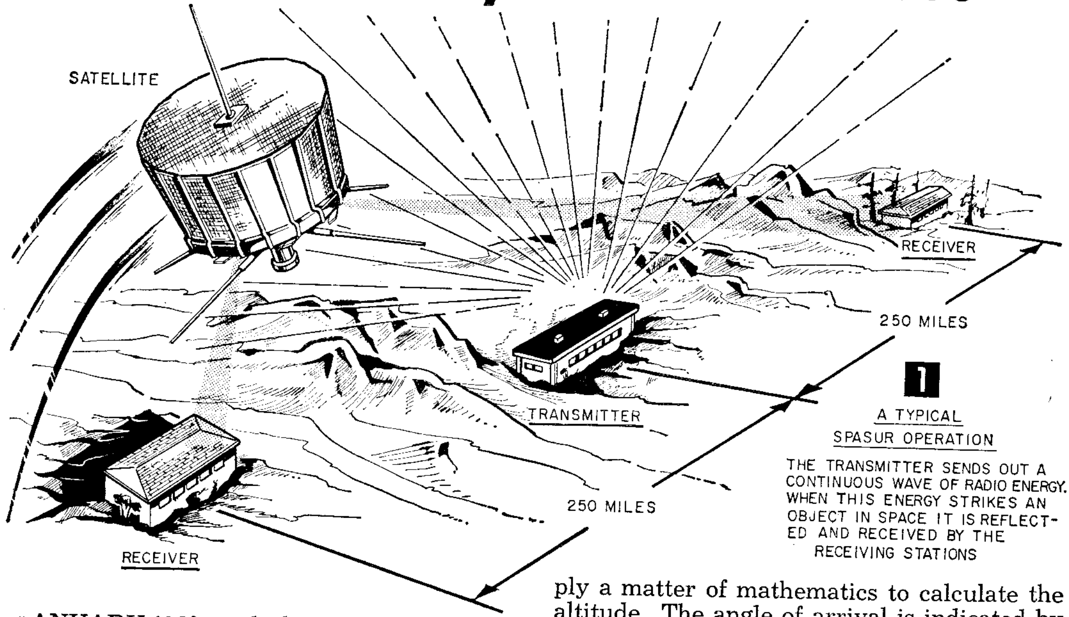
SPASUR: New Eye On The Universe



1 A TYPICAL SPASUR OPERATION

THE TRANSMITTER SENDS OUT A CONTINUOUS WAVE OF RADIO ENERGY. WHEN THIS ENERGY STRIKES AN OBJECT IN SPACE IT IS REFLECTED AND RECEIVED BY THE RECEIVING STATIONS

JANUARY 1960. A dark satellite circles the Earth, its origin unknown. The space vehicle, transmitting no signal—at least no signal audible in the Western world—should have remained undetected, but didn't. Why not? The reason is SPASUR, a new electronic device built by Bendix Radio for the United States government.

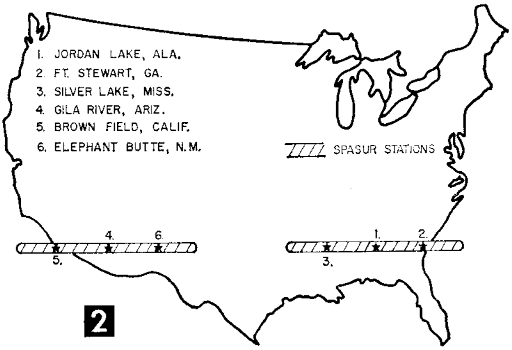
Such an important new system should involve some sweeping new discovery—but that doesn't happen to be the case. SPASUR makes use of two very well known principles of radio reception, proving again that what man does with his discoveries is even more important than the discoveries themselves.

First part of the SPASUR system consists of a VHF transmitter fed into a non-directional antenna. VHF signals are not normally reflected back to Earth unless they happen to strike a solid object. This is precisely what happens when the SPASUR (SPAce SURveillance) transmission strikes an object in space. Once the reflected signal is picked up by a properly equipped receiving station, position and attitude are determined.

Each SPASUR chain consists of a transmitter and two receiving locations, 250 miles either side of the transmitter. Thus the chain is spread out along a 500 mile strip (see Fig. 2). There are presently a pair of chains operating, centered on Jordan Lake, Alabama, and Gila River, Arizona. A satellite orbiting the Earth must eventually pass within range of at least one of these chains.

At a receiving station, the bearing is first taken and then the angle between signal and Earth is measured. From the latter, it is simply a matter of mathematics to calculate the altitude. The angle of arrival is indicated by the phase difference between two parallel antennas. Again this method is nothing new, it's been used for many years in short-wave research. However, when applied to SPASUR it is much more accurate since signals arrive via only one path while on short-wave multipath reception is common.

The received data is fed into a computer and after three sightings both course and speed are revealed. Working with MINITRACK, another Bendix system which keeps tabs on broadcasting satellites, SPASUR provides a complete picture of "nearby" (near Earth) space activities.—C. M. STANBURY II



The approximate positions of the six stations of the U. S. Navy Space Surveillance detection net. The stations are divided into two complexes (eastern and western), each consisting of a transmitting station and two receiver stations. The stations are located along a great circle track between Fort Stewart, Georgia, and the Naval Air Station, Brown Field, just south of San Diego, California.

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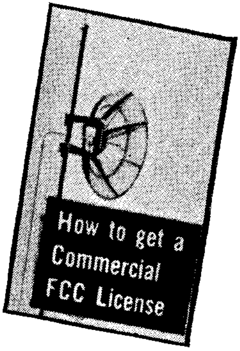

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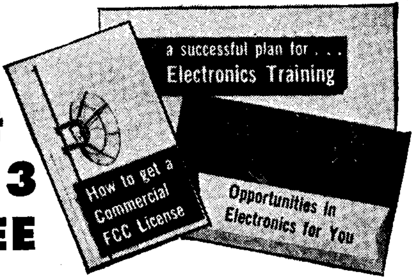

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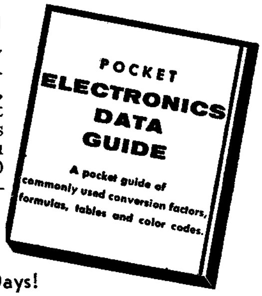

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Memorandum, 1915

Subject: Radio Music Box

David Sarnoff

IN 1915, David Sarnoff was Assistant Traffic Manager of the Marconi Wireless Telegraph Company of America. In September of that year he sent to the Vice President and General Manager of the company the following memorandum:

"I have in mind a plan of development which would make radio a 'household utility' in the same sense as the piano or phonograph. The idea is to bring music into the house by wireless.

"While this has been tried in the past by wires, it has been a failure because wires do not lend themselves to this scheme. With radio, however, it would seem to be entirely feasible. For example—a radio telephone transmitter having a range of, say, 25 to 50 miles can be installed at a fixed point where instrumental or vocal music or both are produced. The problem of transmitting music has already been solved in principle and therefore all the receivers attuned to the transmitting wave length should be capable of receiving such music. The receiver can be designed in the form of a simple 'Radio Music Box' and arranged for several different wave lengths, which should be changeable with the throwing of a single switch or pressing of a single button.

"The 'Radio Music Box' can be supplied with amplifying tubes and a loud speaking telephone, all of which can be neatly mounted in one box. The box can be placed on a table in the parlor or living room, the switch set accordingly and the transmitted music received. There should be no difficulty in receiving music perfectly when transmitted within a radius of 25 to 50 miles. Within such a radius there reside hundreds of thousands of families . . .

"The manufacture of the 'Radio Music Box' including antenna, in large quantities, would make possible their sale at a moderate figure of perhaps $75.00 per outfit. The main revenue to be derived will be from the sale of 'Radio Music Boxes' . . ."

The serious young junior executive above is David Sarnoff as he looked 40 years ago; today he is RCA's Chairman of the Board of Directors and Chief Executive Officer.

Hindsight tells us Marconi Wireless should have seized opportunity by the antenna. Instead, they ignored the memo. Five years later, after the Radio Corporation of America was organized, Sarnoff pulled his copy of the memo out of his files and revived his recommendation of 1915 in a report to Owen D. Young, Chairman of the Board of the new company.

Four weeks later, on March 3, 1920, Sarnoff was asked for an estimate of prospective radio business. He replied:

"The 'Radio Music Box' proposition . . . requires considerable experimentation and development; but, having given the matter much thought, I feel confident in expressing the opinion that the problems involved can be met. With reasonable speed in design and development, a commercial product can be placed on the market within a year or so.

"Should this plan materialize it would seem reasonable to expect sales of one million (1,000,000) 'Radio Music Boxes' within a period of three years. Roughly estimating, the selling price at $75 per set, $75,000,000 can be expected. This may be divided approximately as follows:

First Year	
100,000 Radio Music Boxes....	$ 7,500,000
Second Year	
300,000 Radio Music Boxes....	22,500,000
Third Year	
600,000 Radio Music Boxes....	45,000,000

RCA's actual sales of "Radio Music Boxes" during the first three years of its activities in this field, were:

1st year..........	1922..........	$11,000,000
2nd year.........	1923..........	22,500,000
3rd year..........	1924..........	50,000,000
Total..........		$83,500,000

Broadcasting had been born.

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1AX2	.62	4CS6	.61	6AW8	.89	6DG6	.59	12AF3	.73	12CU5	.58	17DQ6	1.06
1B3GT	.79	4DE6	.62	6AX4	.65	6DQ6	1.10	12AF6	.49	12CU6	1.06	17L6	.58
1DN5	.55	4DK6	.60	6AX7	.64	6DT5	.66	12AJ6	.46	12CX6	.54	17W6	.70
1G3	.73	4DT6	.55	6BA6	.49	6DT6	.53	12AL5	.45	12DB5	.69	19AU4	.83
1J3	.73	5AM8	.79	6BC5	.54	6EU8	.79	12AL8	.95	12DE8	.75	19BG6	1.39
1K3	.73	5AN8	.86	6BC7	.94	6EA8	.79	12AQ5	.52	12DL8	.85	19T8	.80
1L6	1.05	5AQ5	.52	6BC8	.97	6H6GT	.58	12AT6	.43	12DM7	.67	21EX6	1.49
1LN5	.59	5AT8	.80	6BD6	.58	6J5GT	.51	12AT7	.76	12DQ6	1.04	25BQ6	1.11
1R5	.62	5BK7A	.82	6BE6	.55	6J6	.67	12AU6	.50	12DS7	.79	25C5	.53
1S5	.51	5BQ7	.97	6BF6	.44	6K6	.63	12AU7	.60	12DZ6	.56	25CA5	.59
1T4	.58	5BR8	.79	6BG6	1.66	6S4	.48	12AV5	.97	12EL6	.50	25CD6	1.44
1U4	.57	5CG8	.76	6BH6	.65	6SA7GT	.76	12AV6	.41	12EG6	.54	25CU6	1.11
1U5	.50	5CL8	.76	6BH8	.87	6SK7	.74	12AV7	.75	12EZ6	.53	25DN6	1.42
1X2B	.82	5EA8	.80	6BJ6	.62	6SL7	.80	12AX4	.67	12F5	.66	25EH5	.55
2AF4	.96	5EU8	.80	6BK7	.85	6SN7	.65	12AX7	.63	12F8	.66	25L6	.57
3AL5	.42	5J6	.68	6BL7	1.00	6SQ7	.73	12AZ7	.86	12FM6	.45	25W4	.68
3AU6	.51	5T8	.81	6BN4	.57	6T4	.99	12B4	.63	12K5	.65	25Z6	.66
3AV6	.41	5U4	.60	6BN6	.74	6U8	.78	12BA6	.50	12SA7M	.86	35C5	.51
3BA6	.51	5U8	.81	6BQ5	.65	6V6GT	.54	12BD6	.50	12SK7GT	.74	35L6	.57
3BC5	.54	5V6	.56	6BQ6GT	1.05	6W4	.57	12BE6	.53	12SN7	.67	35W4	.52
3BE6	.52	5X8	.78	6BQ7	.95	6W6	.69	12BF6	.44	12SQ7M	.73	35Z5GT	.60
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3BY6	.55	6AC7	.96	6BY6	.54	6X8	.77	12BQ6	1.06	12W6	.69	50DC4	.37
3BZ6	.55	6AF3	.73	6BZ6	.54	7AU7	.61	12BY7	.74	12X4	.38	50EH5	.55
3CB6	.54	6AF4	.97	6BZ7	.97	7A8	.68	12BZ7	.75	17AX4	.67	50L6	.61
3CF6	.60	6AG5	.65	6C4	.43	7B6	.69	12C5	.56	17BQ6	1.09	117Z3	.61
3CS6	.52	6AH6	.99	6CB6	.54	7Y4	.69	12CA5	.59	17C5	.58		
3CY5	.71	6AK5	.95	6CD6	1.42	8AU8	.83	12CN5	.56	17CA5	.62		
3DK6	.60	6AL5	.47	6CF6	.64	8AW8	.93						
3DT6	.50	6AM8	.78	6CG7	.60	8BQ5	.60						
3Q5	.80	6AN4	.95	6CG8	.77	8CG7	.62						
3S4	.61	6AN8	.85	6CM7	.66	8CM7	.68						
3V4	.58	6AQ5	.50	6CN7	.65	8CN7	.97						
4BC5	.56	6AR5	.55	6CR6	.51	8CX8	.93						
4BC8	.96	6AS5	.60	6CS6	.57	8EB8	.94						
4BN6	.75	6AT6	.43	6CU5	.58	10DA7	.71						
4BQ7	.96	6AT8	.79	6CU6	1.08	11CY7	.75						
4BS8	.98	6AU4	.82	6CY5	.70	12A4	.60						
4BU8	.71	6AU6	.50	6CY7	.71	12AB5	.55						
4BZ6	.58	6AU7	.61	6DA4	.68	12AC6	.49						
		6AU8	.87	6DB5	.69	12AD6	.57						

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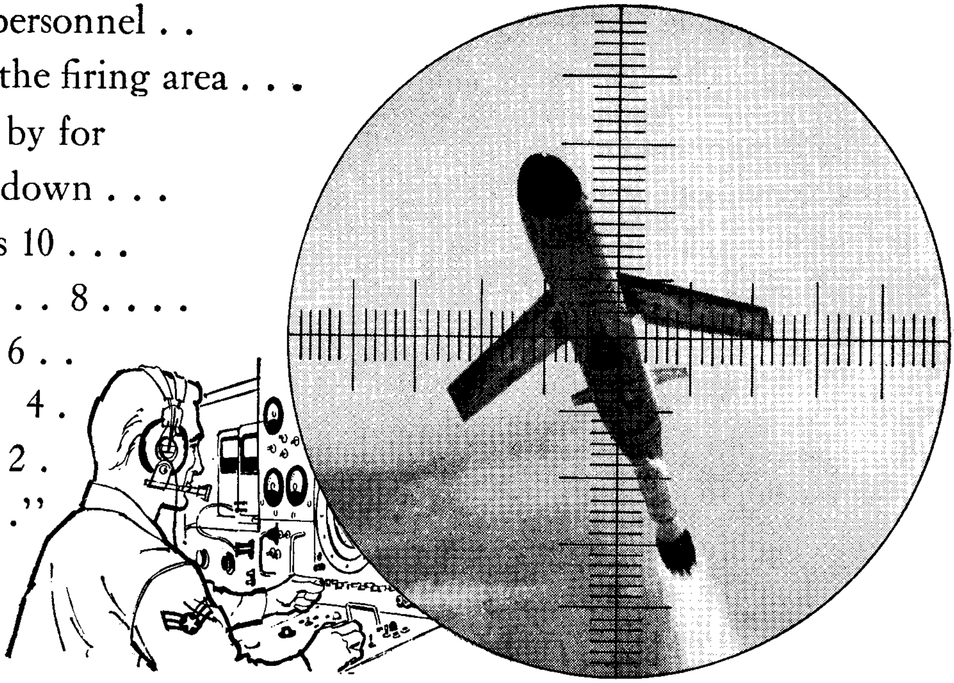
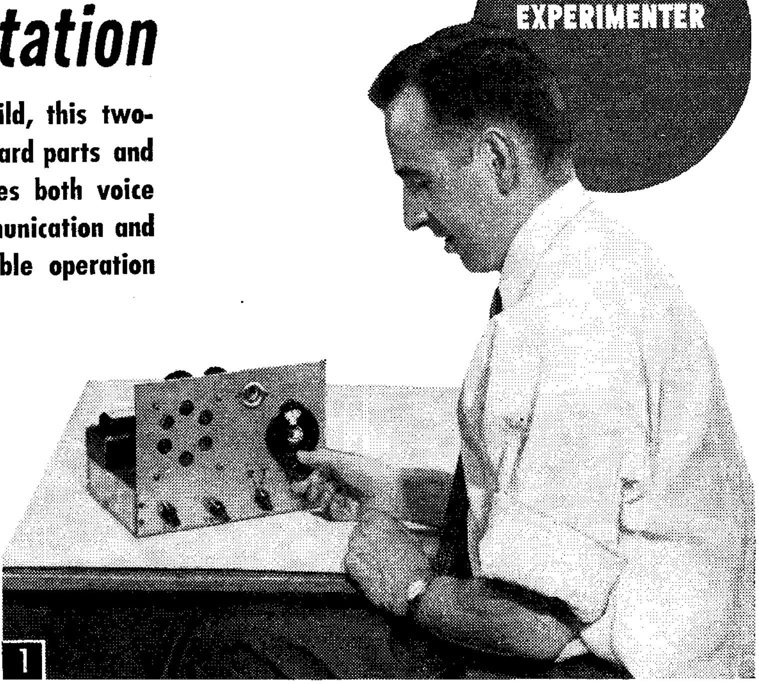


TWO-METER
Amateur Station

Compact and easy to build, this two-meter station uses standard parts and tubes throughout, provides both voice and modulated code communication and may be used for portable operation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You can build this transceiver for less than half of what any similar, presently available commercial rig sells for.

by C. F. ROCKEY,
W9SCH/W9EDC

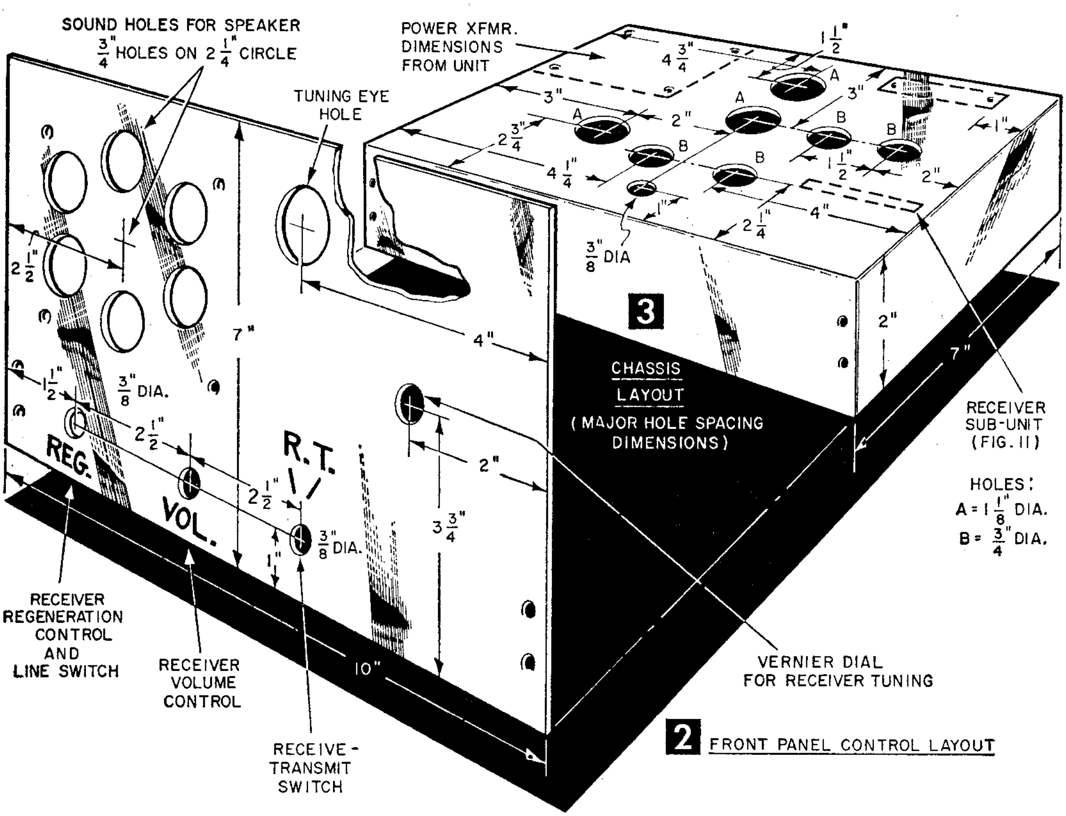
OPEN to holders of all classes of amateur license, the 144-megacycle, two-meter amateur band offers interesting possibilities to the experimentally inclined ham. This little rig provides an excellent starting setup, or a nice little extra rig.

Begin construction by drilling and punching the major holes in the front panel and chassis (Figs. 2 and 3). Mount the panel temporarily upon the chassis while drilling the holes for the two potentiometers and the Receive-Transmit switch. With all major holes drilled, mount the power transformer, then the rectifier tube socket and the Jones barrier terminal strip. Temporarily mount the regeneration control potentiometer upon the panel; it includes the On-Off power-line switch, which is wired-in immediately.

Now complete the power supply wiring (see Fig. 7) first connecting the transformer leads to the rectifier tube socket, then wiring in the 120-*v* primary leads. The electrolytic capacitors are held in place by their mounting brackets, as are the positive "hot" leads which are supported by a two-lug, insulated tie-point strip. Last of all, install and connect the filter choke. Ground one side of the 6.3-*v* heater winding and bring the other end out to one of the unused rectifier socket lugs, which will serve as a tie-point for connection to the heater of each of the tubes (except the rectifier, of course).

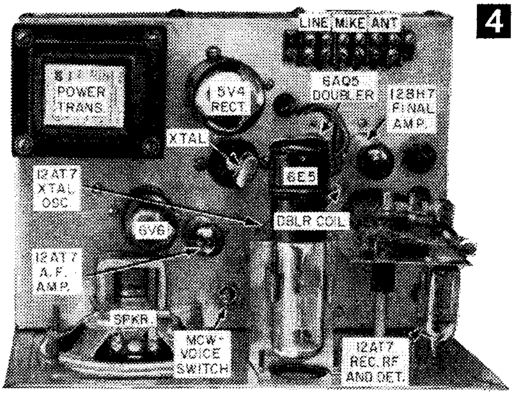
After you've wired and carefully checked the power supply, measure the resistance between the positive high-voltage terminal and ground. There should be more than 10,000 ohms. Less indicates a wrong connection, or short. When the high-voltage circuit has been checked out, connect the line cord to its terminals on the terminal strip and insert the rectifier tube in its socket. When the switch is turned on, the rectifier tube filaments should glow dull red and a dc voltage of at least 250 *v* (more won't hurt) should be observed from the positive terminal of the last filter capacitor to ground.

Audio Section. When the power supply is operational, remove the rectifier tube and line cord and fasten in the sockets for the audio frequency section, including the 12AT7, half of which is used for an AF amplifier. (The other half is the crystal oscillator, which is wired-in later.) The AF section includes one and one-half 12AT7's, and the 6V6GT. The 12AT7 sockets are mounted with 4-36 x ¼-in. *rh* machine-screws and nuts. Be sure to put a soldering-lug under one of the mounting screws for each socket to provide a ground point for that part of the circuit. Pin No. 9 on each 12AT7 socket, and pin No. 7 on the 6V6GT are connected to the 6.3-*v* heater winding (ungrounded green lead) of the power transformer. Ground pins 4 and 5 on each 12AT7 socket, as well as the metal tube



3 CHASSIS LAYOUT (MAJOR HOLE SPACING DIMENSIONS)

2 FRONT PANEL CONTROL LAYOUT



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in the center. On the 6V6 socket, ground pins 1 and 2.

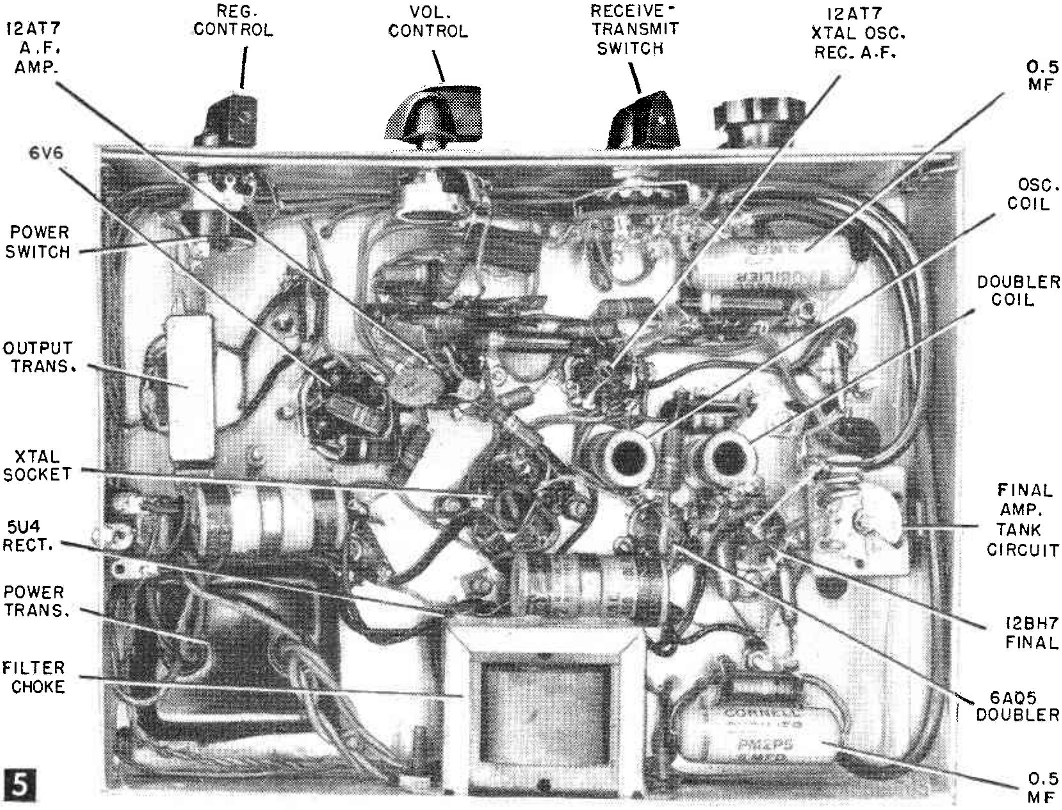
Work backwards from the output transformer through the 6V6 (see Fig. 6). Ground the "common" terminal on the output transformer secondary; leave the other secondary terminal alone for the moment. The output transformer is mounted with 6-32 *rh* machine screws and nuts. When the 6V6 has been wired, *temporarily* connect the loudspeaker (between unused secondary lead and ground), insert the 6V6 and rectifier tube, plug in line cord and turn on power. Both tubes should light and, when warm, a screwdriver touched to pin No. 5 (control grid) of the 6V6 should produce a characteristic clicky buzz in loudspeaker.

With the audio output stage connected and operating, unhook external connections, remove tubes, and wire the 12AT7 stage that feeds the signal to the 6V6. Use 2- and 4-point insulated tie-lugs as needed to hold small parts firmly in place by their leads.

After you've wired and checked this next stage, put in tubes, re-connect speaker and plug in line. When all tubes are warm, carefully touch a screwdriver to the *control grid* terminal (pin No. 7) of the 12AT7. A much louder clicky buzz should be heard.

To complete further AF circuit wiring, you'll have to temporarily install both the Receive-Transmit switch and the volume control potentiometer. Figure 8 shows connections for the non-shorting type R-T switch. Continue wiring by completing the 12AT7 amplifier stage that serves the receiver (see Fig. 9). Make all ground leads short.

To test this stage, set up as previously described, throw the R-T switch to "Receive," and check for the characteristic buzz at the grid. Advance the volume control, of course. Because of the relatively high amplification involved here, it should be possible to hear a faint hiss of tube noise when the volume control is fully advanced.



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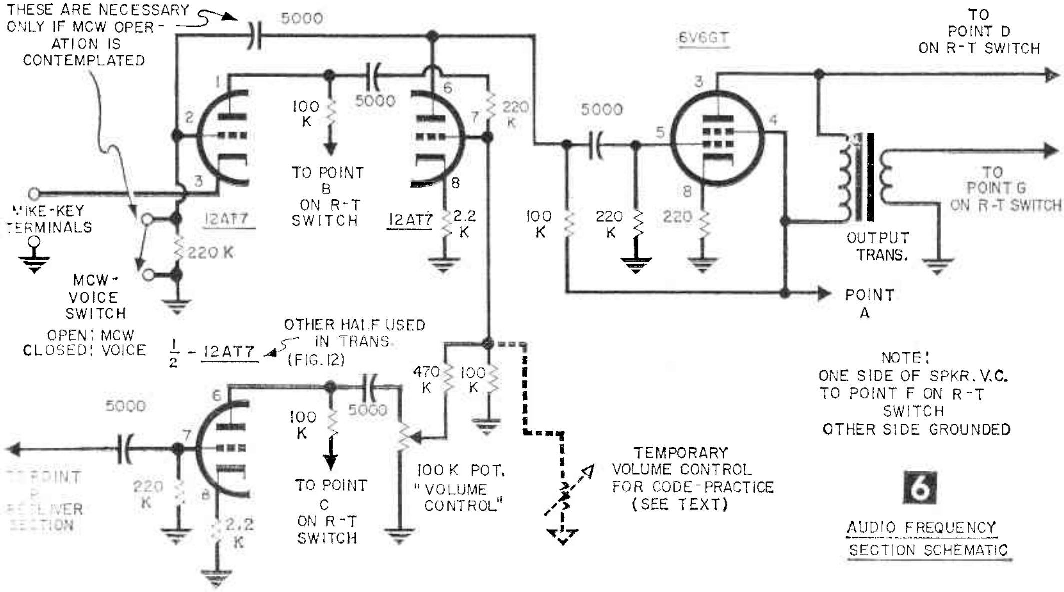
Finish the AF section by wiring the 12AT7, "speech-amplifier" stage. This circuit contains the SPST toggle switch that converts it into an oscillating multivibrator for modulated CW work. When the switch is open the circuit acts as a multivibrator, or tone generator. When closed, the stage becomes a grounded-grid amplifier for the mike.

Connect external connections, as previously described for testing, and insert all tubes involved. Connect a 220K resistor temporarily across the *Mike-Key* terminals on the termi-



6

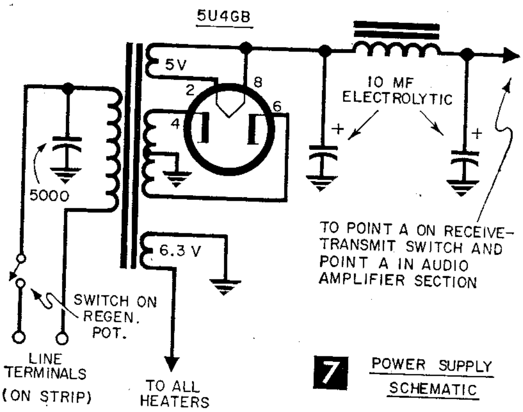
AUDIO FREQUENCY SECTION SCHEMATIC

nal strip. When the toggle switch is in the open position, a loud, clean musical tone should emerge from the speaker. (Note that the volume control, since it is associated with the receiver only, does not affect the strength of the tone.)

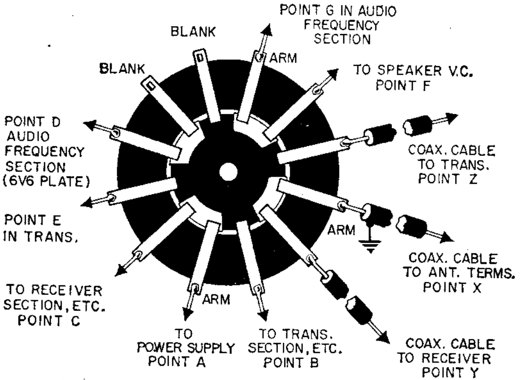
Throw the togggle switch into the closed position and connect a single-button carbon microphone (Type "F-1," from Telephone Engineering Company, Simpson, Penn., or other similar single-button carbon mike) to the microphone terminals. Now, the system should behave exactly like a good, low-power public-address amplifier. (Do *not* use a crystal or a dynamic mike.) Make sure the switch is in "transmit" position, before making these latter tests.

MATERIALS LIST—2-METER STATION

No. Req'd	Description
1	2 x 7 x 10" aluminum chassis
1	7 x 10" aluminum panel
3	knobs for ¼" shaft
1	National type BM dial
1	tuning eye assembly for 6E5 tube (includes bracket, socket and bezel)
1	PM loudspeaker, 4" size Jensen
1	2¾ x 3½" aluminum sheet, for detector (see text)
3	octal plastic tube sockets, Amphenol
4	9-pin miniature sockets, high frequency plastic insulation, Amphenol
1	7-pin miniature socket, Amphenol
1	6-terminal Cinch-Jones barrier terminal strip
1	SPST toggle switch, H&H
1	100K linear-taper potentiometer & switch (Mallory)
1	500K audio-taper potentiometer (Mallory)
1	power transformer, Chicago-Standard Type PM-8408
1	filter choke, Chicago-Standard, Type C-1708
1	output transformer, Chicago-Standard, Type A-3823
2	10 mfd. electrolytic filter capacitors, 450 working volt, Mallory
2	0.5 mfd. paper capacitors, 200 working volt, Cornell Dubilier
3	Ohmite type Z-144, 2-meter RF chokes
3	National type XR-50 coil forms, with iron slugs
1	four-pole, double-throw, non-shorting wafer switch, Centralab No. 1409
1	15 mmf variable tuning capacitor, Hammarlund HF-15
1	15 mmf BUD variable tuning capacitor type MC-1850, with one plate removed (see text)
1	47 ohm, one-watt carbon resistor
8	100K one-watt carbon resistors
2	47K, one-watt carbon resistors
4	22K, one-watt carbon resistors
2	2.2K, one-watt carbon resistors
5	220K, one-watt carbon resistors (includes one extra for new operation)
1	220 ohm, one-watt carbon resistor
1	470K, one-watt carbon resistor
1	1K, one-watt carbon resistor
1	1 meg., one-watt carbon resistor
5	50 mmf, 600 W.V. disk-type ceramic capacitors
8	5000 mmf, 600 W.V. disk-type ceramic capacitors
2	5 mmf., 600 W.V. disk-type ceramic capacitors
3	1000 mmf., 600 W.V. disk-type ceramic capacitors
1	brass shaft coupling ¼" to ⅙" shaft (female to female)
1	type 48, 2-volt, 60 ma dial lamp bulb (for tuning)
1	1N34 crystal diode, Sylvania
1	"overtone" crystal approximately 36 megacycles, Texas Crystal Co., River Grove, Ill. If you are a General class operator, you may select a crystal anywhere between 36 to 36.975 megacycles. Novices and Technicians must select one between 36.25 and 36.75 Ma. If you wish a certain frequency within the 144-megacycle band, divide that frequency by four to get your crystal frequency. Ask for the adapters to adapt the pin diameter to fit *octal* sockets pins. Texas Crystal Co. will supply these gratis when requested in order.
1	line cord and plug
1 pc	plastic rod ¼" dia., 3" long
1	5U4GB vacuum tube
1	6V6GT vacuum tube
3	12AT7 vacuum tube
1	6AQ5 vacuum tube
1	12BH 7 vacuum tube
1	6E5 vacuum tube
1	microphone, *carbon*, type F-1 (Telephone Engineering Co., Simpson, Penna.)
1	telegraph key (optional) Johnson Model 114-100
1	directional antenna for 144-Mc. amateur band, (the 5 element "Hi-Gain," or similar type is recommended.) With Co-axial transmission line and rotator
	wire, rosin-core solder, screws, nuts, tie-points, etc.



7 POWER SUPPLY SCHEMATIC



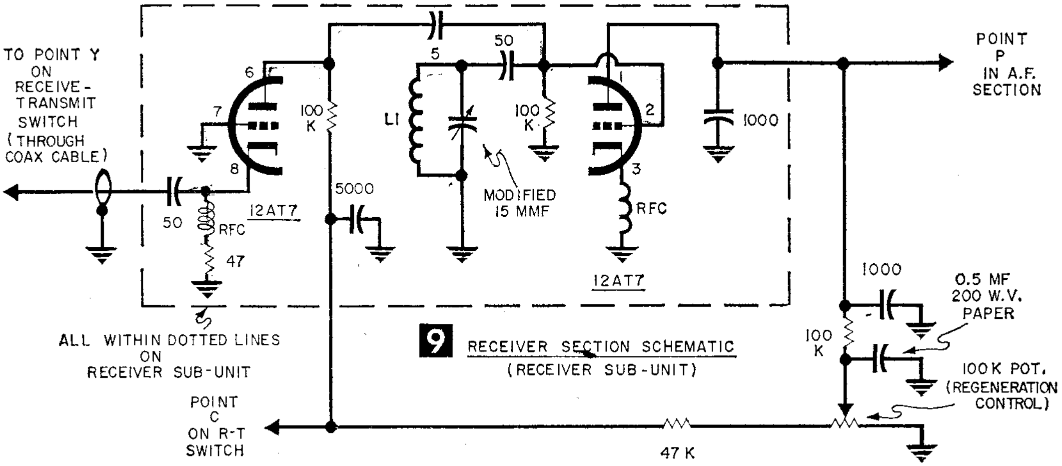
8 BACK VIEW OF RECEIVE - TRANSMIT SWITCH
(SWITCH SHOWN IN RECEIVE POSITION AS SEEN FROM BACK WITH CHASSIS INVERTED)

The unit as so-far constructed will serve very well as a code-practice oscillator with the toggle switch open, or as a small PA amplifier, with the switch closed. If it's too loud for you, connect a 50,000-ohm variable resistor from the grid of the last 12AT7 to ground (see Fig. 6). Varying this control will vary volume, but it may also have some effect upon the tone of the oscillation.

To use the audio system so-far constructed for a code practice oscillator, connect an ordinary telegraph key, in series with a 220K, one-watt carbon resistor to the *Mike-Key* terminals. The frame of the key should be connected directly to the grounded side, the 220K resistor in series with the other side. At full output, the signal is strong enough to serve a roomful of students; the volume may be reduced by the temporary volume control described above. Be sure the toggle switch is in the *open* position, and the R-T switch in the Transmit position, of course.

Receiver Section. Start by connecting the regeneration control, 100K potentiometer and 47K voltage-dropping resistor, along with the 100K detector plate load resistor (see Fig. 9). These parts are installed beneath the chassis —using insulated tie-lugs where appropriate to hold the resistors firmly in place.

With this under-chassis receiver wiring done, drill and assemble the receiver sub-unit (Figs. 10 and 11). Since this receiver operates at the high frequency of 144-million cycles per second, short and direct leads are of paramount importance. This applies especially to grid, plate and bypass-capacitor leads. It is important to return cathode leads and high-frequency bypass capacitors in the same stage to the same ground where possible.



9 RECEIVER SECTION SCHEMATIC (RECEIVER SUB-UNIT)

The 15 mmf Bud receiver tuning capacitor is modified by removing one of its rotary plates. Grasp one of the rotary plates firmly in the jaws of a long-nosed pliers, twist and pull, and the plate will slip cleanly out of its slot. This will leave one rotor and one stator plate. The two remaining plates should not scrape against each other. You may increase the band-spread (number of dial-degrees occupied by the amateur band) by cautiously bending the two plates away from each other. Do not make this adjustment, however, until the receiver is performing properly.

Wind coil L1 (see Fig. 13A) carefully and complete as much of the wiring as possible, before mounting the sub-unit upon the chassis. It is fastened in place with 6-32 *rh* machine screws and nuts. Next, connect heater, dc power, and signal output leads to the appropriate points under the chassis. Do not connect the antenna coaxial lead until later.

With the receiver wiring completed, insert tubes, connect loud speaker temporarily, and apply power. With the R-T switch at Receive, advance the volume control to full-on. Then slowly advance the regeneration control potentiometer. As this control is advanced, a loud, smooth hiss should be heard from the speaker. This hiss indicates *super-regeneration,* the condition for high sensitivity in a receiver of this type. By varying this control, it should be possible to increase the hiss level from zero to strong. Also, a super-regenerative condition should be possible over the entire range of the tuning capacitor.

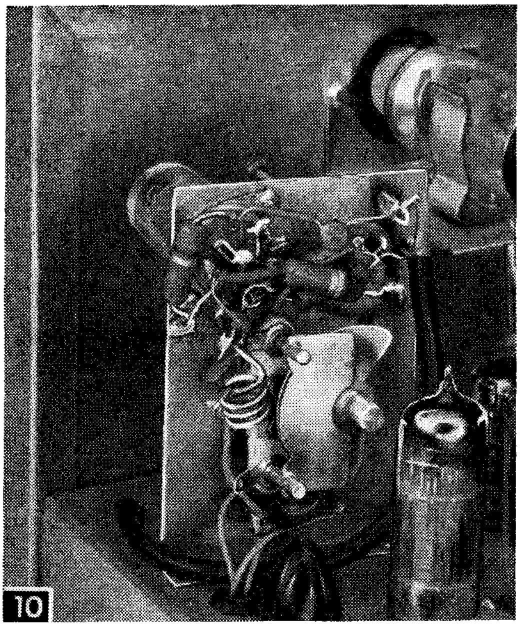
When the receiver super-regenerates properly, check the tuning range with a grid-dip meter. My receiver covers from about 140 to about 150 megacycles, with the 144-148 megacycle amateur band falling between about 60% and 70% of maximum capacitance of the tuning capacitor. The exact tuning range is not critical as long as the 144-148 megacycle amateur band is conveniently included. Squeeze the turns of the coil together or spread them slightly for minor changes.

If you live in or near a large city, you should now be able to hear two-meter amateurs on the air within range when a good antenna is connected between the antenna input tie point and ground. In addition, police, taxicab dispatchers, and aircraft operating adjacent to the amateur band may be heard in many areas. If you have not yet installed a good two-meter antenna, a high, clear outdoor TV antenna may serve temporarily to test the receiver. (Install a knob temporarily on the capacitor shaft to aid in tuning. To use a TV antenna to test receiver, connect one of the lead-in line wires to the antenna input tie point, the other to chassis.)

Transmitter. Start wiring with the crystal oscillator and work forward (see Fig. 11). The crystal plugs into any two *alternate* pins of the octal crystal socket; other unused pins may be used for tie-points for other circuits if desired. The crystal oscillator tube is the half of the 12AT7 that was *not* used for the AF amplifier circuit. The only critical part of the circuit is the coil, and this will cause no trouble if it is wound exactly as described in Fig. 13B.

After carefully checking the crystal oscillator circuit, proceed to the 6AQ5 frequency doubler stage. Again, this stage is straightforward; only the coil being critical. Wind this coil exactly as shown in Fig. 13C, being careful to get the tap in the exact center. Ground the cathode and the screen bypass capacitor to the same point on the chassis, as close to the socket as possible. The 1K resistor should be fastened to a two-point insulated tie lug mounted close by the coil.

When this doubler stage is complete, wire the final amplifier stage. Although a frequency doubler, this circuit develops practically the same efficiency as a straight-through amplifier while at the same time avoiding the self-oscillation troubles which plague the latter. Its push-push feature also helps to eliminate odd harmonics which could get into TV receivers and cause interference. The ordinary distortion-type frequency doubler, often used in simple VHF transmitter arrangements, provides none of this added spurious-harmonic suppression.



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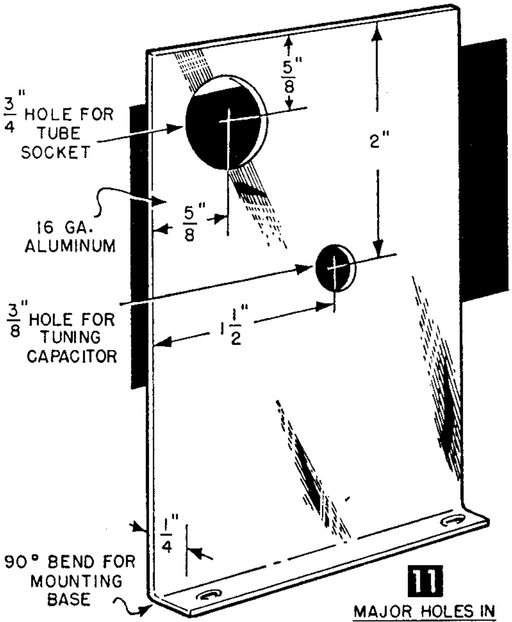


11

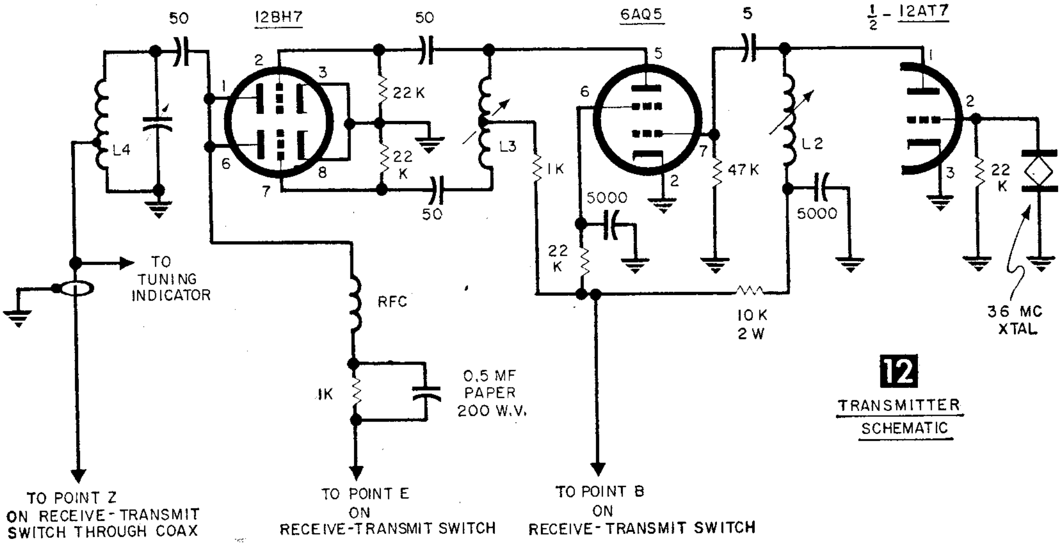
MAJOR HOLES IN RECEIVER SUB-UNIT

Again, since the output circuit is tuned to 144 megacycles, you *must* keep all leads as short and direct as possible. An extra quarter-inch of wire here can spell the difference between success and failure. Wind coil L4 exactly as shown in Fig. 13A and keep the leads short! Wire the entire final amplifier circuit carefully, but do not connect the antenna coax cable yet or the plus high-voltage lead. In the final stage, return all ground connections to the same point near the tube socket.

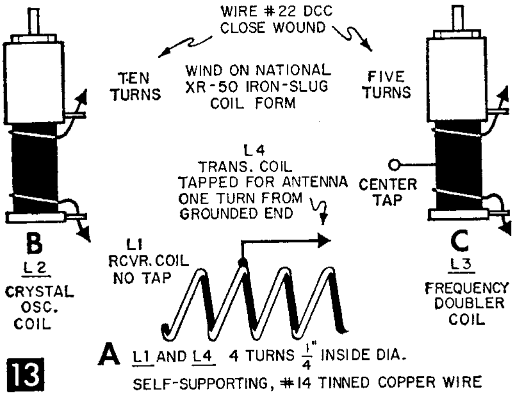
When the wiring of the transmitter RF stages is completed, insert tubes. Do not apply power yet, however. Instead, get your grid-dip meter, and carefully adjust each of the coils as closely as possible to its correct resonant frequency; 36 megacycles for the crystal oscillator, 72 megacycles for the doubler, and set the final tank to resonance at 144 megacycles. Be sure the tubes are in their proper sockets for this operation; their capacitance plays a big part in determining the resonant frequencies. If properly wound and installed, each of the coils should resonate at the correct frequency, with considerable extra slug-adjustment range available in either direction. The final tank coil may be adjusted by squeezing or spreading its turns.

When all coils have been pre-tuned, plug in the crystal, and apply power. Tune the grid dipper to 36 megacycles and immediately adjust the crystal oscillator coil for maximum oscillator output. If the crystal oscillator doesn't oscillate, recheck the wiring, and try another tube. When you find oscillation, screw the slug down until you get maximum output, then screw the slug *out* about three turns in the interest of stability and reliability of oscillation. Then immediately adjust the doubler coil slug for maximum output. Take a No. 48, or No. 49 dial light bulb (pink head) and solder a small loop of wire between its terminals. Then couple this loop closely about the doubler coil. If the doubler is operating properly, the lamp will light noticeably.

Now connect the positive high-voltage lead



12 TRANSMITTER SCHEMATIC



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to the final amplifier, apply power, and tune the final tank capacitor to maximum 144-megacycle output with the grid-dip meter. If you find plenty with the grid-dip meter, couple your "soup-loop" tuning lamp to the final coil and slightly re-tune. The bulb should glow brightly if the lamp is closely coupled. If you get weak, or no output, check the wiring again, or try another 12BH7 tube.

Now temporarily shut off power and plug-in the audio amplifier tubes. Connect your carbon mike to the *Mike-Key* terminals. Set the toggle switch to the closed position. Re-apply power and speak clearly into the mike. The bulb around the final amplifier tank should flicker markedly in step with your voice, indicating proper modulation.

The Finishing Touches. Pull out all tubes and remove all external connections. Mount the loudspeaker, the tuning-eye assembly, and the vernier dial upon the panel. Now remove the potentiometer and Receive-Transmit switch binding nuts and install the panel with the binding nuts and with self-tapping metal screws. Place knobs on potenti-

The VHF Amateur Bands

Today the VHF bands provide the greatest opportunity and challenge to the experimentally minded ham. These frequencies above 144 megacycles seem to be the only ones left wherein simple, low-powered equipment still can compete effectively against expensive, "store-bought" gear.

Nobody knows for sure the exact distance limitations on VHF communication. The first signal bounced off the moon by the U. S. Army back in 1946 was in the VHF range. On the other hand, it is the consistent, interference-free, short-haul communication, up to 50 miles or so, that is the operating bread-and-butter of the VHF amateur. Occasional long-distance spurts are to be considered as interesting diversions, rather than daily fare. Distance chasing, in itself, is not the whole of amateur radio. You'll have a lot of fun, face some stimulating problems, and meet some nice people on the two-meter band, believe me.

Those frequencies between 145 and 147 megacycles are available to both **novice** and **technician** class licenses, as well as the general-class operator. But do make sure that you have a license before you do any transmitting. "Citizens Band" license is **not** sufficient. You must have an **Amateur** license. (Write to the Federal Communications Commission office in the large city nearest you for details.)

In addition to the license, and to the usual hand tools owned by all radio experimenters, you should have available:

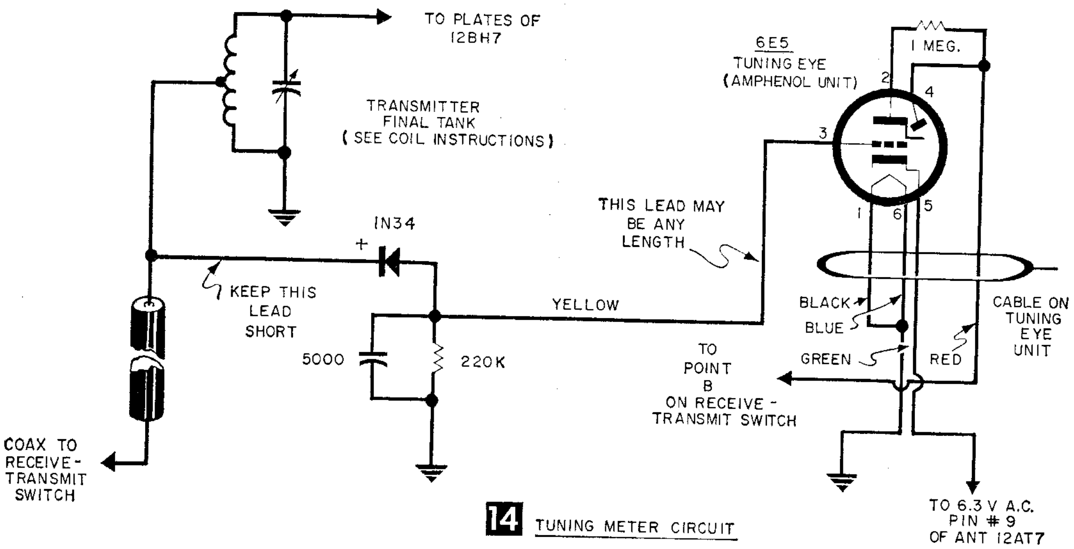
1) A good "two-meter beam," a directional antenna for the 144-megacycle band. Such an antenna is not expensive or unwieldy, in fact it is smaller than the usual outdoor TV antenna. A five-element antenna is sufficient, and can be purchased at a reasonable price from Newark Electric Co., Allied Radio, or any similar Amateur jobber.

You should equip your beam antenna with a suitable rotating-device, (one of those sold for TV antenna use will do very well) and you should get it as high above the ground as you can. A "quick and dirty" rule is that you can reliably work one mile of range per foot of antenna height (above average ground) beyond ten feet. In other words, this is your **consistent** communication range, in miles.

While you can make a number of contacts, particularly in the New York, New England, and Chicago areas, with a dipole in the attic, a good beam will do more for your morale than anything else.

2) A grid-dip meter. Stray capacitance and inductance being unpredictable in most cases, it becomes necessary to individually trim VHF tuned circuits by trial in nearly every case. The proper tool for establishing these resonant frequencies is the grid-dipper.

3) A volt-ohm-milliammeter.



14 TUNING METER CIRCUIT

ometer and R-T switch. Connect the receiver tuning capacitor to the vernier tuning dial with a piece of ¼-in. fiber or plastic rod and a shaft coupling. A setting of zero upon the tuning dial should correspond to maximum capacity, lowest frequency.

Plug the 6E5 tuning-eye tube into its socket, and fit it into the clamp provided on its bracket. Bring the cable from the tuning eye socket through the chassis through a ⅜-in. hole with rubber grommet. Connect the black and blue wires of this cable to ground, the green wire to the 6.3-*v* heater supply, and the red wire to the positive high voltage.

Install the 1N34 crystal diode, the 5000 mmf. capacitor, and the 220K resistor in the tuning meter circuit upon a two-lug insulated tie point, being careful to observe the polarity of the crystal diode. Install the diode-resistor assembly close to the final amplifier tank coil. Connect the yellow wire from the tuning eye tube to the ungrounded end of the 220K resistor as indicated in Fig. 14.

Now is the time to connect the receiver input and the transmitter output to the R-T switch through RG-59-U coaxial cable. Ground the outer sheath of each piece of cable firmly to the chassis at *both* ends of its run. The coaxial cable from the transmitter (center conductor) is tapped one turn from the grounded end of the final tank coil, L4, as shown in Fig. 13A. The receiver cable is run from the R-T switch to the input tie-point on the receiver sub-unit. Bring the cable up through a grommeted hole in the chassis. Next, run a piece of cable from the R-T switch to the antenna terminals on the terminal strip. Connect a short piece of wire—not over ½ in. long—from the center conductor of the coax cable (where it connects to the transmitter tank) to the tuning diode.

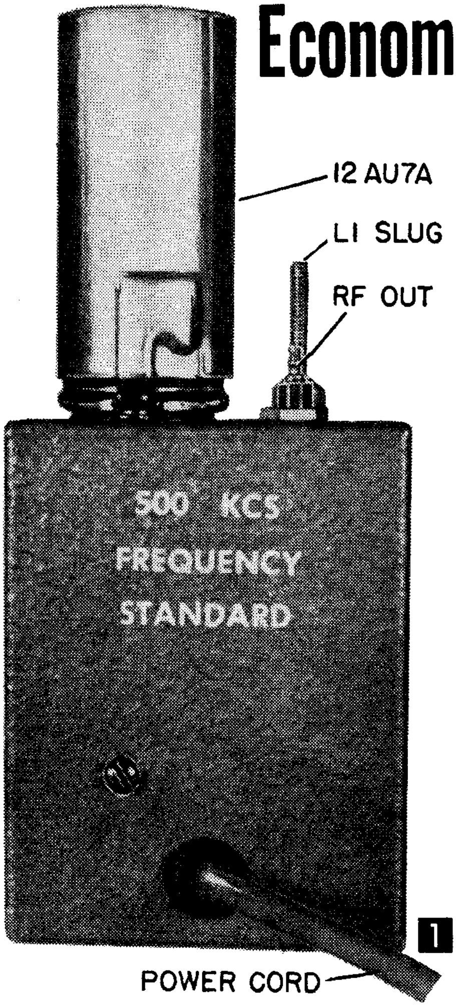
Finally, run the wire from the R-T switch to one side of the speaker, passing it thru a de-burred ⅛-in. hole in the chassis. Ground the other speaker voice-coil lug.

Connect the power cord, and microphone to the proper terminals on the terminal strip. Then connect a No. 48 pilot lamp bulb across the antenna terminals. Apply power and, when the tubes are warm, throw the R-T switch to Transmit. The bulb should glow brightly and the tuning-eye should move toward closed position. (If it opens, reverse the connections to the IN34.) Re-tune the final amplifier tank and buffer tank for maximum glow from the bulb. Note also that the eye closes most when the output is at a maximum. Speak into the mike and note the variation in bulb brilliance and eye closing as you speak, indicating proper modulation.

Now, remove the lamp bulb, and connect a 144-megacycle antenna system, preferably a good, high, beam antenna. Make sure the grounded terminal of the antenna feed coaxial cable is connected to the grounded terminal on the terminal strip. Throw the R-T switch to Receive and adjust regeneration for a smooth hiss. If there are any other two-meter amateur stations operating in your vicinity, you should hear them with no difficulty. Now throw the switch to Transmit position and adjust the final tank capacitor to close the eye as completely as possible. You're tuned-up and ready to go.

Novices learning the code, may wish to operate in the modulated code, MCW mode, which is legal in the 144-megacycle band. To use, throw the toggle switch into the open (MCW) position, and substitute a telegraph key, in series with a 220K resistor, for the microphone. Otherwise operation is identical to voice. The smooth, tone-modulated CW signal radiated can be read by other amateurs, regardless of the receiver employed.

Economy Frequency Standard



Here is a versatile frequency standard that the amateur, SWL, or experimenter can build in one evening for about five dollars

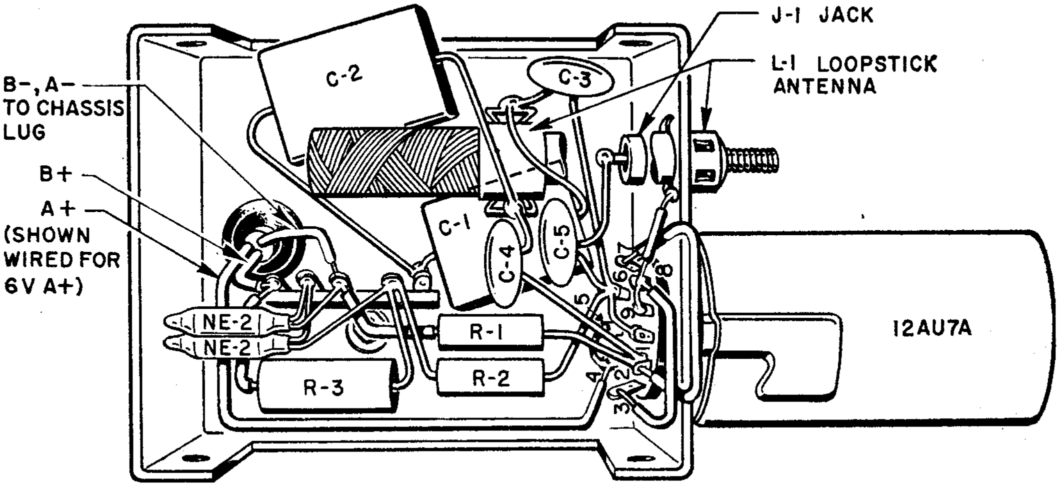
By JOE A. ROLF, K5JOK

THIS compact frequency standard will enable you to calibrate your receiver and check its accuracy at will. It can also be employed as a beat frequency oscillator for receiving CW signals, and for other applications requiring a stable 400 Kc to 1200 Kc RF generator.

The circuit shown in Fig. 3 is a high-C Colpitts oscillator using a parallel connected 12AU7A. Excellent frequency stability is achieved by the use of a high-Q loopstick as tank coil and a large value of tank capacity. Two NE-2 neon lamps regulate the oscillator plate voltage for added stability. With rigid construction and good shielding, the circuit has negligible drift after initial warm-up.

For maximum compactness, the unit is constructed in a 1⅝ x 2⅛ x 2¾ in. Minibox (CU-2100). Construction details are shown in Figs. 2 and 4. The 12AU7A is mounted outside the cabinet to avoid heating frequency-determining components. The output jack, J1, and tank coil, L1, are mounted beside the tube socket. Inductance L1 should be securely mounted and reinforced with a bead of Duco cement to insure against possible vi-

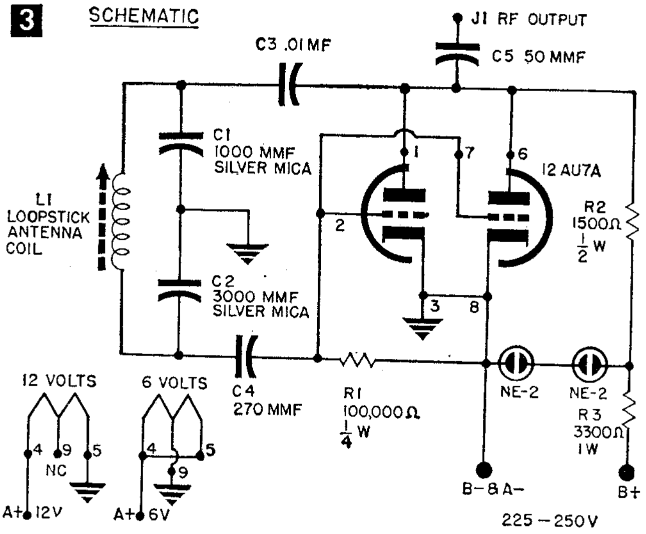
1 Frequency standard is powered from an external source. Designed primarily for 500 Kc, it can be tuned from 400 Kc to 1200 Kc.

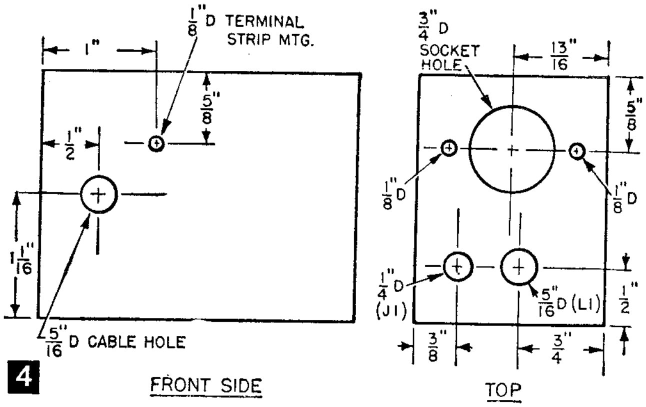


2 PICTORIAL

Components C3, C4, C5 and R1 are mounted to the tube socket beneath C1. Jack J1 is mounted behind L1.

3





4

MATERIALS LIST—FREQUENCY STANDARD

Desig.	Description
C1	1000 mmf silver mica capacitor
C2	3000 mmf silver mica capacitor
C3	.01 mfd disc ceramic
C4	270 mmf mica capacitor
C5	50 mmf mica or disc ceramic
J1	small feed-through insulator, coax jack, or phone tip jack
L1	ferri-loopstick antenna coil
NE-2	NE-2 neon lamp (two required)
R1	100,000 ohm, 1/4 watt resistor
R2	1,500 ohm, 1/2 watt
R3	3,300 ohm, 1 watt
1	Cu-2100 Minibox
1	12AU7A tube
1	3-conductor cable, length as desired
1	5-lug terminal strip
1	9-pin miniature tube socket
3	1/8 x 1/4" machine screws and nuts
1	5/16" rubber grommet
	tube shield, decals, etc.

bration. Jack J1 may be a small feed-through insulator, miniature coax jack, or phone tip jack. Power is furnished by an external source and brought into the cabinet by a three-conductor cable.

It is important, from the standpoint of stability, that wiring be as rigid as possible. Connections between socket pins 2 and 7, and pins 1 and 6, should be made with heavy solid copper wire. Pins 3, 8, and 9 are grounded at the tube socket; other leads should be kept short and rigid to avoid vibration. Keep components away from L1 as much as possible and use quality silver mica capacitors for C1 and C2.

The oscillator is designed to operate with plate voltages from 225 to 250 v at about 15 ma. In most cases these voltages are available from the receiver with which this frequency standard will be used. Less than 225 v can be used if R3 is replaced with a 500 ohm, 1 watt resistor. Filament connections for either 6 or 12 v are shown in Fig. 3. The oscillator is turned on and off by a SPST switch in the external B-plus lead. If desired, this switch can be included in the Minibox.

Adjustment of the slug on L1 permits the unit to be set at any frequency from about 400 Kc to 1200 Kc. This permits a number of applications, the most obvious, of course, as a 500 Kc or 1000 Kc frequency standard. When tuned to 500 Kc, useful harmonics will appear at 500 Kc. intervals up to about 15 Mc. Above 15 Mc, 500 Kc harmonics rapidly become too weak for easy receiver calibration and it is necessary to shift the standard's setting to 1000 Kc to get harmonics of useful amplitude above 35 Mc. The unit can be accurately adjusted to either frequency by zero beating WWV at 2.5 Mc, 5 Mc or 10 Mc.

As a frequency standard, the unit is small enough to fit inside most receiver cabinets. In most cases, a short length of insulated wire connected to J1 and brought near the receiver input circuit will provide sufficient coupling.

However, you may find that with some receivers or with less than 225-v plate voltage, it may be necessary to connect the standard directly to the receiver antenna terminal with a 5-30 mmf mica capacitor.

Another useful application, for the SWL or amateur, is as a BFO (beat frequency oscillator) for 455-Kc IF receivers. The standard can be tuned to the IF frequency and connected to the grid or plate lead of the receiver's last IF stage with a 2 to 5 mmf capacitor for CW reception employing an all-wave set or an automobile receiver.

Note that Fig. 2 is shown wired for a 6-v filament supply, pin 9 of the 12AU7A grounded, pins 4 and 5 tied together. If you are using a 12-v filament supply, pin 9 will have no connection, pin 5 is grounded, and pin 4 is wired to the 12 volts (see Fig. 3).

1

Two-Tube Long Wave Receiver

This compact ac-dc receiver features good sensitivity, better than average selectivity, and simplified construction. It has an adjustable tuning range of 85 to 550 kc. and is easily modified for broadcast-band reception

By JOE A. ROLF, K5JOK

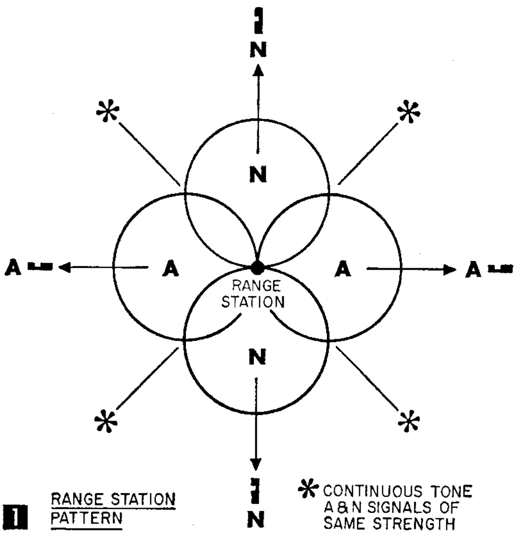
THE circuit of this economical receiver (see Fig. 4) employs two miniature high-gain TV tubes. The 6AN8 is a regenerative detector; the pentode section of the 6AU8 is an audio amplifier. The triode of the 6AU8 serves as an ac-dc type rectifier.

The heart of the circuit is the detector, a regenerative cathode-follower type commonly known as the "Regenode." If you're not familiar with this hybrid circuit, here's how it works: The pentode section of the 6AN8 is a conventional grid-leak detector, with the exception of the signal grid which is separated from the tuned antenna circuit by the cathode-follower connected triode section of the tube. This arrangement permits a degree of selectivity not possible with the detector grid connected directly to the antenna circuit, since the signal-grid loads the tuned circuit and reduces its Q, or selectivity ability. The cathode-follower isolates the detector from its input circuit and allows a great improvement in selectivity. The circuit operates smoothly, is easily adjusted, and eliminates hand-capacity effects common to most regenerators. These advantages are particularly desirable in a LW receiver.

Since hand capacity does not affect operation, an all-wood chassis constructed with simple hand tools can be used. Chassis details are shown in Fig. 5. Large holes (for tube sockets and controls) can be made with a coping saw; fastener holes can be made with a hot ice-pick in the absence of a drill. A

What to Listen To on LW

The long waves provide up-to-the-minute reports on weather and flying conditions, code practice and some good DX



1 RANGE STATION PATTERN

YOU'LL be pleasantly surprised at the number of interesting signals to be heard below the standard broadcast band, though at first they may sound like nothing but jumbled dots and dashes intermixed with weird howls and squeals. Careful listening, however, will reveal this apparent bedlam to be important communication services which make unusual listening and challenging DX.

The main divisions of the 10 Kc. to 535 Kc. band are shown in Table A. It is occupied mainly by aeronautical and marine services, although 150-535 Kc. is part of the standard BC band in Europe and Asia. However, without discounting the possibility of logging some of these BC stations, the marine and aeronautical stations are of prime interest to most LW listeners.

The most popular are the navigational aids, or radiobeacons, heard between 200 Kc. and 405 Kc. Some are marine beacons, others aeronautical. Both employ very slow amplitude modulated code and are easily distinguished from one another by their signals.

Marine beacons usually transmit their call signs continuously in an omni-directional pattern. In some cases the call, consisting of from two to four letters or numerals, is separated by a number of dashes. Many marine beacons can be heard constantly over a considerable range, while the less powerful can be logged at great distances under favorable conditions.

Aeronautical range stations transmit a combination A-N signal in a four-leaf pattern like that of Fig. 1. They identify themselves every thirty seconds and employ two pairs of antennas to obtain the four-leaf radiation pattern. The transmitter is operated continuously and is alternately switched between the two antenna systems so that an *A* (dit dah) is radiated in the directions marked *A* in Fig. 2, and an *N* (dah dit) in the directions marked *N*. Midway between the A and N patterns, the signals merge as a steady tone which aircraft follow to or from the station. If the pilot leaves this course, he will hear either the *A* or the *N*.

These radiobeacons offer an unlimited

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metal chassis will afford more compact construction, but a wooden panel and cabinet should be used to avoid accidental grounding of the chassis.

Construction is not critical and will pose no difficulty if the general layout shown in Figs. 2, 3, and 5 is followed. Keep RF and AF leads separated and away from ac leads. This is best accomplished by wiring the filaments and power supply first, then the AF and detector stages.

Ground connections are made to solder lugs mounted to the socket and tuning capacitor fasteners. Components R4, R6, R9 and R10 mount on a 7-lug terminal strip at the rear underside of the chassis (see Figs. 3 and 4). The filter capacitor, C11, can be wedged between the 6AU8 socket and chassis leg, or secured with a mounting clip. Two sections of this capacitor are used in the power supply filter, the third is used as a cathode bypass for the audio stage.

Other components under the chassis, except R3, C7 and C9, mount to respective tube sockets. Capacitor C9 is connected from J2 to the grounded terminal on R5. Resistors R3 and C7 connect to a machine screw and solder lug placed between L1 and C2. One lead of L2 connects to a solder lug on the same screw on the chassis top.

The antenna trimmer, C1, is secured by the antenna terminal mounting screw as shown in Fig. 3. This component requires only infrequent adjustment, but it can be mounted on the front panel for easier access, if desired.

Inductance L1, a standard TV replacement coil, is mounted last. Before inserting the core, as explained in the manufacturer's instruction leaflet, thread on the 5/16-in. mounting clip and remove ½ in. from the slotted

TABLE A—LONG WAVE ALLOCATIONS

Frequency (Kc.)	Communications Service	Sunset Skip	Night DX
10–14	Radionavigation	none	4 am to 7 am
14–200	Fixed Public Services and Coastal-Marine CW		
200–283	Aeronautical Beacons and Communications		
285–325	Marine Radiobeacons		
325–405	Aeronautical Beacons and Communications	10 pm to 2 am	
405–415	Radio Direction Finding		
415–490	Coastal and Marine CW		
500	International Calling and Distress Frequency	2–4 hours after sunset	11 pm to 7 am
510–535	Misc. Radiobeacons		

Note: Frequencies between 150 Kc. and 535 Kc. also used by foreign BC stations.

TABLE B—STATION LISTS

The Airman's Guide	Superintendent of Documents, Washington 25, D. C. 25¢ per copy. A bi-weekly publication listing all U. S. aeronautical radio beacons.
Location Identifiers	Superintendent of Documents, Washington 25, D. C. $1.50 for copy and one-year supplement service. General listing of all domestic beacons.
Broadcasting Stations of The World, Part II, According to Frequency	Superintendent of Documents, Washington 25, D.C. $2.00. Includes European LW broadcasting stations.
Air Navigation Radio Aids	Department of Transport, Air Service Branch, Ottawa, Ontario, Canada. Complete list of Canadian Radio Beacons, published every two months.
Radio Facility Charts —Caribbean & South America	ACIC, USAF, 2nd & Arsenal Streets, St. Louis 18, Mo. One year subscription $3.50. Listing of Caribbean & South American beacons.
Radio Navigational Aids	Hydrographic Office, U. S. Navy. An annual publication listing worldwide marine beacons.
List of Coast Stations (4.10 Swiss francs) List of Ship Stations (12.80 Swiss francs) List of Call Signs (21 Swiss francs)	Secretary General, International Telecommunications Union, Geneva, Switzerland. Very complete listings of worldwide stations.

source of unusual DX. At first sight, these stations seem to offer poor DX since most are relatively low powered and have a daytime range of less than 200 miles. However, their range is greatly increased at night—best times for night DX are given in Fig. 1. These hours will vary somewhat with the seasons, with the choicest DX being heard from early fall to late spring.

Above 325 Kc. sunset skip is often heard for a half-hour during early darkness. Notable examples are PJG, 343 Kc. in the Netherlands Antilles; ASN, 350 Kc. on Ascension Island; and SWA, 406 Kc. from Swan Island.

Since beacons identify continuously or every thirty seconds, less than a minute is required to log a station. However, in order to determine the locations of the stations you hear, you need a reference log listing the stations you are interested in. Such listings can be purchased (see Table B).

Range stations also transmit verbal weather reports for air fields in their area 15 minutes before and 15 minutes after the hour.

In addition to radiobeacons, many CW stations operate on long waves for maritime, aeronautical, and public service communication. For the CW enthusiast, these are interesting to copy and the slower stations, sometimes sending as slow as eight words a minuite, provide plenty of code practice. Many good DX signals can be heard between 415 Kc. and 500 Kc., particularly on the 500 Kc. international calling and distress frequency. The frequencies below 200 Kc. are also widely used by public service and maritime CW stations.

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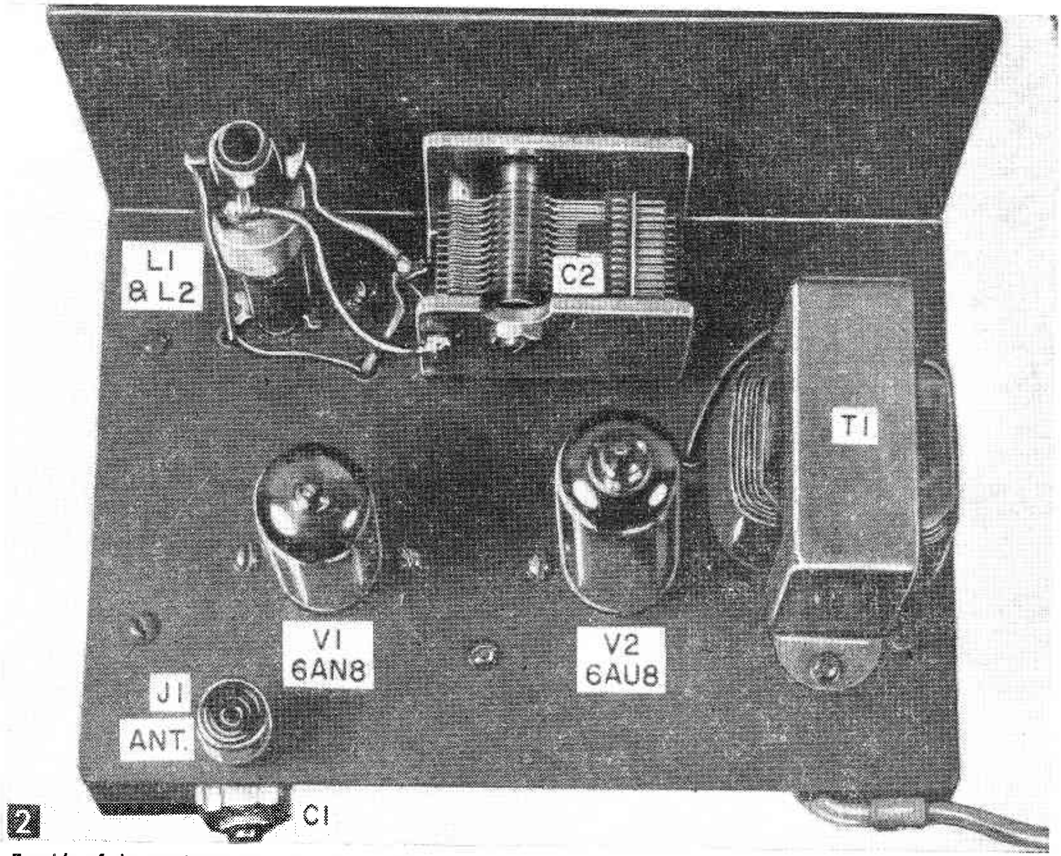
end of the core adjustment screw, otherwise it will protrude below the chassis when the coil is mounted. Clamp the section to be removed in a vise and cut it off with a hacksaw, then cut a new screwdriver slot. Take care not to break or fracture the fragile ferrite coil.

Inductance L2 consists of 35 turns of #26 (or smaller) enameled wire scramble-wound over a 9/16 in. ID tube which slides freely over L1. If not available, this form can be made by winding four or five layers of moist gummed tape, sticky side out, over L1. When dry, slip the tube off and trim to proper length with a razor blade. With L2 in place, secure L1 to the chassis with a bead of Duco cement.

For maximum sensitivity, the position of L2 on L1 should be adjusted for the individual receiver. This simple adjustment is well worth the effort and can be made with a long antenna, 455 Kc signal generator, or a BCB receiver with a 455 Kc intermediate frequency. If possible, use a signal generator or BCB receiver, since this will permit adjustment of L2 and the core of L1 at the same time.

Short out L2 temporarily by connecting a short piece of wire from the R3-C7 solder lug to pin No. 7 of the 6AN8 socket. Turn the core adjustment screw full counterclockwise and connect the antenna, signal generator, or BCB receiver to the antenna terminal.

If a BCB set is used, tune to a strong BCB station and turn the set's volume down. Connect a short piece of insulated wire to your LW receiver antenna terminal and place it near the underside of the BCB set's IF tube socket or IF transformer to hear the 455 Kc IF signal of the BCB receiver.

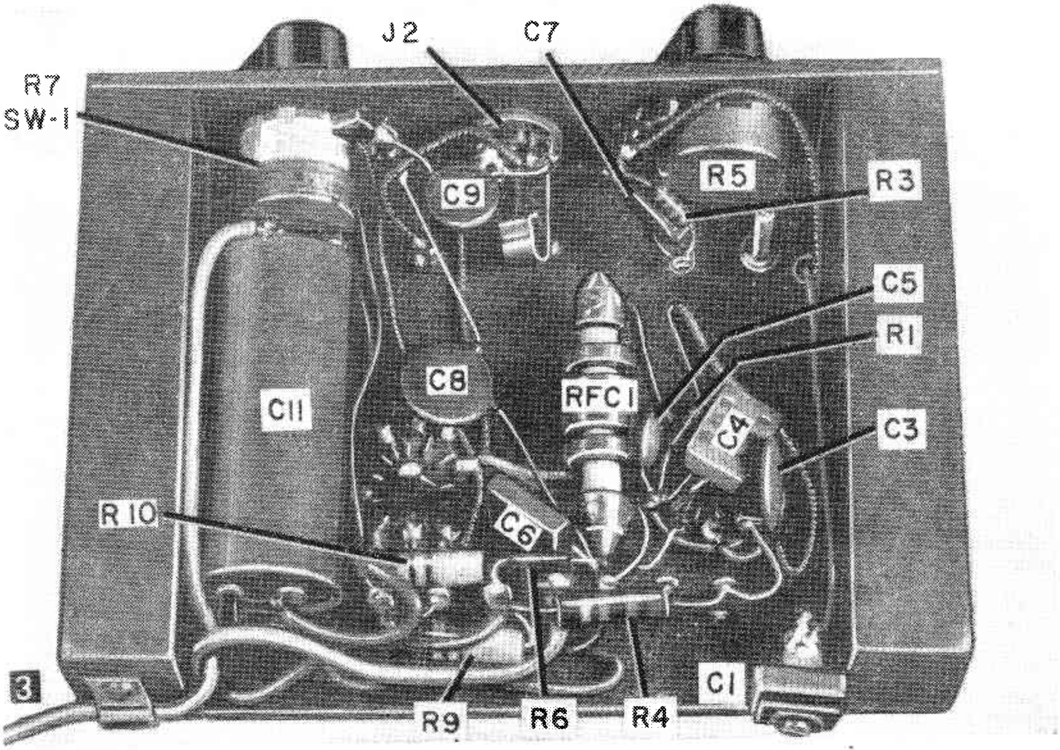


Topside of the receiver's Masonite chassis. The antenna coil, L1, is mounted so that its slug is adjusted from below the chassis.

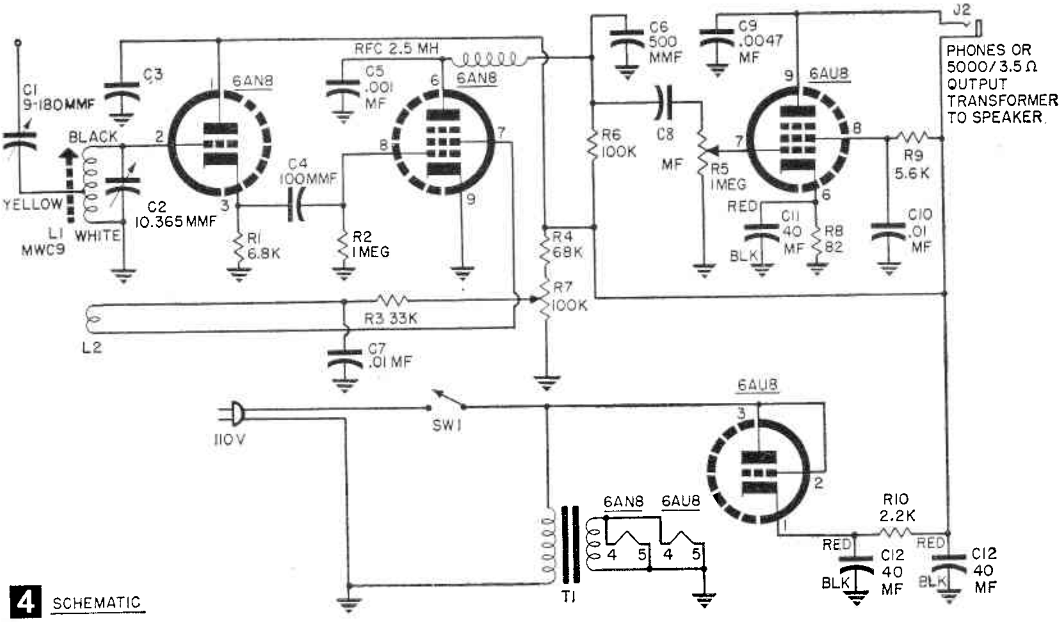
MATERIALS LIST—LONG WAVE RECEIVER

Desig.	Description
C1	9 to 180 mmf trimmer capacitor
C2	10 to 365 mmf variable capacitor, standard single-gang TRF type
C3	.01 mfd disc ceramic
C4	100 mmf mica
C5	.001 mmf disc ceramic
C6	500 mmf mica
C7	.01 mfd disc ceramic
C8	.01 mfd disc ceramic
C9	.0047 mfd disc ceramic
C10	.01 mfd disc ceramic
C11	40-40-40 mfd, 150 wv capacitor, 3-section electrolytic filter capacitor (Cornell-Dubilier BBRT 44415, or equivalent)
R1	6.8 K, ½ watt resistor
R2	1 meg, ½ watt
R3	33 K, ¼ watt
R4	68 K, 1 watt
R5	1 meg, ¼ watt volume control with SPST switch (Mallory U-53 Midgetrol with US-26 switch, or equivalent)
R6	100 K, ½ watt
R7	100 K, ¼ watt, volume control (Mallory U-41 Midgetrol, or equivalent)
R8	82 ohm, ½ watt
R9	5.6 K, 1 watt
R10	2.2 K, 1 watt
J1	antenna terminal post, or Fahnestock clip
J2	standard phone jack
L1	*Long Wave:* Merit MWG-9 Width or Linearity coil, .3 to 12 ma., tapped (see text) *Broadcast:* Ferri-loopstick BCB antenna coil (see text)
L2	*Long Wave:* 35 turns #26, or smaller, enameled wire scramble wound on $\frac{9}{16}$″ ID x ⅜″ form (see text) *Broadcast:* 3 turns #26, or smaller, enameled wire on adjustable form (see text)
RFC1	2.5 mh. RF choke (National R-100, or equivalent)
SW1	on R7
T1	filament transformer, 6.3 vct, 1.2 amp (Stancor P-6134 or equivalent)
T2	optional—for speaker use only; 5000/3.2 ohm, 3 watt, 40 ma, output transformer. (Merit A-3026, or equivalent)
V1	6AN8
V2	6AU8
1 pc	⅛ x 4½ x 6″ Masonite (panel)
1 pc	⅛ x 4 x 6″ Masonite (chassis top)
2 pcs	pine strip, ¾ x 1⅛ x 4″ (chassis sides)
	two miniature 9-pin tube sockets
	one 7-lug terminal strip
	hardware, power cord, dial, knobs, etc.

With the volume control at maximum and the regeneration control set at half-scale, place the tuning capacitor about 85% open and turn L1's core clockwise until the 455 Kc signal is heard. Adjust the regeneration control for maximum volume and mark its position. This is the detector's most sensitive point and will determine the position of L2. Remove the jumper across L2 and slide the coil up or down over L1 until regeneration (signal distortion) occurs just above the point previously marked on the regeneration control. If the detector fails to regenerate, reverse the leads on L2.



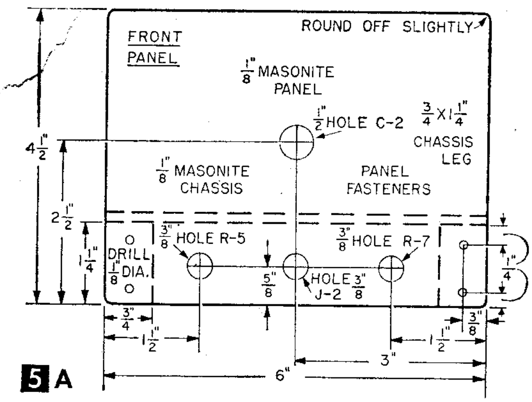
3 Under-chassis view, showing placement of components.



4 SCHEMATIC

This receiver's tuning range, from 85 to 550 Kc, is covered in two adjustments of the core on L1. When set to receive 550 Kc at C2's minimum capacity, the receiver will tune down to about 200 Kc. The range from 85 to 200 Kc is tuned when the slug is almost fully inserted into L1. Overlap on both bands will permit easy bandchanging once the operator is familiar with the stations heard around 200 Kc. On the lower band, L2 may require slight readjustment for best reception of weak signals.

For BCB reception, a ferri-loopstick is used for L1. Inductance L2 consists of three turns



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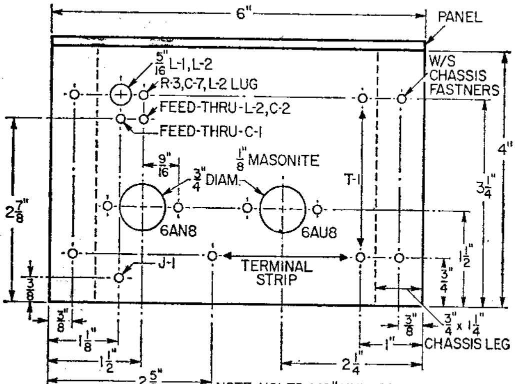
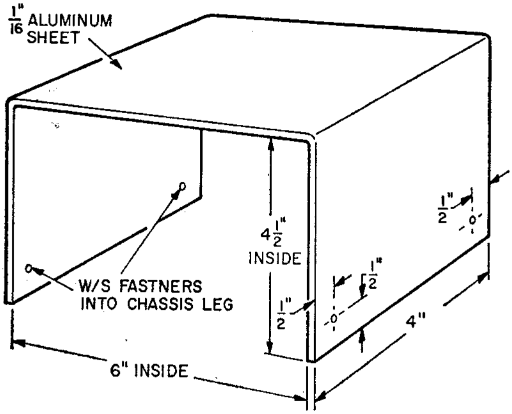


B CHASSIS DETAILS NOTE: HOLES 1/8" UNLESS SPECIFIED C-2 MOUNTING HOLES NOT SHOWN, DRILL TO SIZE

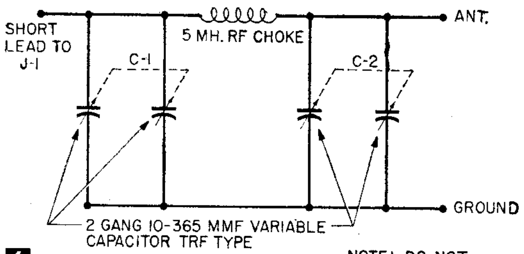


C OPTIONAL CHASSIS COVER

and adjustment is similar to that of LW operation. The lead from C1 should be connected to the grid end of the loopstick.

A high, long-wire antenna will give best all-'round LW reception, though a short length of wire will give satisfactory local reception. Capacitor C1 should be adjusted for best reception on each band and the receiver should not be grounded.

In some localities, interference from strong BCB stations may be bothersome, a trouble commonly encountered with LW receivers having only a single tuned circuit. Such interference can be minimized by reducing the antenna coupling or, in severe cases, by the use of the simple Pi antenna tuner (shown in Fig. 6). The tuner can be built on a small pine block. Adjust C1 and C2 for minimum BCB interference.

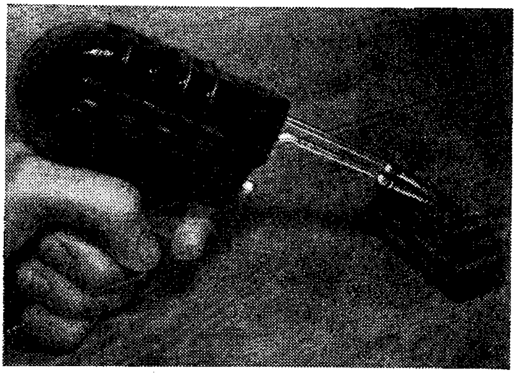


6 PI ANTENNA TUNER

Four or five feet of hookup wire is sufficient antenna for BCB reception. The receiver will give good loudspeaker volume on the BC band and on the stronger LW stations. Due to the low power used by most LW stations, however, headphones are recommended for serious LW listening. For speaker operation plug a 5000-3.5 ohm, 3-watt, output transformer into J2.

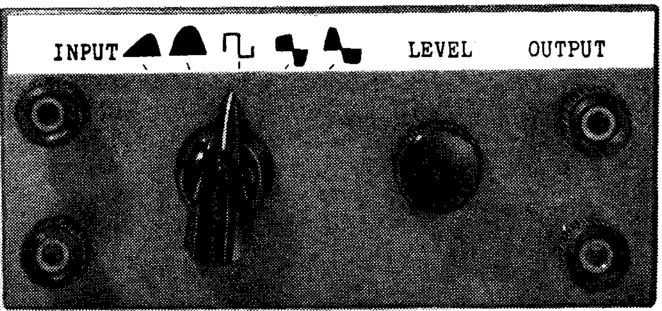
Inverted Brush Cleans Gun's Tip

- To keep the tip of your soldering gun clean of scale, woodscrew-fasten a brass-bristle suede shoe brush to one end of your workbench. Wipe the soldering-gun tip across the brush occasionally to keep it clean for efficient soldering.—J.A.C.



Why Inside Gun-Tip Care?

- To receive maximum soldering efficiency and long-tip life, be sure that cleaning and tinning operations of your soldering gun's tip also include the *inside* surfaces of the tip. A gun's tip that is maintained on the outside, but allowed to deteriorate on the inside, is sure to give lowered soldering efficiency and it will shorten tip life.



This small grey box performs the electronic hocus-pocus that will convert sine waves into varied waveforms.

WAVEFORMER

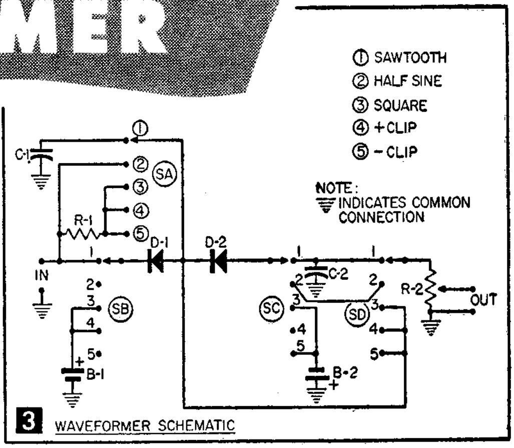
This inexpensive instrument converts 60-cycle ac or audio generator sine waves to sawtooth, half-sine, clipped half-sine, and square waves

By FRANK WOODS, Jr.

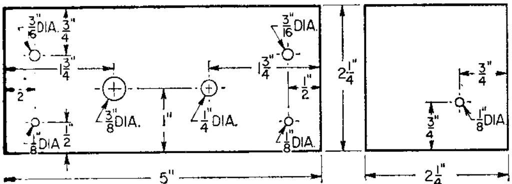
This waveformer is inexpensive (cost: less than $5) and simple to construct. The waveforms generated by it can be used to drive sweep circuits, test amplifiers, check amplifier response, synchronize other equipment, and a host of other test and experimental jobs.

A sine wave is applied to the input terminals, and the switch next to the input terminals is set for the desired waveform; the level control is set for the desired output level. The desired voltage waveform will then be present at the output terminals on the right of the case. It's almost that simple.

Construction. Lay out the front half of the metal case as shown in Fig. 2. All components mount on this half of the case; the back is merely a cover. Mark hole starter marks on the case with an ice pick. Then, with the front and back of the case fastened together, drill ⅛-in. holes for all positions. Separate the front and back of the case and enlarge the specified larger holes to the required dia. with a taper reamer. File the edges to remove burrs.



3 WAVEFORMER SCHEMATIC

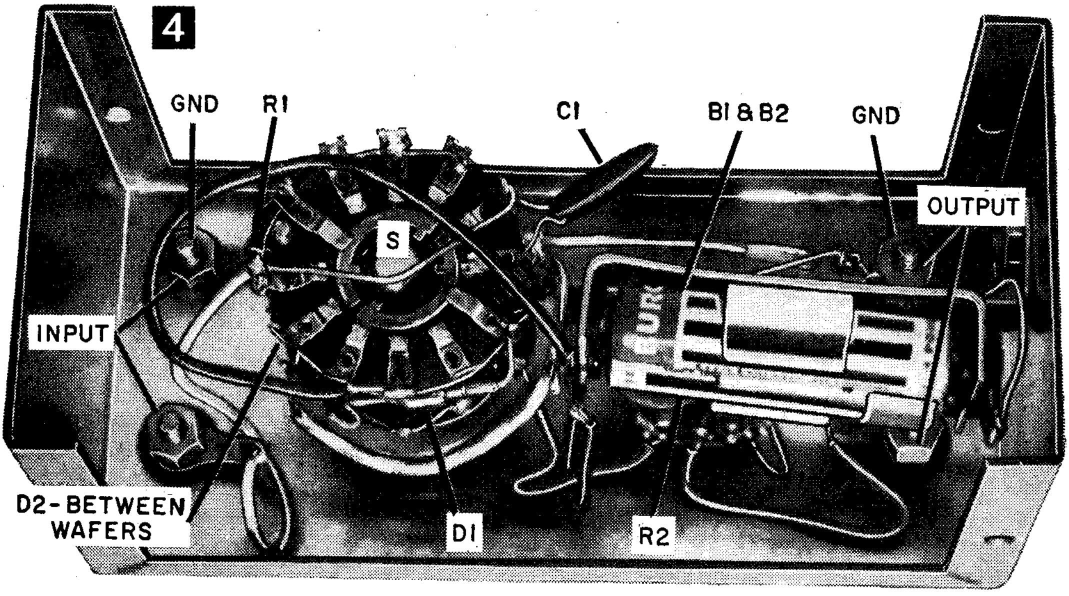


2 PANEL LAYOUT

Saw the shaft of the switch to a length of ½ in. Saw the level control shaft to a length of ⅜ in. To avoid damaging switch and level controls, grip shafts in a vise when sawing. This prevents side pressure on bushings. Catch the switch or control when it is cut free from the shaft. The switch is ruggedly constructed, but it is subject to easy damage since its wafers are brittle.

Mount the input and output terminal binding posts. The bottom-chassis terminals are the common terminals; they make electrical contact to the metal case. The top-chassis terminals are insulated from ground by fiber washers between the binding post and the front of the case and between the retaining nut and the rear of the case, and by centering the binding posts. Note that the holes for the top binding posts are larger than those for the bottom. In the original model soldering lugs were used to permit soldering of binding post leads. A second nut on each binding post holds the soldering lug in place. But, the

4



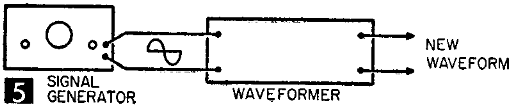
Component layout of Waveformer.

MATERIALS LIST—WAVEFORMER

Desig.	Description
R1	100K, ½ W carbon resistor 10% tolerance
R2	500K potentiometer (Lafayette VC-37)
C1, C2,	.1 mfd, 50 v ceramic capacitor (Sprague TG-P10)
S (A, B, C, D)	4-pole, 5-position switch (Centralab PA-1013)
D1, D2	1N54A diode (RCA)
B1, B2	penlite cell (Burgess #7)
	2-penlite cell holder (Lafayette MS-138)
	pointer knob (comes with switch)
	miniature knob (MS-185)
	binding posts (H. H. Smith 220R-red and 220B-black)
	2¼x2¼x5" metal box (Bud CU-2104)

soldering lugs are unnecessary since the connecting wires may be fastened between the two nuts.

Mount the switch and the level control on the case. Use retaining hex nuts on these controls behind the panel. Adjust to allow only enough of the control to protrude through the case to enable the hex nuts to be fastened on the front of the panel. Retaining washers between the rear retaining nuts and the rear of the panel will prevent the controls from slipping. At this point in the construction the components which fasten to the case are mounted—except for the battery holder.



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When wiring, make connections to the switch so that they can readily be disconnected without damage. This approach will save you grief if you make a mistake in your wiring. Be very careful not to exert undue pressure on the switch terminals or you may twist them out of place or break a wafer. Limit the length of time that you apply heat during soldering. The diodes in particular are susceptible to heat damage. Use a clean soldering iron capable of supplying a large amount of heat. A lot of heat applied for a short time will do a better soldering job with less chance of damage than a reduced amount of heat applied for a long time. Use *rosin core* solder only!

Figure 3, the circuit diagram, and Figure 4, a pictorial view, are used as a guide for wiring. Wire the switch first. Note that its sections are designated SA, SB, SC, and SD. Section SA is the lower half of the rear wafer; SB is the upper half of the rear wafer; SC is the lower half of the front (nearest the front panel) wafer; SD is the upper half of the front wafer. Connect the wires between terminals as shown and wire in components R1, D1, and D2.

Next, connect capacitors C1 and C2. Then connect the wires which run from the switch and capacitors to the terminals, level control and battery holder.

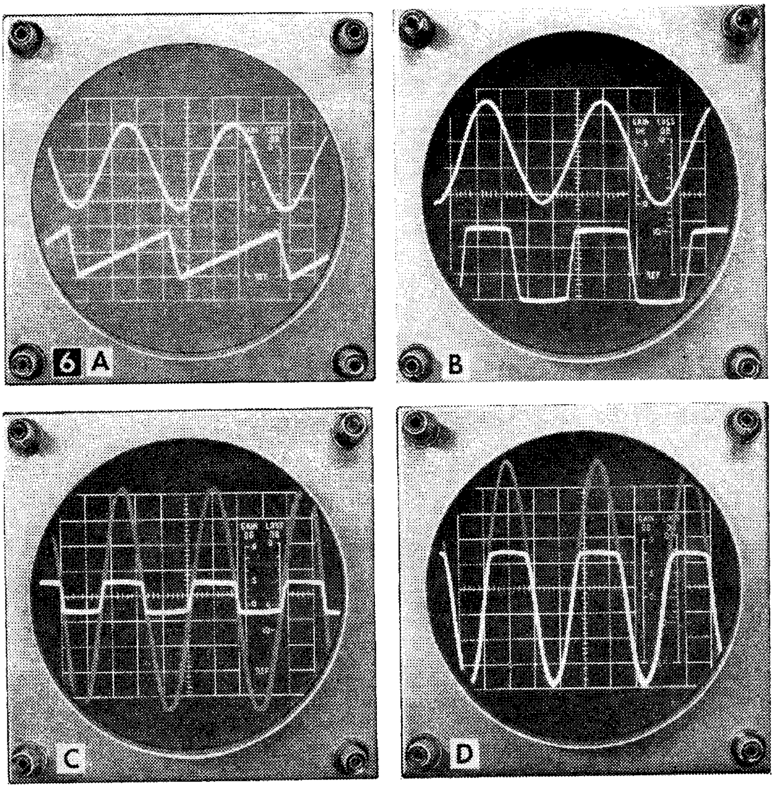
Now mount the battery holder and make connections to it. The battery holder is mounted with a small hardware bracket ⅜-in. wide with 1-in. and ⅝-in. sides. Solder-fill the battery holder eyelets which form the battery contacts to insure good connection to the batteries. Insert the batteries and fasten the knobs on the switch and level control. Fasten the back to the case. The markings for the front panel are made on a strip of paper ⅜ x 5 in.

Free-hand the waveform symbols which identify switch positions and fasten the strip to the front of the case with a 6-in. strip of cellophane tape. You may have to realign the switch knob to match the waveform markings.

Operation. To use the waveformer connect a source of sine wave signals to the input terminals as shown in Fig. 5.

The signal generator may be a 6.3-v filament transformer (supplies 60 cycles only) or an audio signal generator such as the Heathkit AG-9 (frequency 10 cycles upward).

The Waveformer operates through a broad range of frequencies; principal limitations of frequency are imposed by the signal generator for most waveforms. A signal input level of 5 to 15 v is desirable to achieve the best waveforms.



Simultaneous viewing of input to, and output of Waveformer. Explanation is given in text.

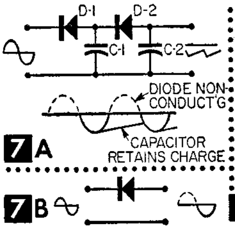
Clean saw-tooth waveforms from about 10 cycles to about 10,000 cycles at .3 v will be produced by a 10-v sine wave. Clean clipped waves from 1.5 to several volts, with a frequency range from 20 cycles to over 20,000 cycles, can be expected.

Science Fair Demonstration. To demonstrate the performance of the Waveformer, a Heathkit AG-9 Audio Generator fed a sine wave to the Waveformer and to a Heathkit S-3 Electronic Switch. The output of the Waveformer was fed to the other set of Electronic Switch input terminals. The output of the Electronic Switch was connected to the vertical input of the oscilloscope. This arrangement permitted simultaneous viewing of the Waveformer input and output waveforms.

Figure 6A shows the waveform output with the Waveformer switch set for saw-tooth output. Figure 6B shows the output with the Waveformer switch set for square wave. In Fig. 6C the input and output waveforms are superimposed with gains adjusted to show how the Waveformer clips the sine wave. The "squareness" of the output waveform will depend on the magnitude of the input sine wave signals. With larger sine wave input signals, the clipping action produces "squarer" waves. Figure 6D shows the superimposed waveforms with the Waveformer switch set to one of the half-clip positions.

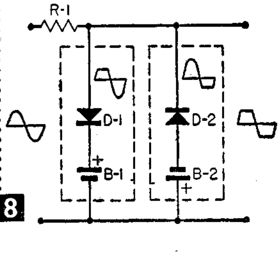
Principles of Operation. When the Waveformer switch is set to the sawtooth-wave position, the basic waveforming circuit connections are those shown in Fig. 7A. First consider only D1 and C1. Diode D1 passes only the negative portion of the sine wave. As the sine wave goes negative, capacitor C1 charges rapidly in the negative direction. This produces the steep portion of the curve. As the input signal falls from the negative peak to the zero line, the charge on C1 prevents further passage of current through D1 and capacitor C1 tends to discharge slowly through any load resistance connected across it. The use of D2 and C2 in the circuit improves the performance by providing additional storage and switch action.

When the switch is in the half-wave position the waveforming circuit reduces to that shown in Fig. 7B with diode D2 only in the



7A

7B



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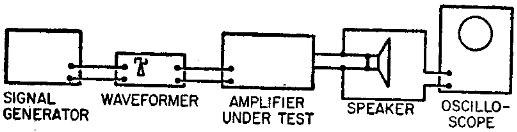


9 SET-UP FOR SQUARE WAVE AMPLIFIER TESTING

circuit. It passes only the negative half cycles.

With the switch in the square-wave position, the basic waveforming circuit is that shown in Fig. 8. As the input voltage builds up from zero, current flows through R1 to the output. But when the voltage becomes sufficiently high (greater than 1.5 v) to cause diode D1 to conduct, the current is shorted and the straight top of the wave results. As the voltage decreases toward the zero line, diode D1 ceases to conduct when the voltage to the anode becomes 1.5 v, and the return to zero portion of the waveform results. Diode D2 and bias battery B2 operate on the negative half cycle in the same way. Only R1, D1, and B1 or R1, D2 and B2 are connected in the circuit to produce the half-clipped sine waves.

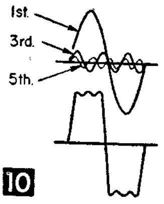
The level control R2 is a potentiometer which permits the setting of a desired output signal level. It is common to all switch positions.

The Waveformer is useful as a teaching tool to explain the operation of diodes, capacitors and pulse circuits, but it has more immediate practical applications. The sawtooth waveform may be used to provide sweep voltage for an oscilloscope. Some of the older inexpensive 'scopes employ sweep circuits that are extremely non-linear and tend to bunch a sine wave applied to the vertical input. If the sawtooth wave of the Waveformer is applied to the horizontal amplifier input of the oscilloscope, the linearity will be improved—if the amplifier has sufficient gain and frequency response.

The half-wave waveform may be used to drive a relay or any other dc device at a specified frequency. Of course, the device to be driven must be of sufficiently low power to allow operation with the signal generator used and the diode in the waveformer. The driven device cannot be operated at frequencies above those to which it can normally respond. The half-clipped sine waves may be used in similar fashion where an opposite "off bias" is desired.

Square-Wave Amplifier Testing. Clipped sine waves may be used to test audio amplifier frequency response. The square wave is applied to the input terminals of the amplifier and the waveform is observed on an oscilloscope connected across the output terminals of the amplifier (see Fig. 9).

A square wave contains a fundamental frequency sine wave and a large number of higher sine wave components. Figure 10 shows the fundamental frequency, the third harmonic, and the fifth harmonic, and how they combine to produce a waveform approaching a square wave. As more odd harmonics of proper phase and amplitude are added, the resulting waveform more nearly approaches a square wave.



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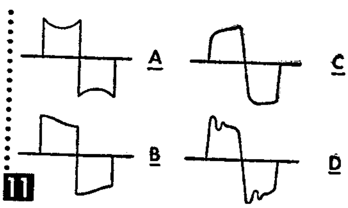

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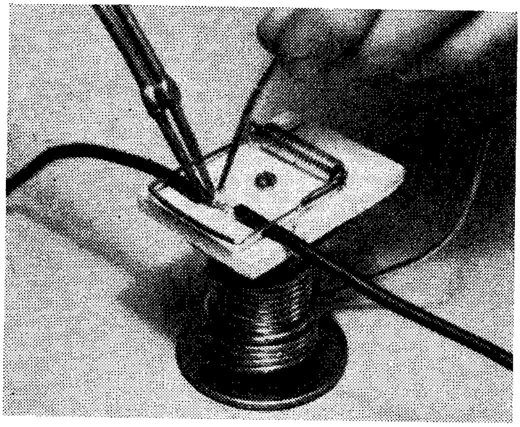
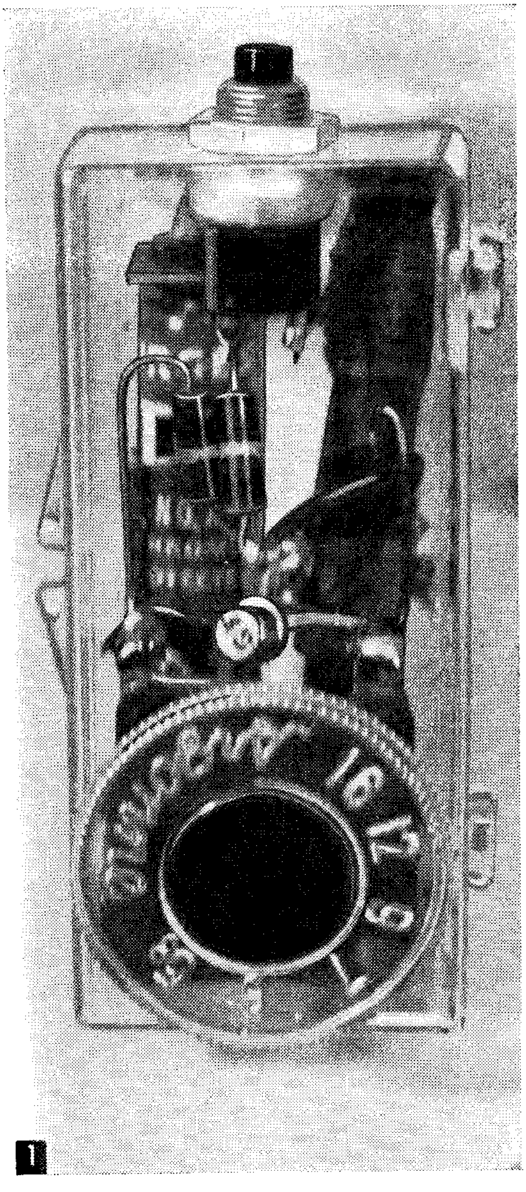
Now, if a square wave is passed through an amplifier, amplifier defects will distort the waveform. Discrimination against frequency, and phase shift dependent on frequency (poor frequency response) will produce distinct distortions. If the response of the amplifier is poor at the fundamental frequency, the scope connected at the amplifier output will display a square wave with drooping midsections as shown in Fig. 11A. Phase shift is indicated by a waveform such as that shown in Fig. 11B. Attenuation and phase shift at high frequencies is indicated by an output waveform like that in Fig. 11C. Overshoot and ripples in the displayed waveform, as shown in Fig. 11D, are also indicative of high-frequency distortion. A pronounced high-frequency resonance in the amplifier under test will cause the overshoot to be further accented.

Mousetrap Third Hand



• Need an additional hand to hold small wires and parts while you solder them? To make certain an extra hand is always available when needed, mount the spring mechanism of a mousetrap on the top of your spool of solder as shown. Screw-fasten the mechanism to a tight-fitting cork inserted into the center of the spool.—John A. Comstock.



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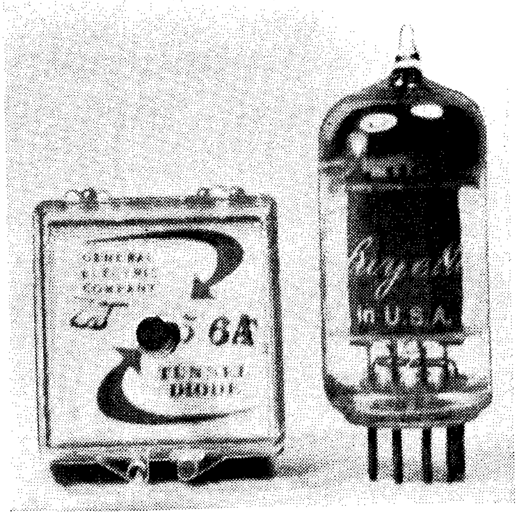


Tunnel Diode Broadcast Oscillator

The tunnel diode—newest member in the fast-growing family of semi-conductors—is giving its first cousin, the transistor, an inferiority complex. Here's a project which helps to explain why

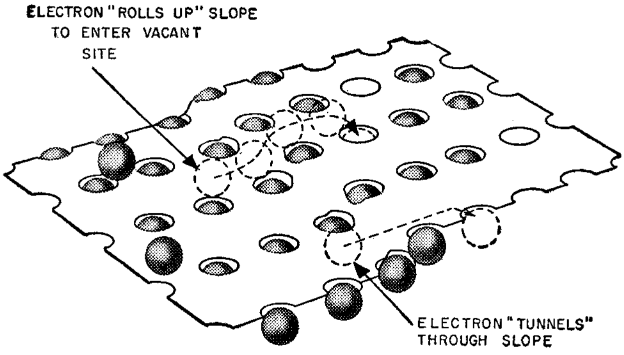
A simple demonstration construction project, this oscillator employs a tunnel diode which, even in its case (above right), is dwarfed by a vacuum tube.

THIS oscillator is one of the earliest tunnel diode construction projects designed for experimenters. It is an effective demonstration device, and it will attract attention by virtue of its simplicity and the fact that the tunnel diode is a novelty. For the builder, it is a painless introduction to the operation and use of the tunnel diode.

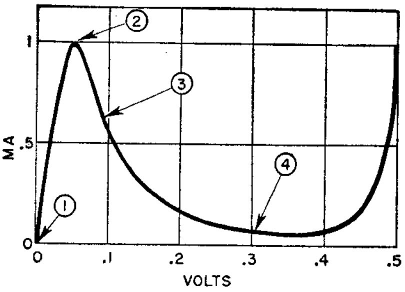
In July 1959 the General Electric Research Laboratory announced progress in the development of tunnel diodes, and offered them in limited quantities at $75 per unit for laboratory use. Prices have been decreasing—thank goodness!—since that time and at the time this article goes to the printer are below $10. Obtain one now, and get in on the ground floor of an exciting new electronic device. Within a year or two tunnel diode prices should have dropped to a dollar or two a unit, and you will have sufficient knowledge to build the many circuits that are possible with this device. The tunnel diode will be the subject of many science fair and engineering day displays, and it will soon be a common component in TV, communications, computer, and other electronic units.

The circuit of the tunnel diode oscillator

Unique Circuit Simplifier THE TUNNEL DIODE



Here—in an extremely simplified diagram—is how the tunnel diode operates. Drawing represents a structure similar to a Chinese checkerboard, with one side slightly raised. Holes on the left side (which represent an n-type semiconductor) are filled with marbles, with a few left over and sitting on top. Right side (representing a p-type semiconductor) has a few holes vacant. The slope represents the potential barrier. A marble (or electron) from the left, can—after being given a push—enter a hole on the right side by rolling up the slope and dropping in. Or, without the push, it can miraculously "tunnel" through the board and appear in a hole. The former process is used in conventional diodes and transistors. The latter represents what happens in tunnel diodes.



TUNNEL DIODE
CURRENT-VOLTAGE CHARACTERISTICS

PTS ① TO ② - POSITIVE RESISTANCE
PTS ② TO ④ - NEGATIVE RESISTANCE
PT ④ ON —— POSITIVE RESISTANCE

THE tunnel diode was first reported by a Japanese scientist—Dr. Leo Esaki—in 1958. It takes its name from the phenomenon that makes its operation possible: quantum-mechanical tunneling.

As with transistors, it depends on the transfer of an electrical charge across a p-n junction, the region between a p-type semiconductor, which has an excess of positive carrier or "holes" (empty electron states), and an n-type, which has an excess of free electrons.

The opposite sides of this junction take on a charge which resists the movement of the "holes" and electrons across it. In the transistor, a charge carrier must be emitted into a region where its energy can be boosted by an outside voltage. It is then collected on an output electrode. The speed of this process is limited by the time it takes the charge carrier—having left the emitter—to traverse the control region and appear on the collector. This time limits the frequency at which the device can function and is quite long compared to, say, the time needed for a signal to travel an equivalent distance along a copper wire.

The quantum-mechanical theory says there is another way in which the particles can pass the barrier: an electron has a small, but definite possibility of disappearing from one side of the potential barrier and re-appearing simultaneously on the other—even though it does not have enough energy to surmount the barrier. It is as though the particles "tunnel" under the barrier, setting up almost instantaneous surges of current. Thus, in the tunnel diode, the signal moves with the same speed as it would in a copper wire—the speed of light.

The construction of a tunnel diode gives it some other interesting characteristics. Its p-n junction is made of materials more heavily loaded—or doped—with impurities than conventional diodes, and made so that the barrier between p and n sections is extremely thin, less than a millionth of an inch thick.

So long as no outside voltage is applied across the p-n junction, there is no net current—since the electrons tunnel back and forth easily through the barrier in both directions. Apply a small voltage, however, and current appears. Add still more voltage, and current *decreases*. Add more, and current increases again.

In the range where an increase in voltage results in a fall-off of current, the tunnel diode is said to have "negative" resistance—making it suited for use as an amplifier or oscillator.

This negative resistance quality, combined with speed-of-light operation, makes possible a very high frequency response. Engineers confidently expect oscillation frequencies of more than 10,000 megacycles.

Some other outstanding features:

- It is smaller than a transistor and, because of its simplicity, ultimately will be just a fraction of its present size.
- It is affected very little by environment. The tunnel diode can operate at the near-absolute zero temperature of liquid helium or—at the other end of the thermometer—at temperatures up to 650° F, while conventional silicon diodes won't operate above 400° F.
- It has a low noise level, only parametric amplifiers and masers competing closely with it. And of these, only the tunnel diode can operate directly from a battery.

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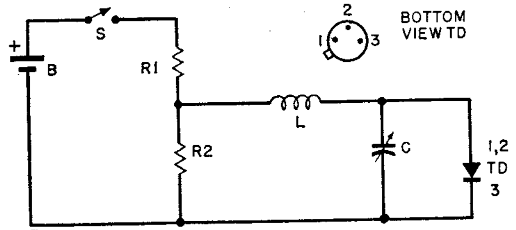
is shown in Fig. 2. Resistors R1 and R2 divide the voltage from the 1.5-*v* battery down to about 0.15 *v*, the approximate voltage for negative resistance operation of the tunnel diode. Resistors R1 and R2 were chosen so that R2 would be a fraction (about ⅕th in this case) of the tunnel diode negative resistance (which is about 150 ohms). Inductor L and capacitor C form a resonant circuit that controls the oscillations of the tunnel diode, TD. (Several symbols for tunnel diodes have been suggested and are presently used by different manufacturers. The conventional symbol is shown in Fig. 2).

Correct polarity of the voltage applied to the diode is important—Be careful not to re-

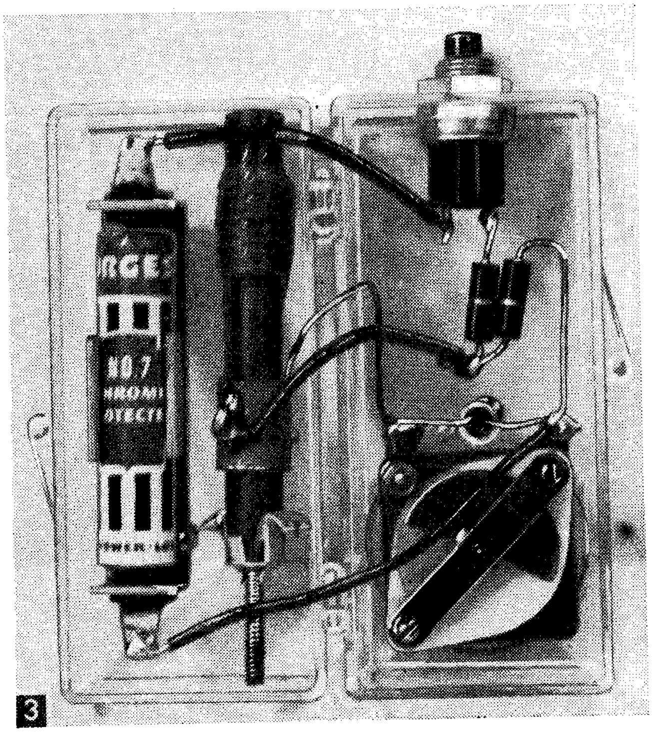
MATERIALS LIST—TUNNEL DIODE OSCILLATOR

Desig.	Description
R2	27 ohm, $\frac{1}{2}$ watt carbon resistor, 10%
R1	270 ohm, $\frac{1}{2}$ watt carbon resistor, 10%
L	broadcast band ferrite loop antenna (Miller 6300)
C	365 mmf. miniature tuning capacitor (Lafayette MS-445)
TD	tunnel diode General Electric 1N2939 (ZJ56) or 1N2940 (ZJ56A)
S	miniature momentary contact switch (Grayhill 4001)
B	1.5 v. penlite cell (Burgess #7)
	penlite cell holder (Lafayette MS-137)
	1 x 1$\frac{3}{16}$ x 2$\frac{7}{8}$" plastic case (Lafayette MS-157)

Components for this project may be obtained from Lafayette Radio, 100 6th Avenue, New York 13, N. Y.



2 SCHEMATIC



3 Rear view of oscillator with case open.

verse it. The General Electric 1N2939, 1N2940, and 1N2941 (formerly designated as the ZJ-56 series) are housed in TO-18 cases and have the pin connections shown in Fig. 2. Note that leads 1 and 2 are both connected to the positive electrode.

The rear view of the tunnel diode oscillator with case open is shown in Fig. 3. Use Figs. 2 and 3 for guidance in assembling the unit and wiring it.

Four holes are required in the plastic case. Start these holes with a heated ice pick. Capacitor C and the switch S are on the case centerline. The hole for the capacitor is $\frac{5}{8}$ in. from the top of the case. The mounting hole for switch S is centered on the bottom side of the front half of the case. Locate the battery holder mounting holes by using the holder, against the back half of the case, as a guide. Enlarge the tuning capacitor and switch mounting holes to $\frac{5}{16}$ in. dia. with a taper reamer. Wash the case with soap and water and rinse with clear water to remove fingerprints after all of the holes have been made.

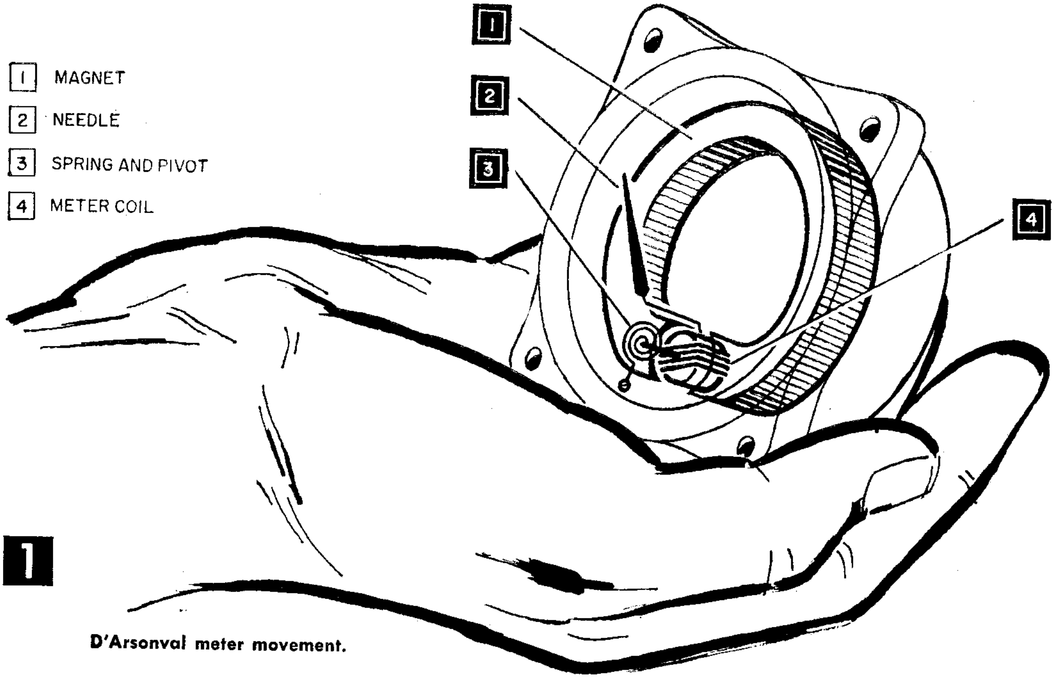
Mount the switch S, the capacitor C and the battery holder. Then wire the circuit. Use a hot, clean soldering iron and rosin core solder to make connections. Minimize the danger of heat damage to the tunnel diode by grasping the leads with needle nose pliers between the tunnel diode case and the connection point during soldering. When wiring is complete, insert the battery in the holder.

This oscillator operates in the broadcast band. To demonstrate its operation, tune in a relatively weak station on a broadcast receiver. Push the switch S on the oscillator. A momentary contact switch, it is "on" only when depressed. Hold the tunnel diode oscillator near the broadcast receiver antenna and tune C till a whistle is heard. At this point, the tunnel diode oscillator is tuned to the frequency of the received station.

The short length of wire furnished on coil L was removed, but if you have trouble picking up the signal on your receiver, simply connect a 6- to 8-in. length of wire at point A (Fig. 2) and provide a hole for it in the plastic case. This lead will act as a short antenna and provide better coupling of the signal to the receiver.

The unmodulated signal from this oscillator will not be audible in a receiver unless the receiver is tuned to a station. The oscillator signal beats against the received signal.

If you have difficulty check the battery voltage, and check capacitor C for a possible short. Remove the battery and the tunnel diode when checking any portion of the circuit with an ohmmeter. A change in the value of R2 may be required. Disconnect it and substitute a 100-ohm variable resistor. Adjust until unit operates, then disconnect and find value, and permanently install a resistor of this value for R2.—FRANK WOODS, JR.



1

D'Arsonval meter movement.

Meters and Multimeters

By FORREST H. FRANTZ, SR.

THE type of meter we are concerned with has an electromagnetic mechanism known as a d'Arsonval movement. From it I'll show you how to make voltmeters and ammeters and ohmmeters.

How Meters Work. The d'Arsonval meter (Fig. 1) contains a permanent magnet, a coil that is free to rotate about its pivot axis, a needle attached to the coil and a spring that resists displacement of the coil from zero and tends to restore the coil to zero.

The torque that causes the coil to turn is developed when a current passes through the meter coil. The amount is proportional to the current passing through the meter coil. The coil and needle are supported by low friction bearings so that mechanical resistance is low. The pole pieces conduct the flux from the magnet poles and the circular iron core over which the coil rotates. This core and the curved pole piece faces assure that the magnet's flux is always cutting the coil windings at right angles.

The most common basic d'Arsonval meter movement is the 0-to-1 milliampere dc meter.

Designing Your Own Meter Instruments. Assume for simplicity in the examples, that all of the work is being done with a 0-1 ma. meter. The resistance of the meter, if not known, can be determined by the circuit of Fig. 2. Adjust pot R, which is connected as a high resistance rheostat, for full scale meter deflection. Connect shunt RS across the meter terminals, and adjust it until the meter deflection is reduced to half scale. The resistance to which RS is adjusted is the resistance of the meter movement. The resistance of RS may be measured with an ohmmeter or Wheatstone bridge.

Once you know the basic movement (I_m) and the resistance (R_m) of the meter, you can increase the current range with a shunt resistance (R_s in Fig. 3.). The value of the shunt resistance for a new range is determined using these formulas:

(a) $I_s = I - I_m$

(b) $R_s = R_m\left(\frac{I_m}{I_s}\right)$

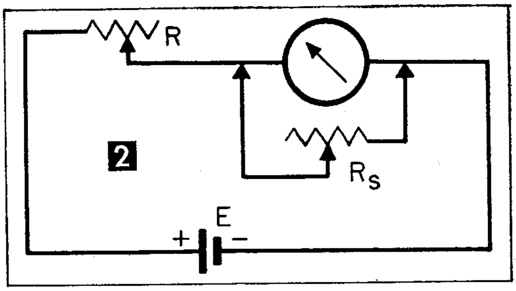
You can buy a 1% shunt resistor, or you can make the shunt by winding insulated resistance or magnet wire on a form, such as a matchstick or a Bakelite bobbin. Or you can use a rheostat, adjust it to the proper resistance, and lock it with a cement seal between the shaft and bushing. Most shunt resistance values will be so low, though, that it's best to wind your own.

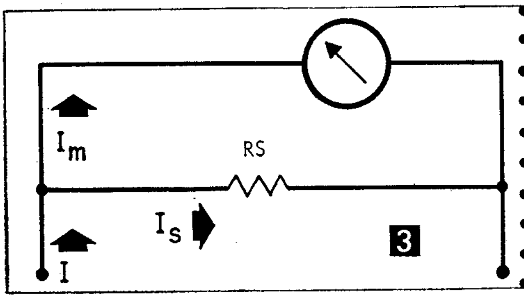
In designing an extended-range meter

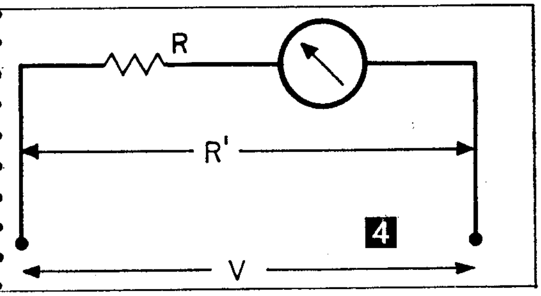
2 Circuit for measuring meter resistance. With RS out of the circuit adjust R for full-scale meter deflection. Then connect RS across the meter as shown and adjust it till the meter reads half scale. The meter resistance is equal to the value to which R is adjusted.

3 Extending the range of a current meter with a shunt resistance.

4 Converting a milliammeter to a voltmeter with a series resistance.







using a basic meter movement, try to select a range that is a convenient multiple of the meter scale range. Multiples of 10 are best since you can read the meter directly, and have to supply only the decimal point. Two and five are the next best choices for scale number multipliers, and of course, multiples of 10 can be used with these also. (Same applies to voltmeters.)

The circuit for converting a milliammeter to a voltmeter is given in Figure 4. These formulas are used:

(a) $R' = \left(\frac{V}{I_m}\right)$

(b) $R = R' - R_m$

By connecting a switch (Fig. 5) you can make a multi-range voltmeter.

These current range extensions and voltmeter conversions are solved by applying Ohm's law. In the ammeter application of Fig. 3, the meter and shunt are in parallel. Thus, the voltage across the meter equals the voltage across the shunt. Therefore, the current through the meter times the meter resistance equals current through the shunt times the shunt resistance. And the current into the combination equals shunt plus meter current. The voltmeter arrangement of the second problem (Fig. 4) was based on the idea that the current through the shunt must equal the current through the meter, and the sum of the voltage drops across the meter and the series resistor equals the voltage drop across the combination.

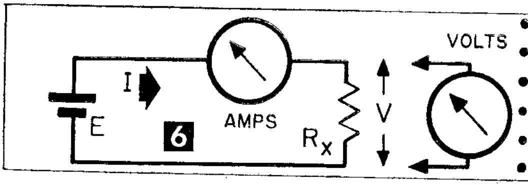
What about measuring resistance with a meter? There are several approaches. The first (Fig. 6) utilizes an ammeter and a voltmeter to measure the current through, and the voltage across, an unknown resistance R_x. Then R_x is calculated from Ohm's law. For example, if V is 4.5 v and I is .005 amp (5 ma.), using:

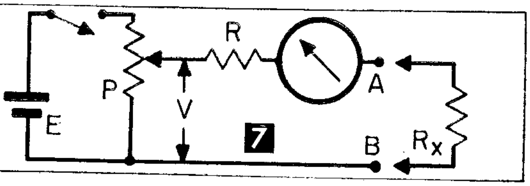
$R_x = \frac{V}{I}$. Then $R_x = \frac{4.5}{.005}$, and $R_x = 900$ ohms.

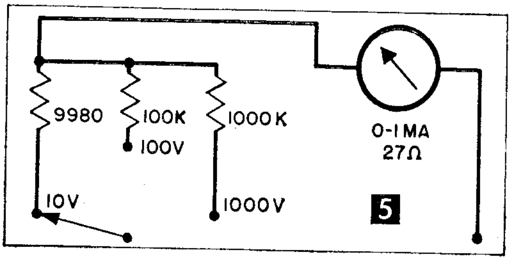
This method is cumbersome, so let's see if we can get around it. If we know the voltage E of the battery, do we need to measure V? No, if R_x is much greater than the resistance of the meter measuring the current I. This leads us to the circuit of Fig. 7, where a pot P is employed to adjust the voltage V to a value around which we'll design our ohmmeter. Assuming that we'll use a 1-ma, 27-ohm meter movement, as before, we'll want the resistance of P to be about 500 ohms. This choice is made on the assumption that the current from the battery should be 10 or more times the current through the meter, for accurate results. The resistance across A and B is zero, if we short these terminals. Therefore the resistance of R and the meter should be 5v (the design voltage) divided by the meter current, .001 amp. Resistance R, therefore, is 5000 ohms, minus the meter resistance of 27 ohms, or 4973 ohms. Since 5000 and 4973 ohms differ by only about ½%, you can let R equal 5000 ohms without noticeable error. The ohms scale may be calculated in terms of the I scale on the meter by assuming different values of R_x using this formula:

$$I = \frac{V}{R + R_x}$$

Thus, R_x in ohms	I in ma.
0	1.000
500	0.909
1000	0.832
2000	0.715
3000	0.625
4000	0.555
5000	0.500







5 A simple 3-range voltmeter. Resistance values were obtained by the method of Fig. 4 and rounded off to practical values.

6 Determining resistance by the volt-current (Ohm's law) method.

7 A simple ohmmeter circuit. In the example in the text, P is 500 ohms. For less critical zero adjustment, substitute (for P) a 100-ohm pot in series with a 400-ohm resistor.

8000	0.384
10,000	0.333
15,000	0.250
20,000	0.200
30,000	0.143
50,000	0.091
100,000	0.048
200,000	0.024

You can compute additional values yourself. Note that the half-scale meter deflection is equal to R for any meter combination which uses this arrangement. That's a handy piece of information for estimates, before you begin design. The ohm readings may be obtained using a table such as that above, or an ohms scale may be pasted on the meter glass. The switch S is turned on only when the ohmmeter is being used.

The potentiometer P may be made up of a 100-ohm pot in series with a 400-ohm, fixed resistance. This arrangement makes the zero resistance adjustment less critical. You can double battery life by doubling the value of P (use a 200-ohm pot and an 800-ohm resistance) with a decrease in accuracy that's negligible.

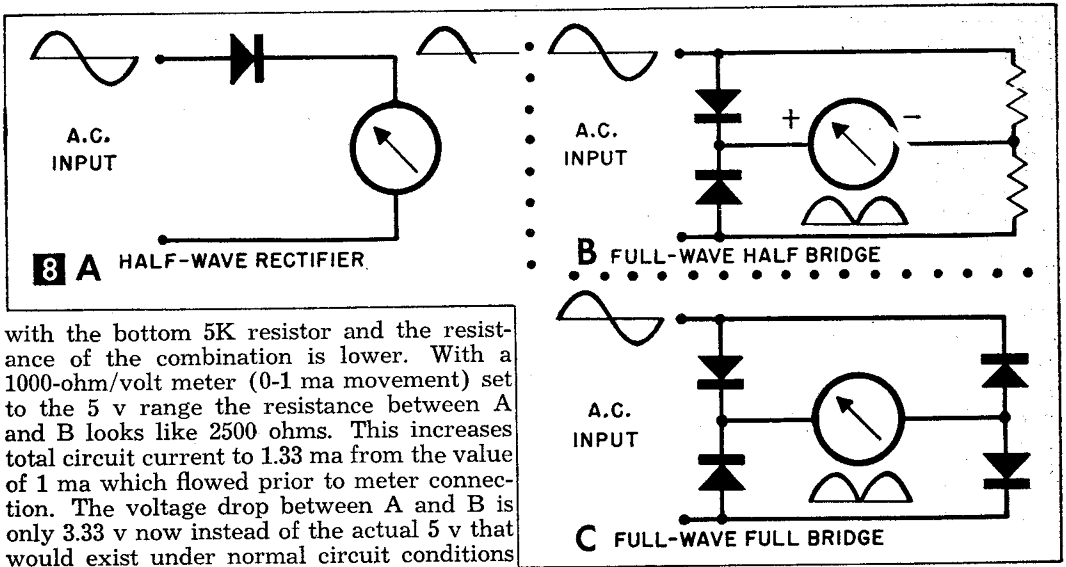
To convert a basic dc meter movement for ac measurements, rectifiers are used. Their difference in forward and back resistance is so great that we generally assume a rectifier acts as a switch. The rectifier circuit of Fig. 8A, not often used with meters, conducts during only half the ac input cycle. The full-wave half bridge of 8B passes current during all of the input cycle. A 2.7K resistor for each R works well with most germanium diodes. The output current is about 0.72 times the input current. The full bridge of Fig. 8C passes current during the entire input cycle also, but presents a greater output for a given input current. The output current is 0.9 times the input current.

The rectifiers may be germanium diodes or copper oxide types. Germanium diodes are more readily available and cover a broader range of frequencies. The GE 1N64, Sylvania IN34A and the Raytheon IN66 are suitable.

The shunt resistances for current meters and the series resistances for voltmeters of the ac variety may be determined in the same way as they were determined for dc instruments, but bear in mind that the transfer factor of the rectifier arrangement alters the value of the ac voltage required for full scale deflection, and that the apparent meter resistance is changed, too. Use the circuit of Fig. 2 for experimentation, considering the rectifier input terminals as the meter terminals and an ac voltage source instead of a battery to determine the apparent meter resistance. The current through the meter is the voltage across R divided by the resistance of R. Then, the formulas of Fig. 3 and 4 can be applied.

Multimeters. There are many meter kits available at low prices. They're called VOM (volt-ohm-milliammeter) or multimeter kits and are good for measuring ac and dc current and voltage, and for measuring resistance. Although many factors enter into the choice of a meter kit, the primary consideration is meter sensitivity: the number of ohms resistance that the meter movement and the series resistance present between the input terminals of the meter, divided by the corresponding voltage range. This is expressed in ohms/volt. This number is a function of meter movement current for full scale deflection. A 1-ma meter has a sensitivity of 1000-ohms/volt; a 200 microamp. meter has a sensitivity of 5000 ohms/volt; and a 50 microamp. meter has a sensitivity of 20,000-ohms/volt.

The sensitiviy is important, because when you connect a voltmeter into a circuit to make a measurement, you're connecting a resistance across the circuit. If you connect too low a resistance across the circuit, you'll draw enough current from the circuit to get a wrong voltage reading. Figure 9 illustrates what can happen. When you connect the meter across AB, its resistance is in parallel



Meter rectifier circuits.

with the bottom 5K resistor and the resistance of the combination is lower. With a 1000-ohm/volt meter (0-1 ma movement) set to the 5 v range the resistance between A and B looks like 2500 ohms. This increases total circuit current to 1.33 ma from the value of 1 ma which flowed prior to meter connection. The voltage drop between A and B is only 3.33 v now instead of the actual 5 v that would exist under normal circuit conditions—a big error. However, if a 20,000 ohm/volt meter were used to make the measurement, the resistance paralleling R2 would be 100,000 ohms on the 5-v range, and the resistance between AB would be 4760 ohms. The total current through the circuit would be 1.023 ma, and the voltage between A and B would be 4.87 volts, very close to exact.

Using a Multimeter. My young son uses his meter to check the resistance of a toy motor. If it's open, the needle reads infinite resistance (no deflection). Sometimes he checks his toy motors by using them as generators, switching the meter to a low dc voltage or current range and looking for a meter deflection as he rotates the motor shaft.

The motor used as a generator with a meter indicating output voltage across or current through a resistance makes a good *rpm* indicator for lathes, drills, motors and engines (including cars). The same scheme may be used for a speedometer for bicycles or a child's wagon. Equipped with a propeller or vane that is outfitted to face into the wind or equipped with anemometer type cups, this same electrical arrangement may be used to measure wind speed. The hook-up of Fig. 10 may be used for any of these applications. The size of the series rheostat must be determined experimentally and may include a series resistance in the meter if you use the dc voltage range of a VOM for the meter. A more versatile approach is to use a dc current range.

Usually the pot adjustment can be made to calibrate the meter so the existing meter scale with a suitable fraction or multiple of 10 will provide the desired range of rpm or mph. Sometimes, though, you'll have to provide a paper and ink scale, and you'll have to figure out the mechanical coupling.

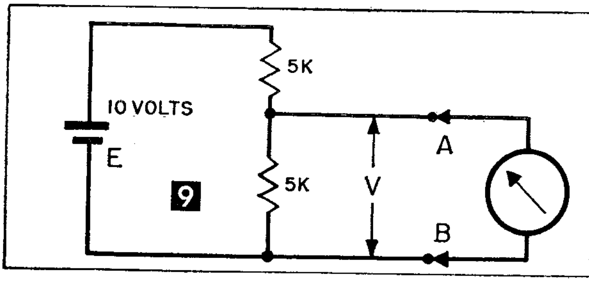
A multitester's ac volts range can be used with an audio amplifier to produce an audio millivoltmeter, a sound survey meter or an applause meter (Fig. 11A). Figure 11B shows resistance-capacitance meter coupling, and 11C shows transformer coupling to the meter. You can rig up a calibration template for the amplifier volume control so you can use it as you'd use a range switch. You can use the meter's decibel or voltage scales.

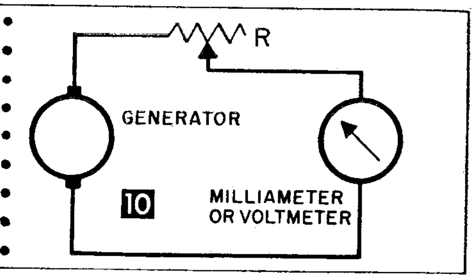
The ac voltmeter ranges may be used to measure capacitance of paper, oil or mica dielectric capacitors. Use the circuit arrangement of Fig. 12. Adjust the pot till the voltages at A and B are equal. Then disconnect the pot and measure its resistance R. For the capacitance in microfarads, substitute the value of R in this formula:

$$C=\frac{1,000,000}{377R}$$

This circuit works best with higher ac voltages, but 30 v is the top, safe limit. (The voltages across C and R won't add up to the applied voltage.) Get the 60-cycle ac voltage from a transformer—either a filament transformer or a train transformer will do. And, don't use this arrangement to measure low-voltage electrolytic capacitors, or you may ruin them! You can use a 6.3-v transformer in the circuit to test electrolytic capacitors rated 100 v or more, without damage.

Beginners can use a meter to get a good understanding of electricity. Use it to find out: What happens when you connect batteries in series and parallel; what happens to the battery voltage when you decrease the resistance connected to it; what happens to the voltage and current when resistors are connected in series or parallel; how to apply





9 Illustrating how a low sensitivity voltmeter upsets low current circuit operation and gives false readings (see text).

10 A toy motor used as a generator in this simple circuit has many practical uses. Determine R experimentally.

Ohm's law; the difference in the resistance of a light bulb before it's turned on and after it has been on a while. Incidentally, never use the ohms scales to measure resistance in a circuit under power. Always disconnect the voltage from the circuit before you measure resistance.

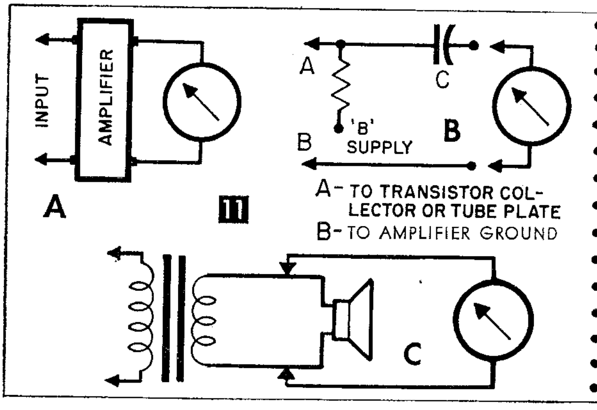
The resistance ranges may be used to check light bulbs and lamp wiring. If the ohmmeter needle deflects at all on the low ohm range, the bulb (or lamp wiring with a good bulb in the lamp and the switch on) isn't open and if the meter needle doesn't hit zero, the bulb or lamp isn't shorted. In the case of a table or floor lamp, if you get this kind of indication, everything's good, except that you're not sure that the switch will work. When you turn the switch off, the meter needle will return to its normal rest position if the switch is operating properly. This is the technique for trouble-shooting radios, electrical appliances and home and car electrical wiring.

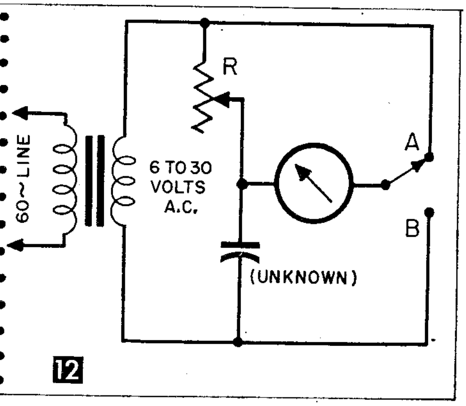
Another example of the continuity check just outlined is locating tubes with open heaters in a radio or TV. If none of the tubes in an ac-dc (transformerless) radio light up when the radio is on, the probable cause of trouble is an open tube heater. An open tube heater will also cause a TV set to be inoperative, but won't necessarily prevent all tubes from lighting up. To check tube filaments for opens, use the ohmmeter test leads across the heater pins (power disconnected). The pin numbers may be obtained from tube manuals.

An ac voltmeter is useful in checking ac line voltages, transformers, circuit wiring, oscillator output, model railroad and toy circuits and for numerous other applications. The dc voltmeter is useful in checking batteries (check them for voltage with the normal load connected), checking dc power supplies, trouble-shooting in radios and car wiring, and for numerous other applications. You should have little difficulty in voltage measurement.

Current measurements are not used as commonly in routine trouble-shooting and experimenting, but are becoming more important with the advent of the transistor. The important thing to remember in making dc current measurements is that the meter is connected in series with source and load. That is, one of the leads connects to the source of voltage and the corresponding connecting point on the device that is receiving power. You might look at it as simply cutting one of the leads in the circuit and connecting the current meter to the lead ends that you've created. The microampere range on the meter is also useful as a current detector in Wheatstone bridge circuits.

11 Using an amplifier with an ac voltmeter as an audio millivoltmeter, sound survey meter or an applause meter (a); R-C coupling meter to amplifier (b); and meter-connected amplifier output transformer (c).





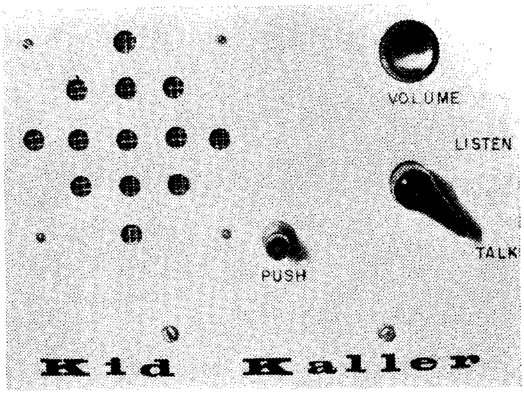
Kid Kaller

By HOMER L. DAVIDSON

WHEN the children are out playing, they can never be found when wanted. With this unit, however, simply by pushing in on a push-button switch you can call them. And then you can hear their reply or listen in on the outdoor happenings.

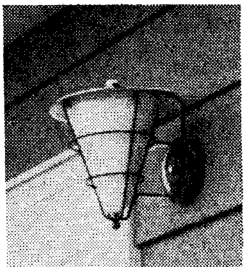
A DPDT two-position is used to switch from Talk to Listen position. A SPST switch of the momentary-hold type shuts the unit off. By using this type of a switch the battery will be on only when pushed, and outside noise will be present only when listening. The unit responds at once when pushed on, since there are no tubes to warm up.

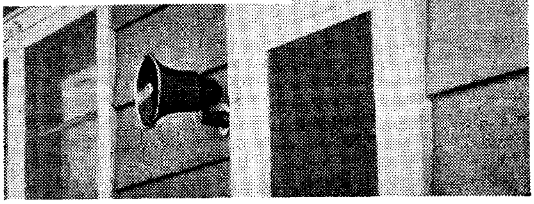
Circuit Description. This intercom caller is built around four transistors. The first three are 2N107—PNP low-cost types. A 2N255 CBS power transistor is used in the output circuit for greater volume. From the input of the house unit a 45-ohm voice coil permanent magnet speaker is placed in the base circuit of the first cascade stage. This speaker, used as a microphone, is coupled to the base circuit through a 5 mfd electrolytic capacitor. The signal is amplified, then capacitively coupled to the second transistor stage through a small volume control that controls the output volume. Both emitters of the first two stages are grounded. A base resistor is tied to each collector terminal.

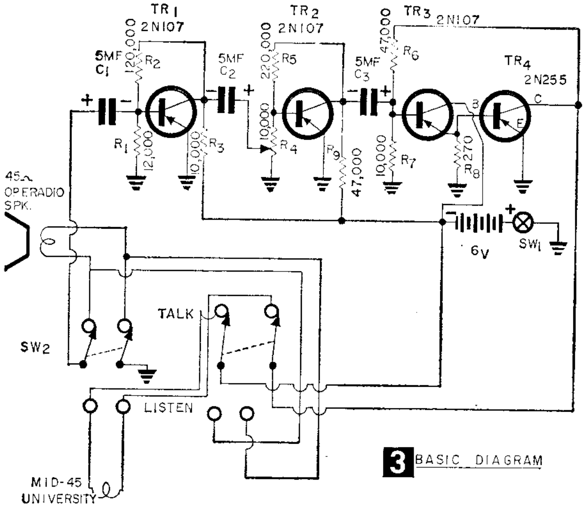


Kid Kaller can be installed in kitchen cabinet, as here, for instant communication outdoors.

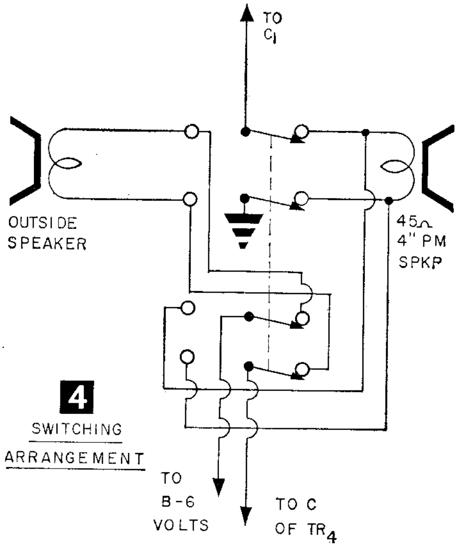
Outside speaker can be located near back door, on post in yard or on garage.



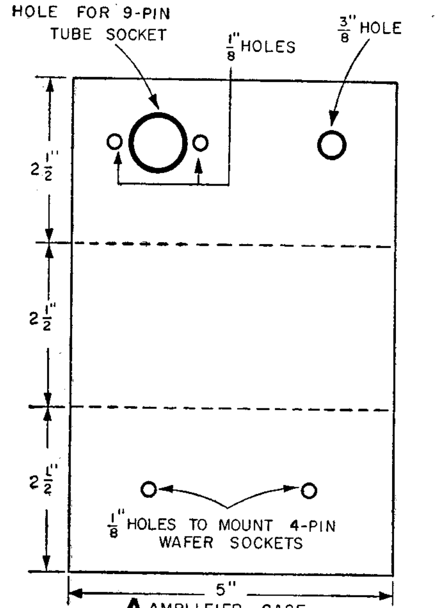




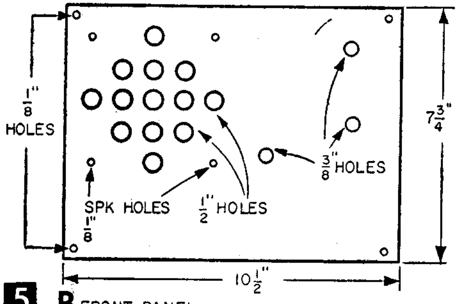
3 BASIC DIAGRAM



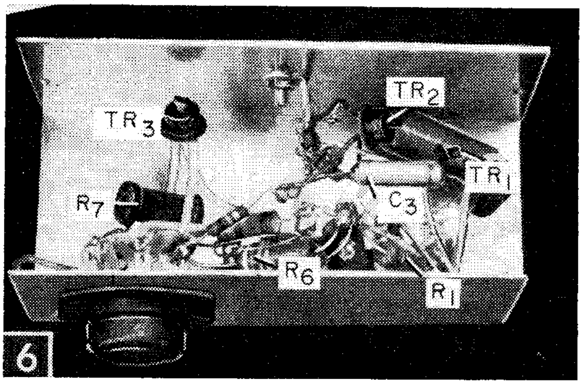
4 SWITCHING ARRANGEMENT

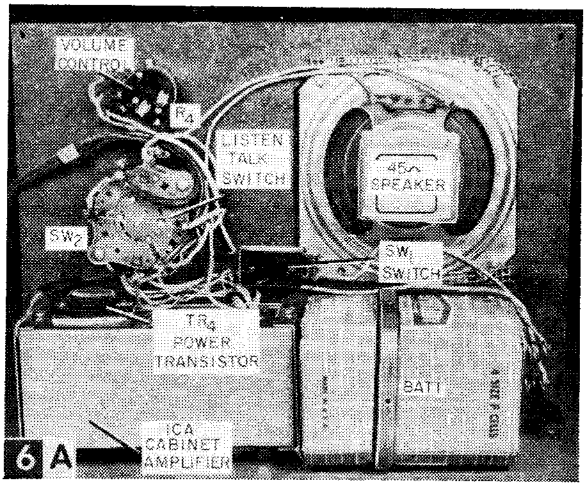


A AMPLIFIER CASE



5 **B** FRONT PANEL





Amplifier and its case (6) and back view of complete unit (6A), except for outside speaker.

In the third audio stage the collector is tied directly to the battery, while the emitter terminal is wired directly to the base circuit of the power transistor. The base return resistor is tied to the collector circuit of the power transistor. A 45-ohm, paging type speaker is switched into the output of the 2N255 collector circuit. As the output

MATERIALS LIST—KID KALLER

Desig.	Description
C1, C2, C3	5 mfd miniature elect. capacitors
R1	12,000-ohm, ½-watt carbon resistor
R2	120,000-ohm, ½-watt carbon resistor
R3, R7	10,000-ohm, ½-watt carbon resistor
R4	10,000-ohm I.R.C. volume control
R5	220,000-ohm, ½-watt carbon resistor
R6, R9	47,000-ohm, ½-watt carbon resistor
R8	270-ohm, ½-watt carbon resistor
TR1, TR2, TR3	2N107 GE transistors
TR4	2N255 CBS power transistor
SW1	SPST hold-type push switch
SW2	Rotary DPDT two-position switch
	Operadio 45-ohm 4" PM spkr. (microphone)
	Mid-45 University paging-type spkr. (outside)
	6-volt battery, lantern type

impedance of the power transistor is around 48 ohms, this insures a perfect match for amplification.

There will be no need for an output transformer in this type of circuit. The power or voltage to be applied to the circuit is furnished by a heavy duty lantern battery. Since the unit is used only intermittently, the battery lasts a long time.

Construction. Construct the amplifier inside an ICA aluminum case (see Materials List), or make your case, as shown in Fig. 5A, from thin-gage aluminum. Mount all 2N107 transistors directly on a three-lug terminal strip; the power transistor, in a standard 9-pin miniature socket insulated from the metal chassis (see Fig. 6A). There is no need to construct a heat sink for the power transistor since the unit is not on long enough to get warm.

Cut the front panel from hard-tempered Masonite and drill necessary holes before painting (see Fig. 5B). I used a white enamel spray paint so that the small unit would match the kitchen walls. The wire lead to the outside speaker can go directly through the wall through a small hole. Place colored putty around the hole so there will be no danger of weather damage.

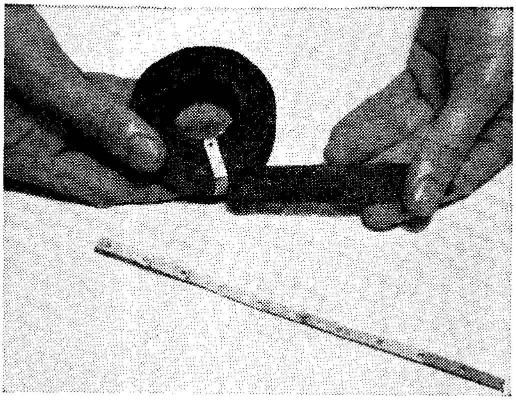
Fasten the amplifier unit to the front panel with four small bolts and nuts and secure the PM speaker to the panel also. Mount the double wafer switch directly above the amplifier chassis (see Fig. 6A). A small metal bracket was constructed from aluminum stock to hold the lantern battery to the front panel. The switching circuit is shown in Fig. 4.

Operation. When the wiring has been completed and the unit installed, except for the outside speaker (which should be wired into circuit but not secured outside), push down on the switch and—with volume half-way up—feedback should occur between outside speaker and microphone speaker.

Then turn the switch to listen position and press the switch again. Again feedback should occur. If it does not, check the wiring of the double wafer switch. Now place the outside speaker outdoors so that feedback will *not* occur with someone talking into the microphone speaker.

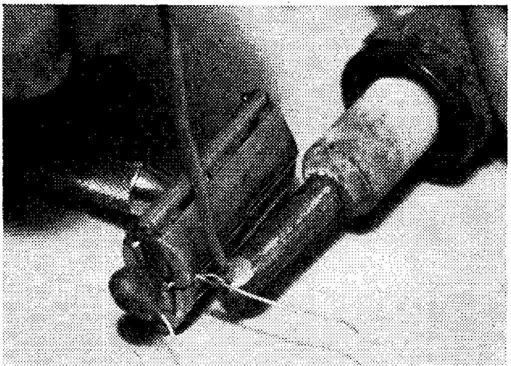
There are many uses for this small unit. The caller can be used as a regular intercom simply by placing a switch on the back of the volume control. Or the outside speaker can be placed on a post in the farm yard so the housewife can speak to her husband outside. Or you may be a rabid bird watcher. The outside speaker can be placed near a bird house and you can hear them while watching them.

Tape Cut-Off



• Rolls of plastic, rubber, and friction electrician's tape have no cutting blade to cut strips to length. A piece of metal cut-off blade removed from a wax paper box makes a good cutting edge. Simply cut off a length of blade that will fit loosely around the roll, overlap it on the inside and solder.—JOHN A. COMSTOCK.

Razor Shunts Iron Heat



• That discarded razor can serve a useful purpose as a heat shunt when soldering radio parts leads. Clamp the razor over the lead and it will absorb the soldering heat that might otherwise damage or change the value of the radio part.

The Hidden DX

Here's something new in DX — tuning FM subcarriers

By C. M. STANBURY II

The experimenter's DX special for hidden DX, consisting of a Hammarlund HQ 120 X and a Granco 780. Almost any combination of short-wave and FM receivers will do, but it is better if the SW set is equipped with band spread.

DO YOU own an FM receiver? Chances are pretty good you do, or could, because there are sets in the stores selling for as little as $29.95. Second question, are you a DXer? If you are, then you're missing one tremendous bet on the FM band.

We're crazy? FM DX is a cross between that found on the Broadcast Band and VHF TV channels. However, DX listeners are missing some very rare catches between 88 and 108 mc, loggings which compare with the most unusual to be found anywhere in the radio spectrum. Hidden on the band are signals which the ordinary FM receiver will never pick up, which even local listeners will probably never hear. But if you have a shortwave receiver, you can. And at a distance, Rare enough for you?

Most of our readers will be familiar with one class of station in this "hidden" group, the satellites on 108 mc, but unless you have special equipment, these require a tremendous amount of patience. A much more inviting target are the *subcarriers* used for background music and storecasting. Believe it or not, such signals you will be able to detect (for DX purposes only), log and QSL with only a reasonable amount of effort.

How's it done? By using AM detection instead of FM. An FM detector measures the deviation between the frequency transmitted and the carrier frequency, subtracts them, and the result is an audio frequency. We have taken WSOM as an example, carrier frequency 105100 kc (105.1 mc). If the signal deviated to 105101 (or 105099) the result would be a 1 kc or 1000 cps audio note. However, should the deviation exceed 15 kc, it would produce a supersonic audio note which your audio circuits would reject, no speaker could reproduce, and of course you couldn't hear it anyway. Thus WSOM may transmit background music around 105167 (the subcarrier) and no ordinary FM set could ever receive it.

But an AM receiver (detector) responds to variations in amplitude, and in this sense, not to frequency deviation. The subcarrier does produce amplitude variations. Thus if you could tune an AM receiver to 105167 it would pick up WSOM's subcarrier. The sounds would not be enjoyable listening but recognizable as music, and—more important from a DX standpoint—loggable.

But you don't have an AM receiver that will tune the FM band? You don't need one, the FM set will do it for you. Double talk? No.

An FM set receives a signal from the antenna, passes it through one stage of RF amplification (a few have two) then feeds it into a mixer tube where it's converted to an intermediate frequency, the most common of

---

QSL's received—

"Dear Mr. Stanbury:

"Thank you for your report on reception of WRRA located on Connecticut Hill, 9 miles southwest of Ithaca, New York.

"The subcarrier you detected was our 67 kc multiplex subcarrier for background music . . .

"You may . . . be able to detect bursts of high frequency tone (19 kc to 29 kc) at station identification time and also our 45 kc telemetering frequency at odd intervals."

Northeast Radio Corporation

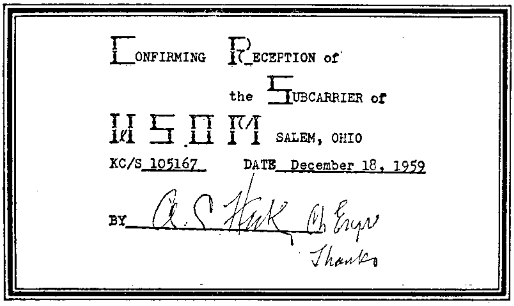
* * *

"Dear Mr. Stanbury:

"This will acknowledge your letter of 7 August 1959, relative to reception of radio signals from the Discoverer Satellite.

"Time, frequency and emission would certainly indicate that the signals you received were from the Satellite . . . "

From a Government Agency



CONFIRMING RECEPTION of

the SUBCARRIER of

WSOM SALEM, OHIO

KC/S 105167 DATE December 18, 1959

BY A. C. Hawk Ch Engr

Thanks

QSL for an FM subcarrier. The card was prepared by the author to expedite verification.

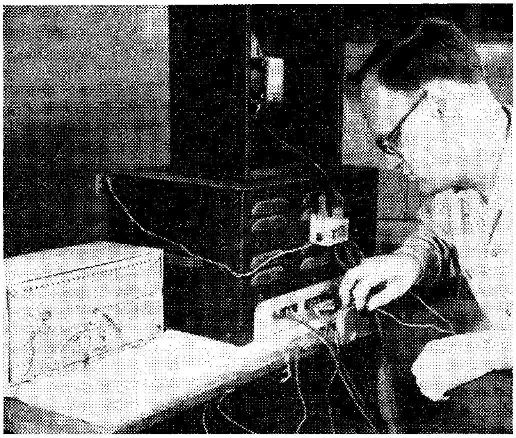
which is 10.7 mc. So far, simple. But what you may not know is that the mixer tube radiates a small portion of the signal at the IF frequency. Such radiation passes back into the antenna circuit. If a shortwave receiver is hooked up to the same antenna, there will be no difficulty picking up the FM signal at 10.7 mc (or whatever the IF is). Once you pick it up on your shortwave receiver, you will of course be using that all-important AM detection.

Now that we've reached the antenna, let's consider it a moment. Subcarriers usually produce weak signals. Thus your antenna must receive signals well from that direction. Which direction? Well, that depends upon which DX station you're after. In other words, your antenna must function in *all* directions. The best solution is a rotor, the kind used for TV antennas. But if you don't already have one, this is also the most expensive. A compromise would be the old fashioned longwire.

Which brings us to a second use for the hidden-DX receivers: That very tough space reception. Most American satellites use either A1 (on/off) or F1 (frequency shift, in this case producing beep effect) modulation to identify their carriers. Both can be received much better on the narrow band set-up described here than on an ordinary broad-band FM receiver.

Now that the equipment is set, you're ready to use it. The first step would be to listen to one or more of your local FM stations so you become familiar with their sound when detected via AM. If you know one of them has a subcarrier, listen to it (look for a subcarrier when the orthodox programming is other than music). Among other things you will note that mixed with the background music will be transmissions from the standard carrier.

Finding a Subcarrier. The process is the same for both local and DX stations. Tune in the stations as well as possible on your FM set, then turn the volume down to nil (but not off). If your shortwave receiver is equipped with band spread, place it at the maximum setting and find the carrier frequency on the main dial (around 10.7 mc or whatever the FM IF is). The carrier will be at the point of peak signal, but it can be found much more accurately by waiting for a moment of dead air (even while the announcer takes a breath). It will then appear as a distinctive hum at just one frequency. (In actual practice this extremely fine tuning is accomplished by a slight adjustment of the bandspread.) Once you find the carrier, look for the subcarrier with the bandspread. Assuming the station has a strong signal, if you fail to find it after a couple tries, place the bandspread at its lowest reading, retune the carrier via the main dial and start searching for your quarry again. If you don't have bandspread, tune in the standard carrier, note the frequency reading carefully, then tune back and forth for the subcarrier. When you find it, note that dial setting also.

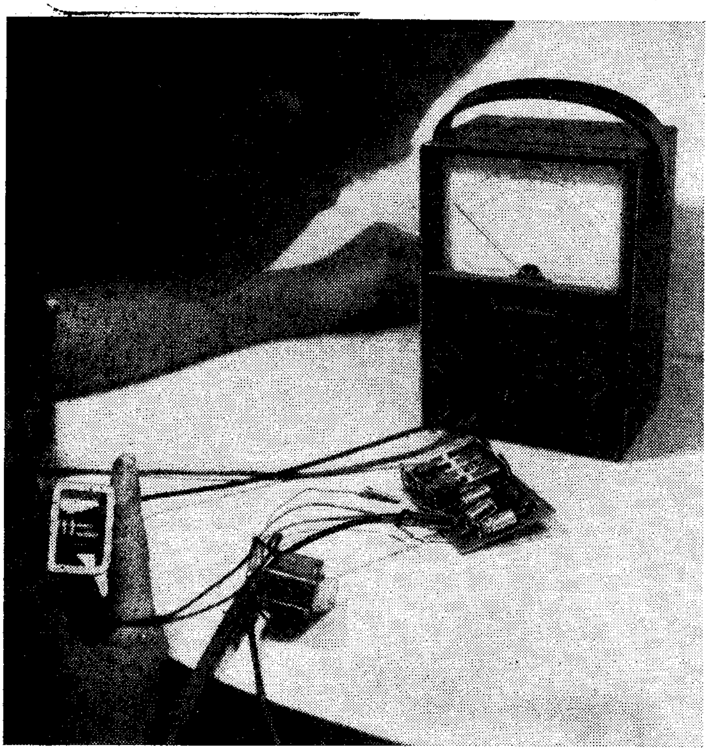


No internal adjustments are required on the rig, only a common antenna.

Although these procedures sound complicated, they will—with a little practice—become simple routine and in the long run prove much easier than any haphazard approach.

Except for identification, which will be obtained from the normal FM transmission, you'll have to garner enough information from the subcarrier to authenticate reception of same. First item is frequency. If the subcarrier appears above the carrier on your shortwave receiver, it will actually be below it and vice versa. However the indicated frequency difference will be correct. Such readings should be as accurate as possible. A bandspread may be calculated via 31-meter SWBC images or more easily by using a 100 kc crystal calibrator. For space reception, pinpoint accuracy is absolutely indispensable.

Other verification data might include timing between records (to the second) and possibly song titles, although many stations keep no record of the latter, so don't depend upon it.



A speaker connected to the Hi-Qual Pre-Amp input can function as a mike sensitive enough to record heart beats.

Hi-Qual Pre-Amp

This preamp is inexpensive, easy to construct. It has a gain of about 500 flat from 10 cycles to 20,000 cycles. It may be used in apparatus requiring a quality preamplifier circuit, or as a laboratory tool

THE electronics and scientific experimenter frequently needs a high quality preamplifier. The preamp must have a low value of internal noise, hum, and hiss. It should have a reasonably high input impedance, high gain, and the gain should be relatively independent of the power supply voltage. The frequency response should be relatively flat over a wide range of frequencies, and distortion should be low.

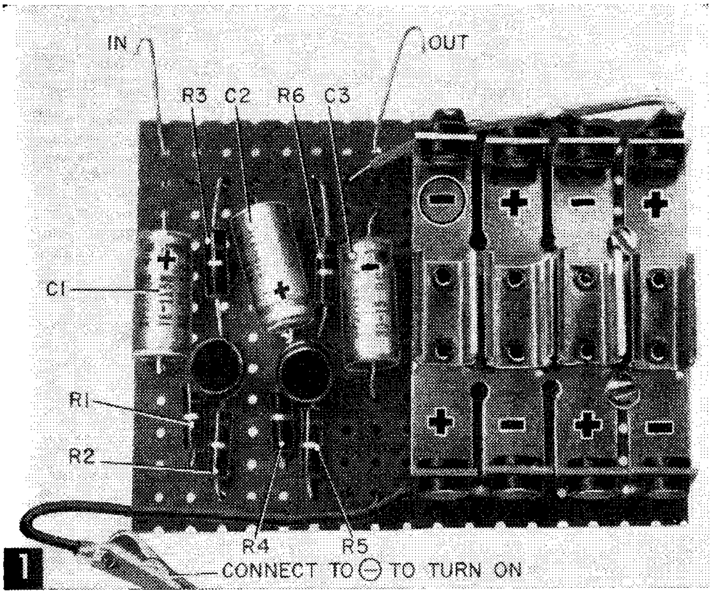
An amplifier that meets these specifications may be used as a phonograph, microphone, or tape recorder pick-up preamplifier. It may be used with a crystal detector tuner to drive a power amplifier for hi-fi listening. As a lab preamp a unit meeting the outlined specs can be used to detect small ac voltages, as a meter amplifier for a conventional meter, as a preamp for older, less sensitive oscilloscopes, and for a host of other uses.

The Hi-Qual Pre-Amp meets the specifications outlined, and it can perform the jobs outlined, plus numerous others. In addition to the characteristics mentioned below the title of this article, it is: 1) transistorized—uses two high gain GE 2N508 transistors; 2) dc operated from 6 v—no line cords to get in your way; 3) battery economy is good—requires less than 2 ma; 4) stabilized for variations in transistor characteristics and temperature; 5) handles inputs from zero to 3 millivolts with minimum distortion. The range may be extended by connecting a volume control in the input circuit (Fig. 4); 3 millivolts input produces a 1.5 v output; 6) input impedance is greater than 10,000 ohms; 7) compact construction—$\frac{3}{4}$ x 2$\frac{7}{16}$ x 3$\frac{3}{8}$ in. including self-contained battery (Figs. 1 and 2); 8) simple construction—can be built in about an hour with minimum chances of wiring mistakes; 9) flexible—can be built into other equipment or as a separate lab instrument and can be modified to meet varying requirements.

Construction. The top and bottom views of the completed amplifier are shown in Figs. 1 and 2; the circuit diagram is shown in Fig. 3. Using these as a guide, proceed as follows:

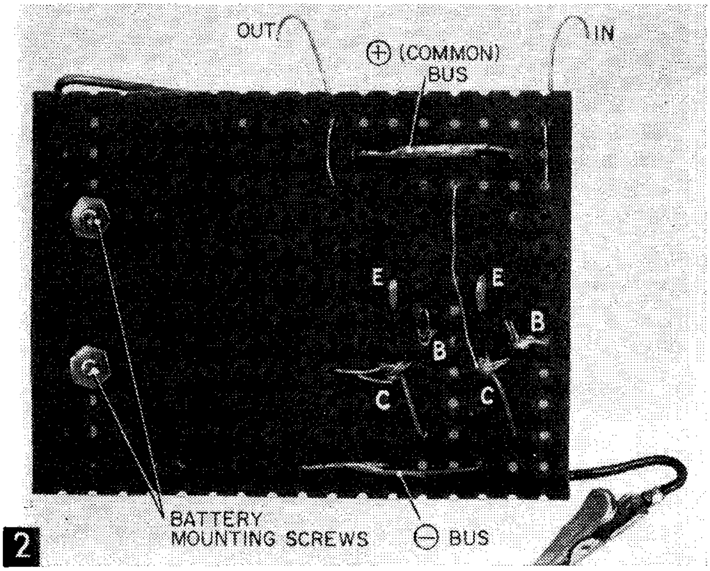
1) Drill two $\frac{1}{8}$-in. dia. holes in the perforated board for the battery holder. There are four small perforations left between these two holes, and the two holes line up on the second row of perforations. Mount the battery holder and connect the terminals for series connection of the batteries. This is accomplished by turning the battery holder lugs till they contact each other, then soldering them together. Fill the inside eyelets of the battery holders which will contact the batteries with solder. This will minimize the chance of poor-contact or no-contact problems later.

2) Insert the transistor, resistor, and capacitor pigtails through the appropriate board perforations. Note that one pigtail of R2 and



1

Top view of Pre-Amp.



2

Bottom view of Pre-Amp.

the collector pigtail of T1 both pass through the same perforation. The same applies to R1 and base T1; R3 and emitter T1. This also occurs for similar elements of T2 and the counterpart resistors. Be careful to position the capacitors with polarities as shown in Fig. 1.

3) The instructions which follow refer to connections made on the bottom side of the perforated board. Connect C1 (−) to junction R1-base T1. Solder and clip off the extra lead length.

4) Connect free end R1 and C2 (−) to collector T1. Solder and clip off extra lead length.

5) Solder R3 and T1 emitter junction; clip off extra lead length.

6) Connect free end C2 (+) to junction R4 and T2 base. Solder and clip excess.

7) Connect free end R4 and C3 (−) to junction R5 and T2 collector.

8) Solder junction R6 and T2 emitter; clip excess lead.

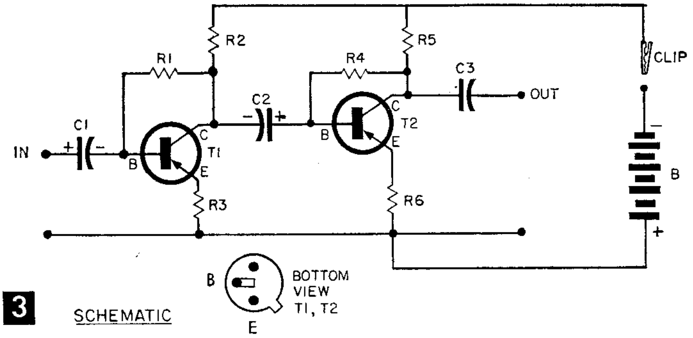
9) Bend free R3 and R6 pigtails against board and solder. Connect a 2-in. length of wire from this junction to the (+) battery holder terminal.

10) Bend free pigtails of R2 and R5 against the board and solder. Connect a 3-in. length of wire to this junction. Solder a Mueller Minigator clip to the other end of this wire. The clip is the On-Off switch for the amplifier. To turn the amplifier on, fasten the clip to the (−) battery holder terminal.

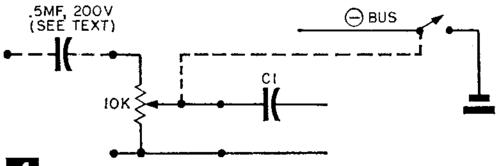
The clip lead switch may be replaced with a more sophisticated switch, but this isn't feasible unless the amplifier is housed in a case which has mounting space. The case may be the case which encloses another piece of equipment of which you want to make the preamp a permanent part, or the amplifier may be housed in its own case. The Lafayette MS-159 plastic case is a good fit, and there's room for a switch or control with switch.

The (+) pigtails of C1 and C3 are the "high" input-output terminals of the amplifier respectively. The junction of R3 and R6 is the "low" common terminal for input and output. A lead may be soldered at this point for connection purposes. Minigator clips may be attached to these input-output leads, or other terminals of the user's choice may be provided.

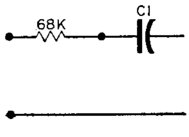
A volume control or volume control with switch may be connected at the input of the amplifier as shown in Fig. 4. The amplifier will begin to distort when the input level exceeds 3 millivolts. The volume control divides higher voltage levels and can be set within



3 SCHEMATIC



4 ADDING VOLUME CONTROL AND SWITCH



5 INCREASING INPUT IMPEDANCE

the amplifier input limits. The Lafayette VC-28 miniature control (10K with switch) is suitable for this application and will fit in the plastic case mentioned previously. The 0.5 mfd, 200 v capacitor shown in Fig. 4 should be used if the input signal contains a dc component.

However, if the dc voltage involved is greater than 200, a capacitor with a larger voltage rating must be used.

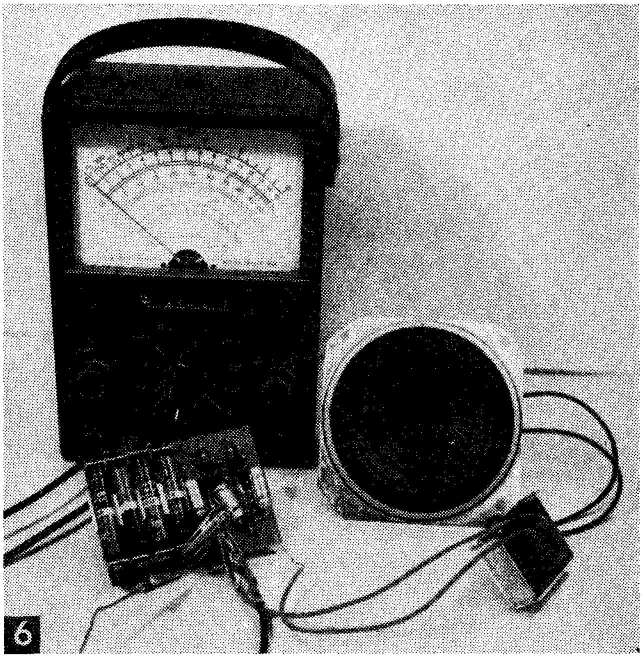
The input impedance of this high-quality pre-amplifier may be increased by connecting a 68,000-ohm resistor in series with the pre-amplifier's high input lead as shown in Fig. 5. This increases the unit's input impedance to approximately 80,000 ohms (80K), adequate for most high-impedance sources. Of course, this results in a reduction of gain to approximately 1/8th of the previous 500 value.

MATERIALS LIST—HI-QUAL PRE-AMP

Desig.	Description
R6	10 ohm, 1/2 watt, 20% carbon resistor
R3	100 ohm, 1/2 watt, 20% carbon resistor
R2, R5	2.7K, 1/2 watt, 20% carbon resistor
R1, R4	680K, 1/2 watt, 20% carbon resistor
C1, C2, C3	30 mfd, 15 v miniature electrolytic capacitor (Sprague TE-1158)
T1, T2	2N508 transistor (General Electric)
B	four 1.5 v penlite cells (RCA VSO-74)
	battery holder (Lafayette MS-170)
	2 7/16 x 3 3/8" miniature perforated board (Lafayette MS-304)
	Minigator clip (Mueller 30)

As happens so often as to establish itself as a general rule, conflicting objectives of high voltage gain and high input impedance in transistor amplifiers must be accepted as a fact of life.

The preamp may be used as an amplifier for any reasonably sensitive low-voltage alternating-current meter or the low alternating-current range of a multimeter (Fig. 6). The Heathkit MM-1 Multimeter has a low range of 1.5 v which is ideally suited to this amplifier.



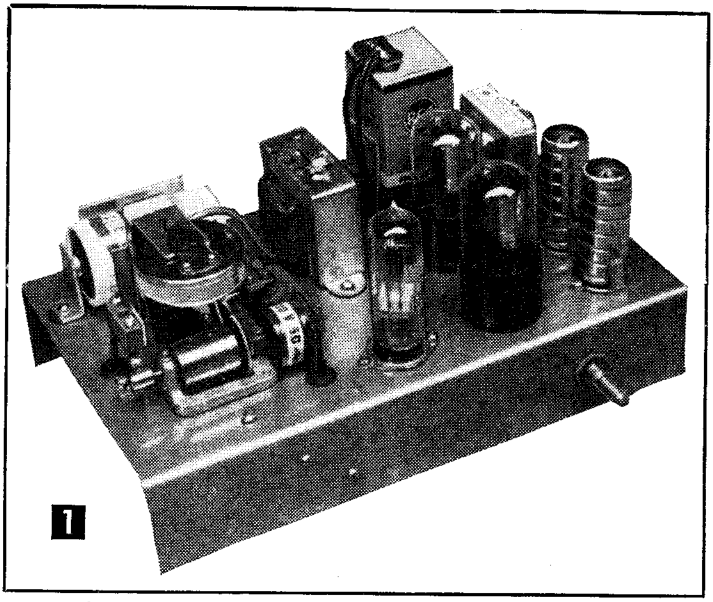
6 Hi-Qual Pre-Amp can be used with ac voltmeter to measure ac millivolts.

Meters with low ranges greater than that of Heath's MM-1 Multimeter may be used with the amplifier by using the scale only up to 1.5 v.

The preamp output may of course be used to drive an earphone or a power amplifier. The earphone arrangement might be used with the amplifier for signal tracing or it might be used in conjunction with a crystal radio input.

Another, but not quite so obvious application of the preamp capitalizes on the distortion created by overdriving. If a signal of 0.1 to 0.2 v is applied to the amplifier input, the output waveform will be clipped and will approach a square wave.—Forrest H. Frantz, Sr.

A Musical Annunciator



1

An electronically amplified Swiss musical movement (at left front) makes a pleasant door annunciator.

With this device hooked into your front door-bell circuit, you substitute the soft, tinkling tones of a music box for the jangle of bell, rasp of buzzer or raucous cling-clang! of chimes

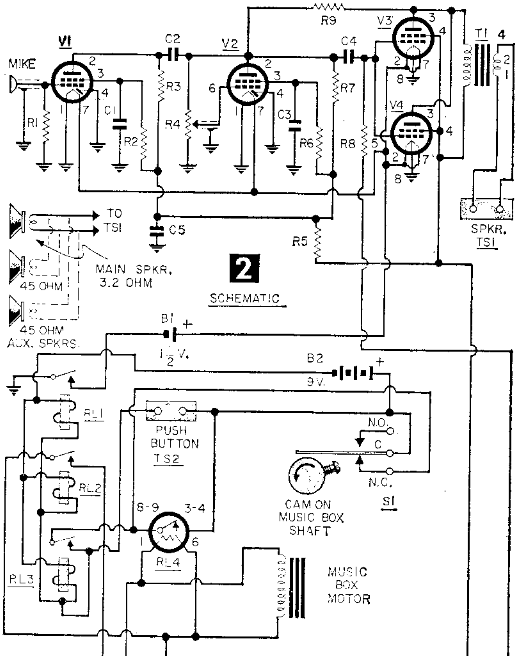
By HARTLAND B. SMITH, W8VVD

THE heart of this annunciator is its Swiss musical movement. Powered by a miniature 110-v, shaded-pole motor, this movement will play a 20-second excerpt from one of your favorite melodies. (The available tunes range from *Adeste Fideles* to the *Third Man Theme,* so you should have little difficulty in finding a composition to suit your taste.)

If this tiny music maker is to be heard throughout your home, however, some form of amplification must be employed—and the amplifier must be ready to operate the instant the front door button is pressed.

For economy's sake, no power should be drawn by the unit during standby periods. Consequently, heater-type vacuum tubes cannot be used. The choice, therefore, lies between battery tubes and transistors. Despite continued transistor price reductions, the capacitors, transformers, etc. needed for transistor circuitry are still relatively expensive. In contrast, the parts required for a vacuum-tube amplifier are quite reasonable and, in addition, many are likely to be found in the average experimenter's junk box. For this reason, the unit shown in Fig. 1 utilizes filament-type tubes rather than transistors.

An inexpensive high-output crystal lapel mike converts the sound produced by the musical movement into electrical impulses. These impulses are fed to the control grid of vacuum tube V1 (see Fig. 2). A dynamic mike cannot be employed at this point, be-



2 SCHEMATIC

cause it would be sensitive to the hum resulting from the magnetic field that surrounds the motor. A vibration pickup mike, as used for electric guitars and similar musical instruments is also impractical, because of its sensitivity to the mechanical noises generated as the motor and its associated gearing operates.

Because of this mechanically generated noise, a relatively shockproof bracket (see Fig. 6) must be used to mount the mike. This bracket makes use of a small section of plastic sponge to deaden vibrations which would otherwise travel up the mount and excite the mike.

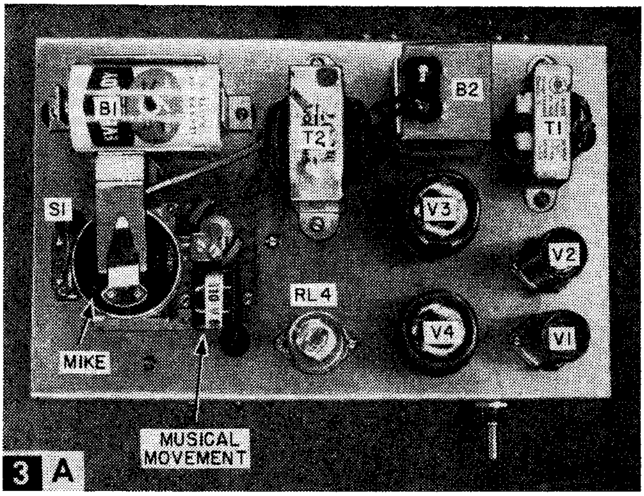
In most respects, the four-tube amplifier is of conventional design. Since the power capability of a single 3Q5GT is rather limited, two of these tubes are operated in parallel. The extra 3Q5GT provides a very useful increase in power output. Parallel, instead of push-pull operation was chosen because no phase inverter tube is needed and an inexpensive output transformer can be employed. Preliminary tests of the completed amplifier showed that its overall gain was so high that there was a tendency toward self-oscillation when the volume control was well advanced, but the addition of resistor R9 (see Fig. 2) provided sufficient inverse feedback to lower the gain and completely eliminate the oscillation problem. The use of inverse feedback also improved the frequency response and minimized distortion in the output stage.

When the annunciator is first plugged into the line, no power can be drawn because relay RL2 is open. However, as soon as the pushbutton is pressed current from the 9-v battery will flow through the coils of RL1, RL2, and RL3. Relay RL2 closes and applies 110 volts to the primary of T2, to the heater of delay relay (RL4), and to the motor of the musical movement. Relay RL1 closes and applies filament power to the tubes. The amplifier becomes operative at once and the tones of the musical movement are heard via loudspeakers placed in convenient spots throughout the home.

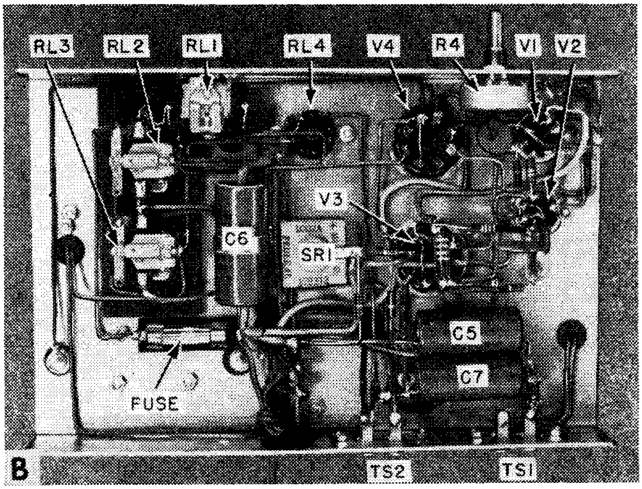
Relay RL3 also closes at the instant the button is pressed. The contacts of RL3—as long as RL4 or S1 remain closed—act as a short across the pushbutton. Thus, current continues to be supplied to the coils of RL1, RL2 and RL3 via the contacts of RL3, even after the visitor stops pressing the button.

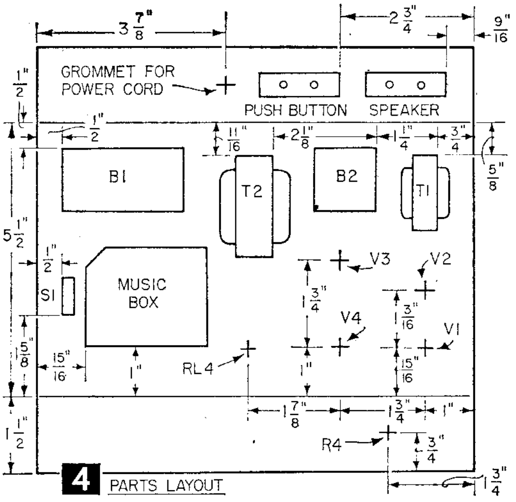
As the unit operates, the heater in RL4 warms up. After a period of approximately 10 seconds, it becomes so hot that the bimetal arm in RL4 bends far enough to open the normally closed contacts of this relay. At the moment, this action has no effect on the operation of the musical movement or amplifier because the points of RL4 are paralleled by those of S1, the miniature snap action switch operated by the cam on the shaft of the musical movement. As soon as the 20-second tune has been completed, the cam opens S1, breaking the current path from the 9-v battery to the coils of RL1, RL2 and RL3. The relays open and the entire unit shuts down until such time as it is reactivated by the push-button.

The cam on the music box is constructed from a short length of volume control shaft and a 6-32 machine screw (see Fig. 5). This



Top-chassis (above) and bottom-chassis (below) views of annunciator circuitry.





4 PARTS LAYOUT

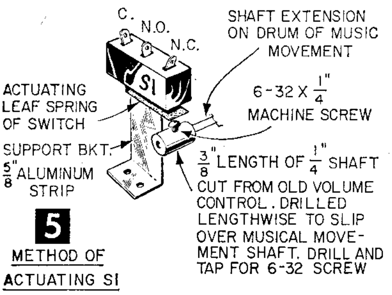
cam must be so positioned that it actuates the lever of S1 when the tune on the barrel has been completed.

The power transformer T2 in Fig. 3A happens to be a surplus unit designed to provide 125 v at 25 ma and 6.3 v at 1 amp. A suitable substitute would be a Knight 62G008 which furnishes 125 volts each side of center-tap, plus 6.3 v. Only half of the high-voltage secondary on the 62G008 should be employed with the center-tap going to R12 and one end of the high-voltage winding going to R10. Since the other end of the secondary and the 6.3-v leads are not required, clip them short and insulate with electrical tape.

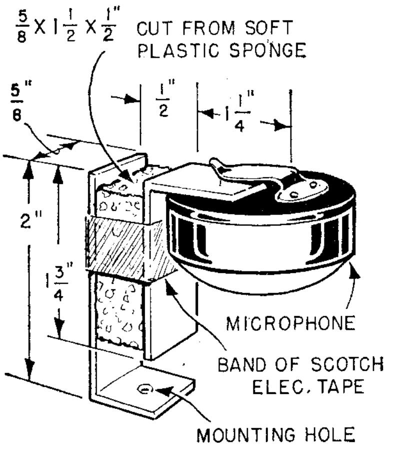
The two small batteries B1 and B2 are subjected to so little use in this particular device that they can be expected to have almost shelf life. Consequently, the battery cost per month will be insignificant.

Constructed on a 1½ x 5½ x 9-in. aluminum chassis, the amplifier is easy to wire since there is plenty of room between the components for the tip of a soldering iron. The armatures of the three small relays are directly connected to the frames. Therefore, RL2 and RL3 should be insulated from the chassis. Figure 3B shows how these relays are mounted on a thin sheet of Bakelite. Any easily worked plastic can be substituted for the Bakelite.

No knob is needed on the shaft of R4. Once the volume has been set to the desired level, no further adjustment is necessary. Battery B1 is kept in place with a home-made battery holder (or use a commercially built holder, such as a Keystone type 175). Two L-shaped brackets bent from small pieces of aluminum clamp battery B2 in position. Since the No. 5



5 METHOD OF ACTUATING S1



6 SHOCK PROOF MOUNT FOR MICROPHONE

MATERIALS LIST—MUSICAL ANNUNCIATOR

Desig.	Description
R1, R6, R8	2.2 megohm, ½ watt (Allied 1MM000)
R2	1 megohm, ½ watt (Allied 1MM000)
R3, R7	220,000 ohm, ½ watt (Allied 1MM000)
R9	330,000 ohm, ½ watt (Allied 1MM000)
R10	75 ohm, ½ watt (Allied 1MM000)
R11	560 ohm, ½ watt (Allied 1MM000)
R12	330 ohm, ½ watt (Allied 1MM000)
R4	500,000 ohm volume control (Allied 29M773)
R5	33,000 ohm, 1 watt (Allied 1MM020)
C1, C2, C3, C4	.01 mfd. disc ceramic capacitors (Allied 11L437)
C5	12 mf., 150-v electrolytic capacitor (Allied 15L194)
C6	20-20 mf., 150 v electrolytic capacitor (Allied 15L247)
C7	100 mf., 15 v. electrolytic capacitor (Allied 16L236)
RL1, RL2, RL3	Sigma 11F-1000G-SIL SPDT Relay (Allied 75P068)
RL4	Amperite 115C10T miniature delay relay (Allied 75PP296)
T1	Stancor A-3822 4 watt universal output transformer (Allied 64G005)
T2	Knight power transformer 125-0-125 v, 25 ma; 6.3 v, 1 amp (Allied 62G008)
B1	1½ v size D A battery (Allied 80J903)
B2	9 v battery VS-305 (Allied 80J838)
SR1	Federal 1002A, 65 ma. rectifier (Allied 4A606)
S1	Unimax USML SPDT Subminiature leaf switch (Allied 34B848)
TS1, TS2	2 screw terminal strip (Allied 41H505)
Mic	Crystal lapel Mike (Lafayette PA-9)
Battery Holder	for 1 size D cell (Lafayette MS-175)
Fuse	3AG ½ amp (Allied 52B232)
V1, V2	1U5 tube
V3, V4	3Q5GT tube
Musical movement	Reuge ELR 1.18 110 v, 60 cps with extended shaft. From Novelties of Distinction, 131 West 42nd St., New York 36, N. Y., or direct from the manufacturer, Reuge S.A., 26, Rue des Rasses, Ste. Croix, Switzerland.
	two octal tube sockets (Allied 40H058)
	one 9-prong miniature socket for RL4 (Allied 41H534)
	two 7-prong tube sockets with shield (Allied 40H194)
	two 1¾" tube shields (Allied 40H198)
	open-end chassis 1½ x 5½ x 9" (Allied 80P440)
	fuse clip (Allied 52B292)
	three terminal tie-point strip (Allied 41H501)
	5" loudspeaker, 3.2-ohm voice coil (Allied 81D617)
	wall baffle for 5" speaker
	wire, power plug, assorted 4-36 and 6-32 screws and nuts

Components available from Allied Radio Corp., 100 N. Western Ave., Chicago 80, Illinois, and Lafayette Radio, 165-08 Liberty Avenue, Jamaica 33, New York.

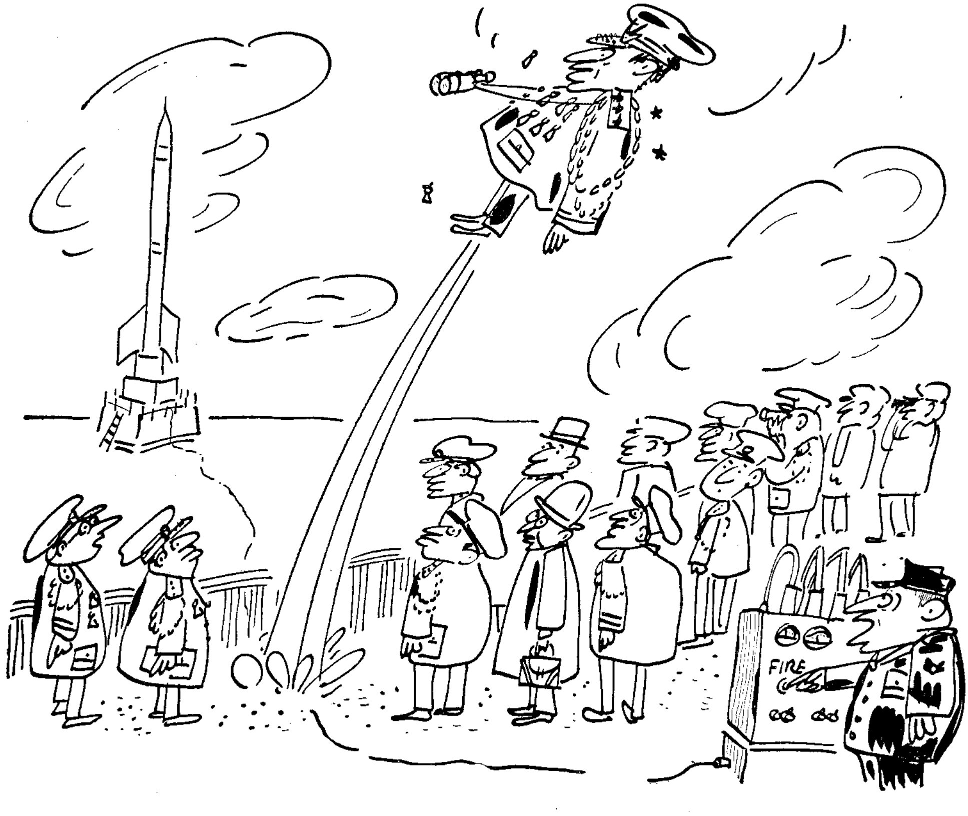
pin on a 1U5 and the No. 1 and 6 pins of a 3Q5GT are not connected to elements within the tubes, those terminals on the sockets can be used as convenient tie points to support resistors and capacitors. Grid bias for the 3Q5GT's is obtained from the voltage drop across R12. Capacitor C7, the bias filter capacitor, must be wired with its positive terminal grounded.

Locate the amplifier where output from the speakers cannot get back into the microphone to produce acoustical feedback—put it in the basement or, if you have no basement, in a utility room. Wherever you put the amplifier, make certain that it is out of reach of your youngsters. With the exception of the terminals on the motor of the musical movement, which ought to be insulated with electrical tape, all high voltages appear only on the under side of the chassis. A fuse has been included as a protection against overheating which might result from a shorted component.

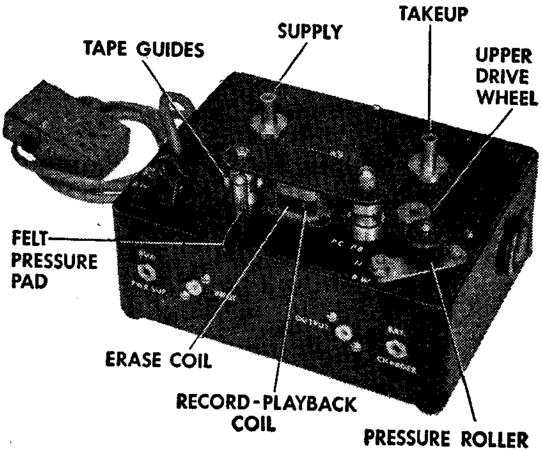
Once it has been permanently installed, plug the amplifier into the power line and run a pair of wires from TS2 to a pushbutton near the front door. Run a second pair of wires from TS1 to the main speaker which may be a 4-in. or 5-in. unit with an impedance of 3.2 ohms. Mounted in a wooden baffle, this speaker can be placed at a convenient point in the most lived-in section of your home.

Overall volume in any one part of the house need not be high, since additional speakers can be placed in those areas where the sound of the main speaker does not penetrate adequately. These extra speakers can be wired in parallel with the main speaker as shown in Fig. 2. Since the desired volume level at remote locations will normally be less than that of the main speaker, intercom replacement units with 45-ohm voice coils will work effectively in these spots. Each intercom speaker will give adequate acoustical output to cover a room or two, but because of the relatively high impedances involved, even when several are connected in parallel, they will not seriously shunt the 3.2-ohm main speaker.

The electronically amplified music box, as a replacement for an ordinary door bell or chime has a number of important features, in addition to its basic one of providing pleasant music. Unlike the ordinary bell or solenoid-operated chime, it plays for a period of 20 seconds, whether or not the pushbutton is held down. The sound of a doorbell is usually of rather short duration and is often masked by noises around the house. On the other hand, the continued output from the music box tends to get through such distractions as children's voices, loud hi-fi's, clacking typewriters, pounding hammers, etc.



Standard flashlight batteries or the new, D-size, rechargeable storage batteries may be used in this instant-ready recorder. Its motor-driven fast rewind and erase features make it possible to use the same tape over and over. Depending on where you buy, and what you have on hand, drive parts should cost between $40 and $60. High precision is not required.



Miniature Tape Recorder

By JAMES E. PUGH

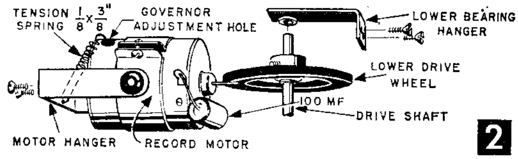
FLICK the mike switch and this battery-powered, 4-lb. midget starts recording immediately. There's no waiting for tube warm-up and no searching for an electrical outlet. And since playback speed is the standard 3¾-*ips* used on home recorders, you can play your tapes with loudspeaker volume through a radio or hi-fi unit, instead of the combination mike-speaker; or—if more volume is required on playback—you can play them on any standard home-type recorder that has 3¾ *ips* speed. A built-in jack plug input also permits you to record voice or music directly from your radio or TV.

The switch on the mike case starts and stops the record motor. For dictation, you can wire in a 4-prong plug and foot switch for the convenience of a typist. If you need loud-speaker volume, feed the output into an amplifier, or use the input jacks on suitable radios, or the amplifier section of tape recorders.

Construction starts with the metal parts detailed in Fig. 6. First scribe lines at the desired points for cuts and saw and then clamp in a vise along the line, using a square to make sure that the metal is vertical to the vise jaws. Next, lay out the hole locations with scriber and center punch and, with the part held firmly in a drill press vise, start the holes with a ¹⁄₁₆-in center drill chucked in a drill press. Use oil and finish the holes to size with sharp drills. File the three notches in the forward-reverse idler lever, but leave the center notch slightly shallow, since it must be deepened later.

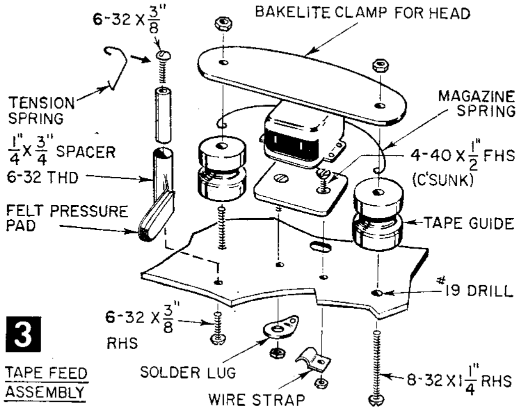
Locate the holes in the plastic case with a machinist square and scriber as in Fig. 7, and back up the plastic with a wooden block to prevent chipping when drilling. For the holes for the two tape spindles, use the metal bracket that goes inside the case as a template to assure matching center-to-center spacing. Countersink each hole requiring a Nyliner bushing inside the case and enlarge them with a tapered hand reamer just enough to obtain a free-turning fit with the shaft when bushing is installed. Each shaft must spin freely in its bushing for smooth tape motion, but it cannot be so loose that it wobbles. Nyliner bushings are split at one side to facilitate this kind of adjustment. Insert them by pressing the lower pointed end of the bushing inward and spiraling clockwise into the hole with your fingers, working from the outside of the case, so the broad flange will be on top.

Next, make up the tape drive parts shown in Fig. 8. The three idler wheels must turn freely on their shafts. Mount the forward and rewind idler lever as in Fig. 9. Tighten the screw on the threaded shaft until the compression washer holds the shaft firmly, but not locked in place. Then, holding the first lock nut with a thin wrench to keep the shaft from turning, tighten the second lock nut. It should now be possible to slide the idler along the length of its slot without rocking.



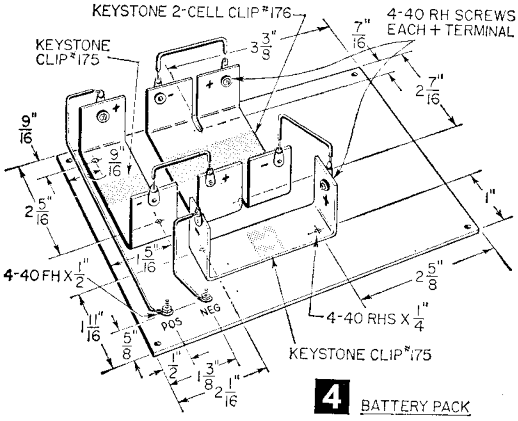
2

Speed of the tape drive motor is reduced through a rubber rim idler wheel. A spring holds the motor shaft in contact.



3 TAPE FEED ASSEMBLY

Tape guides guarantee precise tracking of the tape across the recording head. Adjust felt-covered pressure pad so it lightly presses tape against the head.



4 BATTERY PACK

Four rechargeable batteries (or four flashlight-type D-size dry cells) are mounted on the bottom panel.

After all tape drive parts are made and rotating parts operating smoothly, carefully remove the Nyliner bushings and clean all parts thoroughly. Then replace the bushings and coat the inner and flange surfaces with light machine oil.

Adjustment. Put the various shafts and wheels in place (Fig. 9) and tighten the wheel set screws allowing .001-.002 in. clearance between wheel and bushing flange. Oil the idler shafts and adjust, making sure that no oil gets on the rubber wheels or on the metal friction surfaces.

MATERIALS LIST—TAPE RECORDER

No. Req'd.	Size and Description	Allied. No.
	Tape Drive Mechanism	
1	2 5/16 x 5 9/32 x 6 13/16" black plastic case with panel	86P287, 86P289
1	2" O.D. takeup idler wheel (Walsco 1433)	43N388
1	2" O.D. rewind wheel (Walsco 1433)	
1	2" O.D. lower drive wheel (Walsco 1483)	SPECIAL
1	1" O.D. rewind idler wheel (Walsco 1450)	SPECIAL
1	¾" O.D. pressure roller (Walsco 1458)	SPECIAL
1	⅞" dia. x 6" brass for hubs, wheels and tape guides	
1	3/16" dia. x 12" drill rod for reel, drive and idler shafts	
1	¼" dia. x 3" drill rod for pressure and function lever shafts, function lever hub	
2	3/64 x ½ x 18" precision ground flat stock for hangers and levers	
2	spiral tension washers	
2	¼" dia. x ¾" 6-32 threaded bushings	
3	3/16" I.D. 3L1-FF flanged Nyliners (Thomson Industries, Inc.)	
3	3/16" I.D. 3L2-FF flanged Nyliners (Thomson)	
2	¼" I.D. 4L1-FF flanged Nyliners (Thomson)	
1	¼" I.D. 4L2-FF flanged Nyliners (Thomson)	
1	3/16" dia. x ⅝" tension spring (General Cement H420-F assortment)	SPECIAL
1	⅛" dia. x ⅜" tension spring (General Cement H420-F)	
4	½" dia. rubber feet (General Cement H052-F assortment)	SPECIAL
	Amplifier	
1	B1 battery pack consisting of 4 Sonotone rechargeable nickel-cadmium type S-103D batteries	
or 4	Eveready Type D99 leakproof flashlight cells	80J903
1	M1—6-volt rewind motor (Wilson's of Cleveland, Model 6-100)	
1	M2—6-volt DC record motor (Barber-Coleman BYQM 2022)	76P642
1	D1—3.9-volt voltage regulator Zener Diode (Texas Instrument 1N748A)	8E808
3	V1, V2, V4—2N217 PNP Transistor (RCA)	5E877
1	V3—2N647 NPN Transistor (RCA)	5E986
1	L1, L2—Record-PB-Erase head (Shure 815H)	65R584
1	Magnetic microphone, 1000 ohm (Shure MC11J)	SPECIAL
1	S1—SPST slide switch	34B422
1	S2—5-pole, 3-position wafer switch (Centralab PA-2015)	34B928
	Capacitors	
5	C1, C2, C3, C5, C6—2uf, 8-v ultra-miniature electrolytic capacitors (Barco PT6-2)	10L660
1	C4—.2uf, 75-v ceramic capacitor (Lafayette Radio C-616)	
2	C7, C9—100uf, 25-v ultra-miniature electrolytic capacitors	13L826
1	C8—150uf, 20-v ultra-miniature electrolytic capacitor	18L504
	Resistors	
3	R1, R4, R6—3.3K, ½-watt, 10% carbon resistors	1MM000
3	R2, R5, R10—72K, ½-watt, 10% carbon resistors	1MM000
1	R3—4.7K, ½-watt, 10% carbon resistor	1MM000
1	R7—5K miniature trimmer potentiometer (Bourns Wirewound Trimit 271)	31MM397
1	R8—10K, ½-watt, 10% carbon resistor	1MM000
1	R9—3.3K, ½-watt, 10% carbon resistor	1MM000
1	R11—150 ohm, ½-watt, 10% carbon resistor	
1	R12—1.8K, ½-watt, 10% carbon resistor	
	Tape Cartridge	
4	¼ x ¾" 6-32 threaded bushings (Newark Electric Co.)	
2	2¾ x 6⅜ x 3/32" thick Bakelite sheet	
6	.020 dia. piano wire	
1	3" reel of of long play 1 mil tape	96R237
1	3" empty reel	
	Hardware	
2	J1, J2—phono pin jacks (RCA)	46H213
2	J3, J4—sub-min phone jacks (Switchcraft 42A)	41H517
2	battery clips for 1 type-D cell (Keystone 175)	54J040
1	battery clip for 2 type-D cell (Keystone 176)	54J060

MATERIALS LIST (cont'd)

1	¾ x 1⅜ x 2⅜″ plastic box for mike and S1	
1	3 ft. length, 4-conductor cable (Belden 8444)	47T371
21	turret terminals USECO 1350C	
1	2 x 2¹³⁄₁₆ x ³⁄₃₂″ Bakelite sheet	
12	4-40 x ½″ *fh* screws with nuts	
4	4-40 x ⅜″ *rh* screws with nuts	
5	4-40 x ⅜″ *fh* screws with nuts	
12	6-32 x ⅜″ *fh* screws with nuts	
1	6-32 x ⅝″ *rh* screw with nuts	
1	6-32 x 1¼″ *rh* screw with nuts	
4	6-32 x ½″ *rh* screws with nuts	
1	6-32 x ½″ *fh* screw with nuts	
2	8-32 x 1¼″ *rh* screws with nuts	
2	#6 x ½″ dia. washers (for cams)	
2	carrying strap brackets	
1	shoulder strap (camera stores)	
Misc.	lock washers, ⅛″ decals, plastic spray (Krylon), rosin core solder	

Allied Radio, 100 N. Western Ave., Chicago 80, Ill. Other suppliers are:

Lafayette Radio, 165-08 Liberty Ave., Jamaica 33, N. Y.

Newark Electric Co., 223 W. Madison St., Chicago 6, Ill.

Sonotone Corp., Elmsford, New York (batteries stocked by most electronic supply houses, such as Allied, Lafayette, Newark, etc.)

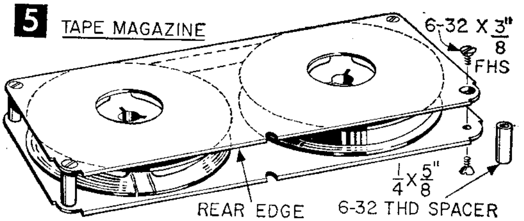
Thomson Industries, Inc., Manhasset, N. Y. (Manufacturers of Nyliner bearings. These bearings are sold through local bearing supply houses. See yellow pages of the phone book, or write factory for name of dealer.)

Wilson's of Cleveland, 6502 16th Street N.W., Fort Lauderdale, Florida. (Motors sold in most model and hobby stores.)

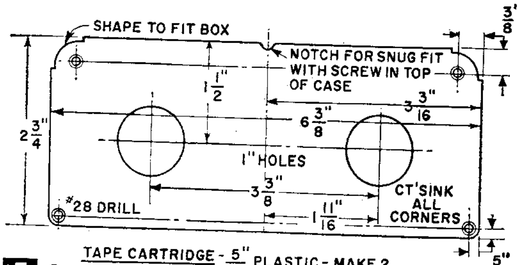
General Cement Co., 400 S. Wyman St., Rockford, Ill. (G-C parts stocked by almost every active electronic supply house.)

Walsco Electronics Corp., 3602 Crenshaw Blvd., Los Angeles, California. (Parts stocked at Allied Radio and other electronic suppliers.)

5



Details of tape cartridge.

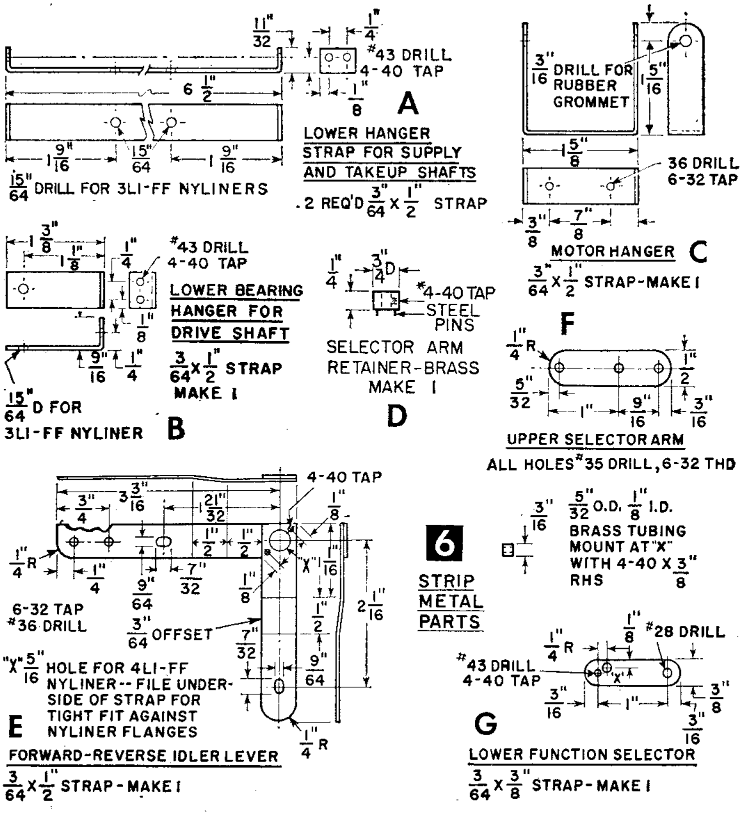


5A TAPE CARTRIDGE - 5/32" PLASTIC - MAKE 2

(COUNTERSINK CORNER HOLES, TOP AND BOTTOM)

With all of the tape transport parts in place, put the lower function lever in the notch nearest the drive shaft. Press the rubber pressure roller firmly against the upper drive wheel and tighten the set screw. Next, adjust the spiral washer at the notch nearest the drive shaft until the takeup hub rotates when the drive shaft is turned, but when a light pressure is applied to the takeup hub the idler wheel slips. This allows the takeup reel to wind up all slack tape, but prevents it from pulling tape through the drive mechanism. Now connect the motors with temporary leads to the battery for testing.

The rewind idler is adjusted by setting the function lever to the outer position and adjusting the outer spiral washer until the rewind motor turns the rewind shaft at just below its highest speed. At this point the slippage should be very small, but the pressure should not be great enough to retard the motor speed excessively. Now set the function lever to the Neutral (center) position and file the center notch in the forward-rewind idler lever until both idler wheels are free



6 STRIP METAL PARTS

A LOWER HANGER STRAP FOR SUPPLY AND TAKEUP SHAFTS . 2 REQ'D 3/64" X 1/2" STRAP

B LOWER BEARING HANGER FOR DRIVE SHAFT 3/64" X 1/2" STRAP MAKE 1

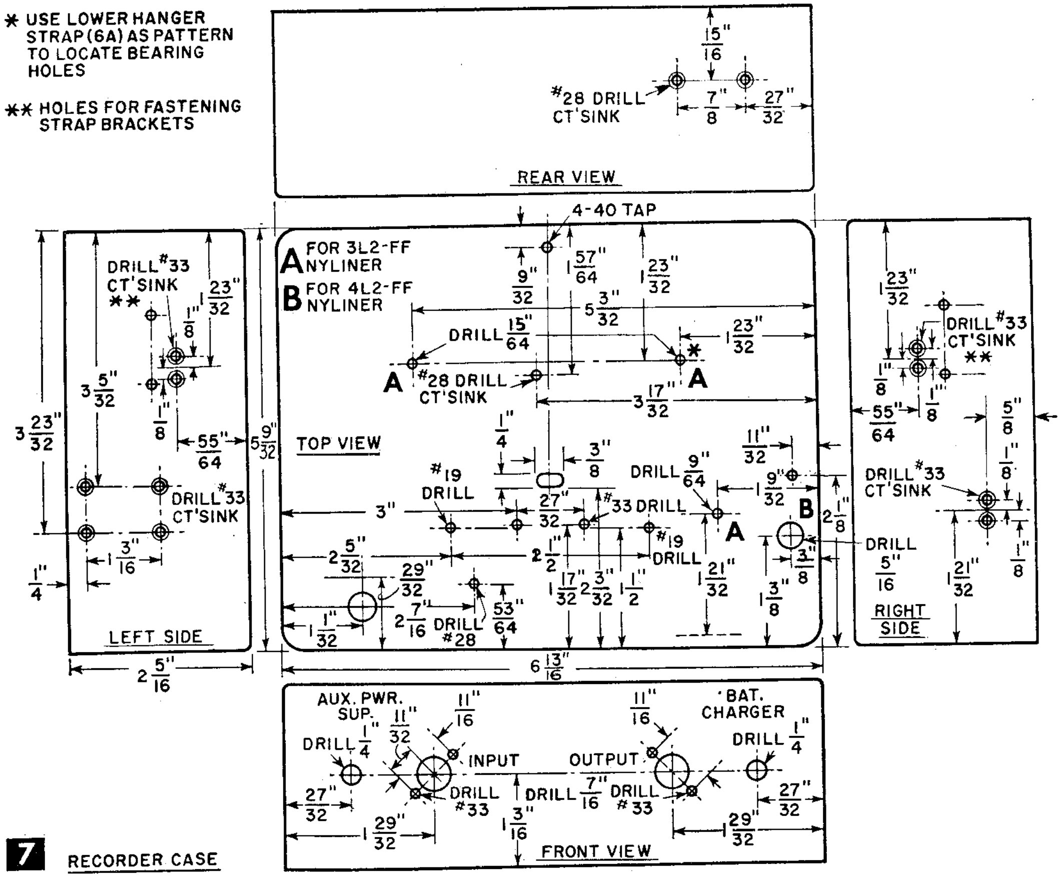
C MOTOR HANGER 3/64" X 1/2" STRAP-MAKE 1

D SELECTOR ARM RETAINER-BRASS MAKE 1

E FORWARD-REVERSE IDLER LEVER 3/64" X 1/2" STRAP-MAKE 1

F UPPER SELECTOR ARM ALL HOLES #35 DRILL, 6-32 THD

G LOWER FUNCTION SELECTOR 3/64" X 3/8" STRAP-MAKE 1



7 RECORDER CASE

from the other wheels and both takeup and rewind shafts turn freely. Cover the idler wheels and clean this part carefully each time it is filed to prevent filings from getting on the wheels and inside the case.

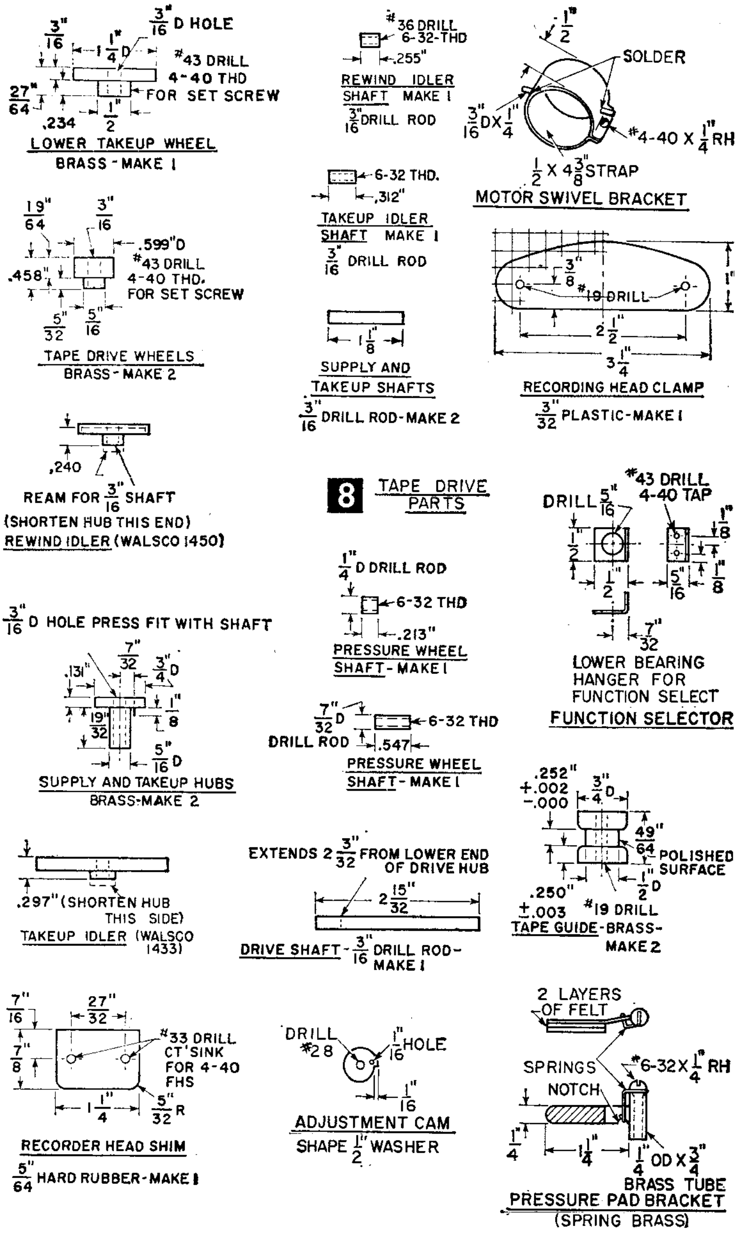
To set the record motor tension, fasten the lower drive wheel surface about 3/8-in. above the lower bearing hanger. Adjust the motor spring tension lever until the drive wheel can be rotated but a noticeable drag from the motor is felt. Too light a tension will allow slippage between motor and tape drive shafts, and too heavy a tension will cause pressure marks in the rubber rim of the drive wheel. The record motor speed is adjusted with a small screw through a hole in the motor case, turning clockwise for more speed. When the upper drive wheel rotates at 120 RPM, the tape will move at 3¾ *ips*.

After these adjustments have been made, run the mechanism both forward and in reverse for several minutes. Then put the tape reels on and check to see that the tape feeds through the drive smoothly and is not pulled too tightly by the takeup. If a slight loop is left in the portion of tape between takeup reel and drive wheel it should hold the loop smoothly, gradually becoming smaller as more tape is wound on the takeup reel.

Wiring. The amplifier is wired as in Figs. 10 and 11. It is best to solder in resistors first, capacitors next, then diodes and transistors. Some of the wire in the four-conductor microphone cable is excellent for wiring as it is small and color coded. Also, short sections of the insulation can be removed from this wire for making color-coded spaghetti.

After the amplifier is completed, wire the upper section of switch S2 (Fig. 11). Mount it in the case and wire in the tape head, motors, and jacks cutting all wires that connect to the amplifier to the approximate length needed. Mount the amplifier in place and finish the wiring. The microphone-speaker is housed in a small plastic box (Fig. 12).

Throw the function switch (S2) to *Playback* (PB) and listen for a weak motor noise in the earphone. Also check to see that both motors rotate in the correct direction. (If not, reverse the motor leads.) Then adjust the tape pressure pad to hold tape lightly against the tape head. Now you can make a recording. Set the potentiometer R7 about two turns above the full counterclockwise (minimum) position, and the function switch, function lever, and microphone switch to *Record.*



8 TAPE DRIVE PARTS

LOWER TAKEUP WHEEL BRASS - MAKE 1

TAPE DRIVE WHEELS BRASS - MAKE 2

REWIND IDLER (WALSCO 1450)

SUPPLY AND TAKEUP HUBS BRASS - MAKE 2

TAKEUP IDLER (WALSCO 1433)

RECORDER HEAD SHIM 5/64" HARD RUBBER - MAKE 1

REWIND IDLER SHAFT MAKE 1 3/16" DRILL ROD

TAKEUP IDLER SHAFT MAKE 1 3/16" DRILL ROD

SUPPLY AND TAKEUP SHAFTS 3/16" DRILL ROD - MAKE 2

PRESSURE WHEEL SHAFT - MAKE 1

PRESSURE WHEEL SHAFT - MAKE 1

DRIVE SHAFT - 3/16" DRILL ROD - MAKE 1

ADJUSTMENT CAM SHAPE 1/2" WASHER

MOTOR SWIVEL BRACKET

RECORDING HEAD CLAMP 3/32" PLASTIC - MAKE 1

LOWER BEARING HANGER FOR FUNCTION SELECT

FUNCTION SELECTOR

TAPE GUIDE - BRASS - MAKE 2

PRESSURE PAD BRACKET (SPRING BRASS)

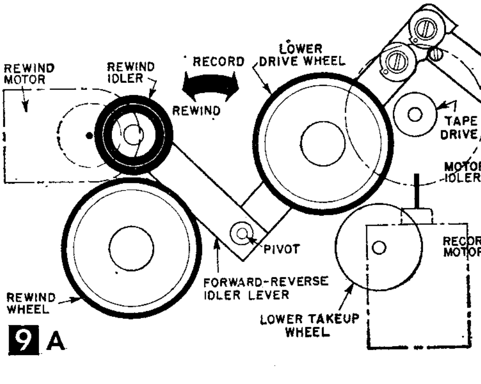
Hold the microphone about 8 in. from your mouth and speak in a normal voice. Play the recording back and adjust the tape pressure pad for maximum volume but be sure that it is not tight enough to drag on the tape. Now make another recording and, if it's weak, turn the volume control up ½ turn (clockwise) and try again. Repeat until the recording is of a suitable volume but not distorted from over-driving. Minor adjustments can now be made in the tape transport mechanism for smoothest recordings, and the recorder is ready to use.

How it Works. The tape feeds from the supply (left) reel across the first tape guide. From here it passes across the erase coil (on the right side of the head). The erase coil thus wipes off any previous recording before it reaches the record coil. The pressure pad holds the tape in contact with the head.

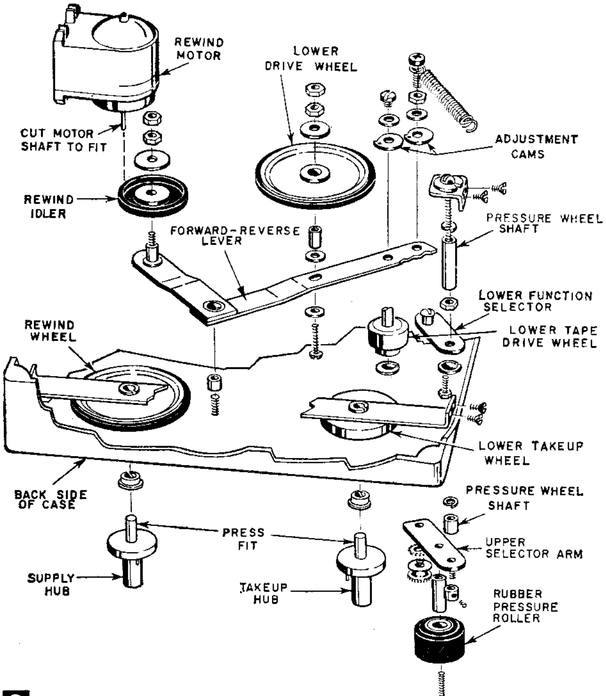
After the tape leaves the recording head it passes between the upper drive wheel and pressure roller and from here to the takeup reel. On playback the erase coil is disconnected by switch (S2) and the recorded signal on the tape energizes the record-playback coil which is now connected to the amplifier input. The amplified signal is fed to the magnetic microphone—now used as an earphone.

A simple three-stage common-emitter amplifier is used. The first two transistors are the PNP and the last the NPN type to allow the mike and record coil return leads to connect directly to common, on both record and playback, without using decoupling filters. High-frequency pre-emphasis is used on *Record* with flat response being used on *Playback* providing better quality with minimum distortion.

Motor noise is removed from the amplifier dc power source with V4, which acts as stable



9 A



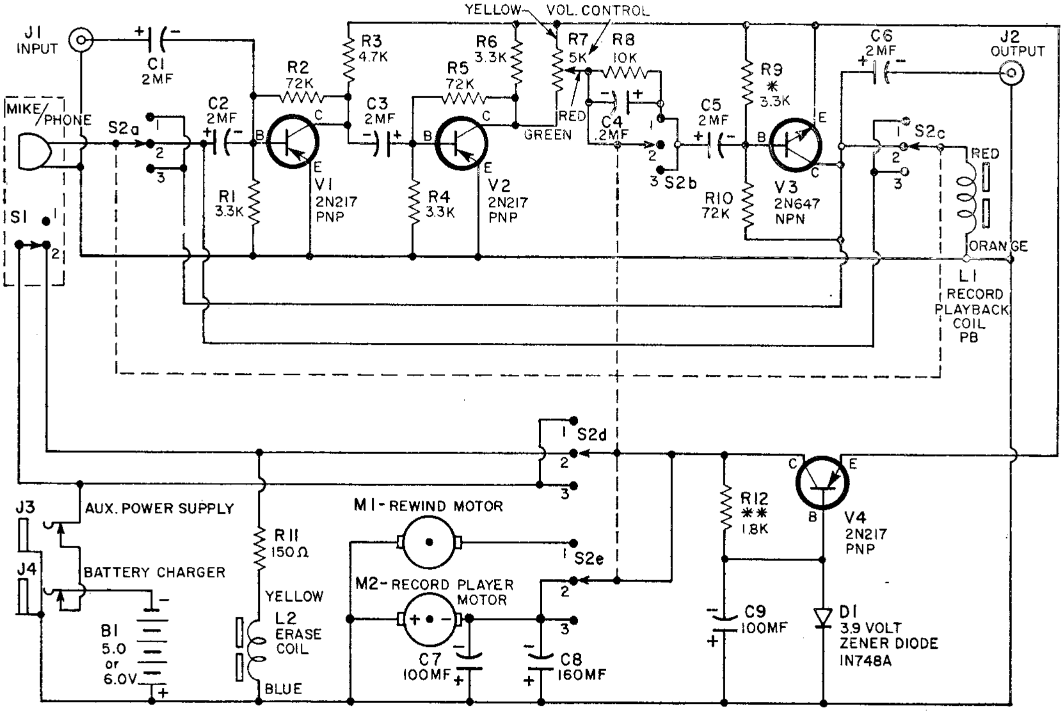
9 ASSEMBLY

voltage regulator. The voltage across the zener diode (D1) is constant at 3.9 as long as the input voltage does not fall below this value. Because this diode is in the base circuit, it determines the voltage output level at the emitter of V4. Since the base voltage is constant, the output voltage will thus be constant regardless of variations at the input (at V4 collector); therefore, variations due to motor noise will be filtered out.

Battery Notes. You can use either rechargeable Sonotone nickel-cadmium, or flashlight cells.

The nickel-cadmium cells provide nearly constant output voltage throughout their charge, whereas the flashlight cells drop off as they are used. Constant voltage is an advantage in maintaining motor speed; however, the 5-volt level approaches the lower limit for best governor operation.

The nickel-cadmium cells are slightly shorter than flashlight cells and a short 4-40 *rh* screw is threaded into the positive terminal of each battery clip to compensate for the difference (Fig. 4).



* ABOUT 3.3K. ADJUST FOR APPROX. .5 MA. L1 CURRENT

** ABOUT 1.8K. ADJUST FOR APPROX. 1 MA. DIODE CURRENT OUTPUT FROM V4 EMITTER SHOULD BE ABOUT 3.9 VOLTS

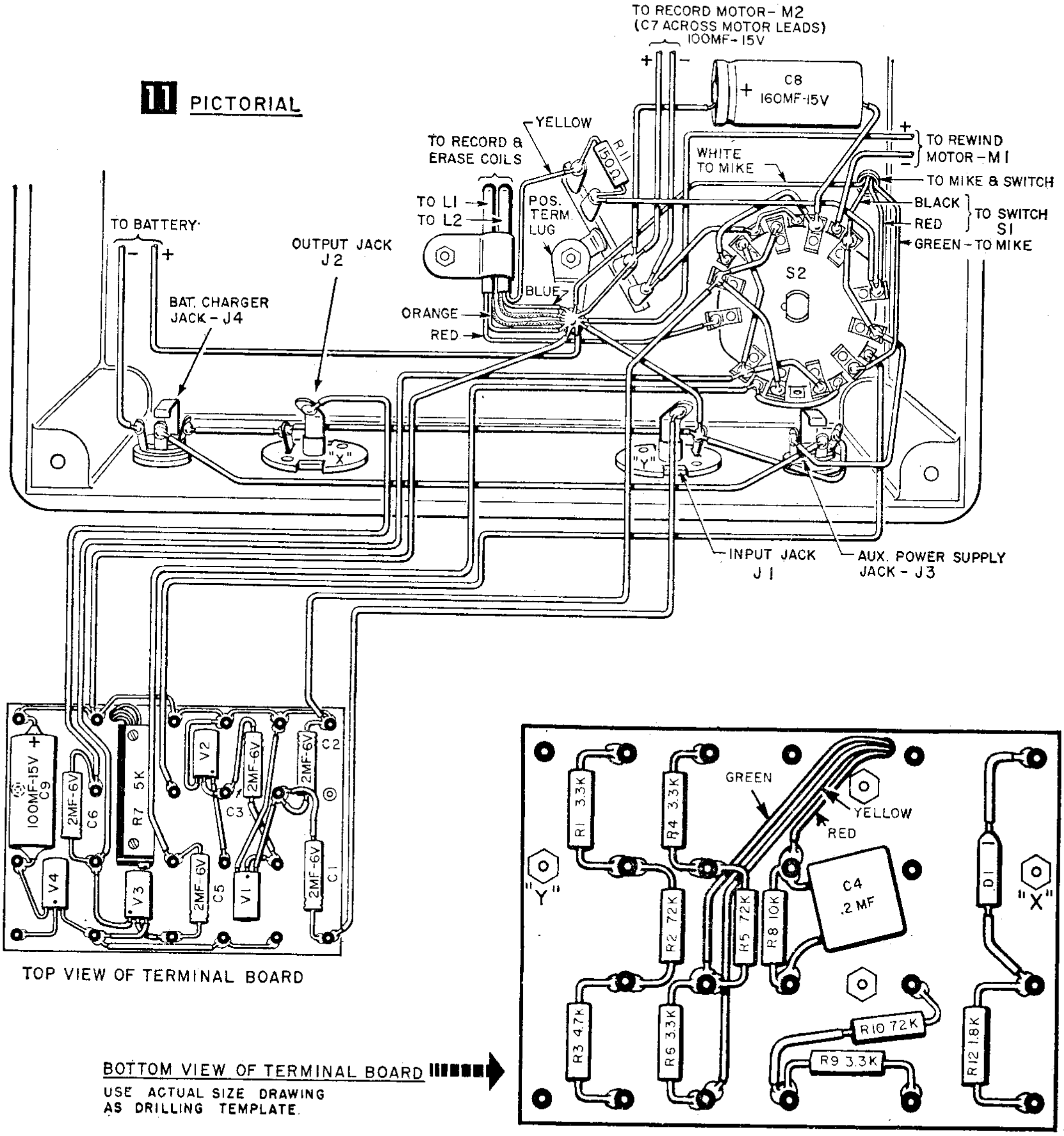
SWITCH POSITIONS

S1
1 = OFF
2 = RECORD

S2
1 = REWIND
2 = RECORD / OFF
3 = PLAYBACK

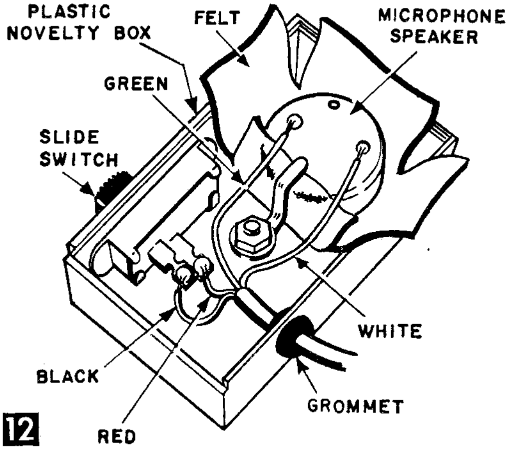
10 SCHEMATIC DIAGRAM

11 PICTORIAL



TOP VIEW OF TERMINAL BOARD

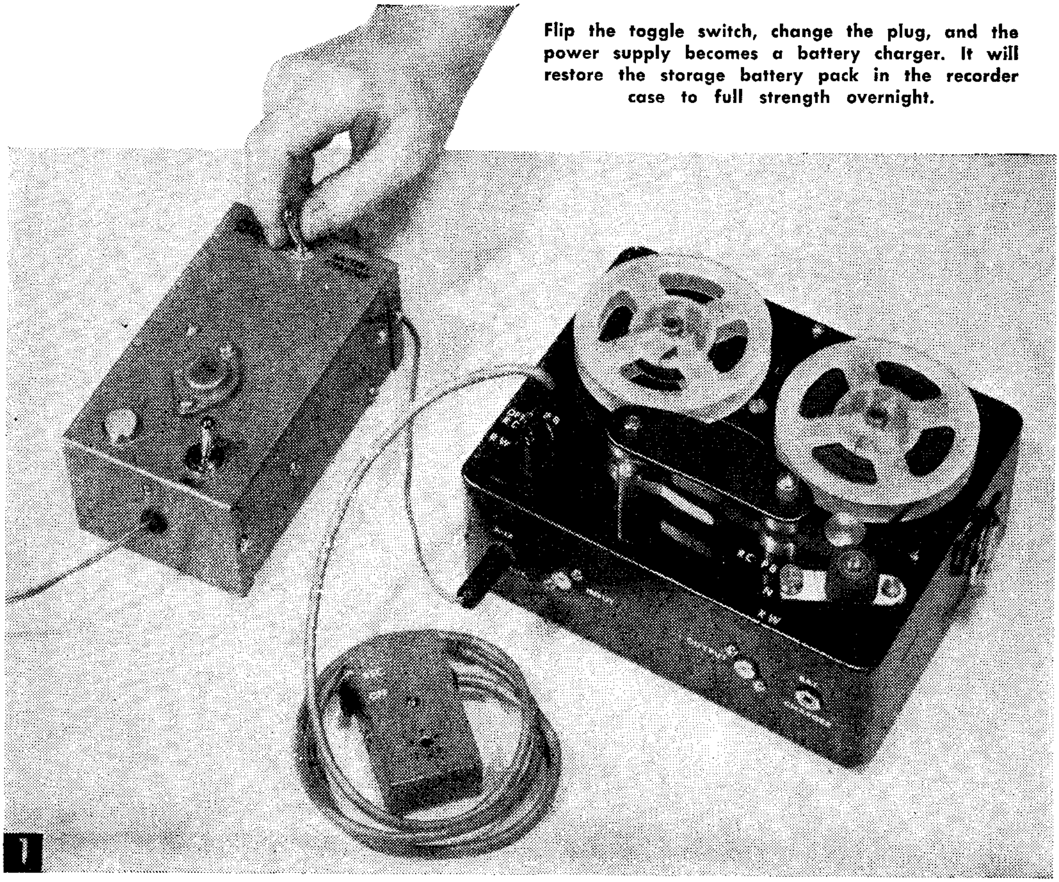
BOTTOM VIEW OF TERMINAL BOARD
USE ACTUAL SIZE DRAWING AS DRILLING TEMPLATE.



12

If you use flashlight cells, select Eveready Type D99, a leakproof type, to avoid damage to the recorder. Jacks are provided to allow recording an external signal; to feed the amplifier output to an external power amplifier; to connect an external power source such as a 6-volt automobile battery or an auxiliary ac power supply; and to connect the charger to the batteries. When the external power supply is connected, internal batteries are disconnected; when the charger is connected, amplifier and motors are disconnected.

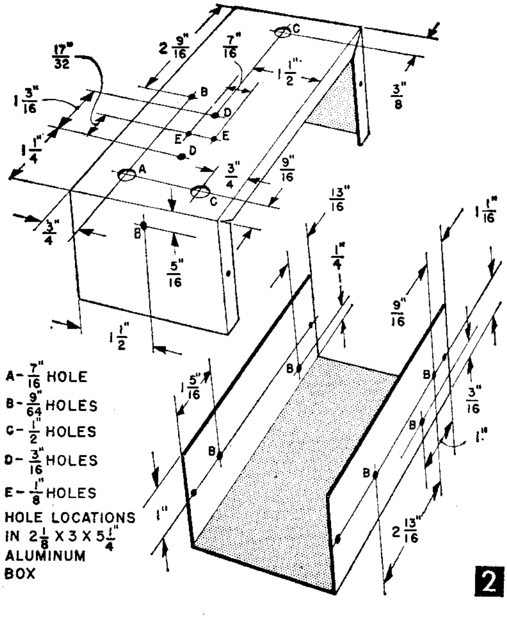
Accessories. The tape cartridge (Fig. 5), allows the recorder to be carried as a portable unit in any position. Plans for a separate power supply appear overleaf this handbook.



Flip the toggle switch, change the plug, and the power supply becomes a battery charger. It will restore the storage battery pack in the recorder case to full strength overnight.

1

Dual Purpose Tape Recorder Power Supply



2

By JAMES E. PUGH

DESIGNED as an accessory for the portable tape recorder, this combination power supply will either recharge the recorder storage batteries, or permit you to operate the recorder without batteries on house current.

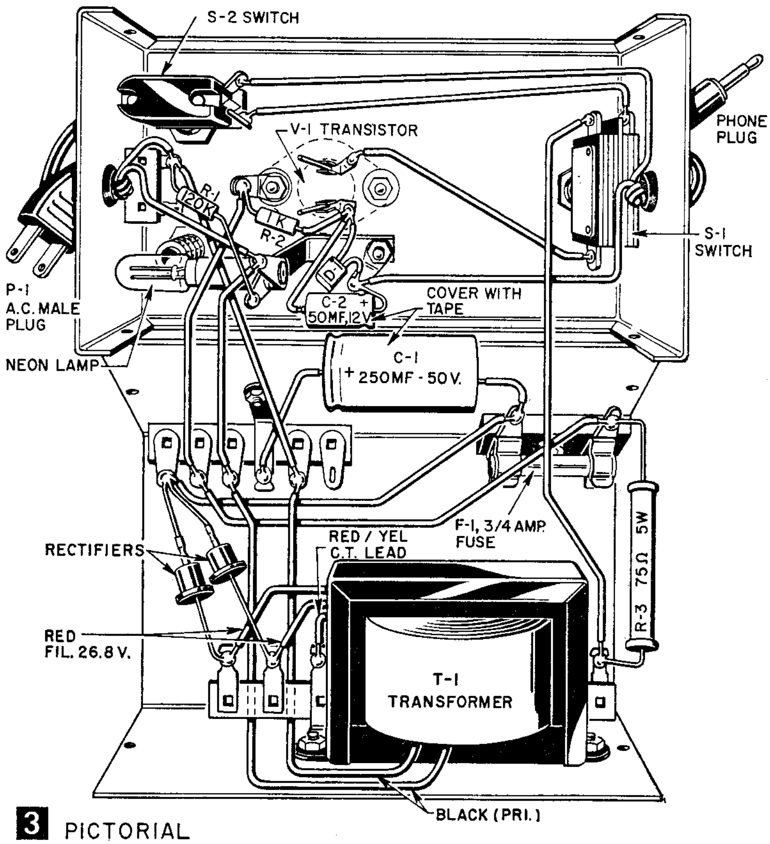
The unit can double as an experimenter's power supply, and to charge miniature storage batteries used in other types of equipment, provided that the charging current (225 ma.) and the charging voltage (5.1, or 6.2-volt) are the same.

While the four *Sonotone* rechargeable batteries used in the portable tape recorder 5-volt power pack will operate continuously for many hours, they must be eventually recharged. This *a-c* power supply unit guarantees that you'll be able to use the tape recorder for continuous dictation or desk use, even though the batteries may be exhausted.

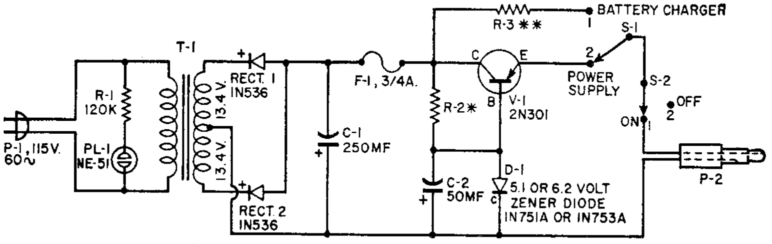
Begin construction by drilling all of the holes (Fig. 2) in the aluminum box. Wire the switches and other parts according to Figs. 3 and 4. Flexible #24 speaker cable is suitable for the *a-c* power cord and the connecting cord since the wattage of this unit is very low.

The power supply regulator, transistor V1, is mounted on top of the aluminum box to provide suitable heat dissipation. Drill the mounting holes in the box first, and then scribe the outline of the transistor case. Scrape away all paint within this outline to allow better thermal contact with the box; sand the surface smooth, and remove all burrs from the insulator holes to prevent puncturing the mounting insulator.

Make a thin mica mounting washer by scribing the transistor case outline on a piece of thin mica. Drill the two mounting holes, cut along the outline with sharp scissors, and then split the mica into thin layers about .002, or .003-in. thick. Coat both sides of the washer with light oil, and mount the transistor with 6-32 machine screws, washers, and nuts. Use an ohmmeter to make sure that the insulation between the aluminum box, and the transistor case is good.



3 PICTORIAL



4 SCHEMATIC

*ABOUT 1000Ω. FOR DIODE CURRENT OF 8 TO 10 MA. OUTPUT FROM V-1 EMITTER SHOULD BE APPROXIMATELY 5.1 OR 6.2 VOLTS (SEE TEXT)
**ABOUT 75Ω FOR CHARGING CURRENT OF 200 TO 225 MA.

Clip off the ends of one of the unused mica mounting washers, and use it as an insulator on the underside of the box. Make the emitter and base contactors from the contacts of a miniature 7 pin wafer tube socket. When soldering to the transistor contacts, remove the transistor to avoid heat damage. Mark the letters B and E near the base and emitter pins to identify them.

Transformer T1 steps the line voltage down to 13.4 volts *a-c* after which it is changed to *d-c* by the full wave rectifier consisting of Rect. 1, and Rect. 2. Transistor V1 and Zener diode D1 form a voltage regulator that filters and maintains the output voltage at the desired level. The same kind of circuit was used in the motor noise filter of the recorder amplifier circuit.

The power supply output voltage should correspond closely to that of the batteries used so as to maintain more consistent motor speed. For example, with four 1.25-volt nickel cadmium cells, use a 5.1-volt Zener diode (IN751A). On the other hand, if you use four flashlight dry cells, 6 volts will result; therefore use a 6.2-volt zener diode (IN753A) for D1.

MATERIALS LIST
TAPE RECORDER POWER SUPPLY

No. Req'd	Size and Description
1	D1—5.1 or 6.2-volt voltage regulator Zener Diode (Texas Instrument IN751A or IN753A, see text)
1	F1—¾ ampere fuse, type 3AG; fuse holder (Littelfuse 3510011)
1	P1—a-c power plug
1	P2—sub-min phone plug (Switchcraft 750)
2	Rect. 1, Rect. 2—IN536 silicon rectifiers (RCA)
1	S1—SPDT toggle switch
1	S2—SPST toggle switch
1	T1—26.8 v., 1A. filament transformer (Triad F-40X)
1	V1—2N301 transistor (RCA)
1	PL1—NE-51 neon lamp
	Capacitors
1	C1—250uf, 50-v. electrolytic capacitor (Mallory TC-50025)
1	C2—50uf, 12-v. ultra-miniature electrolytic capacitor (Barco P12-50)
	Resistors
1	R1—120 K, ½ v., 10% carbon resistor
1	R2—about 1K, ½ watt, 10% carbon resistor (see Fig. 4)
1	R3—about 75 ohm, 5 w., resistor (Sprague 27E)
	Hardware
1	2⅛ x 3 x 5¼″ grey hammertone aluminum box (Bud CU-2106A)
1	On-off toggle switch plate
7 ft.	length 2-conductor chrome vinyl speaker cable (Belden 8782)
1	insulated tie point
1	miniature 7-pin wafer tube socket
1	pilot light socket, miniature bayonet (Dialco 720)
1	½″ pilot light jewel, white (Dialco 10006-435)
misc	rubber grommets, screws, nuts, solder lugs, mica, insulated, extruded washers, decals, plastic spray or lacquer, wire resin core solder

Parts available from Allied Radio, 100 N. Western Ave., Chicago 80, Illinois

When charging the Sonotone batteries, resistor R3 bypasses the regulator circuit to provide a constant current. Between 200 and 225 *ma.* is required for proper charging. About 16 hours are required for a full charge at this rate, though the batteries may be left connected on charge for much longer time without harm.

The pilot light, indicating that the power supply or charger is ready for use, is lit whenever plug P1 is in the 115-volt socket, since the on-off switch does not control this part of the circuit.

When you connect the accessory unit (Fig. 1) to the recorder, always be sure that toggle switch S1 in Fig. 3 is thrown to the position corresponding to the jack to which the plug P2 is connected. When plug P2 is connected to the auxiliary power supply jack on the recorder, the internal battery pack is automatically disconnected. Be sure that S2 is at *Off* when connecting and removing plug P2. Also remove the plug from the charger jack when not charging to prevent the batteries from draining back into the charger circuit.

Polish "Locks" TV Adjustment

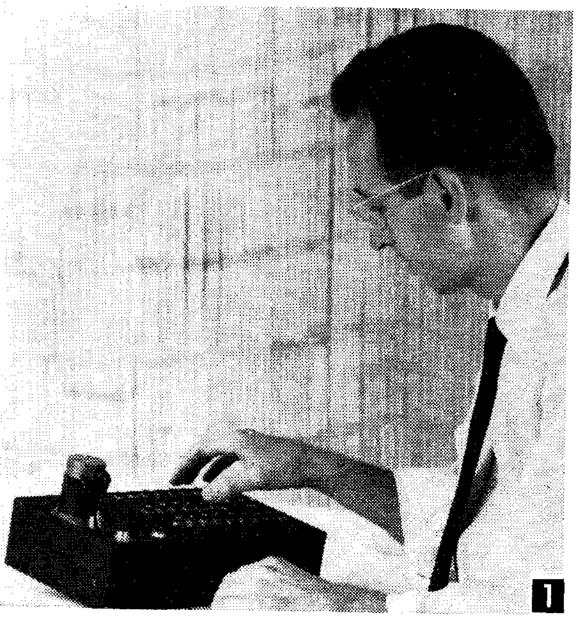
• When you've just finished making a critical adjustment on the service control of a TV set, "lock" the screw firmly against mechanical shocks by coating its threads with fingernail polish. If the control ever needs readjustment, a drop or two of fingernail polish remover will unlock it in a matter of seconds.—JOHN A. COMSTOCK.

"Lady wanted to know could we do anything with this. Hasn't made a move for two weeks."

The Typacode

By BERNARD DICKMAN

With the Typacode you can send Morse code as fast as you can type—whether you know the code or not. Thus, even a person who does not know Morse code can test you on your knowledge of it

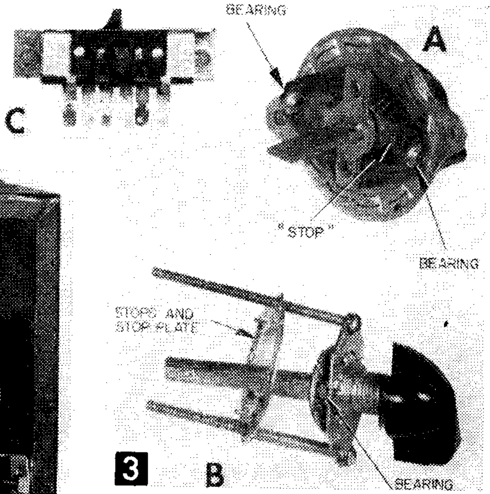


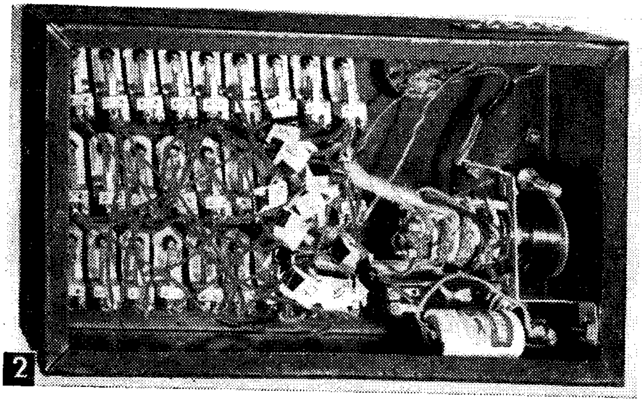
WITH the Typacode, you press a button indicating the letter of your choice and this letter is automatically translated into the correct Morse code pulses. The number of words per minute you can send out with Typacode depends upon the speed of the motor you use to turn the shorting rotary switch, the "brain" of the device. Assuming five letters to the average word, a 100-*rpm* motor will permit you to send 20 words per minute; a 60-*rpm* motor, 12 words per minute, and so on.

But motors aren't usually built to run that slowly, and a gear train is needed to reduce their speed (and increase their torque). I used a worm gear with an 80-tooth gear to get an 80:1 gear ratio and reduce the 6,000 *rpms* of the motor I used to 75 *rpm*. With my Typacode I can send about 15 words per minute. With speed reduced 80 times, torque is increased 80-fold, from 1.5 oz.-in. to 120 oz.-in. The motor I used consumes seven watts. The motor you use should have these approximate specifications in order to be able to turn the rotary switch. Most sewing machine or small fan motors are adequate, or try such a motor as the Hurst 60 *rpm* (RSM-60), Allied Radio catalog No. 76P862.

The number of words the device is capable of sending per minute may also be varied by the introduction of a variable voltage transformer to control the speed of the motor. This will help in adjusting word out-

Standard rotary switch is shown in A; stop to be twisted off or bent down, bearings to be removed. In B is shown a miniature rotary switch. Its stop must be twisted off or bent down, or plate taken off; bearing to be removed. In C is shown an altered (as described in text) slide switch for slide-switch version of Typacode.





Bottom view of Typacode, showing tagged wiring.

put to the sender's typing ability and the auditor's understanding.

Construction. First remove the bearings which cause the rotary switch to click when turned (see Fig. 3). Pry them out with a screwdriver. Also, remove all of the "stops" which prevent the switch from turning continuously in one direction.

There are two basic versions of the device. One uses push-button, and the other uses spring-return slide switches. The spring-return slide switch version is somewhat cheaper, but a bit more difficult to operate. Choose the version you want to build (Figs. 1 and 2 show the push-button version), buy materials, and in either case, wire the shorting gang switch first (Fig. 5 for push-button unit, Fig. 6 for slide-switch unit).

If the gang switch is to be turned clockwise by the motor, Fig. 5 (and Fig. 6) is shown as one looks at the front of the switch. If, on the other hand, the switch shaft is to be turned counterclockwise, reverse the connections. That is, assume that the diagram shows the gang switch as you would look at it from the rear, and wire accordingly. (Remember that gears sometimes change the direction of rotation of the switch shaft.) For convenience, label the wires with tabs numbered as shown in the diagram. Allow approximately 5 in. of wire for connecting the rotary switch to the push-button or slide switches.

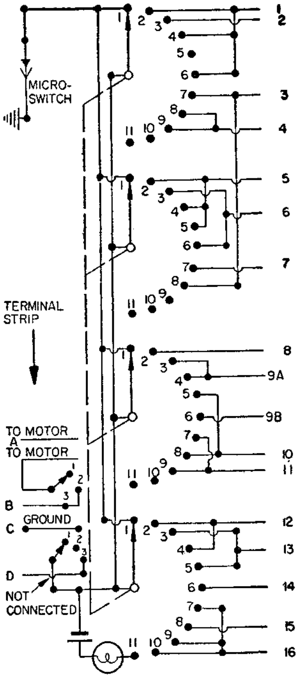
Now drill the holes in the chassis. Arrangement of the keyboard is left to the builder, but it will be found convenient to imitate that of the standard typewriter as closely as possible. Centers of holes for the Allied push-button switches are ¾-in. apart in rows; the rows are spaced 2 in.

If you are using spring-return slide switches, adjust the sliding mechanism as shown in Fig. 3.

Next, install the switches. There is a ground lug

ONE MAKE POS. EACH ON SW......	IS TO BE CONNECTED TO WIRE(S)	WITH MORSE CODE EQUIVALENT
A (SEE FIG.8)	9A	·—
B	1,15	—···
C	1,11	—·—·
D	1	—··
E		·
F	6,10	··—·
G	5,7	——·
H	13,7	····
I	2	··
J	9,16	·———
K	1,7	—·—
L	9,15	·—··
M	5	——
N	12	—·
O	5,3	———
P	9,11	·——·
Q	5,16	——·—
R	9	·—·
S	13	···
T	8	—
U	6,13	··—
V	3,13	···—
W	7,9	·——
X	1, 4	—··—
Y	1,16	—·——
Z	5 11	——··
PERIOD (HOLD FOR THREE FLASHES OF INDICATING LIGHT SEE FIG. 8)	9A	·—·—·—

4 CHART FOR WIRING PUSH BUTTON VERSION



5 WIRING OF PUSH-BUTTON VERSION (SEE FIG 4)

MATERIALS LIST—TYPACODE

Push-Button Version

No. Req'd	Description
18	DPST normally open push button switches for letters B, C, F, G, H, J, K, L, O, P, Q, U, V, W, X, Y, Z and period (Allied 34 B 997)
7	SPST normally open push button switches for letters D, I, M, N, R, S, T (Allied 34 B 994)
1	SPDT push-button switch for letter A (Allied 34 B 996)
1	four pole, 12 positions per pole, shorting rotary switch (Only ten positions are needed for wiring; two extra needed for spacing between letters (Allied 34 B 906)
1	3 x 7 x 12″ chassis (Allied 80 PX 464). Only 7 x 8″ is needed for push button keyboard, but since size of the motor will vary, the rest of the space needed is estimated with ample allowance for variations.
1	motor of the type specified in article and gear assembly *
1	1½ v. flashlight battery
1	indicator light assembly (Allied 52 E 475)
1	miniature bulb (Allied 52 E 330)
1	two-pole, 3 positions per pole, shorting rotary switch (Allied 34 B 303)
1	SPST normally open micro switch (Allied 35 B 028)

* Gears for either push-button or slide switch version are available from the Boston Gear Works with its main office at 14 Hayward St., Quincy 71, Mass. and offices throughout the country. Gear combinations are as follows:

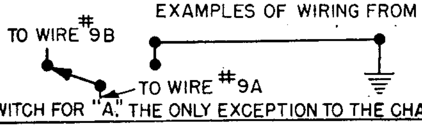
For a 100-1 gear ratio, a 100-tooth worm gear (Boston Gear G1023; hole dia 1/4″) and a worm (Boston Gear HLSH; hole dia. 3/16″) are needed.

For an 80-1 gear ratio, an 80-tooth worm gear (Boston Gear G1022; hole dia 1/4″) and a worm (Boston Gear HLSH; hole dia. 3/16″) are needed.

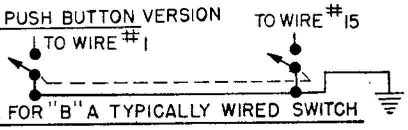
For a 60-1 gear ratio, a 60-tooth worm gear (Boston Gear G1024; hole dia. 1/4″) and a worm (Boston Gear HLSH; hole dia. 3/16″) are needed.

1 coupling between motor and switch or gear assembly

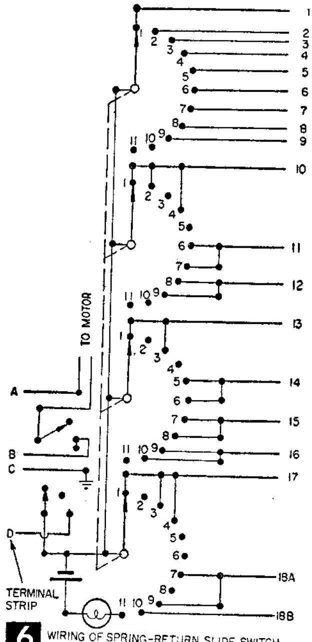
EXAMPLES OF WIRING FROM CHART FIG. 4 ON PUSH BUTTON VERSION



8 SWITCH FOR "A." THE ONLY EXCEPTION TO THE CHART



9 SWITCH FOR "B" A TYPICALLY WIRED SWITCH



6 WIRING OF SPRING-RETURN SLIDE SWITCH VERSION (SEE FIG. 7)

on the Allied push-button switches. Solder two different poles of each two-pole switch, and one pole of each one-pole switch to these lugs. This saves on wiring since now the poles on each switch are interconnected through the metal chassis. Otherwise (on slide switches) interconnect the different poles on each switch. The interconnected poles are referred to as "ground" and are connected to "C" on the terminal strip. Now install the motor, rotary switches, micro switch (this, only in push-button unit), bulb, and bulb socket, and letter the switches. For the push-button switches the letters were typed on a sheet of paper, punched out with a paper punch,

ONE MAKE POS. EACH ON SW....	IS TO BE CONNECTED TO WIRE (S)
A	4, 13
B	6, 8, 10
C	9, 10, 11
D	6, 10
E	1
F	8, 13, 14
G	5, 7, 10
H	5, 7, 13
I	1, 3
J	11, 16, 17
K	10, 11
L	6, 8, 17
M	5, 10
N	10
O	5, 10, 15
P	9, 11, 17
Q	5, 10, 18
R	6, 17
S	5, 13
T	1, 2
U	13, 14
V	5, 13, 15
W	11, 17
X	6, 10, 12
Y	10, 11, 16
Z (SEE FIG. 10)	5, 10, 18A
PERIOD	13, 4 HOLD FOR THREE FLASHES OF INDICATING LIGHT)

7 CHART FOR WIRING SPRING-RETURN SLIDE SWITCH VERSION

then glued to the surface of the button.

Complete the wiring, using the chart Fig. 4 for push-button switches or chart Fig. 7 for slide switches. The first column in the charts refers to the switch, the second to the labeled wire or wires which illustrate connections to switches.

Use. The micro switch is thrown when you want to indicate the end of a word; otherwise the letter "e", a short pulse, is automatically sent. This "e" is a simplifying factor in wiring, since all letters start with a pulse. This pulse is elongated for a beginning dash. The automatic "e" and micro-switch are eliminated on the spring return slide switch unit, the micro switch being comparable to a spacing bar.

On the terminal strip, terminals A and B connect to the power source for the motor (ideally a variable voltage transformer). Terminals C and D connect to the wires otherwise connected to the sending key of the buzzer, code practice oscillator, etc.

Turn the two-pole, three-position switch to the second position. The motor is on, but the unit is not capable of sending code. Next turn the switch to the third position. Each time the motor makes a revolution the bulb will light, and shortly after a short pulse will be sent (only on the push-button unit). Depress the micro "spacing" switch (on the push-button unit only); the bulb will still light, but no pulse will be sent.

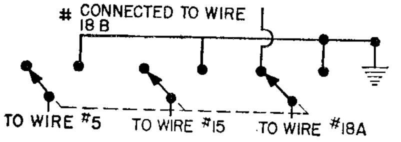
Directly after the bulb lights press the letter "a". A distinct "didah" will be heard. Release "a" and press "b" when the bulb lights again. Continue throughout the alphabet, checking against a standard table showing code equivalents for letters.

MATERIALS LIST—TYPACODE
Spring-Return Slide Switch Version

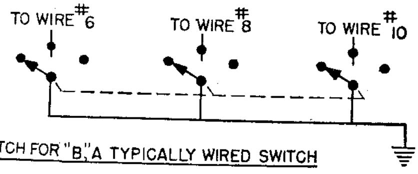
No. Req'd	Description
2	SPST normally open spring return slide switch for letters E, N *
11	DPST normally open spring return slide switches for letters A, D, I, K, M, R, S, T, U, W and period*
13	three-pole, single throw, normally open spring return slide switches for letters B, C, F, G, H, J, L, O, P, Q, V, X, Y*
1	three-pole, double throw, spring return slide switch for letter Z *
1	two-pole, three positions per pole, shorting rotary switch (Allied 34 B 303)
1	1½ v. flashlight battery
1	motor of the type specified in article, and gear assembly
1	7 x 12 x 3" chassis (Allied 80 PX 464). Only 7 x 9 in. is needed for slide switch keyboard, but since size of the motor will vary, the rest of the space needed is estimated with ample allowance for the variations
1	four-pole, 12 positions per pole, shorting rotary switch (Only ten positions are needed for wiring; two extra needed for spacing between letters (Allied 34 B 906)
1	miniature bulb (Allied 52 E 330)
1	indicator light assembly (Allied 52 E 475)
	wire, solder, etc.

* The only spring return slide switch available was a 3-pole, double throw switch. (Allied 34 B 496). If a 3-pole push button switch is available, this device may be built using it.

EXAMPLES OF WIRING FROM CHART FIG. 7 ON SLIDE SWITCH VERSION



10 SWITCH FOR "Z," THE ONLY EXCEPTION TO THE CHART

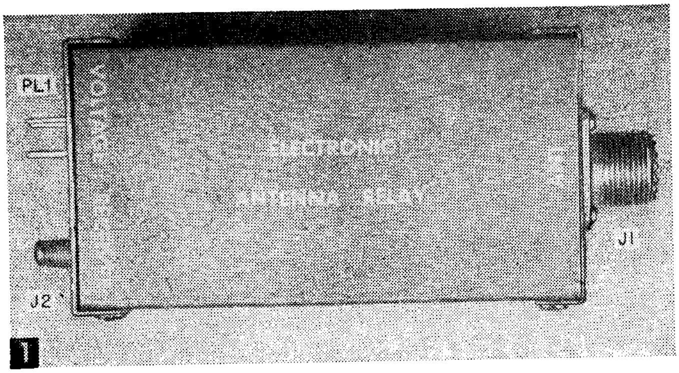


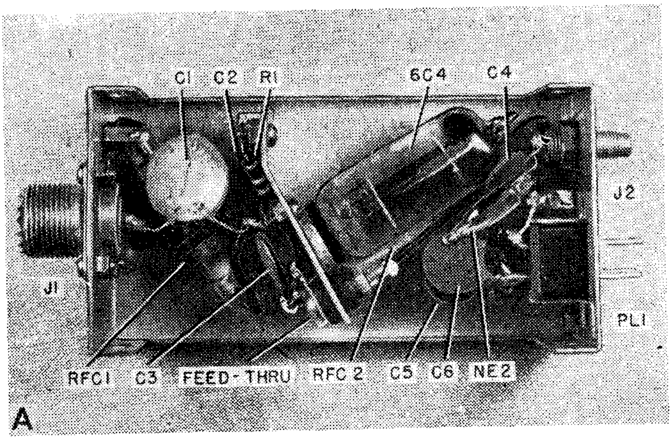
11 SWITCH FOR "B," A TYPICALLY WIRED SWITCH

An Electronic Antenna Relay

For the amateur who still throws an antenna switch, this inexpensive electronic relay will do the job automatically on any band up to two meters, and it will increase the sensitivity of most receivers

By JOE A. ROLF, K5JOK





The completed electronic antenna relay, or T-R Switch, with the cabinet lid in place (above). This unit will permit instant break-in operation with CW transmitters of up to 100 watts input. It can also be used with phone transmitters running up to 85 watts. Interior of the relay cabinet showing construction and layout (below). The 6C4 is mounted on a small aluminum bracket (see Fig. 4) that also serves as a shield between the input and output components. The plate lead on the tube socket is brought through the bracket with a feed-through insulator.

THE one-tube relay shown in Fig. 1 will handle up to 100 watts CW, or 85 watts phone. It is designed for use with any amateur antenna having an impedance of 25 to 300 ohms, and it permits instant CW break-in and greatly simplifies AM transmitter control. It also acts as a low-gain RF amplifier to improve receiver performance.

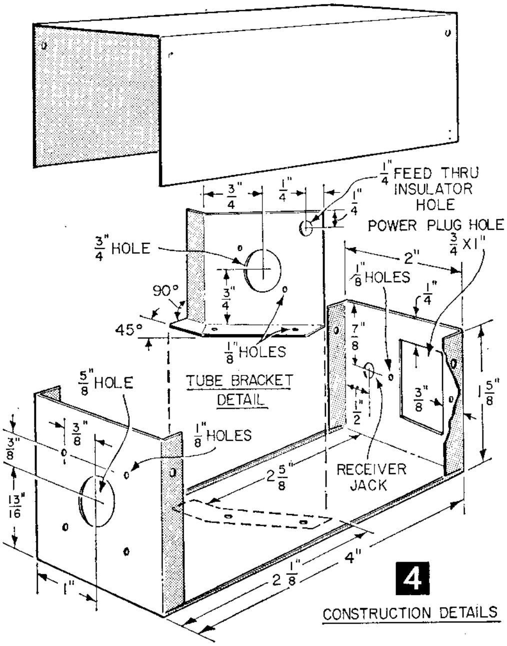
Figure 2 shows the circuit, Fig. 3 the connections to transmitter, receiver, and antenna. The T-R switch is inserted across the antenna feedline, in parallel with the transmitter. With the transmitter inoperative, the relay acts as a grounded-grid amplifier, allowing signals from the antenna to pass through to the receiver. When the transmitter is keyed, however, the relay's 6C4 is blocked and effectively isolates the receiver from the antenna.

The large biasing resistor R1 permits the 6C4 to conduct very weak RF signals to the receiver, while the strong signal from the transmitter creates a cut-off bias on the tube that prevents conduction to the receiver. Very little power is taken from the antenna since only a small amount of RF is required to block the 6C4.

The entire relay is built inside a 1⅝ x 2⅛ x 4-in. Minibox. For compactness and simplicity, the unit is powered by the station receiver or transmitter. A Cinch-Jones chassis plug receives the power cable; a miniature coax antenna jack mounted beside it connects the unit to the antenna terminals of the receiver. A standard coax jack at the other end of the Minibox connects the unit to the antenna feedline. Construction and drilling details are shown in Fig. 4.

The author used a six-prong power plug (Cinch-Jones P-306-AB) on his unit to match an existing cable from his receiver. A three- or four-prong power plug can be used if desired. Also, if the builder prefers, phono jacks can be substituted for the coax antenna jacks—though coax jacks are recommended for high-frequency use to avoid losses and to insure adequate shielding.

The 6C4 is mounted on a small aluminum bracket (see Fig. 4) fastened to the bottom of the Minibox. The bracket is set at an angle



4 CONSTRUCTION DETAILS

relay as shown in Fig. 3. The receiver should *not* be connected during initial tests. Apply power to the T-R Switch and reload the transmitter to the antenna. If the relay is working properly, the transmitter should require only slight readjustment, if any.

The neon bulb NE-2 is a safety device to indicate any dangerous amount of RF across the output terminals of the relay. If this bulb glows when the transmitter is keyed, it is an indication that the relay is not working properly. Check for a bad tube or wire-up.

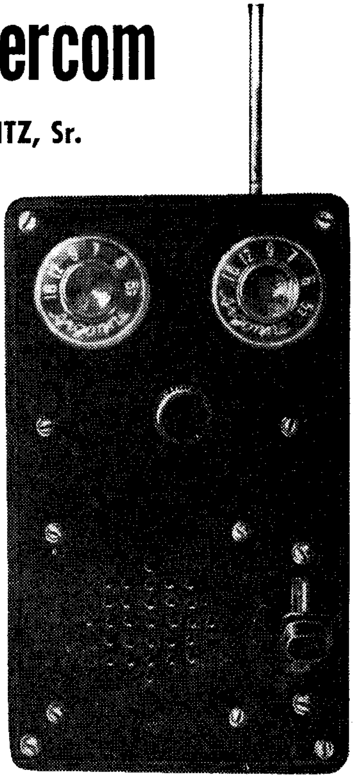
If the unit is carefully constructed, only enough RF will reach the receiver to provide comfortable monitoring. If the receiver overloads while transmitting, it is probable that RF is entering the receiver through ventilation louvers or an exposed antenna connection (if the receiver has a terminal strip antenna post).

But a coax antenna jack and copper window screen taped over ventilation openings in the receiver cabinet will generally cure this. In some cases, shielding the transmitter cabinet will help. Another remedy for overloading on CW, or feedback on phone, is to reduce the receiver gain control when transmitting.

The cost of this simple electronic antenna relay is only slightly more than that of a good antenna relay, but this unit has the advantage of permitting switchless CW operation with a single antenna system. To transmit, just start keying and the receiver is automatically disconnected from the antenna. On phone, only one switch is needed to put the transmitter on the air.

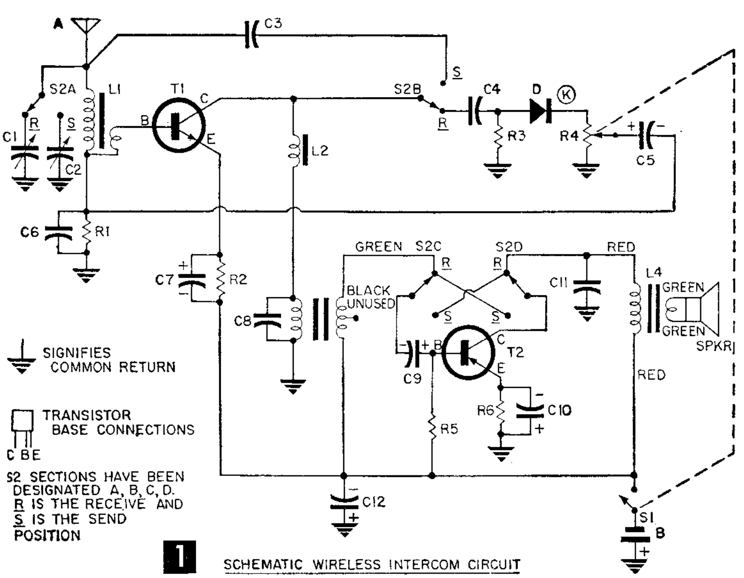
A Portable Wireless Intercom

By FORREST H. FRANTZ, Sr.



A neat, compact, two-transistor device, this portable intercom also functions as a broadcast band receiver.

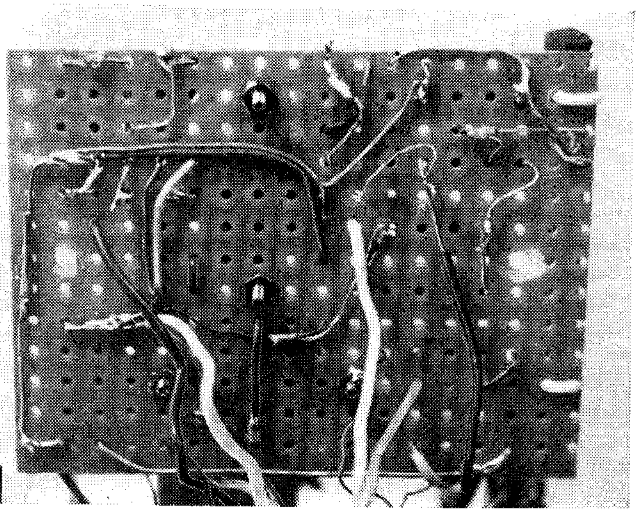
This transceiver makes an excellent week-end construction project. It does not require a license!



1 SCHEMATIC WIRELESS INTERCOM CIRCUIT

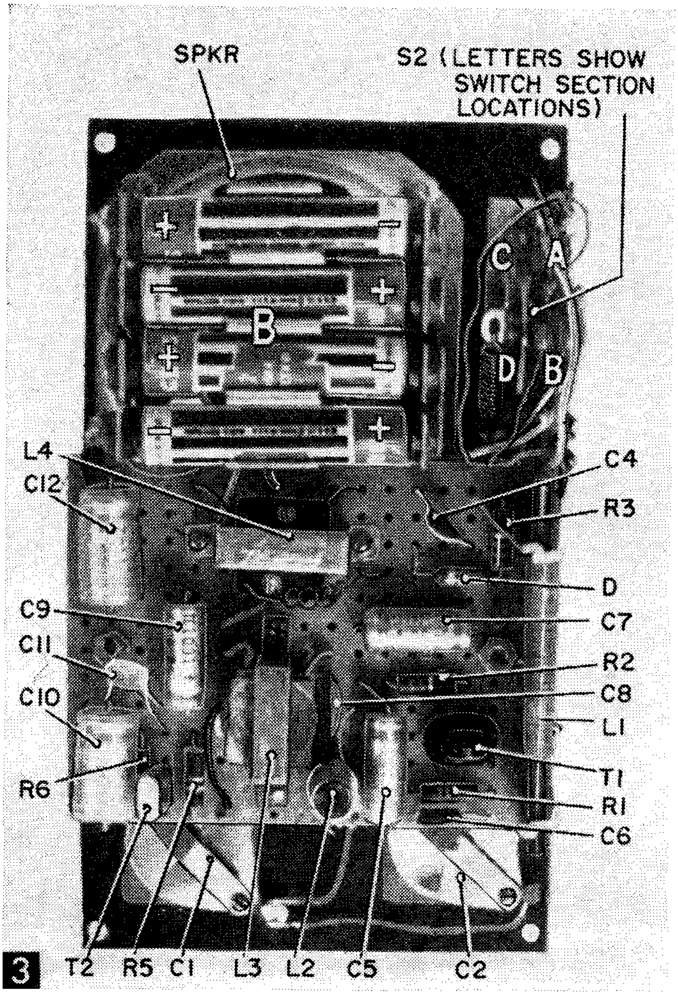
THERE'S no need to be stuck with intercom stations at fixed locations in your home. This portable wireless intercom can be carried wherever you wish to use it. It operates in the broadcast band under FCC limited radiation rules, and therefore does not require a license (limit communication distance to 75 ft.), and the receiver can be used for BCB reception. Components will cost between $10 and $15. For two-way communications, of course, you need two units. But with one unit you can indulge in one-way communication by using a broadcast receiver as the second station.

Trouble-Free Construction. The leads connecting to the Send-Receive switch, and those in the RF portion of the unit should be kept short and direct. When construc-



2

Circuit board wiring.



3

Parts call-out in case.

tion is completed, you may have to redress them to eliminate oscillation. First, remove antenna coil L1 from its Masonite mounting strip. Then cut shaft of volume control R4 to a length of ¼ in. Then turn connection of battery holder lugs over with pliers to form series connections and solder (see Fig. 3). Fill contact eyelets with solder.

Jumble-wind coupling coil L2 from 25 ft. of 7/41 litz wire on ¾-in. length of ¼-in. dia. ferrite core. Leave 1½ in. connecting leads. Apply a coat of Duco cement to hold the windings in place. Clean and tin the ends of the leads.

Drilling and Cut-Outs. The circuit board as purchased is cut to correct size. Holes must be drilled in it as shown in Fig. 4. The front panel as purchased is cut to correct size and contains the four corner holes required to fasten it in the case. The other hole and switch cut-out locations are shown in Fig. 5. The cut-out for the Send-Receive switch is made by drilling a series of adjacent holes, finished with a keyhole saw and a file. The hole in the case for mounting the antenna is 5/32 in. dia. placed 1 in. from the front and 1 in. from the right-hand side on the top of the case.

Front Panel Component Mounting. Mount C1 and C2. The dials are removed by loosening the knurled decorative head screws. These capacitors, because of their compact construction, sometimes develop shorts. Connect an ohmmeter across each of them in turn and rotate the shafts. If either of the capacitors is shorted, send it back to the supplier for replacement. *Don't* attempt a repair.

Mount the volume control (R4), the Talk-Listen switch (S2) and the loudspeaker (SPKR). Place the knob on R4 and the handle on S2. Fasten the 1-in. machine screws (which hold the circuit board in the final assembly) to the front panel.

Circuit Board Wiring. Mount transformers L3 and L4, and mount the antenna coil L1.

Fasten the coil with insulated hook-up wire or cord passed through the circuit board and tied around the coil. A few drops of Duco cement will hold it in place.

Using Figs. 1, 2, and 3 for guidance, wire the circuit board. Mount the components as required in the progress of the wiring. Note that most of the component pigtails pass through the circuit board. The pigtails are bent over and soldered together to form the circuit wiring. This produces a neat job, permits you to make short connections, and makes the compact size of the unit possible.

The leads which are to be connected between the circuit board and the panel wiring of the circuit board should be connected during the wiring of the circuit board. Leave these leads about 6 in. long and cut to length later when the wiring board and panel assemblies are integrated. Use wires of different colors and keep a record of the code to make integration of the circuit board and front panel easier.

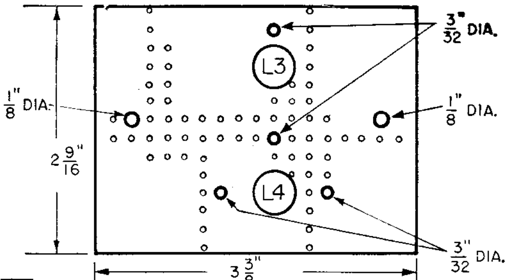
Front Panel Wiring. Wire R4-S, C1, C2 and the portion of the S-2 connections that do not tie into the circuit board wiring. The gimmick C3 is simply a piece of hook-up wire connected to S2 and twisted loosely around the lead from S2 to C2. Wire insulation acts as the dielectric. In making connections to S2, be careful to avoid bending or exerting undue pressure on the switch contacts and lugs. Also be cautious about exerting pressure on the switch wafer.

Mount the circuit board on the 1-in. machine screws provided on the front panel for this purpose. The nuts near the ends of these screws (Fig. 2) should be adjusted for correct spacing of the mounting board from the panel. Be sure that there aren't any shorts between the switch S1 and the circuit board. The lugs of S1 may have to be bent slightly to the side.

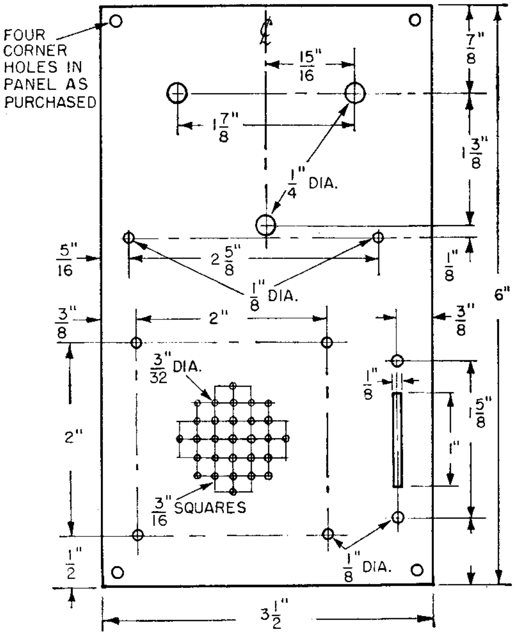
Make the interconnections between the front panel and the circuit board. The secondary of L4 connects to SPKR and several leads from the circuit board connect to R4-S1 and S2.

Mount the battery holder on the speaker magnet frame by passing a loop of wire around the holder and frame on each side of the magnet. Twist the ends together on the bottom side. A drop of Duco between the speaker and the battery holder will tend to make the mounting more solid. Connect the battery holder into the circuit. Insert the batteries in the holder, observing correct polarity. Then provide a lead from S2A to the antenna and place the assembly in the case. But don't fasten the four panel holding screws yet.

Testing Operation. Turn switch S1 on and turn R4 clockwise for maximum volume. Tune C1 to a local broadcast station. If you can't pick up a station, extend the antenna. If you still can't pick up a station (assuming you're within 5 miles of a 250-watt station or within 10 miles of a 5 KW or more powerful station), recheck the wiring. Incorrect positioning of the S2C and S2D leads may cause audio feedback. To cure consistent squealing and whistling, redress these leads.



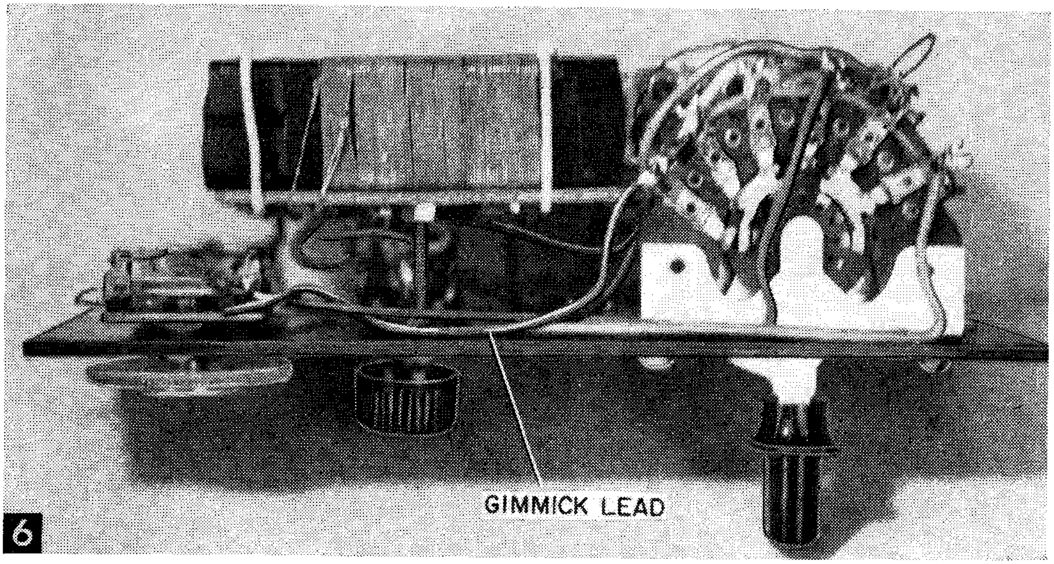
4 CIRCUIT BOARD, FRONT VIEW



5 PANEL, FRONT VIEW

When you have broadcast reception, remove the set from the case and move the position of the lead on the antenna end of L1 relative to C4 for maximum gain at the high-frequency end of the broadcast band. Then decrease the volume control setting to about half of full setting. If the set squeals, decrease the coupling between the L1 lead and C4 till squealing quits.

Turn a broadcast receiver on and tune to a frequency at which you don't receive a broadcast station. Then, from a position near the receiver, with the intercom on and the antenna pushed down, push S2 to the send position. Adjust C2 till the intercom carrier comes in on the broadcast receiver. The



6

Side view of front-panel mountings.

coupling of gimmick C3 may have to be increased to attain a signal or decreased to minimize squealing and distortion at the receiver. Audio feedback due to coupling between intercom and receiver causes squeals also—but occurs only when receiver and intercom are within audible "hearing" distance.

MATERIALS LIST—WIRELESS INTERCOM

Desig.	Description
R2, R6	270 ohm, ½ watt carbon resistor, 10%
R3	33K, ½ watt carbon resistor, 10%
R5	100K, ½ watt carbon resistor, 10%
R1	270K, ½ watt, carbon resistor, 10%
R4-S	10K miniature volume control with switch (Lafayette VC-28)
C3	gimmick (see text)
C4	100 mmf., 1000 v. ceramic capacitor (Sprague 5 GA-T1)
C6, C8, C11	.01 mfd., 50 v. ceramic capacitor (Sprague TG-S10)
C5, C7, C9	25 mfd., 6 v. miniature electrolytic capacitor (Sprague TE-1091)
C10, C12	100 mfd., 6 v. miniature electrolytic capacitor (Sprague TE-1102)
C1, C2	365 mmf. miniature variable capacitor (Lafayette MS-445)
T1	2N168A transistor (General Electric)
T2	2N407 transistor (Sylvania)
D	1N66 diode (Raytheon)
S2	4P2T spring return lever action switch (Centralab 1457)
L1	ferrite antenna loop coil (Miller 2004)
L2	25′ 7/41 litz wire wound on ¾″ length, ¼″ dia. ferrite core. (Lafayette MS-331 is a 7½″ length of ferrite core and Belden 8817 is a 100′ length of the wire)
L3	10K to 2K miniature driver transformer (Lafayette TR-96)
L4	2K to 10 ohm miniature output transformer (Lafayette TR-93)
SPKR	10 ohm, 2½″ loudspeaker (Lafayette SK-66)
A	miniature telescoping antenna (Lafayette F-343)
B	four 1.5 v. penlite cells, series connected (Burgess No. 7)
	battery holder (Lafayette MS-170)
	miniature knob (Lafayette MS-185)
	2 7/16 x 3⅜″ miniature perforated circuit board (Lafayette MS-304)
	2 x 3¾ x 6¼″ Bakelite case (Lafayette MS-216)
	front panel for case (Lafayette MS-217)

Components for this project may be obtained from Lafayette Radio, 100 6th Avenue, New York 13, N. Y.

The antenna may be extended to increase range, but don't open it far enough to permit reception beyond 75 ft. The intercom will function best for communication when held upright with the antenna vertical. It will function best as a broadcast receiver when the antenna loop is horizontal. It is extremely directional and selective in this plane.

Operating Principles. The remote wireless intercom is an intercom that permits talk-and-listen operation with another unit without requiring connecting wires. The speaker functions as mike and speaker. Separate talk and listen tuning controls permit tuning to any desired frequency with easy switching from talk to listen without having to retune. To receive, C1 must be set for the frequency that C2 of a second intercom is tuned to in order to receive it. It is best to tune the two intercoms and then lock the capacitors. Don't depend on dial calibration to do the job.

The wireless intercom employs only two transistors and one diode. In the listen function T1 acts as an RF amplifier, and diode D1 rectifies the signal to provide an audio voltage signal. This signal is fed back through T1 which amplifies the signal again. Then the signal progresses to output stage T2 and the loudspeaker. The receiving circuit achieves considerable gain and selectivity with minimum equipment through the use of good components and the exercise of design innovations.

On the talk function, the coupling from the collector of T1 to the antenna and base of T1 is increased by C2 to produce broadcast frequency oscillation. The input and output connections to T2 are changed by S2 to make the speaker function as a mike and to make T2 function as a modulator for T1.

Dry Battery Tester-Charger

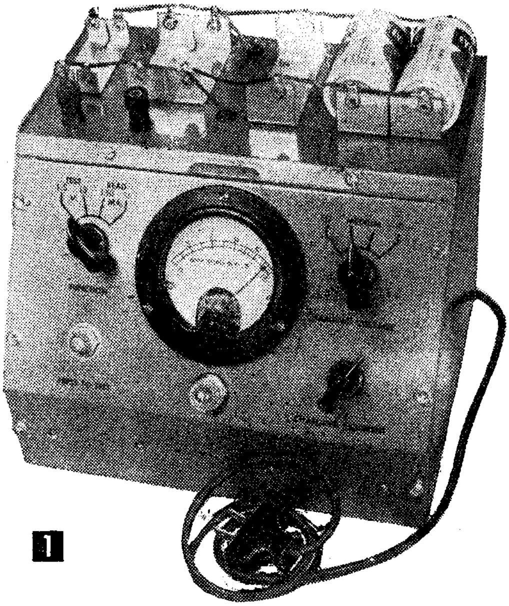
A single unit to test and charge flashlight, transistor radio and other small batteries

By W. F. GEPHART

RECHARGING or boosting small dry batteries can be worthwhile if you have several flashlights, battery radios or other battery-powered equipment. Properly used, a charger can triple or quadruple the lift of batteries, making the investment in a charger worthwhile. The unit shown in Fig. 1 also includes a tester to show when "recharging" is desirable. (Since dry batteries are essentially primary cells in which a chemical reaction takes place, true recharging is not possible. However, rejuvenation, which will extend the life of the cells, *is* possible. We'll call this recharging.)

Recharging must be done before the battery is completely exhausted. New batteries usually read about 1.5 *v* per cell (without load) on the average meter. Under normal load (about 25 *ma* for a battery made up of penlight cells, and about 150 *ma* for the larger flashlight batteries) the voltage of a fresh cell should not drop more than 10%. Thus, a type "D" flashlight battery in top condition ought to test at 1.5 *v* or better without load, and not less than 1.35 *v* with a 150 *ma* load. When it drops below these levels, it should be recharged. Recharging is not too effective when the voltage (with or without load) is below two-thirds of the new-condition voltage.

Bear in mind, too, that the battery must be placed in service promptly after recharging. The shelf life of recharged batteries is short (probably due to the limited chemical action that takes



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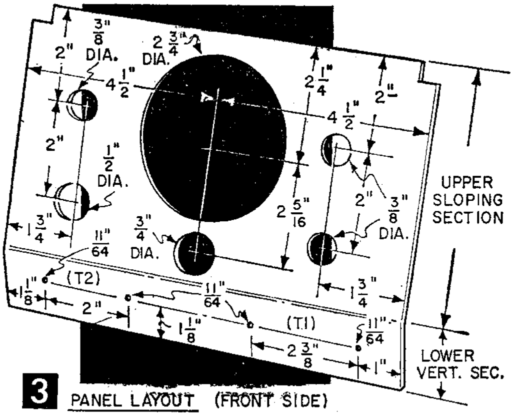
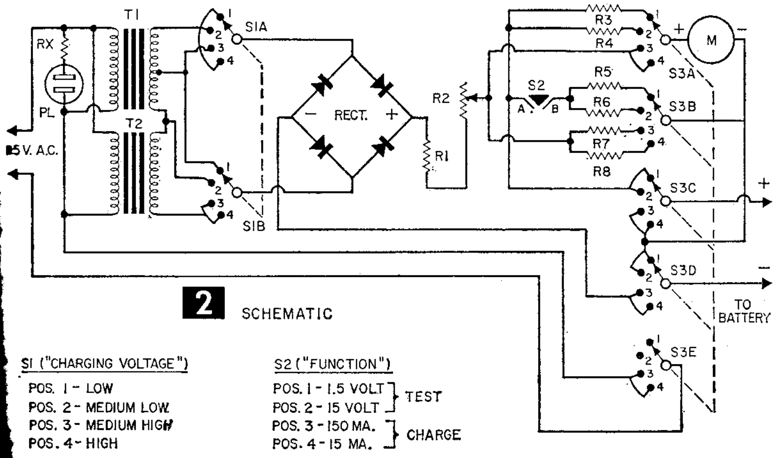
Overall view of charger. Battery clip arrangement may be varied to meet individual needs.



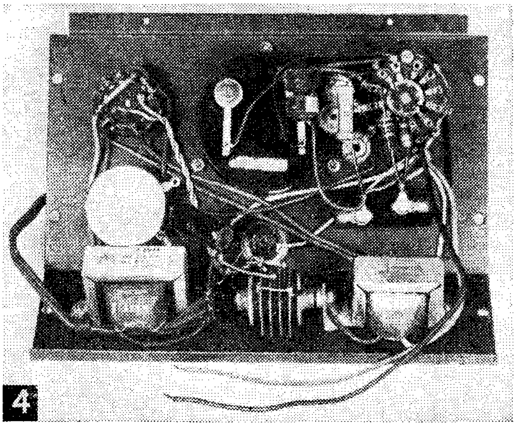
3 PANEL LAYOUT (FRONT SIDE)



2 SCHEMATIC

S1 ("CHARGING VOLTAGE")
POS. 1 - LOW
POS. 2 - MEDIUM LOW
POS. 3 - MEDIUM HIGH
POS. 4 - HIGH

S2 ("FUNCTION")
POS. 1 - 1.5 VOLT } TEST
POS. 2 - 15 VOLT } TEST
POS. 3 - 150 MA. } CHARGE
POS. 4 - 15 MA. } CHARGE



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Inside view of unit. All parts are mounted on back of front panel.

MATERIALS LIST—BATTERY CHARGER

Desig.	Description
Rx	56K, 1/2 watt (required only if not included in PL)
R1	20 ohm, 1 watt
R2	200 ohm, 4 watt potentiometer (Mallory M200PK)
R3	1500 ohm 1% precision (see text)
R4	15K 1% precision (see text)
R5	10 ohm, 1/2 watt
R6	330 ohm, 1/2 watt
R7	.66 ohm 1% precision (see text)
R8	7.14 ohm 1% precision (see text)
S1	two-pole, 4-position rotary switch (Mallory 3226J)
S2	SPST push button, normally open
S3	five-pole, 4-position rotary switch (Mallory 1335L)
T1	6.3v CT 1 amp filament transformer (Merit P-2944)
T2	6.3v 1/2 amp filament transformer (Merit P-2964)
Rect.	bridge-connected selenium rectifier: a-c input—15 v maximum, at 200 ma (Federal 1016)
PL	pilot light holder for NE-51 lamp (Dialco Series 95408X and 942208 have built-in resistor Rx)
M	0-1 milliammeter
	Steel cabinet, 6 1/2 x 7 1/4 x 9" (Bud C-1585), NE-51 lamp, 3 knobs, 2 binding posts, battery holders as desired, line cord, miscellaneous hardware

place). Even so, the drop in voltage after charging is the greatest in the first 24 hours.

No one seems quite sure what actually happens in dry battery recharging, and some experimenters claim the best results with *ac* charging voltages, some with *dc*, and some with a combination. This unit uses unfiltered, fluctuating *dc*, which seems to give the best results in the shortest time. Filtered *dc* (secured by placing a large capacitor across rectifier output) seems to give about the same results, but requires a charging time of 12-20 hours.

Here are some results with unfiltered *dc* and an hour's charging time:

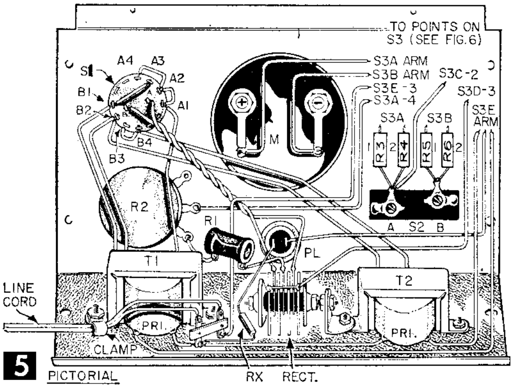
Type Battery & Service		Before Charge	Immediately After Charge	2-5 Days Later*
Two "D" Cells	No Load	1.35 v	1.52 v	1.40 v
(Flashlight)	Load	1.20 v	1.37 v	1.35 v
Three "D" Cells	No Load	1.33 v	1.40 v	1.35 v
(Strobelight)	Load	1.15 v	1.33 v	1.30 v
Two "C" Cells	No Load	1.35 v	1.60 v	1.45 v
(Flashlight)	Load	1.15 v	1.50 v	1.35 v
9 v Transistor#	No Load	7.5 v	8.7 v	8.0 v
(Radio)	Load	2.0 v	7.2 v	6.0 v

* shelf life time; not in service
\# charged at 9 ma; all others charged at 100 ma

We see that particularly in the case of the transistor battery, recharging is not too effective when the battery nears exhaustion. The charging rate must be fairly low, with a range of 5-30 *ma* recommended for batteries made up of penlight cells, and a range of 50-200 *ma* for the larger cells, such as "C", "D", and "A" cells.

Schematic Fig. 2 shows that switch S_3 controls the function of the unit. On Positions 1 and 2, used for testing, proper meter multipliers are switched into the circuit for reading the battery voltages, and load resistors are cut in by pressing switch S_2. When switch S_3, is on Positions 3 and 4, *ac* power is on, and the *dc* output is fed through the meter (with proper current shunts) to the battery, with terminal polarity reversed. The proper charging voltage and current is selected by switch S_1 and rheostat R_2. Two filament transformers, with their secondaries wired in series through S_1, provide *ac* input voltages to the rectifier of 3.15, 6.3, 9.45, and 12.6, which are sufficient for all batteries up to 9 volts. Resistor R_1 is a limiting resistor to prevent the current from reaching excessive levels.

All parts (except battery holders and terminals) are mounted on the front panel of a small sloping-front cabinet, as shown in Figs. 4 and 5. The layout for the panel is shown in Fig. 3, except for the meter mounting screw holes, which should be drilled to fit the meter being used.



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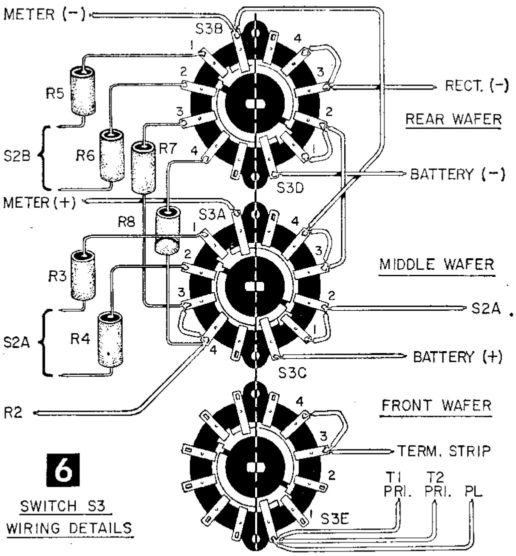
The values shown for resistors R_3, R_4, R_7 and R_8 are applicable only to a 0-1 *ma* meter with an internal resistance of 100 ohms. This is a standard 1000 ohms/volt movement, but values for other meter movements can be calculated with the formulas top of opposite page for the ranges shown on Fig. 2:



6
SWITCH S3
WIRING DETAILS

$$R3 = \frac{15 - (Im \times Rm)}{Im} \qquad R4 = \frac{15}{Im}$$

$$R7 = \frac{Im \times Rm}{.014} \qquad R8 = \frac{Im \times Rm}{.150}$$

Im is the full scale deflection of meter in amperes, Rm is the internal resistance of meter in ohms.

Wire the primaries of the transformers and pilot light first. Then check polarity of the secondary leads of the transformers so that series wiring will give 12.6 *v*. If the polarity is incorrect, the two secondaries will buck each other, and give no output voltage when wired in series. Complete the wiring.

The selection of the number and types of battery holders mounted on the cabinet will depend on individual needs. Two binding posts, wired in parallel with the battery holders, are also provided. Several sets of leads, using the most often needed battery plugs can then be used with the binding posts for those batteries that do not fit in the holders.

To use the unit, plug it in, turn S_1 to "Low", R_2 to full counterclockwise position, and S_3 to "15V Test." Put the batteries in the proper holder (or attach to leads), and switch S_3 to the appropriate scale and read the no-load voltage. Then press S_2 to read the voltage under load. Resistor R_5 provides a 150 *ma* load with 1.5 *v*, and R_6 provides a load of about 14 *ma* at 4.5 *v*, 18 *ma* at 6 *v*, and 27 *ma* at 9 *v*. Next, switch S_3 to the desired charging current range, and set the charging rate by adjusting S_1 and R_3.

Generally, charging for an hour or two at the rates mentioned above will be effective. The rate may be increased, but under no conditions should the battery be permitted to get warm. Longer charging times can be used, with varying effectiveness, depending on the charging rate and battery condition, but the unit should be watched. Sometimes excessive charging, either in current rate or time, seems to break the cell down, and the current rises, increasing the damage.

Unscrewing the Inscrutable

Those Darn Decibels!

by Ol' Rock

Few terms are as frequently misused or widely misunderstood in electronics as is the *decibel.*

The decibel system merely *compares* signal power levels. Properly used, it makes possible a great simplification of arithmetic.

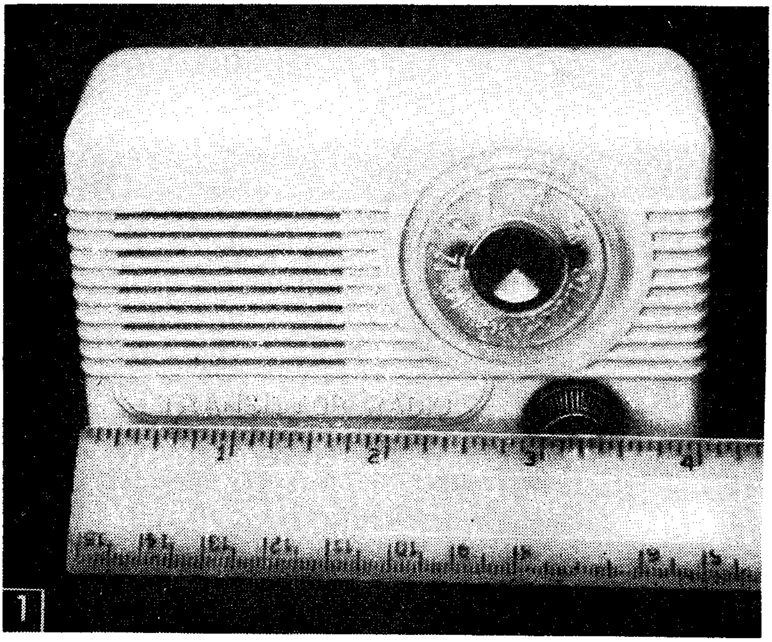
Decibels can be used to compare any two signal power levels of the same kind, in either an acoustical or electrical system. Or, one may compare the power of a given signal with a previously agreed-upon standard. When the signal being considered is compared to a similar, hypothetical, one-milliwatt signal, we speak of the "level" of the signal concerned, in DBM. Further, one may compare, in decibels, the strength of a given signal to that of the noise power in the same system—the "signal to noise ratio."

Let's get straight on the basic facts: First, the decibel measures *ratios*, that is, how many times greater or less-powerful is the signal concerned, as compared to the reference signal. Second, decibels are not measured upon an ordinary arithmetical scale, but rather upon what engineers call a *logarithmic* scale. This is perhaps the most confusing point to the uninitiated. Twice as many decibels do *not* mean twice as strong a signal, for instance. Here's how a decibel scale works:

Ratio of Signal Power	DB Greater	DB Less
Signal powers equal	0 DB	0 DB
First signal twice as strong, or one-half as strong as the other	+ 3 DB	− 3 DB
First four times as strong or weak	+ 6 DB	− 6 DB
First ten times stronger or weaker	+10 DB	−10 DB
First 100 times greater or less	+20 DB	−20 DB
First 1000 times greater or less	+30 DB	−30 DB
First one million times greater or less	+60 DB	−60 DB

Any good electrical engineering reference book will show you how to obtain decibel values or corresponding power ratios for the intermediate values, such as −36 DB, +57 DB, etc.

A convenient feature of the decibel system is that amplifier gains and circuit losses, when each is expressed in DB, may be added and subtracted by simple arithmetic directly, to evaluate simply the performance of an entire communication system.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A set that's small but one that will scoop up rock 'n' roll from local broadcasters, commercials and all.

The *Little* Red Hot

This compact, attractive reflex receiver is so small it fits easily into pocket or purse

By FORREST H. FRANTZ, Sr.

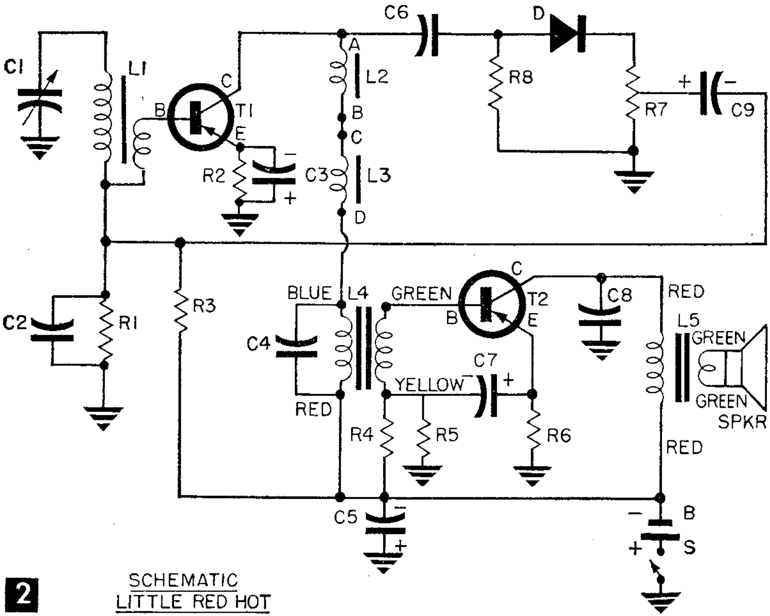
TO get plenty of gain in the Little Red Hot transistor T1 (see Fig. 2) amplifies the signal twice, once while it is still RF and then again when it is AF after detection by diode D. The audio output of T1 is introduced to the base of transistor T2 through the audio driver transformer L4. The impedance match between T1 and T2 provided by L4 affords considerably more gain than you could expect from resistance-capacitance coupling.

Though not apparent from the circuit, and though not enough to make the set oscillate, there is positive feedback in the RF stage, resulting from the relative placement of the components in the case. This feedback feature and the high Q of the antenna coil (L1) make the set quite selective in spite of the fact that it has only one tuned circuit.

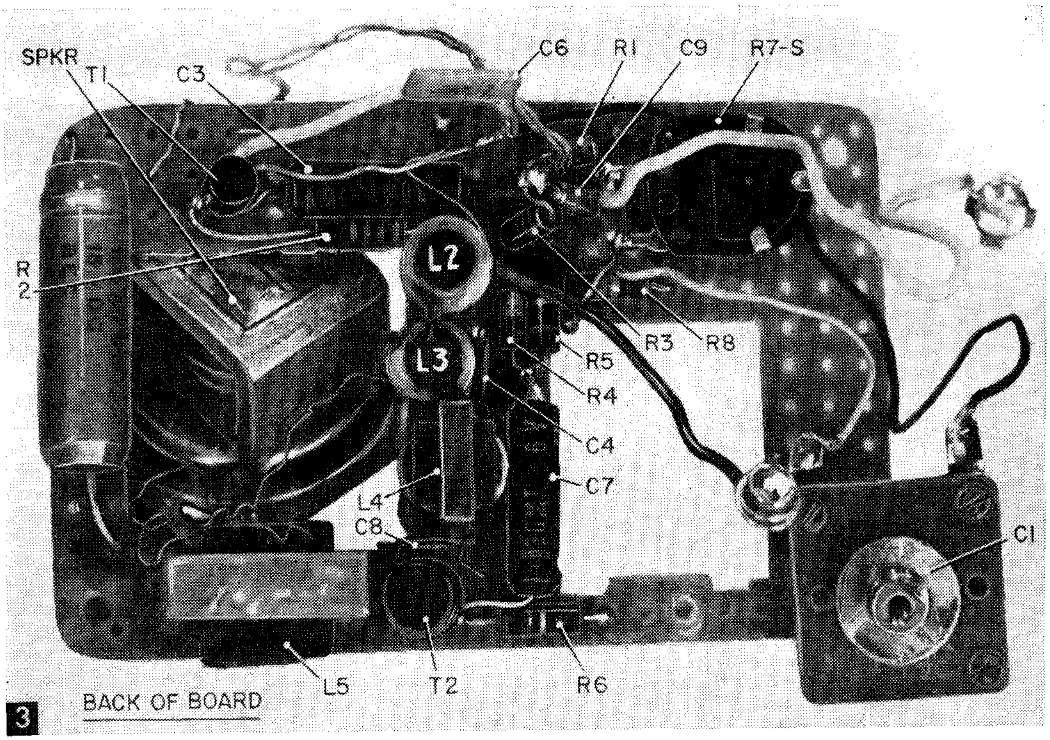
Cost of the components for the Little Red Hot will be a little over $15. Construction time will vary with the builder's experience, but the compact construction makes this project a delightful experience in miniaturization.

Construction. The construction of this receiver may be accomplished most efficiently by pursuing the task in these phases:

1) Adapt parts.
2) Make the circuit board.



2 SCHEMATIC LITTLE RED HOT



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Back view before assembly.

3) Mount parts.
4) Wire the circuit board.
5) Complete wiring and assemble.
6) Test, adjust and debug.

Begin by cutting the volume control shaft to a length of ⅜ in. Place the portion of the shaft to be eliminated in a vise and cut with a hacksaw. Now remove antenna coil L1 from its Masonite mounting board. Replace the paper tape around the coil ends to hold and protect the windings.

Make coils L2 and L3 using the data shown in the Materials List. Coat these coils with Duco cement to prevent unwinding of the turns.

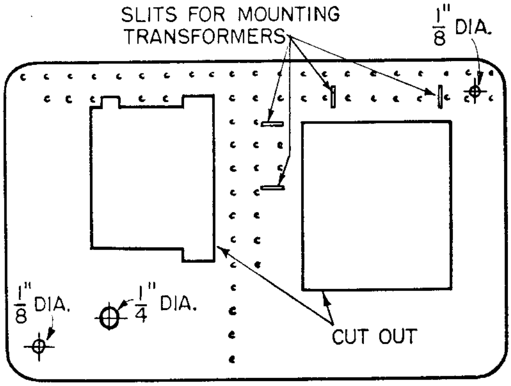
The number of turns is not too critical, so if you slip a bit in counting them, don't worry about it.

Next, place two layers of cellophane tape about ⅜ in. wide around the edges of the speaker frame on the back of the speaker to prevent the speaker frame from shorting some of the receiver wiring which it would otherwise touch.

The circuit board is cut from a miniature perforated board according to the layout shown in Fig. 4. Speaker and tuning capacitor cut-outs are made by using the hacksaw blade removed from the saw frame. Starter holes can be made with drill and taper reamer. The slots for the transformers (L4 and L5) are also made with the hacksaw blade.

Drill a ⅛-in. starter hole for the volume control shaft and ream to size, or simply drill using a ⅜-in bit. When cutting and drilling is completed, dress the edges of the board and the cutouts with a file.

Use Fig. 3 as a guide for mounting parts. Mount volume control-switch R7-S and transformers L4 and L5 first. The transformers are mounted by bending their mounting lugs down 90° so they can be inserted in the circuit board slits. With the transformer mounting lugs inserted in the circuit board slits, press the transformer against the board, and bend the lugs over on the front of the circuit board. Duco cement placed between the base



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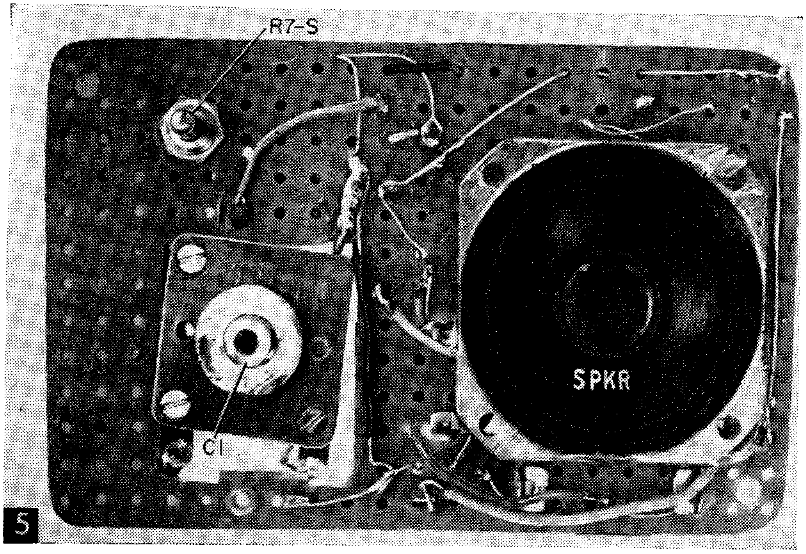
CIRCUIT BOARD LAYOUT—BACK VIEW



Front view of circuit board.

of the transformers and the circuit board will stabilize the mounting and may bail you out if you break a transformer lug in the mounting process.

Mount L2 and L3 by fastening with Duco cement, but go easy on the cement because you may have to loosen and re-orient these coils. The remaining components are mounted in the process of wiring the circuit board.

MATERIALS LIST—LITTLE RED HOT

Desig.	Description
	½ watt carbon resistors, 10% tolerance
R6	100 ohms
R2	470 ohms
R5	2.7K
R1	10K
R4, R8	15K
R3	47K
R7-S	10K miniature volume control with switch (Lafayette VC-28)
C6	100 mmf. Mini Kap ceramic capacitor (Lafayette DM-101)
C2, C4, C8	.01 mfd. 75v. subminiature capacitor (Lafayette C-612)
C9	1 mfd., 6v. subminiature electrolytic capacitor (Lafayette P6-1)
C3, C7	30 mfd., 6v. miniature electrolytic capacitor (Lafayette CF-104)
C5	100 mfd., 15v. miniature electrolytic capacitor (Lafayette CF-126)
C1	365 mmf. miniature tuning capacitor (Lafayette MS-445, includes tuning dial)
L1	flat ferrite antenna loop coil (Miller 2004)
L4	10,000 ohm to 2,000 ohm subminiature transformer (Lafayette TR-98)
L5	2,000 ohm to 10 ohm miniature output transformer (Lafayette TR-93)
L2, L3	Coils L2 and L3 are jumble-wound with Belden 8817 litz wire on ¼" dia. ferrite cores (saw or break off of Lafayette MS-331). Wind 25′ of wire on a ¾" length of core for L2, and 15′ on ½" of core for L3
T1	2N412 transistor (RCA)
T2	2N321 transistor (GE)
D	1N60 diode (Raytheon)
SPKR	1½" PM loudspeaker (Lafayette SK-61)
B	9v. transistor radio battery (Mallory TR-146R)
	volume control knob (Lafayette MS-185)
	miniature perforated board (Lafayette MS-305)
	case (Lafayette MS-424 ivory or MS-427 maroon)

All components for this project are available from Lafayette Radio, Dept. SM, 165-08 Liberty Avenue, Jamaica 33, New York.

The circuit board is wired by inserting component pigtails through the perforations and making connections on the front of the board. Where several component pigtails form a common junction, the pigtails may be inserted in a common perforation. The connection routes on the front of the board are short enough in most cases to permit direct connection with component pigtails.

Solder the connections as you go along. Use a hot clean iron and *rosin* core solder. Solder quickly. Miniature components, particularly transistors and diodes, may be damaged by soldering iron heat applied for too long a time. Be cautious about electrolytic capacitor and battery polarities in making connections.

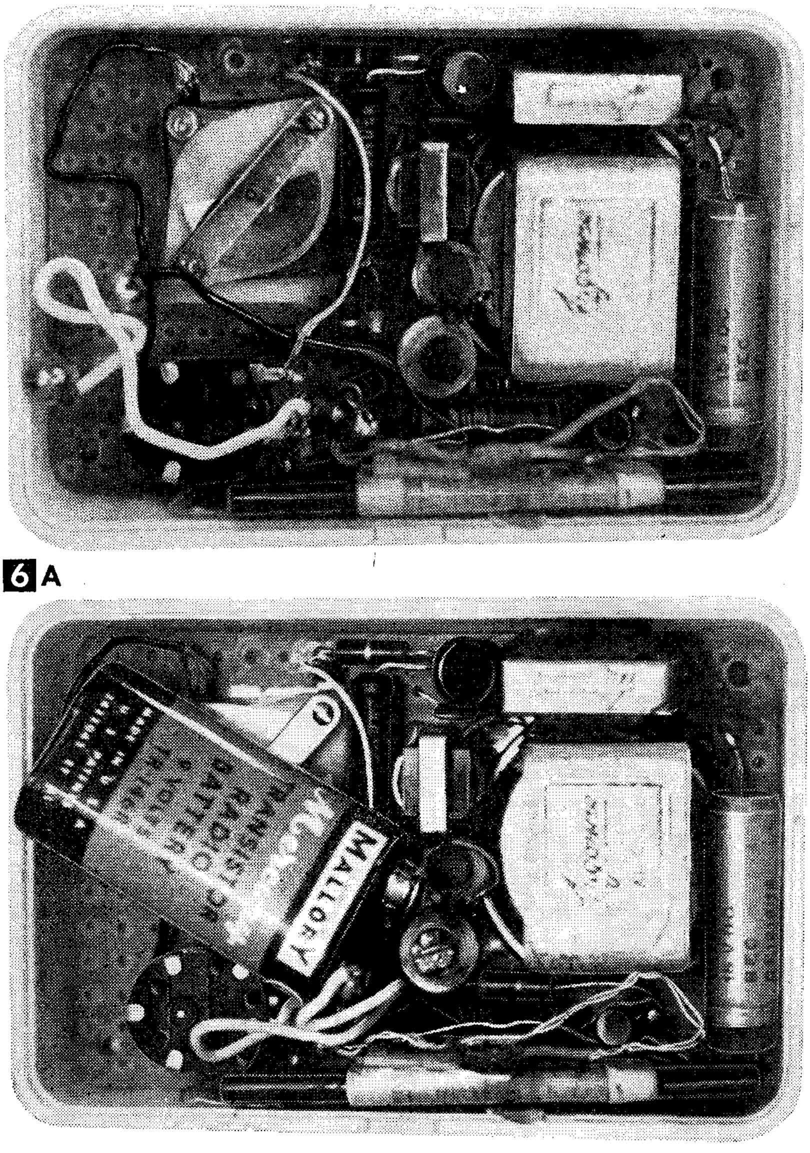
Mount T2 first and then wire C3, C7, R5, R6, R4, and C5 into the circuit. Then wire R3, R1 and C2. The connection of C4, L2 and L3 follows. Don't cut L2 and L3 leads too short; you may have to reverse connections later.

Next, mount diode D and connect C6, R7, R8 and C9 into the circuit. Mount T1 and complete connections to L2. Mount and connect R2 and C3.

Now recheck the wiring for correctness and examine the circuit board for poor connections and shorts. Then attach leads for C1 and for battery connections. Solder battery connection lugs on the battery leads, connect C1, and connect the L5 secondary leads to the loudspeaker voice coil lugs. Connect L1 into the circuit.

Whether it is best to place the Little Red Hot in the case or leave it out for test, adjustment and debugging is a tossup. If you don't place it in the case, care must be exercised to prevent shorting of components, and the tuning capacitor (C1) is difficult to adjust. If you place the receiver in the case, you'll probably have to pull it out if there are difficulties.

To test, adjust, and debug, connect the battery to the set (if it's available, use another less expensive 9-v battery—six series-connected penlite or flashlight cells are fine—for first tests), turn the volume on, and tune for a station. If the set is insensitive over the entire broadcast band, interchange the A and D



6 A

B Back view of entire assemby without (A) and with (B) battery.

lead connections of L2-L3. Sensitivity should increase as L1 is moved toward the position approaching the "in-case" mounting relationship of L1 and L2-L3.

If the set is insensitive at one end of the band only, interchange L2's AB connections or L3's CD connections. Try the possible combinations till you arrive at the best results.

Next mount the set in the case and try it again. Slide L1 back and forth along the edge of the case till you get best sensitivity. It may be possible to reach a point where the set will oscillate (squeal). Simply change the position of L1 till the squealing stops.

The position of C6 relative to L1 influences sensitivity. The sensitivity of the set may also be increased by tilting L2 and L3 slightly from their vertical orientation relative to the circuit board if oscillations did not occur during the previous adjustment of the position of L1. Experiment with tilting to right and left with the set in the case. When optimum position is found, fasten L2-L3 in place permanently with cement, and fasten L1 against the side of the case with cellophane tape.

The circuit board assembly is held in the case with two machine screws. Pressure between the circuit board and the case holds the speaker in place. Position the speaker so that maximum cone area is visible through the cabinet speaker openings. Fasten C1 directly to the case with the two small machine screws provided with the capacitor for this purpose. Install the dial provided with the capacitor and fasten the volume control knob. Position the battery so the back of the case can be snapped on. Insulate the battery lugs and any portion of the battery outer metal shell that might touch connections with cellophane tape.

The Little Red Hot will give you reasonable performance up to 10 or 15 miles from a broadcast station. It's extremely directive. A short (1 to 3 ft.) antenna lead connected to the junction of the C1 stator and the top of L1 will reduce this directivity.

Removing Enamel Wire Insulation

- To remove enamel insulation on magnet and hook-up wire quickly and cleanly, wrap a piece of sandpaper around the wire and give a twisting, rotary motion.—E. L. BURNER.

Underwater Intercom

This unusual intercom provides constant contact between boat and diver, amplifying your voice through a loudspeaker

By C. L. HENRY

DESIGNED for rough boat service or dockside operation, the amplifier of this intercom is transistorized for battery economy. Its simple circuitry and reliable operation make it ideal for Scuba divers, or even "hard hat" professionals.

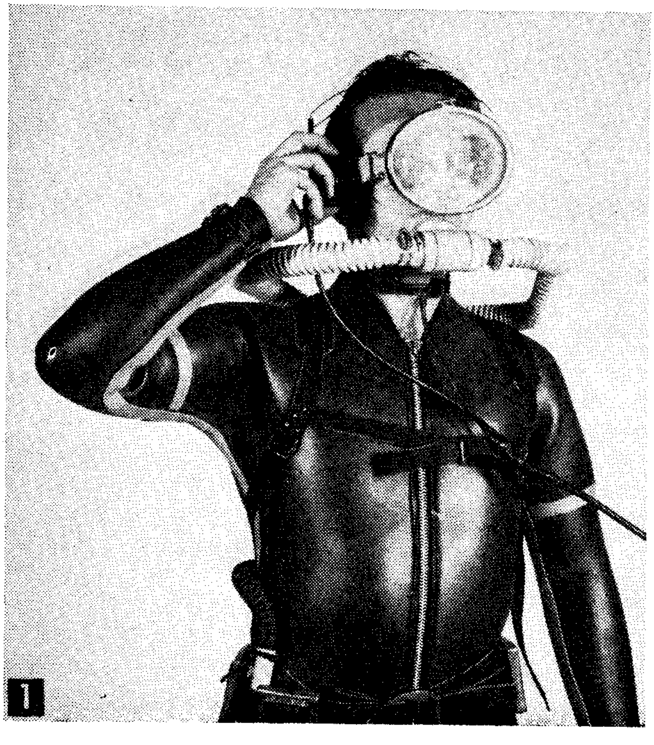
The diver wears a throat mike and earphone (Figs. 1, 3). When he talks, his voice is amplified to speaker volume and can be heard by anyone within earshot on the boat or dock above. Unlike an ordinary telephone set, there is no push button or ringer, and the diver's hands are always free. Also, a special sidetone circuit enables him to hear his voice in the earphone and know that the surface is also hearing him.

At the "upstairs" end (Fig. 2) operation is ultra-simple, with a push-to-talk switch and loudspeaker volume control as the only live controls. A separate volume control, R12, (Fig. 5B) is equipped with a Millen shaft lock so that the volume fed to the diver's earphone cannot be changed accidentally. Also, an auxiliary audio output jack enables you to connect in a remote speaker. One diver reported that this interphone, which uses less than $20 worth of parts, paid for itself quickly in helping to salvage lost articles. It's fine for treasure hunting or coaching Scuba students and since the throat mike would enable it to work well in very noisy locations, it might have many uses on dry land as well.

Power for the microphone circuit is supplied by two D-size flashlight cells mounted inside the case. The 300-*ma.* amplifier requires an outside battery. You can use a lantern size dry cell, which will give you up to 15 hours of continuous operation, equal to many days of diving. Or, using the 6-12 volt selector switch, you can tap any convenient storage battery.

Construction. Begin by marking, drilling and punching all of the holes in the case, the front and back covers, Fig. 4 and in the internal chassis box (Fig. 6). Even though the case itself will be sealed later by rubber gaskets, it is necessary for salt water operation especially, to protect all metal surfaces against accidental wetting.

Coat the inside of the case and the surfaces of parts that you can't reach later with several layers of acrylic or silicone resin spray, which both insulates and provides corrosion resistance. Completely waterproof the speaker with 4 to 6 heavy coats of the plastic spray.


1

Wearing a waterproof earphone and throat mike, the diver is always in instant contact with the surface. The phone must be worn loosely to avoid unequalized ear pressure which could rupture the eardrum.

The diver's voice, at loudspeaker volume can be clearly heard on boat or dock. Man on surface presses push-to-talk button on top of amplifier case.

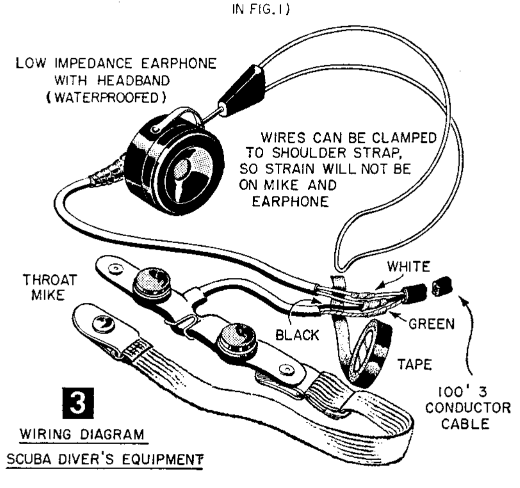
2

Next mount all the parts as shown in Figs. 5A, 5B, using lock washers or lock nuts. The transistors are located on the cover of a small 4 x 2 x 2¾-in. chassis box (Fig. 6) which in turn is mounted on the inside of the back panel of the amplifier case. Bolt the 2N155 transistor directly to the box, after scraping the box paint off to provide tight contact and effective heat dissipation.

Transformer T1 is mounted inside the chassis box along with the resistors and capacitors in the transistor circuitry. Positioning of parts is not critical, but keep the input and output circuits as far apart as possible, since feedback or whistling may occur if they are close enough to couple. Wire the transistor circuit (Fig. 5C) and then complete the rest of the amplifier, using color coded hookup wire.

Now check your wiring carefully against the schematic. If the transistors are wired incorrectly, they will be ruined instantly when power is applied to the circuit. Complete construction by lacing the wiring carefully, and then coat the entire assembly (switch contacts protected temporarily with tape) with the waterproofing sprays mentioned earlier. Cut strips of rubber and cement them to the case to make a watertight gasket for the front and back panels.

How It Works. In the amplifier, two transistors are used to obtain a full 2-watt output with a carbon mike input. Mike power is supplied by two flashlight cells mounted inside the amplifier case. They will provide months of use. The diver's carbon mike is connected through a transformer, T1, and volume control R4 to the input of the first transistor, TR1, a Sylvania type 2N35. An NPN type, this transistor is operated in a common emitter type of circuit. Resistors R5 and R6 determine the bias or operating point of the transistor, and it requires about 4 *ma* collector current. The collector or output lead of the 2N35 is connected to the transformer T2. The winding of T2 is bypassed with C5 to correct the high frequency response of the amplifier. The secondary of T2 connects to the second transistor, TR2, a CBS type 2N155. Output of TR2 feeds to transformer T3 where the collector current



3

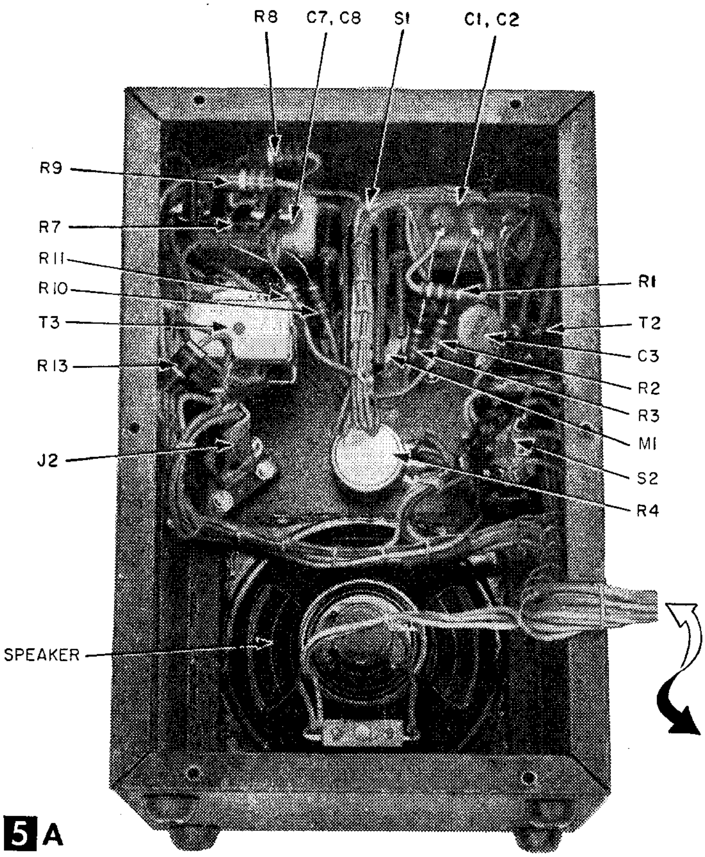
WIRING DIAGRAM
SCUBA DIVER'S EQUIPMENT

is about 350 *ma.*

The 2N155 output circuit is unusual: in effect, it is a common emitter-type amplifier, with two feedback windings on T3 canceling each other to allow the 2N155 collector to be connected directly to chassis in order to provide an effective heat sink.

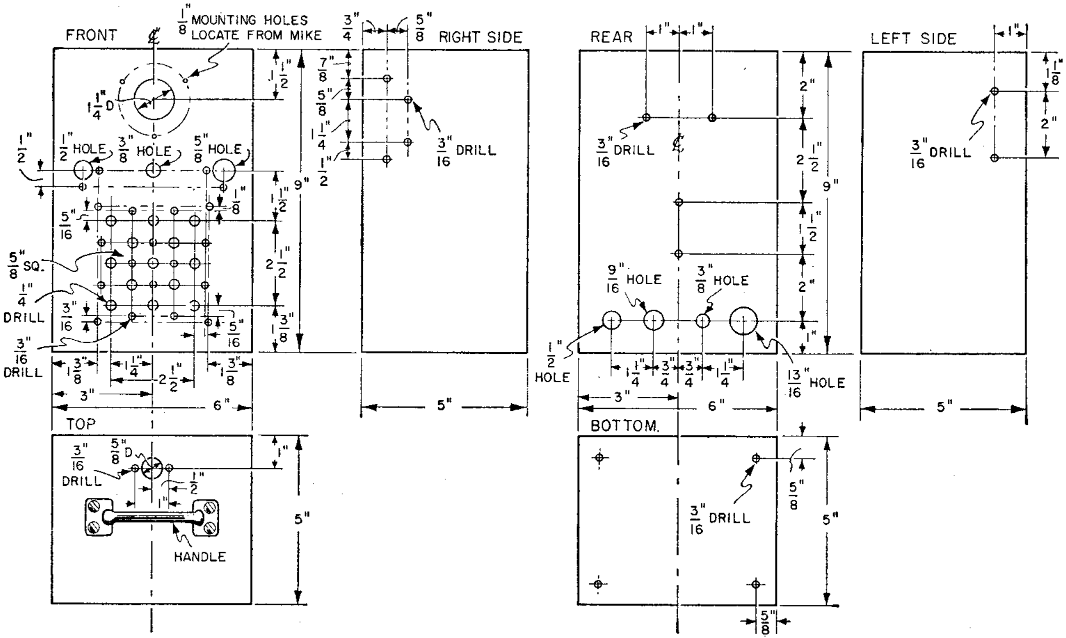
The T3 secondary is connected to the push-to-talk switch, and in normal position, through this switch to the loudspeaker mounted in the case. When the push-to-talk switch is pressed, the output of the amplifier output connects through the remote volume control, R12, to the diver's earphone. Capacitor C8 supplies a sidetone circuit which allows the diver to hear himself talk. When he can't hear himself, it warns him that there is no communication to the surface. If you want more sidetone, increase the size of this capacitor.

Water Proofing Mike and Phone. The amplifier serves either the scuba or skin diver, or the hard-hat suit diving rig. Since the scuba diver must submerge with a tightly-fitting mouthpiece, speech in the ordinary manner would be impossible; hence a surplus throat

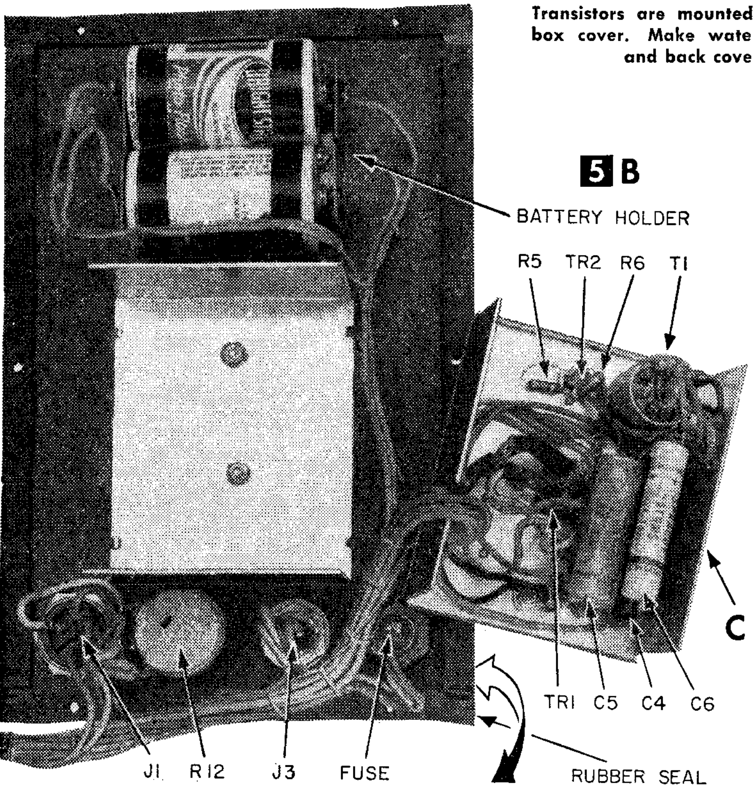


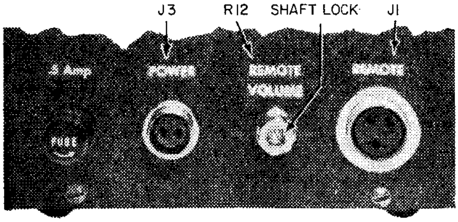
5A

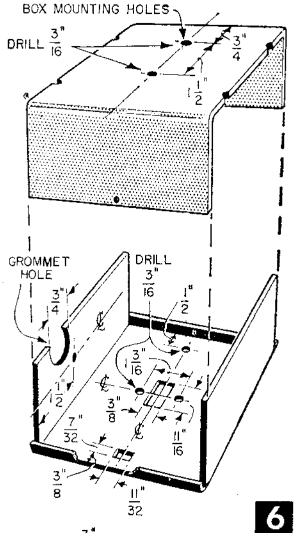
Wiring inside the case is not crowded. Be sure to separate the input from the output circuit wiring to prevent audio howl. The speaker must be coated heavily with waterproofing spray.



Transistors are mounted on the top of the small circuit box cover. Make waterproofing gaskets for both front and back covers of ½-in. rubber strip.







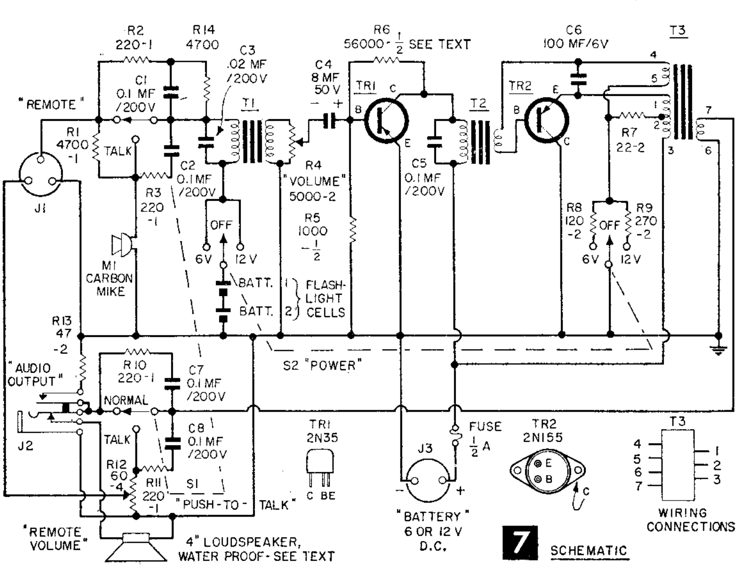
6

4 X 2 X 2¾" BOX CHASSIS

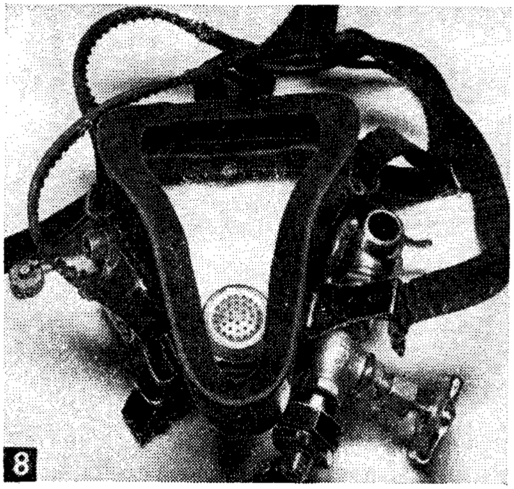
mike is used. Sound is picked up via throat contact and while the results are not hi-fi, a little practice makes simple words understandable. Seal the edge of the throat mike with *Scotchkote* (or equivalent) Electrical Coating.

Select an earphone of low impedance for greatest volume. Remove the diaphragm, spray it and the wiring, and then seal the entire assembly with plastic electrical tape covered with Scotchkote. For extreme depths, you may want to do some experimenting with the alternate method of drilling holes in the earphone case, and allowing water to enter and equalize pressure. Underwater, the earphone is almost as clear sounding as on dry land, since the short distance to the ear is not enough to muffle the sound. You can use an earphone clip, or attach both throat mike and earphone to an elastic headboard. One important caution: *When in the water, do not fit the headphone tightly over the ear since pressure variations in descent can rupture your eardrum.*

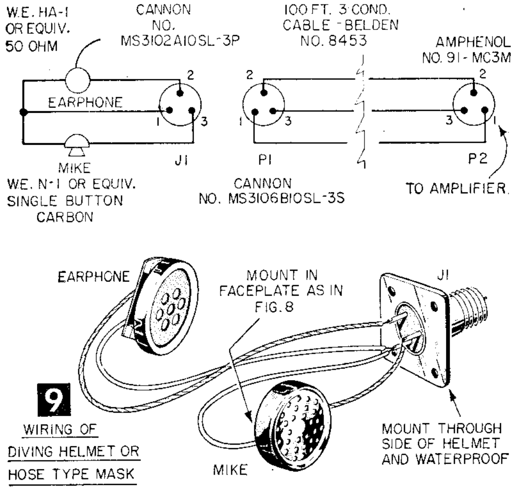
Fig. 9 details the in-



7 SCHEMATIC



This type of face mask connects to an air hose. Since the diver has no mouthpiece, the microphone can be installed near the bottom of the plastic faceplate.



9

WIRING OF DIVING HELMET OR HOSE TYPE MASK

MATERIALS LIST—UNDERWATER TELEPHONE	
No. Req'd	Size and Description
	AMPLIFIER
1	R1—4.7K, 1 watt, 10% carbon resistor
4	R2, R3, R10, R11—220 ohm, 1 watt, 10% carbon resistors
1	R4—5K, 2 watt, variable resistor (volume control) Ohmite type AB
1	R5—1K, ½ watt, 10% carbon resistor
1	R6—56K, 0 watt, 10% carbon resistor
1	R7—22 ohm, 2 watt, 10% carbon resistor
1	R8—120 ohm, 2 watt, 10% carbon resistor
1	R9—270 ohm, 2 watt, 10% carbon resistor
1	R12—60 ohm, 4 watt, variable resistor (remote volume control) IRC type 60
1	R13—47 ohm, 2 watt, 10% carbon resistor
1	R14—4.7K, 1 watt, 10% carbon resistor
5	C1, C2, C5, C7, C8—0.1 mfd., 200-volt paper capacitors
1	C3—0.02 mfd., 200-volt paper capacitor
1	C4—8 mfd., 50-volt electrolytic capacitor
1	C6—100 mfd., 6-volt capacitor
1	S1—Telever type 16006L, push-to-talk switch (Alternate Switchcraft 11006)
1	S2—Arrow-Hart and Hegeman bat handle toggle, type 82024-D
1	T1—transformer, Argonne AR-123
1	T2—transformer, Argonne AR-105
1	T3 transformer, Motorola type 25C536761 only (auto radio replacement) available Motorola parts distributors
1	TR1—Sylvania type 2N35 transistor, NPN
1	TR2—CBS type 2N155 transistor, PNP
1	M1—carbon microphone, Western Electric type F-1 or equiv.* (Surplus item available Columbia Electronics; 2251 W. Washington Blvd., Los Angeles, Calif.)
1	speaker, 4 in. PM type, cone speaker
	HARDWARE
1	J1—connector, 3 conductor, Amphenol type 91-PC3F
1	J2—telephone jack, Mallory type XP4B
1	J3—connector, 2 conductor, Amphenol type 80-PC2F
1	9 x 6 x 5" steel carrying case, Bud #CC-1095, black wrinkle finish, with handle
1	4 x 2 x 2¾" box chassis, LMB Model 102
1	fuse retainer, Buss type 342001
1	shaft lock for R12, Mallory type 12A1496
1	socket, transistor
1	battery holder, Keystone type
Misc.	plastic spray, rubber feet, mounting screws, nuts, lockwashers, decals Unless indicated otherwise, all parts are available from Lafayette Electronics, 165-58 Liberty Ave., Jamaica 33, N.Y.
	PARTS FOR SCUBA OR SKIN DIVER
1	microphone, throat type, Army or Air Force surplus, available from Roscoe Ward Bargain Bazaar, 3831 Hixson Pike, Chattanooga 5, Tenn.
1	headphone, 11 ohm, low impedance type, Western Electric HA1 or equal
1	P1—Cannon MS3106B12S-3P, with Cannon MS3057-4A cable clamp (optional)
1	P2—Cannon MS3106B10SL-3S, with MS3057-4A cable clamp (optional)
1	P3—Amphenol 91-MC3M
100 ft	3-conductor cable, rubber covered Belden 8453 with spool, or windup reel
	PARTS FOR SUIT DIVER'S FACE MASK
1	microphone—Western Electric type N1, single button carbon, 50 ohm*
1	headphone, Western Electric type HA1, or equal
1	J1—Amphenol MS3102A10SL-3P
1	P1—Amphenol MS3106B10SL-3S, with Cannon MS3057-4A cable clamp
1	P2—Amphenol 91-MC3M
100 ft	3-conductor cable, rubber-covered Belden 8453

* Telephone parts are also available from Telephone Repair and Supply Company, 1760 Lunt Avenue, Chicago 26, Ill.

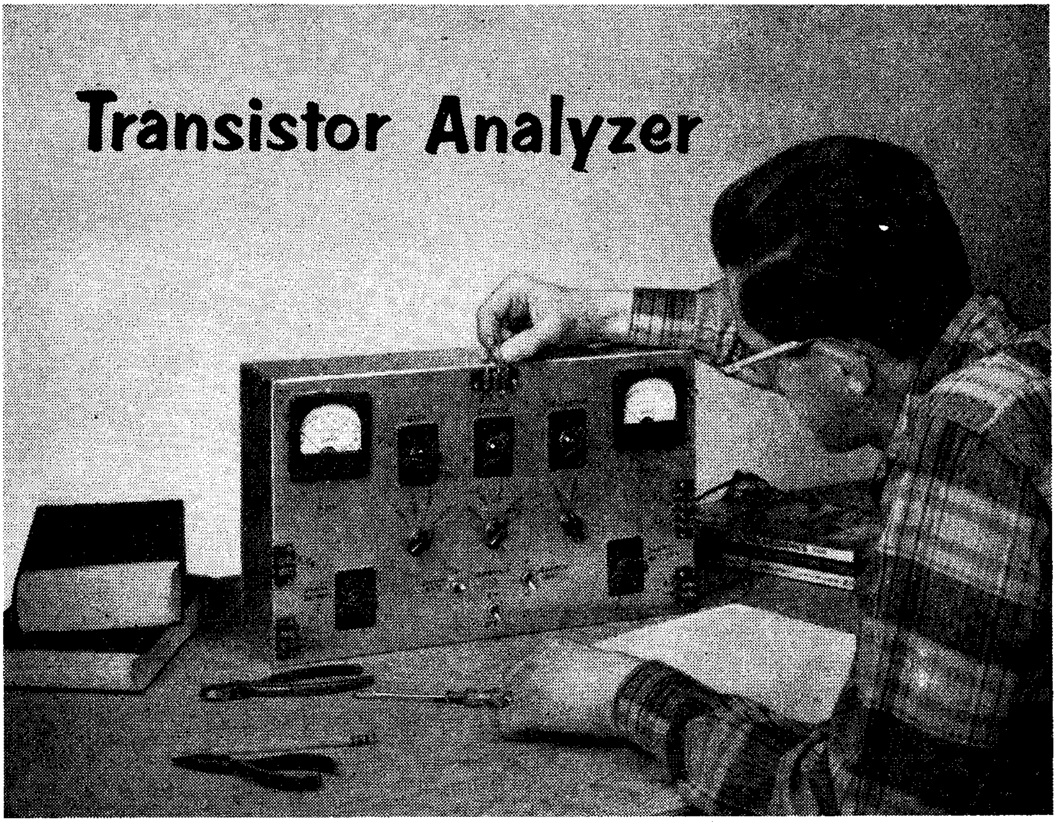
stallation of a single button type microphone in the faceplate of the hard-hat diving rig. Waterproof the microphone, and install the earphone, also waterproofed, in the head covering of the suit. Both mike and phones are connected to the 3-wire cable with a surplus AN waterproof connector. Tape the cable directly to the air hose.

Connect the cable to the skin diver's mike and earphone directly—taping and covering the wire joint with Scotchkote. For extensive Scuba diving and exploration, a wire reel and about 150-feet of the 3-wire cable can be arranged for easy operation. Lines to several divers can be connected to the amplifier, simply by wiring in parallel.

If the Scuba diver needs complete freedom of movement, he can shed his phone, mike and cable, and tie it to an underwater marker anchored in position. Brightly colored, it will be easy to find for use at any time.

Such a completed underwater intercom will add an immense safety factor for novice divers.

Transistor Analyzer



It's fun to build gadgets, but the serious experimenter soon realizes that this is but a preliminary to real electronic understanding. To master any branch of science, one must learn to take, graph, and analyze ***quantitative*** data. With this convenient transistor characteristics analyzer you do just that.

By C. F. ROCKEY

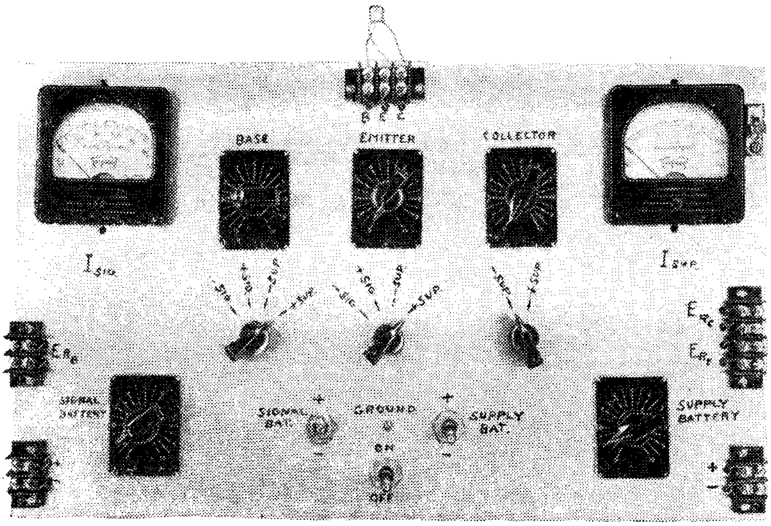
BLOCK diagram (Fig. 2) and schematic (Fig. 3) show how this transistor analyzer works. A relatively low-voltage *dc* source provides a "signal" which may be applied in either polarity to either the base or emitter circuit of the transistor under test. Likewise, a variable supply *dc* source may be connected at will to any electrode. Appropriate current-measuring instruments are associated with each source, and either positive or negative terminals of either source may be made the common point by grounding switches. All significant points of the circuit are brought out to terminal screws for convenient reading of all important circuit potentials. Thus voltage/current relationships in any parts of a three-terminal semiconductor element may be conveniently adjusted and measured. Two-terminal crystal diodes may also be studied by connecting to the two appropriate terminals.

You can build this device easily in a couple of evenings. Total cost to build will be approximately $50 (including batteries and at least one experimenter's transistor for demonstration). You will also need a volt-ohm-milliammeter of the ordinary radio-servicing sort.

Constructing the Unit. Begin by drilling the major chassis holes (see Fig. 4). Any linear-taper, radio-replacement potentiometers of the right value may be used. They need not be equipped with switches. Multi-element function switches were used, even though so few positions were utilized, because these switches cost no more than those with fewer positions, and the manufacturer provides an adjustable stop so that the user may readily select as many positions as he needs; also, the additional switch positions provide for expansion as the transistor art advances. You may use appropriate switches you have on hand, but make sure that they are of the *non-shorting* type.

After drilling the major holes, drill chassis and mount the Cinch-Jones terminal strips using 6-32 steel machine screws and nuts. Then fasten into place each of the potentiometers and switches.

Solder each connection carefully with rosin-core solder, avoiding short-circuits between lugs or to the chassis. The exact order of the wiring is not critical; just be sure you



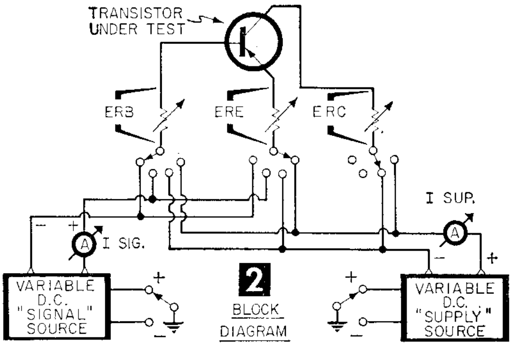
1 This analyzer provides maximum flexibility for quantitatively studying the dc and low-frequency interlectrode relationships of transistors.

follow an orderly procedure, and check each step carefully.

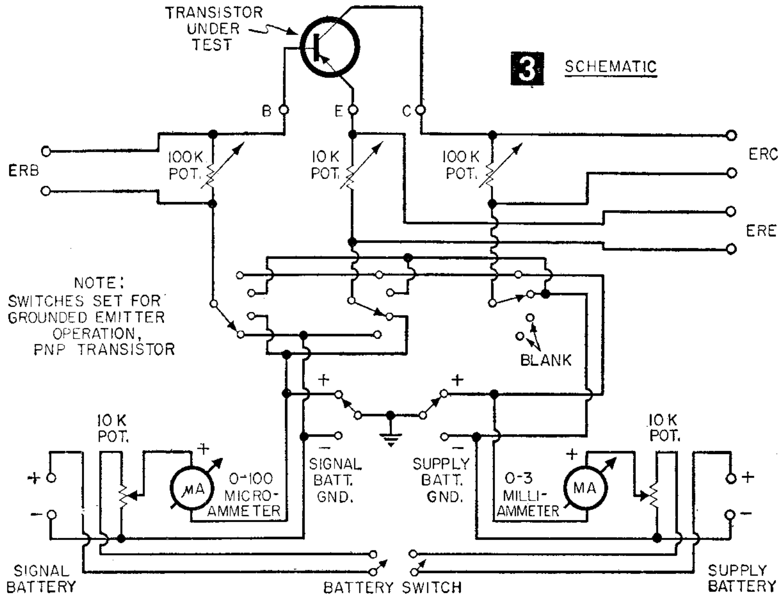
Finally, install and connect the meters. Be sure to observe the little plus-sign, and polarize these correctly. When the meters have been installed, and the wiring checked, clean off the top of the chassis with carbon tetrachloride, or other grease solvent and mark the terminals and switch positions with a steel pen, using draftsman's ink. When the markings are complete and dry, give the chassis a coat of clear, water-white spray lacquer.

Using the Transistor Analyzer. Prepare the instrument for use by connecting a single 1.5-*v* flashlight battery to Signal Battery terminals, a 4.5- to 6-*v* battery to Supply Battery connections. Be sure to observe correct polarity. I recommend a 6-*v* "lantern battery," available at most large hardware stores, for the supply battery. Provide connections to it by soldering wires to the spring terminals usually used. Make sure the battery switch is in *off* position.

Next, connect the leads of the transistor you wish to examine to the terminals provided. Be sure to first ascertain whether it is a PNP or an NPN unit; incorrect information here will cause confusion in the measurements, and *may* result in transistor or meter damage.



2 BLOCK DIAGRAM



NOTE: SWITCHES SET FOR GROUNDED EMITTER OPERATION, PNP TRANSISTOR

3 SCHEMATIC

Perhaps the most significant first determination that can be made is that of the grounded-emitter *current transfer characteristic.* This property clearly illustrates the control impedance property of the transistor, and thus its ability to amplify. In this measurement we hold the emitter-collector voltage constant, and vary the base current. The corresponding variations in collector current are then observed and tabulated.

Before turning-on the battery switch, set

MATERIALS LIST—TRANSISTOR ANALYZER

No. Req'd	Size and Description
1	aluminum chassis 4 x 10 x 17"
1	0 to 100 microammeter, Triplett Model 327
1	0 to 3 milliammeter, Triplett Model 327
1	DPST toggle switch
2	SPDT toggle switches
3	10K, wire-wound linear taper potentiometers, Mallory
2	100K, linear taper potentiometers, Mallory
3	non-shorting single deck rotary switches, Mallory, Number 1311-L
1	3 terminal, Cinch-Jones terminal strip
1	4 terminal, Cinch-Jones terminal strip
3	2 terminal, Cinch-Jones terminal strip
5	270° dial plates, Croname
8	bar knobs
1	Fahnestock clip
	6-32 machine screws, ½" long, steel hex nuts, steel for above, plastic insulated hookup wire, rosin core solder
	Also needed for measurements, if not already on hand:
1	1.5 v flashlight cell
1	6 v lantern battery
1	volt-ohm-milliammeter, or vacuum-tube volt-ohmmeter
1	experimenter's junction transistor

up the other controls as follows: For an NPN transistor (grounded emitter connection): Base selector switch, + sig; Emitter selector switch, − sup; Collector selector switch, + sup; Signal battery grounding switch, − ground; supply bat grounding switch, − ground.

For a PNP transistor: Base selector switch, − sig; Emitter selector switch, + sup; Collector selector switch, − sup; Sig bat grounding switch, + ground; Sup bat grounding switch, + ground.

In either case, the potentiometers in *series* with each element of the transistor should be set to *zero* resistance position. Set both of the battery potentiometers to zero voltage position.

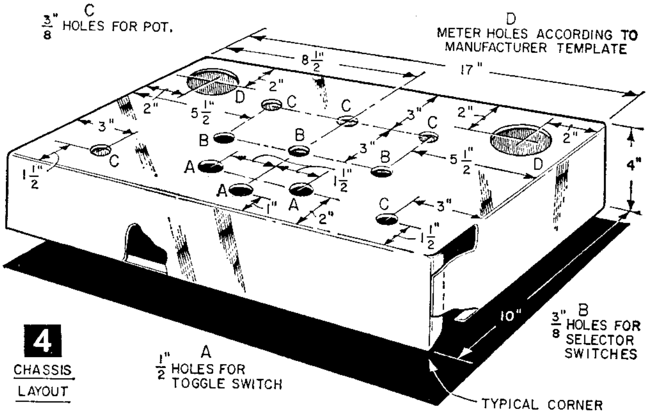
Now, using the 10-*v* (or similarly-scaled) range, connect a radio-serviceman's VOM or VTVM from the collector to ground. Connection to the collector may be reached directly at the *upper* terminal of the pair marked Erc, and ground connection may be made to the Fahnestock clip.

Turn on the battery switch and adjust the *supply* battery potentiometer to 1.5 *v* from collector to ground. This may cause the Isig microammeter to read backwards. If it does, slowly advance the Signal battery potentiometer until it reads at zero. (This "back current" is due to normal interaction within the transistor.) After this change has been made you will probably have to reset the Supply battery pot to the correct voltage. (The input and output circuits of a transistor are interrelated, unlike those of a vacuum-tube at low frequencies which are isolated.)

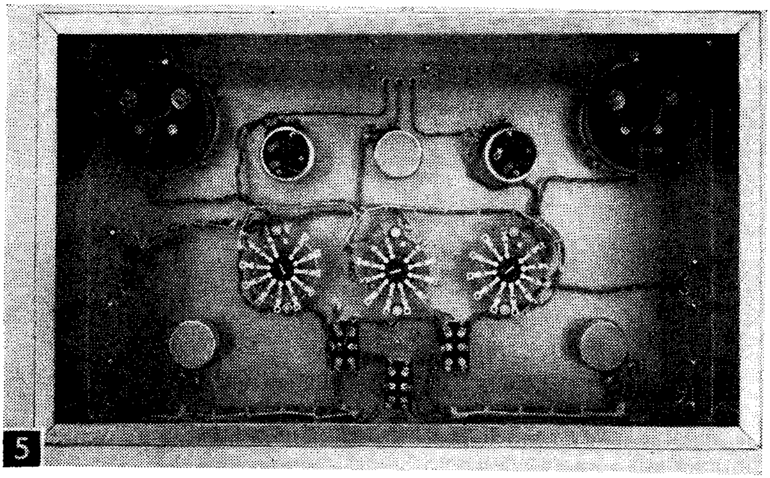
With the collector voltage at 1.5 *v* and the base current (Isig) at zero, observe and tabulate the collector current, which will be read from Isup, the 0-3 milliammeter. Now, keeping the collector voltage at 1.5 *v*. by adjustment of the Supply battery potentiometer, advance the Signal battery potentiometer to make the base current 5 microamperes. Jockey the two battery pots as necessary to achieve this condition. Again, observe and tabulate the collector current, Isup. Repeat, in 5 - microampere (base current) steps until the maximum collector current of 3 milliamperes is reached.

Be sure that the voltage from collector to ground remains at 1.5 *v* at the time each reading is taken.

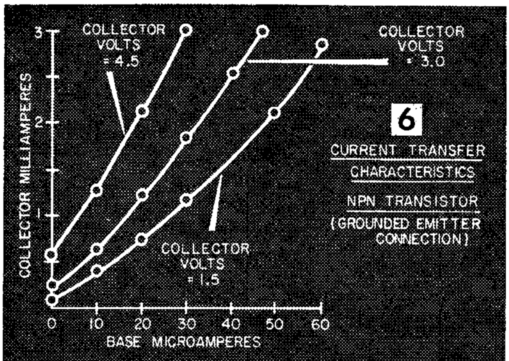
When all of this data has been taken, plot it

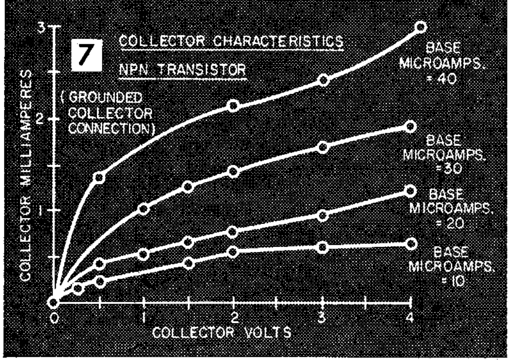


4 CHASSIS LAYOUT



5 **Under-chassis view of completed analyzer.**





in graphic form. It is customary to plot the independent variable, in this instance the base current, along the horizontal axis (abscissa) and the dependent variable, the collector current, along the vertical (ordinate) axis.

Figure 6 represents a set of curves taken in this manner using a popular brand of experimenter's NPN junction transistor. When completed, such a graph may give rise to a number of significant conclusions. One of these might be that since with an Ec of 4.5 *v* an approximate base current change of 12 microamperes gives rise to a collector current change of one milliampere, or 1000 microamperes, this transistor provides a current amplification of about 80 times. Is there any doubt as to why such a transistor is useful in practical electronics?

Another useful transistor relationship is that between the collector current and the collector voltage, when the base current is kept constant (grounded collector connection). A family of such curves run by the author (using the same NPN unit) is shown in Fig. 7. The identical switch setup, as used for the transfer curves is used for this investigation. Such a family of curves is of first importance to an engineer, who must match a given transistor to a given load resistance, in a practical design problem.

With increasing experience in the use of this analyzer, a student may plan and execute many interesting measurements and experiments. Curves resulting from several such investigations, as made by the writer, are shown in Figs. 8, 9, and 10. All of the usual transistor circuit configurations can be investigated by merely selecting the appropriate switch settings (see Table A).

Due to the non-uniformity of experimenter's-type transistors, you should not expect your measurements to agree with the author's. Corresponding curves should be of approximately the same shape, however.

TABLE A—SWITCH SETTINGS FOR TRANSISTOR CIRCUIT CONFIGURATIONS:

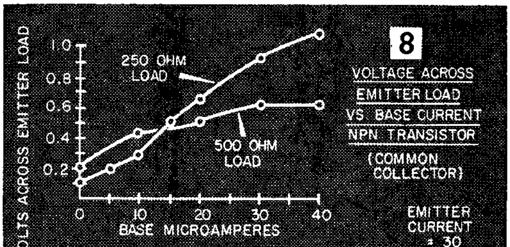
COMMON EMITTER:	*NPN*	*PNP*
Base Selector Switch	+sig	−sig
Emitter Selector Switch	−sup	+sup
Collector Selector Switch	+sup	−sup
Signal Battery Grounding	−ground	+ground
Supply Battery Grounding	−ground	+ground

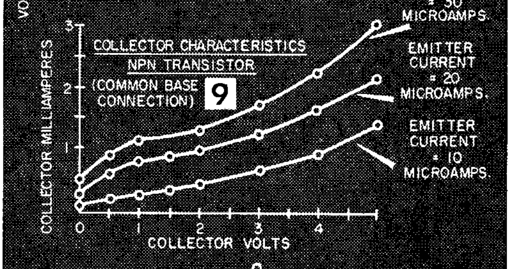
Isig reads base current, Isup reads collector current. Load resistance provided by *Collector* series potentiometer.

COMMON BASE:	*NPN*	*PNP*
Base Selector Switch	+sig	−sig
Emitter Selector Switch	−sig	+sig
Collector Selector Switch	+sup	−sup
Signal Battery Grounding	+ground	−ground
Supply Battery Grounding	−ground	+ground

Isig reads emitter current, Isup reads collector current. Load resistance provided by *Collector* series potentiometer.

COMMON COLLECTOR:
Same as for common emitter, except that the load resistance is provided by the potentiometer in series with the *Emitter.*





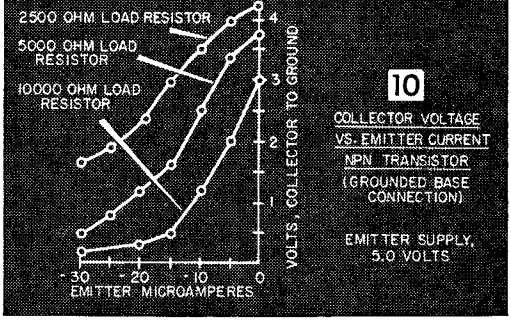
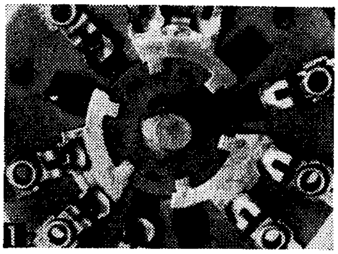


Photo Quiz

Turn a camera loose in a radio-electronic hobbyist's shop and it will come up with some odd-looking pictures. Do you have a good "eye" for solving photo quizzes? Write in the names of the objects in the spaces provided, then check your answers against those on page 122.

1.____________________ 3.____________________ 5.____________________

2.____________________ 4.____________________ 6.____________________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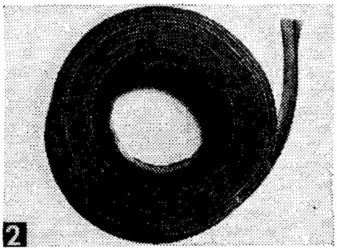
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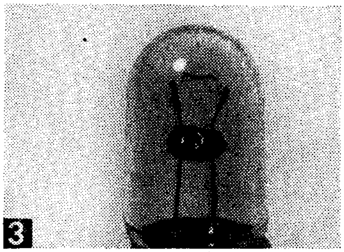
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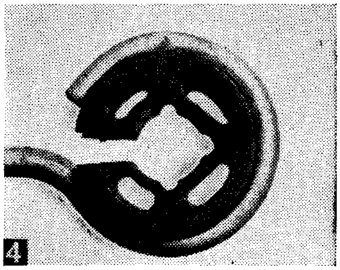
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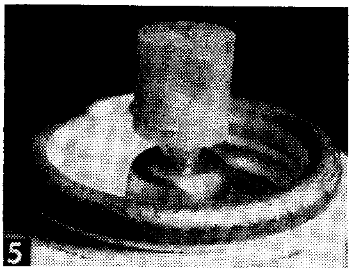
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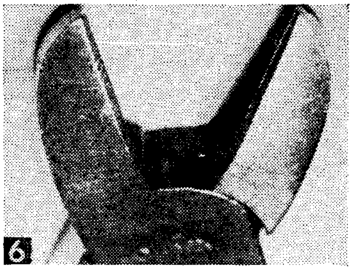
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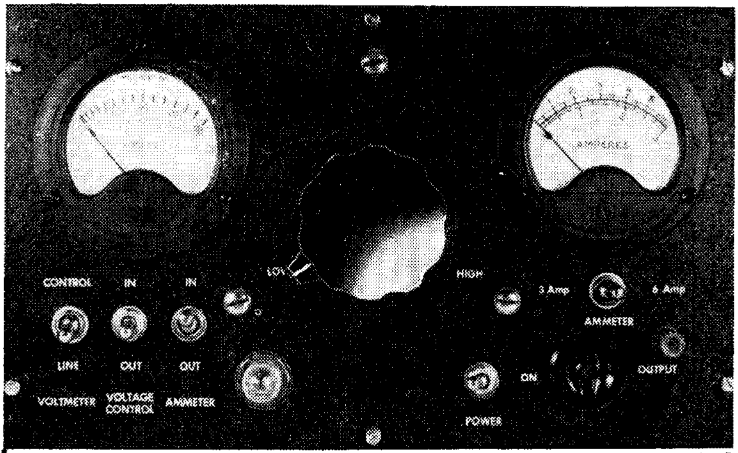


1 Panel view of unit, showing parts placement, with voltage control knob in center.

AC Power Panel

Simple unit checks power input and furnishes various ac voltages

By W. F. GEPHART

Problem: A TV or radio set that goes bad only between 5:30 and 7:00 PM, or on rainy Monday mornings.

Problem: An electric motor that heats up excessively, even though the shaft turns freely.

Problem: Can a small radio output transformer be used as a step-down voltage transformer for a given load?

The solution to all of these problems lies in the metered variable-voltage power unit shown in Fig. 1. By reducing the normal line voltage to the TV set and radio (as happens when electric stoves create a peak load at dinner time, or when electric clothes dryers are being used on rainy Mondays), adjustments can be made to the set to provide proper operation at lower line voltages. By checking the current being drawn by the motor, evidence of shorted windings can be found. And by checking the current into the transformer as the voltage is increased, and comparing with its rating, its suitability for a given job can be determined.

There are many other uses for a high-powered, metered, variable *ac* power source in servicing work, appliance repair, and general experimental work. By using surplus or imported meters, and adapting the common *ac* voltmeter to the more scarce *ac* ammeter, costs can be kept down to a reasonable figure. Excluding the cabinet, and by using 2½-in. meters, the unit shown can be built with surplus parts for less than $20, as compared to nearly $40 if built with new parts.

Basically, the unit consists of a variable voltage auto-transformer, an *ac* voltmeter and *ac* ammeter. Switches transfer the voltmeter connections, cut the ammeter and auto-transformer in and out of the circuit and (in the unit shown) provide two ammeter ranges. Figure 1 and the schematic (Fig. 2) also show a neon pilot light

MATERIALS LIST—POWER PANEL

(Applicable to unit shown in Fig. 1)

Desig.	Description
R1	56,000 ohms, ½ watt (not required if included in PL)
R2	27,000 ohms, ½ watt (see text)
T1	7.5 amp variable auto-transformer (Superior Electric 116U, Standard Electric 500BU or T51U, Ohmite VT-8, or surplus unit of desired ampere capacity)
T2	"Current Transformer" (see text)
S1	DPST toggle (see text)
S2	DPDT toggle (see text)
S3, S4	SPDT toggle, 3 amp
S5	SPST toggle, 3 amp
PL	neon pilot light holder (Dialco 95408X or equivalent)
M1	0-150 volt a-c meter
M2	low-range a-c voltmeter (see text)
SO1	female panel receptacle (Amphenol 61-F1)
	6 x 7 x 12" cabinet (Bud CU-1124), binding posts (optional), plastic scraps, miscellaneous hardware

Some companies handling surplus material where auto-transformers and meters might be secured:
Advance Electronics, 6 West Broadway, New York 7, N. Y.
Barry Electronics Corp., 512 Broadway, New York 12, N. Y.
Columbia Electronics, 2251 W. Washington Blvd., Los Angeles 18, Calif.
G & G Radio Supply, 51 Vesey Street, New York 7, N. Y.
Hi-Mu Electronics, 133 Hamilton St., New Haven, Conn.
Peak Electronics, 66 W. Broadway, New York 7, N. Y.
Standard Surplus, 1230 Market Street, San Francisco 3, Calif.
TAB, 111-WD Liberty Street, New York 6, N. Y.

Also refer to local Classified Telephone Directories under the headings of:
"Radio Equipment and Supplies"
"Electronic Equipment and Supplies"
"Surplus Materials"

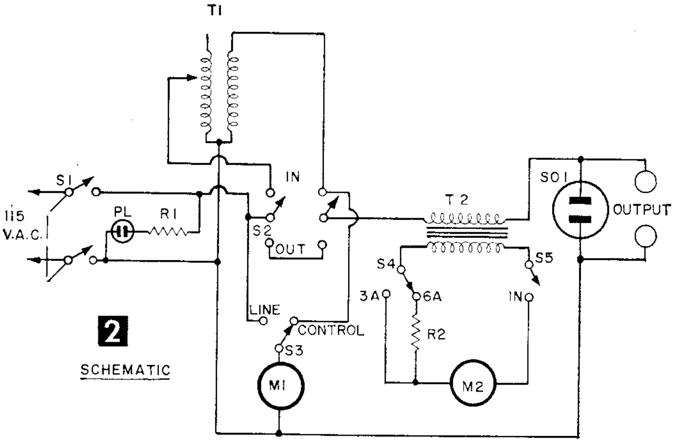
and binding posts paralleling the outlet socket, neither of which is absolutely essential.

The only unusual item is the home-made "current transformer" (T2), the details of which are shown in Figs. 3 and 4. AC ammeters are scarce in surplus stocks, and since any ammeter's scale is non-linear, lower values are hard to read. Both of these problems are overcome by using a simple low voltage *ac* meter, the "current transformer," and multipliers to provide two or more ranges.

The transformer shown was made by wrapping insulated #14 wire around an old relay coil. The coil used was from a surplus relay, has a *dc* resistance of nearly 7000 ohms, and is about 2 in. long and of 1 in. dia. The #14 wire (top winding of T2 in Fig. 2) is in series with the power line through the unit, and current flowing through these turns of heavy wire induce a voltage in the relay coil, which deflects meter M2. The action is fairly linear, and the meter can readily be calibrated in amperes.

The meter used was a 0-2 volt *ac* meter. About 8 turns of #14 wire give a full-scale deflection (2 volts) when 3 amperes flow through the circuit. Smaller wire, with more turns, could be used to get greater deflection. For example, 3 amps flowing through the additional turns permitted by using #18 wire might give induced voltages of over 5 volts, permitting the use of a higher range voltmeter.

To make the transformer, first decide on the current to be required to give a full-scale deflection of the meter on the lowest range (if more than one range is desired). Then make a mounting for the relay coil on the back of the meter, as shown in Figs. 3 and 4. Temporarily connect the relay coil terminals to the voltmeter and solder one end of the heavy wire to the lug at one corner of the mounting plate. Wrap as many turns of heavy wire as



2

SCHEMATIC

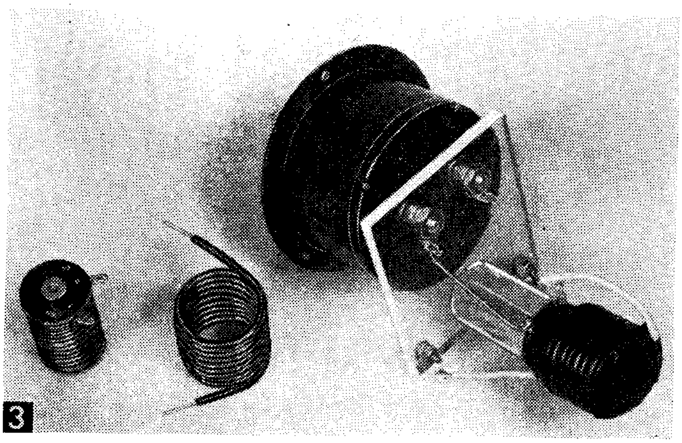
TABLE A—LIGHT BULBS REQUIRED TO GIVE SPECIFIC CURRENTS (at 120 volts)
Note: The wattage rating of domestic lamps is usually quite accurate. Due to the combinations used for most readings, any inaccuracies tend to offset each other. However, only new or relatively new lamps should be used for the greatest accuracy.

FOR CURRENT (amperes)	WATTS REQUIRED	LAMPS REQUIRED (connected in parallel)
.125	15	15
.25	30	15 + 15
.5	60	60
.75	90	60 + 15 + 15
1.0	120	100 + 10 + 10
1.25	150	150
1.5	180	150 + 15 + 15
1.75	210	150 + 60
2.0	240	200 + 15 + 15 + 10
2.25	270	200 + 60 + 10
2.5	300	200 + 100
2.75	330	200 + 100 + 15 + 15
3.0	360	200 + 100 + 60
3.25	390	200 + 150 + 25 + 15
3.5	420	200 + 150 + 60 + 10
3.75	450	200 + 150 + 100
4.0	480	300 + 150 + 15 + 15
4.25	510	300 + 150 + 60
4.5	540	300 + 200 + 25 + 15
4.75	570	300 + 200 + 60 + 10
5.0	600	300 + 200 + 100
5.25	630	300 + 200 + 100 + 25 (minus 5W)
5.5	660	300 + 200 + 100 + 60
5.75	690	300 + 200 + 150 + 40
6.0	720	300 + 200 + 150 + 60 (minus 10W)

Lamps required to calibrate to 3 amperes: two 10 watt, two 15 watt, one 60 watt, one 100 watt, one 150 watt, one 200 watt

Additional lamps required to calibrate to 6 amperes: one 25 watt, one 40 watt, one 300 watt.

Four sockets will be maximum required for either calibration.



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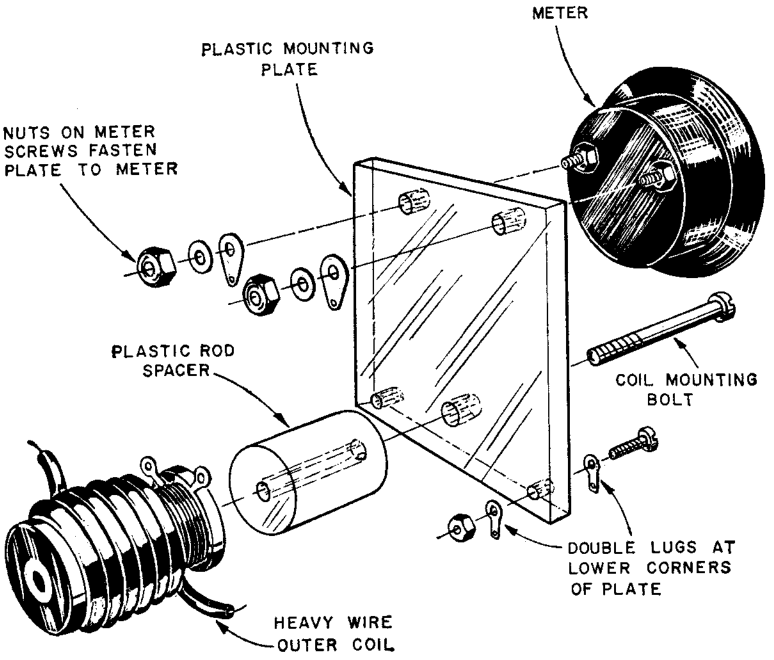
"Current transformer" and meter, showing at left the type of relay coil and heavy wire used.



4 CURRENT TRANSFORMER MOUNTING

possible around the relay coil (single layer) and hold the turns in place with a turn or two of plastic electrician's tape. Connect the coil of heavy wire in series with the load desired for full-scale reading (see Table A).

If the meter goes off-scale, reduce the number of turns of heavy wire by unwinding the free end of the coil, a turn at a time. Continue checking the meter reading, and as the exact full-scale point is approached, reduce the turns by half- and quarter-turns, to get the exact winding required to give full-scale deflection when the desired current is flowing. When this point is reached, tape the free end of heavy wire on the relay coil, and solder the end to the lug at the other corner.

If the full number of turns will not give full scale deflection for the desired current, these are several alternatives. One, use a meter of greater sensitivity; two, try winding a second layer of heavy wire; three, increase the current desired for full-scale deflection; and four, use smaller wire. The second layer of wire may reduce induced voltage unless wound carefully, and the use of smaller wire may be undesirable if it has insufficient current capacity for the full load required, particularly if several ranges are to be used.

In making the transformer mounting, make the plastic rod spacer as long as possible (within the limits of the cabinet chosen) to keep the relay coil away from the meter. This is particularly important if the meter is in a non-metallic case, as it reduces the possibility of the magnetic field around the coil affecting the meter action.

To determine the multiplier used for the higher range (R2), use a variable resistance or resistance decade. Set the value high (50K or more), and connect the load required to give the desired deflection at full-scale on the higher range. The meter should read less than full-scale, and gradually reducing the resistance to the value required for full-scale deflection will give the multiplier (R2) value required.

To calibrate the meter, place the meter-transformer assembly in the panel (if a metal panel is used), and, using the lamp combinations shown in Table A, note the meter readings on the existing scale at different current values, for both ranges (if more than one is used). In the unit shown, intermediate markings were not made up to 3 amps on the 6-amp scale, since those values would be read on the lower range.

There are definite reasons for the voltmeter switch (S3), the voltage control switch (S2), and the ammeter switch (S5). The voltmeter switch permits the voltmeter to be switched to read either direct line voltage or controlled voltage. The voltage control switch allows the control to be switched out of the circuit to permit measurement of current at direct line voltage, without "artificial" adjustment. The ammeter switch permits the ammeter to be switched out of the circuit when using devices that have a high starting current in excess of meter capacity, but a lower running current.

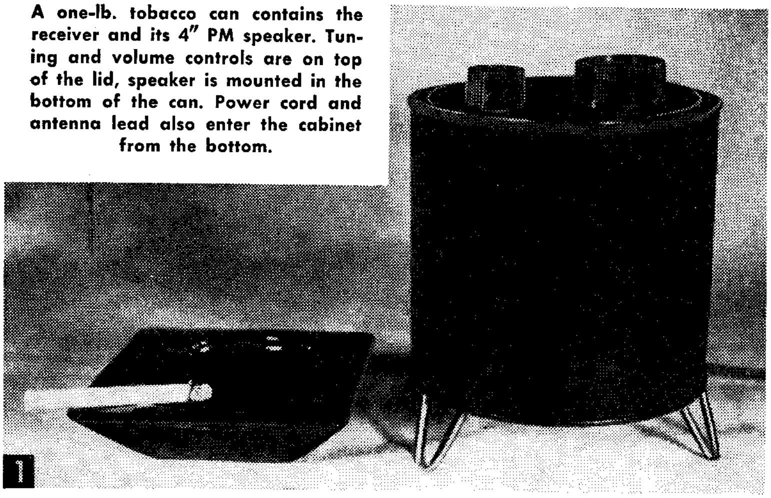
No dimensions are given, as they will vary with individual needs and the exact surplus parts secured. For most use, a 3-amp autotransformer will do, as it will handle up to 360 watts, although a larger unit might be needed if much work is done with fractional horsepower motors.

Two-in. meters will do, although three-in. meter faces give longer scale length and only cost a dollar more at most surplus houses. Switches S1 and S2 must have a current capacity equal to the maximum to be handled by the unit; the others can be standard 3-amp switches.

One-Tube Tin Can Receiver

Here is an inexpensive one-tube broadcast band receiver that will give four-tube performance. Stations nearly 70 miles away come in with good loudspeaker volume

By JOE A. ROLF, K5JOK



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A one-lb. tobacco can contains the receiver and its 4" PM speaker. Tuning and volume controls are on top of the lid, speaker is mounted in the bottom of the can. Power cord and antenna lead also enter the cabinet from the bottom.

IF you're a pipe smoker, you no doubt already have a cabinet for this receiver. If not, you probably have a friend who buys his tobacco in a one-lb. can. An empty cigar tin or a two-lb. coffee tin can also be used or, if desired, the unit can be easily built on a small standard chassis.

A Prince Albert tobacco can, 5 in. high and 5 in. dia., was used as cabinet by the author. Some tobaccos are packaged in slightly smaller containers and using one of these may make it necessary to alter the parts layout slightly from that shown in Figs. 3 and 4. However, with care there will be no difficulty in getting the components to fit easily in any one-lb. tin you use.

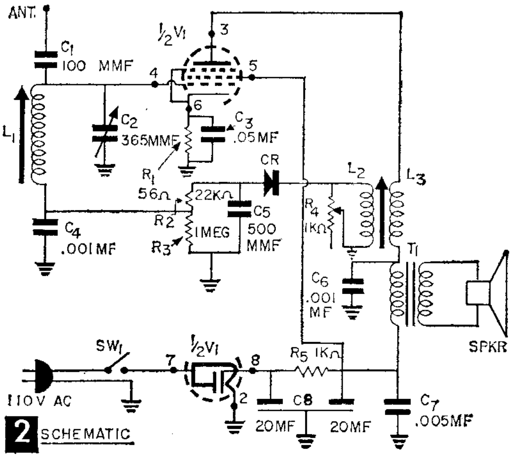
If you're an old-timer in radio, you'll probably recognize the circuit shown in Fig. 2. Similar to those popular in the days when multi-tubers were large and cumbersome and vacuum tubes expensive, it's a reflex circuit designed for economy and compactness and making a single tube do the work of two—both RF and AF amplifier. Here's how the reflex circuit shown in Fig. 2 works:

The 117N7/GT contains a rectifier and power pentode section in the same envelope. The rectifier is employed as a half-wave power supply, the pentode works as a combination RF-AF amplifier. A crystal diode (CR) is used for an RF detector.

Radio signals enter the receiver from the antenna through C1 and the desired station is selected by the tuned circuit formed by C2 and L1. The selected signal is then amplified by the tube which is biased for RF amplification by the cathode resistor R1. The amplified signal appears across L3 in the plate lead of the tube and, since L3 and L2 form an RF transformer, RF is transferred to L2; RF does not flow through the primary of the output transformer T1, but is passed to ground by C6 which offers very little impedance to RF.

The amplitude of the signal appearing across L2 is controlled by R4 (the volume control). This voltage is rectified by diode CR, and an AF voltage appears across the detector load, R2 and R3. Any RF still present at this point is passed to ground by C4 and C5 which have low impedance to radio frequencies, but high to audio frequencies.

The grid of the tube is connected between



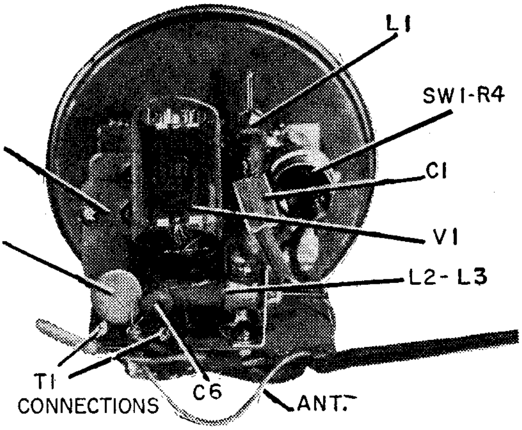
2 SCHEMATIC

R2 and R3 where the AF voltage is negative with respect to ground. This negative audio voltage, acting through L1 (low AF impedance) biases the tube automatically and causes it to act as an AF amplifier. The AF signal in the tube's plate lead is not affected by L3, nor is it transferred to L2. Nor is it grounded by C6. Instead, it appears across the primary of the audio transformer T1 to operate the speaker connected to the secondary winding.

Construction. The receiver is built with the speaker and output transformer mounted in the bottom of the can and other components mounted on an L-shaped chassis which is fastened to the lid of the can by the volume control shaft and two machine screws. The chassis may either be of aluminum or sheet metal. Sheet metal will be somewhat harder to work, but will allow the builder to solder ground connections directly to the chassis without using solder lugs.

Form the chassis from a piece of material 3¼ x 5 in. bent to a right angle with sides measuring 2 x 3¼ in. and 3 x 3¼ in. The 2-in. side fastens to the lid with the other leg of the angle centered about ¾ in. from one edge of the lid. The 2 x 3¼-in. covers most of the lid to reinforce the thin material to which it is attached. The 3-in. leg is used for mounting the components.

Tuning capacitor, C2 and volume control R4 are placed so that their shafts are centered in the lid. The tube socket is placed behind C2 as close as possible. Transformer L2-L3 is mounted horizontally next to the tube as shown in Fig. 3, while L1 is mounted in a vertical position between the tuning capacitor and volume control. A two-lug terminal strip on the top of the chassis, at the right rear edge, is used to connect the output transformer leads to the chassis. Capacitors C6 and C7 are also mounted on this strip.



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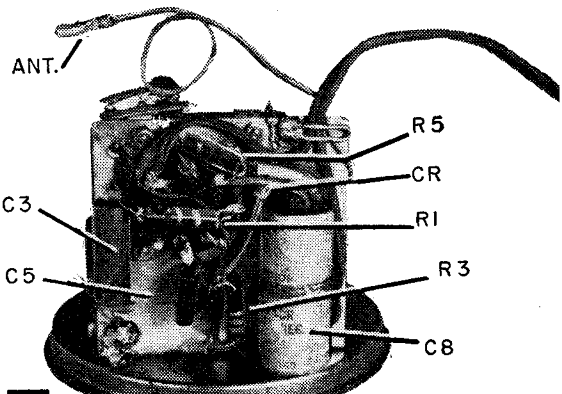
Chassis for the receiver is an L-shaped bracket which fastens to the tobacco can lid. This photo shows the layout of parts on the topside of the chassis. Leads from the output transformer are soldered to the terminal strip at the rear edge.



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Underside of chassis. Holes for bringing leads from the top of the chassis should be placed so that plate and grid leads are short and separated from one another.

Filter capacitor C8 is placed on the right underside of the chassis and next to it, toward the front, is a two-lug terminal strip for mounting R2, R3, and C5. The layout of the remaining components is not critical, but care should be taken that the lid will fit properly with everything mounted and that the grid and plate leads are separated as much as possible to avoid the possibility of feedback. It is particularly important that L1 and L2 be mounted at right angles to one another and separated as much as possible in order to minimize coupling.

The RF transformer L2-L3 is made by winding 75 turns of litz wire (obtainable from a discarded RF or IF coil) over the windings of a ferrite antenna coil. The added winding should be secured with several coats of coil dope or finger-nail polish. The original winding is L2; the added winding, L3.

A 12-in. piece of hookup wire brought out of the cabinet with the power cord serves as an antenna lead-in to the chassis. A pin-jack from a discarded tube socket can be soldered to this wire and shielded with tape or plastic tubing to make a handy antenna jack.

Mount the speaker in the bottom of the can with four machine screws. Output transformer T1 can be mounted with screws or soldered in place. If the recommended speaker is not used, its replacement should not extend above the bottom of the can more than 1¾ in., otherwise the chassis may have to be made smaller.

Small holes in the bottom of the can serve as a speaker grille. Or, for better tone, cut a 4-in. dia. hole in the bottom with a sharp

MATERIALS LIST—TIN CAN RECEIVER

Desig.	Description
C1	100 mmf. mica capacitor
C2	365 mmf. variable (double-bearing replacement type) capacitor
C3	.05 mf. 200 WV midget tubular capacitor
C4	.001 mf. disc ceramic capacitor
C5	500 mmf. mica capacitor
C6	.001 mf. disc ceramic capacitor
C7	.005 mf. disc ceramic capacitor
C8	20-20 mf. 150 WV dual electrolytic (Cornell Dubilier BBRD 2215) capacitor
Cr	1N34 or CK-705 diode
L1	hi-Q ferrite antenna coil
L2	hi-Q ferrite antenna coil
L3	75 turns of litz wire wound over L2 (see text)
R1	56 ohm, ½ watt resistor
R2	22,000 ohm, ¼ watt resistor
R3	1 megohm, ¼ watt resistor
R4	1,000 ohm, ¼ watt volume control (with SPST switch)
R5	1,000 ohm, 1 watt resistor
Spk	4″ PM replacement type speaker, 3.2-ohm coil (Jensen 4J6 or Cletron PM-4P2)
Swl	SPST switch (on volume control R4)
T1	3,000/3.2 ohm, 3-watt output transformer
V1	117N7/GT tube
	1 wafer or saddle-mount octal socket, 2 terminal strips (2-lug type), twenty ⅛ x ¼″ machine screws, 5′ power cord with plug, 3¼ x 5″ pc. of #16 or #18 ga. aluminum or sheet metal, 12″ #8 copper wire, plain or tinned, solder & hook-up wire.

knife. But watch the sharp edges! When the mounting holes for speaker and output transformer have been drilled plus a hole at one edge for the power cord, glue a piece of perforated cardboard over the bottom of the can to protect the speaker cone.

Then make three hairpin legs of #8 silvered copper wire formed into V shapes 1¼ in. high and soldered in place. For gold legs, use untinned copper wire that has been polished and given a coat of clear finger-nail polish to retard tarnishing.

With completion of chassis wiring and speaker mounting, bring the power cord and antenna lead through the hole in the bottom of the can and attach a power plug. Next, solder the output transformer primary leads to the lugs of the terminal strip at the rear of the chassis. These leads should be long enough to permit the chassis to be removed from the cabinet with the speaker in place.

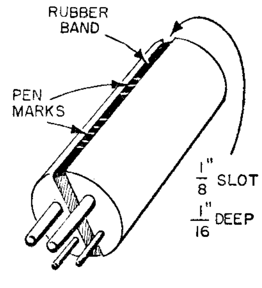
To test the unit, use a long antenna. (The set should never be grounded or operated on a metal surface.) With an antenna connected, turn the set on and advance the volume control to maximum. Check and see if the filaments are lit before tuning across the band. If working properly, the receiver will receive stations clearly—or with a whistle. In either case, find a strong station at the high end of the band and adjust L2's slug for best reception. At some point of adjustment the audio will become distorted. Set the slug just below this point.

Because of the metal cabinet and the absence of a loop antenna, a short external antenna is necessary. For local stations, 4 ft. of hook-up wire is sufficient. For distant stations, a longer length strung around the room will do. When the set is working properly, connect a short antenna and adjust L1 so that C2 tunes the entire broadcast band and then adjust the slug on L2 again for best reception. The receiver is now ready to be placed in its cabinet.

A small amount of regeneration requires the initial adjustment of L2 to avoid distortion or oscillation at the upper edge of the band. This also tends to make the receiver more sensitive on the high end of the band, but volume for all stations is nearly the same due to the AVC action of the audio bias. While not as selective, the receiver has better tone than most small table-models, despite the small speaker and tin cabinet. If poor selectivity is noticed when the set is operated near local, high-power stations, reduce the value of C1 by about half.

Note: To avoid the possibility of shock, either: 1) always plug the power cord into the 110-v outlet with the cabinet common to the ground side of the power line (this will also give best reception); or 2) completely isolate the line from the cabinet and chassis by making all ground connections to a terminal lug insulated from the chassis. Capacitor C4, however, should be grounded to the chassis to provide an RF return to the tuning capacitor frame.

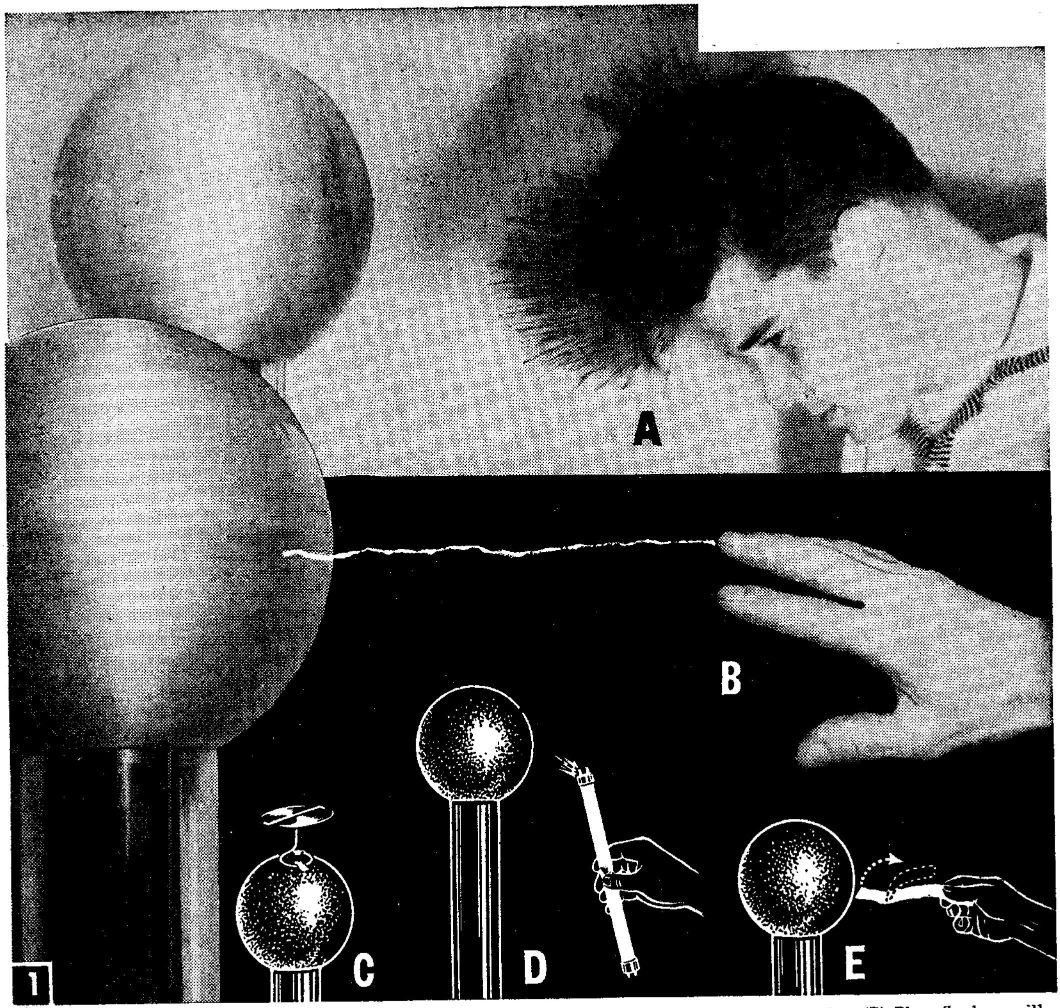
Coil-Winding Tip



- Amateur radio operators who wind their own short wave coils know how difficult it sometimes is to properly space and anchor just a few turns of wire. The solution is to saw or file two opposite slots ⅛ in. wide and about 1/16 in. deep on the top edge of the coil form. Place a wide, flat No. 32 rubber band in these slots and stretch it over the form and between two pairs of prongs. Fountain pen or ball pen marks are easily made on the rubber band, exactly where each turn of wire should pass. Draw the wire tightly to embed it in the insulating rubber and hold it neatly in place without the use of cement.

Invert Aerial to Speed Installation

- The neighbors may think you're crazy if you start the installation of a TV or radio aerial upside down, but doing this will help you to quickly and easily align a bracket on the edge of your house. By having the mast parallel a corner of the building, one of the windows, or some other vertical part, it is easy to sight the alignment while adjusting the mounting bracket. Then you need only reverse the mast to finish the job.



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(A) Standing close to the sphere stands your hair on end and charges to tingle your scalp. (B) Blue flashes will jump to your fingers held 12 in. or more away. (C) Corona point discharge from the tips of a wire rotor spins it like a pin wheel. (D) When end of a fluorescent tube is held closely to sphere, small streamers of blue discharges burn from the lamp terminals and lamp lights. (E) Cloth strip shows electrostatic laws of attraction and repulsion. Tossing a strip of cotton cloth at sphere causes it to remain horizontal. When end touches sphere, it becomes charged to its polarity and is violently repelled.

Experimental Van de Graaff Generator

Develop up to 380,000 volts on the same principle as scuffing across a heavy rug

By HAROLD P. STRAND

YOU can build a simplified version of the electrostatic generator developed in 1931 by Dr. Robert J. Van de Graaff that aided in the development of the atomic bomb. The full-size generators produce several million volts on an aluminum sphere at the top of an insulated column.

The small counterpart of these Van de Graaff generators will perform a variety of experiments (Fig. 1) and develop up to 380,000 volts under ideal atmospheric conditions. Dampness in the air reduces the efficiency of the unit causing leaks of the static charges from the belt, the column and the sphere to the air. When this unit was tested at the high-voltage laboratory of a large university in dry air, the short-circuit current was 18 microamps at the calculated voltage.

The high voltages generated are not usually dangerous, although you can feel a good sting if sparks jump to your fingertips when held too close to the ball. There is no electrical power supplied to the belt; it picks up charges as the velvet rubs over plastic. Static charges on the surface of the plastic are positive and attract negative charges from the ground through a brush near the bottom end of the belt. These negative charges are carried upward on the moving belt, picked off by one of the two brushes in the top and carried to the surface of the sphere through the corona gap. The other brush is called the charging brush because it insures a positive polarity of the belt on the way down (Fig. 3). After a few minutes of operation, voltage builds up on the sphere to the maximum possible with the insulation provided and atmospheric conditions present. The model stands 39½ in. high and only weighs 18 pounds. The only requirement for operating it is a 115-volt *a-c* or *d-c* outlet for the motor.

An inexpensive motor for driving the belt can be salvaged from an old Hoover vacuum cleaner. A slide-wire resistor or rheostat controls the speed to around 3000-4000 *rpm.* These motors are usually available at repair shops for $5 or $6 and develop about ¼ *hp.* Be sure to select one with tight bearings that runs fast, smooth and without excessive sparking. It's a good idea to disassemble the motor, clean out dirt and old oil first. While the armature is out, turn the threaded end of the shaft to a ¼-in. diameter (Fig. 5). To reverse the direction of rotation to drive the vel-

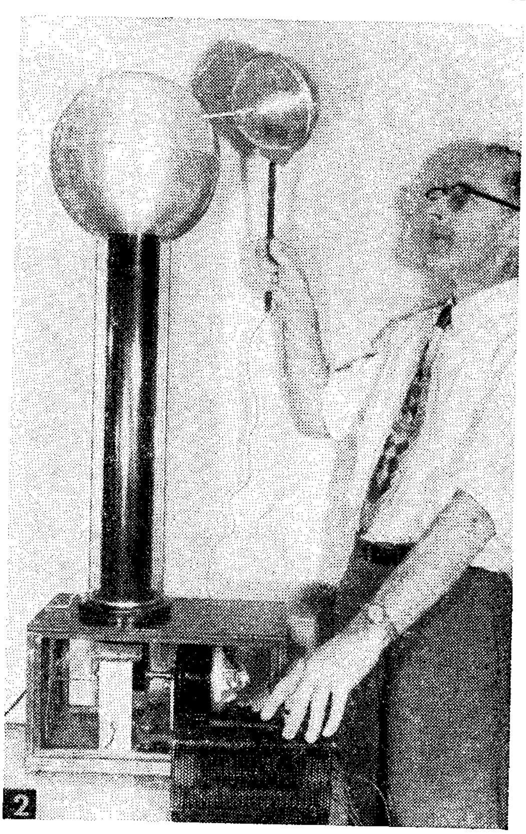
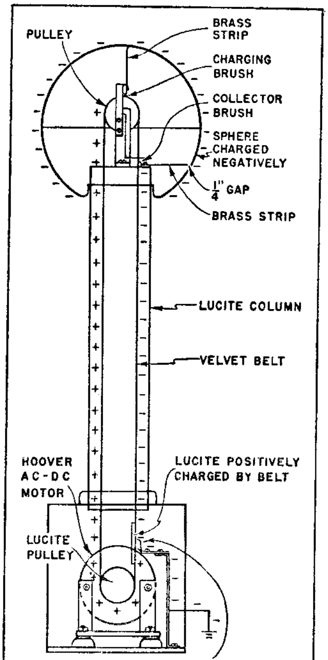


Table-top Van de Graaff throws heavy, noisy discharge to hand electrode up to 5 in. or thinner discharges up to 8 or 10 in. This model simulates the full-size generators that helped in atomic research.



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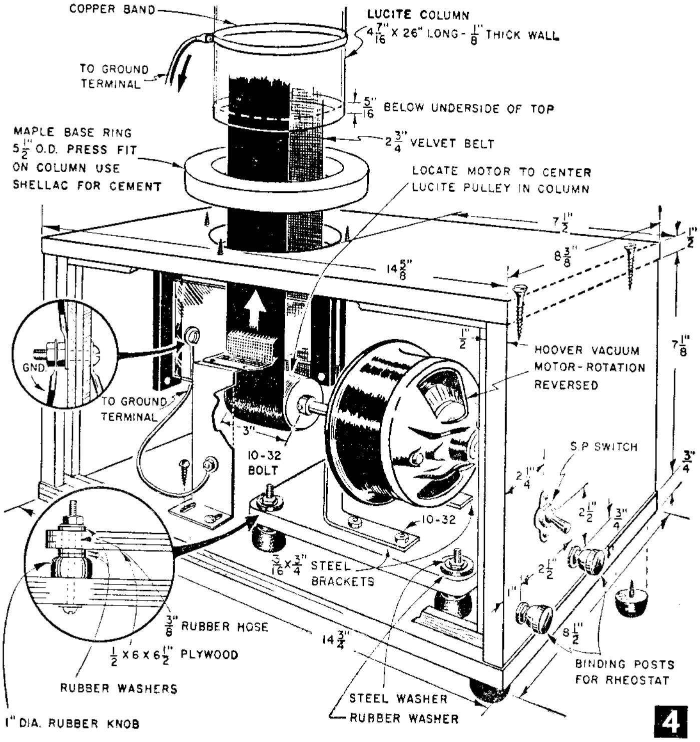
NEGATIVE ELECTRONS ATTRACTED FROM GROUND TO TWIN BRUSH ON TO BELT (UNLIKE CHARGES ATTRACT)



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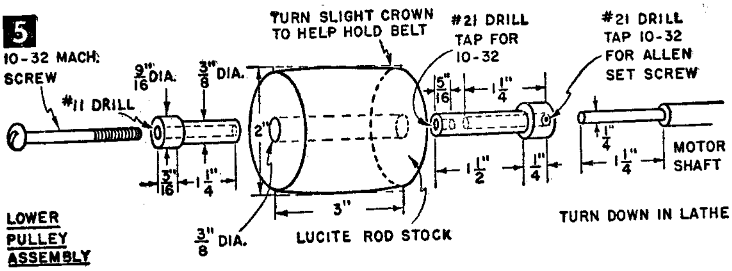

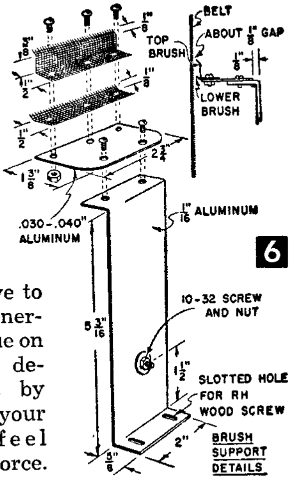

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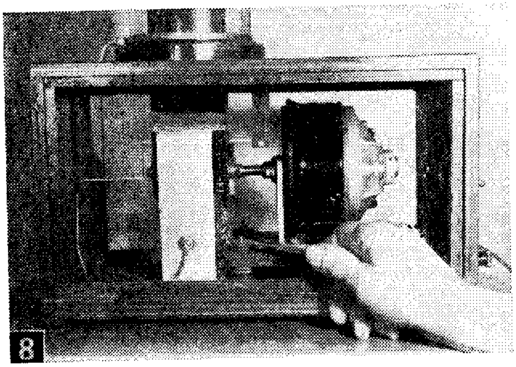
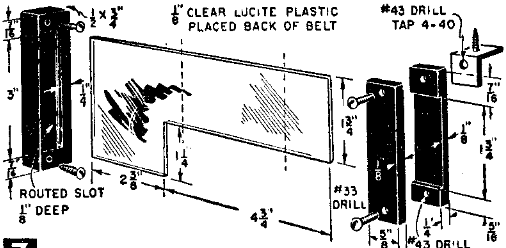
vet belt counter clock-wise, reverse the brush leads by soldering on extensions. When you test the reassembled motor on the line with the resistance in series, loosen the two screws securing brush yoke and move to the position that generates maximum torque on the shaft; you can determine this point by holding the shaft in your hand lightly to feel maximum turning force.



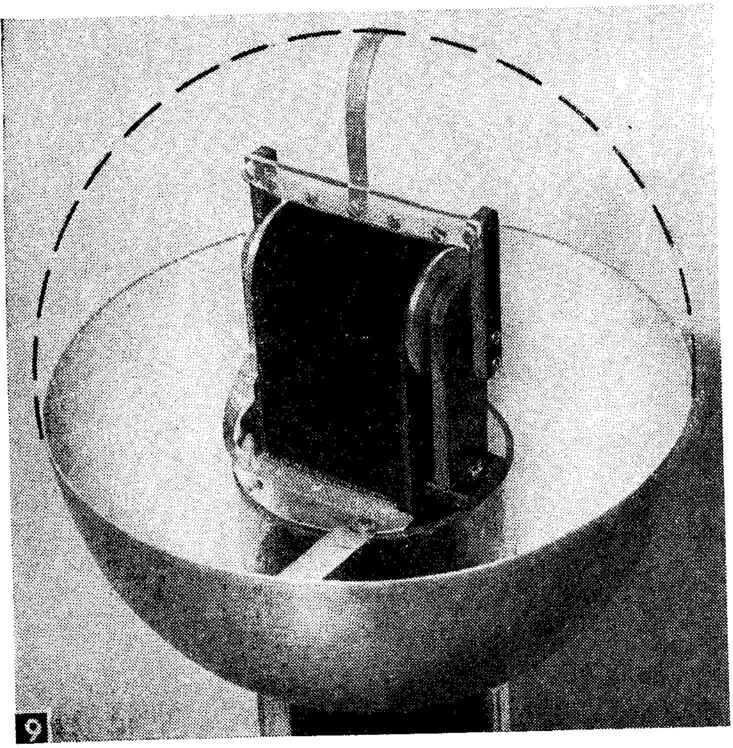
8

Adjusting compression of rubber mounts helps to align lower pulley to keep belt tracking. Sides can be fitted with masonite panels if desired.



7

Below, noisy discharge sparks jump from top of sphere to hand electrode suspended without its handle from ceiling with ground wire. Air space is 5 to 6 in. Interval between sparks depends on atmospheric conditions and speed of belt. Below left, pulley, charging brush, collector brush and spark strips at top end of column. Pulley supports are made of *Bakelite* for strengthened insulation.



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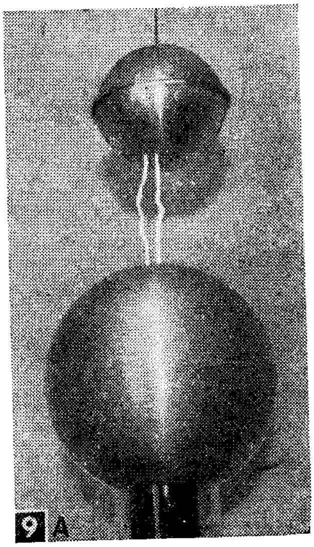


9A

A plywood cabinet encloses the motor and the base of the plastic column (Fig. 4). The motor mounts on two angle brackets bent up from 3/16 x 3/4-in. mild steel or aluminum. Make a base for the motor from 1/2-in. birch plywood and mount it on large rubber knobs at the four corners to reduce vibration and to allow the belt to be tightened by compressing the rubber. Adjust compression on rubber mounts to align pulley.

A turned hardwood ring with its inside diameter of about 4 7/16 in. should be a tight fit around the *Lucite* column. Shellac or varnish makes an effective cement to hold the column in the ring. A flat copper wire (salvaged from the field winding of an old automobile starter) around the column keeps lower end of unit at ground potential.

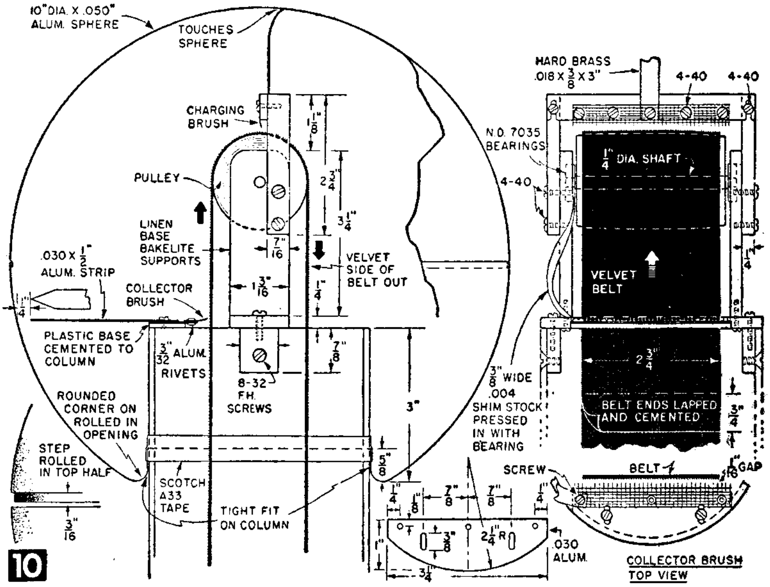
The lower belt pulley mounts directly on the end of the motor shaft (Fig. 5). Turn a slight crown on the solid *Lucite* pulley to help keep the belt centered. Turn the center rod parts from brass stock and assemble pulley to the end of the motor shaft with set screw. Turning and center hole boring must be done accurately.

A bent-up piece of .064 aluminum supports the ground inductor brush (Fig. 6). Two pieces of copper screening, 1/32-in. mesh, give numerous arcing points and are adjusted with screws to about 1/8 in. from the moving belt after it is in place.

A piece of *Lucite* sheet must be fitted inside the cabinet so the back of the belt rubs it (Fig. 7). Fit the *Bakelite* supports after the belt is in place.

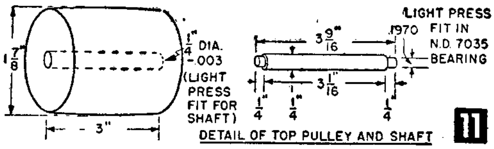
When you complete the base cabinet, mount the driving motor, lower brush pickup and pulley, you're ready to add the top pulley assembly, make the belt and top sphere.

The top pulley and brush collector assembly inside the aluminum sphere mounts on two chunks of paperbase *Bakelite* screwed and *Pliobond* cemented to the inside of the *Lucite* column (Fig. 10). These blocks are curved to fit the column and must be mounted directly opposite each other and centered. The vertical U-supports that hold the top pulley must be bored for a press fit with the bearings. Use a 3/4-in. end cutting bit or end mill .0003-.0006 in. undersize in a drill press to bore out for the bearings. Or you may use a single lip type wood boring bit without a threaded center worm in a drill press if well sharpened.

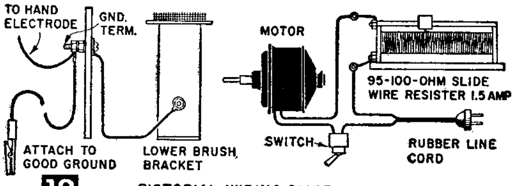


10

Bore a 1/4-in. center hole about .0003 in. undersize in the piece of 2-in. dia. Lucite to be used for the top pulley for a press fit with the 1/4-in.



DETAIL OF TOP PULLEY AND SHAFT **11**



12 PICTORIAL WIRING DIAGRAM

shaft, or you can drill a full-size 1/4-in. hole and turn a slightly oversize steel shaft for a press fit in the hole (Fig. 11). Cut bearing seats on the ends of the shaft for a light press fit in the bearings. Use the lathe cut-off tool to indicate length of the shaft, remove from lathe and remove the excess length; file ends smooth. Now, cut a piece of aluminum foil long enough to wrap around the pulley and lap 1/16 in. Pliobond to pulley.

To assemble the upper pulley unit, press the bearings on the ends of the pulley shaft, then press the *Bakelite* side supports over the outer race of the bearings. The U-supports and the cross piece must be centered so the pulley is directly over and in alignment with the bottom pulley. A plumb bob or weight on a string helps to align the pulleys vertically, but be sure the bottom assembly is resting level. After locating the U-supports, screw them to the *Bakelite* cross piece and screw the cross piece to the blocks at the top of the column. The top pulley assembly will be removed later to slip on the belt.

MATERIALS LIST—VAN de GRAAFF GENERATOR

Clear Lucite

- 1 tubing 26″ long x 4½″ dia. x ⅛″ wall. May come about 4 7/16″ diameter actual measurement, column
- 2 solid rod stock 3″ long x 2″ dia., pulleys

Natural paper base Bakelite

- 1 ½ x ¾ x 3⅞″ (Friction piece support in base)
- 1 ¼ x ⅝ x 2½″ (Friction piece support in base)
- 1 ⅛ x ⅝ x 2½″ (Friction piece support in base)

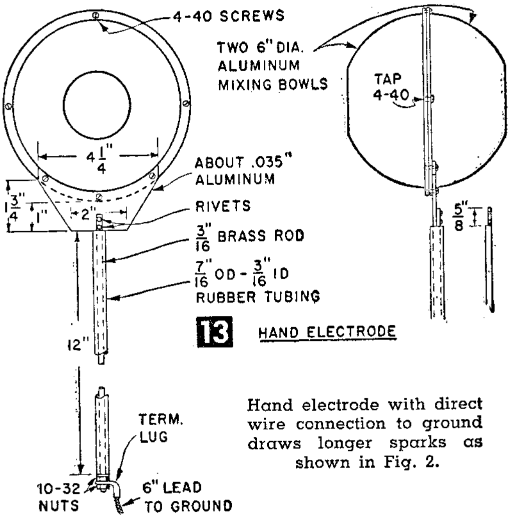
Forest Products Company Inc., 131 Portland St., Cambridge, Mass. will supply the above material postage paid to any part of the U.S.

- 1 1/16 x 2 x 6½″ alum. brush bracket (base)
- 1 .032 x 1⅜ x 2¾″ alum. alloy (top of bracket)
- 2 3/16 x ¾ x 5½″ mild steel motor angle brackets
- 1 9/16″ dia. x 1 7/16″ brass lower pulley
- 1 ⅝″ dia. x 1¾″ brass lower pulley
- 1 ½″ 8⅜ x 14⅝″ birch plywood, cabinet
- 2 7⅛ x 8⅜″ birch plywood, cabinet
- 1 fir plywood ¾ x 8½ x 14¾″ base
- 8 ft ⅜ x ⅜″ hardwood strip stock

Miscellaneous

- 4 rubber knobs or feet
- 4 rubber knobs about ¾ to 1″ diameter for motor base
- 1 universal motor from an old Hoover vacuum cleaner
- 1 3 x 4″ copper screening, preferably 1/32″ mesh
- 1 flat copper wire from the field coil of an old auto starter, about 24″ long, ground band around column

No.	Size and Material	Use
1	⅛ x ½ x 4¼″ sheet Lucite	top brush strip
1	⅛ x ¾ x 3¼″ sheet Lucite	brush base in top
1	¼ x 1 3/16 x 4½″ paper base Bakelite	top support
2	¼ x 7/16 x 2¾″ paper base Bakelite	side support
2	¼ x ¾ x ⅞″ paper base Bakelite	blocks, top edge of column
2	¼ x 1 3/16 x 3¼″ linen base Bakelite	pulley supports
	(Forest Products Company Inc., 131 Portland St., Cambridge, Mass. will supply the above material postpaid to any part of the U.S.)	
1	¼ dia x 4½″ cold rolled steel	top pulley shaft
1	.030 x 1 x 3¼″ sheet aluminum	side collector brush base
1	.030 x ½ x 3″ sheet aluminum	corona gap strip
2	6″ dia mixing bowls aluminum	hand electrode
1	.050 x 1¾ x 4¼″ sheet aluminum	handle support, hand electrode
1	10″ dia sphere, .050 alum. (available from Robert Towne, 49 Abbott Ave., Everett, Mass., $8.25 ppd. in U.S.)	
1	.018 x ⅜ x 3″ hard brass sheet	connecting strip
1	.003 or .004 x ⅜ x 4″ shim stock	jumper to pulley
1	slide wire resistor or a rheostat 95-100 ohms, 1.5 to 2 amps	
1	S.P.S.T. toggle switch	
1	2¾″ wide x 6′ long velvet ribbon	belt
2	New Departure ball bearings #7035 (Available from Bearings Specialty Company, 665 Beacon Street, Boston, Mass.)	
1	3/16 dia x 13″ long steel or brass rod	handle for hand electrode
1	3/16 I.D. x ½ O.D. x 12″ long rubber tubing	handle for hand electrode
	misc. wire, stain, shellac, screws, nuts, etc.	
	heavy duty aluminum foil, Pliobond cement	



13 HAND ELECTRODE

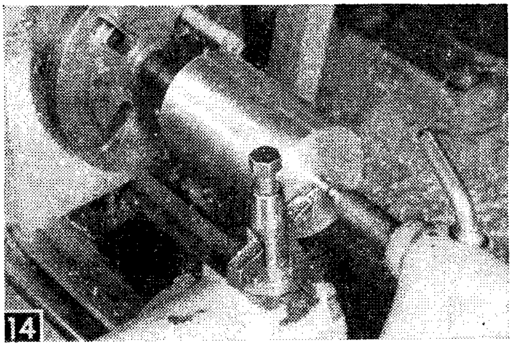
Hand electrode with direct wire connection to ground draws longer sparks as shown in Fig. 2.

Velvet ribbon for the belt may usually be obtained from a large department store. You'll need about 6 ft. of 2¾-in. ribbon of any color. To determine the exact length, run a string over both pulleys and allow about ¾ in. for lapping at the joint (Fig. 10). Apply a generous coating of *Pliobond* cement to both surfaces to be joined and clamp between two pieces of wood in C-clamps. Be careful not to allow cement outside of the lap area, or it will be difficult to separate from the wood later. Let the lap set overnight.

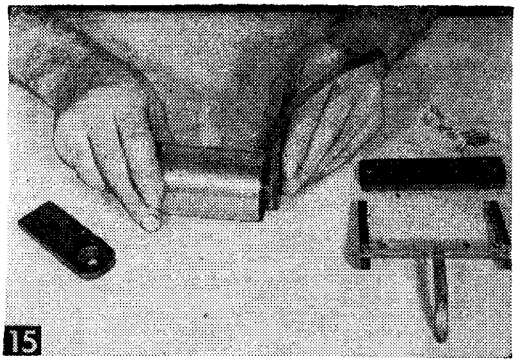
To install the belt, remove the top pulley assembly at the two #6-32 screws and slip the unit through the loop of the belt. Tightening the base nuts maintains the reasonably tight tension required. When the belt is running straight and true, adjust the plastic piece in the base and fit the ground brush in place.

In case you have difficulty keeping the belt running true, there are several ways to correct misalignment. Thin shims of cardboard under either base end of the top pulley support or tightening front or rear motor bolts allow considerable adjustment. For further adjustment, the holes in the cabinet base can be slotted to permit shifting the motor as required.

The aluminum sphere is a metal spinning made according to Fig. 10. You should be able to have a local metal-spinning shop do the job for you, if not, you can get a sphere by mail from the source indicated in the Materials List. When spinning the turned-in neck that should fit tightly over the top end of the column, avoid any sharp corners or the built-up energy from the sphere will leak away. The seam between the two halves of the sphere should form a smooth joint to eliminate any edges where energy can leak off.



14 Machining shaft to be a light press fit in New Departure ball bearings 7035.



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A strip of .003-in. brass shim stock is pressed in with bearing at left side (facing collector brush). After starting the bearings in their holes, an arbor press can be used to seat them. Note other top end parts.

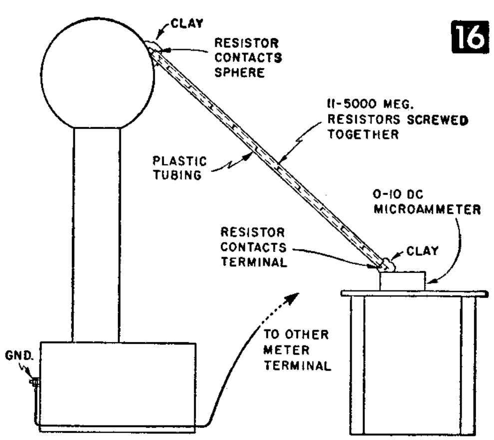
When the bottom half of the sphere is adjusted, fit the brush collectors and the spark gap strip at the top (Fig. 10). The wiring diagram (Fig. 12) shows the necessary connections with the slide-wire resistor or rheostat in the circuit to control the motor's speed.

When all parts are assembled and you're ready to make the initial test, run the motor up to about 3000 *rpm* with the top half of the sphere off. After a few minutes, you should be able to draw short sparks to your finger at the belt in the region between the brushes if the generator is working right. Possible causes for non operation may be that the plastic sheet in the base is not in full contact with the belt or too much humidity.

A final test is to set the half-sphere on top and connect a *d-c* microammeter between the sphere's surface and the ground terminal. A small chunk of modeling clay will plaster the top lead to the sphere's surface. Start the motor and, after a few moment's operation, you should read 15-20 microamperes, the short-circuit current of the unit.

To test the voltage output of the generator, connect a string of eleven 5000-megohm special high-voltage resistors (Type BBV, available from Resistance Products Co., Harrisburg, Pa.) by screwing their ends together (Fig. 16). Connect the series resistor string to one terminal of a 0-10 *d-c* microammeter away from the generator, using modeling clay to hold it in constant contact with meter terminal. Attach other end of the resistor string to the sphere with clay. Enclose the resistors in a tube of plastic or other insulation. The other terminal of the meter is connected to the ground terminal of the generator. You might be able to test your generator in a nearby university or electrical testing laboratory which would probably have the special resistors and microammeter.

When you complete the voltage test set up, run the motor at about 3000 *rpm* for a few minutes to allow voltage to build up on the sphere. Depending upon the humidity conditions in your test room, you should be able to read from 6 to 8 microamperes. If the meter's needle fluctuates wildly, it probably indicates the plastic piece is not making full contact with the back of the belt. Good contact between the sphere's surface and the resistor string and at the meter is also important for correct readings.



Set up of resistors and microammeter for checking voltage of generator. It will vary with humidity.

When you read the current on the meter, calculate the voltage using Ohm's law (E = I x R, where E represents voltage, I the current in amperes and R the resistance in ohms). One microampere is one millionth of an ampere, so 7 microamperes becomes .000007 amperes. One megohm equals 1,000,000 ohms and 55,000 megohms converts to 55,000,000,000 ohms. Completing the calculation shows the voltage at a current reading of 7 microamperes is 385,000 volts.

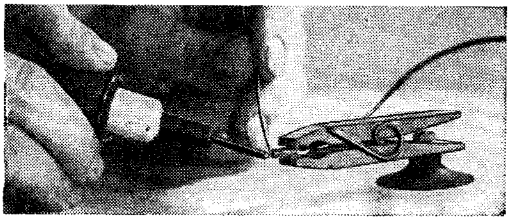
The hand electrode (Fig. 13) capacitor aids in experimenting with the Van de Graaff generator. It should be possible to get satisfactory discharges at speeds as low as 1000 *rpm*.

Foil Aids Set Alignment

• To avoid interference, it is common practice to stop a superhet's oscillator before aligning the intermediate-frequency amplifiers. A simple way to do this, is to wedge a piece of aluminum foil between the plates of the oscillator's tuning capacitor. When the dial is rotated, the foil between the rotor plates makes contact with the stator plates and "kills" the oscillator.

The Radioman's Third Hand

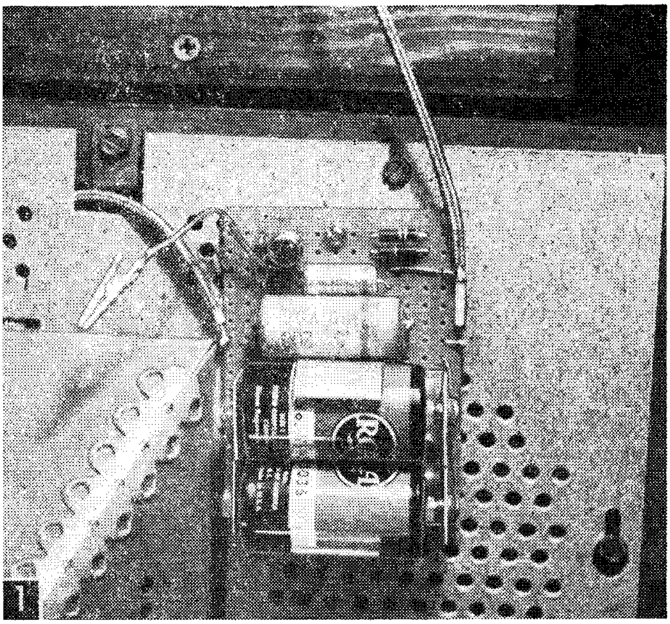
• A wood clip-type clothespin fastened to tabletop by a suction cup makes a handy holder for soldering of eyelets, terminals and lugs.



Build An Emitter Follower!

You can couple low-impedance devices to high-impedance circuits with this emitter follower. The unit can be built in a few hours for about $3

By FORREST H. FRANTZ, Sr.



1

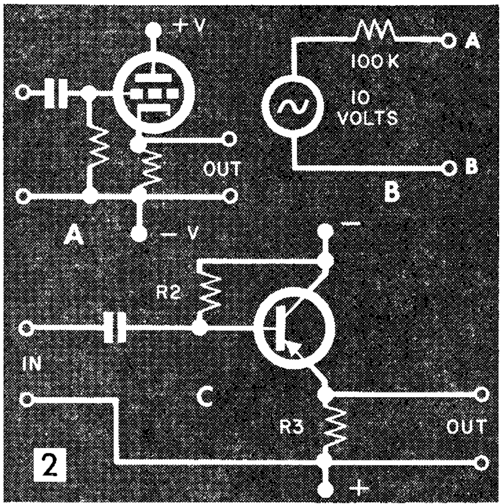
An emitter follower can be used to connect the audio of a radio or TV set to a hi-fi amplifier. If back of set is metal, insulate back of emitter follower.

ELECTRONIC experimenters and hi-fi enthusiasts frequently need to connect a low-impedance load to a high-impedance output. Typical applications are coupling a low-impedance microphone or phono pickup, or using a low-impedance meter to measure voltages in a high-impedance circuit. An emitter follower will do the job.

Sometimes the problem of coupling high impedance devices separated by considerable distance crops up because the capacitance between the connecting wire center lead and shield is sufficiently large to affect the frequency response of the system. If an emitter follower is connected in the line, the problem can be licked.

The emitter follower described in this article is relatively small in spite of the fact that no special effort was made to miniaturize it. Flashlight batteries were employed as a power source to obtain operating economy. The current drain on these batteries is less than 1 milliampere.

The emitter follower is the transistor equivalent of the vacuum-tube cathode follower. The voltage gain of a cathode follower is approximately unity. A simplified vacuum tube cathode follower circuit is shown in Fig. 2A. The input impedance of a cathode follower is high (several megohms), but the output impedance is low (several hundred ohms). Thus, if a low-impedance device such as the *ac* voltmeter section of a multimeter is to be used to measure *ac* voltage in a high-impedance circuit, it can be connected to the output terminals and the



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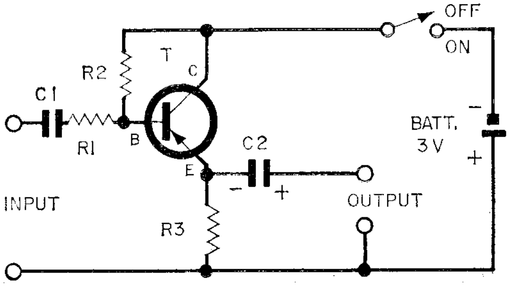
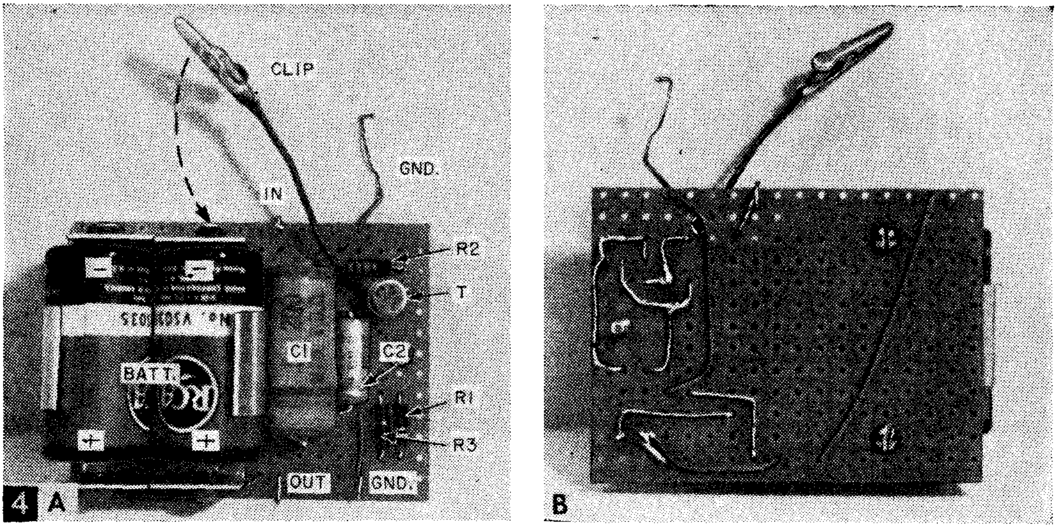


3 SCHEMATIC



Front (A) and back (B) views of follower's parts placement and wiring.

input terminals of the cathode follower become high-impedance input terminals for the meter. Probe leads connected to these input terminals can be connected across high-impedance circuits without loading them significantly.

If, on the other hand, the low-impedance *ac* voltmeter section of the multimeter were placed across a high-impedance circuit, the circuit would be—for all practical purposes—shorted, and the voltage indicated on the meter would be very low. In addition to causing a low meter reading, the near-short circuit would affect the operation of the circuit under test. An example will illustrate this more clearly:

Assume that the voltage across terminals A and B in Fig. 2B is to be measured. If a meter with 5K impedance (1000 ohms per volt set to the 5-volt scale) is connected across terminals A and B, it will measure $5/(100 + 5)$ or $1/21$ of the 10 volts. However, if, the meter is connected to the output terminals of the cathode follower, and the input terminals of the cathode follower are connected across terminals A and B, the meter will read nearly 10 volts. Assuming the input impedance of the cathode follower to be 10 megohms, the voltage across the cathode follower input is $10 \times 10/10.1$, which is nearly 10.

The cathode follower unfortunately has the drawbacks associated with a vacuum-tube circuit: high voltage supply requirements, wasted power and large size.

An emitter follower is free of these drawbacks, but there are some differences between it and the cathode follower. The circuit of a simplified emitter follower is shown in Fig. 2C. The input impedance of this emitter follower would be approximately equal to beta times R3, if R2 were not present. The beta of the transistor is the current gain, and for the better audio driver transistors, beta is around 100. Then, if R3 is 1K, the input impedance of the emitter follower would be about 100K if R2 could be neglected. But R2 acts in shunt with the input signal, and therefore if R2 is about 200K (this is a practical approximation), the input impedance would be about 67K.

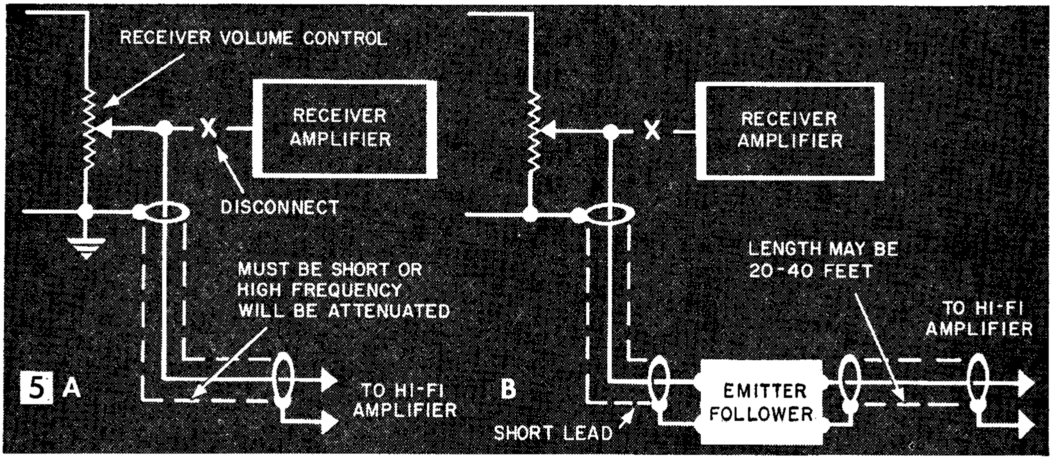
MATERIALS LIST—EMITTER FOLLOWER

Desig.	Description
R3	2.2K, ½ watt carbon resistor
R2	220K, ½ watt carbon resistor
R1	470K, ½ watt carbon resistor
C1	.5 mfd, 200 v paper capacitor (Sprague 2EP-P50)
C2	30 mfd, 15 v miniature electrolytic capacitor (Sprague TE-1158 Littl Lytic)
B	two 1.5-v flashlight cells (RCA VS035 or Burgess No. 1)
	two cell battery holder (Lafayette MS-174)
	$2\frac{7}{16} \times 3\frac{3}{8}''$ miniature perforated board (Lafayette MS-304)
	minigator clip (Mueller 30)
T	2N362 Raytheon transistor (or any PNP transistor, see text)

Components may be obtained from Lafayette Radio, 165-09 Liberty Ave., Jamaica 33, New York.

It might seem that the input impedance could be increased considerably by increasing R3. Suppose R3 were 10K. Then, if R2 could be neglected, the input impedance would be 1 megohm! Now, assuming that R2 can be 1 megohm, the input impedance becomes ½ megohm or 500K. Unfortunately, the size of the battery must be increased (greater voltage required) to use such values. Furthermore, the previous 1K output impedance has been increased to about 10K. This is a relatively high impedance in itself.

The Circuit that was chosen for the practical emitter follower described in this article is shown in Fig. 3. This circuit contains the compromises between voltage and circuit values that produce a high ratio of input to output impedance and relatively good frequency response. Resistor R3 was chosen as



2.2K; R2 was chosen as 220K. A series resistance R1 was added to increase the input impedance. In the original model, this resistor was 470K. The input impedance of the amplifier without this resistance was about 100K with a gain of unity. With R1 in the circuit and equal to 470K, the voltage gain was about 1/6, and the input impedance was about 570K. If R1 is 100K, the input impedance is about 200K, and voltage gain is about ½.

If a lower beta transistor such as a Raytheon CK722 or a GE2N107 is substituted for the higher beta 2N362 used in the original model, the input impedance of the emitter follower without R1 in the circuit will dedrease to about 40K. Now if R1 is made equal to 40K, the input impedance of the unit will be 80K and the voltage gain will be ½. If R1 is 200K, the input impedance will be 240K and the voltage gain will be 1/5. It is easy to see that any PNP transistor that you might have will work in this circuit, but some performance is lost with lower beta transistors.

The front and back views of the emitter follower are shown in Fig. 4. The emitter follower is constructed on a perforated Bakelite board. The on-off switch is a Minigator clip which is connected to the unconnected battery holder lug to turn the emitter follower on. Two flashlight cells connected in series furnish the 3 volts required to power the emitter follower. The input capacitor C1 is 200-*v* paper capacitor which permits connecting the emitter follower to vacuum-tube circuits. The output capacitor C2 is a 30 mfd. electrolytic capacitor rated at 15 *v*. If you intend to couple into a circuit that has high voltage present, a higher voltage rating is required for this capacitor, but most circuits that you'll couple to won't have high voltage present.

To construct the emitter follower, drill the two battery mounting holes and the third mounting hole. This third hole has been provided to allow the emitter follower to be bolted down on other electronic equipment for permanent or semi-permanent installation.

Next, mount the battery holder. Then place all of the parts on the board as shown in Fig. 4 by inserting the pigtails through appropriate holes in the board. Then turn the board over and use Figs. 3 and 4 to guide you in wiring. Most of the connections are made with the pigtails of the component parts. The pigtails are bent against the board, and wherever a connection is to be made, the wires are run against each other and soldered.

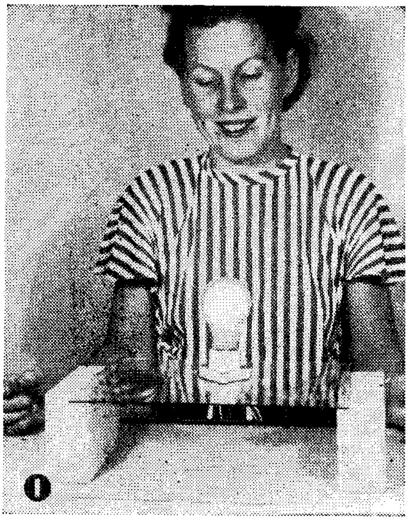
Input and output terminals consist simply of pigtail or wire ends to which Minigator clip leads may be connected on the original model. If you wish, you may provide wire leads with clips on the ends, or you may provide terminals on the model. The input leads should be shielded. Output leads must not be shielded unless a long length of connecting wire is involved.

The emitter follower will permit two high-impedance devices that are separated by a great distance to be connected together without high frequency attenuation. You might, for example, wish to use an inexpensive table radio as a tuner with a hi-fi amplifier since the tone quality of most inexpensive radios is quite poor. If you disconnect the radio audio amplifier from the center lug of the volume control and run a shielded lead to the amplifier as shown in Fig. 5A, you've converted the radio into a tuner for your hi-fi amplifier.

But, if the shielded lead is over, say, a foot or two long, it will attenuate the high frequencies due to the inherent capacitance of the shielded lead required to minimize *ac* hum voltage pick-up. If the capacitance of the shielded lead was in parallel with a low impedance such as that of the emitter follower output, the frequency response would remain relatively flat. Such an arrangement is shown in Fig. 5B.

Magic Light Bulb

THIS 60 watt Mazda bulb, removed from a light socket, glows when held in the fingertips or mouth, and when placed on a suspended pane of glass. Of course, it takes a little doctoring to make it work this way. First remove the "innards" from a burned-out 60 watt frosted bulb. With pliers, crush the black composition at tip of lamp base (Fig. 2). Shake out composition and remove brass button. With brass shell opening clear, insert plier handle and tap sharply, thus breaking off glass stem inside lamp (Fig. 3). Pull out glass stem and burned out filament through opening in bottom of brass screw base (Fig. 4).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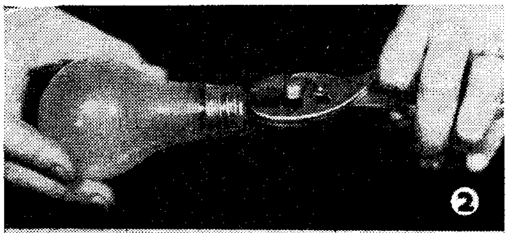
Obtain an anodized hole plug at an auto accessory or radio supply store, and a 1½ volt penlight bulb and a penlight battery. Cut a ⅜ in. hole in the hole plug. Insert pen-cell into plug, brass tip *down*. Solder tip of bulb to bottom of battery. Connect thin insulated wire from brass shell of penlight bulb to brass shell of hollowed out Mazda bulb. Ream base with closed scissors to admit battery and insert penlight cell assembly into bottom of lamp base (as shown in drawing).

So trick will look natural, insert bulb into a lamp which has been disconnected from the house current. When occasion arises, remove bulb from socket, and hold it in your fingers. Press a dime, small paper clip or pin concealed in your hand against bottom of bulb. This completes circuit from center cap of inverted pen cell to outer brass shell of Mazda lamp and bulb lights up. A paper clip concealed under tongue may be used to light the bulb when held in the teeth. To light bulb in porcelain cleat socket with no connections and resting on a suspended pane of glass (Fig. 1), simply previously short-circuit the two screw terminals on socket with a piece of fine wire.—R. R. DOISTER.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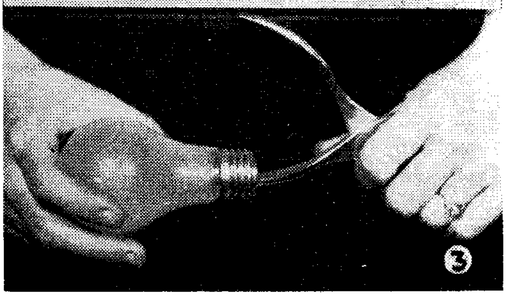
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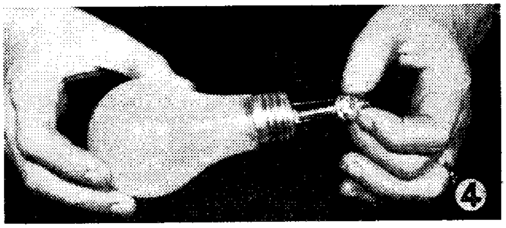
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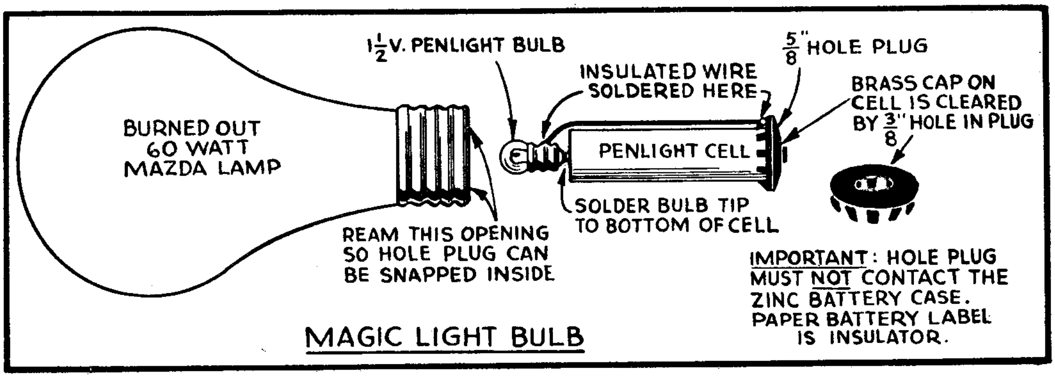
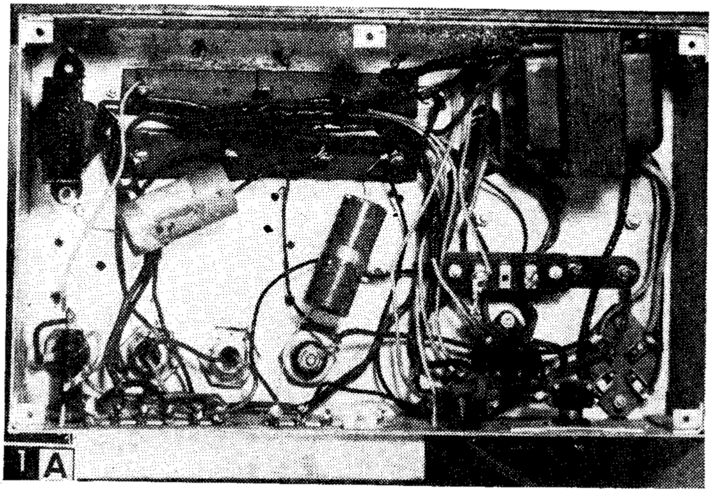
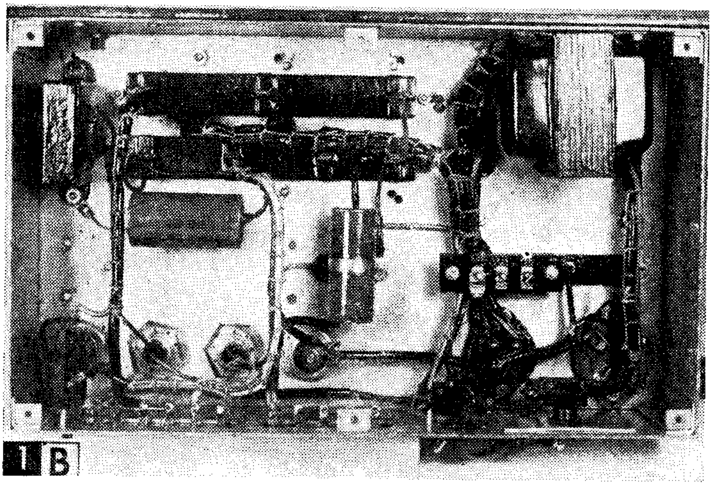


Professional Electronic Wiring


1A

A general-purpose power supply is shown scramble-wired above. While it works, it looks bad and is difficult to troubleshoot. The same power supply is shown cleaned up below. An even more workmanlike job would have resulted if the builder had been willing to rewire the unit completely.


1B

By HOWARD S. PYLE

WHETHER you build hi-fi or amateur radio equipment, you want gear you can point to with pride. What you are building is something which you expect to be more or less permanent. If and when you have occasion to abandon it, you can ask, and receive a far better price if your wiring, as reflected by your terminal connections and other circuitry, are of professional appearance and workmanship. Fig. 1A shows a "hay-wire" method of termination; Fig. 1B is the professional version. Which of the two would attract *your* cold, hard cash.

Figures 2, 3, 4 and 5 illustrate the method of accomplishing the professional touch shown in Fig. 1B. A final touch of spit-and-polish can be given by applying a generous coating of clear lacquer (such as Fuller's ANL-232 "Synalac") over wire, sleeving and number tape.

A slack loop consists of nothing more than an excess wire length of 2 or 3 in. at the terminal, where it is formed into either a horseshoe or a complete circle. Use a ½-in. or ¾-in. wooden dowel to form your circles. Slack loops serve two purposes: they provide sufficient slack in the wire to permit rerouting it to an adjacent terminal in the event of later modification in circuitry and they provide for re-termination to the same terminal without a short splice in case a wire breaks at a lug or soldered connection.

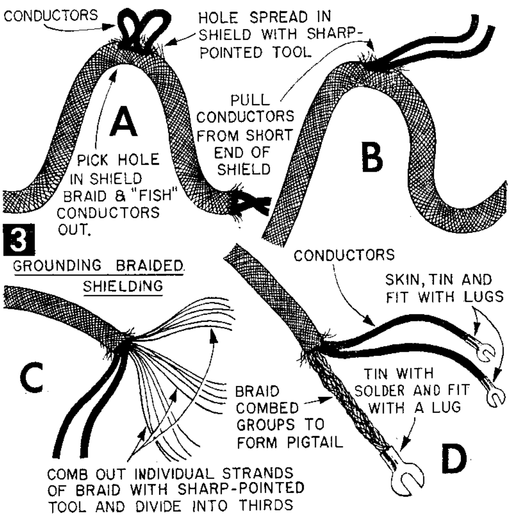
Shielded wire, one or more insulated conductors enclosed in a cross-hatch weave of tinned copper, is used in both radio and audio frequency applications to prevent stray radiation of RF fields and to avoid pick-up of *ac* hum and similar disturbing influences on audio leads. Grid wiring to vacuum electron tubes is particularly susceptible to such undesirable influences which then are amplified in the tube; microphone wiring should *always* be in shielded conductors. Frequently the shield itself is used with microphones of the "push-to-talk" variety with a built-in switch. The shield then becomes common and forms part of both the switch and microphone circuits.

Before the advent of plastic insulated conductors, it was possible, by skillful handling, to run a small solder "collar" around the end of the shielded braid—even include a short length of wire in the collar which could be used to terminate the shield on a chassis ground-point. This is still possible when the conductors themselves are fabric insulated, but not so with plastic which will melt completely with application of sufficient heat to the shield to permit a hot solder joint.

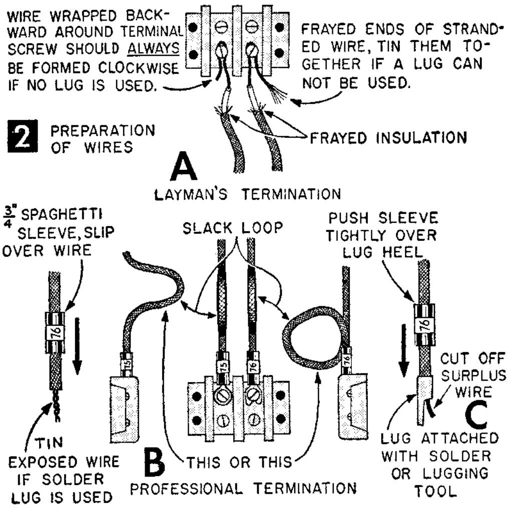
The answer? Well, if the shield is merely to be ended or tied-off without grounding, put a drop of liquid solder or aluminum (both applied cold) on the end of the braid and form it smoothly with your fingers to make a solid collar. Such a collar will set up hard in a few minutes and requires no heat, hence there is no damage to insulation. I use either Warner's Liquid Solder or Duro Liquid Aluminum.

As an alternate method of avoiding fray at the end of shielding, you can pinch the shield between spaghetti sleeving. The sleeve that goes over the conductors, the inner sleeve, should be a snug fit, and still capable of being pushed up *under* the shield braid; the outer sleeve must be of an inside diameter which will permit sliding over both the shielded braid and the spaghetti on the conductors.

Suppose, however, that you do have to ground the shield at either or both ends. Liquid solders are a mechanical binder only and should not be relied on for electrical connections. A far better method is to form a pig-tail directly with the end of the braid itself. This can be done neatly and effectively by following the steps illustrated in Fig. 3. First, push the shield back up the wire to form a bulge or hump in the shielding by working the braid apart. Using the same tool, pick the conductors out of the shielding, one at a time in small loops. Once you have them within easy finger grasp, withdraw them completely from the short end of the shield.



3 GROUNDING BRAIDED SHIELDING

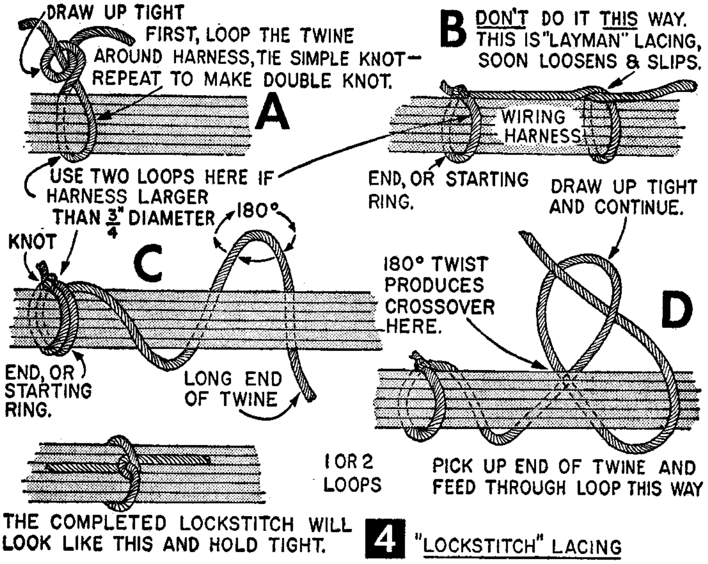


2 PREPARATION OF WIRES

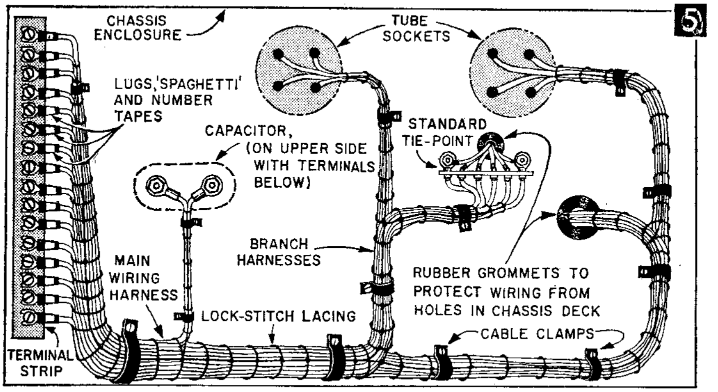
Next, separate the wires of the shield which will form the short pig-tail by using the pick or a nail to unbraid the web. Divide the resulting individual wires into approximate thirds and braid them tightly like a small girl's hairdo. Seal the end of the pig-tail with a spot of hot solder and fit it with a lug, either the solder type or solderless, as you prefer.

Cabling and Lacing. In forming your wiring prior to cabling and lacing, do not attempt to run wires from point-to-point by the shortest route. Except in a few isolated instances (high-frequency carriers, for example), whether a wire is 5 in. long or 7 in. long is of no consequence. Using that reasoning, you will be able to form your wires to follow the line of the chassis, making short, rounded 90° turns at the corners and at branches leaving the main cable harness. If, by extending some individual wire for a few inches you can include it in a main cable harness, do so. If you are careful to use shielded wire wherever the schematic you are working from specifies, or, if not so designated, wherever you are carrying radio or audio frequency such as microphone and speaker leads and wiring to the grid circuits of vacuum tubes, you'll have no trouble. See that all such shielded wires are solidly grounded to the chassis at both ends either by the pig-tail method of Fig. 3 or by small wiring clamps screwed to the chassis.

Now to the actual cabling and lacing. Obviously if you are to run in one harness a number of wires that will terminate at scattered points, each wire will be of a different length. Be sure that each is long enough or you'll have the tedious job of unlacing all of your harness to replace the short wire. You can cut to exact length when you come to the point of actual termination but better to



4 "LOCKSTITCH" LACING



begin by making each wire a few inches longer than necessary.

In some instances you can completely preform your harness, including the lacing, right on the bench and have it fall in proper place in your chassis. Where chassis layout makes such pre-fabrication of a harness impossible, it will be necessary to place each individual wire in proper position in the chassis, routing each one carefully alongside the others with which it is to be cabled and making the final termination at each end. Hold the bundle in place temporarily with a few ties here and there to maintain the final harness form. Then, when all wiring for that particular harness run is complete, lace it in place in the chassis.

One tip on pre-fabrication: use different color wires for ready identification individually at each end of the harness. If your available wire stock is insufficient to permit this color coding, mark both ends of each wire with adhesive number tapes or tags. Some craftsmen prefer to "ring out" each individual wire with a buzzer or an ohmmeter as a double-check, when terminating.

Professional practice dictates the use of "lock-stitch" which, while really simple, almost defies written description (see Fig. 4). Start your lacing about an inch from the main termination point of your harness . . . a connection block for instance. If it is a harness of relatively few small wires, space the twine rings around the harness about ½ in. apart. If it is a larger number of heavier wires, 1-in. spacing will be adequate. Multi-wire harnesses of more than 1-in. cross-section can be laced every 2 in., but if 6-cord lacing twine is used it should be doubled for added strength.

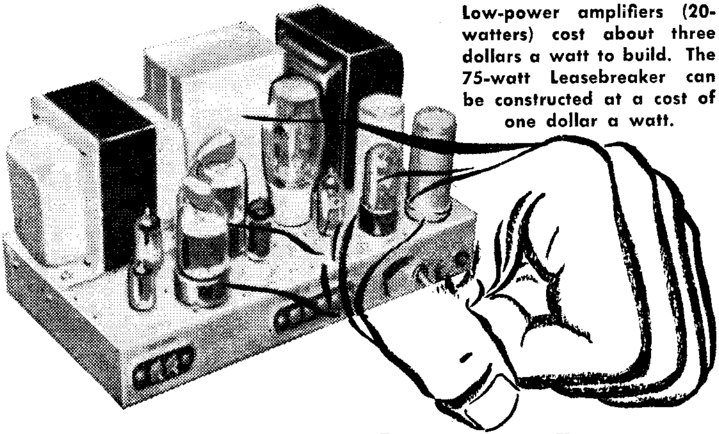
A good rule to follow is to space the twine rings for a distance about equal to the dia. of the bundled harness and use the twine doubled on any harness over 1 in. Tie-off the ends, both at the starting point of the lacing and at completion, with an ordinary square knot, double tied.

Chassis wiring by the cabled and laced method does *not* mean that all wires of the harness will terminate in the same area at each end. There will be considerable branch wiring from the main harness trunk. As your lacing progresses, you reach various points where one or more wires leave the harness to connect to an adjacent component.

At this point, wrap the twin ring twice around the main harness and bend the wires leaving the harness 90° toward the terminals to which they will connect. Then proceed with your lacing to the next branch. This will result in a tapered harness (see Fig. 5).

Answers to Photo Quiz on Page 103

1. Rotary wafer switch.
2. Roll of electrician's rubber tape.
3. Pilot lamp.
4. TV lead-in stand-off insulator.
5. Top of spray can of service chemical.
6. Diagonal cutters.



Low-power amplifiers (20-watters) cost about three dollars a watt to build. The 75-watt Leasebreaker can be constructed at a cost of one dollar a watt.

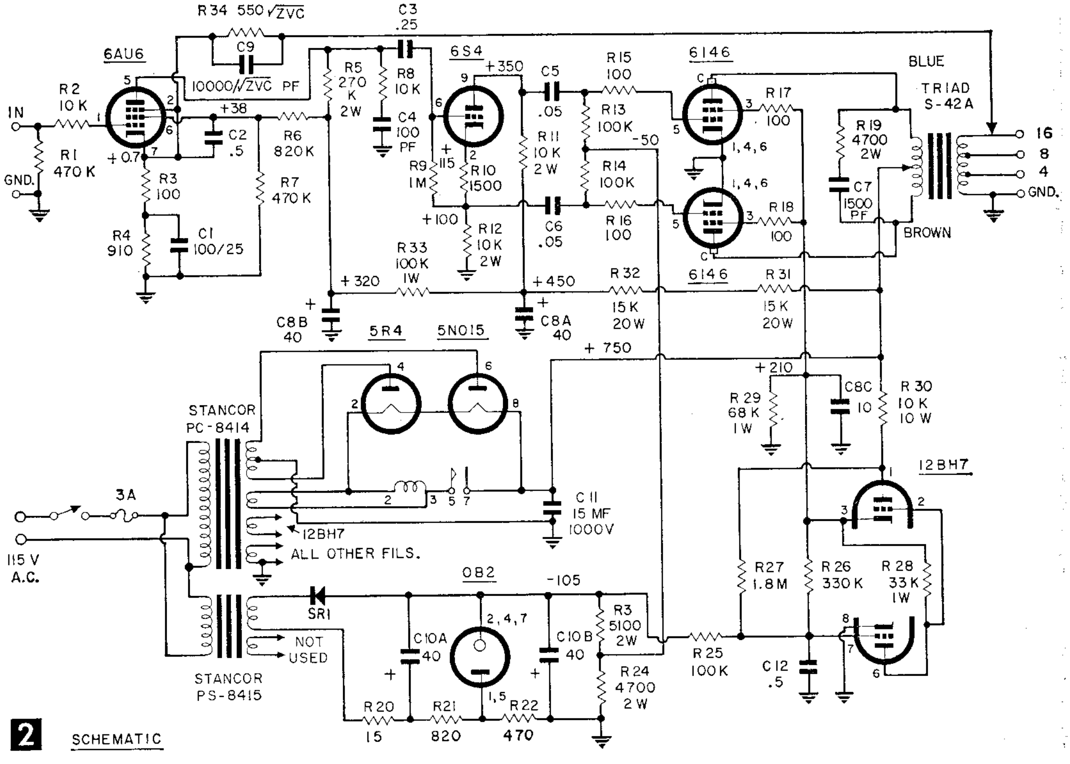
The Leasebreaker

Not the perfect amplifier—that hasn't been built—but an outstanding bargain in high-power amplifiers. Net price, including tubes, is $75—or a dollar per watt

By LEE/SHERIDAN

WHEN we decided we needed a new amplifier we knew we wanted the greatest possible power output per dollar of cost. What we achieved was a dandy little job with enough wallop to enable anyone to break his lease by popular request within three minutes! Whether or not that is your projected use for it, this amplifier will deliver—subject to rising costs and picking up a few good buys—one watt of power per dollar of construction cost.

It is an engineering maxim that when cost is an object, no element of a system should be unduly stronger, or unduly weaker, than any other. There is no sense in paying for performance that cannot be utilized. At the outset, we gained considerable simplification in design by deciding that the amplifier would be used only to handle program material and not sinusoidal signals. This is a compromise that has been used for years in the design of modulators for high power AM transmitters. Since a sine wave contains much more average energy than does program material of the same peak amplitude, it is permissible to use much lighter components than would



2 SCHEMATIC

be required for continuous sine-wave operation. It's only necessary that components be capable of handling the occasional peaks in program material.

For the amplifier, we felt that the simplest configuration would be a pentode gain stage, a split-load phase inverter, and the output stage. For the gain stage, a 6AU6 vacuum tube is excellent, very low in noise and capable of high gain. In our circuit, it provides a gain of 200, with well over 200-v peak-to-peak of signal delivered to the following stage.

A 6S4 is used for the phase inverter; set to draw 10 milliamperes, it can deliver 150 v peak-to-peak at the output grids, which require about 100 v for full output. The heavy degeneration provides a very high impedance for the 6AU6 to work into, thus raising its gain—while the 6S4 presents a fairly low driving impedance to the output grids.

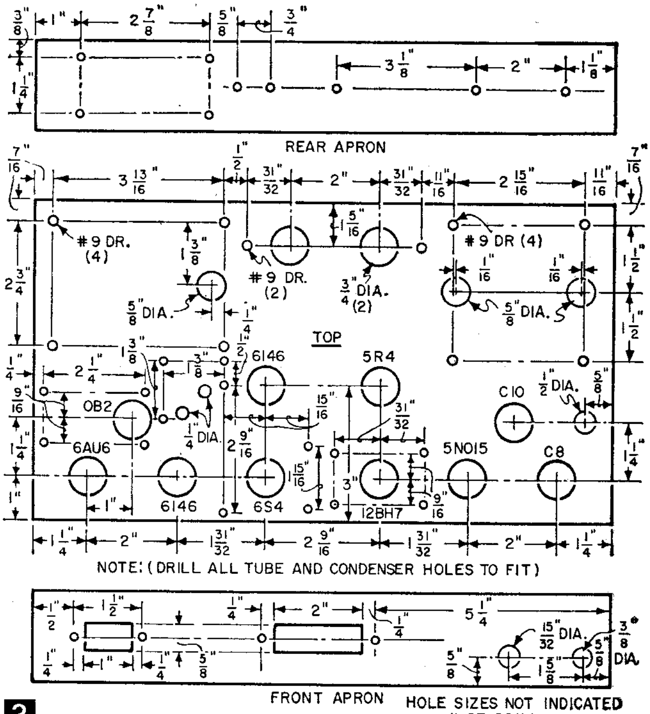
But if the amplifier is to be stable under feedback, it must be "tamed." At the high-frequency end, this poses a problem due to the low resonant frequency of the output transformer. We solved this problem by the joint action of three devices: a series RC (R8 and C4, see Fig. 2) from plate to ground in the first stage, another across the primary of the output transformer (R19 and C7), and the customary capacitor (C9) across the feedback resistor (R34).

Low-frequency stabilization is also achieved by the use of a cathode capacitor in the input stage, coupling capacitors and grid resistors feeding the output stage, and the falling response of the output transformer itself.

In consequence, The Leasebreaker is so stable that the removal of the load has absolutely no effect on frequency response!

We consider that *any* rise in response at the end of the passband is the mark of an unstable amplifier—and judging from what we've seen, unstable amplifiers are in the majority today. Our Leasebreaker, however, employs 20 db of feedback overall, and the response at the ends of the passband is never anything but a smooth drop below 20 cycles and from 20 kc out to 500 kc. At this point, there is a slight resonance, but the response is over 30 db down from midband. No value of capacity up to 10 mfd produced oscillation when shunted across the 16-ohm load.

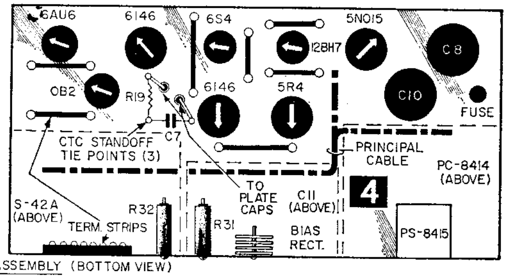
Think we're making too much ado about this business of stability? Remember—an amplifier of this power capacity (75 watts) can, if it runs away, ruin a speaker in just a few seconds!



NOTE: (DRILL ALL TUBE AND CONDENSER HOLES TO FIT)

HOLE SIZES NOT INDICATED #27 DRILL

3 CHASSIS (2X7X13" ALUMINUM)

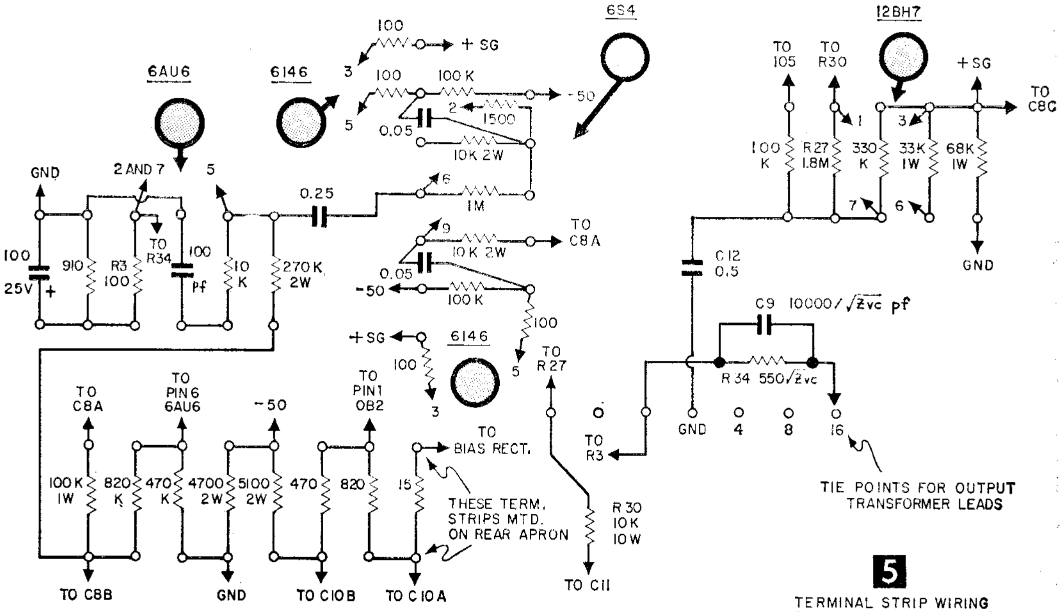


ASSEMBLY (BOTTOM VIEW)

The power supply. We used a Stancor PC-8414 transformer, which delivers 600 volts on each side of center at 200 mils. While this would overheat badly if the amplifier were driven to full output continuously by a sinusoidal signal, it's perfectly capable of handling occasional high level peaks.

For the rectifier, we think there's no argument about a 5R4, and one tube is adequate. A single 15 mfd, 1000-v oil slug (C11) is used in the high-voltage section. The ripple here is distressing (35 v peak-to-peak quiescent, rising to 75 v at full load), but a 40-40-10 mfd, 450-v electrolytic capacitor (C8) provides the filtering necessary for lower level stages and the screens of the output stage.

To protect the electrolytic capacitors and to make things easier on the tubes by giving the heaters a chance to come up to operating temperature before the high voltage hits, we used an Amperite thermostatic delay relay—with a 5-v heater so there is no potential difference



5

TERMINAL STRIP WIRING

between heater and contacts. We preferred the octal-based relay to the miniature for this job because the octal socket provides a longer flashover path to ground than does the miniature.

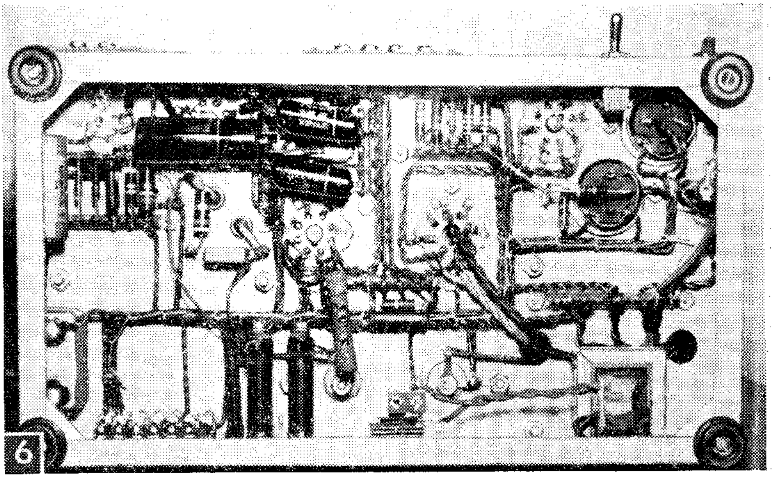
A simple bias supply is provided with a configuration which permits use of a dual 40 mfd can. An OB2 glow tube holds the bias voltage constant. With the values shown, it draws about 10 mils. Some selection of the 5100 and 4700 ohm resistors may be needed to get just exactly minus-50 volts at the tap, and these should be 2-watt units for best temperature stability.

Screen regulation is an absolute necessity if maximum power is to be developed. We blithely started with VR tubes and encountered trouble! By the time the screens are stabilized the tubes are beyond their ratings when there's no signal. And there is also considerable additional heat dissipation.

So we cast about for a simple solution and came up with that shown in Fig. 2. Note that the conditions which increase the screen drain also pull down the supply voltage considerably, due to the poor high-voltage regulation.

The 12BH7 is a husky twin triode, designed for use as a TV vertical deflection amplifier, with a 500-v plate voltage rating and a permissible dissipation of 3.5 watts per section. The two sections are connected in series, with the upper as pass tube and the lower as dc amplifier. The control voltage divider is returned to the minus-105-v bias supply, to keep the dc amplifier grid near ground, yet allow large swings.

In operation, this has proved an excellent little regulator, its output voltage being the same at full output as at zero signal, with a rise of about 10 v in the middle range. Initially, the output voltage had a tendency to drift with changes in line voltage, but the addition of R26 reduced this drift to an acceptable range. Correction is not complete, of course, because the dc amplifier does not have sufficient gain.


6

Bottom-chassis view of the Leasebreaker. (Photo was taken before addition of C12.)

Construction. We constructed The Leasebreaker compactly on a 2 x 7 x 13-in. chassis, and the large transformers and filter capacitor must butt against each other in order to fit (see Figs. 1, 3 and 4). Tubes and electrolytic capacitors are placed along the front, the 6146's being staggered, rather than side by side, to reduce the heat problem.

A neat terminal board effect is achieved through the use of Cinch-Jones 2000 series terminal strips mounted in parallel pairs (See Fig. 5). For the input stage, we used 2006's; a 2005 and 2007 for the phase inverter, 2005's for the screen regulator, and 2008's for mounting miscellaneous power supply resistors. This scheme is a real space saver, since tube sockets may easily be straddled.

The two 15K 20-watt dropping resistors are mounted with long screws through the back apron of the chassis. Be sure to use an insulated shoulder washer here and several insulated flat washers on each end!

Cinch type 2C7 sockets were used for the two electrolytic cans. Note that the outer contacts are tied together to make maximum use of contact area. The bias supply capacitor should be provided with an insulated sleeve, since its can is negative with respect to the chassis.

A double ground system is used to avoid hum troubles, for the charging current through the 15 mfd capacitor is quite high and can easily give trouble if it gets into a common ground bus. For this reason, a power supply ground is made right at the negative terminal of the 15-mfd capacitor to which transformers, electrolytic capacitors and 6146 cathodes are returned. A separate signal ground is made at the input terminals, to which all other grounds are returned through separate ground wires.

Good quality steatite sockets should be used, at least for the rectifier and delay relay, since these parts carry the full 750 volts.

Use an aluminum chassis, because the high heat conductivity of the metal makes the whole chassis surface available as a radiator. While heat dissipation of this amplifier is considerably below that of most others in its power class, its compact design does keep the dissipation per unit volume fairly high. For this reason, The Leasebreaker should never be enclosed in a small space.

Testing. With the 5R4 removed, a dummy load connected and the feedback loop open, the first job is to adjust the bias. Select 4700 and 5100 ohm resistors so that the bias is minus-50 volts. If necessary, other resistors can be shunted across one or the other for vernier adjustment.

Next, if a milliameter is available, check the current drawn by the OB2, which should be around 10 mils. Variation of R21, an 820-ohm resistor, can raise or lower this as desired.

To set the screen voltage, replace the 5R4 and turn on the power. The high voltage at the 15-mfd capacitor should be around 750 v. Now check screen voltage. If it is not in the range of 200-215 v, shunt one of the resistors in the control voltage divider. Shunting R27 reduces the screen voltage; shunting R25 increases it. Use high values for the first try; the circuit is quite sensitive.

When screen voltage is set, the various other voltages can be checked. A VTVM should be used to measure the 6AU6 plate and screen. If results are

MATERIALS LIST—LEASEBREAKER

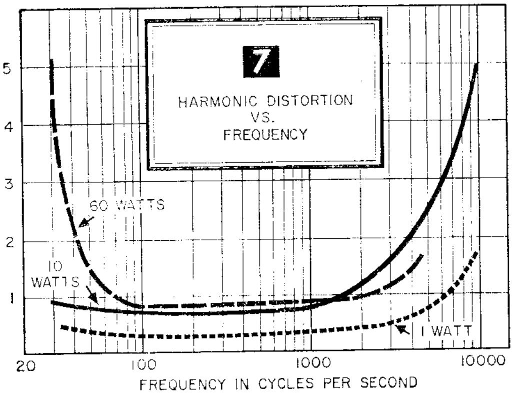
Desig.	Description
T1	45000 ohms plate-to-plate to 4, 8, 16 ohms (Triad S-42A)
T2	600-0-600v, 220ma; 5v, 3a; 2 x 6.3v, 3a (Stancor PC-8414)
T3	115v. 15ma; 6.3a, 0.6a (Stancor PS-8415, Triad R-54X)
V1	6AU6
V2	6S4
V3, V4	6146
V5	5R4
V6	0B2
V7	12BH7
V8	Amperite 5N015
SR1	50 ma, 115-v selenium rectifier
C1	100 mfd, 25-v electrolytic
C2	0.5 mfd, 600-v bathtub **or** 0.5 mfd, 400-v molded paper tubular
C3	0.25 mfd, 600-v molded paper tubular
C4	100 mmfd mica
C5, C6	0.05 mfd, 600-v molded paper tubular (matched, if possible)
C7	1500 mmfd, mica
C8	40-40-10 mfd, 450-v electrolytic (Mallory FP 376.8)
C9	$10000/\sqrt{Zvc}$ mmfd
C10	40-40 mfd, 450-v electrolytic (Mallory FP-238)
C11	15 mfd, 1000-v oil
C12	0.5 mfd, 200-v molded paper tubular

(All resistors ½ watt 10% unless otherwise indicated)

Desig.	Description
R1	470 k
R2	10 K
R3	100
R4	910, 5%
R5	270 K, 2 w
R6	820K
R7	470 K
R8	10 K
R9	1 meg
R10	1500 w
R11, R12	10 K, 2w matched
R13, R14	100 K matched
R15, R16, R17, R18	100
R19	4700 2w
R20	15
R21	820
R22	470
R23	5100, 2w, 5% } see text
R24	4700, 2w } see text
R25	100 K
R26	330 K
R27	1.8 meg
R28	33 K 1w
R29	68 K 1w
R30	10 K 10w
R31, R32	15 K 20 w
R33	100 K 1w
R34	$550\sqrt{Zvc}$

Miscellaneous

2	Millen #36002 ceramic plate caps
1	SPST toggle switch
1	extractor fuse holder
1	3AG, 3-amp fuse
2	Cinch #2008 terminal strips
2	Cinch #2007 terminal strips
2	Cinch #2006 terminal strips
3	Cinch #2005 terminal strips
3	Cambridge Thermionics #X2006 (or equivalent) insulated terminals
1	2 x 7 x 13″ aluminum chassis
2	7-pin miniature tube sockets
2	9-pin miniature tube sockets
4	octal tube sockets
2	Cinch #2C7 FP capacitor sockets
1	Eby #56-2 (or equivalent) screw terminal strip
1	Eby #56-4 (or equivalent) screw terminal strip
	hook-up wire, rosin solder, misc. hardware



satisfactory, feed a 400-cycle test signal into the input and turn up its level. The amplifier should deliver 75 watts (33 v rms into a 15-ohm load) just at the clipping level as seen on a scope.

As regards the feedback loop, if the output transformer primary leads have been connected as indicated, and if the manufacturer is uniform in attaching leads to the windings, the feedback should be negative. With the oscillator providing the 400-cycle test signal set for low output, watch the output signal on a scope while touching a 22K resistor across the feedback terminals. If the output decreases, the feedback is indeed negative and the proper feedback resistor may be installed. If the output increases, reverse the output transformer primary leads and try again. It is wise to use the 22K resistor for the initial test so that if the feedback happens to be positive, the amplifier will be spared the burden of violent oscillation. Resistor R34 and capacitor C9 are chosen according to voice coil impedance (see Materials List); but explicitly:

Voice Coil Impedance	*R34*	*C9*
16 ohms	150 ohms	2500 mmf
8 ohms	200 ohms	3600 mmf
4 ohms	270 ohms	5000 mmf

With the feedback loop closed, a frequency response run at a level of about 1-v output may be made. The amplifier should be down about 0.5 db at 20 and 20,000 cycles, and should fall continuously outside of those points as discussed previously.

Note particularly—this amplifier is intended only to be flat to 20 kc, not to 100 kc! People accustomed to 100-kc bandwidth and a fancy square wave response will be disappointed by this—but our aim was a stable amplifier. This type of response is the price of using a cheap output transformer. Similarly at the low end—but it should be noted that smoothly falling response below 20 cycles is beneficial in attenuating rumble from turntables.

In checking the power output, the amplifier should deliver 65 watts at 30 cycles and 75 watts at 40 cycles and above, at the clipping level and just before noticeable flattening appears on the scope. Full power should not be run continuously above 5000 cycles since the network across the output transformer primary begins to absorb power and the 4700 ohm resistor R19 will "head west" in a big hurry.

Instead, make quick checks at 10 and 15 kc by turning up the oscillator for no more than a second or two, reading the meter and immediately turning down the oscillator. Power should be 65 watts at 10 kc and 40 watts at 15 kilocycles.

This drooping power response does no harm to program material where the vast bulk of power lies below 1000 cycles, and the amplifier will break up at low frequencies long before the point where high-frequency power will endanger the 4700-ohm resistor.

The Leasebreaker may be used with any standard pre-amplifier, although we don't recommend that the preamp power be drawn from the amplifier, as it is very difficult to provide sufficient plate supply decoupling to make the system really stable at sub-audible frequencies. Either the preamp should be self-powered, or a separate power supply should be built for it. Voltage gain from input to 16-ohm output is 20, hence 1 v in will produce 25 watts—a sensitivity of the same order as any usual home music amplifier.

Internal impedance as measured at the 16-ohm output tap is 1.3 ohms, resulting in a damping factor of 12, which is adequate for restricting speaker hangover. Total hum and noise output with the input shorted is less than 5 millivolts at the 16-ohm tap, or better than 75 db below 60 watts output. This is predominantly power-supply ripple due to imbalance in the output tubes, but 5 millivolts of hum is so low as to be barely audible a foot from a good speaker.

Harmonic distortion was measured as a function of frequency for several power levels and the results were about what might be expected.

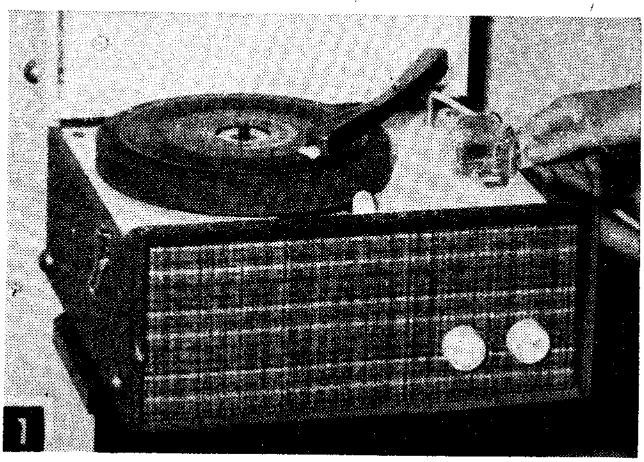
The low-level distortion is higher than that in units of the Williamson type, but not seriously, since any reasonable amplifier distortion pales into insignificance compared to that contributed by even the best of speakers. The curves (Fig. 7) show the usual rise at the ends of the range, the low end curve at 60 watts being due to the onset of core saturation. The high end rise, however, is only of academic interest since the 10- and 60-watt power levels will never be reached by program material at frequencies above 1000 cycles.

If you haven't seen curves like Fig. 7 before, be advised that the usual practice of using only mid-band frequencies in distortion ratings tends to make an amplifier look better than it really is.

Radio Tuner for Child's Phono

Your child can have his phono and radio, too—all in one package

By HOMER L. DAVIDSON



1

Enjoyment is doubled with the addition of a radio tuner to a child's record player.

THIS tiny RF tuner can easily be attached to the young fry's record player, converting it to a radio receiver. The tuner consists of a tuned input stage with a small, variable capacitor. The separated signal is then rectified to audio power and amplified by a small transistor. From here the signal is applied to the pick-up arm and then amplified by the phono-amplifier itself.

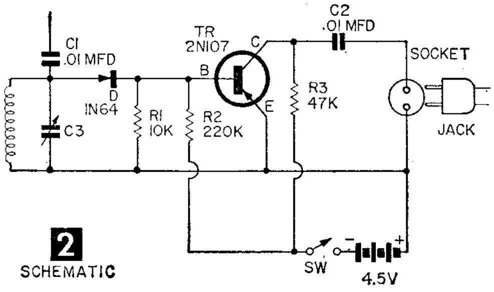
Circuit. The RF signal is picked up from a small lead that should be clipped to an outside antenna for best results. For local stations, a bed spring or metal window frame will pick up enough signal to drive the loudspeaker. A small ferrite coil with a tunable slug and a variable capacitor separates the stations. The slug can be tuned in or out to separate several local stations if one (or more) seems to bother the desired station.

A fixed crystal diode detects the audio signal, which is then amplified by the 2N107 transistor. The transistor was added here to help amplify the weak detected signal, as some of the cheaper record players have only one amplifying tube. Since all phonographs have their own volume control, there was no need to place one upon the small tuner. Also, most record players have a tone control, but most radios do not.

A small, fixed capacitor couples the audio signal to the phono pickup arm. It is best to first remove the record player arm from the phonograph before wiring up the male jack. Be careful not to damage the crystal cartridge by rough handling. Generally, a small pin or swivel screw holds the pickup arm to the horizontal swivel bracket. Remove this, and the arm can be taken off. Be sure to unsolder the two small wires that go from the amplifier to the pickup arm.

Phono Arm Repair. Drill a 9/32-in. hole in the middle of the phono pickup arm. This hole should not be drilled too far back on the arm because of the sharp angle in lifting the arm before the male plug is inserted into the radio tuner. Two small, flexible wires are soldered to each terminal and brought out so they can be soldered to the crystal cartridge connection. Do not solder these connections until they are pulled off the cartridge. Heat will sometimes damage the crystal cartridge. Place the connections back on the cartridge, and the arm is ready to go. Now remount the phono arm in its original position. All that you're doing is making a simple way to plug the phono amplifier into the radio tuner box.

Battery and Cabinet Construction. If your case is large enough, use two penlite cells in series or an Eveready 4.05 v. (E133) or an RCA 4.5 v. battery. Since my plastic case was only 1¼ x 1½ x 2¼ in., I had to devise a smaller battery: Three small button mercury cells were used to furnish 4.5 v. of collector voltage. These batteries are the size of small buttons, and being so small, must be mounted in such a way that good contact is made. Cut the closed end from the zinc casing of a small penlite cell to a length of ¾ in. Clean out all loose carbon and residue from the inside of the cell. Cut a piece of thin cardboard long enough to just meet the ends when inserted inside of the penlite zinc case. Drop a small



2 SCHEMATIC

MATERIALS LIST—CHILD'S PHONO-RADIO

Desig.	Description
C1, C2	.01 mfd flat ceramic capacitors
D	1N64 xtal fixed diode
C3	365 mfd miniature variable capacitor (Lafayette MS-274)
L	ferrite coil (Lafayette MS-11)
R1	10,000 ohm resistor, ½ watt
R2	220,000 ohm resistor, ½ watt
R3	47,000 ohm resistor, ½ watt
SW	SPST switch (Lafayette VC-42 or equivalent to fit case—such as Cutler-Hammer's type 8098-K3, Allied 34B510)
TR	GE 2N107
Batt	4.5 v (see text)
plug	miniature plug (Lafayette MS-284)
jack	miniature jack (Lafayette MS-283)
	plastic cabinet (Lafayette MS-298 or other)

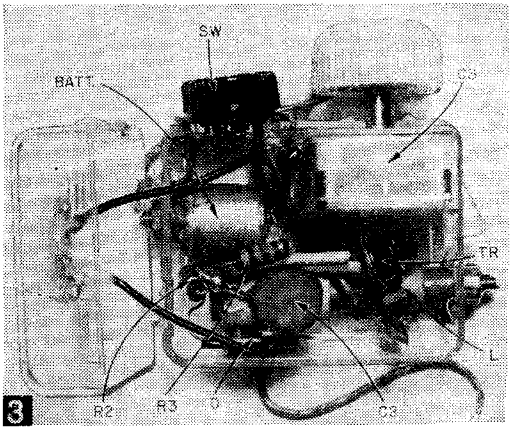
shiny split lock washer into the bottom of the case, and insert the first button battery. Insert all three batteries, observing correct polarity. The batteries will fit snugly, and should be pressed together as tightly as possible.

The center contact connector and mounting screw are bolted to a small fiber washer (see Figure 5). Use the smallest bolt and nut combination here, so that they do not touch the crimped sides.

Place the washer and bolt into the top of the battery. While pressing down on the bolt, crimp the edges of the zinc case over the top of the insulated washer. Be very careful not to touch the center post to the crimped edge, as this will short out the newly constructed battery. The little battery is ready to mount with its own mounting screw.

The plastic case I used was the container from an Argonne (Lafayette) interstage transformer. Any plastic box at least 1⅛ in. high, but not too high to fit under the pickup arm can be used. If no other box is available, you will have to use Lafayette's MS-298 (1⅛ x 3⅛ x 3⅞ in.). Drill holes for the ferrite coil assembly, variable capacitor and on-off switch. Mount the female plug atop the case. You can use the tip of the soldering iron to make the larger holes in the plastic, as long as you don't hold the iron to the case too long.

After all the holes are drilled, the large components are mounted. First, the capacitor and switch are mounted, then the battery.



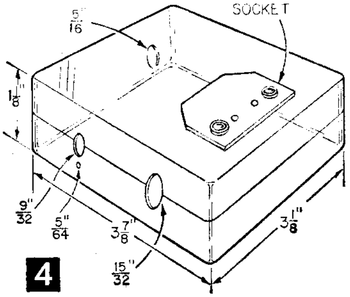
Parts layout of the RF tuner in a tiny 1¼x1½x2½ in. box. Any case you have available may be used (see text).

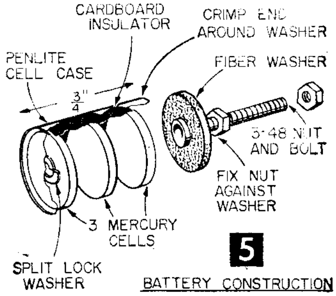
Before mounting the ferrite coil, solder the diode and resistor into place, and solder two small pigtails to each side. This will save a lot of close soldering down inside the case. The small resistor, capacitors and transistor can be soldered as they are mounted. While the lid is open, solder two small flexible leads to the female plug and to its corresponding circuit. The unit can now be wired. Be sure the battery polarity is observed.

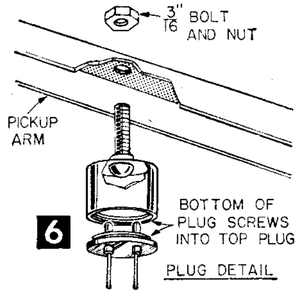
The unit is placed directly under the pickup arm and plugged into it. Turn the record player on, and let the tube heat up a few seconds. Hook an outside antenna or long wire to the small antenna wire. Then, turn on the radio-tuner. If there is hum, reverse the *ac* plug on the phono.

Surprising results were obtained with the small radio-tuner on local and distant stations. The batteries should last a long time, as only 1/5th of a milliampere is pulled from them.

The small plastic case can now be bolted to the phonograph mounting board. Always turn the batteries off when only the record player is being used to play records. The pickup arm mounting holder can be removed or re-mounted closer toward the turntable if so desired.







ELECTRON TUBE ANAGRAM

Although transistors are rapidly replacing electron tubes in many applications, tubes still perform jobs that transistors cannot handle. This anagram puzzle pertains entirely to electron tube terminology.

Can you correctly fill in all the empty blocks with the correct words, letters, symbols and abbreviations? When you have the blocks all filled, check your solution with the correct one on page 152.

By JOHN A. COMSTOCK

ACROSS:

1) Seven-element electron tube.

4) A ——— cutoff tube is one in which the control grid spirals are uniformly spaced.

7) A gain compensating vacuum tube circuit (abbr.).

10) A straight line drawing across a series of plate current-plate voltage curves.

11) A ——— tron is a five-element tube having two plates.

15) Output power (abbr.).

16) Target (abbr.).

18) A vacuum tube circuit that sets up and maintains sustained oscillations. (abbr.).

19) A tube in which the electron stream is concentrated or "focused" for greater amplification.

20) To reduce this, some tubes have a center-tapped filament.

21) Unit of current usually applied to electron tubes. (abbr.).

22) A floating grid.

24) A cathode-ray tuning indicator tube is sometimes called a "magic- ———."

25) A tube noise effect that limits high amplification.

27) Negative potential applied to a control grid.

28) Interelectrode capacitance between grid and plate (letters symbol).

30) Part of a CRT tube.

32) ——— uration is the point reached when current is maximum obtainable by increasing plate voltage or cathode temperature.

33) Particles heavier than electrons that are harmful to a CRT tube's screen.

35) A variable resistor used in many vacuum tube circuits (abbr.).

37) An electron tube's signal input element.

41) Electron flow effect in an electron tube.

44) The "at-rest" potential applied to tube elements.

46) Unit of conductance.

48) A cathode that emits electrons when struck by light rays.

49) Heater tap for pilot lamp (letters symbol).

51) ——— = Rp x Gm (supply missing term).

52) The alkali earth metal introduced into a vacuum tube to remove residual gas.

53) $u = \frac{dEp}{?}$ (supply missing term).

DOWN:

1) A ——— -wave rectifier has only one plate.

2) Electron receiving element.

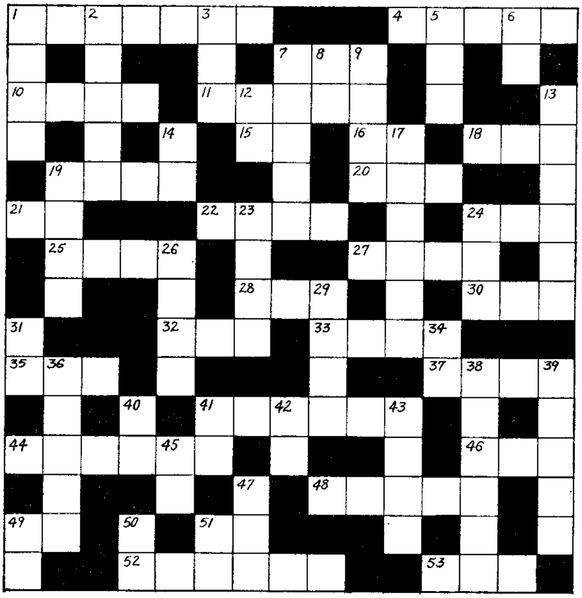
3) $u = \frac{?}{dEg}$ (supply missing term).

5) A ——— ode tube is one having a total of six elements.

6) The ratio of a small change in plate voltage divided by a small change in plate current (letters symbol).

7) A particular vacuum tube element.

8) A tube envelope designation (abbr.).



9) Electron tube emitting element (abbr.).

12) Plate potential (letters symbol).

13) The name of the grid that was added to triodes in 1929.

14) ——— $= \frac{dIp}{dEg}$ (supply missing term).

17) The name of Lee de Forest's triode tube.

19) The ones used on most octal tubes are of Bakelite.

23) A unilateral vacuum tube circuit (abbr.).

26) Made to determine whether or not a tube is good.

29) Tube connectors.

31) Plate capacitance letters symbol.

34) A tube's second grid (abbr.).

36) A tube base having eight equally spaced pins and a central aligning key.

38) A ——— cutoff tube is sometimes called a "supercontrol" tube.

39) The vacuum tube invented by Fleming.

40) A tube that doesn't contain gas (abbr.).

41) C-bias voltage (letters symbol).

42) Cathode current (letters symbol).

43) An inert gas used in some gaseous electron tubes.

45) Plate current flow (letters symbol).

47) A remote ——— off tube is a variable Mu tube.

49) Heater mid-tap (letters symbol).

50) Grid conductance (letters symbol).

51) Shell designation: metal tube (letters symbol).

What to Listen for on Short Wave

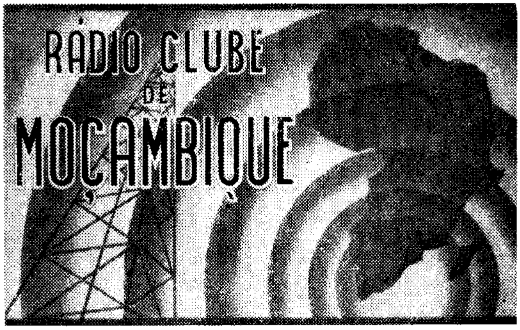
Fall & Winter 1960

By C. M. STANBURY II

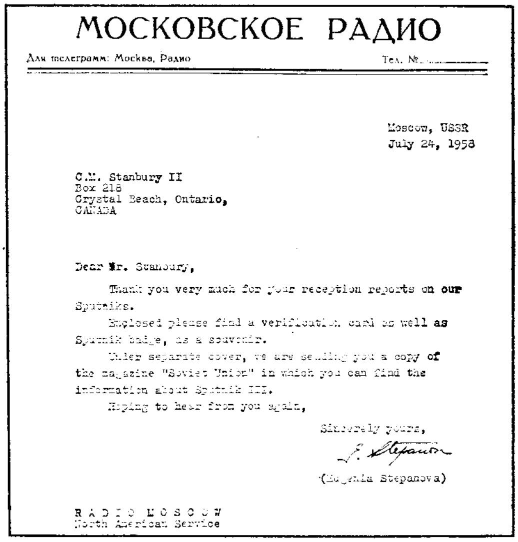
WINTER on short wave presents a paradox, an important one for the listener. As you probably know, ionization (caused when ultra violet radiation from the sun passes through the atmosphere) is responsible for both the reflection of radio waves back to earth (essential for distant reception) and the absorption (weakening) of radio waves, especially frequencies below 7000 kc. Also commonly known, during winter with shorter days and rays from the sun received more obliquely, ionization is reduced, signals are stronger, and reflection from the ionosphere should decrease at higher frequencies. The latter is *not* true. Frequencies above 15 mc are normally reflected by the F2 layer, the uppermost portion of the ionosphere, and reflection in this region is actually improved as the earth approaches its winter solstice, the point in the earth's orbit when it is closest to the sun. Why? We don't know and neither does anybody else. Some researchers have linked this phenomenon with temperature but the theory appears to have holes in it.

In any case, the result is a broader range of usable wavelengths with both higher and lower frequencies open. However, there is a second factor to consider, sunspots. Ionization, reflection and absorption all vary directly with the number of "spots" on the sun and right now we have a dropping count. Result, the higher frequencies will be slightly poorer than last winter, but low frequencies will be better. Add to this little or no static on downstair channels and you have prospects for an excellent short wave season.

We should say excellent for the serious listener. If you read the article *Tune In On The World* in Radio-TV Experimenter #565, you may recall that I suggested that one way to know other countries was to listen in on local broadcasts intended only for the area from which they originate. This is usually not easy. But many countries do use the lower short wave frequencies for such purposes, particularly in the tropics and in such a country as Russia where one transmitter must cover a good many square miles of sparsely populated territory. Of course you'll still face a language barrier. Which leaves the music. However this is sometimes more revealing than words particularly when the words are propaganda while the music is not too polished folk music.



Verification card from Radio Clube de Mocambique, a semilocal (regional) broadcaster heard throughout the World on 11760 kc. However, as indicated on reverse side of card, this QSL is for reception on the Broadcast Band during the peak period for lower frequencies, 1953-55. Winter 1960 will represent the very early stages of another such period.



МОСКОВСКОЕ РАДИО

Для телеграмм: Москва, Радио Тел. №

Moscow, USSR
July 24, 1958

C.M. Stanbury II
Box 218
Crystal Beach, Ontario,
CANADA

Dear Mr. Stanbury,

Thank you very much for your reception reports on our Sputniks.

Enclosed please find a verification card as well as Sputnik badge, as a souvenir.

Under separate cover, we are sending you a copy of the magazine "Soviet Union" in which you can find the information about Sputnik III.

Hoping to hear from you again,

Sincerely yours,

E. Stepanova

(Eugenia Stepanova)

RADIO MOSCOW
North American Service

Verification letter for Sputniks I and III (no longer broadcasting) heard at 20.005 mc.

With reception of local broadcasters as the goal, frequencies below 7000 kc. become all important and a dropping sunspot count can be nothing but good news. How far has it dropped? Well, the count has a long way to go but even in April two stations in the 120 meter band, H13C (2440 kc, La Romana, Dominican Republic) and Radio Martinique could be heard throughout the eastern United States.

International Broadcasting. If you're new to short wave listening, or you just plain want to listen and keep DXing down to minimum, then the International Bands, 31 through 13

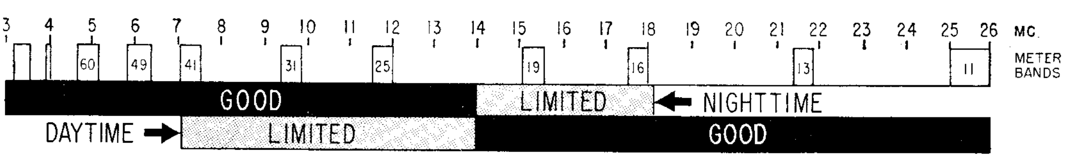


TABLE A: BEST BANDS BY NIGHT AND DAY

meters (see Table A) will interest you most. That boost in the F2 layer will certainly make things better than in the summer. But reception will be slightly poorer than last winter.

The 13 meter band will be open many days to all parts of the world with north and south paths having an edge. Europe will be best during daylight hours on the 19 and 16 meter bands and then at night on the 31 and 25 meter bands. Africa will follow a roughly similar pattern. The 19 and 16 meter bands may remain open the first few hours of darkness with both Europe and Asia received. Such a path will occasionally hold up most of the night with the 25 meter band providing an alternate band for evening reception of the Orient. During the hours after midnight both 25 and 31 meters will produce signals from Asia and the Pacific. Technically this would be the best time for such listening but most broadcasts to North America are made during the more convenient evening hours: Thus 19, 25 and 31 become bands for all parts of the world with the latter pair most dependable.

Possibly you gathered from these predictions the increasing importance of 31 meters. As the sunspot count continues to drop it will become almost irreplaceable in international broadcasting. Unfortunately, it may have to be replaced. Crowding on this band is fast reaching an intolerable saturation, even for the comparatively hardy SWL. As an example, listen to the 15 kc spread between 9585 and 9600. During the evening we have no less than 5 transmitters in this tiny portion of the radio spectrum, Radio Canada (CKLP), Radio Nederland, Radio Cultura de Bahia (ZYN 29), Radio Moscow, Radio Republik Indonesia (YDF6) and the British Broadcasting Corp. (GRY). Of this group, ZYN29 and YD F6 would be the newer, and it is this continuous stream of new tropical stations coming on the band which is mainly responsible for such overloaded channels. Of course they have as much right here as any other country.

The International Telecommunications Union is taking steps to alleviate this situation but the ITU does not have enforcement powers.

If the malady is not cured, or at least arrested, broadcasters will either have to concentrate on 25 meters, in which case that band might soon look like 31, or switch their programs to less advantageous afternoon periods.

TABLE B—GOOD SHORTWAVE LISTENING

COUNTRY	FREQUENCY IN KC/S	TIME* (EST)	STATION AND DETAILS
WINDWARD ISLANDS	3365, 15085 5010	1600-2115 1600-1730	West Indies Broadcast Service. Here we have the happy circumstance of a semi-local broadcaster using an international band (after 7:30). This one intended for the Caribbean Federation (British West Indies) features a variety of local programs which are a blend of British, Caribbean and American cultures.
MOZAMBIQUE	11760	2230 until fadeout	Another semi-local program in international territory. This will give you a good idea what the English and Afrikaan (Dutch) of Central and South Africa consider entertainment. Programs do not include news. Reception will be best on the Pacific Coast.
CONGO REPUBLIC	11725	2100-2145	Radio Brazzaville. African news from a French point of view. Also French music and French lessons.
ISRAEL	9008 (or 9725)	1530-1600	Kol Israel (or Kol Zion), Zionist picture of Near East news, limited amount of folk music.
SWITZERLAND	11865, 9535 and 6165	2030-2215 and 2315-2400	Swiss Broadcasting Corporation. Neutral international news (government) followed by democratic West European viewpoint from Swiss newspapers. Has sunspot report once a month.
NETHERLANDS	15220 (or 16 meters) 11755 and 9590 (or 9715)	1615-1705 2130-2210	Radio Nederland. Most interesting features here are international news and topical talks.
GREAT BRITAIN	Several frequencies throughout the bands	1600-2200	General Overseas Service, British Broadcasting Corporation. Good example of conservative British programming and thought.
JAPAN	17855, 15235 and 11705	1930-2015	Radio Japan. Features on Japan and a limited amount of Japanese folk music.
AUSTRALIA	11710 11810	0714-0845 1014-1145	Radio Australia. Most important feature here is news from the fifth continent. Remainder of program is primarily entertainment.
ARGENTINA	9690 (or 15345)	2200-2300 and 0000-0100	R.A.E. Compare the polished Argentine music with the more interesting Latin varieties easily heard on 49 and 60 meters.

* Time is given on the 24-hour clock. 1200 is 12 noon, 1300 is 1 pm, 2400 is midnight, and so on. In other words, for times past noon subtract 1200 to get Eastern Standard Time.

† Frequencies listed in brackets are alternate possibilities. If you fail to hear a program on the channels listed first, try these.

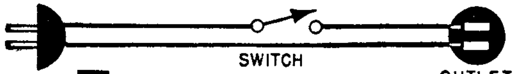
Handy Foot Switch

A FOOT switch on your table saw or drill press may limit the damage that can occur in the event of an accident. A foot switch comes in handy at the telephone to mute a blaring radio or near your easy chair to kill TV commercials. There are uses for the foot switch in the kitchen, too.

There are several types of switches that may be employed for foot switch duty. Several commercial foot switches, some of them in the form of a mat, are available. But these switches are rather expensive. You can make your own from inexpensive basic switch units, enabling you to choose according to your power and function requirements.

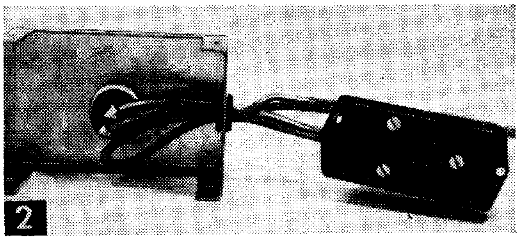
You'll want either a positive action switch, which remains on once you switch it, or a momentary contact switch, which is only on when you hold it on. A positive action switch may be desirable for a foot switch for your wife's electric mixer; a momentary contact switch is desirable for power tools since the natural tendency in an emergency is to release the switch.

Power handling ability is important too. Switches are rated by volts and amps rather than by watts. To determine the amperage of an appliance, divide the wattage of the device by the voltage, usually about 120. Thus, the switch required for a 600 watt appliance must have at least a 5 amp. rating at 120 v. Another point to remember is that switches are rated for resistive loads. Devices which involve coils or capacitors (for example, anything containing a motor) usually demand currents in excess of the current computed by this method. It's usually desirable to use a switch that can handle more current than the controlled appliance requires.



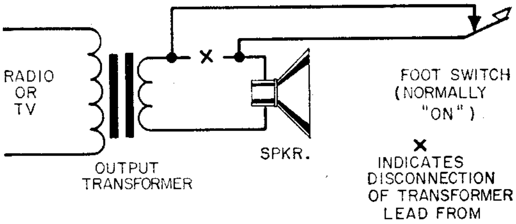
1 FOOT SWITCH CIRCUIT

The circuit for a practical foot switch is shown in Figure 1. The SPST switch is connected in one side of the ac line. A plug is provided for easy connection to any ac outlet. A receptacle is provided so that the switch may be used to control any or several appliances. The back view of the unit is shown in Figure 2. The switch is housed in a small metal box. A ½-in. hole drilled in or near the center of the front side of the box is required for the switch. A ⅜-in. hole is needed in the end of the box for the line cord. Insert a rubber grommet in the end hole. Double a convenience outlet extension cord on itself near the outlet end, and push the doubled end through the grommet into the metal box. Mount the switch, separate the parallel conductors, and connect them and solder. Wrap tape around the cord next to the grommet on the inside of the metal box as a strain relief. The box may be fastened to the floor with four small brackets attached to the sides. The connection to the line and to a specific power tool can be made permanent, too. If current exceeds 5 amps, a permanent installation is desirable.



2

Chassis view of switch before attaching back.



3 SPEAKER MUTING FOOT SWITCH

Speaker muting foot switch. X indicates disconnection of transformer lead from loudspeaker.

Several switches are listed in the materials list. Pick the one that suits your function and current requirements. Note that you can obtain a normally on switch which will turn off when you place your foot on it. This type of switch placed near the phone with radio or TV set connected to the outlet is handy for turning either of these blaring contraptions off during a phone conversation. An alternate scheme which utilizes a normally on switch to mute the audio on a TV set from your easy chair during commercials is shown in Figure 3. In this case the switch is connected in the speaker coil circuit and does not control high voltages or currents.—FRANK WOODS, JR.

MATERIALS LIST—FOOT SWITCH

No. Req.	Description
1	switch, either a momentary contact type, such as ½ amp, normally off (Grayhill 4001) or ½ amp, normally on (Grayhill 4002) or 10 amp, normally off (Grayhill 2201) or 10 amp, normally on (Grayhill 2202) or a positive contact type, 4 amp, push on-push off (Carling 110-SP).
1	3¼x2⅛x1⅝" metal box (Bud CU-2101)
1	convenience outlet extension (electrical or variety store)

Transmitter for the Novice

1

Novice transmitter shown here atop a Knight-Kit receiver, is powered by an external power supply, permitting fixed or mobile use. Inset shows closeup of transmitter face.

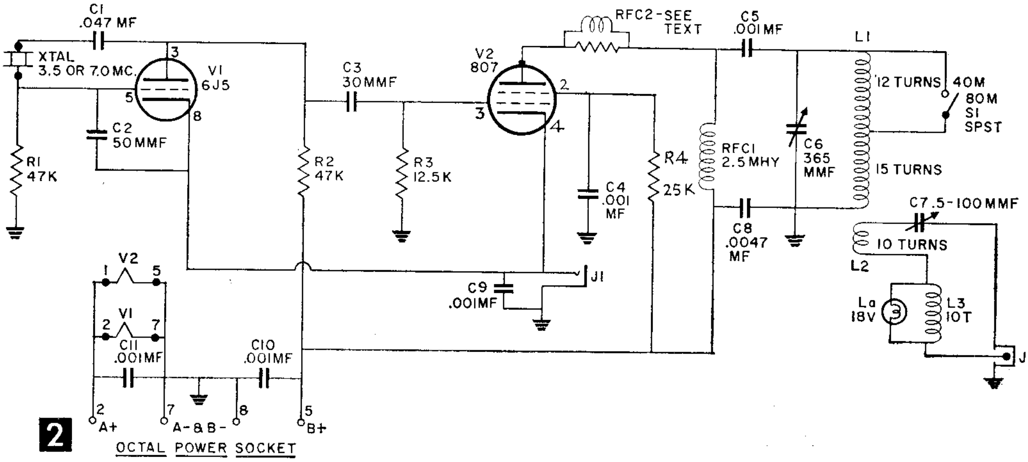
By ALICE ROLF, KN5SEL

HERE'S a compact 75-watt transmitter that even a Novice YL can build. In fact, a Novice XYL did build it after her husband drilled the panel and took over as babysitter. The rig puts out a good signal on 40 and 80 meters, featuring bandswitching, and can be used either at home or in the car with a suitable power supply.

The two-tube circuit shown in Fig. 2 fits into a U.S. Army 30 cal. ammunition tin, available at surplus stores. The 3¼ x 6¾ x 10¼-in. cabinet is modern enough to enhance any shack, and small enough to fit comfortably under the dash of even a foreign car. If an ammo tin is not available, the circuit can easily be enclosed in a small commercial metal cabinet available from radio supply houses.

The transmitter is built in a 5¾ x 9¾-in. hardboard chassis, with a 3¼ x 10⅛-in. metal panel bracket-attached. Use two brackets of any convenient size and sturdy enough to support the panel, which extends about ¼-in. below the Masonite.

Drill all the panel holes before fastening the panel to the chassis. The power socket, key jack, band switch, tuning capacitors, dial light jewel, and antenna jack mount on this panel, the remainder of the components mount on the chassis. The 807 socket mounts on an aluminum bracket 1¾-in. high at the right-rear of the chassis, leaving plenty of



2

MATERIALS LIST—NOVICE TRANSMITTER

Desig.	Description
C1	.047 mfd 200 wv tubular
C2	50 mmfd mica
C3	30 mmfd mica
C4	.001 mfd 1 kv, disc
C5	.001 mfd 1.5 kv tubular
C6	365 mmfd single gang broadcast type variable (Philmore)
C7	5-100 mmfd variable (Bud MC 1873)
C8	.0047 mfd 1 kv, disc
C9	.001 mfd, 1 kv, disc
C10	.001 mfd, 1 kv disc
C11	.001 mfd, 1 kv, disc
J1	phono jack, single circuit (Mallory)
J2	miniature coax jack
L1	27 turns #22 enameled close wound on 1" form, tapped 15 turns from bottom
L2	10 turns #22 enameled close wound over top half of L1
L3	10 turns #22 or #18 enameled close wound ½" form
La	#1455 18-V pilot lamp
RFC 1	2.5 mhy, 100 ma RF choke (National)
RFC 2	parasitic choke or 5 turns #22 or #18 enameled wound on 50-ohm, 1-watt resistor
R1	47,000 ohm, ½ watt
R2	47,000 ohm, 1 watt
R3	12,500 ohm, 10 watt
R4	25,000 ohm, 10 watt
S1	SPST toggle switch (Arrow-Hart & Hegmen #20994NV)
V1	6J5 vacuum tube
V2	807 vacuum tube
Xtal	80- or 40-meter crystal—for Novice band 3750 KC to 3800 KC (80 M) or 7150 to 7200 KC (40 M)
20	6-32 x ¼" machine screws and nuts
10	#8 terminal lugs
2	single lug terminal strips
1	dial lamp jewel
1	ceramic octal socket (6J5)
1	5-prong socket (807)
2	octal wafer sockets (xtal and power sockets)
1	octal plug (for power cable)
1 pc	hardboard ¾ x 5 x 10" (chassis)
1 pc	1/16" steel or aluminum 3¼ x 10" (panel)
6 ft	4-wire rubber insulated cable (insulated for 1000 volts)

room for the 807. Place the tank coil between the panel and the 807 (Fig. 3).

Mount the socket for the 6J5 on the left side of the chassis. Clip the mounting saddle of the socket away with a pair of snips and drill holes in the hardboard so that the socket solder lugs extend through the chassis. These holes are aligned by first drilling the key hole for the key pin of the 6J5. Put a drop of finger-nail polish on the pins of the 6J5 and press it against the chassis with the key in the drilled hole. The polish will mark hole locations. After drilling, press the lugs into the holes until the socket is flush with the chassis. Bend the lugs back so that they lock the socket in place.

Mount the remainder of the components on #8 terminal lugs which are fastened to the hardboard by 6-32 x ¼-in. machine screws—except for the two connections of RFC1. This choke is mounted on two single lug terminal strips in order to isolate the high RF potentials from the metal cabinet. Parts layout is not critical, but should be similar to that shown in Fig. 3.

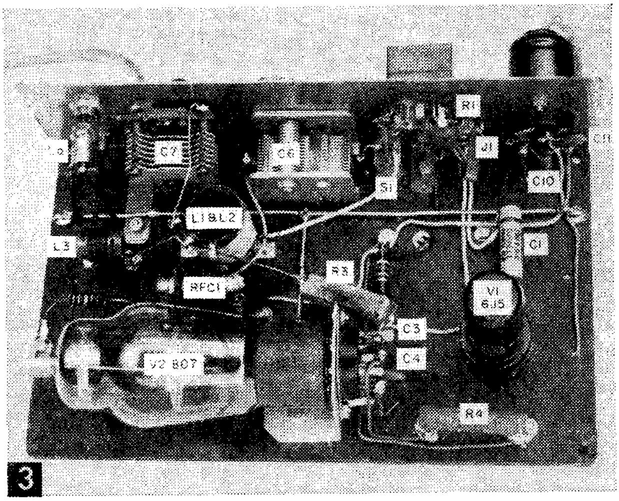
Extend a length of #12 wire across the front of the chassis and ground it to the panel for a ground bus bar. Connect the 807 mounting bracket to this bar. All ground leads should be connected to this bus, the panel, or the 807 mounting bracket.

Connect the leads to the 6J5 socket and bring them to the top of the chassis through holes drilled around the tube socket. Indicator lamp terminals must not be grounded; they are supported by two pieces of solid wire.

Coils L1 and L2 are #22 enameled copper wire wound in a 1-in. dia. form. This form can be a commercial unit with mounting brackets, or a cardboard or plastic tube 1½-in. long. L1 is wound with the connection for C5 at the bottom of the form, nearest the chassis, and the ground connection at the top.

The tap for the bandswitch is placed 12 turns from the bottom of the coil. Twist the wire into a loop for the bandswitch connection and wind the other 15 turns. Coil L2 is wound over the top of L1 between the bandswitch tap connection and the top of the form. Wind it over a layer of Scotch tape with the connection to C7 at the top of the form.

Coil L3 consists of 10 turns of #22 or #18 enameled wire close-wound on a ½-in. form; RFC 2 can either be a commercial parasitic choke of five turns of #22 or #18 enameled wire wound on a 47 ohm, 1-watt resistor. For the antenna jack (J2 in Fig. 2) use a miniature connector jack of a coax type.



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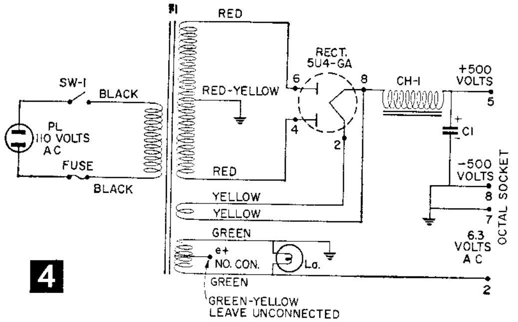
Components are mounted on terminal lugs, the 807 socket is mounted on an aluminum bracket and the 6J5 socket mounts similar to sockets in printed circuitry. A wafer-type octal socket is used for the crystal.



4

Power supply for novice transmitter.

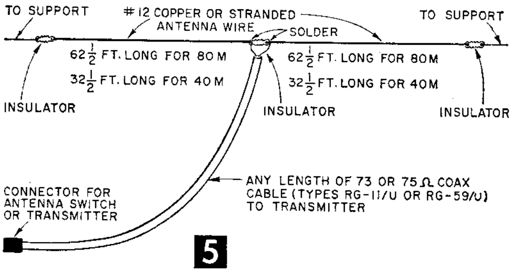
POWER SUPPLY PARTS LIST

Desig.	Description
C1	12 mfd. 700 W.V.D.C. electrolytic capacitor (Cornell Dubilier BRHV 712, or equiv.)
CH1	7 or 8 hy. 200 to 250 ma. filter choke (Thordarson 20C56, or equiv.)
Fuse	3 amp fuse, with holder
La	#47 pilot lamp, with holder
PL	Line cord, heavy duty
SW1	SPST switch'(On-Off switch)
T1	1200 volt c.t. @ 200 to 260 ma. power transformer with 5 volt, 3 amp, winding; 6.4 volt, 3 amp, winding. (Stancor PC-8414, or Burstein-Applebee Co., Kansas City, special #3B164, or equiv.)
Rect	5U4-GA tube
Misc:	2 octal sockets, chassis, mounting screws, etc.
Note:	BA #3B164 transformer has 350 volt tap, at 10 ma, and 5 volt, at 2 amp., windings in secondary. These should be left unconnected if the unit is used.

Use a 3- or 4-wire cable to connect the transmitter to the power supply. The power supply should be capable of delivering from 500 to 750 *v* at 150 *ma* for plate voltage, and 6.3 *v* at 1.2 *amps* filament voltage. For fixed use, an inexpensive full-wave rectifier circuit will work. For mobile work use a dynamotor or heavy duty vibrapack. At 500 *v*, the input will be about 50 watts; with 750 *v*, about 75 watts. A power supply circuit which will serve well is shown in Fig. 4.

Test the Unit on a non-metallic surface before putting it in the cabinet. Plug in the power cable, key, and a 40- or 80-meter crystal. Switch the bandswitch to the band the crystal operates in. Remove the 807 and turn on the power supply. After the tubes have had time to warm up, key the transmitter and listen for the oscillator signal with a shortwave receiver. If nothing is heard, check the oscillator wiring and try a smaller value for C2.

If the oscillator is working, turn off the power supply and insert the 807. If the power supply does not have a bleeder resistor, short the B-plus to ground before replacing the 807 or handling the chassis to avoid shock. Connect a 60-watt light bulb to the antenna terminals and again turn on the power. Place C7 at about half scale and rotate C6 while holding the key down.



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Antenna recommended for use with novice transmitter. Should be as high and clear of obstacles as possible. Solder inner conductor of coax cable to one side of center insulator, and outer conductor to other side. Tape cable to insulator to relieve strain on soldered joints. Ground outer conductor of cable at the transmitter.

With C6 at about half scale, the indicator lamp and the 60-watt lamp will show some sign of output. Adjust C6 and C7 until the indicator lamp (La) glows brightest. Check the plate of the 807; if it is red, replace C3 with a 50 *mmfd* capacitor. This will increase the drive from the 6J5 and allow the final tube to run cool.

If available, a grid-dip meter (or an absorption frequency meter) should be used to check the transmitter's frequency and harmonic output at twice the crystal frequency, and to note the keying characteristics. If carefully constructed, the rig will be clean.

After the transmitter has been tested, place it in the cabinet. Before doing this, however, drill a number of ½-in. holes in the rear of the cabinet and directly above the 807 tube location for ventilation. Then cement a piece of thin Bakelite plastic or three or four layers of "Saran Wrap" to the bottom of the cabinet to insulate the screw heads and 6J5 socket lugs from the cabinet's metal bottom. Secure the unit in the cabinet with two small wood screws on the underside which fasten into the Masonite chassis. Cement rubber feet on the cabinet to avoid scratching surface on which unit stands.

The transmitter will work with most types of popular amateur antennas. We had good results with the antenna rig shown in Fig. 5. The ground lead of the antenna connection should be connected to a good ground. Capacitors C6 and C7 are adjusted until the indicator glows brightest. At this point the transmitter is loaded, and with a good antenna, is capable of working just about any station within range that can be heard on either 80 or 40 meters.

On 80 meters, the daytime range is 50-75 miles and night range is 800-900 miles with 40 to 75 watts input. On 40 meters, with the same input, daytime range is about 200 miles, night range is several thousand miles.

Amplification Amplification Amplification Amplification

The simple "control-impedance" principle explains this vital, modern process

By C. F. ROCKEY

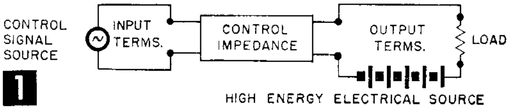
NOT all amplification is electronic. Fundamentally, amplification is any process in which a great amount of power is controlled by a lesser amount. The throttle valve of an automobile, through which the full power of a several hundred *hp* engine is controlled by the touch of a toe, is a crude amplification system.

Because electronic amplification first found wide use in radio, however, this process is firmly linked with electronics in most peopel's minds. Although technicians frequently speak of "current amplication" or "voltage gain," the most fundamental form of amplification is *power* amplification:

$$\text{Power Amplification} = \frac{\text{Power Output}}{\text{Power Input}}$$

Power Output refers to the large amount of power being controlled; Power Input, the much smaller amount of power that does the controlling. Often, in industrial usage, the power input may be called the "control signal." Both quantities in the fraction may be in ergs per second, joules per second, kilocalories per second, horsepower, or other power units, but *watts* or *kilowatts* are most widely used in electrical systems. Since both numerator and denominator must be expressed in the same units, it is seen that power amplification is a dimensionless, "pure ratio," without units in itself.

Power amplification is considered most fundamental here because neither current nor voltage amplification can occur without the simultaneous occurrence of power amplification. This is the case in the vacuum tube, the transistor, the magnetic amplifier, and all other true amplifying devices used today. For instance, although a transformer can readily step up electrical voltage, it does so at the expense of a proportionately decreased amount of available current. Therefore the power available for exerting any useful function has not been increased, and in practice it is usually decreased slightly. Thus a transformer, in itself, is not an amplifier.



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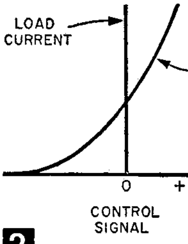

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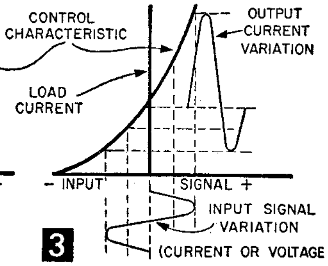

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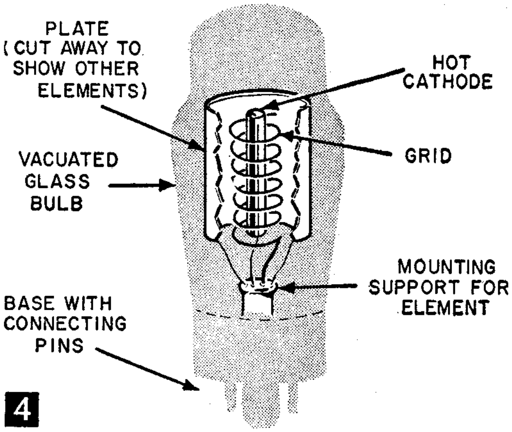
The basis of all amplification is control. No amplifier generates power, it merely makes it possible for a small amount to control a large amount. Thus the essence of an amplifier is what engineers call a *control impedance,* a device whose ability to pass electric current is at the direct command of a small control signal—a relatively small electrical current or voltage. In Fig. 1 the input control signal is shown as an alternating voltage generator and the supply voltage as a direct-current source, but this is by no means always the case. Amplifiers may be made to work with either *ac* or *dc* signals or supply sources. All that is needed fundamentally is an input or control signal, a control impedance, a relatively large power source, and a load. The *load* (represented in Fig. 1 as a resistor) may be an electric motor, solenoid coil, transformer, lighting circuit, loudspeaker, radio transmitting antenna, heating coil, or any other device capable of applying electrical power to a useful function.

The high-energy source in the output circuit of an amplifier causes a steady current to flow through the control impedance and load, normally, even when no control signal exists at the input terminals. When the input control signal, either voltage or current as the case may be, increases, it decreases the opposition which the control impedance offers to the flow of current from the high-energy source, and more current flows through it and the load. The load then consumes more power, normally, in proportion to the input signal. If the control signal decreases to zero, the current supplied to the load decreases to its resting value.

Now, should the control signal reverse in



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polarity, it will increase the opposition to current flow in the load circuit, causing the load to consume less than the resting current value. The control signal at the input terminals directly regulates the internal opposition to current flow by the control impedance. Since the power supplied to the load is the product of the current flowing through it times the voltage across it, changing its current supply directly affects the power consumed by the load. And because the load current is a function of the input control signal's intensity and polarity, power amplification is the result.

The control characteristic is a graph (or curve, as engineers call it) relating output or load current to input signal magnitude. Although the control characteristic of tubes, transistors, or magnetic amplifiers may be quite irregular in practice, it is represented in Fig. 2 as a smooth, gradually curving line. The output current magnitude is found on the vertical, the control signal magnitude on the horizontal line.

To show how an engineer uses the control characteristic to predict the behavior of a control impedance as an amplifying device, a hypothetical alternating-control signal is projected in Fig. 3 upon the characteristic curve's horizontal axis.

Note in Fig. 3 that there is a specific value of load current for each instantaneous value of control signal magnitude. Thus the output or load current is under constant, direct control by the input signal. And, since the output or load power may be large in comparison with the input signal (sometimes several hundred times larger), we have true *amplifying* action.

The exact shape of the control characteristic may be of the utmost importance to the engineer. For instance, where voice, television, or music signals are being amplified, it is essential that this curve be a nearly straight line. Otherwise, the output current will not resemble the input signal, it will be distorted. In certain scientific or industrial applications, accurate reproduction of the input signal by the output current is not necessary, and more efficiency can be secured by purposely distorting it. Then a highly curved control characteristic is advantageous. Other problems, such as feedback from the output to the input of the system may sometimes arise to complicate the designer's plans for a successful amplifier.

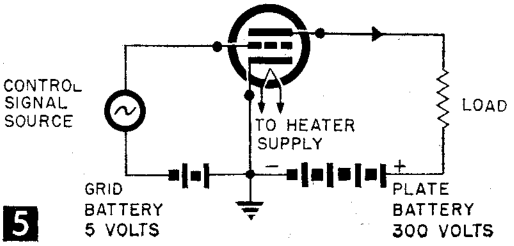
The earliest, highly successful control impedance applied to electrical amplification—the device still called "the king of amplifiers"—is the three-element vacuum tube. First made for "wireless detection" by Dr. Lee DeForest in the early 1900's, the vacuum tube was *the* amplifier until 1947.

The triode vacuum tube consists first of all of a bulb full of nothing; that is, an evacuated envelope. Placed within this envelope is an electrically heated wire or metal tube called the cathode. When heated to a red, or higher temperature, the cathode boils off millions of negatively charged electrons. Surrounding the cathode is a spiral of wire called the grid. Finally a (frequently) cylindrical electrode, called the plate is mounted coaxially with the cathode and grid, and outward from the latter, as shown in Fig. 4.

Vacuum tubes of myriad shapes and sizes have been made and used since about 1908, but the one diagrammed in Fig. 4 illustrates the principle as well as any. The connections of a basic triode vacuum-tube amplifier circuit are diagrammed in standard schematic symbols in Fig. 5. For simplicity, batteries are shown as the *dc* supply sources, but they are seldom used in modern practice. Instead, an electronic power supply, operating from the commercial power line is most often substituted. Basic principles remain the same.

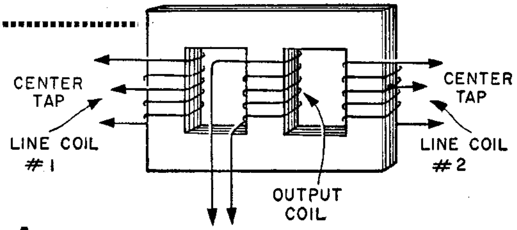
When the cathode of the vacuum tube is heated, clouds of electrons collect about it. When a positive potential (positive with respect to the cathode) is placed upon the plate, the negatively charged electrons are attracted to it, and current flows between cathode and plate, around through the load and plate battery and back to the cathode. These electrons must, however, pass between the wires of the grid enroute to the plate.

Normally, the grid is connected to a slightly negative *dc* potential, and this causes it

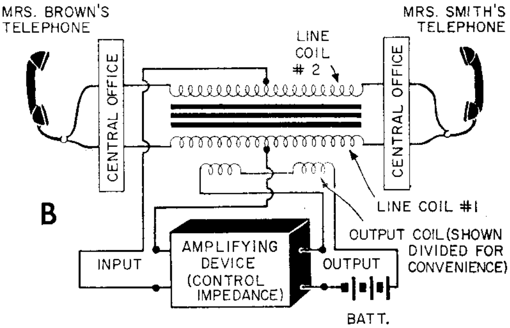


5

THE HYBRID COIL



A GENERAL ARRANGEMENT OF A HYBRID COIL



B

One most interesting modification of the amplifier exists. Although it is an old idea, comparatively few people are aware of it.

As everyone knows, telephone signals lose their "kick" rapidly as they travel down the line. After traversing about 30 miles of ordinary cable pair, the voice signals have been reduced to one-thousandth of their original strength. Thus, amplification becomes necessary to long-distance telephony.

But the telephone is a two-way device. Mrs. Smith in Boston wants both to talk and to listen to Mrs. Brown in San Francisco. In fact, both ladies are often talking at the same time. How can we arrange a two-way amplifier that will amplify the signals equally well in both directions without complex switching, and without getting the signals mixed up?

The answer lies in a special kind of transformer called a hybrid coil (see Fig. A). Two identical, carefully balanced coils, the line coils, are connected in series with the two wires of the line. A third winding, the output coil, is arranged to couple its magnetic field equally into both of the line coils. The output coil is connected to the output terminals of the amplifying device, which may be either a vacuum-tube or a transistor. The input terminals of the amplifier are connected to the two center-taps of the two line coils (see Fig. B).

The two line coils have small resistance, about that of a mile or two of line, so the signal can pass through them with little loss. And since the input of the amplifier is connected to the two center taps, it is effectively connected across the line. Thus the voice signals from either Mrs. Brown's or Mrs. Smith's phone will be fed equally well into the amplifier.

These signals act to vary the battery current in the output circuit via the control impedance. Therefore, a greatly enlarged replica of either or both voice currents flows through the output winding of the hybrid coil. These strong voice currents cause a changing magnetic flux to pass through both line coils in the right direction, thus inducing a large voice voltage back into the line. This greatly-amplified signal propagates down the line in both directions, giving both parties the benefit of the boost.

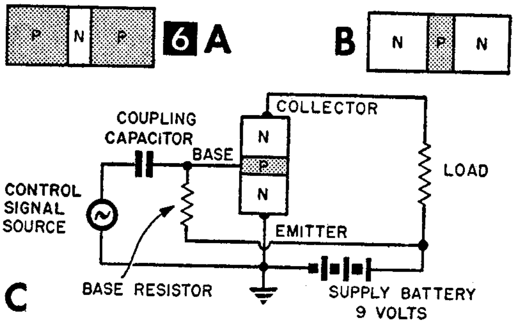
Because the input of the amplifier is connected to the exact center of each of the coils, and since half of the signal is sent each way down the line, the amplifier's output voltage is cancelled out at its own input terminals. Thus, when things are adjusted properly, the voice signals may be amplified many times without annoying "singing," or feedback.

to have a definite repulsive effect upon the electrons. The control-signal voltage source is connected in series with the grid battery so that its variations will add to and subtract from the negative, fixed grid voltage. Thus the signal voltage will make the grid instantaneously more or less negative with respect to the cathode. When the grid becomes less negative, it repels the electrons less strongly, and the cathode-plate-load current increases. When the signal makes the grid more negative, it repels more electrons, reducing the load current. Thus the triode vacuum tube acts as a control impedance whose internal opposition to load current flow is at the command of the grid voltage.

Like all practical devices, the vacuum tube can develop "indigestion" which interferes with its action under some circumstances. To avoid this, more grids have been added which, when properly connected, vastly improve its universality. Also, vacuum tubes ranging from pea-size (for hearing-aids and microwave use) to 100-kilowatt giants have been built and are in use as amplifiers on all sorts of jobs today. They're made of metal, glass and special ceramics. Vacuum tubes are shot into outer space on satellites, and are operating miles beneath the surface of the ocean as transoceanic cable amplifiers. They work.

The Transistor. In 1947, after countless hours of cogitation upon solid-state physics, quantum mechanics, statistical theory, and (possibly) voodoo, Drs. Bardeen and Brattain, of the Bell Telephone Laboratories brought forth a remarkable new control impedance called the *transistor*. Unlike the vacuum tube, the transistor makes use of conduction through a special kind of solid substance called a semiconductor instead of through a vacuum. The stuff most of the practical ones are made of today is element No. 32, *germanium*, an element recovered as a by-product from the combustion of certain coals.

When it's pure, germanium is an almost perfect insulator. But when the minutest whiff of indium, arsenic, gallium, aluminum, or certain other elements are added, it becomes a semiconductor. By adding the right stuff, in the right amount, one may make at will *two* different types of semi-conducting germanium, either N-type, or P-type. An N-type germanium conducts practically like copper does, that is, by means of free electrons which may move about inside the crystal. The P-type, however, is missing a few electrons which it should normally contain. These missing electrons, called *holes*, can



move around inside the crystal and conduct electricity too. However, since they're "missing electrons," they're positively charged particles and move in the opposite direction through the system. But they still conduct, nevertheless.

The art of semiconductor fabrication has advanced so far as to allow different zones of the *same* chunk of germanium to be made into either N- or P-type material. In fact, such technique is necessary in the routine fabrication of a modern transistor. A modern "junction" transistor, the presently most common and practical type is made of a small bar of germanium about ⅛ in. long and about 1/16 in. square. This little bar is divided into three alternate zones of P- and N-type material. The finished bar is sealed in a neat case, for convenience and security.

As Figs. 6A and 6B show, two types of junction transistors are thus possible—PNP and NPN. Both operate upon the same basic theory, the main difference being in the polarity of the supply voltages.

Fundamentally, in schematic terms, an NPN transistor is connected into its most generally practical amplifier circuit in the manner shown in Fig. 6C. The magnitude of the voltages and current shown apply to the typical experimenter's transistor. Power transistors are made which are capable of dealing with much greater voltages and currents when necessary.

Connections made to the ends of the bar of N-type germanium are designated the *emitter* and the *collector,* while the thin layer of P-type material in the center of the bar is called the *base.* In normal operation an electron current of about one milliampere flows from the grounded side of the supply battery into the emitter end of the transistor and up toward the base. Here, within the transistor, it divides, about 95% of it flowing through the entire bar and into the load through the collector connection. The remaining 5% flows out of the base connection, through the base resistor, and back to the positive terminal of the battery. This is the resting state of the circuit.

When the control signal source is energized, it causes an alternating signal current to flow between the base and emitter connections of the transistor. We recall that an alternating current can flow readily through the coupling capacitor, but that this capacitor acts as an open circuit for unvarying, *dc* battery current. Thus the capacitor prevents the generator from short-circuiting the base resistor, while allowing the *ac* control signal current to flow with relative ease.

From one point of view, we may think of the base section acting something like a semi-permeable wall, allowing electrons to pass through it in proportion to the base-emitter current. When the signal source current acts in such a direction as to add to the steady base current, its permeability is increased, and more current can flow from the emitter to the collector through the load. On the other hand, when the signal current subtracts from the battery current from base to emitter, base permeability decreases, the collector-load current is forced to decrease in proportion. Thus the load current is at the direct control of the base current from the signal source; the transistor, like the vacuum tube, acts as a true control impedance. And since the magnitude of the base signal current change is always much less than the corresponding load current change, transistors are effective amplifiers.

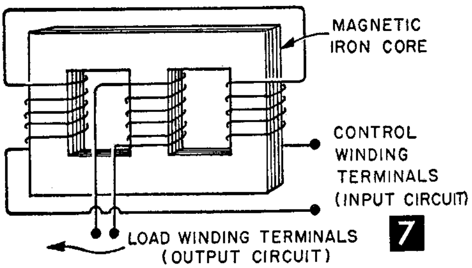
It is most important to observe here that, while the vacuum tube and the transistors are both control impedances, and thus amplifiers, they differ drastically in one important operational aspect. Whereas the vacuum tube is a voltage-controlled impedance, the transistor is a current-controlled device. Thus, while these two devices may often do similar jobs, they are by no means interchangeable, either in theory or in practice.

Both the vacuum-tube and the transistor have particular amplifying jobs to do at which each excels. At present, high-quality vacuum tubes are relatively inexpensive, easy to manufacture on a mass scale uniformly, and operate well when the control signal changes rapidly with time, that is, at high frequencies. On the other hand they are relatively bulky, mechanically fragile, and require excessive operating power in the form of cathode-heating requirements.

The transistor is exceedingly compact, operates well with a low-voltage supply source, requires no heating power, and laughs at mechanical shock that would shatter a vacuum tube. But, transistors are exceedingly difficult to manufacture to within close tolerances. Every production run includes a high precentage of rejects which do not meet government and commercial standards. (These culls are what you and I buy for experimenter's projects today, unless we pay over $5 per unit.) Furthermore, transistors are extremely subject to quick and fatal electrical damage if wrongly connected or allowed to become too warm. Truly effective high-power or high-frequency transistors remain extremely expensive, if indeed they are available to ordinary mortals at all, while vacuum tubes capable of supplying hundreds of watts at hundreds of megacycles may be bought over the counter for a few dollars almost anywhere.

Magnetic Amplifiers: While the vacuum-tube or transistor is still necessary for amplification of signals which change magnitude appreciably in less than one-thousandth of a second, slower signals may be effectively handled by the *magnetic amplifier*.

This interesting device depends for its operation upon the fact that an iron-alloy core, similar to that used in transformers, can, so to speak, pass only a limited number of magnetic force (flux) lines per square-inch of cross-section area. When such a core has been filled with magnetic flux it becomes very difficult to force any more to pass through it.

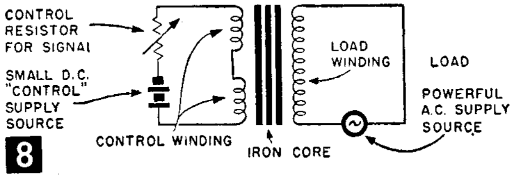


7

BASIC ARRANGEMENT OF SIMPLE MAGNETIC AMPLIFIER

The heavy alternating current to the load is made to pass through the load winding (see Fig 7), while a small, possibly slowly changing unidirectional (*dc*) control current passes through the control windings. Because the two control windings consist of the same number of turns effectively wound in *opposite* directions, the heavy load current induces equal but opposite voltages into each winding, which thus effectively cancel-out in the control circuit. By this means, effective electrical isolation is maintained between control and load circuits. On the other hand, the control currents may still magnetize the core, and exert control action.

A more easily understood schematic diagram of a simple magnetic amplifier circuit is shown in Fig. 8. Assume that the control resistor is of such high resistance that negligible current flows through the control winding. The *ac* load current then flows through the load winding, developing a large and constantly changing magnetic field within the iron core. This continually changing magnetic field induces an *opposing ac* voltage back into the turns of the load winding. This opposing, self-induced voltage subtracts from the *ac* generator voltage, thus, reducing the current in the load circuit to a small number of amperes. In other words, the load winding acts as an efficient "choke coil" in the *ac* load circuit, opposing the flow of current therein.



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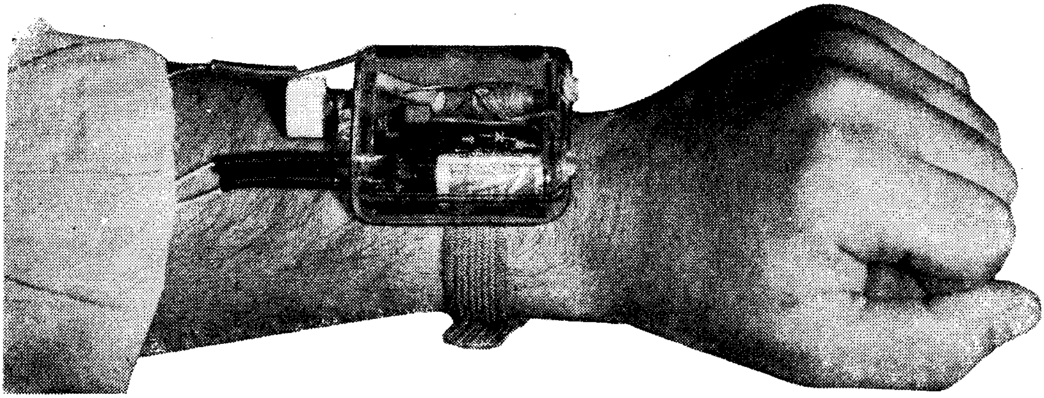
But now let us pass a small current through the control windings. This current now adds a second set of magnetic flux lines to those present due to the load current. But, as we have just said, the iron core can only contain a certain maximum number of total magnetic lines. Since an appreciable amount of the core's magnetic capacity is now being used by the *dc* control flux, the *ac* load current can no longer produce as great a changing field within the core as formerly. Since the opposing voltage induced with in the load winding is directly proportional to its own changing field, and this must be appreciably less than formerly, the load winding's "choking" effect is less, allowing more load current to flow.

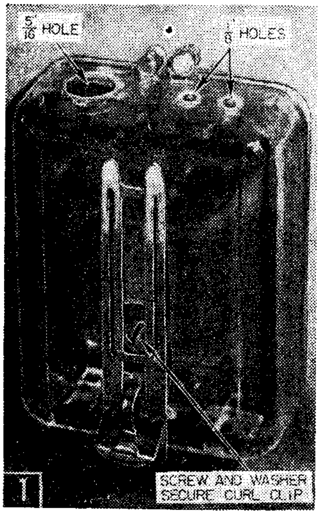
Increasing the steady current further leaves still less "space" within the core for the changing flux about the load coil, so the choking-effect of the latter is reduced still further. Finally, we may increase the control winding current to the point where it almost fills, or "saturates" the iron core. Then, even though the *ac* load current is still changing as rapidly as before, it can produce little or no changing flux within the coil.

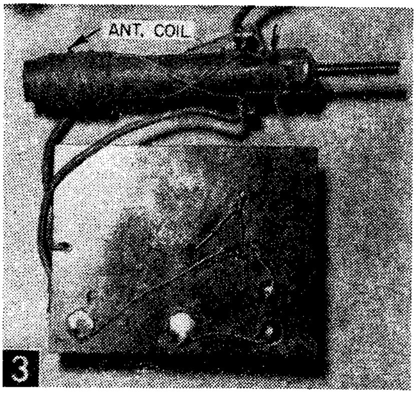
Thus we see that the magnetic amplifier is really nothing but a variable choke coil, whose current-opposing effect is at the direct control of a small direct current in the control windings. Though relatively slow in response, it is a powerful amplifier, finding much use in multi-kilowatt applications. By its use, thousands of horsepower involved in the rolling-mills of a large steel plant may be perfectly synchronized and controlled in an automatized steel-plate production system.

Of course, numerous improvements are possible, and are frequently applied in magnetic amplifier practice. By inserting a rectifier, or electrical "one-way valve" between the control source and the control windings, a magnetic amplifier may be made to amplify low-frequency *ac* control signals. Also, a feedback circuit by which some of the output power is reapplied to the input circuit, may improve the action and response-speed of the device. Where its inherent slowness is not a disadvantage, the magnetic amplifier is certain to find increasingly wider use, since it is the simplest, longest-lived (practically immortal), most rugged high-powered amplifier we have available at present.

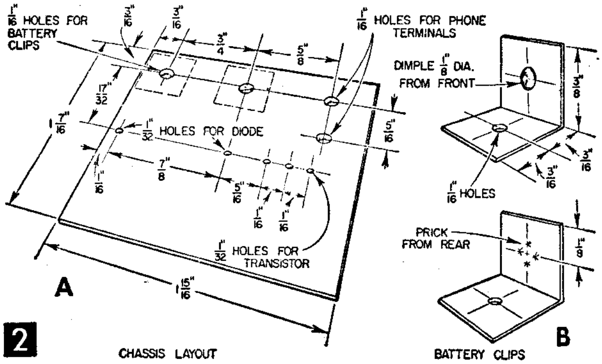


WRIST RADIO





Left, the versatile curl clip is fastened to the case with screw and washer. Holes in end of case are for phone clips and antenna coil. Above, underside of chassis. Virtually all wiring is done with pigtail leads of circuit components.



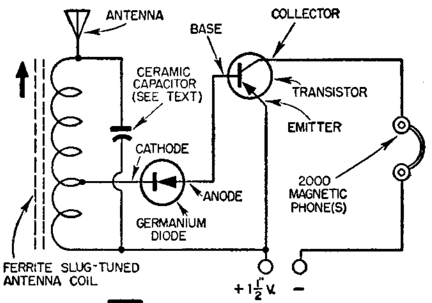
THIS super-small set can—honestly—be called a *Wrist, Clip-On,* or *Pendant Radio;* its minute size lends itself to these applications without forcing the name upon it as is done so often with sets that should have been labeled *Pocket Radios Only.* It's one-third smaller, and 75% lighter, than a diminutive hearing aid whose manufacturer advertises his unit as tiny enough to be hidden in milady's hair. Only slightly larger than a book of paper matches, it still has up to twice the volume and selectivity of ordinary transistor or transistor-diode circuits.

In spite of its tiny dimensions, all parts for the set are readily available. The polystyrene plastic case you'll find on the "Cosmetics" counters of any dime store. There also you'll find the versatile clip which attaches to the case. The trade name is "Lady Ellen Curl Clips." Get the 1⅞-in. size.

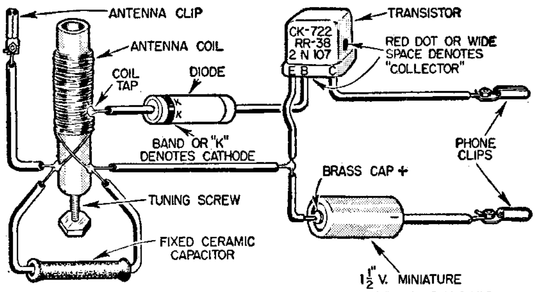
For the chassis, we used a $1\frac{7}{16} \times 1\frac{15}{16}$ in. piece of linen impregnated Bakelite. Thin fiber or cardboard can also be used. Lay out and punch the $\frac{1}{16}$ in. holes (Fig. 2A) with a paper punch and pierce the $\frac{1}{32}$ in. holes for diode and transistor with a needle. If you use cardboard for the chassis, dip it in shellac, remove and allow to dry after making mounting holes. Repeat if necessary to give the cardboard the stiffness that fiber or Bakelite has.

Insert the germanium diode and transistor "pigtail" leads into their mounting holes and bend to right angles on the underside of the chassis (Fig. 3). This gives rigidity to circuit components without resorting to ultra-miniature clips and sockets.

Make the battery clips from strips of brass, copper or tinplate as in Fig. 2B. To hold the brass cap end of the battery securely, dent or dimple one of the clips with a ⅛-in. flat punch, or



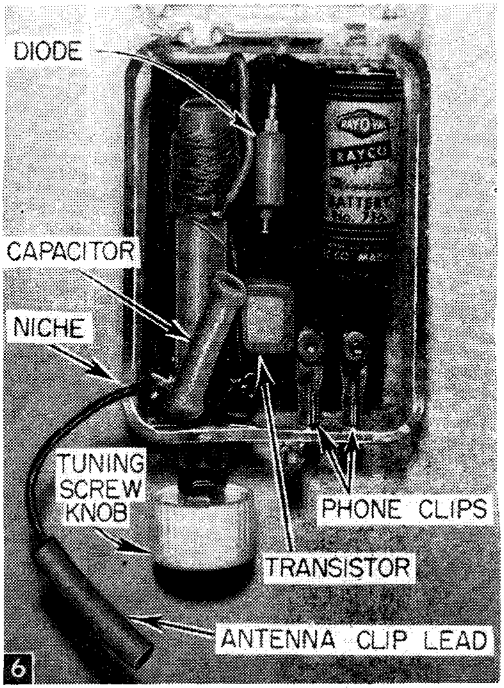
4 SCHEMATIC



5 WIRING PICTORIAL

MATERIALS LIST—WRIST RADIO

No.	Description
1	Plastic utility box, 2⅛ x 1¾ x ⅞ in.
1	General purpose diode (1N34, 1N66, 1N48, or 1N65)
1	Transistor (CK-722, RR-38 or 2N107)
1	Ferrite antenna coil (Miller, Stanwyck, Grayburne, etc.)
1	Ceramic fixed capacitor (120 mmf. to tune 1590-880 kc.; 220 mmf. to tune 880-550 kc.)
1	Pair standard magnetic headphones, or miniature earphone (D.C. resistance should be 2000 ohms minimum)
1	Miniature flashlight battery (Ray-O-Vac #716 or any other size "N" 1½ v. cell. If mercury type cell should be used, note that cap is minus, not plus as with regular batteries)
3	Tube pin contacts salvaged from octal wafer socket
5	2-56 x ⅛ in. brass machine screws and nuts
1	4-40 nut or 4-40 knob for tuner screw
1	Small alligator clip (or "frictional" paper clip)
1	3 ft. length light, flexible hook-up wire
1	"Lady Ellen" curl clip, 1⅞" size



Set with case open. It measures only 2⅛x1¾x⅞ in.

machine screw. To prevent the smooth, zinc shell end of the battery from sliding out of position, pierce the other clip with a prick punch or nail. Fasten the battery clips to the chassis with 2-56 machine screws and nuts not more than ⅛ in. long and the phone clips with 2-56 screws.

The set uses either standard-size or hearing-aid-size magnetic phones. Standard-size phones have cords fitted with tips, but with the miniature phone you'll have to add them. To do this, carefully remove about ¼ in. of the insulation from the cord to expose its tinsel conductors. Then place a common pin parallel with the tinsel conductors, and bind pin and tinsel together with a single strand of ordinary stranded fixture wire, snip off the protruding end of the pin and solder.

Suppose you use standard-size phones—then what about the jacks we used? Well, these are nothing more than the pin clips used in cheap octal wafer tube sockets. A 5¢ socket yields 8 of them if you don't have an old socket from which you can salvage the 3 used in this project. If your standard-size phone tips don't fit, simply compress the clips with a pliers until they do.

Except for the coil connections, wire all components on the underside of the chassis with the transistor and diode pigtail leads (Fig. 3); separate hook-up wire is not required. When soldering to the screw terminal points, use a thumbnail-size wad of wet cleansing tissue pressed over the pigtail lead so that heat is not transmitted up into the diode or transistor. Just as soon as the solder sets, move the wad over the hot connection so that it will cool rapidly. This protects transistor and diode from damage. *Electrical* connections are shown in Fig. 4; *physical* connections, in Fig. 5.

In order to provide the most efficient match between the high-impedance resonant circuit of coil and capacitor and the low-impedance diode detector—which, in turn, feeds into the low impedance transistor—the ferrite slug-tuned antenna coil is tapped 16 turns from the outside end of the winding. Using the coil shown in Fig. 3, which has a progressive type winding, you needn't count off turns; just unwind 21 inches of wire. This is equal to 16 turns. *Carefully* scrape off the cotton insulation and form a small loop, then rewind the coil wire as closely as possible into its original space and pie-layer arrangement and reconnect the end of the coil to the terminal lug. No great harm will result, however, if you "scramble wind" the turns back on the coil form.

With two short lengths of light stranded, plastic-covered hook-up wire, connect one coil lug and the tap to chassis components. With a third length, connect the inside coil lug to another octal socket clip. This is the antenna connection. A 3 ft. length of wire fitted with a small alligator clip and brass weatherstrip nail or phone tip attaches to it. Removed from the set when not in use, this type of antenna eliminates dangling wires.

A fixed ceramic capacitor connected across the coil lugs completes the wiring. Its value will depend upon stations operating in your area. If stations tune in between 1590 and 880 kc., the value of the capacitor should be about 120 mmf. To tune from 880 kc. to the top of the dial, 550 kc., use 220 mmf. Solder a 4-40 brass nut to the end of the threaded coil slug, or a small bakelite knob with a 4-40 lock nut, to turn the coil's tuning slug in and out.

When testing the set before installing in its case, attach the alligator clip to the finger stop or metal box of your telephone. If wiring is correct, and the correct size capacitor for your area is across the coil, you may find that powerful local stations are so loud that the earphone is overloaded and reception distorted. If this happens, remove the alligator clip from the phone. The volume will still be loud, but the set will be free of distortion—and quite selective.

Try the antenna clip on metal lamp bases, screens, bedsprings, etc., but you will probably find you can let it hang free and still get good reception.

With the set tested, it's ready for mounting in the case. Drill two $\frac{1}{8}$-in. holes for the phone clips and a $\frac{5}{16}$-in. hole for mounting the tuning coil (Fig. 1). Drill a $\frac{1}{16}$-in. hole in the back of the case for securing the curl clip and slip a $\frac{5}{16}$-in. dia. washer over a 2-56 screw and clamp the clip between washer and case. The chassis with its wiring friction-fits in the case.

The antenna lead passes through a niche filed between case lid and cover. (Fig. 6.) When not in use, it's tucked inside. Since the case is transparent, a snapshot, colorful floral print or decal can be inserted under the lid when the set is used as a Pendant Radio. There is a $\frac{1}{8}$-in. hole in the curl clip to which either a ribbon or chain may be attached. As a Wrist Radio, a plain leather strap is all that is required—the set clips to the strap—and as a Clip-On Radio, it clips to tie, shirt pocket, belt.

We've obtained fair results with an aluminum-foil-lined hat as a walking antenna, receiving 50 kw. stations located 20 airline miles away. For so tiny a receiver, mobility is asking a lot, but in many areas this stunt is possible. Note that no ground connection is required for normal reception. In remote areas, of course, a ground may be connected to the battery's minus terminal.—THOMAS A. BLANCHARD.

I don't object to your doing-it-yourself—but I do draw the line at growing your own needles!

Code Practice Oscillators

The article describes two code practice oscillator kits that are easy to build, instructive, and inexpensive

The Lafayette Transistor Code Practice Kit completed.

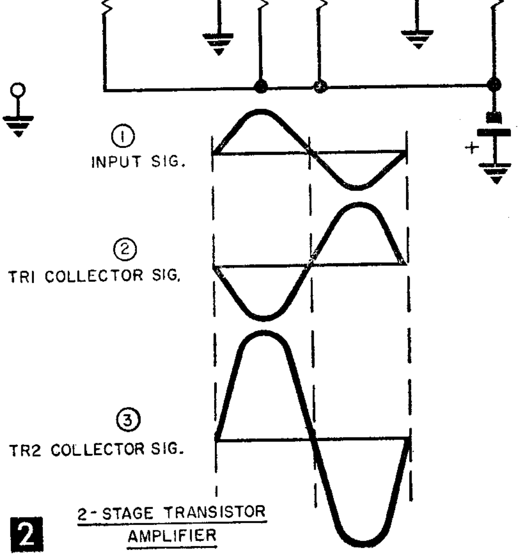
CODE practice oscillators are comparatively simple electronic devices. The simplest use only a single transistor or tube. The output is an audible tone, generally between 400 and 2,000 cycles per second, which the user can hear in an earphone.

The Lafayette KT-72 kit is available for $2.99 from Lafayette Radio, 165-08 Liberty Avenue, Jamaica 33, New York. It comes complete with key, but the headphone must be bought separately. The Knight 83Y239 kit is available from Allied Radio, 100 N. Western Avenue, Chicago 80, Illinois, for $3.95. The key and the headphone are not included in the kit and cost $3.33 more.

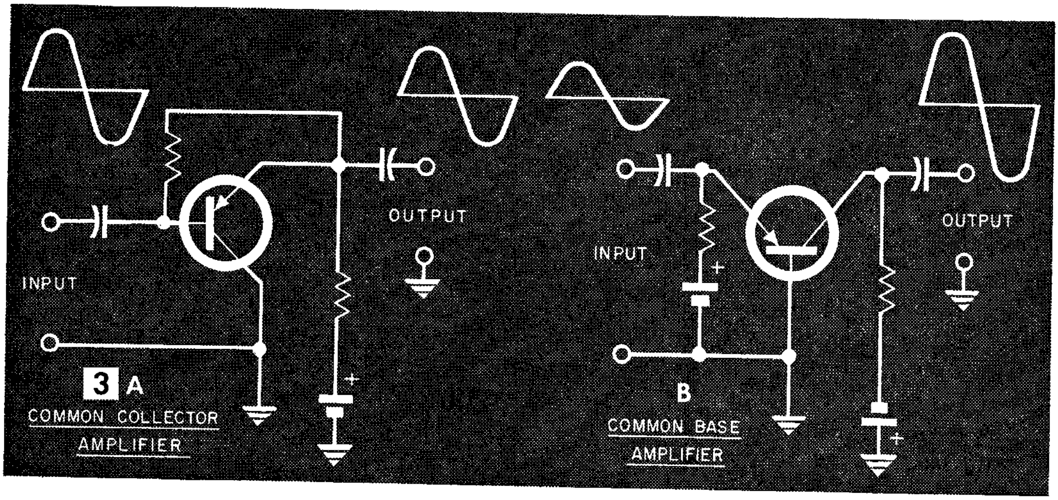
Theory. A small signal voltage at the input to the base of the first transistor shown in Fig. 2 will produce a larger signal at the second transistor (TR2) output. Now even if there's no signal at the input of the amplifier, there's still a very small signal at the first transistor collector made up of noise generated within the transistor and the circuit components. This noise is amplified by the second transistor.

If we were to feed the output of this amplifier back to its input (through a resistance to keep the low-impedance input from partially shorting the higher impedance output), this noise would pass through the amplifier. It would again appear at the output—amplified this time—and it would continue to recirculate in this way until it was prevented from becoming any louder by the value of battery voltage and the parts values employed in the circuit.

Did I intentionally use two transistors to illustrate this? Yes. The transistor circuit configuration used in the circuit of Fig. 2 is called a common emitter circuit because one battery terminal and one input terminal (indicated by the ground symbol) are connected to the emitter. The amplifier in Fig. 2 consists of two cascaded common emitter connected transistors.



2 2-STAGE TRANSISTOR AMPLIFIER



3A COMMON COLLECTOR AMPLIFIER

B COMMON BASE AMPLIFIER

The common emitter circuit configuration is more popular than the common collector and the common base circuits shown in Figs. 3A and 3B because the common emitter circuit has greater power gain and because only one battery power supply is required to operate it. But the common emitter circuit inverts the signal (see Fig. 2). Thus, if we fed some of the output of a single transistor back to its input, the signal would subtract and cancel the tendency to oscillate. This type of feedback is described as degenerative.

However, if two of these transistor stages are cascaded, the signal will be inverted a second time, and when a portion of the output is fed to the input of this two-stage amplifier, the signals are in phase. This results in the build-up required for oscillation.

If a resonating circuit consisting of an inductance (a pair of headphones in the case of this code practice oscillator) and a suitable capacitance *ac* voltage divider combination for feedback is provided, one transistor will produce oscillations. In this case the LC (inductance and capacitor) combination tends to oscillate at a given frequency depending on the product of their values. But the internal *dc* resistance of the headphone windings dissipates energy, and the combination needs a recurring kick of energy—from somewhere—for continued oscillation.

A single transistor can furnish the kick. This type of oscillator is generally known as a Colpitts oscillator, and this circuit is utilized in the Lafayette KT-72 code practice kit. The circuit is shown in Fig. 4.

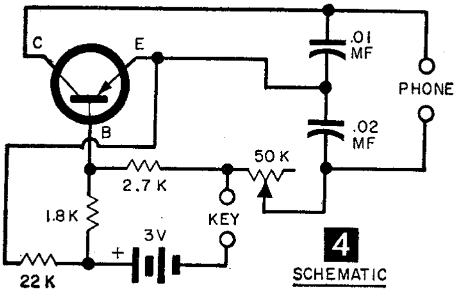
The oscillator circuit of the Knight kit also utilizes a resonant LC circuit, but in this case, feedback is introduced with a transformer. The circuit is shown in Fig. 5.

The instructions which come with the Lafayette code practice oscillator kit include a step-by-step wiring sequence. Many of the connections are made without any soldering and rely instead on screws and nuts and Fahnestock clips.

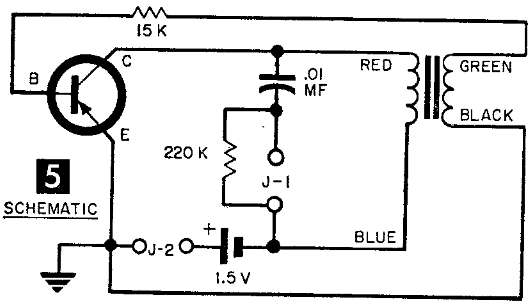
The components are mounted on a perforated Masonite board before any wiring is attempted. The shaft for the volume control must be cut to about 3/8-in. length before it is inserted in the volume control. The 50-K volume control is connected as a rheostat (only two terminals are used) instead of as a potentiometer (where three terminals would be used).

The Knight transistor code practice oscillator kit fits in a compact Bakelite case 1 5/8 x 2 7/8 x 4 in. with an aluminum front panel. It operates from a single 1½-v penlite cell. Terminals for connecting key and headphones are provided on the front panel.

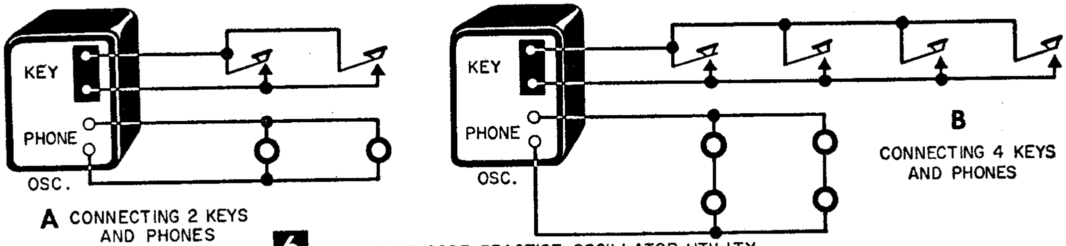
The parts in both kits are covered by a



4 SCHEMATIC



5 SCHEMATIC



A CONNECTING 2 KEYS AND PHONES

B CONNECTING 4 KEYS AND PHONES

6 EXTENDING CODE PRACTICE OSCILLATOR UTILITY

7

Front-panel view of the Knight Transistorized Code Practice Kit.

standard RETMA 90-day warranty. Any defective parts will be replaced within 90 days provided the damage was not due to carelessness or abuse. Each of the suppliers will troubleshoot your kit for a nominal cost if you can't make it work yourself, but the chance that you'll have trouble with either is very small.

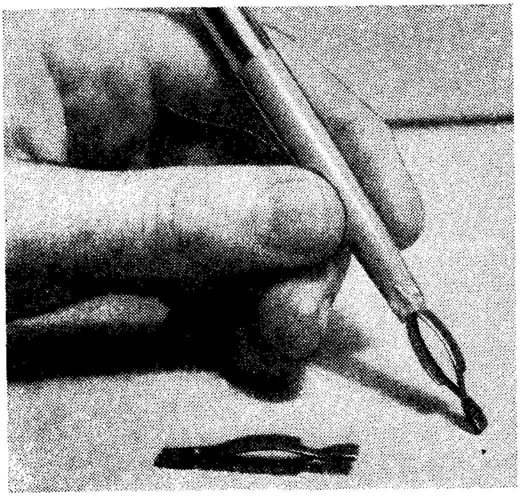
Almost any kind of magnetic headphones of 1,000 ohms or greater impedance may be used with either oscillator. Lafayette recommends a single headphone which may be ordered from them as AM-15-1 at $1.18. Allied recommends a unit which sells for $1.08 (59Y112, their catalog number). The key for the Knight Kit may be Allied's 76 PO53 at $2.25 or Lafayette's MS-309 at $1.25.

If you wish to use either code practice oscillator with another person, another key and headset may be added as shown in Fig. 6A. If you wish to get as many as four people into the circuit, connect the keys in parallel and the headphones in series-parallel as shown in Fig. 6B. This kind of operation is a lot of fun and it will help you and your friends learn the code faster.

In comparing the two kits, I find it difficult to recommend one over the other. The Knight Kit is simpler to construct and can be built in less time. It is housed in a very attractive, functional package. The Lafayette Kit, on the other hand, is less expensive and it includes the key.—F.H.F.

Soldering "Pen" Absorbs Heat

• Soldering iron heat can ruin transistors and other small electronic parts, unless you use a heat sink. Pliers are often too bulky and heavy for the job, especially in the corners of chassis wiring, or working on miniaturized circuits. Remove the ink cartridge from an old ball point pen, and saw off the tip about ½-in. from the end. Then heat the back end of a Mueller #88 test clip and force it into the pen handle. A drop of cement completes this handy tool.



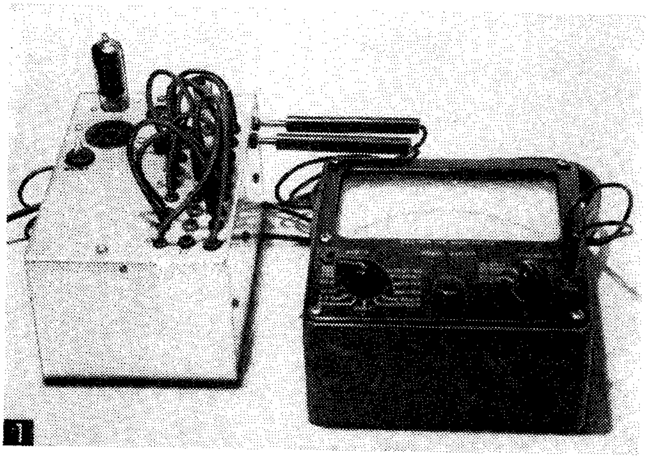
Draftsman's Tape Holds Tight

• Draftsman's tape makes an excellent "third hand" to hold electronic components together during assembly or soldering. Due to its high insulation, the tape can be left on permanently, or can be peeled off easily.

—J. A. McRoberts

Adapter Unit Checks Tubes With Your Multimeter

This adapter unit enables you to check tubes with your volt-ohmmeter, makes a fine filament source for experimental setups, and provides multi-ac taps for measurement and calibration work



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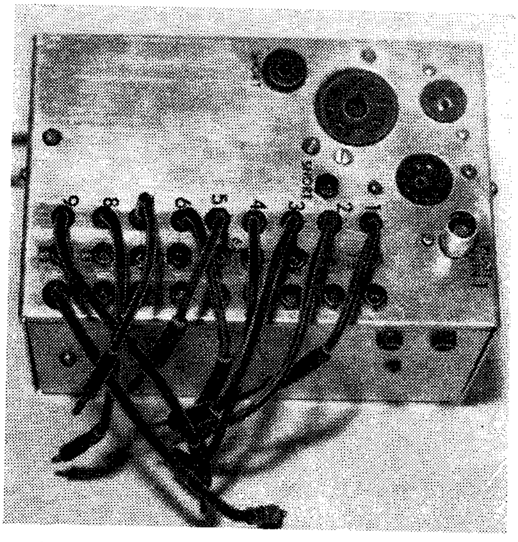


Adapter unit at left above (and below) used with volt-ohmmeter for checking tubes.

By TOM JASKI

THE most common and one of the simplest tube tests which can give reasonably reliable information about a vacuum tube is the emission test. Together with tests for continuity of the filament, shorts and opens of the elements, these are the tests that are made when you take your tube to a service shop for a free tube test, and these are also the tests which you perform on do-it-yourself tube testers. With the unit described here and with your volt-ohmmeter you can make these tests yourself.

Figure 2A shows the filament continuity test in schematic form. If a neon tube is connected to an appropriate voltage source, through a tube filament, it will glow brightly. If the filament is open, the neon tube will stay dark. Similarly, if any of the elements are shorted, and the neon tube is connected through both of them to its source, it will glow again brightly (Fig. 2B). Usually we are interested in shorts to cathode, because they are the most commonly found shorts in tubes.

When a tube is in good condition, the cathode is capable of emitting all the electrons which can be demanded by plate and grid voltages. Actually, the cathode can deliver many more electrons, but there is a finite limit, the saturation current. When a vacuum-tube cathode starts to deteriorate, the first indication is a drop in saturation current. Thus by testing what the saturation current is, we can pretty well determine the condition of the tube. We do this by tying the cathode to ground, heating the filament normally, and applying an *ac* voltage to all the other elements together. Then we measure the current through the tube, this is the emission test. (See Fig. 3.) Since this measured emission current is the total of that received by all of the elements, when we remove one of them from the circuit, there will be a slight drop in current. Not much, but enough to be perceptible and enough to indicate whether the element in question is open. The recommended *maximum* time to take a reading is three seconds.

Multimeter Requirements. The schematic is shown in Fig. 4. The transformer for the adapter unit is a tube checker transformer with many voltages tapped off. The tapped voltages are supplied to jacks. There are five jacks to a red lead; these supply *ac* to the elements of the tube under test. There are three black pin-jacks; these are grounded.

One of these must be used for one side of the filament, one for the cathode and one is a spare in case you want to ground the suppressor grid also. There are two jacks for the meter, one red for the positive prod, one black for the negative meter prod. The neon tube circuit was shown in Fig. 2. Each lead of the group of nine flexible black leads with phone tips on the ends is connected to a numbered pin on the tube test socket S. Lead one connects to all the #1 pins, lead two to all the #2 pins, etc. These are plugged into the appropriate jacks when you are using the unit.

The meter must have at least a 100 *ma* scale and preferably a higher one. If your multimeter does not have a scale as high as 100 *ma*, make a shunt to use with whatever scales you have. If you have only an ordinary 1 *ma* meter, you can use this provided you make a shunt for it which has a resistance of $\frac{1}{99}$th of the meter internal resistance, for the 100 *ma* range, or $\frac{1}{198}$th for the 200 *ma* range. The reason your meter needs these high ranges is that the saturation current of cathodes is considerable, in some cases over 200 *ma*. (In regular emission tube checkers, this is compensated for by a *dc* voltage circuit which counteracts the deflection of the meter.)

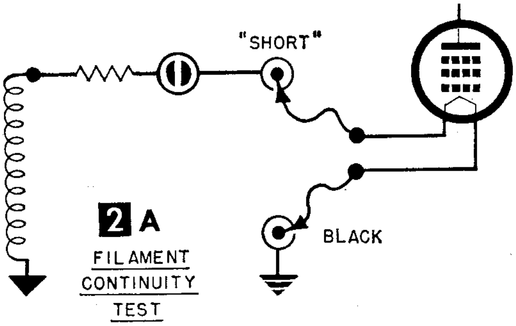
TABLE A

EMISSION CURRENT AND TEST VOLTAGE OF REPRESENTATIVE TUBES

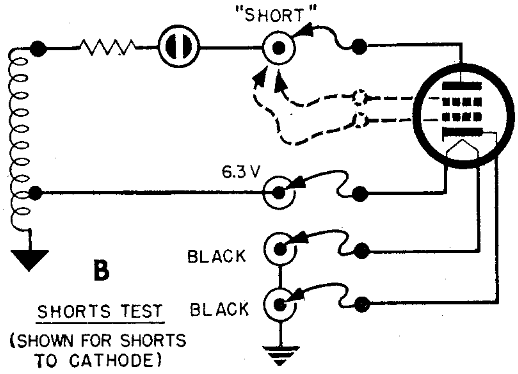
For other tubes, refer to tube manual. Similarity for emission test can be judged from maximum dissipation, maximum plate current and voltage or max. cathode current.

(For dual tubes, the figures refer to each section separately with the other section *unconnected*.)

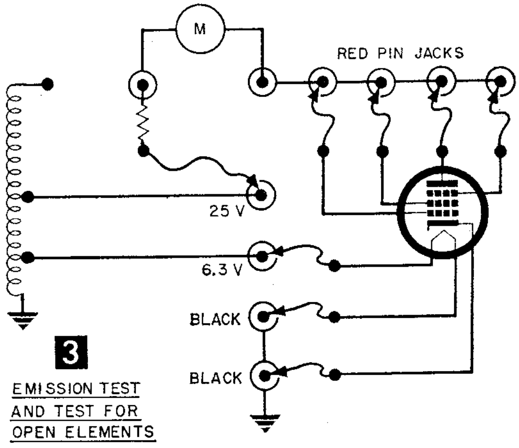
Type	Test Voltage	Current (ma)
5U4G	70	180
5Y3	70	60
5Y4	70	65
5Z3	70	70
6AG5	25	65
6AH6	12	70
6AK5	25	65
6AL5	12	50
6AQ5	35	80
6AU6	12	60
6BA6	12	40
6BC5	12	70
6C4	25	65
6J6	25	40
6L6	50	200
6SL7	25	50
6SN7	25	75
6V6	35	90
6X4	50	100
6X5	50	90
12AU7	25	75
12AX7	25	50
12SN7	25	80
25L6	35	160
25Z5	35	150
25Z6	35	140
35L6	25	140
35W4	25	140
35Z5	25	140
50B5	35	160
50C5	35	140
50L6	25	180



2A FILAMENT CONTINUITY TEST

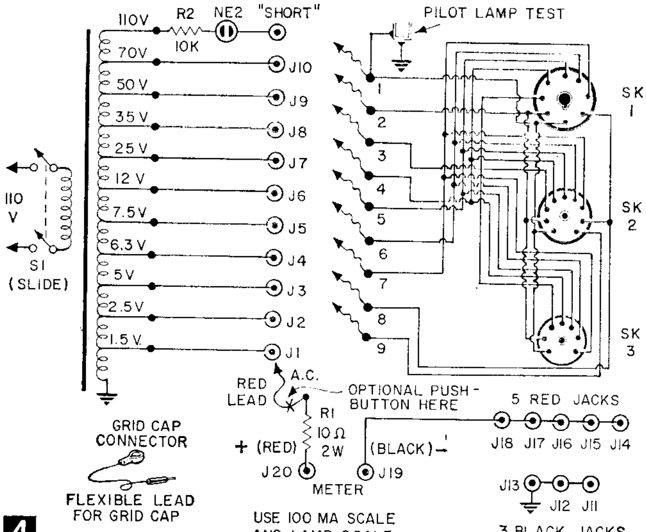


B SHORTS TEST (SHOWN FOR SHORTS TO CATHODE)



3 EMISSION TEST AND TEST FOR OPEN ELEMENTS

Plug in the adapter unit, but do not yet turn it on. Find the base connections of the tube you wish to check from a tube manual. (Electronic supply stores have good tube manuals available for from 25¢ to 75¢.) Plug one of the filament terminals into a black pin-jack, the other into the appropriate voltage jack. For split filament tubes, use the entire filament. For example a 12AX7 can be used on 6.3 and 12.6 *v*, but in this case you would use the 12.6-*v* tap and apply it to either pin #4 or pin #5, with the other one connected to the ground jack. Next, determine what the cathode is. On 7-pin miniature tubes, for ex-



4 SCHEMATIC

ample, it will usually be either pin #2 or #7. Plug it into a black pin-jack. If the suppressor grid is internally tied to the cathode, ignore its pin # lead. If it isn't, plug it into a red jack.

Now plug all the remaining element leads which are appropriate into red jacks. Of course on a 7-pin tube you will have two unused leads. If a tube socket has no connection to, say, pin #6, this lead will not be used. Hang the leads away from the box, in case there is an internal connection in the tube.

Insert the meter prods, and make sure the meter is at least on the 100-*ma* range. Observe meter polarity. (Note that so far we have done nothing with the red lead which supplied *ac* to the red jacks.) Turn the unit on, and let the tube warm up for about a minute. Then select the proper *ac* voltage and plug in the red tip to that particular jack. In table A, a representative group of tube types are listed, together with the voltage which should be used to test them and the current the meter should read for a good tube. Tubes which belong to the same family can be found in your tube manual. For example a 12AY7 is tested with the same voltages as a 12AU7, draws a bit more current.

As soon as you plug in the red lead, read the meter and unplug it again. Don't leave the red lead connected any longer than necessary. If you don't want to plug and unplug a hot lead, build in a normally open "test" pushbutton so that this lead can be plugged in ahead of time and pushed *on* as needed.

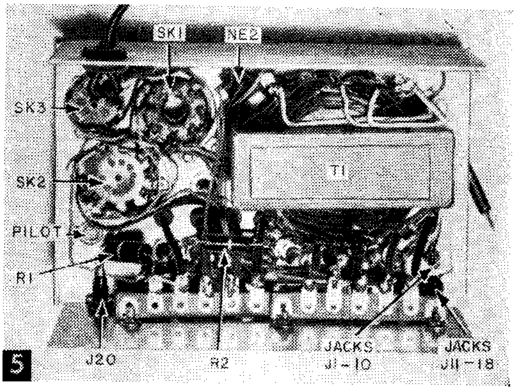
If the tube reads the approximate current listed in Table A, or a value you calculate must be about right from similar tube listings, it passes the emission test. If it reads only 60% of these values, the tube is doubtful. If it reads only 50%, reject the tube.

Construction. Front panel layout is shown in Fig. 1; internal construction in Fig. 5. The flexible leads are anchored on the tie-point strips, so they won't pull out. You *could* solder them directly to one of the tube sockets, but then they must be made longer. There is nothing critical about the layout, just make sure the leads are long enough to reach all of the jacks. A bayonet type socket is included for testing pilot lamps. If you expect to check other types of tubes, with different bases, there is nothing to keep you from including as many different kinds as are available—simply use a larger box.

The shorts and filament continuity tests have not been discussed in detail, but once you know how to set up a tube for the emission check, it is obvious from Figs. 2A and B what must be done for the others. Simply plug in the appropriate leads, one at a time on the shorts test. Don't be alarmed if the neon tube glows slightly when you test the cathode to filament short (which is done by simply plugging the cathode lead in the "short" jack). There is always some leakage between cathode and filament, and only if the tube lights up brightly should the tube be rejected.

MATERIALS LIST—ADAPTER UNIT

No. Req'd	Description
1	transformer (T1) Stancor P-1834-3—tube checker transformer (or equivalent)
1	octal socket
1	7-pin miniature socket
1	9-pin miniature socket
21	phone-tip jacks
10	phone tips
1	resistor, (R1) 10 ohms, 2 watts
1	resistor, (R2) 10,000 ohms, ½ watt
1	pilot lamp socket, bayonet type
1	NE2 neon lamp
1	DPST slide switch (S1)
1	grip-cap connector
3 ft	extra flexible test lead
2	5-point tie-point strips
1	3 x 4 x 6" box
	hardware, wire and solder, decals
1	pushbutton switch for "Test" (optional)



5 Under-chassis view of adapter unit.

One-String Electric Guitar

How one string and an earphone make music for you

BY ART TRAUFFER

MELLOW, rich and vibrant are the tones produced by this experimental unit. It can be built in an evening, and will play notes ranging through 1½ octaves.

Ordinarily, the magnets in an earphone cause the diaphragm to vibrate, making sound. This instrument uses the same principle in reverse: when the steel string (Fig. 1) vibrates, voltage induced in the coils produces a musical tone when fed through an amplifier. You can plug the unit into the phono jack of a radio, TV set, phono amplifier or tape recorder, and when you move the sliding block (Fig. 2), the pitch of the note varies as you pluck the string.

1

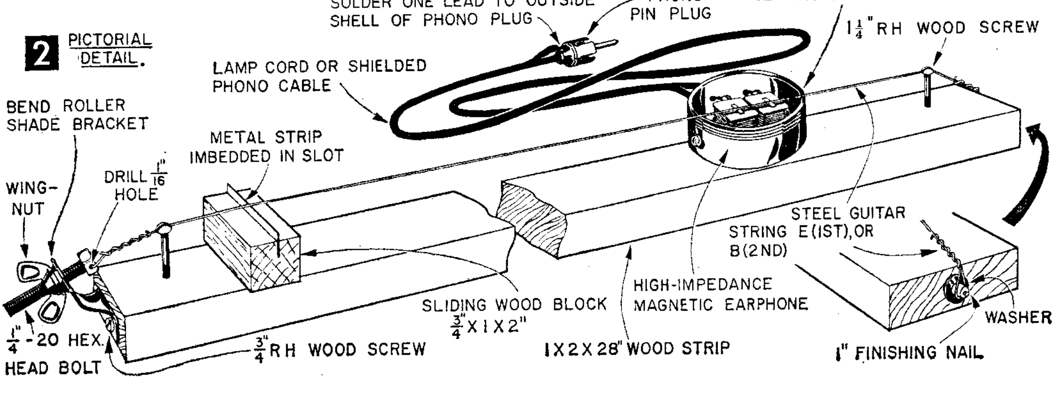
Connect the one string electric guitar to the phono plug of your amplifier, radio, TV set, or tape recorder. Be sure that your set is properly grounded for safety.

Cut a piece of straight 1 x 2-in. lumber about 28-in. long. Sand it perfectly smooth (the block must slide easily), and then give it two coats of varnish or shellac. About 1 in. from each end center the 1¼-in. long rh wood screws. These screws allow for height adjustment and their slots support the string above the board.

You can use either a "B" or "E" steel string. Obtainable in any music store, these strings are the two highest pitched strings on a standard 6-string guitar. Usually they are supplied with a loop or factory made collar at one end. Fasten this to one end of the board, with the nail and washer assembly shown in Fig. 2.

The tie post which holds the other end of the string is made of a roller window shade mounting bracket. Drill the center hole out to ¼ in., bend the bracket as in Fig. 2, and

2 PICTORIAL DETAIL.



MATERIALS LIST—"ONE-STRING ELECTRONIC GUITAR"

Amt.	Description
1	1 x 2 x 28" hardwood strip
1	1 x ¾ x 2" wood block
1	metal strip ½ by 2"
2	1¼" x 8 rh wood screws
2	¾" x 5 rh wood screws
1	¼–20 wing-nut
1	¼ x 20 x 1" brass bolt, hex-head
1	roller-shade bracket
1	1" finishing nail, or fh nail
1	⅜" dia. washer
1	high-impedance magnetic earphone (1,000—2,000 ohm, higher ohmage preferred)
5 ft	lamp cord, or shielded phono or mike cable
1	phono pin plug
1	Gibson steel guitar string (E or B)

mount it on the end of the board with two ¾-in. rh wood screws. Now drill a 1⁄16-in. hole for the string through the head of a ¼-20 x 1-in. hex-head screw.

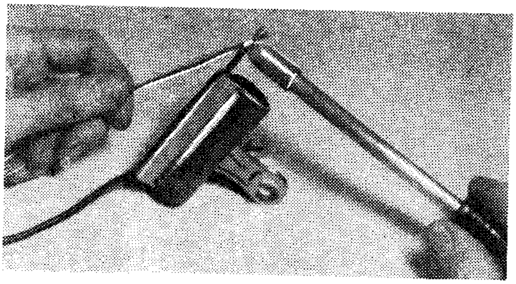
The pickup is made of a discarded earphone of high impedance, between 1,000 and 2,000 ohms dc resistance, and with magnet coils in good working condition. Remove the outside screw cap and the metal diaphragm disc. Then cement, or screw the phone onto the wood board about 5-in. from one end. If your earphone has cord terminals on the back side, you may have to cut grooves in the board for the cord. This connecting cord can be made of ordinary lamp cord, with a phono-pin plug soldered at one end. However, if you find later that there is objectionable hum pickup, you may have to substitute shielded phono or mike cable.

Make the sliding wood block 1 in. wide by ¾ in. high and about 2 in. long. With a thin-bladed hacksaw, cut the slot in the top to accept a thin strip of sheet metal.

Stretch the strings over the heads of the supporting screws, thread the end through the hole and twist the end securely. Turn the wing nut slowly until the string is taut enough to produce a medium pitch. For best results the space between the string and the tops of the magnets should be as small as possible, but not so the string hits the phone when it is plucked. Plug the phono tip into the jack of your hi-fi amplifier, a radio, TV or recorder. The instrument is now ready to play.

Safety note. In most types of ac-dc radios (having no power transformer), the chassis is hot and hence, if the power is not polarized, the string of the instrument could also be "hot," and serious electrical shock could result. Be cautious about using this instrument on, or near damp floors, or near radiators, etc., and if in doubt, have your phono input jacks checked for safety by a radio serviceman.

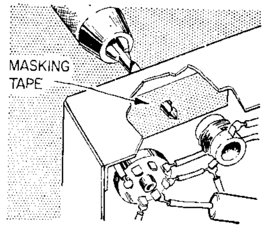
How It Works. In theory, this one-string "guitar" works like a musician's electric guitar with magnetic pickup. When the steel guitar string vibrates in the magnetic field of the earphone pole pieces, the string cuts the lines of force between the poles and induces a small e.m.f. (electromotive force) in the coils. This e.m.f. is amplified by an audio amplifier, or by the audio section of a radio or TV, and then reproduced by a loudspeaker. The tone you hear depends on the rate of vibration of the string. A 1000 c.p.s. tone means that the string is vibrating 1000 times per second. The amplitude of the tone depends on the strength of the strings vibration, the gain of the audio amplifier, and on the spacing between the string and the magnets.



Clamp Holds Wire for Soldering

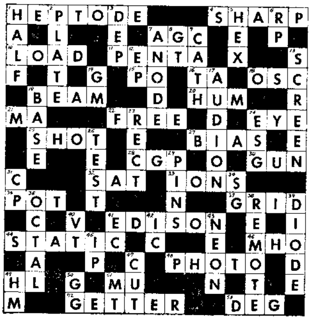
• When tinning the tips of electric wires and soldering on lugs, use a large paper clamp to hold the wire still and keep it from rolling while you touch the iron and solder to the wire's tip.—John A. Comstock.

Drilling Chassis Holes

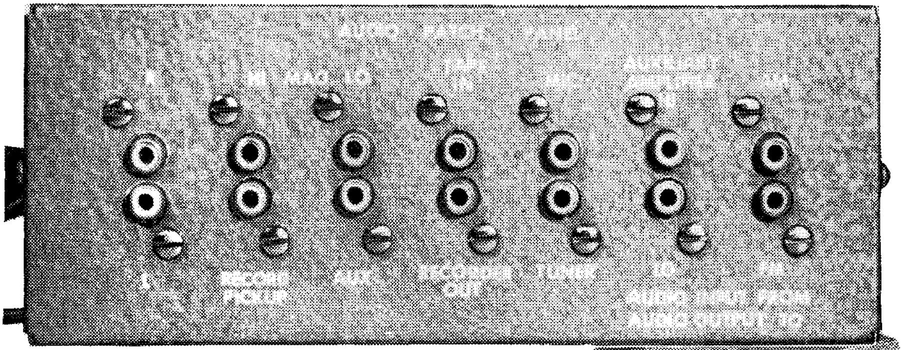


• When drilling holes in the metal chassis of electronics gear, there's a good possibility that some of the metal chips will fall between contact points on the underside of the chassis and cause a short circuit. To prevent this, apply a wide strip of masking tape to the underside of chassis where the drill will come through, to catch and hold the chips. Once the hole has been drilled, remove the tape, being especially careful not to spill the metal chips.

SOLUTION TO ELECTRON TUBE ANAGRAM Page 130



H	E	P	T	O	D	E	■	■	■	S	H	A	R	P
A	■	L	■	■	E	■	A	G	C	■	E	■	P	■
L	O	A	D	■	P	E	N	T	A	■	X	■	■	S
F	■	T	■	G	■	P	O	■	T	A	■	O	S	C
■	B	E	A	M	■	■	D	■	H	U	M	■	■	R
M	A	■	■	■	F	R	E	E	■	D	■	E	Y	E
■	S	H	O	T	■	E	■	■	B	I	A	S	■	E
■	E	■	■	E	■	C	G	P	■	O	■	G	U	N
C	■	■	■	S	A	T	■	I	O	N	S	■	■	■
P	O	T	■	T	■	■	■	N	■	■	G	R	I	D
■	C	■	V	■	E	D	I	S	O	N	■	E	■	I
S	T	A	T	I	C	■	C	■	■	E	■	M	H	O
■	A	■	■	P	■	C	■	P	H	O	T	O	■	D
H	L	■	G	■	M	U	■	■	■	N	■	T	■	E
M	■	■	G	E	T	T	E	R	■	■	D	E	G	■



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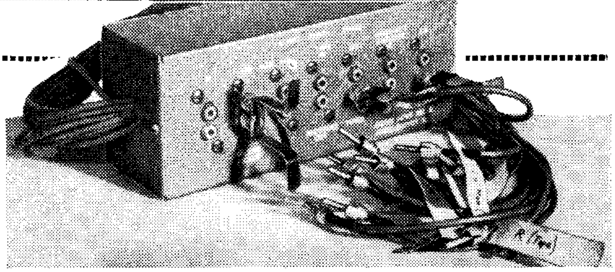


The far-flung connections made by the connectors in the foreground of the photo at right are all brought into one plane for easy handling in the patch-panel. A patch plug and patch cord are shown plugged in to connect inputs of one unit to outputs of others. On the chassis, lettering stands for: R and L, stereo head; HI and LO MAG., AUX, TAPE IN, MIC., and TUNER, terminations found on rear panel of a DB-110 amplifier; AM and FM are tuner outputs, as is RECORDER OUT; RECORD PICKUP jack connects to monaural disc head; AUXILIARY AMPLIFIER, HI and LO refer to inputs of a second amplifier for stereo; AUDIO INPUT FROM and AUDIO OUTPUT TO refer to color coding that simplifies making connections.

Audio Patch-Panel

Build this $10 version of a broadcast station patchboard to broaden the use of your hi-fi components

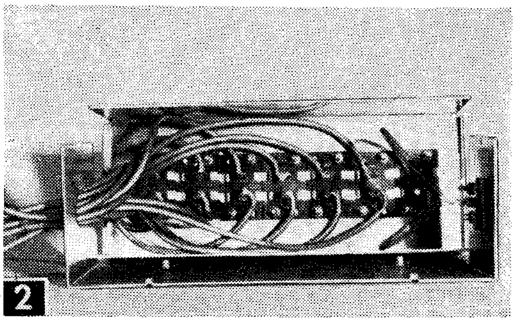
BY DON SCHROEDER

EASY to wire in an evening, this audio patch panel will enable you to set up practically any combination of audio components without delay, and without fumbling for matched cords and connectors.

For many years, audio engineers have used patchboards to quickly connect combinations of equipment in broadcast stations, recording studios, and theatres. These panels offer not only convenience, but a complete variety of possible combinations. But the broadcaster has a great advantage over the hi-fi enthusiast in that most of his lines are low impedance and thus less vulnerable to screaming or hum.

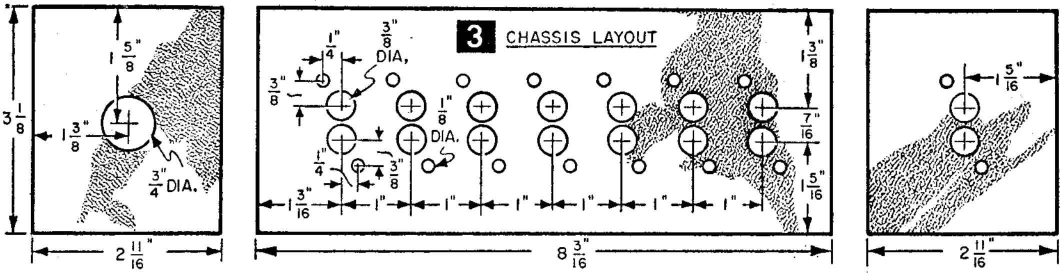
This article describes an easily assembled high-impedance patch panel that will greatly facilitate the connection changes required for straight play-back of records, dubbing discs onto tapes, or any other connection it might be desirable to make. With it, all inputs become accessible in one location, eliminating the need to pull amplifiers off shelves or out of cabinets to get access to rear or underside terminals. It also simplifies the adapter fitting problem that plagues most audiophiles because all changes are made with RCA type plugs.

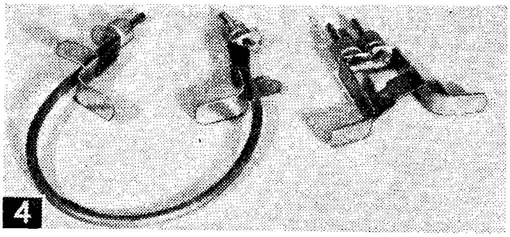
Construction. The patch panel shown in Fig. 1 was designed for use with a Bogen DB-110 amplifier. It therefore includes all those jacks that are present on the back of that model amplifier. It will probably be necessary to change these to suit your particular amplifier. The important thing to bear in



2

Interior wiring is not difficult and is further simplified by the use of double jacks. All shields are grounded in the box but only one is grounded at the plugs going to any one unit, to avoid ground loops and hum. Two pairs of jacks are connected together at the right. These take care of the tuners which usually come equipped with an output cord.


3 CHASSIS LAYOUT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Two plugs are soldered together to make the patch cord (left), the inner connectors being joined with shielded wire. Note that only the right plug connects to the shield on the patch cord, the other end being insulated with tape to prevent ground loops. At right, patch plug.

MATERIALS LIST—PATCH PANEL

No. Reqd.	Description
10	Handi-Grip pin plugs, solder type BA #12A904. Mfg. by Workman TV
8	Double pin jack, BA #12A676, Mfg. by H. H. Smith, #1214
50 ft.	microphone cable, Belden 8411, BA #2A102
1	gray aluminum box, 8 x 3 x 2¾", BA #20A501, LMB #137
16	binder head screws and nuts 6-32 x ⅜", BA #19B863 and 19A1014
	connectors to match inputs and outputs of existing components in system.

Suppliers parts numbers above are for Burstein-Applebee, 1012 McGee St., Kansas City, Mo.

mind is to keep those combinations most likely to be in constant use above and below each other. For instance, the magnetic input will most often be connected to the magnetic cartridge. Therefore those jacks representing magnetic input and magnetic cartridge should be vertically aligned. The same is true of a tape input and a tape output.

Double jacks are used to keep hole drilling to a minimum, two less mounting screws being necessary. Handi-Grip plugs were used on the patch cords to make plugging easier. Several of these plugs were soldered directly together to provide easy vertical patching.

Between patch and interconnecting cords a considerable amount of shielded wire stripping is required. For this I usually use a dull knife, a scriber, soldering aid, or nut pick, and a pair of scissors. Cut a ring around the outer jacket about 1 in. from the end and pull the piece of jacket off the wire. Now unravel the shield, pull the strands to one side, and twist them together. Where no termination is to be made to the shield, fan the wires and cut them off. Then wrap with two turns of any kind of tape. With as little pressure as possible cut a circle in the inner plastic insulation—no closer than ⅛ in. to the earlier cut—and pull the plastic off the end. It is now possible to unravel the protective threads. Bend the inner wires to one side. Then, gripping all the threads, cut them off at the plastic.

Often in the course of soldering, an excess of heat melts the plastic insulation. Skill is the most effective means of avoiding this but a clean, thoroughly tinned and heated soldering iron is a great help. If you use a soldering gun, trigger it and allow it to get hot enough to melt solder before touching it to the wire. Simultaneously touching tip, wire, and solder together allows the rosin to run on the wire, giving maximum flux when it is needed. High heat, rapidly applied and quickly removed, does far less damage than prolonged heating at subsoldering temperature.

To minimize the danger of hum from ground loops, shields were connected only at one plug of all patch cords, the other end being carefully insulated with a piece of plastic tape. The same was true of lines running to the units when more than one line ran to the same unit. Only one of the wires going to the amplifier is grounded at both ends. Again these lines were carefully insulated with plastic tape against accidental grounding.

Generally a good rule of thumb with high-impedance lines is that they should not exceed 20 ft. in length. Actually, the shorter the better. If your equipment is spread around the walls of the room it might be wise to regroup it to keep line lengths to a minimum. Should hum occur it can sometimes be relieved by use of the larger Belden #8401 shielded wire in place of the smaller Belden #8411 specified in the Materials List.

Aside from the care required in grounding, construction is straightforward and no difficulty should be encountered. "Audio" Teknicals were used to put the finishing touch on the unit These are applied like any decal, wetting the surface to ease positioning. Careful blotting with a dry rag sets them in position. After at least 12 hours drying time the decal can be permanently attached by a very light brushing with clear "Cutex" nail polish.

If you have been having a battle keeping track of your audio terminations, try this unit. It pays big dividends in frustration reduction.

Portable Radio-Phonograph

Here's a transistorized radio and phonograph turntable that operates off batteries. You can take it, and use it, anywhere

By HOMER L. DAVIDSON

Belting and catch on case are available in dime stores.

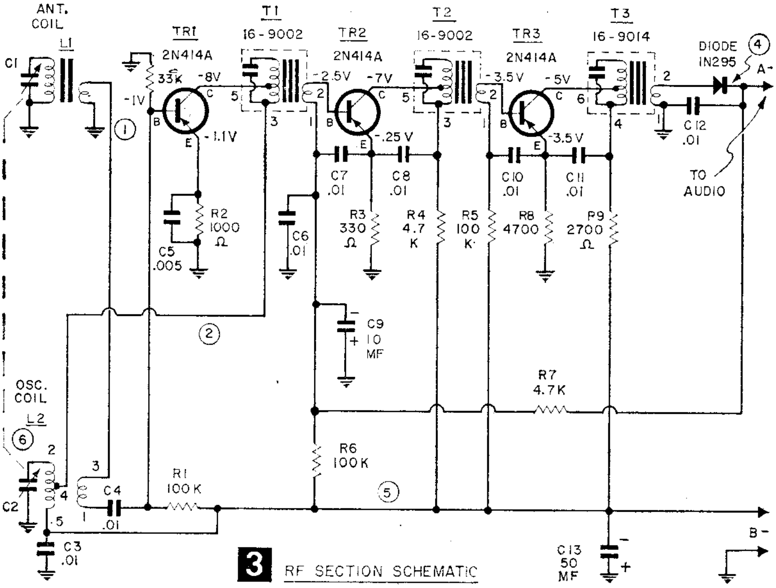
In the home, on the beach, in the air, overseas—wherever you happen to be or go, this radio-phono combination can go with you.

THE RF section of the radio circuit of this portable consists of three RF transistors and a fixed diode rectifier (see Fig. 3). Transistor TR1 is the oscillator mixer stage, TR2 and TR3 are IF amplifiers. The intermediate frequency is 445 kilocycles. This IF signal is rectified to audio frequency by the fixed crystal diode.

A 3 x 11-in. printed circuit board is used as a subchassis for the RF and audio circuit (see Fig. 5 for RF section

MATERIALS LIST—PORTABLE RADIO-PHONOGRAPH

Desig.	Description	Desig.	Description
		RF SECTION	
C1, C2	variable capacitor, RF section 6.3 to 123.1 mmfd; osc. section 5.7 to 78.2 mfd—Lafayette M5261	R3	330 ohm, ½ watt resistor
		R4, R7, R8	4.7k ohm, ½ watt resistor
		R9	2700 ohm, ½ watt resistor
C3, C4, C6, C7, C8 C10, C11, C12	.01 mfd disc capacitors	R10	33k ohm, ½ watt resistor
		L1	ant. loop, 700 mh (Lafayette MS-264)
C5	.005 mfd disc capacitor	L2	osc. coil (Lafayette MS-265 or equiv.)
C8	10 mfd 25 v elec. capacitor	T1, T2	Meisner 16-9002 455 kc IF transformer
C13	50 mfd 25 v elec. capacitor	T3	Meisner 16-9014 455 kc output IF transformer
R1, R5, R6	100k ohm, ½ watt resistor	TR1, TR2, TR3	Raytheon 2N414A transistors (PNP)
R2	1000 ohm, ½ watt resistor	diode	Raytheon 1N295 fixed diode
		AUDIO SECTION	
C14	8 mfd 25 v electrolytic capacitor	T5	AR119 Argonne output transformer PRI 500 ohm C. T.; sec. 3.2 ohm
C15	.05 mfd 200 v paper capacitor		
R10	10k volume control, with sw	SW1	SPST switch on rear of R10
R11	470k ohm, ½ watt resistor	Batteries	9-volt (Eveready #276 or equiv.)
R12	12k ohm, ½ watt resistor	Spk. jack	standard female phono jack
R13	3000 ohm, ½ watt resistor	1	pickup arm and crystal (PK-89 phono arm and cartridge, Lafayette)
R14	68 ohm, ½ watt resistor		
R15, R16	10 ohm, ½ watt resistor	1	6-volt phono motor, 45 rpm, 33⅓, 16 rpm (Lafayette)
TR4	2N107 GE transistor (PNP)		
TR5, TR6	2N188 GE transistor (PNP)	SW2	rotating DPDT switch
T4	AR109 Argonne transformer driver PRI 10,000 ohm; sec. 2000 C.T.	1	6-volt battery (Eveready #409 or equiv.)
		PRINTED CIRCUIT	
1 pt.	PE-5 liquid etchant	1	PRLT ball point pen
1	XXXP copper laminated board (3 x 11″ cut from 12″ piece)	1 roll	tape resist

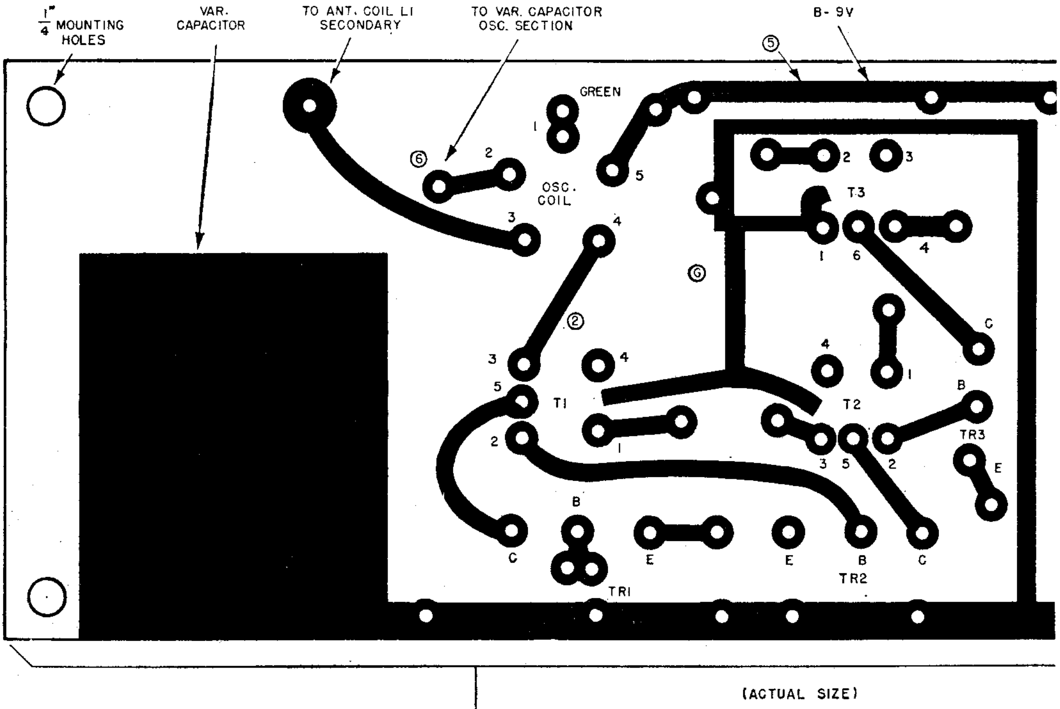


3 RF SECTION SCHEMATIC

and Fig. 6 for audio section portions of the PC board). The audio circuit consists of an audio amplifier with a volume control in the base circuit of TR4. The last two audio stages are operated push-pull for greater amplification. This little portable has two 5 x 7-in. PM speakers in the output and pulls only 10 *ma* with full volume. A 6-*v* phono-motor is switched into the phonograph circuit, with a separate battery for this circuit since the radio operates off 9 *v*.

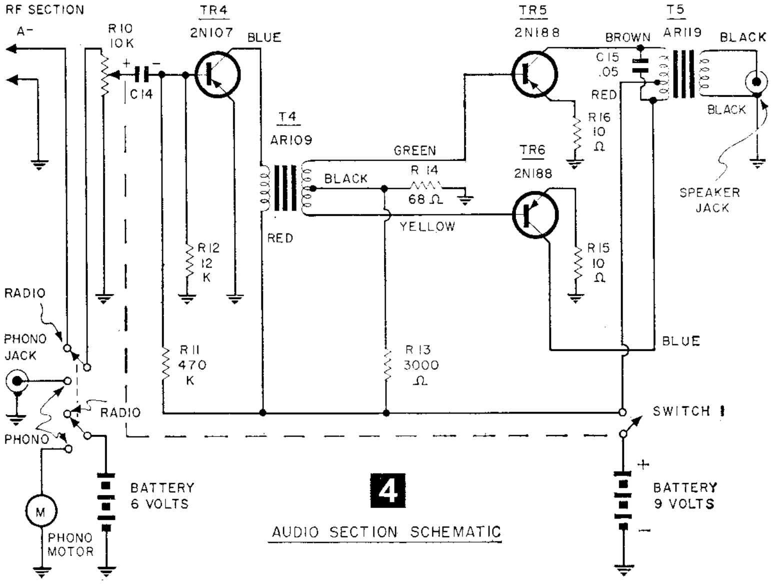
Printed Circuit. Wash the copper side of the PC board with soap and water, and then trace on it the RF and audio circuits through carbon paper. Unroll resist tape and apply, using a sharp pocket knife to cut all corners. Dots can be made with a ball-point resist paint by simply pressing down on the ball point of the pen.

When the circuits have been completely laid out on the printed board, pour enough etching solution into a tray to sufficiently cover the board. The solution should be agitated or rocked back and forth to quicken the etching process. It will take about one hour to complete the process. Wash the finished board in cold-running water, wash out the etching tray or dish, and pour the remaining solution back into the bottle. It can be used again. Remove the tape



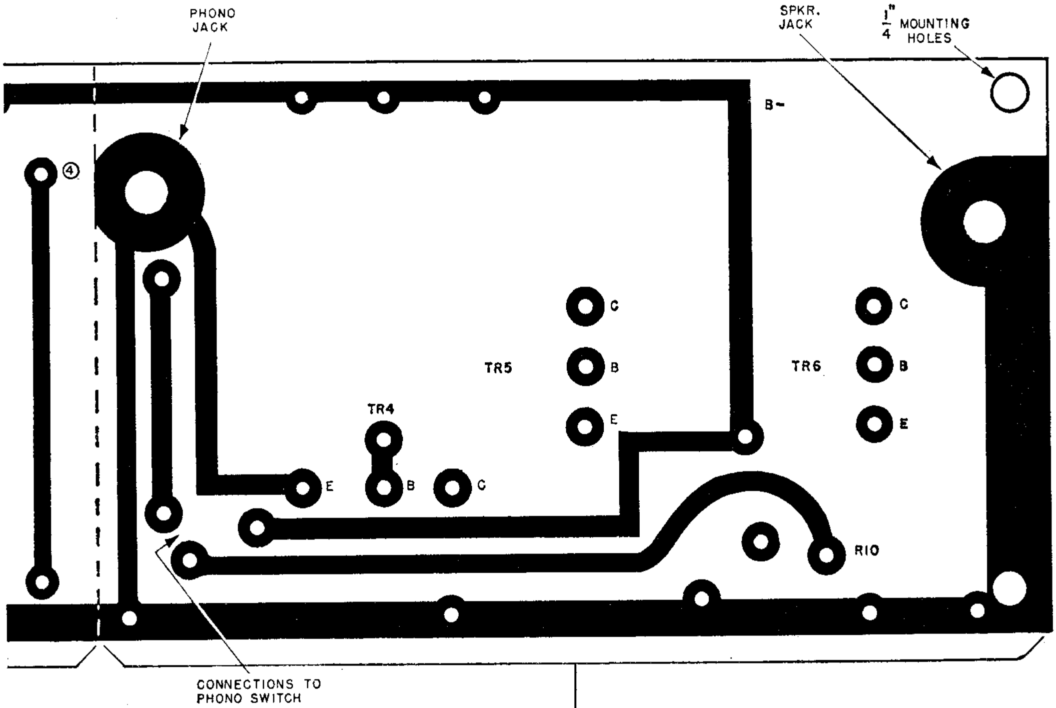
5 RF SECTION P.C. (SEE FIG. 3)

and pen resist paint. Now drill all holes in the printed circuit board before mounting any parts. A very small drill should be used for all small parts such as resistor, capacitors, and transistor wires. The phono and speaker jacks take ⅜-in. dia. holes. At the two ends of the printed circuit board drill ¼-in. holes for mounting the PC board on the wooden cabinet.

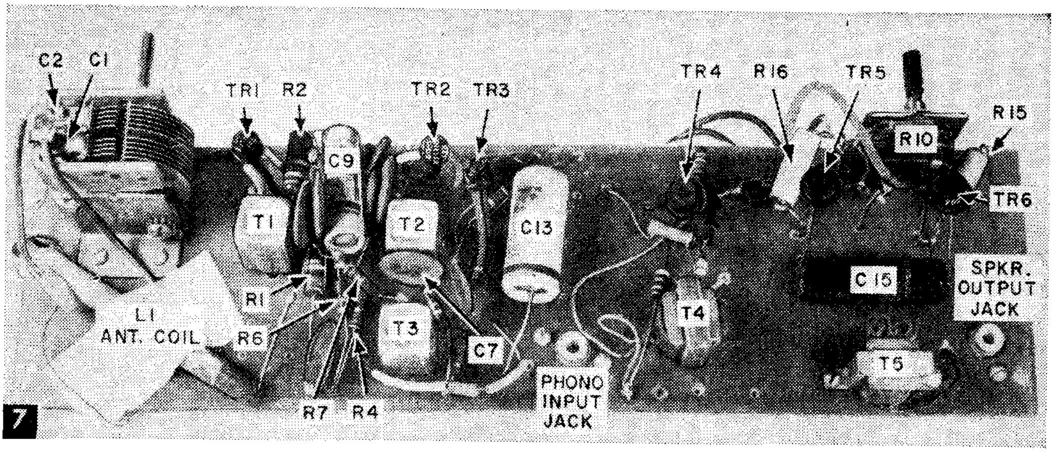


4 AUDIO SECTION SCHEMATIC

Mounting Components. All the small parts are mounted as they are wired into the circuit. Wait until the last thing to solder the transistors into the circuit so that excessive heat on a given point will not ruin them. The variable capacitor and volume control are bolted to the printed chassis, as are the phono and speaker jacks. The small antenna is temporarily taped to the printed board while alignment and mounting is done (see Fig. 7). If you have a signal generator, you already know how to do the IF and RF receiver alignment. (See "How To Align Superhet Circuits," p. 66, *Radia-TV Experimenter,* No. 559, 75¢ from *Science and Mechanics,* 450 East Ohio Street, Chicago 11, Ill.) If not, the local radio and television shop can easily do a professional job of alignment of the small portable receiver.



6 AUDIO SECTION P.C (SEE FIG. 4)



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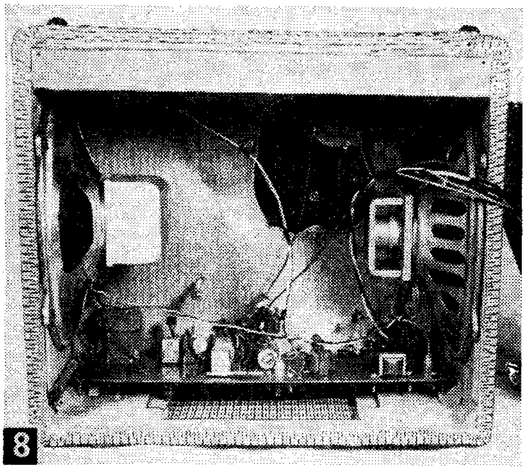
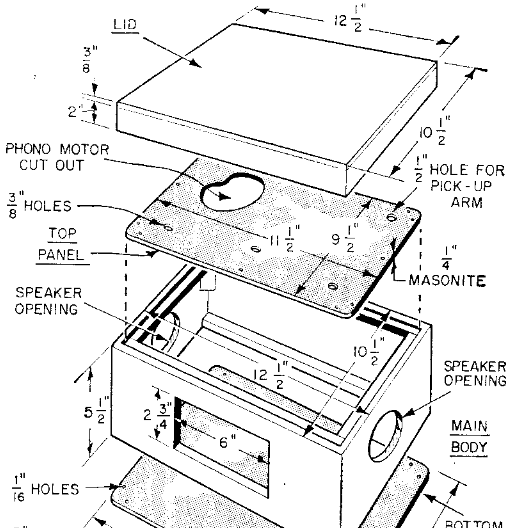
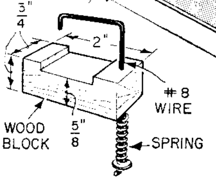


8

Looking up into cabinet. Speakers mount at opposite ends of case.





9 PHONO ARM HOLDER

10 CABINET CONSTRUCTION

Test the audio portion of the printed circuit board first. Do all alignment and testing of the chassis before it is mounted in the cabinet. Turn the switch on and the volume up half-way, and plug the crystal pickup arm into the audio phono jack. A noise should be heard. Rub your finger over the needle and a scratchy sound will be audible. The radio portion can be checked by simply turning the switch to the radio position, and aligning first the IF stages with a signal generator, then the RF section.

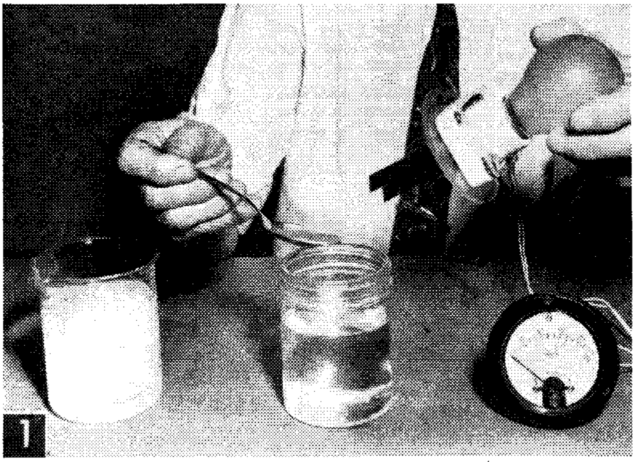
Cabinet Construction. After the receiver and phonograph printed circuit board has been thoroughly tested it is ready to be mounted into the cabinet. The cabinet can be made from 3/8-in. plywood. If you already have a case, be sure it is large enough to take both chassis and speakers.

The speakers mount at the ends of the cabinet (see Fig. 8). A piece of 1/4-in. Masonite was cut and drilled for the top panel to hold the record player and phono pickup arm, and another piece of 1/4-in. Masonite was cut and drilled for the bottom, as in Fig. 10.

Cover the cabinet with plastic grille cloth, stapling it to the case. Apply glue around the speaker holes before stapling. Both Masonite panels and the top phono-lid were sprayed with red enamel paint.

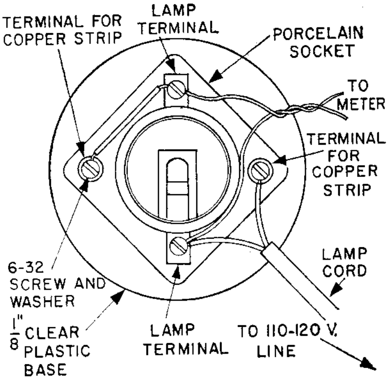
The small batteries were bracketed to the bottom Masonite panel. A small wooden block and No. 8 wire form a holder (see Fig. 9) to secure the phono arm to the cabinet when transporting this portable.

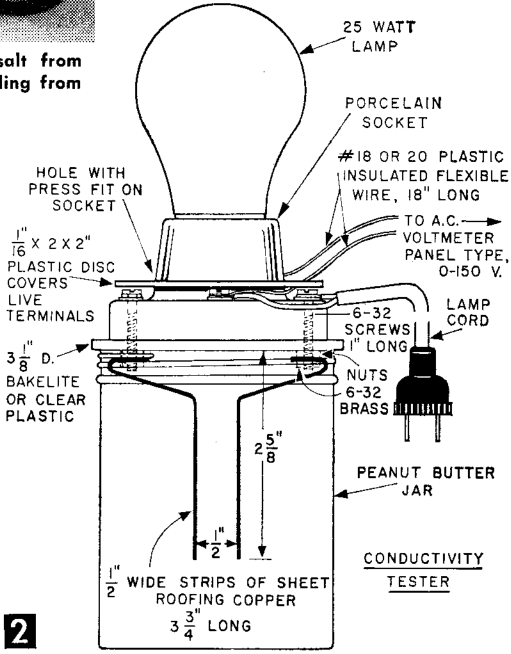
Measuring the Conductivity of Liquids



1

Adding a teaspoonful of saturated solution common salt from beaker at left to test jar of water, upped voltmeter reading from 10 to 112.





2

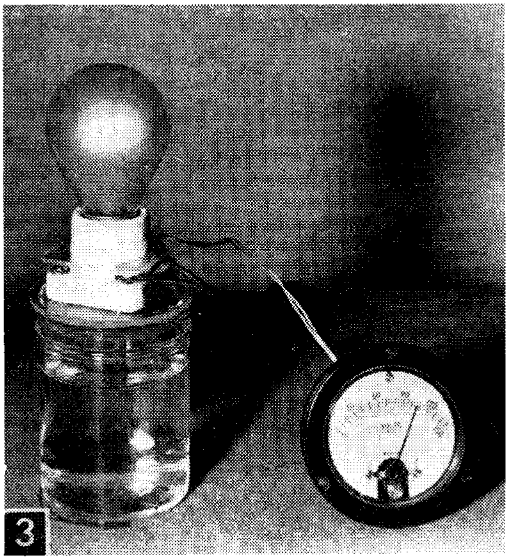
CONDUCTIVITY TESTER

SOME liquids conduct electricity better than others. You can test this fact with the setup shown in Fig. 2. Two strips of sheet copper secured to the underside of a plastic disc are immersed in the liquid to be tested. A meter connected across the lamp terminals indicates voltage applied to the lamp.

With this setup, we found, for example, that the voltmeter registered 10 volts with pure water in the peanut butter jar. We then added one teaspoonful of a saturated solution of common salt to the pure water (Fig. 1). The voltmeter reading jumped up to 112 volts, and the lamp burned brightly. No wonder medical technicians use salt-soaked pads when attaching various types of electrical equipment to the body!

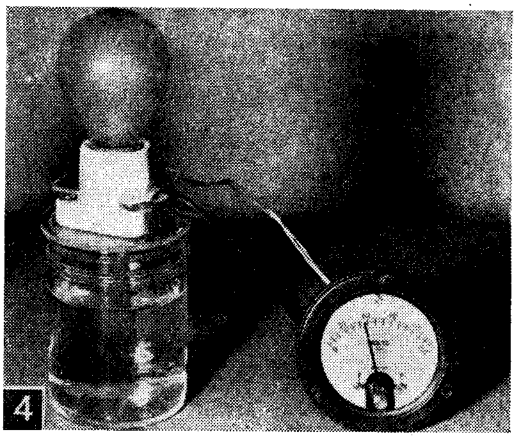
Figure 3 shows an experiment using a teaspoonful of bicarbonate of soda from a saturated solution placed in a fresh jar of water. Here the voltmeter registers 108 volts, as against 112 for salt.

Figure 4 shows how a teaspoon of vinegar results in 58 volts to the lamp, indicating conductivity better than water but not nearly



3

Teaspoonful of saturated bicarbonate of soda resulted in a lighted lamp and 108-volt reading.



4

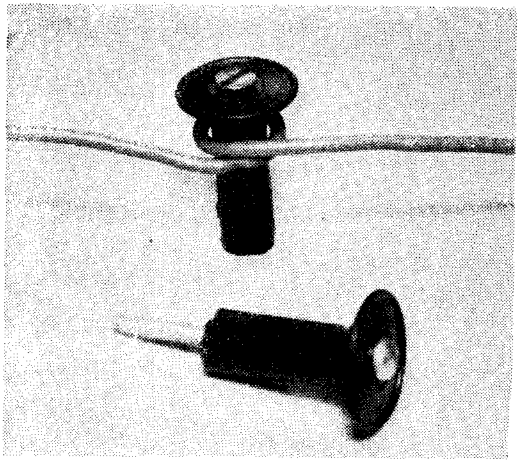
Teaspoonful of vinegar produced reading of 58 volts.

so high as either salt or soda.

For accurate comparisons, use the same quantity of each additive, e.g. a teaspoonful. You'll find salammoniac (ammonium chloride) similar to salt in conductivity. A few drops of dilute sulphuric acid (battery acid) will show a surprising degree of added conductivity to water.

Caution: Do not try any but aqua solutions—an inflammable liquid could easily be touched off in contact with the copper electrodes. Also, don't leave your test setup plugged in, or out where youngsters can poke around its live terminals under the plastic guard ring.—HAROLD P. STRAND.

Film Spools As Wire Stand-Offs



• Those plastic spools that 120 film comes wound around can be made into low-loss, no-cost stand-off insulators for wires such as radio lead-in. Cut the spool in half, drill a hole through the inside and insert a long wood-screw. Wrap one turn of the wire around the insulator near the flange as shown.

WHITE'S RADIO LOG

An up-to-date broadcasting directory
AM, FM, TV and Short-Wave Stations

Vol. 37
No. 2

QUICK REFERENCE INDEX

U. S. and Canadian AM Stations by Frequency

U.S. stations listed alphabetically by states within groups, Canadian stations precede U.S.
Abbreviations: Kc., frequency in kilocycles; W.P., watt power; d—operates daytime only. Wave length is given in meters

Kc. Wave Length	*W.P.*
540—555.5	
CBK Regina, Sask.	50000
KVIP Redding, Calif.	1000d
KFMB San Diego, Calif.	5000
WGTO Cypress Gardens, Florida	50000d
WDAK Columbus, Ga.	5000
KBRV Soda Springs, Idaho	500d
KWMT Ft. Dodge, Iowa	1000d
WDMV Pocomoke City, Md.	500d
WBIC Islip, N.Y.	250d
WCNG Canonsburg, Pa.	250d
WDXN Clarksville, Tenn.	250d
WRIC Richlands, Va.	1000d
550—545.1	
CFNB Fredericton, N.B.	50000
CFBR Sudbury, Ont.	1000
CHLN Three Rivers, Que.	5000
CKPG Prince George, B.C.	250
KENI Anchorage, Alaska	5000
KOY Phoenix, Ariz.	5000
KAFY Bakersfield, Calif.	1000
KRAI Craig, Colo.	1000
WGGA Gainesville, Ga.	5000
KMVI Wailuku, Hawaii	1000
KFRM Concordia, Kansas	5000d
WCBI Columbus, Miss.	1000
KSD St. Louis, Mo.	5000
KOPR Butte, Mont.	1000
WGR Buffalo, N.Y.	5000
WDBM Statesville, N.C.	500d
KFYR Bismarck, N.Dak.	5000
WKRC Cincinnati, Ohio	5000
KOAC Corvallis, Oreg.	5000
WHLM Bloomsburg, Pa.	500
WPAB Ponce, P.R.	5000
WPAW Pawtucket, R.I.	1000d
KCRS Midland, Tex.	5000
KTSA San Antonio, Tex.	5000
WDEV Waterbury, Vt.	5000
WSVA Harrisonburg, Va.	5000
WSAU Wausau, Wis.	5000
560—535.4	
CFRA Ottawa, Ont.	5000
CJKL Kirkland Lake, Ont.	5000
CFOS Owen Sound, Ont.	1000
WOOF Dothan, Ala.	5000d
KYUM Yuma, Ariz.	1000
KSFO San Fran., Calif.	5000
KLZ Denver, Colo.	5000
WQAM Miami, Fla.	5000
WIND Chicago, Ill.	5000
WMIK Middlesboro, Ky.	500d
WGAN Portland, Maine	5000
WHYN Springfield, Mass.	1000
WMIC Monroe, Mich.	500d
WEBC Duluth, Minn.	5000
KWTO Springfield, Mo.	5000
KMON Great Falls, Mont.	5000
WGAI Elizabeth City, N.C.	1000
WFIL Philadelphia, Pa.	5000
WIS Columbia, S.C.	5000
WHBQ Memphis, Tenn.	5000
KFDM Beaumont, Tex.	5000
KPQ Wenatchee, Wash.	5000
WJLS Beckley, W.Va.	5000
570—526.0	
CKEK Cranbrook, B.C.	1000
CKCQ Quesnel, B.C.	1000
CJEM Edmundston, N.B.	1000
WAAX Gadsden, Ala.	5000
KCNO Alturas, Calif.	1000
KLAC Los Angeles, Calif.	5000
WGMS Washington, D.C.	50000
WACL Waycross, Ga.	5000
WKYB Paducah, Ky.	1000
WVMI Biloxi, Miss.	1000d
KGRT Las Cruces, N.Mex.	1000d
WMCA New York, N.Y.	5000
WSYR Syracuse, N.Y.	5000
WWNC Asheville, N.C.	5000
WSHE Raleigh, N.C.	500d
WKBN Youngstown, Ohio	5000
WNAX Yankton, S.Dak.	5000
WFAA Dallas, Tex.	5000
WBAP Ft. Worth, Tex.	5000
KLUB Salt Lake City, Utah	5000
KVI Seattle, Wash.	5000
WMAM Marinette, Wis.	250
580—516.9	
CJFX Antigonish, N.S.	5000
CKEY Toronto, Ont.	5000
CKPR Ft. William, Ont.	5000
CKUA Edmonton, Alta.	10000
CKY Winnipeg, Man.	50000
WABT Tuskegee, Ala.	500d
KTAN Tucson, Ariz.	5000
KMJ Fresno, Calif.	5000
KUBC Montrose, Colo.	5000
WDBO Orlando, Fla.	5000
WGAC Augusta, Ga.	5000
KFXD Nampa, Idaho	5000
WILL Urbana, Ill.	5000d
KSAC Manhattan, Kans.	5000
WIBW Topeka, Kans.	5000
KALB Alexandria, La.	5000
WTAG Worcester, Mass.	5000
WELO Tupelo, Miss.	1000
WAGR Lumberton, N.C.	500d
WHP Harrisburg, Pa.	5000
WKAQ San Juan, P.R.	5000
KOBH Hot Springs, S.Dak.	500d
WRKH Rockwood, Tenn.	1000d
KDAV Lubbock, Tex.	500d
WCHS Charleston, W.Va.	5000
WKTY LaCrosse, Wis.	5000
590—508.2	
CFAR FlinFlon, Man.	1000
CKAR Huntsville, Ont.	1000
CKRS Jonquiere, Que.	1000
VOCM St. Johns, N.F.	10000
WRAG Carrollton, Ala.	1000d
KBHS Het Springs, Ark.	5000d
KFXM San Bernardino, Cal.	1000
KCSJ Pueblo, Colo.	1000
WDLP Panama City, Fla.	1000
WPLO Atlanta, Ga.	5000
KGMB Honolulu, Hawaii	5000
KID Idaho Falls, Idaho	5000
WVLK Lexington, Ky.	5000
WEEI Boston, Mass.	5000
WKZO Kalamazoo, Mich.	5000
WOW Omaha, Nebr.	5000
WROW Albany, N.Y.	5000
WGTM Wilson, N.C.	5000
KUGN Eugene, Oreg.	5000
WARM Scranton, Pa.	5000
WMBS Uniontown, Pa.	1000
KTBC Austin, Tex.	5000
KSUB Cedar City, Utah	1000
WLVA Lynchburg, Va.	1000
KHQ Spokane, Wash.	5000
600—499.7	
CFCF Montreal, Que.	5000
CFCH North Bay, Ont.	1000
CFQC Saskatoon, Sask.	5000
CJOR Vancouver, B.C.	5000
CKCL Truro, N.S.	1000
WIRB Enterprise, Ala.	1000
KCLS Flagstaff, Ariz.	5000
KVCV Redding, Calif.	1000
KFSD San Diego, Calif.	5000
WICC Bridgeport, Conn.	1000
WPDQ Jacksonville, Fla.	5000
WMT Cedar Rapids, Iowa	5000
WYFE New Orleans, La.	1000d
WFST Caribou, Maine	5000d
WCAO Baltimore, Md.	5000
WLST Escanaba, Mich.	1000d
WTAC Flint, Mich.	1000
KGEZ Kalispell, Mont.	2000
WCVP Murphy, N.C.	1000d

WSJS Winston-Salem, N.C.	5000
KSJB Jamestown, N.D.	5000
WFRM Coudersport, Pa.	1000d
WAEL Mayaguez, P.R.	1000
WREC Memphis, Tenn.	5000
KROD El Paso, Tex.	5000
KERB Kermit, Tex.	1000d
KTBB Tyler, Tex.	1000

610—491.5

CHNC New Carlisle, Que.	5000
CJAT Trail, B.C.	1000
CKKL Thompson, Man.	1000
CKTB St. Catharines, Ont.	5000
WSGN Birmingham, Ala.	5000
KAVL Lancaster, Calif.	1000
KFRC San Francisco, Calif.	5000
WCKR Miami, Fla.	5000
WDEB Pensacola, Fla.	500d
WCEH Hawkinsville, Ga.	500d
WRUS Russellville, Ky.	500d
KDAL Duluth, Minn.	5000
WDAF Kansas City, Mo.	5000
KOJM Havre, Mont.	1000
WGIR Manchester, N.H.	5000
KGGM Albuquerque, N.Mex.	5000
WAYS Charlotte, N.C.	5000
WTVN Columbus, Ohio	5000
WIP Philadelphia, Pa.	5000
KILT Houston, Tex.	5000
KVNU Logan, Utah	1000
WSLS Roanoke, Va.	5000
KEPR Kennewick, Wash.	5000

620—483.6

CFCL Timmins, Ont.	10000
CKCK Regina, Sask.	5000
KTAR Phoenix, Ariz.	5000
KNGS Hanford, Calif.	1000
KWSD Mt. Shasta, Calif.	1000d
KSTR Grand Junction, Colo.	5000d
WSUN St. Petersburg, Fla.	5000
WTRP LaGrange, Ga.	1000d
KWAL Wallace, Idaho	1000
KMNS Sioux City, Iowa	1000
WTMT Louisville, Ky.	500d
WLBZ Bangor, Maine	5000
WJDX Jackson, Miss.	5000
WVNJ Newark, N.J.	5000
WHEN Syracuse, N.Y.	5000
WDNC Durham, N.C.	5000
KGW Portland, Oreg.	5000
WHJB Greensburg, Pa.	1000
WCAY Cayce, S.C.	500d
WATE Knoxville, Tenn.	5000
KWFT Wichita Falls, Tex.	5000
WCAX Burlington, Vt.	5000
WWNR Beckley, W.Va.	1000
WTMJ Milwaukee, Wis.	5000

630—475.9

CFCO Chatham, Ont.	1000
CHLT Sherbrooke, Que.	10000
CFCY Charlottetown, P.E.I.	5000
CJET Smith Falls, Ont.	1000
CKRC Winnipeg, Man.	5000
CKOV Kelowna, B.C.	1000
CKYL Peace River, Alta.	1000
WAVU Albertville, Ala.	1000d
WJDB Thomasville, Ala.	1000d
KJNO Juneau, Alaska	1000
KVMA Magnolia, Ark.	1000d
KIDD Monterey, Calif.	1000
KHOW Denver, Colo.	5000
WMAL Washington, D.C.	5000
WSAV Savannah, Ga.	5000
KIDO Boise, Idaho	5000
WLAP Lexington, Ky.	5000
KTIB Thibodaux, La.	500
WJMS Ironwood, Mich.	1000
KDWB So. St. Paul, Minn.	5000
KXOK St. Louis, Mo.	5000
KGVW Belgrade, Mont.	1000d
KOH Reno, Nev.	5000
KLEA Lovington, N.Mex.	500
WIRC Hickory, N.C.	1000d
WMFD Wilmington, N.C.	1000
WEJL Scranton, Pa.	500d
WPRO Providence, R.I.	5000
KGFX Pierre, S.Dak.	250
KMAC San Antonio Tex.	5000
KGDN Edmunds, Wash.	1000d
KZUN Opportunity, Wash.	500d

640—468.5

CBN St. John's, N.F.	10000
KFI Los Angeles, Calif.	50000
WOI Ames, Iowa	5000d
WHLO Akron, Ohio	1000
WNAD Norman, Okla.	1000d

650—461.3

KPOA Honolulu, Hawaii	10000
WSM Nashville, Tenn.	50000
KRCT Baytown, Texas	250d

660—454.3

KFAR Fairbanks, Alaska	10000
KMEO Omaha, Nebr.	500d
WNBC New York, N.Y.	50000

WESC Greenville, S.C.	5000d
KSKY Dallas, Tex.	1000

670—447.5

WMAQ Chicago, Ill.	50000

680—440.9

CHFA Edmonton, Alta.	5000
CHLO St. Thomas, Ont.	1000
CJOB Winnipeg, Man.	10000
CKGB Timmins, Ont.	10000
KNBC San Fran., Calif.	50000
WPIN St. Petersburg, Fla.	1000d
WCTT Corbin, Ky.	1000
WCBM Baltimore, Md.	10000
WNAC Lawrence, Mass.	50000
WDBC Escanaba, Mich.	1000
KFEQ St. Joseph, Mo.	5000
WINR Binghamton, N.Y.	1000
WRVM Rochester, N.Y.	250d
WPTF Raleigh, N.C.	50000
WISR Butler, Pa.	250d
WAPA San Juan, P.Rico.	10000
WMPS Memphis, Tenn.	10000
KENS San Antonio, Tex.	50000
KOMW Omak, Wash.	1000d

690—434.5

CBU Vancouver, B.C.	10000
CBF Montreal, Que.	50000
WVOK Birmingham, Ala.	50000d
KVNA Flagstaff, Ariz.	1000
KEVT Tucson, Ariz.	250d
KBBA Benton, Ark.	250d
KAPI Pueblo, Colo.	250d
WADS Ansonia, Conn.	500d
WAPE Jacksonville, Fla.	25000d
KULA Honolulu, Hawaii	10000
KBLI Blackfoot, Idaho	1000d
KGGF Coffeyville, Kans.	10000
WTIX New Orleans, La.	50000
KSTL St. Louis, Mo.	1000d
KRCO Prineville, Oreg.	1000d
KUSD Vermillion, S.Dak.	1000d
KHEY El Paso, Tex.	10000
KPET Lamesa, Tex.	250
KZEY Tyler, Tex.	250d
WCYB Bristol, Va.	10000d
WNNT Warsaw, Va.	250d
WELD Fisher, W.Va.	500d

700—428.3

WLW Cincinnati, Ohio	50000

710—422.3

CJSP Leamington, Ont.	1000d
CFRG Gravelbourg, Sask.	5000d
CKVM Ville Marie, Que.	1000
WKRG Mobile, Ala.	1000
KMPC Los Angeles, Calif.	50000
KICN Denver, Colo.	5000
WGBS Miami, Fla.	50000
WROM Rome, Ga.	1000d
KEEL Shreveport, La.	10000
WHB Kansas City, Mo.	10000
WOR New York, N.Y.	50000
DZRH Manila, P.I.	10000
WKJB Mayaguez, P.Rico	1000
WTPR Paris, Tenn.	250d
KGNC Amarillo, Tex.	10000
KURV Edinburg, Tex.	250
KIRO Seattle, Wash.	50000
WDSM Superior, Wis.	5000

720—416.4

WGN Chicago, Ill.	50000

730—410.7

CJNR Blind River, Ont.	1000
CKAC Montreal, Que.	50000
CKDM Dauphin, Man.	1000
CKLG No. Vancouver, B.C.	10000
KFQD Anchorage, Alaska	10000
WJMW Athens, Ala.	1000d
KNBY Newport, Ark.	1000d
WKTG Thomasville, Ga.	1000d
KBLR Goodland, Kans.	1000d
WFMW Madisonville, Ky.	250d
WMTC Vancleve, Ky.	1000d
KTRY Bastrop, La.	250d
WARB Covington, La.	250d
WMMS Bath, Maine	500d
WACE Chicopee, Mass.	1000d
KWRE Warrenton, Mo.	500d
KWOA Worthington, Minn.	1000d
KURL Billings, Mont.	500d
WDOS Oneonta, N.Y.	1000d
WFMC Goldsboro, N.C.	1000d
WOHS Shelby, N.C.	1000d
WHRW Bowling Green, Ohio	250d
KBOY Medford, Oreg.	1000d
WNAK Nanticoke, Pa.	1000d
WPIT Pittsburgh, Pa.	1000d
WPAL Charleston, S.C.	1000d
WLIL Lenoir, Tenn.	1000d
KKSN Grand Prairie, Tex.	500d
KSVN Ogden, Utah	1000d
WPIK Alexandria, Va.	1000d
WMNA Gretna, Va.	1000d
KULE Ephrata, Wash.	1000d

740—405.2

CBXA Edmonton, Alta.	250
CBL Toronto, Ont.	50000
WBAM Montgomery, Ala.	50000d
KUEQ Phoenix, Ariz.	1000d
KBIG Avalon, Calif.	10000d
KCBS San Francisco, Calif.	50000
KSSS Colo. Springs, Colo.	1000
KVFC Cortez, Colo.	1000d
WKIS Orlando, Fla.	5000
KYME Boise, Idaho	500d
WVLN Olney, Ill.	250d
KBOE Oskaloosa, Iowa	250d
WNOP Newport, Ky.	1000d
WFRB Frostburg, Md.	250d
WTAO Cambridge, Mass.	250d
KPBM Carlsbad, N.Mex.	1000d
WGSM Huntington, N.Y.	1000d
WMBL Morehead City, N.C.	1000d
WPAQ Mount Airy, N.C.	10000d
KRMG Tulsa, Okla.	50000
WVCH Chester, Pa.	1000d
WIBS Santurce, P.Rico	10000d
WBAW Barnwell, S.C.	500d
WIRJ Humbolt, Tenn.	250d
WJIG Tullahoma, Tenn.	250d
KTRH Houston, Tex.	50000

750—399.8

WSB Atlanta, Ga.	50000
WBMD Baltimore, Md.	1000d
KMMJ Grand Island, Neb.	1000
WHEB Portsmouth, N.H.	1000
KSEO Durant, Okla.	250d
KXL Portland, Oreg.	10000
WPDX Clarksburg, W.Va.	1000d

760—394.5

KGU Honolulu, Hawaii	10000
WJR Detroit, Mich.	50000
WCPS Tarboro, N.C.	1000

770—389.4

KUOM Minneapolis, Minn.	5000d
WCAL Northfield, Minn.	5000d
WEW St. Louis, Mo.	1000d
KOB Albuquerque, N. Mex.	50000
WABC New York, N.Y.	50000
KXA Seattle, Wash.	1000

780—384.4

WBBM Chicago, Ill.	50000
WJAG Norfolk, Neb.	1000
WCKB Dunn, N.C.	1000d
WBBO Forest City, N.C.	1000d
KSPI Stillwater, Okla.	250d
WARL Arlington, Va.	1000d

790—379.5

CBY Corner Brook, N.F.	1000
CKMR Newcastle, N.B.	1000
CKSO Sudbury, Ont.	10000
WTUG Tuscaloosa, Ala.	500d
KCEE Tucson, Ariz.	1000d
KOSY Texarkana, Ark.	1000
KDAN Eureka, Calif.	5000d
KABC Los Angeles, Calif.	5000
WLBE Leesburg, Fla.	5000
WPFA Pensacola, Fla.	1000d
WQXI Atlanta, Ga.	5000
WGRA Cairo, Ga.	1000d
KXXX Colby, Kans.	5000d
WAKY Louisville, Ky.	5000
WRUM Rumford, Me.	1000d
WSGW Saginaw, Mich.	1000
KGHL Billings, Mont.	5000
WWNY Watertown, N.Y.	1000
WLSV Wellsville, N.Y.	1000d
WTNC Thomasville, N.C.	1000d
WKLM Wilmington, N.C.	500d
KXGO Fargo, N.Dak.	5000
KWIL Albany, Oreg.	1000
WAEB Allentown, Pa.	500
WPIC Sharon, Pa.	1000d
WEAN Providence, R.I.	5000
WWBD Bamberg, S.C.	1000d
WETB Johnson City, Tenn.	1000d
WMC Memphis, Tenn.	5000
KTHT Houston, Tex.	5000
KFYO Lubbock, Tex.	5000
WSIG Mount Jackson, Va.	1000d
WTAR Norfolk, Va.	5000
KVOS Bellingham, Wash.	1000
KNEW Spokane, Wash.	5000
WEAQ Eau Claire, Wis.	5000
WEAU Washington, Wis.	5000

800—374.8

CHAB Moose Jaw, Sask.	10000
CKOK Penticton, B.C.	10000
CFOB Ft. Frances, Ont.	1000
CJLX Ft. William, Ont.	5000
CJBQ Belleville, Ont.	1000
CKLW Windsor, Ont.	50000
CHRC Quebec, Que.	10000
CJAD Montreal, Que.	10000
VOWR St. Johns, N.F.	1000
WHOS Decatur, Ala.	1000d
WMGY Montgomery, Ala.	1000d
KINY Juneau, Alaska	5000
KAGH Crossett, Ark.	250d
KVOM Morrilton, Ark.	250d
KUZZ Bakersfield, Calif.	250d
KBRN Brighton, Colo.	500d
WLAD Danbury, Conn.	250d
WMBM Miami Beach, Fla.	1000d
WSUZ Palatka, Fla.	1000d
WJAT Swainsboro, Ga.	1000d
KXIC Iowa City, Iowa	1000d
WRUS Russellville, Ky.	1000d
WBOK New Orleans, La.	1000d
WCCM Lawrence, Mass.	1000d
KREI Farmington, Mo.	1000d
KDBM Dillon, Mont.	1000d
WKDN Camden, N.J.	1000d
KJEM Okla City, Okla.	250d
KPDQ Portland, Oreg.	1000d
WCHA Chambersburg, Pa.	1000d
WDSC Dillon, S.C.	1000d
WEAB Greer, S.C.	250d
WDEH Sweetwater, Tenn.	1000d
KDDD Dumas, Tex.	250d
KBUH Brigham City, Utah	250d
WSVS Crewe, Va.	1000d
WKEE Huntington, W.Va.	1000d
WDUX Waupaca, Wis.	1000d

810—370.2

CFAX Victoria, B.C.	1000d
KGO San Francisco, Calif.	50000
WABW Annapolis, Md.	250d
KCMO Kansas City, Mo.	50000
WGY Schenectady, N.Y.	50000
WKBC N.Wilkesboro, N.C.	1000d
WCEC Rocky Mount, N.C.	1000d
WEDO McKeesport, Pa.	1000d
WKVM San Juan, P.R.	25000

820—365.6

WAIT Chicago, Ill.	5000d
WIKY Evansville, Ind.	250d
WOSU Columbus, Ohio	5000d
KIKI Honolulu, Hawaii	250
WFAA Dallas, Tex.	50000
WBAP Ft. Worth, Tex.	50000

830—361.2

WCCO Minneapolis, Minn.	50000
KBOA Kennett, Mo.	1000d
WNYC New York, N.Y.	1000d

840—356.9

WKAB Mobile, Ala.	1000d
WKNB New Britain, Conn.	1000d
WHAS Louisville, Ky.	50000
WVPO Stroudsburg, Pa.	250d

850—352.7

CKVL Verdun, Que.	50000
CKRD Red Deer, Alta.	1000
WYDE Birmingham, Ala.	10000
KOA Denver, Colo.	50000
WRUF Gainesville, Fla.	5000
WEAT W. Palm Beach, Fla.	1000
KIMO Hilo, Hawaii	1000
WHDH Boston, Mass.	50000
WKBZ Muskegon, Mich.	1000
KFUO St. Louis, Mo.	5000d
WKIX Raleigh, N.C.	10000
WJW Cleveland, Ohio	5000
WEEU Reading, Pa.	1000
WABA Aguadilla, P.R.	250
WRAP Norfolk, Va.	5000
KTAC Tacoma, Wash.	1000

860—348.6

CJBC Toronto, Ont.	50000
WHRT Hartselle, Ala.	250d
WAMI Opp, Ala.	1000d
KIFN Phoenix, Ariz.	1000d
KOSE Osceola, Ark.	1000d
KWRF Warren, Ark.	250d
KTRB Modesto, Calif.	10000
WKKO Cocoa, Fla.	1000d
WERD Atlanta, Ga.	1000d
WDMG Douglas, Ga.	5000d
WMRI Marion, Ind.	250d
KWPC Muscatine, Iowa	250d
KOAM Pittsburg, Kans.	10000
WSON Henderson, Ky.	500d
WAYE Dundalk, Md.	500d
WSBS Gt. Barrington, Mass.	250d
KNUJ New Ulm, Minn.	1000d
WMAG Forest, Miss.	500d
WFMO Fairmont, N.C.	1000d
WAMO Homestead, Pa.	250d
WTEL Philadelphia, Pa.	250d
WLBG Laurens, S.C.	1000d
WIVK Knoxville, Tenn.	1000d
WMTS Murfreesboro, Tenn.	250d
KFST Ft. Stockton, Tex.	250d
KPAN Hereford, Tex.	250d
KSFA Nacogdoches, Tex.	1000d
KONO San Antonio, Tex.	5000d
KWHO Salt Lake City, Utah	1000d
WEVA Emporia, Va.	1000d
WOAY Oak Hill, W.Va.	10000d
WFOX Milwaukee, Wis.	250d

870—344.6

KIEV Glendale, Calif.	250d
KAIM Kaimuki, Hawaii	1000
WWL New Orleans, La.	50000
WKAR E. Lansing, Mich.	5000d
WHCU Ithaca, N.Y.	1000d
WGTL Kannapolis, N.C.	1000d
KJIM Ft. Worth, Tex.	250d
WFLO Farmville, Va.	1000d

880—340.7

WCBS	New York, N.Y.	50000
WRRZ	Clinton, N.C.	1000d
WRFD	Worthington, Ohio	5000d

890—336.9

WLS	Chicago, Ill.	50000
WHNC	Henderson, N.C.	1000d
KBYE	Okla. City, Okla.	1000d

900—333.1

CKTS	Sherbrooke, Que.	1000
CHML	Hamilton, Ont.	5000
CHNO	Sudbury, Ont.	10000
CJBR	Rimouski, Que.	10000
CKJL	St. Jerome, Que.	1000
CJVI	Victoria, B.C.	10000
CKBI	Prince Albert, Sask.	10000
CJGX	Yorkton, Sask.	10000
WATV	Birmingham, Ala.	1000d
WGOK	Mobile, Ala.	1000d
WOZK	Ozark, Ala.	1000d
KPRB	Fairbanks, Alaska	10000
KHOZ	Harrison, Ark.	1000d
KBIF	Centerville, Calif.	1000d
WJWL	Georgetown, Del.	1000d
WSWN	Belle Glade, Fla.	1000d
WMOP	Ocala, Fla.	1000d
WCGA	Calhoun, Ga.	1000d
WCRY	Macon, Ga.	250d
WJIV	Savannah, Ga.	1000d
KSIR	Wichita, Kan.	250
WKYW	Louisville, Ky.	1000d
WLSI	Pikeville, Ky.	1000d
KREH	Oakdale, La.	250d
WCME	Brunswick, Maine	500d
WATC	Gaylord, Mich.	1000d
KTIS	Minneapolis, Minn.	1000d
WDDT	Greenville, Miss.	1000d
KFAL	Fulton, Mo.	1000d
KJSK	Columbus, Nebr.	1000d
WOTW	Nashau, N.H.	1000d
WBRV	Boonville, N.Y.	1000d
WSPN	Saratoga Sprgs., N.Y.	250d
WAYN	Rockingham, N.C.	1000d
WIAM	Williamston, N.C.	1000d
KFNW	Fargo, N.Dak.	1000d
WAND	Canton, Ohio	500d
WFRO	Fremont, Ohio	500d
WCPA	Clearfield, Pa.	1000d
WFLN	Philadelphia, Pa.	1000d
WKXV	Knoxville, Tenn.	1000d
WCOR	Lebanon, Tenn.	500d
KALT	Atlanta, Tex.	1000d
KMCO	Conroe, Tex.	500d
KFLD	Floydada, Tex.	250d
KCLW	Hamilton, Tex.	250d
WAFC	Staunton, Va.	1000d
KUEN	Wenatchee, Wash.	500
WATK	Antigo, Wis.	250d

910—329.5

CJDV	Drumheller, Alta.	1000
CKLY	Lindsay, Ont.	1000
CBO	Ottawa, Ont.	5000
CFJC	Kamloops, B.C.	10000
CHRL	Roberval, Que.	1000
KPHO	Phoenix, Ariz.	5000
KLCN	Blytheville, Ark.	5000d
KAMD	Camden, Ark.	1000
KDEO	El Cajon, Calif.	1000
KEWB	Oakland, Calif.	5000
KOXR	Oxnard, Calif.	1000d
KPOF	nr. Denver, Colo.	5000
WHAY	New Britain, Conn.	5000
WPLA	Plant City, Fla.	1000d
WGAF	Valdosta, Ga.	5000
WAKO	Lawrenceville, Ill.	500d
WSUI	Iowa City, Iowa	5000
WLCS	Baton Rouge, La.	1000
WABI	Bangor, Maine	5000
WFDF	Flint, Mich.	5000
WCOC	Meridian, Miss.	5000
KOYN	Billings, Mont.	1000d
KYSS	Missoula, Mont.	1000d
KBIM	Roswell, N.Mex.	5000d
WLAS	Jacksonville, N.C.	1000d
KCJB	Minot, N.Dak.	1000
WPFB	Middletown, Ohio	1000
KGLC	Miami, Okla.	1000
KURY	Brookings, Oreg.	500
WAVL	Apollo, Pa.	1000d
WGBI	Scranton, Pa.	1000
WSBA	York, Pa.	1000
WPRP	Ponce, P.R.	5000
WORD	Spartanburg, S.C.	1000
WJCW	Johnson City, Tenn.	5000
WEPG	S. Pittsburgh, Tenn.	500d
KNAF	Fredericksburg, Tex.	1000d
KRIO	McAllen, Tex.	1000
KRRV	Sherman, Tex.	1000
KALL	Salt Lake City, Utah	1000
WWRJ	White River Junction, Vermont	1000d
WRNL	Richmond, Va.	5000
WHYE	Roanoke, Va.	1000d
KORD	Pasco, Wash.	1000d
KUDY	Renton, Wash.	1000
KISN	Vancouver, Wash.	1000
WHSM	Hayward, Wis.	1000d
WDOR	Sturgeon Bay, Wis.	500d

920—325.9

CJCH	Halifax, N.S.	10000
CJCJ	Woodstock, N.B.	1000
CKNX	Wingham, Ont.	2500
WCTA	Adalusia, Ala.	5000
WWWR	Russellville, Ala.	1000d
KARK	Little Rock, Ark.	5000
KDES	Palm Springs, Calif.	1000d
KVEC	San Luis Obispo, Cal.	1000
KIUP	Durango, Colo.	5000
KREX	Grd. Junction, Colo.	5000
KLMR	Lamar, Colo.	1000
WMEG	Eau Gallie, Fla.	1000d
WGST	Atlanta, Ga.	5000
KAHU	Waiphau, Hawaii	1000
WMOK	Metropolis, Ill.	1000d
WBAA	W. Lafayette, Ind.	5000
KFNF	Shenandoah, Iowa	1000
WTCW	Whitesburg, Ky.	1000d
WBOX	Bogalusa, La.	1000d
KTOC	Jonesboro, La.	500d
WPIX	Lexington Pk., Md.	500d
WMPL	Hancock, Mich.	1000d
KDHL	Faribault, Minn.	1000
KWAD	Wadena, Minn.	1000
KRAM	Las Vegas, Nev.	1000
KOLO	Reno, Nev.	1000
KQEO	Albuquerque, N.Mex.	1000
WTTM	Trenton, N.J.	1000
WKRT	Cortland, N.Y.	1000
WGHQ	Saugerties, N.Y.	1000d
WBBB	Burlington, N.C.	5000d
WMNI	Columbus, Ohio	500
KGAL	Lebanon, Oreg.	1000
WKVA	Lewistown, Pa.	1000d
WJAR	Providence, R.I.	5000
WTND	Orangeburg, S.C.	1000d
KEZU	Rapid City, S.Dak.	1000d
WLIV	Livingston, Tenn.	1000d
KELP	El Paso, Tex.	1000
KECK	Odessa, Tex.	1000
KTLW	Texas City, Tex.	1000d
KITN	Olympia, Wash.	1000d
KXLY	Spokane, Wash.	5000
WMMN	Fairmont, W.Va.	5000
WOKY	Milwaukee, Wis.	1000

930—322.4

CFBC	Saint John, N.B.	5000
CJCA	Edmonton, Alta.	10000
CJON	St. John's, N.F.	10000
WETO	Gadsden, Ala.	1000d
KTKN	Ketchikan, Alaska	1000
KAPR	Douglas, Ariz.	1000d
KHJ	Los Angeles, Calif.	5000
KIUP	Durango, Colo.	5000
WKSB	Milford, Del.	500d
WJAX	Jacksonville, Fla.	5000
WKXY	Sarasota, Fla.	1000
WMGR	Bainbridge, Ga.	5000d
KSEI	Pocatello, Idaho	5000
WTAD	Quincy, Ill.	5000
WKCT	Bowling Green, Ky.	1000
WFMD	Frederick, Md.	1000
WREB	Holyoke, Mass.	500d
WBCK	Battle Creek, Mich.	1000
WSLI	Jackson, Miss.	5000
KWOC	Poplar Bluff, Mo.	1000
KOFI	Kalispell, Mont.	5000d
KOGA	Ogallala, Nebr.	500d
WWNH	Rochester, N.H.	5000d
WPAT	Paterson, N.J.	5000
WBEN	Buffalo, N.Y.	5000
WIST	Charlotte, N.C.	5000
WRRF	Washington, N.C.	5000
WEOL	Elyria, Ohio	1000
WKY	Oklahoma City, Okla.	5000
KAGI	Grants Pass, Oreg.	1000
WCNR	Bloomsburg, Pa.	1000d
KSDN	Aberdeen, S.D.	1000
WSEV	Sevierville, Tenn.	5000d
KDET	Center, Tex.	1000d
KENY	Bellingham-Ferndale Wash.	1000d
WSAZ	Huntington, W.Va.	5000
WLBL	Auburndale, Wis.	5000d

940—319.0

CBM	Montreal, Que.	50000
CJGX	Yorkton, Sask.	10000
CJIB	Vernon, B.C.	1000
KFRE	Fresno, Calif.	50000
WINZ	Miami, Fla.	50000
WMAZ	Macon, Ga.	50000
WMIX	Mt. Vernon, Ill.	1000
KIOA	Des Moines, Iowa	10000
WYLD	New Orleans, La.	1000
WWOM	New Orleans, La.	1000d
KGRL	Bend, Oreg.	1000d
WESA	Charleroi, Pa.	250
WIPR	San Juan, P.R.	10000
KIXZ	Amarillo, Tex.	1000

950—315.6

CKNB	Campbellton, N.B.	1000
CKBB	Barrie, Ont.	5000
WRMA	Montgomery, Ala.	1000d
KXJK	Forrest City, Ark.	5000d
KFSA	Ft. Smith, Ark.	1000
KAHI	Auburn, Calif.	1000d
KIMN	Denver, Colo.	5000
WFBS	Ft. Walton Sch., Fla.	1000d
WLOF	Orlando, Fla.	5000
WGTA	Summerville, Ga.	1000d
WGOV	Valdosta, Ga.	5000
KBOI	Boise, Idaho	5000
KLER	Orofino, Idaho	500d
WAAF	Chicago, Ill.	1000d
WXLW	Indianapolis, Ind.	5000d
KOEL	Oelwein, Iowa	1000
KJRG	Newton, Kans.	500d
WBVL	Barbourville, Ky.	1000d
WAGM	Presque Isle, Maine	5000
WORL	Boston, Mass.	5000d
WWJ	Detroit, Mich.	5000
KRSI	St. Louis Park, Minn.	1000d
WBKH	Hattiesburg, Miss.	5000d
KLIK	Jefferson City, Mo.	5000d
WBBF	Rochester, N.Y.	1000
WIBX	Utica, N.Y.	5000
WPET	Greensboro, N.C.	500d
WNCC	Barnesboro, Pa.	500d
WPEN	Philadelphia, Pa.	5000
WSPA	Spartanburg, S.C.	5000
KWAT	Watertown, S.Dak.	1000
WAGG	Franklin, Tenn.	1000d
KDSX	Denison, Tex.	500
KPRC	Houston, Tex.	5000
KSEL	Lubbock, Tex.	1000
WXGI	Richmond, Va.	1000d
KJR	Seattle, Wash.	5000
WKAZ	Charleston, W.Va.	5000
WKTL	Sheboygan, Wis.	500d

960—312.3

CFAC	Calgary, Alta.	10000
CHNS	Halifax, N.S.	10000
CKWS	Kingston, Ont.	5000
WBRC	Birmingham, Ala.	5000
WMOZ	Mobile, Ala.	1000
KOOL	Phoenix, Ariz.	5000
KAVR	Apple Valley, Calif.	5000d
KNEZ	Lompoc, Calif.	500
KABL	Oakland, Calif.	1000
WELI	New Haven, Conn.	5000
WGRO	Lake City, Fla.	500d
WJCM	Sebring, Fla.	1000d
WRFC	Athens, Ga.	5000
KSRA	Salmon, Idaho	1000d
WSBT	South Bend, Ind.	5000
KMA	Shenandoah, Iowa	5000
WPRT	Prestonsburg, Ky.	1000d
KROF	Abbeville, La.	1000d
WBOC	Salisbury, Md.	5000
WFGM	Fitchburg, Mass.	1000
WHAK	Rogers City, Mich.	5000d
KLTF	Little Falls, Minn.	500d
WABG	Greenwood, Miss.	1000
KFVS	Cape Girardeau, Mo.	1000
KNEB	Scottsbluff, Nebr.	1000
KWYK	Farmington, N.Mex.	1000d
WEAV	Plattsburg, N.Y.	5000
WFTC	Kinston, N.C.	5000
WWST	Wooster, Ohio	1000d
KGWA	Enid, Okla.	1000
KLAD	Klamath Falls, Oreg.	5000d
WHYL	Carlisle, Pa.	5000d
WADP	Kane, Pa.	1000d
WATS	Sayre, Pa.	1000d
WBEU	Beaufort, S.C.	1000d
WBMC	McMinnville, Tenn.	500d
KIMP	Mt. Pleasant, Tex.	1000d
KGKL	San Angelo, Tex.	5000
KOVO	Provo, Utah	5000
WDBJ	Roanoke, Va.	5000
KALE	Richland, Wash.	1000
WTCH	Shawano, Wis.	1000

970—309.1

CKCH	Hull, Que.	5000
WERH	Hamilton, Ala.	5000d
WTBF	Troy, Ala.	5000
KNEA	Jonesboro, Ark.	1000d
KBIS	Bakersfield, Calif.	1000
KCHV	Coachella, Calif.	1000d
KBEE	Modesto, Calif.	1000
KFEL	Pueblo, Colo.	1000d
WFLA	Tampa, Fla.	5000
WIIN	Atlanta, Ga.	5000d
WVOP	Vidalia, Ga.	5000d
KHBC	Hilo, Hawaii	1000
KAYT	Rupert, Idaho	1000d
WMAY	Springfield, Ill.	1000
WAVE	Louisville, Ky.	5000
KSYL	Alexandria, La.	1000
WCSH	Portland, Maine	5000
WAMD	Aberdeen, Md.	500d
WESO	Southbridge, Mass.	1000d
WJAN	Ishpeming, Mich.	5000d
WKHM	Jackson, Mich.	1000
KOOK	Billings, Mont.	5000
KJLT	No. Platte, Nebr.	5000d
WNTA	Newark, N.J.	5000
WEBR	Buffalo, N.Y.	5000
WCHN	Norwich, N.Y.	500d
WRCS	Ahoskie, N.C.	1000d
WWIT	Canton, N.C.	1000d
WDAY	Fargo, N.Dak.	5000
WICA	Ashtabula, Ohio	5000
WATH	Athens, Ohio	1000d
KAKC	Tulsa, Okla.	1000
KOIN	Portland, Oreg.	5000
WWSW	Pittsburgh, Pa.	5000
WJMX	Florence, S.C.	5000
KNOK	Ft. Worth, Tex.	1000d
WDTI	Danville, Va.	500d
KREM	Spokane, Wash.	5000
WWYO	Pineville, W.Va.	1000d
WHA	Madison, Wis.	5000d

980—305.9

CKNW	New Westminster, Brit. Columbia	5000
CFPL	London, Ont.	10000
CBV	Quebec, Que.	5000
CHEX	Peterboro, Ont.	5000
CKRM	Regina, Sask.	5000
WKLF	Clanton, Ala.	1000d
KINS	Eureka, Calif.	5000
KEAP	Fresno, Calif.	500d
KFWB	Los Angeles, Calif.	5000
KGLN	GlenwoodSprgs., Colo.	1000d
WSUB	Groton, Conn.	1000
WRC	Washington, D.C.	5000
WDVH	Gainesville, Fla.	5000d
WTOT	Marianna, Fla.	1000d
WBOP	Pensacola, Fla.	1000d
WLOD	Pompano Beach, Fla.	1000d
WKLY	Hartwell, Ga.	1000d
WBBN	Perry, Ga.	500d
WRIP	Rossville, Ga.	500d
KUPI	Idaho Falls, Idaho	1000d
WITY	Danville, Ill.	1000
KOKA	Shreveport, La.	5000d
WCAP	Lowell, Mass.	1000d
WPBC	Minneapolis, Minn.	1000d
WAPF	McComb, Miss.	1000d
KMBC	Kansas City, Mo.	5000
KSGM	Ste. Genevieve, Mo.	500
KVER	Clovis, N.Mex.	1000
KMIN	Grants, N. Mex.	1000d
WTRY	Troy, N.Y.	5000
WKLM	Wilmington, N.C.	5000d
WAAA	Win.-Salem, N.C.	1000d
WONE	Dayton, Ohio	5000
WILK	Wilkes-Barre, Pa.	5000
KDSJ	Deadwood, S.Dak.	1000
WSIX	Nashville, Tenn.	5000
KFRD	Rosenberg, Tex.	1000d
KSVC	Richfield, Utah	5000
WFHG	Bristol, Va.	5000
WMEK	Chase City, Va.	500d
KUTI	Yakima, Wash.	5000d
WHAW	Weston, W.Va.	1000d
WCUB	Manitowoc, Wis.	1000d
WPRE	Prairie du Chien, Wis.	500d

990—302.8

CBW	Winnipeg, Man.	50000
CBT	Grand Falls, N.F.	1000
WWWF	Fayette, Ala.	1000d
WTCB	Flomaton, Ala.	500d
KTKT	Tucson, Ariz.	10000d
KKIS	Pittsburg, Calif.	5000
KLIR	Denver, Colo.	1000d
WBZY	Torrington, Conn.	1000d
WHOO	Orlando, Fla.	10000
WDWD	Dawson, Ga.	1000d
KOOD	Honolulu, Hawaii	1000
WCAZ	Carthage, Ill.	1000d
WITZ	Jasper, Ind.	1000d
KAYL	Storm Lake, Iowa	250d
KRSL	Russell, Kans.	250d
WJMR	New Orleans, La.	250d
KRIH	Rayville, La.	250d
WABO	Waynesboro, Miss.	250d
KRMO	Monett, Mo.	250d
KSVP	Artesia, N.Mex.	1000
WEEB	Southern Pines, N.C.	1000d
WJEH	Gallipolis, Ohio	1000d
WTIG	Massillon, Ohio	250d
KABY	Albany, Oreg.	250d
WIBG	Philadelphia, Pa.	50000
WVSC	Somerset, Pa.	250d
WPRA	Mayaguez, P.R.	10000
WAKN	Aiken, S.C.	1000d
WNOX	Knoxville, Tenn.	10000
KWAM	Memphis, Tenn.	1000d
KTRM	Beaumont, Tex.	1000
KAML	Kenedy, Tex.	250
KSYD	Wichita Falls, Tex.	10000
KDYL	Tooele, Utah	1000d
WNRV	Narrows, Va.	1000d
WANT	Richmond, Va.	1000d
WKLJ	Sparta, Wis.	250

1000—299.8

CKBW	Bridgewater, N.S.	1000
WCFL	Chicago, Ill.	50000
KTOK	Okla. City, Okla.	5000
KSTA	Coleman, Tex.	250d
KJAT	Henderson, Tex.	250d
WHWB	Rutland, Vt.	1000d
KOMO	Seattle, Wash.	50000

1010—296.9

CBX	Edmonton, Alta.	50000
CFRB	Toronto, Ont.	50000
KVNC	Winslow, Ariz.	1000
KLRA	Little Rock, Ark.	10000
KCHJ	Delano, Calif.	5000
KCMJ	Palm Sprgs., Calif.	1000
KSAY	San Fran., Calif.	10000d
WCNU	Crestview, Fla.	1000d
WZRO	Jacksonville Beach, Florida	1000d
WGUN	Decatur, Ga.	50000d
WCSI	Columbus, Ind.	500d
KSMN	Mason City, Iowa	1000d
KIND	Independence, Kans.	250d
KDLA	DeRidder, La.	1000d
WSID	Baltimore, Md.	1000d

Kc.	Wave Length	W.P.
KCHI	Chillicothe, Mo.	250d
KJCF	Festus, Mo.	50000d
KRVN	Lexington, Nebr.	25000d
WINS	New York, N.Y.	50000
WABZ	Albermarle, N.C.	1000d
WELS	Kinston, N.C.	1000d
WIOI	New Boston, Ohio	500d
WITT	Lewisburg, Pa.	250d
WHIN	Gallatin, Tenn.	1000d
WORM	Savannah, Tenn.	250d
KBUY	Amarillo, Tex.	5000
KMLW	Marlin, Tex.	250d
WELK	Charlottesville, Va.	1000d
WMEV	Marion, Va.	1000d
WCST	Berkeley Sprgs., W.Va.	250d
WSPT	Stevens Pt., Wis.	1000d

1020—293.9

KPOP	Los Angeles, Calif.	5000
WCIL	Carbondale, Ill.	1000d
WPEO	Peoria, Ill.	1000d
KDKA	Pittsburgh, Pa.	50000

1030—291.1

WBZ	Boston, Mass.	50000
WBZA	Springfield, Mass.	1000
KOB	Albuquerque, N.Mex.	10000
KCTA	Corpus Christi, Tex.	50000d

1040—288.3

KHVH	Honolulu, Hawaii	5000
WHO	Des Moines, Iowa	50000
KIXL	Dallas, Tex.	1000d

1050—285.5

CFGP	Grande Prairie, Alta.	10000
CKSB	St. Boniface, Man.	10000
CJIC	Sault Ste. Marie, Ont.	250
CHUM	Toronto, Ont.	5000
WRFS	Alexander City, Ala.	1000d
WCRI	Scottsboro, Ala.	250d
KVWM	Show Low, Ariz.	250d
KVLC	Little Rock, Ark.	1000d
KOFY	San Mateo, Calif.	1000d
KWSO	Wasco, Calif.	1000d
KLMO	Longmont, Colo.	250d
WJSB	Crestview, Fla.	1000d
WIVY	Jacksonville, Fla.	1000d
WHBO	Tampa, Fla.	250d
WRMF	Titusville, Fla.	500d
WJAZ	Albany, Ga.	1000d
WAUG	Augusta, Ga.	1000d
WBIE	Marietta, Ga.	500d
KZIN	Coeur D'Alene, Idaho	250d
WDZ	Decatur, Ill.	1000d
KNCO	Garden City, Kans.	1000d
WZIP	Covington, Ky.	1000d
KLPL	Lake Providence, La.	250d
KCIJ	Shreveport, La.	250d
WQMR	Silver Sprg., Md.	1000d
WPAG	Ann Arbor, Mich.	1000d
KLOH	Pipestone, Minn.	1000d
WACR	Columbus, Miss.	1000d
KSIS	Sedalia, Mo.	1000d
KRBO	Las Vegas, Nev.	500d
WBNC	Conway, N.H.	1000d
WSEN	Baldwinsville, N.Y.	250d
WSTS	Massena, N.Y.	1000d
WMGM	New York, N.Y.	50000
WBTL	Farmville, N.C.	250d
WFSC	Franklin, N.C.	500d
WLON	Lincolnton, N.C.	1000d
WWGP	Sanford, N.C.	1000d
KCCO	Lawton, Okla.	250d
KFMJ	Tulsa, Okla.	1000d
KUBE	Pendleton, Oreg.	1000d
KEED	Springfield, Oreg.	1000d
WBUT	Butler, Pa.	250d
WLYC	Williamsport, Pa.	1000d
WSMT	Sparta, Tenn.	1000d
KLEN	Killeen, Tex.	250d
KWLD	Liberty, Tex.	250d
WGAT	Gate City, Va.	250d
WBRG	Lynchburg, Va.	1000d
WCMS	Norfolk, Va.	1000d
KNBX	Kirkland, Wash.	1000d
WCEF	Parkersburg, W.Va.	1000d
WECL	Eau Claire, Wis.	1000d
WLIP	Kenosha, Wis.	250d
KWIV	Douglas, Wyo.	250d

1060—282.8

CFCN	Calgary, Alta.	10000
CJLR	Quebec, Que.	5000
KPAY	Chico, Calif.	10000
WNOE	New Orleans, La.	50000
WHFB	Benton Harbor, Mich.	1000d
WMAP	Monroe, N.C.	250d
WCMW	Canton, Ohio	1000d
WRCV	Philadelphia, Pa.	50000

1070—280.2

CBA	Sackville, N.B.	50000
CHOK	Sarnia, Ont.	5000
WAPI	Birmingham, Ala.	50000
KNX	Los Angeles, Calif.	50000
WVCG	Coral Gables, Fla.	1000d
WIBC	Indianapolis, Ind.	50000
KFBI	Wichita, Kans.	10000
KHMO	Hannibal, Mo.	5000
WHPE	High Point, N.C.	1000d
WDIA	Memphis, Tenn.	50000
KOPY	Alice, Tex.	1000
WKOW	Madison, Wis.	10000

1080—277.6

CHED	Edmonton, Alta.	10000
KSCO	Santa Cruz, Calif.	1000
WTIC	Hartford, Conn.	50000
WKLO	Louisville, Ky.	5000
WOAP	Owosso, Mich.	250d
WYSL	Kenmore, N.Y.	1000d
WEWO	Laurinburg, N.C.	1000d
KWJJ	Portland, Oreg.	10000
WEEP	Pittsburgh, Pa.	1000d
KRLD	Dallas, Tex.	50000

1090—275.1

CHEC	Lethbridge, Alta.	5000
CHIC	Brampton, Ont.	250
CHRS	St. Jean, Que.	1000
KTHS	Little Rock, Ark.	50000
WCRA	Effingham, Ill.	250d
KNWS	Waterloo, Iowa	1000d
WBAL	Baltimore, Md.	50000
WILD	Boston, Mass.	1000d
WMUS	Muskegon, Mich.	1000d
KING	Seattle, Wash.	50000

1100—272.6

KFAX	San Francisco, Calif.	1000d
WLBB	Carrollton, Ga.	250d
WHLI	Hempstead, N.Y.	10000d
KYW	Cleveland, Ohio	50000
WGPA	Bethlehem, Pa.	250d

1110—270.1

CFML	Cornwall, Ont.	1000
CFTJ	Galt, Ont.	250
KRLA	Pasadena, Calif.	10000
WALT	Tampa, Fla.	10000d
KIPA	Hilo, Hawaii	1000
WMBI	Chicago, Ill.	5000d
KFAB	Omaha, Nebr.	50000
WBT	Charlotte, N.C.	50000
KBND	Bend, Oreg.	5000
WNAR	Norristown, Pa.	500d
WVJP	Caguas, P.R.	250
WHIM	Providence, R.I.	1000d

1120—267.7

WUST	Bethesda, Md.	250d
KMOX	St. Louis, Mo.	50000
WWOL	Buffalo, N.Y.	1000d
KCLE	Cleburne, Tex.	250d

1130—265.3

CKWX	Vancouver, B.C.	50000
KSDO	San Diego, Calif.	5000
KWKH	Shreveport, La.	50000
WCAR	Detroit, Mich.	50000
WDGY	Minneapolis, Minn.	50000
WNEW	New York, N.Y.	50000

1140—263.0

CKXL	Calgary, Alta.	10000
KRAK	Stockton, Calif.	5000
WMIE	Miami, Fla.	10000
KGEM	Boise, Idaho	10000
WSIV	Pekin, Ill.	1000d
KLPR	Oklahoma City, Okla.	1000d
WITA	San Juan, P.R.	500
KSOO	Sioux Falls, S.Dak.	10000
KORC	Mineral Wells, Tex.	250
WRVA	Richmond, Va.	50000

1150—260.7

CKSA	Lloydminster, Alta.	1000
CHSJ	Saint John, N.B.	5000
CKOC	Hamilton, Ont.	5000
CKX	Brandon, Man.	5000
CKTR	Three Rivers, Que.	5000
WBCA	Bay Minette, Ala.	1000d
WGEA	Geneva, Ala.	1000d
WJRD	Tuscaloosa, Ala.	5000
KCKY	Coolidge, Ariz.	1000
KXLR	No. Little Rock, Ark.	5000
KFSG	Los Angeles, Calif.	2500
KRKD	Los Angeles, Calif.	5000
KJAX	Santa Rosa, Calif.	5000
KGMC	Englewood, Colo.	1000d
WCNX	Middletown, Conn.	500d
WDEL	Wilmington, Del.	5000
WNDB	Daytona Bch., Fla.	1000
WTMP	Tampa, Fla.	5000d
WFPM	Fort Valley, Ga.	1000d
WJEM	Valdosta, Ga.	1000d
KANI	Oahu, Hawaii	1000
WGGH	Marion, Ill.	5000d
KWKY	Des Moines, Iowa	1000
KSAL	Salina, Kans.	5000
WMST	Mt. Sterling, Ky.	500d
WLOC	Mumfordville, Ky.	1000d
WJBO	Baton Rouge, La.	5000
WGHM	Skowhegan, Maine	5000d
WCOP	Boston, Mass.	5000
WCEN	Mt. Pleasant, Mich.	1000
KASM	Albany, Minn.	1000d
WXTN	Lexington, Miss.	500d
KRMS	Osage Beach, Mo.	1000d
KSEN	Shelby, Mont.	1000
KDEF	Albuquerque, N.Mex.	1000d
WRUN	Utica, N.Y.	5000
WBAG	Burlington, N.C.	1000d
WGBR	Goldsboro, N.C.	5000
WCUE	Akron, Ohio	1000d
WIMA	Lima, Ohio	1000
KNED	McAlester, Okla.	1000
KAGO	Klamath Falls, Oreg.	5000
WHUN	Huntingdon, Pa.	1000d
WKPA	New Kensington, Pa.	1000d
WORA	Mayaguez, P.R.	1000
WRNO	Orangeburg, S.C.	5000
WTYC	Rock Hill, S.C.	1000d
WSNW	Seneca Township, South Carolina	1000d
WAPO	Chattanooga, Tenn.	5000
WCRK	Morristown, Tenn.	1000
WTAW	Bryan, Tex.	1000d
KCCT	Corpus Christi, Tex.	1000d
KIZZ	El Paso, Tex.	1000d
KJBC	Midland, Tex.	1000d
KPNG	Port Neches, Tex.	1150
KOLJ	Quanah, Tex.	500d
KOFE	Pullman, Wash.	1000d
KAYO	Seattle, Wash.	5000
KKEY	Vancouver, Wash.	1000d
WELC	Welch, W.Va.	1000d
WAXX	Chippewa Falls, Wis.	5000d
WISN	Milwaukee, Wis.	5000

1160—258.5

WJJD	Chicago, Ill.	50000
KSL	Salt Lake City, Utah	50000

1170—256.3

CFNS	Saskatoon, Sask.	1000
WCOV	Montgomery, Ala.	10000
KCBQ	San Diego, Calif	50000
KLOK	San Jose, Calif.	10000
KOHO	Honolulu, Hawaii	1000
WLBH	Mattoon, Ill.	250d
KSTT	Davenport, Iowa	1000
KVOO	Tulsa, Okla.	50000
WLEO	Ponce, P.R.	250
KPUG	Bellingham, Wash.	1000
WWVA	Wheeling, W.Va.	50000

1180—254.1

WLDS	Jacksonville, Ill.	1000d
WHAM	Rochester, N.Y.	50000

1190—252.0

KEZY	Anaheim, Calif.	1000
KNBA	Vallejo, Calif.	250d
WOWO	Ft. Wayne, Ind.	50000
WANN	Annapolis, Md.	10000d
WKOX	Fram'gham, Mass.	1000d
WLIB	New York, N.Y.	1000d
KEX	Portland, Oreg.	50000
KLIF	Dallas, Tex.	50000

1200—249.9

WOAI	San Antonio, Tex.	50000

1210—247.8

WCNT	Centralia, Ill.	1000d
WKNX	Saginaw, Mich.	1000d
WADE	Wadesboro, N.C.	1000d
WAVI	Dayton, Ohio	250d
WCAU	Philadelphia, Pa.	50000

1220—245.8

CJOC	Lethbridge, Alta.	10000
CKDA	Victoria, B.C.	10000
CJRL	Kenora, Ont.	1000
CKEC	New Glasgow, N.S.	250
CKCW	Moncton, N.B.	10000
CJSS	Cornwall, Ont.	1000
CKSM	Shawinigan, Quebec	1000
WEZB	Birmingham, Ala.	1000d
WPRN	Butler, Ala.	1000d
KVSA	McGehee, Ark.	1000d
KIBE	Palo Alto, Calif.	1000d
KFSC	Denver, Colo.	1000d
WTTT	Arlington, Fla.	250d
WKBX	Kissimmee, Fla.	250d
WFEC	Miami, Fla.	250d
WCLB	Camilla, Ga.	1000d
WPLK	Rockmart, Ga.	250d
WSFT	Thomaston, Ga.	250d
WLPO	LaSalle, Ill.	1000d
WKRS	Waukegan, Ill.	1000d
WSLM	Salem, Ind.	1000d
KJAN	Atlantic, Iowa	250d
KOFO	Ottawa, Kans.	250d
WFKN	Franklin, Ky.	250d
KBCL	Bossier City, La.	250d
WLBI	Denham Springs, La.	250d
WSME	Sanford, Maine	1000d
WBCH	Hastings, Mich.	250d
WAVN	Stillwater, Minn.	1000d
WMDC	Hazlehurst, Miss.	250d
KBHM	Branson, Mo.	1000d
KGMO	Cape Girardeau, Mo.	250d
KLPW	Union, Mo.	1000d
WKBK	Keene, N.H.	1000d
WGNY	Newburgh, N.Y.	1000d
WJMK	N. Syracuse, N. Y.	1000d
WKMT	Kings Mtn., N.C.	1000d
WREV	Reidsville, N.C.	250d
WENC	Whiteville, N.C.	1000d
KEYD	Oakes, N.Dak.	1000d
WGAR	Cleveland, Ohio	50000
WERT	Van Wert, Ohio	250d
KGYN	Guymon, Okla.	1000d
WJUN	Mexico, Pa.	250d
WRIB	Providence, R.I.	1000d
WALD	Walterboro, S.C.	1000d
WFWL	Camden, Tenn.	250
WCPH	Etowah, Tenn.	1000d
WHEY	Millington, Tenn.	250
KLBS	Livingston, Tex.	250d
KZEE	Weatherford, Tex.	250d
WLSD	Big Stone Gap, Va.	1000d
WFAX	Falls Church, Va.	1000d
KASY	Auburn, Wash.	250d

1230—243.8

CFCW	Camrose, Alta.	1000
CHFC	Churchill, Man.	250
CFKL	Schefferville, Que.	250
CFGR	Gravelbourg, Sask.	250
CFYT	Dawson City, Yukon T.	100
CJBQ	Belleville, Ont.	250
CFPA	Port Arthur, Ont.	1000
CKLD	Thetford Mines, Que.	250
CKMP	Midland, Ont.	250
VOAR	St. John's, Nfld.	100
CKVD	Val D'Or, Que.	250
WAUD	Auburn, Ala.	250
WJBB	Haleyville, Ala.	250
WBHP	Huntsville, Ala.	250
WNUZ	Talledega, Ala.	250
WTBC	Tuscaloosa, Ala.	250
KIFW	Sitka, Alaska	250
KSUN	Bisbee, Ariz.	250
KAAA	Kingman, Ariz.	250
KRIZ	Phoenix, Ariz.	250
KCON	Conway, Ark.	250
KFPW	Ft. Smith, Ark.	250
KBTM	Jonesboro, Ark.	250
KGEE	Bakersfield, Calif.	250
KWTC	Barstow, Calif.	250
KIBS	Bishop, Calif.	250
KXO	El Centro, Calif.	250
KDAC	Ft. Bragg, Calif.	250
KGFJ	Los Angeles, Calif.	250
KPRL	Paso Robles, Calif.	250
KRDG	Redding, Calif.	250
KWG	Stockton, Calif.	250
KEXO	Grand Junc., Colo.	250
KLVC	Leadville, Colo.	250
KDZA	Pueblo, Colo.	250
KGEK	Sterling, Colo.	250
WINF	Manchester, Conn.	250
WGGG	Gainesville, Fla.	250
WONN	Lakeland, Fla.	250
WMAF	Madison, Fla.	250
WSBB	New Smyrna Bch., Fla.	250
WNVY	Pensacola, Fla.	250
WCNH	Quincy, Fla.	250
WJNO	W. Palm Beach, Fla.	250
WBIA	Augusta, Ga.	250
WBLJ	Dalton, Ga.	250
WXLI	Dublin, Ga.	250d
WFOM	Marietta, Ga.	250
WSOK	Savannah, Ga.	250
WAYX	Waycross, Ga.	250
KBAR	Burley, Idaho	250
KORT	Grangeville, Idaho	250
KRXK	Rexburg, Idaho	250
WJBC	Bloomington, Ill.	250
WQUA	Moline, Ill.	250
WHCO	Sparta, Ill.	250
WJOB	Hammond, Ind.	250
WSAL	Logansport, Ind.	250
WTCJ	Tell City, Ind.	250
WBOW	Terre Haute, Ind.	250
KFJB	Marshalltown, Iowa	250
WHIR	Danville, Ky.	250
WHOP	Hopkinsville, Ky.	250
WMLF	Pineville, Ky.	250
KLIC	Monroe, La.	250
WJBW	New Orleans, La.	250
KSLO	Opelousas, La.	250
WQDY	Calais, Maine	250
WITH	Baltimore, Md.	250
WCUM	Cumberland, Md.	250
WMNB	No. Adams, Mass.	250
WESX	Salem, Mass.	250
WNEB	Worcester, Mass.	250
WJEF	Grand Rapids, Mich.	500
WIKB	Iron River, Mich.	250
WMPC	Lapeer, Mich.	250
WSOO	Slt. Ste. Marie, Mich.	250
WSTR	Sturgis, Mich.	250
WKLK	Cloquet, Minn.	250
KYSM	Mankato, Minn.	250
KTRF	Thief Riv. Flls., Minn.	250
KWNO	Winona, Minn.	250
WCMA	Corinth, Miss.	280
WHSY	Hattiesburg, Miss.	250
WSSO	Starkville, Miss.	250
WAZF	Yazoo City, Miss.	250
KODE	Joplin, Mo.	250
KLWT	Lebanon, Mo.	250
KNCM	Moberly, Mo.	250
KANA	Anaconda, Mont.	250
KBMN	Bozeman, Mont.	250
KXLO	Lewistown, Mont.	250
KLCB	Libby, Mont.	250
KTNC	Falls City, Nebr.	100
KHAS	Hastings, Nebr.	250
KELY	Ely, Nev.	250
KLAS	Las Vegas, Nev.	250
KDOT	Reno, Nev.	250
WMOU	Berlin, N.H.	250

Kc.	Wave Length	W.P.
WTSV	Claremont, N.H.	250
WCMC	Wildwood, N.J.	100
KALG	Alamogordo, N.Mex.	250
KOTS	Deming, N.Mex.	250
KYVA	Gallup, N.Mex.	250
KFUN	Las Vegas, N.Mex.	250
KSWS	Roswell, N.Mex.	250
WNIA	Cheektowaga, N.Y.	250
WENY	Elmira, N.Y.	250
WHUC	Hudson, N.Y.	250
WLFH	Little Falls, N.Y.	250
WFAS	White Plains, N.Y.	250
WSKY	Asheville, N.C.	250
WFAI	Fayetteville, N.C.	250
WMFR	High Point, N.C.	250
WISP	Kinston, N.C.	250
WNNC	Newton, N.C.	250
WCBT	Roanoke Rap., N.C.	250
KDIX	Dickinson, N.Dak.	250
WCPO	Cincinnati, Ohio	250
WCOL	Columbus, Ohio	250
WIRO	Ironton, Ohio	250
WTOL	Toledo, Ohio	250
KADA	N. of Ada, Okla.	250
WBBZ	Ponca City, Okla.	250
KVAS	Astoria, Oreg.	250
KRNS	Burns, Oreg.	250
KOOS	Coos Bay, Oreg.	250
KGRO	Gresham, Oreg.	250
KYJC	Medford, Oreg.	250
KQIK	Lakeview, Oreg.	250
WBVP	Beaver Falls, Pa.	250
WEEX	Easton, Pa.	250
WKBO	Harrisburg, Pa.	250
WCRO	Johnstown, Pa.	250
WBPZ	Lock Haven, Pa.	250
WNIK	Arecibo, P.R.	250
WERI	Westerly, R.I.	250
WAIM	Anderson, S.C.	250
WNOK	Columbia, S.C.	250
WOLS	Florence, S.C.	250
KISD	Sioux Falls, S.Dak.	250
WMMT	McMinnville, Tenn.	250
KSIX	Corpus Christi, Tex.	250
KDLK	Del Rio, Tex.	250
KNUZ	Houston, Tex.	250
KERV	Kerrville, Tex.	250
KLVT	Levelland, Tex.	250
KEEE	Nacogdoches, Tex.	250
KOSA	Odessa, Tex.	250
KHHH	Pampa, Tex.	250
KSEY	Seymour, Tex.	250
KCMC	Texarkana, Tex.	250
KSST	Sulphur Sprgs., Tex.	250
KWTX	Waco, Tex.	250
KMUR	Murray, Utah	250
KOAL	Price, Utah	250
WJOY	Burlington, Vt.	250
WBBI	Abingdon, Va.	250
WCFV	Clifton Forge, Va.	250
WFVA	Fredericksburg, Va.	250
WNOR	Norfolk, Va.	250
KQTY	Everett, Wash.	250
KLYK	Spokane, Wash.	250
KREW	Sunnyside, Wash.	250
WLOG	Logan, W.Va.	250
WTAP	Parkersburg, W.Va.	250
WHBY	Appleton, Wis.	250
WCLO	Janesville, Wis.	250
WHVF	Wausau, Wis.	250
KVOC	Casper, Wyo.	250

1240—241.8

Kc.	Wave Length	W.P.
CFLM	La Tuque, Que.	1000
CFNW	Norman Wells, Northwest Terr.	100
CFPR	Prince Rupert, B.C.	250
CFWH	Whitehorse, Y.T.	250
CJAV	Port Alberni, B.C.	250
CJCS	Stratford, Ont.	250
CJRW	Summerside, P.E.I.	250
CKBS	St. Hyacinthe, Que.	250
CKLS	LaSarre, Que.	250
WEBJ	Brewton, Ala.	250
WULA	Eufaula, Ala.	250
WOWL	Florence, Ala.	250
WARF	Jasper, Ala.	250
KZOW	So. of Globe, Ariz.	250
KOFA	Yuma, Ariz.	250
KVRC	Arkadelphia, Ark.	250
KAGH	Crossett, Ark.	250
KHOZ	Harrison, Ark.	250
KWAK	Stuttgart, Ark.	250
KPLY	Crescent City, Calif.	250
KRDU	Dinuba, Calif.	250
KMBY	Monterey, Calif.	250
KPPC	Pasadena, Calif.	100
KRKS	Ridgecrest, Calif.	250
KROY	Sacramento, Calif.	250
KRNO	San Bernardino, Calif.	250
KSON	San Diego, Calif.	250
KSMA	Santa Maria, Calif.	250
KSUE	Susanville, Calif.	250
KRDO	Colo. Sprgs., Colo.	250
KDGO	Durango, Colo.	250
KSLV	Monte Vista, Colo.	250
KCRT	Trinidad, Colo.	250
WWCO	Waterbury, Conn.	250
WBGC	Chipley, Fla.	250
WLCO	Eustis, Fla.	250
WINK	Fort Myers, Fla.	250
WMMB	Melbourne, Fla.	250
WFOY	St. Augustine, Fla.	250
WBHB	Fitzgerald, Ga.	250
WDUN	Gainesville, Ga.	250
WLAG	LaGrange, Ga.	250
WBML	Macon, Ga.	250
WWNS	Statesboro, Ga.	250
WPAX	Thomasville, Ga.	250
WTWA	Thomson, Ga.	250
KANI	Kailua, Hawaii	250
KVNI	Coeur d'Alene, Idaho	250
KWIK	Pocatello, Idaho	250
WCRW	Chicago, Ill.	100
WEDC	Chicago, Ill.	250
WSBC	Chicago, Ill.	250
WEBQ	Harrisburg, Ill.	250
WTAX	Springfield, Ill.	250
WSDR	Sterling, Ill.	100
WHBU	Anderson, Ind.	250
KDEC	Decorah, Iowa	250
KWLC	Decorah, Iowa	250
KBIZ	Ottumwa, Iowa	250
KICD	Spencer, Iowa	250
KIUL	Garden City, Kans.	250
KAKE	Wichita, Kans.	250
WINN	Louisville, Ky.	250
WFTM	Maysville, Ky.	250
WPKE	Pikeville, Ky.	250
WSFC	Somerset, Ky.	250
KASO	Minden, La.	250
KANE	New Iberia, La.	250
WCOU	Lewiston, Maine	250
WCEM	Cambridge, Md.	250
WJEJ	Hagerstown, Md.	250
WHAI	Greenfield, Mass.	250
WOCB	W. Yarmouth, Mass.	250
WATT	Cadillac, Mich.	250
WCBY	Cheboygan, Mich.	250
WJPD	Ishpeming, Mich.	250
WJIM	Lansing, Mich.	250
WMFG	Hibbing, Minn.	250
WJON	St. Cloud, Minn.	250
WMPA	Aberdeen, Miss.	250
WGRM	Greenwood, Miss.	250
WGCM	Gulfport, Miss.	250
WMOX	Meridian, Miss.	250
WMIS	Natchez, Miss.	250
KFMO	Flat River, Mo.	250
KWOS	Jefferson City, Mo.	250
KNEM	Nevada, Mo.	250
KBMY	Billings, Mont.	250
KLTZ	Glasgow, Mont.	250
KXLJ	Helena, Mont.	250
KFOR	Lincoln, Nebr.	250
KODY	North Platte, Nebr.	250
KELK	Elko, Nev.	250
WKBR	Manchester, N.H.	250
WSNJ	Bridgeton, N.J.	250
KAVE	Carlsbad, N.Mex.	250
KCLV	Clovis, N.Mex.	250
WGBB	Freeport, N.Y.	250
WGVA	Geneva, N.Y.	250
WJTN	Jamestown, N.Y.	250
WVOS	Liberty, N.Y.	250
WNBZ	Saranac Lake, N.Y.	250
WSNY	Schenectady, N.Y.	250
WATN	Watertown, N.Y.	250
WPNF	Brevard, N.C.	250
WSOC	Charlotte, N.C.	250
WCNC	Elizabeth City, N.C.	250
WJNC	Jacksonville, N.C.	250
WRAL	Raleigh, N.C.	250
KDLR	Devils Lake, N.Dak.	250
WBBW	Youngstown, Ohio	250
WHIZ	Zanesville, Ohio	250
KVSO	Ardmore, Okla.	250
KBEK	Elk City, Okla.	250
KBEL	Idabel, Okla.	250
KOKL	Okmulgee, Okla.	250
KFLY	Corvallis, Oreg.	1000d
KKID	Pendleton, Oreg.	250
KPRB	Redmond, Oreg.	250
KQEN	Roseburg, Oreg.	250
WRTA	Altoona, Pa.	250
WLEM	Emporium, Pa.	1000
WHUM	Reading, Pa.	250
WKOK	Sunbury, Pa.	250
WBAX	Wilkes-Barre, Pa.	250
WALO	Humacao, P.R.	250
WWON	Woonsocket, R.I.	250
WKDK	Newberry, S.C.	250
WBEJ	Elizabethton, Tenn.	250
WEKR	Fayetteville, Tenn.	250
WBIR	Knoxville, Tenn.	250
WKDA	Nashville, Tenn.	250
WENK	Union City, Tenn.	250
KVLF	Alpine, Tex.	250
KEAN	Brownwood, Tex.	100
KORA	Bryan, Tex.	250
KOCA	Kilgore, Tex.	250
KSOX	Raymondville, Tex.	250
KXOX	Sweetwater, Tex.	250
WSKI	Montpelier, Vt.	250
WSSV	Petersburg, Va.	250
WROV	Roanoke, Va.	250
WTON	Staunton, Va.	250
KXLE	Ellensburgh, Wash.	250
KGY	Olympia, Wash.	250
WKOY	Bluefield, W.Va.	250
WTIP	Charleston, W.Va.	250
WDNE	Elkins, W.Va.	250
WOMT	Manitowoc, Wis.	250
WIBU	Poynette, Wis.	250
WOBT	Rhinelander, Wis.	250
WJMC	Rice Lake, Wis.	250
KFBC	Cheyenne, Wyo.	250
KLUK	Evanston, Wyo.	250
KASL	Newcastle, Wyo.	250
KRAL	Rawlins, Wyo.	250
KTHE	Thermopolis, Wyo.	250

1250—239.9

Kc.	Wave Length	W.P.
CHWO	Oakville, Ont.	1000
CKBL	Matane, Que.	5000
CKSB	St. Boniface, Man.	1000
WZOB	Ft. Payne, Ala.	1000d
WETU	Wetumpka, Ala.	5000d
KFAY	Fayetteville, Ark.	500d
KAJI	Little Rock, Ark.	1000
KHOT	Madera, Calif.	500d
KTMS	Santa Barbara, Calif.	1000
KXXI	Golden, Colo.	1000d
WNER	Live Oak, Fla.	1000d
WRIM	Pahokee, Fla.	500d
WDAE	Tampa, Fla.	5000
WYTH	Madison, Ga.	1000d
WIZZ	Streator, Ill.	500d
WGL	Ft. Wayne, Ind.	1000
WRAY	Princeton, Ind.	1000d
KFKU	Lawrence, Kans.	5000
WREN	Topeka, Kans.	5000
WLCK	Scottsville, Ky.	500d
WGUY	Bangor, Maine	5000d
WARE	Ware, Mass.	1000
WWBC	Bay City, Mich.	1000d
KOTE	Fergus Falls, Minn.	1000
KCUE	Red Wing, Minn.	1000d
WHNY	McComb, Miss.	5000
KVLV	Fallon, Nev.	1000d
WMTR	Morristown, N.J.	1000d
WIPS	Ticonderoga, N.Y.	1000d
WBTC	Farmville, N.C.	500d
WBRM	Marion, N.C.	1000d
WCHO	Washington Court House, Ohio	500d
WPEL	Montrose, Pa.	1000d
WCAE	Pittsburgh, Pa.	5000
WNOW	York, Pa.	1000d
WTMA	Charleston, S.C.	5000
WKBL	Covington, Tenn.	1000d
KFTV	Paris, Tex.	500d
KPAC	Port Arthur, Tex.	5000
KUKA	San Antonio, Tex.	500d
KSML	Seminole, Tex.	1000d
KVEL	Vernal, Utah	1000d
WDVA	Danville, Va.	5000
WYSR	Franklin, Va.	1000d
WNRG	Grundy, Va.	1000d
KWSC	Pullman, Wash.	5000
KTW	Seattle, Wash.	1000
WEMP	Milwaukee, Wis.	5000

1260—238.0

Kc.	Wave Length	W.P.
CFRN	Edmonton, Alta.	10000
DYBU	Cebu, P.I.	1000
WCRT	Birmingham, Ala.	5000d
KPIN	Casa Grande, Ariz.	1000d
KCCB	Corning, Ark.	500d
KBHC	Nashville, Ark.	500d
KGIL	San Fernando, Calif.	1000
KYA	San Francisco, Calif.	5000
WMMM	Westport, Conn.	1000d
WWDC	Washington, D.C.	5000
WFTW	Fort Walton Beach, Florida	1000d
WMMA	Miami, Fla.	5000d
WWPF	Palatka, Fla.	1000
WHAB	Baxley, Ga.	5000d
WBBK	Blakely, Ga.	1000d
WTJH	East Point, Ga.	5000d
KIFI	Idaho Falls, Idaho	5000
KWEI	Weiser, Ida.	1000d
WIBV	Belleville, Ill.	1000d
WFBM	Indianapolis, Ind.	5000
KFGQ	Boone, Iowa	250d
KWHK	Hutchinson, Kans.	1000
WXOK	Baton Rouge, La.	1000d
WEZE	Boston, Mass.	5000
WALM	Albion, Mich.	1000
WJBL	Holland, Mich.	5000d
KROX	Crookston, Minn.	1000
KDUZ	Hutchinson, Minn.	1000d
WGVM	Greenville, Miss.	1000d
WNSL	Laurel, Miss.	1000d
KGBX	Springfield, Mo.	5000
KIMB	Kimball, Nebr.	1000d
WBUD	Trenton, N.J.	5000
KVSF	Santa Fe, N.Mex.	1000
WNDR	Syracuse, N.Y.	5000
WGWR	Asheboro, N.C.	1000d
WCDJ	Edenton, N.C.	1000d
WDOK	Cleveland, Ohio	5000
WNXT	Portsmouth, Ohio	5000
KWSH	Wewoka-Seminole, Oklahoma	1000
KMCM	McMinnville, Oreg.	1000
WERC	Erie, Pa.	5000
WPHB	Philipsburg, Pa.	1000d
WISO	Ponce, P.R.	1000
WMUU	Greenville, S.C.	1000d
WJOT	Lake City, S.C.	1000d
KWYR	Winner, S.Dak.	5000d
WNOO	Chattanooga, Tenn.	1000d
WMCH	Church Hill, Tenn.	1000d
WDKN	Dickson, Tenn.	1000d
WCLC	Jamestown, Tenn.	1000d
KSPL	Diboll, Tex.	1000d
KBLP	Falfurrias, Tex.	500d
KWFR	San Angelo, Tex.	1000d
KTUE	Tulia, Tex.	1000d
KTAE	Taylor, Tex.	1000d
WCHV	Charlottesville, Va.	5000
WBCR	Christiansburg, Va.	1000d
KWIQ	Moses Lake, Wash.	1000d
WVVW	Grafton, W.Va.	500d
WWIS	Black River Falls, Wis.	1000d
WEKZ	Monroe, Wis.	1000d
KPOW	Powell, Wyo.	5000

1270—236.1

Kc.	Wave Length	W.P.
CHAT	Medicine Hat, Alta.	1000
CHWK	Chilliwack, B.C.	10000
CJCB	Sydney, N.S.	5000
CFGT	St. Joseph d'Alma, Quebec	1000
WGSV	Guntersville, Ala.	1000d
WAIP	Prichard, Ala.	1000d
KBYR	Anchorage, Alaska	1000
KDJI	Holbrook, Ariz.	1000d
KPAP	Redding, Calif.	1000d
KCOK	Tulare, Calif.	1000
WNOG	Naples, Fla.	500d
WHIY	Orlando, Fla.	5000d
WTAL	Tallahassee, Fla.	5000
WGBA	Columbus, Ga.	5000d
WJJC	Commerce, Ga.	1000d
KTFI	Twin Falls, Idaho	5000
WEIC	Charleston, Ill.	1000d
WHBF	Rock Island, Ill.	5000
WCMR	Elkhart, Ind.	500
WWCA	Gary, Ind.	1000
WORX	Madison, Ind.	1000d
KSCB	Liberal, Kans.	1000d
WAIN	Columbia, Ky.	1000d
WFUL	Fulton, Ky.	1000d
KVCL	Winnfield, La.	1000d
WSPR	Springfield, Mass.	1000
WXYZ	Detroit, Mich.	5000
KWEB	Rochester, Minn.	500d
WLSM	Louisville, Miss.	1000d
KUSN	St. Joseph, Mo.	1000d
WTSN	Dover, N.H.	5000
WDVL	Vineland, N.J.	500d
KRAC	Alamogordo, N.Mex.	1000d
WHLD	Niagara Falls, N.Y.	5000d
WDLA	Walton, N.Y.	1000d
WCGC	Belmont, N.C.	1000
WMPM	Smithfield, N.C.	1000d
KBOM	Mandan, N.Dak.	1000
WILE	Cambridge, Ohio	1000d
KWPR	Claremore, Okla.	500d
KAJO	Grants Pass, Oreg.	1000d
WLBR	Lebanon, Pa.	1000
WBHC	Hampton, S.C.	1000d
KIHO	Sioux Falls, S.Dak.	1000
WLIK	Newport, Tenn.	5000d
KIOX	Bay City, Tex.	1000
KHEM	Big Spring, Tex.	1000d
KEPS	Eagle Pass, Tex.	1000d
KFJZ	Fort Worth, Tex.	5000
WYUO	Newport News, Va.	1000d
KCVL	Colville, Wash.	1000d
KBAM	Longview, Wash.	1000d
WKYR	Keyser, W.Va.	5000d

1280—234.2

Kc.	Wave Length	W.P.
CJMS	Montreal, Que.	5000
CKCV	Quebec, Que.	5000
WPID	Piedmont, Ala.	1000d
WNPT	Tuscaloosa, Ala.	5000
KHEP	Phoenix, Ariz.	1000d
KFOX	Long Beach, Calif.	1000
KJOY	Stockton, Calif.	1000
KTLN	Denver, Colo.	5000
WSUX	Seaford, Del.	1000d
WDSP	DeFuniak Springs, Florida	5000d
WQIK	Jacksonville, Fla.	5000d
WIPC	Lake Wales, Fla.	1000d
WIBB	Macon, Ga.	1000d
WMRO	Aurora, Ill.	250d
WGBF	Evansville, Ind.	5000
KCOB	Newton, Iowa	1000d
KSOK	Arkansas City, Kans.	1000
WCPM	Cumberland, Ky.	1000d
WDSU	New Orleans, La.	5000
KWCL	Oak Grove, La.	500d
WEIM	Fitchburg, Mass.	5000
WFYC	Alma, Mich.	1000d
WTCN	Minneapolis, Minn.	5000
KVOX	Moorhead, Minn.	1000
WSJC	Magee, Miss.	500d
KDKD	Clinton, Mo.	1000d
KYRO	Potosi, Mo.	500d
KCNI	Broken Bow, Nebr.	1000d
KTOO	Henderson, Nev.	5000d
WHBI	Newark, N.J.	2500
KZUM	Farmington, N.Mex.	5000d
KHOB	Hobbs, N.Mex.	1000d
WADO	New York, N.Y.	5000
WVET	Rochester, N.Y.	5000d
WRSA	Saratoga Sprgs., N.Y.	1000
WSAT	Salisbury, N.C.	1000
WONW	Defiance, Ohio	500
WLMJ	Jackson, Ohio	1000d
KLCO	Poteau, Okla.	1000d
KERG	Eugene, Oreg.	5000
WBRX	Berwick, Pa.	500d
WHVR	Hanover, Pa.	5000
WKST	New Castle, Pa.	5000
WCMN	Arecibo, P.R.	1000
WANS	Anderson, S.C.	1000
WJAY	Mullins, S.C.	1000d
WMCP	Columbia, Tenn.	1000d
WDNT	Dayton, Tenn.	1000d
KNIT	Abilene, Tex.	500d
KWHI	Brenham, Tex.	1000d
KLUE	Longview, Tex.	1000d
KNAK	Salt Lake City, Utah	5000
WYVE	Wytheville, Va.	1000d
KIT	Yakima, Wash.	5000
WVAR	Richwood, W.Va.	1000d
WNAM	Neenah, Wis.	1000

1290—232.4

Kc.	Wave Length	W.P.
CFAM	Altona, Man.	5000
CKSL	London, Ont.	5000
WTHG	Jackson, Ala.	1000d
WMLS	Sylacauga, Ala.	1000d
KEOS	Flagstaff, Ariz.	1000
KCUB	Tucson, Ariz.	1000
KDMS	El Dorado, Ark.	5000d
KUOA	Siloam Sprgs., Ark.	5000d
KHSL	Chico, Calif.	5000
KPER	Gilroy, Calif.	1000d
KITO	San Bernardino, Calif.	5000
WOCC	Hartford, Conn.	500d
WTUX	Wilmington, Del.	1000d
WTMC	Ocala, Fla.	5000
WSCM	Panama City Beach, Florida	500d
WIRK	W. Palm Bch., Fla.	5000
WDEC	Americus, Ga.	1000d
WCHK	Canton, Ga.	1000d
WTOC	Savannah, Ga.	5000
KYTE	Pocatello, Idaho	1000d
WIRL	Peoria, Ill.	5000
WCBL	Benton, Ky.	1000d
KJEF	Jennings, La.	1000d
WHGR	Houghton Lake, Michigan	5000d
WNIL	Niles, Mich.	500d
WOIA	Saline, Mich.	500d
KBMO	Benson, Minn.	500d
WBLE	Batesville, Miss.	1000d
KALM	Thayer, Mo.	1000d
KGVO	Missoula, Mont.	5000
KOIL	Omaha, Nebr.	5000
WKNE	Keene, N.H.	5000
KSRC	Socorro, N.M.	1000d
WGLI	Babylon, N.Y.	1000
WNBF	Binghamton, N.Y.	5000
WHKY	Hickory, N.C.	5000
WEYE	Sanford, N.C.	1000d
WOMP	Bellaire, Ohio	1000d
WHIO	Dayton, Ohio	5000
KUMA	Pendleton, Oreg.	5000
KLIQ	Portland, Oreg.	1000d
WTRN	Tyrone, Pa.	1000d
WICE	Providence, R.I.	5000
WFIG	Sumter, S.C.	1000
WATO	Oak Ridge, Tenn.	1000
KBLT	Big Lake, Tex.	1000d
KIVY	Crockett, Tex.	500d
KRGV	Weslaco, Tex.	5000
KTRN	Wichita Falls, Tex.	5000
WPVA	Colonial Hgts., Va.	5000d
WAGE	Leesburg, Va.	1000d
WVOW	Logan, W.Va.	5000
WMIL	Milwaukee, Wis.	1000d
WCOW	Sparta, Wis.	1000d

1300—230.6

CBAF	Moncton, N.B.	5000
CJME	Regina, Sask.	1000
WAVC	Boaz, Ala.	500d
WTLS	Tallassee, Ala.	1000d
KWCB	Searcy, Ark.	1000d
KROP	Brawley, Calif.	1000
KYNO	Fresno, Calif.	1000
KWKW	Pasadena, Calif.	1000
KVOR	Colo. Sprgs., Colo.	1000
WAVZ	New Haven, Conn.	1000
WRKT	Cocoa Beach, Fla.	500d
WSOL	Tampa, Fla.	5000d
WMTM	Moultrie, Ga.	5000d
WIMO	Winder, Ga.	1000d
KOZE	Lewiston, Idaho	5000
WTAQ	LaGrange, Ill.	500
WFRX	W. Frankfort, Ill.	1000d
WHLT	Huntington, Ind.	500d
WMFT	Terre Haute, Ind.	500d
KGLO	Mason City, Iowa	5000
WBLG	Lexington, Ky.	1000
WIBR	Baton Rouge, La.	1000
KLUE	Shreveport, La.	1000d
WFBR	Baltimore, Md.	5000
WJDA	Quincy, Mass.	1000d
WOOD	Grand Rapids, Mich.	5000
WRBC	Jackson, Miss.	5000
KMMO	Marshall, Mo.	1000d
KBRL	McCook, Nebr.	1000d
KPTL	Carson City, Nev.	5000
WAAT	Trenton, N.J.	250d
WOSC	Fulton, N.Y.	1000d
WGOL	Goldsboro, N.C.	1000d
WSYD	Mt. Airy, N.C.	5000
WERE	Cleveland, Ohio	5000
WMVO	Mt. Vernon, Ohio	500
KOME	Tulsa, Okla.	5000
KDOV	Medford, Oreg.	5000d
KACI	The Dalles, Oreg.	1000d
WTIL	Mayaguez, P.R.	1000
WCKI	Greer, S.C.	1000d
KOLY	Mobridge, S.Dak.	1000d
WMTN	Morristown, Tenn.	5000d
WMAK	Nashville, Tenn.	5000
KVET	Austin, Tex.	1000
KTFY	Brownfield, Tex.	1000d
KKAS	Silsbee, Tex.	500d
KOL	Seattle, Wash.	5000
WCLG	Morgantown, W.Va.	1000d
WKLC	St. Albans, W.Va.	1000d

1310—228.9

CKOY	Ottawa, Ont.	5000
CJRH	Richmond Hill, Ont.	1000
WHEP	Foley, Ala.	1000d
WJAM	Marion, Ala.	5000d
KBUZ	Mesa, Ariz.	5000
KBOK	Malvern, Ark.	1000d
KWBR	Oakland, Calif.	1000
KTKR	Taft, Calif.	500d
KFKA	Greeley, Colo.	1000
WICH	Norwich, Conn.	1000
WOOO	Deland, Fla.	5000d
WAUC	Wauchula, Fla.	500d
WBRO	Waynesboro, Ga.	1000d
WBMK	West Point, Ga.	1000
KLIX	Twin Falls, Idaho	1000
WISH	Indianapolis, Ind.	5000
KOKX	Keokuk, Iowa	1000
WTTL	Madisonville, Ky.	500d
WDOC	Prestonsburg, Ky.	5000d
KIKS	Sulphur, La.	500
KUZN	W. Monroe, La.	1000d
WLOB	Portland, Maine	1000d
WORC	Worcester, Mass.	5000
WKMH	Dearborn, Mich.	5000
KRBI	St. Peter, Minn.	1000d
WXXX	Hattiesburg, Miss.	1000d
KFSB	Joplin, Mo.	5000
KFBB	Great Falls, Mont.	5000
WJLK	Asbury Park, N.J.	250
WCAM	Camden, N.J.	250
KARA	Albuquerque, N.M.	1000d
WVIP	Mt. Kisco, N.Y.	1000d
WTLB	Utica, N.Y.	1000
WISE	Asheville, N.C.	5000
WKTC	Charlotte, N.C.	1000
WTIK	Durham, N.C.	1000
KNOX	Grand Forks, N.Dak.	5000
WFAH	Alliance, Ohio	1000d
KNPT	Newport, Oreg.	5000
WBFD	Bedford, Pa.	1000d
WGSA	Ephrata, Pa.	1000d
WNAE	Warren, Pa.	5000d
WDKD	Kingstree, S.C.	5000d
WDOD	Chattanooga, Tenn.	5000
WDXI	Jackson, Tenn.	5000
WBNT	Oneida, Tenn.	1000d
KZIP	Amarillo, Tex.	1000d
WRR	Dallas, Tex.	5000
KOYL	Odessa, Tex.	500d
KUBO	San Antonio, Tex.	5000d
WEEL	Fairfax, Va.	1000
WGH	Newport News, Va.	5000
KARY	Prosser, Wash.	1000d
WIBA	Madison, Wis.	5000

1320—227.1

CHQM	Vancouver, B.C.	10000
CKEC	New Glasgow, N.S.	1000
CJSO	Sorel, P.Q.	1000
CKKW	Kitchener, Ont.	1000
WAGF	Dothan, Ala.	1000
WENN	Birmingham, Ala.	5000d
KBLU	Yuma, Ariz.	500d
KWHN	Fort Smith, Ark.	5000
KRLW	Walnut Ridge, Ark.	1000d
KHSJ	Hemet, Calif.	500d
KUDE	Oceanside, Calif.	500
KCRA	Sacramento, Calif.	5000
KAVI	Rocky Ford, Colo.	1000d
WATR	Waterbury, Conn.	1000
WGMA	Hollywood, Fla.	1000d
WJHP	Jacksonville, Fla.	5000
WHIE	Griffin, Ga.	5000d
WNEG	Toccoa, Ga.	1000d
WKAN	Kankakee, Ill.	1000d
KMAQ	Maquoketa, Iowa	500d
KLWN	Lawrence, Kans.	500d
WBRT	Bardstown, Ky.	1000d
WNGO	Mayfield, Ky.	1000d
KVHL	Homer, La.	1000d
WICO	Salisbury, Md.	1000d
WARA	Attleboro, Mass.	1000
WILS	Lansing, Mich.	5000
WDMJ	Marquette, Mich.	1000
WCPC	Houston, Miss.	5000d
WRJW	Picayune, Miss.	5000d
KXLW	Clayton, Mo.	1000d
KOLT	Scottsbluff, Nebr.	5000
WWHG	Hornell, N.Y.	5000d
WAGY	Forest City, N.C.	500d
WCOG	Greensboro, N.C.	5000
KQDY	Minot, N.Dak.	1000d
WHOK	Lancaster, Ohio	1000d
KWOE	Clinton, Okla.	1000d
WKAP	Allentown, Pa.	1000
WAMP	Pittsburgh, Pa.	5000
WSCR	Scranton, Pa.	1000
WRIO	Rio Piedras, P.R.	5000
WMSC	Columbia, S.C.	1000
KELO	Sioux Falls, S.Dak.	5000
WKIN	Kingsport, Tenn.	5000d
WMSR	Manchester, Tenn.	1000d
KVMC	Colo. City, Tex.	1000d
KXYZ	Houston, Tex.	5000
KCPX	Salt Lake City, Utah	5000
WLLY	Richmond, Va.	1000d
KXRO	Aberdeen, Wash.	1000
KHIT	Walla Walla, Wash.	1000d
WQMN	Superior, Wis.	1000d

1330—225.4

CBH	Halifax, N.S.	100
WROS	Scottsboro, Ala.	1000d
KMOP	Tucson, Ariz.	500d
KFAC	Los Angeles, Calif.	5000
WARN	Ft. Pierce, Fla.	1000d
WYSE	Lakeland, Fla.	1000d
WEBY	Milton, Fla.	5000d
WMEN	Tallahassee, Fla.	5000d
WMLT	Dublin, Ga.	5000d
WEAW	Evanston, Ill.	1000d
WRAM	Monmouth, Ill.	1000d
WRRR	Rockford, Ill.	1000d
WJPS	Evansville, Ind.	5000
KWWL	Waterloo, Iowa	5000
KFH	Wichita, Kans.	5000
WMOR	Morehead, Ky.	1000d
KVOL	Lafayette, La.	1000
WASA	Harve deGrace, Md.	1000d
WCRB	Waltham, Mass.	5000
WTRX	Flint, Mich.	1000
WLOL	Minneapolis, Minn.	5000
WCRR	Corinth, Miss.	500d
WJPR	Greenville, Miss.	1000
WDAL	Meridian, Miss.	1000d
KUKU	Willow Springs, Mo.	500d
KGAK	Gallup, N.Mex.	5000
WEVD	New York, N.Y.	5000
WPOW	New York, N.Y.	5000
WEBO	Oswego, N.Y.	1000d
WHAZ	Troy, N.Y.	1000
WFIN	Findlay, Ohio	1000d
WKOV	Wellston, Ohio	500d
KPOJ	Portland, Oreg.	5000
KCFA	Spokane, Wash.	5000d
WBLF	Bellefonte, Pa.	500
WICU	Erie, Pa.	5000
WLAT	Conway, S.C.	5000d
WFBC	Greenville, S.C.	5000
WAEW	Crossville, Tenn.	1000d
WTRO	Dyersburg, Tenn.	500d
KMIL	Cameron, Tex.	500d
KSWA	Graham, Tex.	500d
KINE	Kingsville, Tex.	1000d
KDOK	Tyler, Tex.	1000d
WBTM	Danville, Va.	5000
WESR	Tasley, Va.	1000d
KFKF	Bellevue, Wash.	1000d
WETZ	New Martinsville, West Virginia	1000d
WHBL	Sheboygan, Wis.	1000
KOVE	Lander, Wyo.	1000

1340—223.7

CFGB	Goose Bay, Nfld.	250
CJAF	Cabano, Que.	250
CFSL	Weyburn, Sask.	250
CFYK	Yellow Knife, N.W.T.	150
CHAD	Amos, Que.	250
CJLS	Yarmouth, N.S.	250
CHRD	Drummondville, Que.	250
CJQC	Quebec, Que.	250
CKAR-I	Parry Sound, Ont.	250
CKOX	Woodstock, Ont.	250
WKUL	Cullman, Ala.	250
WJOI	Florence, Ala.	250
WGWC	Selma, Ala.	250
WFEB	Sylacauga, Ala.	250
KIBH	Seward, Alaska	250
KIKO	Miami, Ariz.	250
KNOG	Nogales, Ariz.	250
KZOK	Prescott, Ariz.	250
KBTA	Batesville, Ark.	250
KBRS	Springdale, Ark.	250
KENL	Arcata, Calif.	250
KMAK	Fresno, Calif.	250
KSFE	Needles, Calif.	250
KATY	San Luis Obispo, Calif.	250
KIST	Santa Barbara, Calif.	250
KOMY	Watsonville, Calif.	250
KDEN	Denver, Colo.	250
KVRH	Salida, Colo.	250
WNHC	New Haven, Conn.	250
WOOK	Washington, D.C.	250
WTAN	Clearwater, Fla.	250
WROD	Daytona Bch., Fla.	250
WDSR	Lake City, Fla.	250
WTYS	Marianna, Fla.	250
WQXT	Palm Beach, Fla.	250
WSEB	Sebring, Fla.	250
WNSM	Valparaiso-Niceville, Fla.	250
WGAU	Athens, Ga.	250
WAKE	Atlanta, Ga.	250
WBBQ	Augusta, Ga.	250
WGAA	Cedartown, Ga.	250
WOKS	Columbus, Ga.	250
WBBT	Lyons, Ga.	250
WTIF	Tifton, Ga.	250
KPST	Preston, Idaho	250
WSOY	Decatur, Ill.	250
WJPF	Herrin, Ill.	250
WJOL	Joliet, Ill.	250
WBIW	Bedford, Ind.	250
WTRC	Elkhart, Ind.	250
WLBC	Muncie, Ind.	250
KROS	Clinton, Iowa	250
KLIL	Estherville, Iowa	250
KCKN	Kansas City, Kans.	250
KSEK	Pittsburg, Kans.	250
WCMI	Ashland, Ky.	250
WBGN	Bowling Green, Ky.	250
WNBS	Murray, Ky.	250
WEKY	Richmond, Ky.	250
KVOB	Bastrop, La.	250
KRMD	Shreveport, La.	250
WFAU	Augusta, Maine	250
WHOU	Houlton, Maine	250
WGAW	Gardner, Mass.	250
WNBH	New Bedford, Mass.	250
WBRK	Pittsfield, Mass.	250
WLEW	Bad Axe, Mich.	250
WLAV	Grand Rap., Mich.	250
WCSR	Hillsdale, Mich.	100
WMTE	Manistee, Mich.	250
WAGN	Menominee, Mich.	250
WMBN	Petoskey, Mich.	250
WEXL	Royal Oak, Mich.	250
KDLM	Detroit Lakes, Minn.	250
WEVE	Eveleth, Minn.	250
KROC	Rochester, Minn.	250
KWLM	Willmar, Minn.	250
WJMB	Brookhaven, Miss.	250
WAML	Laurel, Miss.	250
KXEO	Mexico, Mo.	250
KSMO	Salem, Mo.	250
KICK	Springfield, Mo.	250
KCAP	Helena, Mont.	250
KPRK	Livingston, Mont.	250
KATL	Miles City, Mont.	250
KQTE	Missoula, Mont.	250
KFGT	Fremont, Nebr.	100
KGFW	Kearney, Nebr.	250
KSID	Sidney, Nebr.	250
KORK	Las Vegas, Nev.	250
KBET	Reno, Nev.	250
WDCR	Hanover, N.H.	250
WMID	Atlantic City, N.J.	250
KNDE	Aztec, N.M.	250
KSIL	Silver City, N.Mex.	1000
WMBO	Auburn, N.Y.	250
WENT	Gloversville, N.Y.	250
WJOC	Jamestown, N.Y.	250
WUSJ	Lockport, N.Y.	250
WMSA	Massena, N.Y.	250
WALL	Middletown, N.Y.	250
WIRY	Plattsburg, N.Y.	250
WJRI	Lenoir, N.C.	250
WTSB	Lumberton, N.C.	250
WOXF	Oxford, N.C.	250
WOOW	Washington, N.C.	250
WGNI	Wilmington, N.C.	250
WAIR	Winston-Salem, N.C.	250
KGPC	Grafton, N.D.	250
WNCO	Ashland, Ohio	250
WOUB	Athens, Ohio	250
WIZE	Springfield, Ohio	250
WSTV	Steubenville, Ohio	250
KIHN	Hugo, Okla.	250
KOCY	Okla. City, Okla.	250
KLOO	Corvallis, Oreg.	250
KIHR	Hood River, Oreg.	250
KFIR	North Bend, Oreg.	250
WFBG	Altoona, Pa.	250
WCVI	Connellsville, Pa.	250
WSAJ	Grove City, Pa.	100
WKRZ	Oil City, Pa.	250
WHAT	Philadelphia, Pa.	250
WRAW	Reading, Pa.	250
WBRE	Wilkes-Barre, Pa.	250
WWPA	Williamsport, Pa.	250
WGRF	Aguadilla, P.R.	250
WOKE	Charleston, S.C.	250
WRHI	Rock Hill, S.C.	250
WSSC	Sumter, S.C.	250
KIJV	Huron, S.D.	250
KRSD	Rapid City, S.Dak.	250
WBAC	Cleveland, Tenn.	250
WKRM	Columbia, Tenn.	250
WGRV	Greenville, Tenn.	250
WKGN	Knoxville, Tenn.	250
WHHM	Memphis, Tenn.	250
WCDT	Winchester, Tenn.	250
KWKC	Abilene, Tex.	250
KAND	Corsicana, Tex.	250
KSET	El Paso, Tex.	250
KDUB	Lubbock, Tex.	250
KRBA	Lufkin, Tex.	250
KVKM	Monahans, Tex.	250
KPDN	Pampa, Tex.	250
KOLE	Port Arthur, Tex.	250
KTXL	San Angelo, Tex.	250
KVIC	N. of Victoria, Tex.	250
WTWN	St. Johnsbury, Vt.	250
WKEY	Covington, Va.	250
WHAP	Hopewell, Va.	250
WJMA	Orange, Va.	250
KAGT	Anacortes, Wash.	250
KPKW	Pasco, Wash.	250
KAPA	Raymond, Wash.	250
KMEL	Wenatchee, Wash.	250
WHAR	Clarksburg, W.Va.	250
WEPM	Martinsburg, W.Va.	250
WMON	Montgomery, W.Va.	250
WOVE	Welch, W.Va.	250
WLDY	Ladysmith, Wis.	250
WRIT	Milwaukee, Wis.	250
WFHR	Wis. Rapids, Wis.	250
KOWB	Laramie, Wyo.	250
KWOR	Worland, Wyo.	250

1350—222.1

CHOV	Pembroke, Ont.	1000
CJDC	Dawson Creek, B.C.	1000
CHGB	St. Anne de la Pocatiere, Que.	1000
CKLB	Oshawa, Ont.	10000
CKEN	Kentville, N.S.	1000
WELB	Elba, Ala.	1000d
WGAD	Gadsden, Ala.	5000
KAAB	Hot Springs, Ark.	1000
KLYD	Bakersfield, Calif.	1000d
KCKC	San Bernardino, Calif.	500
KSRO	Santa Rosa, Calif.	1000
KGHF	Pueblo, Colo.	5000
WNLK	Norwalk, Conn.	500
WPCT	Putnam, Conn.	1000d
WDCF	Dade City, Fla.	1000d
WRPB	Warner Robins, Ga.	1000d
KRLC	Lewiston, Idaho	5000
WAAP	Peoria, Ill.	1000
WJBD	Salem, Ill.	500d
WIOU	Kokomo, Ind.	1000

Kc.	Wave Length	W.P.
KRNT	Des Moines, Iowa	5000
KMAN	Manhattan, Kans.	500d
WLOU	Louisville, Ky.	5000d
WSMB	New Orleans, La.	5000
WDEA	Ellsworth, Me.	1000d
WHMI	Howell, Mich.	500
KDIO	Ortonville, Minn.	1000d
WCMP	Pine City, Minn.	1000d
WKOZ	Kosciusko, Miss.	5000d
KCHR	Charleston, Mo.	1000d
KBRX	O'Neill, Nebr.	1000d
WLNH	Laconia, N.H.	5000d
KABQ	Albuquerque, N.M.	5000
WCBA	Corning, N.Y.	1000d
WRNY	Rome, N.Y.	500d
WHIP	Mooresville, N.C.	1000d
KQDI	Bismarck, N.D.	500d
WADC	Akron, Ohio	5000
WCHI	Chillicothe, Ohio	500d
KRHD	Duncan, Okla.	250
KTLQ	Tahlequah, Okla.	1000d
WORK	York, Pa.	5000
WDAR	Darlington, S.C.	500d
WGSW	Greenwood, S.C.	1000d
WRKM	Carthage, Tenn.	500d
KTXJ	Jasper, Tex.	1000d
KCOR	San Antonio, Tex.	5000
WBLT	Bedford, Va.	1000d
WNVA	Norton, Va.	5000d
WAVY	Portsmouth, Va.	5000
WPDR	Portage, Wis.	1000d

1360—220.4

WWWB	Jasper, Ala.	1000d
WMFC	Monroeville, Ala.	1000d
WELR	Roanoke, Ala.	1000d
KRUX	Glendale, Ariz.	5000
KLYR	Clarksville, Ark.	500d
KFFA	Helena, Ark.	1000
KFIV	Modesto, Calif.	1000
KRCK	Ridgecrest, Calif.	1000d
KGB	San Diego, Calif.	1000
WDRC	Hartford, Conn.	5000
WOBS	Jacksonville, Fla.	5000d
WKAT	Miami Beach, Fla.	5000
WIOD	Sanford, Fla.	500d
WINT	Winter Haven, Fla.	1000d
WAZA	Bainbridge, Ga.	1000d
WLAW	Lawrenceville, Ga.	1000d
WLBK	DeKalb, Ill.	500d
WVMC	Mt. Carmel, Ill.	500d
KXGI	Ft. Madison, Iowa	1000d
KSCJ	Sioux City, Iowa	5000
KBTO	El Dorado, Kans.	500d
WFLW	Monticello, Ky.	1000d
KDBC	Mansfield, La.	1000d
KVIM	New Iberia, La.	1000d
KTLD	Tallulah, La.	500d
WEBB	Dundalk, Md.	5000d
WLYN	Lynn, Mass.	1000d
WKMI	Kalamazoo, Mich.	5000
KLRS	Mountain Grove, Mo.	1000d
WNNJ	Newton, N.J.	500d
WWBZ	Vineland, N.J.	1000
WKOP	Binghamton, N.Y.	5000
WMNS	Olean, N.Y.	1000d
WCHL	Chapel Hill, N.C.	1000d
KEYZ	Williston, N.D.	5000
WSAI	Cincinnati, Ohio	5000
WWOW	Conneaut, Ohio	500d
KUIK	Hillsboro, Oreg.	1000d
WMCK	McKeesport, Pa.	1000
WPPA	Pottsville, Pa.	1000
WELP	Easley, S.C.	1000d
WLCM	Lancaster, S.C.	1000d
WNAH	Nashville, Tenn.	1000d
KRAY	Amarillo, Tex.	500d
KACT	Andrews, Tex.	1000d
KWBA	Baytown, Tex.	1000
KRYS	Corpus Christi, Tex.	1000
KXOL	Ft. Worth, Tex.	5000
WBOB	Galax, Va.	1000d
WHBG	Harrisonburg, Va.	5000d
KFDR	Grand Coulee, Wash.	1000d
KMO	Tacoma, Wash.	5000
WHJC	Matawan, W.Va.	1000d
WMOV	Ravenswood, W.Va.	1000d
WBAY	Green Bay, Wis.	5000
WISV	Virouqua, Wis.	500d
WMNE	Menomonie, Wis.	1000d
KVRS	Rock Springs, Wyo.	1000

1370—218.8

WBYE	Calera, Ala.	1000d
KBUC	Corona, Calif.	1000
KEEN	San Jose, Calif.	5000
KGEN	Tulare, Calif.	1000d
WHYS	Ocala, Fla.	1000d
WCOA	Pensacola, Fla.	5000
WAXE	Vero Beach, Fla.	1000d
WBGR	Jesup, Ga.	1000d
WFDR	Manchester, Ga.	1000d
WKLE	Washington, Ga.	1000d
WPRC	Lincoln, Ill.	500d
WTTS	Bloomington, Ind.	5000
WGRY	Gary, Ind.	500d
KDTH	Dubuque, Iowa	1000
KGNO	Dodge City, Kans.	5000
WGOH	Grayson, Ky.	5000d
KAPB	Marksville, La.	1000d
WKIK	Leonardtown, Md.	1000d
WGHN	Grand Haven, Mich.	500d
KSUM	Fairmont, Minn.	1000
WDOB	Canton, Miss.	1000d
KWRT	Boonville, Mo.	1000d
KCRV	Caruthersville, Mo.	1000d
KXLF	Butte, Mont.	5000
KAWL	York, Nebr.	500d
WFEA	Manchester, N.H.	5000
WALK	Patchogue, N.Y.	500d
WSAY	Rochester, N.Y.	5000
WLTC	Gastonia, N.C.	1000d
WTAB	Tabor City, N.C.	5000d
KFJM	Grand Forks, N.D.	1000d
WSPD	Toledo, Ohio	5000
KAST	Astoria Oreg.	1000
WOTR	Corry, Pa.	1000
WPAZ	Pottstown, Pa.	1000d
WKMC	Roaring Sprgs., Pa.	1000d
WIVV	Vieques, P.R.	1000
WDEF	Chattanooga, Tenn.	5000
WDXE	Lawrenceburg, Tenn.	1000d
WRGS	Rogersville, Tenn.	1000d
KOKE	Austin, Tex.	1000d
KFRO	Longview, Tex.	1000
KUKO	Post, Tex.	500d
KSOP	Salt Lake City, Utah	1000d
WBTN	Bennington, Vt.	500d
WHEE	Martinsville, Va.	1000d
WJWS	South Hill, Va.	1000d
KPOR	Quincy, Wash.	1000d
WMOD	Moundsville, W.Va.	1000d
WCCN	Neillsville, Wis.	5000d
KVWO	Cheyenne, Wyo.	1000

1380—217.3

CFDA	Victoriaville, Que.	1000
CKPC	Brantford, Ont.	10000
CKLC	Kingston, Ont.	5000
WGYV	Greenville, Ala.	1000d
KDXE	N. Little Rock, Ark.	1000d
KBVM	Lancaster, Calif.	1000d
KGMS	Sacramento, Calif.	1000
KSBW	Salinas, Calif.	5000
KFLJ	Walsenburg, Colo.	1000d
WAMS	Wilmington, Del.	1000
WLIZ	Lake Worth, Fla.	500d
WQXQ	Ormond Bch., Fla.	1000d
WLCY	St. Petersburg, Fla.	5000
WAOK	Atlanta, Ga.	5000
WRWH	Cleveland, Ga.	500d
KPOI	Honolulu, Hawaii	5000
WITE	Brazil, Ind.	500d
WKJG	Ft. Wayne, Ind.	5000
KCIM	Carroll, Iowa	1000
WMTA	Central City, Ky.	500d
WWKY	Winchester, Ky.	1000d
WYNK	Baton Rouge, La.	500d
WKTJ	Farmington, Me.	1000d
WTTH	Port Huron, Mich.	1000
KLIZ	Brainerd, Minn.	1000d
KAGE	Winona, Minn.	1000d
WDLT	Indianola, Miss.	500d
KUDL	Kansas City, Mo.	1000d
KWK	St. Louis, Mo.	5000
KUVR	Holdredge, Nebr.	500d
WAWZ	Zarephath, N.J.	5000
WBNX	New York, N.Y.	5000
WLOS	Asheville, N.C.	5000
WTOB	Winston-Salem, N.C.	5000
WWIZ	Lorain, Ohio	500d
WPKO	Waverly, Ohio	1000d
KSWO	Lawton, Okla.	1000
KMUS	Muskogee, Okla.	1000
KBCH	Ocean Lake, Oreg.	1000d
KSRV	Ontario, Oreg.	5000
WACB	Kittanning, Pa.	1000d
WAYZ	Waynesboro, Pa.	1000d
WNRI	Woonsocket, R.I.	1000d
WAGS	Bishopville, S.C.	1000d
KOTA	Rapid City, S.Dak.	5000
KJET	Beaumont, Tex.	1000d
KBWD	Brownwood, Tex.	1000
KCRN	Crane, Tex.	1000d
KTSM	El Paso, Tex.	1000
KMUL	Muleshoe, Tex.	500d
KBOP	Pleasanton, Tex.	1000d
WSYB	Rutland, Vt.	5000
WMBG	Richmond, Va.	5000
KRKO	Everett, Wash.	1000
WBEL	Beloit, Wis.	5000

1390—215.7

CKLN	Nelson, B.C.	1000
WHMA	Anniston, Ala.	5000
KDQN	DeQueen, Ark.	500d
KAMO	Rogers, Ark.	1000d
KGER	Long Beach, Calif.	5000
KTUR	Turlock, Calif.	1000
KFML	Denver, Colo.	1000d
WAVP	Avon Park, Fla.	1000d
WGES	Chicago, Ill.	5000
WFIW	Fairfield, Ill.	500d
WJCD	Seymour, Ind.	1000d
KCLN	Clinton, Iowa	1000d
KCBC	Des Moines, Iowa	1000
KNCK	Concordia, Kans.	500d
WANY	Albany, Ky.	1000d
WKIC	Hazard, Ky.	5000d
KNOE	Monroe, La.	5000
WCAT	Orange, Mass.	1000d
WPLM	Plymouth, Mass.	5000d
WCER	Charlotte, Mich.	1000d
KRFO	Owatonna, Minn.	500d
WROA	Gulfport, Miss.	1000d
WQIC	Meridian, Miss.	5000d
KENN	Farmington, N.Mex.	5000
WEOK	Poughkeepsie, N.Y.	1000d
WRIV	Riverhead, N.Y.	1000d
WFBL	Syracuse, N.Y.	5000
WFNC	Fayetteville, N.C.	5000
WKRK	Murphy, N.C.	1000d
WEED	Rocky Mount, N.C.	5000
WADA	Shelby, N.C.	500d
KLPM	Minot, N.Dak.	5000
WOHP	Bellefontaine, Ohio	500d
WMPO	Middleport-Pomroy, Ohio	1000d
WFMJ	Youngstown, Ohio	5000
KCRC	Enid, Okla.	1000
KSLM	Salem, Oreg.	5000
WLAN	Lancaster, Pa.	1000
WHPB	Belton, S.C.	500d
WCSC	Charleston, S.C.	5000
WTJS	Jackson, Tenn.	5000
KULP	El Campo, Tex.	500d
KBEC	Waxahachie, Tex.	500d
KLGN	Logan, Utah	1000d
WEAM	Arlington, Va.	5000
WWOD	Lynchburg, Va.	5000
KLOQ	Yakima, Wash.	1000

1400—214.2

CKBC	Bathurst, N.B.	250
CKCY	Sault Ste. Marie, Ont.	250
CJFP	Riviere-du-Loup, Que.	1000
CKRN	Rouyn, Que.	250
CKSW	Swift Current, Sask.	250
WMSL	Decatur, Ala.	250
WXAL	Demopolis, Ala.	250
WFPA	Ft. Payne, Ala.	250
WJLD	Homewood, Ala.	250
WJHO	Opelika, Ala.	250
KSEW	Sitka, Alaska	250
KCLF	Clifton, Ariz.	250
KXIV	Phoenix, Ariz.	250
KTUC	Tucson, Ariz.	250
KVOY	Yuma, Ariz.	250
KELD	El Dorado, Ark.	250
KCLA	Pine Bluff, Ark.	250
KWYN	Wynne, Ark.	250
KRE	Berkeley, Calif.	250
KREO	Indio, Calif.	250
KSDA	Redding, Calif.	250
KSPA	Santa Paula, Calif.	250
KHOE	Truckee, Calif.	1400
KUKI	Ukiah, Calif.	250
KONG	Visalia, Calif.	250
KRLN	Canon City, Colo.	250
KDTA	Delta, Colo.	250
KFTM	Ft. Morgan, Colo.	250
KBZZ	La Junta, Colo.	250
WSTC	Stamford, Conn.	250
WILI	Willimantic, Conn.	250
WFTL	Ft. Lauderdale, Fla.	250
WIRA	Ft. Pierce, Fla.	250
WRHC	Jacksonville, Fla.	250
WPRY	Perry, Fla.	250
WTRR	Sanford, Fla.	250
WCOS	Alma, Ga.	250
WSGC	Elberton, Ga.	250
WNEX	Macon, Ga.	250
WMGA	Moultrie, Ga.	250
WCOH	Newnan, Ga.	250
WGSA	Savannah, Ga.	250
KART	Jerome, Idaho	250
KRPL	Moscow, Idaho	250
KSPT	Sandpoint, Idaho	250
WDWS	Champaign, Ill.	250
WGIL	Galesburg, Ill.	250
WEOA	Evansville, Ind.	250
WBAT	Marion, Ind.	250
KCOG	Centerville, Iowa	100
KVFD	Fort Dodge, Iowa	250
KVOE	Emporia, Kans.	250
KAYS	Hays, Kans.	250
WCYN	Cynthiana, Ky.	100
WIEL	Elizabethtown, Ky.	250
WFTG	London, Ky.	250
WFPR	Hammond, La.	250
KAOK	Lake Charles, La.	250
WRDO	Augusta, Maine	250
WIDE	Biddeford, Maine	250
WWIN	Baltimore, Md.	250
WALE	Fall River, Mass.	250
WLLH	Lowell, Mass.	250
WHMP	Northampton, Mass.	250
WELL	Battle Creek, Mich.	250
WJLB	Detroit, Mich.	250
WHDF	Houghton, Mich.	250
WMAB	Munising, Mich.	250
WSAM	Saginaw, Mich.	250
WSJM	St. Joseph, Mich.	250
WTCM	Traverse City, Mich.	250
KEYL	Long Prairie, Minn.	250
KMHL	Marshall, Minn.	250
WMIN	Mpls.-St. Paul, Minn.	250
WHLB	Virginia, Minn.	250
WBIP	Booneville, Miss.	250
WNAG	Grenada, Miss.	250
WFOR	Hattiesburg, Miss.	250
WJQS	Jackson, Miss.	250
WMBC	Macon, Miss.	250
KFRU	Columbia, Mo.	250
KSIM	Sikeston, Mo.	250
KTTS	Springfield, Mo.	250
KXGN	Glendive, Mont.	250
KARR	Great Falls, Mont.	250
KCOW	Alliance, Nebr.	250
KLIN	Lincoln, Nebr.	250
KBMI	Henderson, Nev.	250
KWNA	Winnemucca, Nev.	250
WTSL	Hanover, N.H.	250
KGFL	Roswell, N. Mex.	250
KTRC	Santa Fe, N.Mex.	250
KCHS	Truth or Consequences, New Mexico	250
KTNM	Tucumcari, N.Mex.	250
WOND	Pleasantville, N.J.	250
WABY	Albany, N.Y.	250
WBNY	Buffalo, N.Y.	250
WELM	Elmira, N.Y.	250
WSLB	Ogdensburg, N.Y.	250
WOTT	Watertown, N.Y.	5000d
WBMA	Beaufort, N.C.	250
WGBG	Greensboro, N.C.	250
WKDX	Hamlet, N.C.	250
WSIC	Statesville, N.C.	250
WLSE	Wallace, N.C.	250
WHCC	Waynesville, N.C.	250
KEYJ	Jamestown, N.Dak.	250
WPAY	Portsmouth, Ohio	250
KWON	Bartlesville, Okla.	250
KTMC	McAlester, Okla.	250
KNOR	Norman, Okla.	250
KWIN	Ashland, Oreg.	250
KOMB	Cottage Grove, Oreg.	250
WEST	Easton, Pa.	250
WJET	Erie, Pa.	250
WHGB	Harrisburg, Pa.	250
WJAC	Johnstown, Pa.	250
WKBI	St. Marys, Pa.	250
WICK	Scranton, Pa.	250
WRAK	Williamsport, Pa.	250
WHOA	San Juan, P.R.	250
WPCC	Clinton, S.C.	500
WCOS	Columbia, S.C.	1000
WGTN	Georgetown, S.C.	250
WTHE	Spartanburg, S.C.	250
WJZM	Clarksville, Tenn.	250
WHUB	Cookeville, Tenn.	250
WLSB	Copper Hill, Tenn.	250
WKPT	Kingsport, Tenn.	250
WGAP	Maryville, Tenn.	250
WHAL	Shelbyville, Tenn.	250
KRUN	Ballinger, Tex.	250
KBYG	Big Spring, Tex.	100
KUNO	Corpus Christi, Tex.	250
KILE	nr. Galveston, Tex.	250
KGVL	Greenville, Tex.	250
KEBE	Jacksonville, Tex.	250
KIUN	Pecos, Tex.	250
KEYE	Perryton, Tex.	250
KVOP	Plainview, Tex.	250
KDWT	Stamford, Tex.	250
KTEM	Temple, Tex.	250
KTFS	Texarkana, Tex.	250
KVOU	Uvalde, Tex.	250
KIXX	Provo, Utah	250
WDOT	Burlington, Vt.	250
WINA	Charlottesville, Va.	250
WLOW	Portsmouth, Va.	250
WHLF	So. Boston, Va.	250
WINC	Winchester, Va.	250
KWLK	Longview, Wash.	250
KRSC	Othello, Wash.	250
KTNT	Tacoma, Wash.	250
WBOY	Clarkesburg, W.Va.	250
WRON	Ronceverte, W.Va.	250
WKWK	Wheeling, W.Va.	250
WBTH	Williamson, W.Va.	250
WATW	Ashland, Wis.	250
WBIZ	Eau Claire, Wis.	250
WDUZ	Green Bay, Wis.	250
WRJN	Racine, Wis.	250
WRDB	Reedsburg, Wis.	250
WRIG	Wausau, Wis.	250
KATI	Caspar, Wyo.	250
KODI	Cody, Wyo.	250

1410—212.6

CFUN	Vancouver, B.C.	10000
WALA	Mobile, Ala.	5000
KTCS	Fort Smith, Ark.	500d
KERN	Bakersfield, Calif.	500
KRML	Carmel, Calif.	500d
KMYC	Marysville, Calif.	5000
KCAL	Redlands, Calif.	1000d
KCOL	Ft. Collins, Colo.	1000
WPOP	Hartford, Conn.	5000
WDOV	Dover, Del.	1000d
WMYR	Fort Myers, Fla.	5000
WBIL	Leesburg, Fla.	1000d
WDAX	McRae, Ga.	1000d
WLAQ	Rome, Ga.	1000
WRMN	Elgin, Ill.	500d
WTIM	Taylorville, Ill.	1000d
KGRN	Grinnell, Iowa	500d
KLEM	LeMars, Iowa	1000d
KCLO	Leavenworth, Kans.	5000d
KWBB	Wichita, Kans.	5000
WLBJ	Bowling Green, Ky.	5000
WHLN	Harlan, Ky.	5000d
KDBS	Alexandria, La.	1000d
WGRD	Grand Rap., Mich.	1000d
KLFD	Litchfield, Minn.	500d
WDSK	Cleveland, Miss.	1000d
WBKN	Newton, Miss.	500d
WHTG	Eatontown, N.J.	500d
WDOE	Dunkirk, N.Y.	500
WEGO	Concord, N.C.	1000d
WSRC	Durham, N.C.	1000d
WING	Dayton, Ohio	5000
KPAM	Portland, Oreg.	5000d
WLSH	Lansford, Pa.	1000d
KQV	Pittsburgh, Pa.	5000
WYMB	Manning, S.C.	1000d
WCMT	Martin, Tenn.	1000d
KBUD	Athens, Tex.	1000d
KBAN	Bowie, Tex.	500d
KVLB	Cleveland, Tex.	500
KXIT	Dalhart, Tex.	500d
KADO	Marshall, Tex.	500
KRIG	Odessa, Tex.	1000

Kc.	Wave Length	W.P.
KBAL	San Saba, Tex.	500d
KNAL	Victoria, Tex.	500
WRIS	Roanoke, Va.	5000d
WKBH	LaCrosse, Wis.	5000
KWYO	Sheridan, Wyo.	1000

1420—211.1

CKPT	Peterborough, Ont.	1000
CJMT	Chicoutimi, Que.	1000
CKOM	Saskatoon, Sask.	5000
WACT	Tuscaloosa, Ala.	5000d
KHFH	Sierra Vista, Ariz.	1000d
KPOC	Pocahontas, Ark.	1000d
KSTN	Stockton, Calif.	1000
WLIS	Old Saybrook, Conn.	500d
WBRD	Bradenton, Fla.	1000
WDBF	Delray Beach, Fla.	500d
WSTN	St. Augustine, Fla.	1000d
WAVO	Avondale Estates, Ga.	500d
WRBL	Columbus, Ga.	5000
WLET	Toccoa, Ga.	5000d
WINI	Murphysboro, Ill.	500d
WIMS	Michigan City, Ind.	1000
WOC	Davenport, Iowa	5000
KJCK	Junction City, Kans.	1000d
WTCR	Ashland, Ky.	5000d
WHBN	Harrodsburg, Ky.	1000d
WVJS	Owensboro, Ky.	1000
KPEL	Lafayette, La.	1000
WBSM	New Bedford, Mass.	1000
WBEC	Pittsfield, Mass.	1000
WAMM	Flint, Mich.	500
KTOE	Mankato, Minn.	5000
WSUH	Oxford, Miss.	1000d
WQBC	Vicksburg, Miss.	1000
KBTN	Neosho, Mo.	500d
KOOO	Omaha, Nebr.	500d
WALY	Herkimer, N.Y.	1000d
WACK	Newark, N.Y.	500
WLNA	Peekskill, N.Y.	1000d
WMYN	Mayodan, N.C.	500
WGAS	S. Gastonia, N.C.	500d
WVOT	Wilson, N.C.	1000
WHK	Cleveland, Ohio	5000
KTJS	Hobart, Okla.	1000d
KYNG	Coos Bay, Oreg.	1000d
WCOJ	Coatesville, Pa.	5000
WCED	DuBois, Pa.	5000
WEUC	Ponce, P.R.	1000
WCRE	Cheraw, S.C.	1000d
KABR	Aberdeen, S.D.	1000d
WEMB	Erwin, Tenn.	5000d
WKSR	Pulaski, Tenn.	1000
KFYN	Bonham, Tex.	250d
KTRE	Lufkin, Tex.	1000
KGNB	New Braunfels, Tex.	1000d
KPEP	San Angelo, Tex.	1000d
WWSR	St. Albans, Vt.	1000d
WDDY	Gloucester, Va.	1000d
WKCW	Warrenton, Va.	5000d
KITI	Chehalis, Wash.	1000d
KUJ	Walla Walla, Wash.	5000
WPLY	Plymouth, Wis.	500d

1430—209.7

CKFH	Toronto, Ont.	5000
WFHK	Pell City, Ala.	1000d
KHBM	Monticello, Ark.	1000d
KAMP	El Centro, Calif.	1000d
KARM	Fresno, Calif.	5000
KALI	Pasadena, Calif.	5000
KOSI	Aurora, Colo.	5000
WSDB	Homestead, Fla.	500d
WLAK	Lakeland, Fla.	5000
WPCF	Panama City, Fla.	5000
WGFS	Covington, Ga.	1000d
WRCD	Dalton, Ga.	1000d
WWGS	Tifton, Ga.	5000d
WCMY	Ottawa, Ill.	500d
WIRE	Indianapolis, Ind.	5000
KASI	Ames, Iowa	1000d
KMRC	Morgan City, La.	500d
WNAV	Annapolis, Md.	1000
WHIL	Medford, Mass.	5000d
WION	Ionia, Mich.	500d
WBRB	Mt. Clemens, Mich.	500d
WLAU	Laurel, Miss.	5000d
WIL	St. Louis, Mo.	5000
KRGI	Grand Island, Nebr.	1000
WNJR	Newark, N.J.	5000
WENE	Endicott, N.Y.	5000
WMNC	Morganton, N.C.	5000d
WRXO	Roxboro, N.C.	1000d
WFOB	Fostoria, Ohio	1000
WCLT	Newark, Ohio	500d
KALV	Alva, Okla.	500
KTUL	Tulsa, Okla.	5000
KGAY	Salem, Oreg.	5000d
WVAM	Altoona, Pa.	1000
WFRA	Franklin, Pa.	500d
WBLR	Batesburg, S.C.	5000d
WATP	Marion, S.C.	1000d
KBRK	Brookings, S. Dak.	1000d
WENO	Madison, Tenn.	5000d
WHER	Memphis, Tenn.	1000
KSTB	Breckenridge, Tex.	1000d
KSIJ	Gladewater, Tex.	1000d
KCOH	Houston, Tex.	1000d
KLO	Ogden, Utah	5000
KBRC	Mt. Vernon, Wash.	5000
WEIR	Weirton, W.Va.	1000
WBEV	Beaver Dam, Wis.	1000d

1440—208.2

CFCP	Courtenay, B.C.	1000
WHHY	Montgomery, Ala.	5000
KPOK	Scottsdale, Ariz.	5000d
KOKY	Little Rock, Ark.	5000d
KVON	Napa, Calif.	500
KPRO	Riverside, Calif.	1000
KCOY	Santa Maria, Calif.	1000
WBIS	Bristol, Conn.	500d
WABR	Winter Park, Fla.	5000
WWCC	Bremen, Ga.	1000d
WGIG	Brunswick, Ga.	5000
WRAJ	Anna, Ill.	500d
WPRS	Paris, Ill.	500d
WGEM	Quincy, Ill.	1000
WROK	Rockford, Ill.	1000
WPGW	Portland, Ind.	500d
KCHE	Cherokee, Iowa	500d
KJAY	Topeka, Kans.	5000
WKLX	Paris, Ky.	1000d
WEZJ	Williamsburg, Ky.	500d
KMLB	Monroe, La.	5000
WJAB	Westbrook, Me.	5000d
WAAB	Worcester, Mass.	5000
WBCM	Bay City, Mich.	1000
WCHB	Inkster, Mich.	1000d
KEVE	Golden Valley, Minn.	5000
WMVB	Millville, N.J.	1000d
WBAB	Babylon, N.Y.	500d
WJJL	Niagara Falls, N.Y.	1000d
WBLA	Elizabethtown, N.C.	1000d
WBUY	Lexington, N.C.	5000d
KILO	Grand Forks, N.D.	1000
WHHH	Warren, Ohio	5000
KMED	Medford, Oreg.	5000
KODL	The Dalles, Oreg.	1000
WCDL	Carbondale, Pa.	5000d
WGCB	Red Lion, Pa.	1000d
WQOK	Greenville, S.C.	5000
WZYX	Cowan, Tenn.	1000d
WHDM	McKenzie, Tenn.	500d
KFDA	Amarillo, Tex.	5000
KEYS	Corpus Christi, Tex.	1000
KDNT	Denton, Tex.	1000
KETX	Livingston, Tex.	1000d
WKLV	Blackstone, Va.	5000d
WHIS	Bluefield, W.Va.	5000
WAJR	Morgantown, W.Va.	5000
WJPG	Green Bay, Wis.	5000

1450—206.8

CBG	Gander, Nfld.	250
CFAB	Windsor, N.S.	250
CFJR	Brockville, Ont.	1000
CHEF	Granby, P.Q.	1000
CJOY	Guelph, Ont.	250
WDNG	Anniston, Ala.	250
WYAM	Bessemer, Ala.	250
WDIG	Dothan, Ala.	250
WFUN	Huntsville, Ala.	250
WLAY	Muscle Shoals City, Ala.	250
KLAM	Cordova, Alaska	250
KAWT	Douglas, Ariz.	250
KNOT	Prescott, Ariz.	250
KOLD	Tucson, Ariz.	250
KHOG	Fayetteville, Ark.	250
KENA	Mena, Ark.	250
KYOR	Blythe, Calif.	250
KOWN	Escondido, Calif.	250
KPAL	Palm Springs, Calif.	250
KTIP	Porterville, Calif.	250
KSAN	San Francisco, Calif.	250
KROG	Sonora, Calif.	250
KVEN	Ventura, Calif.	250
KAGR	Yuba City, Calif.	100
KGIW	Alamosa, Colo.	250
KYOU	Greeley, Colo.	250
WNAB	Bridgeport, Conn.	250
WILM	Wilmington, Del.	250
WOL	Washington, D.C.	250
WWJB	Brooksville, Fla.	250
WMFJ	Daytona Beach, Fla.	250
WSKP	Miami, Fla.	250
WBSR	Pensacola, Fla.	250
WSPB	Sarasota, Fla.	250
WSTU	Stuart, Fla.	250
WTNT	Tallahassee, Fla.	250
WGPC	Albany, Ga.	250
WBHF	Cartersville, Ga.	250
WCON	Cornelia, Ga.	250
WKEU	Griffin, Ga.	250
WMVG	Milledgeville, Ga.	250
WCCP	Savannah, Ga.	250
WVLD	Valdosta, Ga.	250
KEOK	Payette, Idaho	250
KEEP	Twin Falls, Idaho	250
WHFC	Cicero, Ill.	250
WKEI	Kewanee, Ill.	100
WCVS	Springfield, Ill.	250
WANE	Ft. Wayne, Ind.	250
WASK	Lafayette, Ind.	250
WAOV	Vincennes, Ind.	250
KPIG	Cedar Rapids, Iowa	250
KWBW	Hutchinson, Kans.	250
WTCO	Campbellsville, Ky.	250
WWXL	Manchester, Ky.	250
WPAD	Paducah, Ky.	250
KSIG	Crowley, La.	250
KNOC	Natchitoches, La.	250
WNPS	New Orleans, La.	250
WRKD	Rockland, Maine	250
WKTQ	South Paris, Maine	250
WTBO	Cumberland, Md.	250
WMAS	Springfield, Mass.	250
WATZ	Alpena Township, Mich.	250
WHTC	Holland, Mich.	250
WMIQ	Iron Mtn., Mich.	250
WIBM	Jackson, Mich.	250
WKLA	Ludington, Mich.	250
WHLS	Port Huron, Mich.	250
KATE	Albert Lea, Minn.	250
KBUN	Bemidji, Minn.	250
KBMW	Breckenridge, Minn.	250
WELY	Ely, Minn.	250
KFAM	St. Cloud, Minn.	250
WROX	Clarksdale, Miss.	250
WCJU	Columbia, Miss.	250
WJXN	Jackson, Miss.	250
WOKK	Meridian, Miss.	1000
WNAT	Natchez, Miss.	250
WROB	West Point, Miss.	250
WMBH	Joplin, Mo.	250
KIRX	Kirksville, Mo.	250
KOKO	Warrensburg, Mo.	250
KWPM	West Plains, Mo.	250
KXXL	Bozeman, Mont.	250
KUDI	Great Falls, Mont.	250
KXLL	Missoula, Mont.	250
KVCK	Wolf Point, Mont.	250
KWBE	Beatrice, Nebr.	250
KCSR	Chadron, Nebr.	250
KONE	Reno, Nev.	250
WKXL	Concord, N.H.	250
WFPG	Atlantic City, N.J.	250
WCTC	New Brunswick, N.J.	250
KLOS	Albuquerque, N.Mex.	250
KLMX	Clayton, N.Mex.	250
KOBE	Las Cruces, N.Mex.	250
KENM	Portales, N.Mex.	250
WHDL	Allegany, N.Y.	250
WCLI	Corning, N.Y.	250
WWSC	Glen Falls, N.Y.	250
WHDL	Olean, N.Y.	250
WKIP	Poughkeepsie, N.Y.	250
WKAL	Rome, N.Y.	250
WATA	Boone, N.C.	250
WGNC	Gastonia, N.C.	250
WHVH	Henderson, N.C.	250
WHKP	Hendersonville, N.C.	250
WHIT	New Bern, N.C.	250
WJER	Dover, Ohio	250
WMOH	Hamilton, Ohio	250
WLEC	Sandusky, Ohio	250
KWHW	Altus, Okla.	250
KGFF	Shawnee, Okla.	250
KSIW	Woodward, Okla.	250
KWRO	Coquille, Oreg.	250
KORE	Eugene, Oreg.	1000
KFLW	Klamath Falls, Oreg.	250
KLBM	La Grande, Oreg.	250
KBPS	Portland, Oreg.	250
WLEU	Erie, Pa.	250
WGET	Gettysburg, Pa.	250
WDAD	Indiana, Pa.	250
WPAM	Pottsville, Pa.	250
WMPT	So. Williamsport, Pa.	250
WMAJ	State College, Pa.	250
WJPA	Washington, Pa.	250
WNEL	Caguas, P.R.	250
WWRI	W. Warwick, R.I.	250
WQSN	Charleston, S.C.	250
WCRS	Greenwood, S.C.	250
WMYB	Myrtle Beach, S.C.	250
WHSC	Hartsville, S.C.	250
KBFS	Belle Fourche, S.Dak.	250
KYNT	Yankton, S.Dak.	250
WLAR	Athens, Tenn.	250
WOGA	Chattanooga, Tenn.	250
WDSG	Dyersburg, Tenn.	250
WLAF	LaFollette, Tenn.	100
WGNS	Murfreesboro, Tenn.	250
KRIC	Beaumont, Tex.	250
KBEN	Carrizo Sprgs., Tex.	250
KCTI	Gonzales, Tex.	250
KMBL	Junction, Tex.	250
KCYL	Lampasas, Tex.	250
KMHT	Marshall, Tex.	250
KCMR	McCamey, Tex.	250
KNET	Palestine, Tex.	250
KSNY	Snyder, Tex.	250
KURA	Moab, Utah	250
KEYY	Provo, Utah	250
KDXU	St. George, Utah	250
WSNO	Barre, Vt.	250
WTSA	Brattleboro, Vt.	250
WFTR	Front Royal, Va.	250
WREL	Lexington, Va.	250
WMVA	Martinsville, Va.	250
WLPM	Suffolk, Va.	250
KBKW	Aberdeen, Wash.	250
KCLX	Colfax, Wash.	250
KRSC	Othello, Wash.	100
KONP	Port Angeles, Wash.	250
KAYE	Puyallup, Wash.	250
WPAR	Parkersburg, W.Va.	250
KFIZ	Fond du Lac, Wis.	250
WDLB	Marshfield, Wis.	250
WPFP	Park Falls, Wis.	250
WRCO	Richland Center, Wis.	250
KBBS	Buffalo, Wyo.	250
KWRL	Riverton, Wyo.	250

1460—205.4

CKRB	Ville St. Georges, Quebec	10000
CJNB	N. Battleford, Sask.	10000
WFMH	Cullman, Ala.	5000d
WPNX	Phenix City, Ala.	5000
KCCL	Paris, Ark.	500d
KTYM	Inglewood, Calif.	1000d
KDON	Salinas, Calif.	5000
KYSN	Colo. Sprgs., Colo.	1000
WBAR	Bartow, Fla.	1000d
WZEP	DeFuniak Springs, Florida	1000d
WMBR	Jacksonville, Fla.	5000
WDMF	Buford, Ga.	1000d
WROY	Carmi, Ill.	1000d
WKAM	Goshen, Ind.	1000d
WOCH	North Vernon, Ind.	500d
KSO	Des Moines, Iowa	5000
KCRB	Chanute, Kans.	1000d
WRVK	Mt. Vernon, Ky.	500d
WAIL	Baton Rouge, La.	5000
KBSF	Springhill, La.	1000d
WBET	Brockton, Mass.	1000
WBRN	Big Rapids, Mich.	1000d
WPON	Pontiac, Mich.	500
KDMA	Montevideo, Minn.	1000
WELZ	Belzoni, Miss.	1000d
KADY	St. Charles, Mo.	5000d
KRNY	Kearney, Nebr.	5000d
KENO	Las Vegas, Nev.	1000
WOKO	Albany, N.Y.	5000
WVOX	New Rochelle, N.Y.	500d
WHEC	Rochester, N.Y.	5000
WFVG	Fuquay Sprgs., N.C.	1000d
WMMH	Marshall, N.C.	500d
WBNS	Columbus, Ohio	5000
WPVL	Painesville, Ohio	500d
KPLK	Dallas, Oreg.	1000d
WMBA	Ambridge, Pa.	500d
WCMB	Harrisburg, Pa.	5000
WBCU	Union, S.C.	1000
WGOG	Walhalla, S.C.	500d
WJAK	Jackson, Tenn.	1000d
WEEN	Lafayette, Tenn.	1000d
KBRZ	Freeport, Tex.	500d
KLLL	Lubbock, Tex.	1000d
WACO	Waco, Tex.	1000
WPRW	Manassas, Va.	500d
WRAD	Radford, Va.	5000
KIMA	Yakima, Wash.	5000
WRAC	Racine, Wis.	500d

1470—204.0

CHOW	Welland, Ontario	500d
CFOX	Pointe Claire, Que.	1000
WBLO	Evergreen, Ala.	1000d
KBLO	Hot Springs, Ark.	1000d
KBMX	Coalinga, Calif.	500d
KUTY	Palmdale, Calif.	1000d
KXOA	Sacramento, Calif.	1000
WMMW	Meriden, Conn.	1000d
WPOM	Pompano Beach, Fla.	5000d
WDCL	Tarpon Sprgs., Fla.	5000d
WAAG	Adel, Ga.	1000d
WDOL	Athens, Ga.	1000d
WCLA	Claxton, Ga.	1000
WRGA	Rome, Ga.	5000
WMBD	Peoria, Ill.	5000
WCBC	Anderson, Ind.	1000d
KTRI	Sioux City, Iowa	5000
KWVY	Waverly, Iowa	1000d
KARE	Atchison, Kans.	1000
WSAC	Fort Knox, Ky.	1000d
KPLC	Lake Charles, La.	5000
WLAM	Lewiston, Maine	5000
WJDY	Salisbury, Md.	5000d
WTTR	Westminster, Md.	1000d
WSRO	Marlborough, Mass.	1000d
WNBP	Newburyport, Mass.	500d
WKMF	Flint, Mich.	1000
WKLZ	Kalamazoo, Mich.	500d
KANO	Anoka, Minn.	1000d
WCHJ	Brookhaven, Miss.	1000d
WNAU	New Albany, Miss.	500d
KGHM	Brookfield, Mo.	500d
KTCB	Malden, Mo.	1000d
WTKO	Ithaca, N.Y.	1000d
WPDM	Potsdam, N.Y.	1000d
WBIG	Greensboro, N.C.	5000
WPNC	Plymouth, N.C.	1000d
WTOE	Spruce Pine, N.C.	1000d
WOHO	Toledo, Ohio	1000
KVLH	Pauls Valley, Okla.	250d
KVIN	Vinita, Okla.	500d
WSAN	Allentown, Pa.	5000
WFAR	Farrell, Pa.	1000d
WOIC	Columbia, S.C.	5000d
WEAG	Alcoa, Tenn.	1000d
WHER	Memphis, Tenn.	1000d
WVOL	Nashville, Tenn.	1000d
KRBC	Abilene, Tex.	5000
KWRD	Henderson, Tex.	500d
KCNY	San Marcos, Tex.	250d
KELA	Centralia, Wash.	5000
KSEM	Moses Lake, Wash.	5000
WPLH	Huntington, W.Va.	5000d
WBKV	West Bend, Wis.	500d
KTWO	Casper, Wyo.	5000

1480—202.6

WABB	Mobile, Ala.	5000
KHAT	Phoenix, Ariz.	500
KGLU	Safford, Ariz.	1000
KTCN	Berryville, Ark.	1000
KIEM	Eureka, Calif.	5000
KYOS	Merced, Calif.	5000
KWIZ	Santa Ana, Calif.	1000
KTUX	Pueblo, Colo.	1000d
WAPG	Arcadia, Fla.	1000d
WEZY	Cocoa, Fla.	1000d
WTHR	Panama Beach, Fla.	500d
WYZE	Atlanta, Ga.	5000d
WRDW	Augusta, Ga.	5000
WTHI	Terre Haute, Ind.	1000
WRSW	Warsaw, Ind.	500

Kc.	Wave Length	W.P.
KYOK	Houston, Tex.	5000
KCBD	Lubbook, Tex.	1000
KBUS	Mexia, Tex.	500d
KTOD	Sinton, Tex.	1000d
WEZL	Richmond, Va.	5000d
KTIX	Seattle, Wash.	5000d
WSWW	Platteville, Wis.	1000d
WTRW	Two Rivers, Wis.	1000d
KCHY	Cheyenne, Wyo.	1000d

1600—187.5

Kc.	Wave Length	W.P.
CHVC	Niagara Falls, Ont.	5000
WEUP	Huntsville, Ala.	5000d
WAPX	Montgomery, Ala.	1000
KGST	Fresno, Calif.	1000d
KWOW	Pomona, Calif.	1000
KUBA	Yuba City, Calif.	1000
KLAK	Lakewood, Colo.	1000
WKEN	Dover, Del.	500d
WKTX	Atlantic Beach, Fla.	1000d
WKWF	Key West, Fla.	500
WHEW	Riviera Beach, Fla.	1000d
WOKB	Winter Garden, Fla.	1000d
WGKA	Atlanta, Ga.	1000d
WCGO	Chicago Hgts., Ill.	1000d
WMCW	Harvard, Ill.	500d
WBTO	Linton, Ind.	500d
WARU	Peru, Ind.	1000d
KLGA	Algona, Iowa	5000d
KCRG	Cedar Rapids, Iowa	5000
KMDO	Ft. Scott, Kans.	500d
WNES	Central City, Ky.	500d
WSTL	Eminence, Ky.	500d
KFNV	Ferriday, La.	1000d
KLFT	Golden Meadow, La.	1000d
KLVI	Vivian, La.	500d
WINX	Rockville, Md.	1000
WBOS	Brookline, Mass.	5000
WTYM	East Longmeadow, Mass.	5000d
WHRV	Ann Arbor, Mich.	1000
WTRU	Muskegon, Mich.	5000
WKDL	Clarksdale, Miss.	1000d
KATZ	St. Louis, Mo.	5000
KTTN	Trenton, Mo.	500d
KNCY	Nebraska City, Nebr.	500d
WONG	Oneida, N.Y.	1000d
WWRL	Woodside, N.Y.	5000
WGIV	Charlotte, N.C.	1000d
WIDU	Fayetteville, N.C.	1000d
WFRC	Reidsville, N.C.	1000
WKSK	W. Jefferson, N.C.	1000d
WBLY	Springfield, Ohio	1000d
WTTF	Tiffin, Ohio	500d
KUSH	Cushing, Okla.	1000d
KASH	Eugene, Oreg.	1000
WHOL	Allentown, Pa.	500d
WEZN	Elizabethtown, Pa.	500d
WFIS	Fountain Inn, S.C.	1000d
WGUS	N. Augusta, S.C.	500
WHBT	Harriman, Tenn.	5000d
WKBJ	Milan, Tenn.	1000d
KBBB	Borger, Tex.	500d
KBOR	Brownsville, Tex.	1000
KWEL	Midland, Tex.	1000
KCFH	Cuero, Tex.	500d
KMAE	McKinney, Tex.	1000d
KOGT	Orange, Tex.	1000
KBBC	Centerville, Utah	1000d
WBOF	Virginia Bch., Va.	1000d
WHLL	Wheeling, W.Va.	5000d
WCWC	Ripon, Wis.	5000d

U. S. and Canadian AM Stations by Location

Abbreviations: C.L., call letters; Kc., frequency in kilocycles; N.A., network affiliation—A: American Broadcasting Co., C: Columbia Broadcasting System, Inc.; M: Mutual Broadcasting System; N: National Broadcasting Co., Inc.

Location	C.L.	Kc.	N.A.
Abbeville, La.	KROF	960	
Abbeville, S.C.	WABV	1590	
Aberdeen, Md.	WAMD	970	
Aberdeen, Miss.	WMPA	1240	
Aberdeen, S.Dak.	KABR	1220	
	KSDN	930	A
Aberdeen, Wash.	KBKW	1450	
	KXRO	1320	M
Abilene, Tex.	KRBC	1470	A
	KNIT	1280	
	KWKC	1340	M
Abingdon, Va.	WBBI	1230	
Ada, Okla.	KADA	1230	A
Adel, Ga.	WAAG	1470	
Adrian, Mich.	WABJ	1490	A
Aguadilla, P.R.	WABA	850	
	WGRF	1340	
Ahoskie, N.C.	WRCS	970	
Aiken, S.C.	WAKN	990	
Akron, Ohio	WAKR	1590	A
	WADC	1350	C
	WCUE	1150	
	WHLO	640	M
Alamogordo, N.M.	KALG	1230	M
	KRAC	1270	
Alamosa, Colo.	KGIW	1450	M
Albany, Ga.	WALB	1590	A
	WGPC	1450	C
	WJAZ	1050	
Albany, Ky.	WANY	1390	
Albany, Minn.	KASM	1150	
Albany, N.Y.	WABY	1400	
	WOKO	1460	M
	WPTR	1540	A
	WROW	590	C
Albany, Oreg.	KWIL	790	M
	KABY	990	
Albemarle, N.C.	WABZ	1010	
	WZKY	1580	
Albert Lea, Minn.	KATE	1450	A
Albertville, Ala.	WAVU	630	
Albion, Mich.	WALM	1260	
Albuquerque, N.M.	KABQ	1350	
	KDEF	1150	
	KGGM	610	C
	KOB	1030	N
	KQEO	920	M
	KARA	1310	
	KLOS	1450	
	KHAM	1580	A
Alcoa, Tenn.	WEAG	1470	
Alexander City, Ala.	WRFS	1050	
Alexandria, La.	KALB	580	A
	KDBS	1410	
	KSYL	970	N
Alexandria, Minn.	KXRA	1490	A
Alexandria, Va.	WPIK	730	M
Algona, Iowa	KLGA	1600	
Alice, Tex.	KOPY	1070	
Allegan, Mich.	WOWE	1580	
Allentown, Pa.	WHOL	1600	
	WAEB	790	
	WKAP	1320	
	WSAN	1470	C
Alliance, Nebr.	KCOW	1400	
Alliance, Ohio	WFAH	1310	
Alma, Ga.	WCOS	1400	
Alma, Mich.	WFYC	1280	
Alpena Township, Mich.	WATZ	1450	
Alpine, Tex.	KVLF	1240	M
Alton, Ill.	WOKZ	1570	
Altona, Man.	CFAM	1290	
Altoona, Pa.	WFBG	1340	N
	WRTA	1240	A
	WVAM	1430	C
Alturas, Calif.	KCNO	570	
Altus, Okla.	KWHW	1450	
Alva, Okla.	KALV	1430	
Amarillo, Tex.	KBUY	1010	M
	KFDA	1440	A
	KGNC	710	N
	KIXZ	940	C
	KRAY	1360	
	KZIP	1310	
Ambridge, Pa.	WMBA	1460	
Americus, Ga.	WDEC	1290	
Ames, Iowa	KSAI	1430	
	WOI	640	
Amherst, N.S.	CKDH	1400	
Amite, La.	WABL	1570	
Amory, Miss.	WAMY	1580	
Amos, Que.	CHAD	1340	
Amsterdam, N.Y.	WCSS	1490	
Anaconda, Mont.	KANA	1230	
Anacortes, Wash.	KAGT	1340	
Anaheim, Calif.	KEZY	1190	
Anchorage, Alaska	KBYR	1270	
	KFQD	730	C-A
	KENI	550	A-M-N
Andalusia, Ala.	WCTA	920	
Anderson, Ind.	WCBC	1470	M
	WHBU	1240	C
Anderson, S.C.	WAIM	1230	C
	WANS	1280	M
Andrews, Tex.	KACT	1360	
Annapolis, Md.	WANN	1190	
	WABW	810	
	WNAV	1430	
Ann Arbor, Mich.	WHRV	1600	A
	WPAG	1050	
Anna, Ill.	WRAJ	1440	
Anniston, Ala.	WANA	1490	
	WDNG	1450	A
	WHMA	1390	
Anoka, Minn.	KANO	1470	
Ansonia, Conn.	WADS	690	
Antigo, Wis.	WATK	900	
Artesia, N.M.	KSVP	990	M
Antigonish, N.S.	CJFX	580	
Apollo, Pa.	WAVL	910	
Apple Valley, Cal.	KAVR	960	
Appleton, Wis.	WAPL	1570	
	WHBY	1230	M
Arcadia, Fla.	WAPG	1480	
Arcata, Calif.	KENL	1340	
Ardmore, Okla.	KVSO	1240	A
Arecibo, P.R.	WCMN	1280	
	WMIA	1070	
	WNIK	1230	
Arkadelphia, Ark.	KVRC	1240	M
Arkan. City, Kans.	KSOK	1280	
Arlington, Fla.	WTTT	1220	
Arlington, Va.	WARL	780	
	WEAM	1390	
Artesia, N.M.	KSVP	990	M
Asbury Park, N.J.	WJLK	1310	
Asheboro, N.C.	WGWR	1260	
Asheville, N.C.	WISE	1310	
	WLOS	1380	N-M-A
	WSKY	1230	
	WWNC	570	C
Ashland, Ky.	WCMI	1340	C
	WTCR	1420	
Ashland, Ohio	WNCO	1340	
Ashland, Oreg.	KWIN	1400	M
Ashland, Wis.	WATW	1400	
Ashtabula, Ohio	WICA	970	
Astoria, Oreg.	KAST	1370	M
	KVAS	1230	
Atchison, Kans.	KARE	1470	
Athens, Ala.	WJMW	730	
Athens, Ga.	WGAU	1340	C
	WDOL	1470	
	WRFC	960	
Athens, Ohio	WATH	970	
	WOUB	1340	
Athens, Tenn.	WLAR	1450	M
Athens, Tex.	KBUD	1410	
Atlanta, Ga.	WPLO	590	C
	WAKE	1340	
	WAOK	1380	
	WERD	860	
	WGKA	1600	
	WGST	920	A
	WIIN	970	
	WQXI	790	
	WSB	750	N
	WYZE	1480	M
Atlanta, Tex.	KALT	900	
Atlantic, Iowa	KJAN	1220	
Atlantic Beach, Fla.	WKTX	1600	
Atlantic City, N.J.	WFPG	1450	C
	WLDB	1490	M
	WMID	1340	A
Atmore, Ala.	WATM	1590	
Attleboro, Mass.	WARA	1320	
Auburn, Ala.	WAUD	1230	A
Auburn, Calif.	KAHI	950	
Auburn, N.Y.	WMBO	1340	M
Auburn, Wash.	KASY	1220	
Auburndale, Fla.	WTWB	1570	
Augusta, Ga.	WAUG	1050	
	WBBQ	1340	M
	WBIA	1230	N
	WGAC	580	A
	WRDW	1480	C
Augusta, Maine	WRDO	1400	N
	WFAU	1340	M
Aurora, Colo.	KOSI	1430	
Aurora, Ill.	WMRO	1280	
Austin, Minn.	KAUS	1480	M
Austin, Tex.	KNOW	1490	A
	KTBC	590	C
	KOKE	1370	
	KVET	1300	M
Avalon, Calif.	KBIG	740	
Avon Park, Fla.	WAVP	1390	
Avondale Estates, Ga.	WAVO	1420	
Aztec, N. Mex.	KNDE	1340	
Babylon, N.Y.	WBAB	1440	
	WGLI	1290	
Bad Axe, Mich.	WLEW	1340	
Bainbridge, Ga.	WMGR	930	
	WAZA	1360	
Baker, Oreg.	KBKR	1490	
Bakersfield, Calif.	KAFY	550	M
	KBIS	970	
	KERN	1410	C
	KGEE	1230	
	KUZZ	800	
	KLYD	1350	
	KMAP	1490	
	KPMC	1560	A
Baldwinsville, N.Y.	WSEN	1050	
Ballinger, Tex.	KRUN	1400	
Baltimore, Md.	WBAL	1090	N
	WBMD	750	
	WCAO	600	
	WCBM	680	C
	WFBR	1300	
	WITH	1230	
	WSID	1010	
	WWIN	1400	A-M
Bamberg, S.C.	WWBD	790	
Bangor, Maine	WABI	910	A-M
	WGUY	1250	C
	WLBZ	620	N
Banning, Calif.	KPAS	1490	
Barboursville, Ky.	WBVL	950	
Bardstown, Ky.	WBRT	1320	
Barnesboro, Pa.	WNCC	950	
Barnwell, S.C.	WBAW	740	
Barre, Vt.	WSNO	1450	
Barrie, Ont.	CKBB	950	
Barstow, Calif.	KWTC	1230	A
Bartlesville, Okla.	KWON	1400	M
Bartow, Fla.	WBAR	1460	
Bastrop, La.	KTRY	730	
	KVOB	1340	
Batavia, N.Y.	WBTA	1490	M
Batesburg, S.C.	WBLR	1430	
Batesville, Ark.	KBTA	1340	
Batesville, Miss.	WBLE	1290	
Bath, Maine	WMMS	730	
Bathurst, N.B.	CKBC	1400	
Baton Rouge, La.	WAIL	1460	M
	WYNK	1380	
	WIBR	1300	
	WJBO	1150	N
	WLCS	910	
	WXOK	1260	
Battle Creek, Mich.	WBCK	930	
	WELL	1400	A
Baxley, Ga.	WHAB	1260	
Bay City, Mich.	WBCM	1440	A
	WWBC	1250	
Bay City, Tex.	KIOX	1270	M
Bay Minette, Ala.	WBCA	1150	
Bayamon, P.R.	WENA	1560	
Baytown, Tex.	KRCT	650	
	KWBA	1360	
Beatrice, Nebr.	KWBE	1450	
Beaufort, N.C.	WBMA	1400	
Beaufort, S.C.	WBEU	960	
Beaumont, Tex.	KFDM	560	A
	KJET	1380	
	KRIC	1450	
	KTRM	990	
Beaver Dam, Wis.	WBEV	1430	
Beaver Falls, Pa.	WBVP	1230	
Beckley, W. Va.	WJLS	560	C
	WWNR	620	
Bedford, Ind.	WBIW	1340	
Bedford, Pa.	WBFD	1310	
Bedford, Va.	WBLT	1350	
Beeville, Tex.	KIBL	1490	
Belgrade, Mont.	KGVW	630	
Bellaire, Ohio	WOMP	1290	M
Bellefontaine, Ohio	WOHP	1390	
Bellefonte, Pa.	WBLF	1330	
Bell Fourche, S.Dak.	KBFS	1450	
Belle Glade, Fla.	WSWN	900	
Belleville, Ont.	CJBQ	800	
Belleville, Ill.	WIBV	1260	
Bellevue, Wash.	KFKF	1330	
Bellingham, Wash.	KPUG	1170	M
	KVOS	790	A
Bellingham-Ferndale, Wash.	KENY	930	
Belmont, N.C.	WCGC	1270	M-A
Beloit, Wis.	WBEL	1380	
	WGEZ	1490	M
Belton, S.C.	WHPB	1390	
Belzoni, Miss.	WELZ	1460	
Bemidji, Minn.	KBUN	1450	M
Bend, Oreg.	KBND	1110	A
	KGRL	940	
Bennetsville, S.C.	WBSC	1550	M
Bennington, Vt.	WBTN	1370	
Benson, Minn.	KBMO	1290	
Benton, Ark.	KBBA	690	
Benton, Ky.	WCBL	1290	
Benton Harbor, Mich.	WHFB	1060	
Berkeley, Calif.	KRE	1400	
Berkeley Springs, W.Va.	WCST	1010	
Berlin, N.H.	WMOU	1230	
Berryville, Ark.	KTCN	1480	
Berwick, Pa.	WBRX	1280	
Bessemer, Ala.	WYAM	1450	
Bethesda, Md.	WUST	1120	
Bethlehem, Pa.	WGPA	1100	
Biddeford, Maine	WIDE	1400	M
Big Lake, Tex.	KBLT	1290	
Big Rapids, Mich.	WBRN	1460	
Big Sprg., Tex.	KBST	1490	A
	KHEM	1270	
	KBYG	1400	M
Big Stone Gap, Va.	WLSD	1220	
Bijou, Calif.	KOWL	1490	
Biloxi, Miss.	WLOX	1490	M
	WVMI	570	
Billings, Mont.	KBMY	1240	M
	KGHL	790	N
	KOOK	970	C
	KOYN	910	
	KURL	730	
Binghamton, N.Y.	WINR	680	N
	WKOP	1360	M
	WNBF	1290	C
Birmingham, Ala.	WAPI	1070	N
	WBRC	960	C
	WCRT	1260	A
	WEZB	1220	
	WENN	1320	M
	WATV	900	
	WSGN	610	
	WYDE	850	
	WVOK	690	
Bisbee, Ariz.	KSUN	1230	A
Bishop, Calif.	KIBS	1230	A
Bishopville, S.C.	WAGS	1380	
Bismarck, N.Dak.	KFYR	550	N
	KQDI	1350	
Bismarck-Mandan, N.Dak.	KBOM	1270	

Location	C.L.	Kc.	N.A.
Black River Falls, Wis.	WWIS	1260	
Blackfoot, Idaho	KBLI	690	
Blackstone, Va.	WKLV	1440	
Blackwell, Okla.	KLTR	1580	
Blakely, Ga.	WBBK	1260	
Blind River, Ont.	CJNR	730	
Bloomington, Ill.	WJBC	1230	A
Bloomington, Ind.	WTTS	1370	A
Bloomsburg, Pa.	WCNR	930	
	WHLM	550	
Bluefield, W.Va.	WHIS	1440	N
	WKOY	1240	M
Blythe, Calif.	KYOR	1450	A
Blytheville, Ark.	KLCN	910	
Boaz, Ala.	WAVC	1300	
Bogalusa, La.	WIKC	1490	N
	WBOX	920	
Boise, Idaho	KBOI	950	C
	KGEM	1140	M
	KIDO	630	N
	KYME	740	
Bonham, Tex.	KFYN	1420	
Boone, Iowa	KFGQ	1260	
	KWBG	1590	
Boone, N.C.	WATA	1450	
Boonville, Ind.	WBNL	1540	
Boonville, Mo.	KWRT	1370	
Booneville, Miss.	WBIP	1400	A
Boonville, N.Y.	WBRV	900	
Borger, Tex.	KHUZ	1490	M
	KBBB	1600	
Bossier City, La.	KBCL	1220	
Boston, Mass.	WBZ	1030	
	WCOP	1150	
	WILD	1090	
	WNAC	680	
	WEZE	1260	N
	WEEI	590	C
	WHDH	850	
	WMEX	1510	
	WORL	950	M
Boulder, Colo.	KBOL	1490	
Bowie, Tex.	KBAN	1410	
Bowling Green, Ky.	WKCT	930	A
	WBGN	1340	
	WLBJ	1410	M
Bowl. Green, Ohio	WHRW	730	
Bozeman, Mont.	KXXL	1450	N
	KBMN	1230	
Bradbury Hgts., Md.	WPGC	1580	
Braddock, Pa.	WLOA	1550	
Bradenton, Fla.	WTRL	1490	
	WBRD	1420	
Bradford, Pa.	WESB	1490	M
Brady, Tex.	KNEL	1490	
Brainerd, Minn.	KLIZ	1380	
Brampton, Ont.	CHIC	1090	
Brandon, Man.	CKX	1150	
Branson, Mo.	KBHM	1220	
Brattleboro, Vt.	WTSA	1450	
Brawley, Calif.	KROP	1300	A
Brazil, Ind.	WITE	1380	
Breckenridge, Minn.	KBMW	1450	
Breckenridge, Tex.	KSTB	1430	
Bremen, Ga.	WWCC	1440	
Bremerton, Wash.	KBRO	1490	
Brenham, Tex.	KWHI	1280	
Brevard, N.C.	WPNF	1240	M-N
Brewton, Ala.	WEBJ	1240	M
Bridgeport, Conn.	WICC	600	M
	WNAB	1450	A
Bridgeton, N.J.	WSNJ	1240	
Bridgewater, N.S.	CKBW	1000	
Brigham City, Utah	KBUH	800	
Brighton, Colo.	KBRN	800	
Brinkley, Ark.	KBRI	1570	
Bristol, Conn.	WBIS	1440	
Bristol, Tenn.	WOPI	1490	N
Bristol, Va.	WCYB	690	A
	WFHG	980	M
Brockton, Mass.	WBET	1460	
Brockville, Ont.	CFJR	1450	
Broken Bow, Nebr.	KCNI	1280	
Brookfield, Mo.	KGHM	1470	
Brookhaven, Miss.	WCHJ	1470	
	WJMB	1340	M
Brookings, Oreg.	KURY	910	
Brookings, S.Dak.	KBRK	1430	
Brookline, Mass.	WBOS	1600	
Brooklyn, N.Y.	WPOW	1330	
Brooksville, Fla.	WWJB	1450	
Brownfield, Tex.	KTFY	1300	
Brownsville, Tex.	KBOR	1600	A
Brownwood, Tex.	KBWD	1380	M
	KEAN	1240	
Brunswick, Ga.	WGIG	1440	A
	WMOG	1490	
Brunswick, Maine	WCME	900	
Bryan, Tex.	KORA	1240	M
	WTAW	1150	
Buffalo, N.Y.	WBEN	930	C
	WBNY	1400	
	WEBR	970	M
	WGR	550	
	WKBW	1520	N
	WWOL	1120	A
Buffalo, Wyo.	KBBS	1450	
Buford, Ga.	WDMF	1460	
Burbank, Calif.	KBLA	1490	
Burley, Idaho	KBAR	1230	A-M
Burlington, Iowa	KBUR	1490	A
Burlington, N.C.	WBBB	920	M
	WBAG	1150	
Burlington, Vt.	WCAX	620	N
	WDOT	1400	
	WJOY	1230	A
Burns, Oreg.	KRNS	1230	
Butler, Ala.	WPRN	1220	

Location	C.L.	Kc.	N.A.
Butler, Pa.	WBUT	1050	
	WISR	680	
Butte, Mont.	KBOW	1490	C
	KOPR	550	M
	KXLF	1370	N
Cabano, Que.	CJAF	1340	
Cadillac, Mich.	WATT	1240	M
Caguas, P.R.	WNEL	1450	
	WRDL	1450	
	WVJP	1110	
Cairo, Ga.	WGRA	790	
Cairo, Ill.	WKRO	1490	
Calais, Maine	WQDY	1230	N
Caldwell, Idaho	KCID	1490	
Calera, Ala.	WBYE	1370	
Calexico, Calif.	KICO	1490	A
Calgary, Alta.	CFAC	960	
	CFCN	1060	
	CKXL	1140	
Calhoun, Ga.	WCGA	900	
Camas, Wash.	KVAN	1480	
Cambridge, Md.	WCEM	1240	
Cambridge, Mass.	WTAO	740	A
Cambridge, Ohio	WILE	1270	
Camden, Ark.	KAMD	910	
Camden, N.J.	WCAM	1310	
	WKDN	800	
Camden, S. C.	WACA	1590	
Camden, Tenn.	WFWL	1220	
Cameron, Tex.	KMIL	1330	
Camilla, Ga.	WCLB	1220	
Campbell, Ohio	WHOT	1570	
Campbellsville, Ky.	WTCO	1450	
Campbellton, N.B.	CKNB	950	
Camrose, Alta.	CFCW	1230	
Canon City, Colo.	KRLN	1400	M
Canonsburg, Pa.	WCNG	540	
Canton, Ga.	WCHK	1290	
Canton, Ill.	WBYS	1560	
Canton, Miss.	WDOB	1370	
Canton, N.C.	WWIT	970	
Canton, Ohio	WAND	900	
	WCMW	1060	
	WHBC	1480	A
Cape Girardeau, Mo.	KFVS	960	
	KGMO	1220	
Carbondale, Ill.	WCIL	1020	
Carbondale, Pa.	WCDL	1440	
Caribou, Maine	WFST	600	
Carlisle, Pa.	WHYL	960	
Carlsbad, N.Mex.	KAVE	1240	C
	KPBM	740	
Carmel, Calif.	KRML	1410	
Carmi, Ill.	WROY	1460	
Carrizo Springs, Tex.	KBEN	1450	
Carroll, Iowa	KCIM	1380	
Carrollton, Ala.	WRAG	590	
Carrollton, Ga.	WLBB	1100	
Carson City, Nev.	KPTL	1300	
Cartersville, Ga.	WBHF	1450	M
Carthage, Ill.	WCAZ	990	
Carthage, Mo.	KDMO	1490	
Carthage, Tenn.	WRKM	1350	
Carthage, Tex.	KGAS	1590	
Caruthersville, Mo.	KCRV	1370	
Casa Grande, Ariz.	KPIN	1260	
Casper, Wyo.	KTWO	1470	C
	KATI	1400	
	KVOC	1230	A-M
Cayce, S.C.	WCAY	620	
Cedar City, Utah	KSUB	590	C
Cedar Rapids, Iowa	KCRG	1600	M
	KPIG	1450	
	WMT	600	C
Cedartown, Ga.	WGAA	1340	
Center, Tex.	KDET	930	
Centerville, Iowa	KCOG	1400	
Centerville, Tenn.	WHLP	1570	
Centerville, Utah	KBBC	1600	
Central City, Ky.	WNES	1600	
	WMTA	1380	
Centralia, Ill.	WCNT	1210	
Centralia & Chehalis, Wash.	KELA	1470	
Centreville, Miss.	WGLC	1580	
Chadron, Nebr.	KCSR	1450	
Chambersburg, Pa.	WCHA	800	
	WCBG	1590	
Champaign, Ill.	WDWS	1400	C
Chanute, Kans.	KCRB	1460	
Chapel Hill, N.C.	WCHL	1360	
Charleroi, Pa.	WESA	940	
Charles City, Iowa	KCHA	1580	
Charleston, Ill.	WEIC	1270	
Charleston, Mo.	KCHR	1350	
Charleston, S.C.	WCSC	1390	C
	WOKE	1340	A-M
	WPAL	730	
	WQSN	1450	
	WTMA	1250	N
Charleston, W.Va.	WCAW	1400	
	WCHS	580	C
	WHMS	1490	A
	WKAZ	950	N
	WTIP	1240	M
Charlotte, Mich.	WCER	1390	
Charlotte, N.C.	WBT	1110	C
	WAYS	610	A
	WGIV	1600	
	WKTC	1310	
	WIST	930	M
	WSOC	1240	N
	WWOK	1480	
Charlottesville, Va.	WCHV	1260	A
	WELK	1010	
	WINA	1400	M
Charlottetown, P.E.I.	CFCY	630	
Chase City, Va.	WMEK	980	

Location	C.L.	Kc.	N.A.
Chatham, Ont.	CFCO	630	
Chattanooga, Tenn.	WOGA	1450	M
	WAPO	1150	A
	WDEF	1370	N
	WDOD	1310	C
	WDXB	1490	
	WNOO	1260	
Cheboygan, Mich.	WCBY	1240	
Cheektowaga, N.Y.	WNIA	1230	
Chehalis, Wash.	KITI	1420	
Chelan, Wash.	KOZI	1220	
Cheraw, S.C.	WCRE	1420	
Cherokee, Iowa	KCHE	1440	
Chester, Pa.	WEEZ	1590	
	WVCH	740	
Chester, S.C.	WGOD	1490	
Cheyenne, Wyo.	KFBC	1240	A
	KCHY	1590	
	KVWO	1370	M
Chicago, Ill.	WAAF	950	
	WAIT	820	
	WBBM	780	C
	WCFL	1000	
	WCRW	1240	
	WEDC	1240	
	WGES	1390	
	WGN	720	M
	WIND	560	
	WJJD	1160	
	WLS	890	A
	WMAQ	670	N
	WMBI	1110	
	WSBC	1240	
Chicago Hgts., Ill.	WCGO	1600	
Chickasha, Okla.	KWCO	1560	
Chico, Calif.	KHSL	1290	C
	KPAY	1060	
Chicopee, Mass.	WACE	730	
Chicoutimi, Que.	CBJ	1580	
	CJMT	1420	
Childress, Tex.	KCTX	1510	
Chillicothe, Mo.	KCHI	1010	
Chillicothe, Ohio	WBEX	1490	A
	WCHI	1350	
Chilliwack, B.C.	CHWK	1270	
Chipley, Fla.	WBGC	1240	
Chippewa Falls, Wis.	WAXX	1150	
Christiansburg, Va.	WBCR	1260	
Christiansted, V.I.	WIVI	1040	
Church Hill, Tenn.	WMCH	1260	
Churchill, Man.	CHFC	1230	
Cicero, Ill.	WHFC	1450	
Cincinnati, Ohio	WCKY	1530	
	WCIN	1480	
	WCPO	1230	
	WKRC	550	C
	WLW	700	N-A
	WSAI	1360	
Clanton, Ala.	WKLF	980	
Claremore, Okla.	KWPR	1270	
Claremont, N.H.	WTSV	1230	
Clarksburg, W.Va.	WBOY	1400	N
	WHAR	1340	M
	WPDX	750	
Clarksdale, Miss.	WROX	1450	M
	WKDL	1600	
Clarksville, Ark.	KLYR	1360	
Clarksville, Tenn.	WJZM	1400	M
	WDXN	540	
Clarksville, Tex.	KCAR	1350	
Claxton, Ga.	WCLA	1470	
Clayton, Mo.	KXLW	1320	
	KFUO	850	
Clayton, N.Mex.	KLMX	1450	
Clearfield, Pa.	WCPA	900	
Clearwater, Fla.	WTAN	1340	
Cleburne, Tex.	KCLE	1120	
Cleveland, Ga.	WRWH	1380	
Cleveland, Miss.	WCLD	1490	
	WDSK	1410	
Cleveland, Ohio	KYW	1100	
	WDOK	1260	M
	WERE	1300	
	WGAR	1220	C
	WHK	1420	
	WABQ	1540	
	WJW	850	N
Cleveland, Tenn.	WBAC	1340	M
	WCLE	1570	
Cleveland, Tex.	KVLB	1410	
Cleve. Hgts., Ohio	WJMO	1490	A
Clifton, Ariz.	KCLF	1400	A
Clifton Forge, Va.	WCFV	1230	
Clinton, Ill.	WHOW	1520	
Clinton, Iowa	KCLN	1390	
	KROS	1340	M
Clinton, Mo.	KDKD	1280	
Clinton, N.C.	WRRZ	880	A
Clinton, Okla.	KWOE	1320	
Clinton, S.C.	WPCC	1400	
Cloquet, Minn.	WKLK	1230	
Clovis, N.Mex.	KCLV	1240	
	KVER	980	
Coachella, Calif.	KCHV	970	
Coalinga, Calif.	KBMX	1470	
Coatesville, Pa.	WCOJ	1420	
Cocoa, Fla.	WKKO	860	
	WEZY	1480	
Cocoa Beach, Fla.	WRKT	1300	
Cody, Wyo.	KODI	1400	A
Coeur d'Alene, Ida.	KVNI	1240	M
	KZIN	1050	
Coffeyville, Kans.	KGGF	690	A
Colby, Kans.	KXXX	790	
Coldwater, Mich.	WTVB	1590	
Coleman, Tex.	KSTA	1000	
Colfax, Wash.	KCLX	1450	
College Park, Ga.	WEAS	1570	

Location	C.L.	Kc.	N.A.
Colonial Heights, Va.	WPVA	1290	
Colorado City, Tex.	KVMC	1320	
Colo. Sprgs., Colo.	KRDO	1240	
	KPIK	1580	
	KVOR	1300	C
	KSSS	740	
	KYSN	1460	M
Columbia, Ky.	WAIN	1270	
Columbia, Miss.	WCJU	1450	M
Columbia, Mo.	KFRU	1400	A
	KBIA	1580	
Columbia, Pa.	WCOY	1580	
Columbia, S.C.	WCOS	1400	A
	WIS	560	N
	WMSC	1320	C
	WNOK	1230	
	WOIC	1470	
Columbia, Tenn.	WMCP	1280	
	WKRM	1340	
Columbus, Ga.	WDAK	540	N
	WRBL	1420	C
	WGBA	1270	M
	WCLS	1580	
	WOKS	1[illegible]0	
Columbus, Ind.	WCSI	1010	
Columbus, Miss.	WACR	1050	
	WCBI	550	M
Columbus, Nebr.	KJSK	900	
Columbus, Ohio	WBNS	1460	C
	WCOL	1230	A
	WMNI	920	
	WOSU	820	
	WTVN	610	
	WVKO	1580	
Colville, Wash.	KCVL	1270	
Commerce, Ga.	WJJC	1270	
Concord, N.H.	WKXL	1450	C
Concord, N.C.	WEGO	1410	
Concordia, Kans.	KNCK	1390	
	KFRM	550	A
Conneaut, Ohio	WWOW	1360	
Connellsville, Pa.	WCVI	1340	
Connersville, Ind.	WCNB	1580	
Conroe, Tex.	KMCO	900	
Conway, Ark.	KCON	1230	
Conway, N.H.	WBNC	1050	
Conway, S.C.	WLAT	1330	M
Cookeville, Tenn.	WHUB	1400	C
Coolidge, Ariz.	KCKY	1150	C
Coos Bay, Oreg.	KOOS	1230	M
	KYNG	1420	
Copper Hill, Tenn.	WLSB	1400	
Coquille, Oreg.	KWRO	1450	
Coral Gables, Fla.	WVCG	1070	
Corbin, Ky.	WCTT	680	M
Cordele, Ga.	WMJM	1490	M
Cordova, Alaska	KLAM	1450	
Corinth, Miss.	WCMA	1230	
	WCRR	1330	
Cornelia, Ga.	WCON	1450	
Corner Brook, Nfld.	CBY	790	
Corning, Ark.	KCCB	1260	
Corning, N.Y.	WCBA	1350	
	WCLI	1450	A
Cornwall, Ont.	CJSS	1220	
	CFML	1110	
Corona, Calif.	KBUC	1370	
Corpus Christi, Tex.	KCTA	1030	M
	KCCT	1150	
	KEYS	1440	
	KRYS	1360	N
	KSIX	1230	A-C
	KUNO	1400	
Corry, Pa.	WOTR	1370	
Corsicana, Tex.	KAND	1340	
Cortez, Colo.	KVFC	740	
Cortland, N.Y.	WKRT	920	
Corvallis, Oreg.	KOAC	550	
	KFLY	1240	
	KLOO	1340	
Coshocton, Ohio	WTNS	1560	
Cottage Grove, Oreg.	KOMB	1400	
Coudersport, Pa.	WFRM	600	
Council Bluffs, Iowa	KSWI	1560	M-A
Courtenay, B.C.	CFCP	1440	
Covington, Ga.	WGFS	1430	
Covington, Ky.	WZIP	1050	M
Covington, La.	WARB	730	
Covington, Tenn.	WKBL	1250	
Covington, Va.	WKEY	1340	A
Cowan, Tenn.	WZYX	1440	
Craig, Colo.	KRAI	550	
Cranbrook, B.C.	CKEK	570	
Crane, Tex.	KCRN	1380	
Crescent City, Calif.	KPLY	1240	
Creston, Iowa	KSIB	1520	
Crestview, Fla.	WCNU	1010	
	WJSB	1050	
Crewe, Va.	WSVS	800	
Crockett, Tex.	KIVY	1290	
Crookston, Minn.	KROX	1260	
Crossett, Ark.	KAGH	800	
Crossville, Tenn.	WAEW	1330	
Crowley, La.	KSIG	1450	M
Cuero, Tex.	KCFH	1600	
Cullman, Ala.	WFMH	1460	
	WKUL	1340	
Culpeper, Va.	WCVA	1490	M
Cumberland, Ky.	WCPM	1280	
Cumberland, Md.	WCUM	1230	C
	WTBO	1450	
Cushing, Okla.	KUSH	1600	

Location	C.L.	Kc.	N.A.
Cypress Gardens, Fla.	WGTO	540	
Cynthiana, Ky.	WCYN	1400	
Dade City, Fla.	WDCF	1350	
Dalhart, Tex.	KXIT	1410	
Dallas, Oreg.	KPLK	1460	
Dallas, Tex.	KRLD	1080	C
	KIXL	1040	
	KSKY	660	
	KLIF	1190	
	WFAA	570	A
	WFAA	820	N
	KBOX	1480	
	WRR	1310	M
The Dalles, Oreg.	KACI	1300	
	KODL	1440	A
Dalton, Ga.	WBLJ	1230	M
	WRCD	1430	
Danbury, Conn.	WLAD	800	
Danville, Ill.	WDAN	1490	C
	WITY	980	
Danville, Ky.	WHIR	1230	M
Danville, Va.	WBTM	1330	A
	WDTI	970	
	WDVA	1250	M
	WILA	1580	
Darlington, S.C.	WDAR	1350	
Dauphin, Man.	CKDM	1050	
Davenport, Iowa	WOC	1420	N
	KWNT	1580	
	KSTT	1170	M
Dawson, Ga.	WDWD	990	
Dawson, Yukon T.	CFYT	1230	
Dawson Creek, B.C.	CJDC	1350	
Dayton, Ohio	WHIO	1290	C
	WING	1410	
	WONE	980	
	WAVI	1210	
Dayton, Tenn.	WDNT	1280	
Daytona Beach, Fla.	WNDB	1150	M-A
	WMFJ	1450	
	WROD	1340	
Deadwood, S.Dak.	KDSJ	980	
Dearborn, Mich.	WKMH	1310	
Decatur, Ala.	WHOS	800	
	WAJF	1490	
	WMSL	1400	M
Decatur, Ga.	WGUN	1010	
Decatur, Ill.	WDZ	1050	
	WSOY	1340	C
Decorah, Iowa	KDEC	1240	
	KWLC	1240	
Defiance, Ohio	WONW	1280	
De Funiak Springs, Fla.	WDSP	1280	
	WZEP	1460	
De Kalb, Ill.	WLBK	1360	
De Land, Fla.	WJBS	1490	
	WOOO	1310	
Delano, Calif.	KCHJ	1010	
Delray, Bch., Fla.	WDBF	1420	
Del Rio, Tex.	KDLK	1230	
Delta, Colo.	KDTA	1400	
Deming, N.Mex.	KOTS	1230	
Demopolis, Ala.	WXAL	1400	M
Denham Sprgs., La.	WLBI	1220	
Denison, Iowa	KDSN	1580	
Denison, Tex.	KDSX	950	
Denton, Tex.	KDNT	1440	
Denver, Colo.	KDEN	1340	
	KFML	1390	
	KHOW	630	A
	KIMN	950	M
	KLIR	990	
	KLZ	560	C
	KICN	710	
	KOA	850	N
	KPOF	910	
	KFSC	1220	
	KTLN	1280	
De Queen, Ark.	KDQN	1390	
DeRidder, La.	KDLA	1010	
Des Moines, Iowa	KCBC	1390	A
	KIOA	940	
	KRNT	1350	C
	KSO	1460	
	KWKY	1150	M
	WHO	1040	N
Detroit, Mich.	WCAR	1130	
	WJBK	1500	
	WJLB	1400	
	WJR	760	
	WWJ	950	N
	WXYZ	1270	A
Detroit Lakes, Minn.	KDLM	1340	
Devils Lake, N.Dak.	KDLR	1240	M
Dexter, Mo.	KDEX	1590	
Diboll, Tex.	KSPL	1260	
Dickinson, N.Dak.	KDIX	1230	
Dickson, Tenn.	WDKN	1260	
Dillon, Mont.	KDBM	800	
Dillon, S.C.	WDSC	800	A
Dinuba, Calif.	KRDU	1240	
Dodge City, Kans.	KGNO	1370	M
Dothan, Ala.	WAGF	1320	
	WDIG	1450	M
	WOOF	560	
Douglas, Ariz.	KAWT	1450	M
	KAPR	930	
Douglas, Ga.	WDMG	860	
Douglas, Wyo.	KWIV	1050	
Dover, Del.	WDOV	1410	
	WKEN	1600	
Dover, N.H.	WTSN	1270	
Dover, Ohio	WJER	1450	
Doylestown, Pa.	WBUX	1570	
Drumheller, Alta.	CJDV	910	
Drummondville, Que.	CHRD	1340	
Dublin, Ga.	WMLT	1330	
	WXLI	1230	
Du Bois, Pa.	WCED	1420	C
Dubuque, Iowa	KDTH	1370	A
	WDBQ	1490	M
Duluth, Minn.	KDAL	610	C
	WEBC	560	
	WREX	1080	
Dumas, Tex.	KDDD	800	
Duncan, Okla.	KRHD	1350	M
Dundalk, Md.	WAYE	860	
	WEBB	1360	
Dundee, N.Y.	WFLR	1570	
Dunkirk, N.Y.	WDOE	1410	
Dunn, N.C.	WCKB	780	
Du Quoin, Ill.	WDQN	1580	
Durango, Colo.	KIUP	930	
	KDGO	1240	
Durant, Okla.	KSFO	750	
Durham, N.C.	WDNC	620	C
	WSRC	1410	
	WSSB	1490	
	WTIK	1310	A
Dyersburg, Tenn.	WDSG	1450	
	WTRO	1330	
Eagle Pass, Tex.	KEPS	1270	
Easley, S.C.	WELP	1360	
E. Grand Forks, Minn.	KRAD	1590	
Eastland, Tex.	KERC	1590	
E. Lansing, Mich.	WKAR	870	
E. Liverpool, Ohio	WOHI	1490	A
East Longmeadow, Mass.	WTYM	1600	
E. Point, Ga.	WTJH	1260	
E. St. Louis, Ill.	WAMV	1490	A
Easton, Pa.	WEEX	1230	
	WEST	1400	N
Eatontown, N.J.	WHTG	1410	
Eau Claire, Wis.	WEAQ	790	N
	WBIZ	1400	M
	WECL	1050	
Eau Gallie, Fla.	WMEG	920	
Edenton, N.C.	WCDJ	1260	
Edinburg, Tex.	KURV	710	
Edmonds, Wash.	KGDN	630	
Edmonton, Alta.	CBX	1010	
	CBXA	740	
	CFRN	1260	
	CHED	1080	
	CHFA	680	
	CJCA	930	
	CKUA	580	
Edmundston, N.C.	CJEM	570	
Effingham, Ill.	WCRA	1090	
Elba, Ala.	WELB	1350	
Elberton, Ga.	WSGC	1400	
El Cajon, Calif.	KDEO	910	A
El Campo, Tex.	KULP	1390	
El Centro, Calif.	KXO	1230	M
	KAMP	1430	
El Dorado, Ark.	KDMS	1290	
	KELD	1400	A
Eldorado, Kans.	KBTO	1360	
Elgin, Ill.	WRMN	1410	
Elizabeth City, N.C.	WCNC	1240	
	WGAI	560	
Elizabethton, Tenn.	WBEJ	1240	
Elizabethtown, Ky.	WIEL	1400	
Elizabethtown, N.C.	WBLA	1450	M
Elizabethtown, Pa.	WEZN	1600	
Elk City, Okla.	KBEK	1240	A
Elkhart, Ind.	WTRC	1340	N
	WCMR	1270	
Elkin, N.C.	WIFM	1540	
Elkins, W.Va.	WDNE	1240	
Elko, Nev.	KELK	1240	M
Ellensburg, Wash.	KXLE	1240	
Ellsworth, Me.	WDEA	1350	
Elmira, N.Y.	WELM	1400	A-C
	WENY	1230	N
Elmira Heights-Horseheads, N.Y.	WEHH	1590	M
El Paso, Tex.	KROD	600	C
	KELP	920	
	KHEY	690	
	KINT	1590	
	KIZZ	1150	
	KSET	1340	M
	KTSM	1380	N
Ely, Minn.	WELY	1450	M
Ely, Nev.	KELY	1230	
Elyria, Ohio	WEOL	930	
Eminence, Ky.	WSTL	1600	
Emporia, Kans.	KVOE	1400	
Emporia, Va.	WEVA	860	
Emporium, Pa.	WLEM	1250	
Endicott, N.Y.	WENE	1430	A
Englewood, Colo.	KGMC	1150	
Enid, Okla.	KCRC	1390	A
	KGWA	960	M
Enterprise, Ala.	WIRB	600	
Ephrata, Pa.	WGSA	1310	
Ephrata, Wash.	KULF	730	
Erie, Pa.	WERC	1260	A
	WICU	1330	N
	WJET	1400	
	WLEU	1450	
Erwin, Tenn.	WEMB	1420	
Escanaba, Mich.	WDBC	680	M
	WLST	600	A
Escondido, Calif.	KOWN	1450	
Estherville, Iowa	KLIL	1340	
Etowah, Tenn.	WCPH	1220	
Eufaula, Ala.	WULA	1240	M
Eugene, Oreg.	KORE	1450	M
	KASH	1600	A
	KERG	1280	C
	KUGN	590	N
Eunice, La.	KEUN	1490	M
Eureka, Calif.	KINS	980	C
	KDAN	790	
	KIEM	1480	M
Eustis, Fla.	WLCO	1240	
Evanston, Ill.	WEAW	1330	
	WNMP	1590	
Evanston, Wyo.	KLUK	1240	
Evansville, Ind.	WEOA	1400	C
	WGBF	1280	N
	WIKY	820	
	WJPS	1330	A
Eveleth, Minn.	WEVE	1340	M
Everett, Wash.	KRKO	1380	
	KQTY	1230	
Evergreen, Ala.	WBLO	1470	
Fairbanks, Alaska	KFAR	660	A-M-N
	KFRB	900	C-A
Fairfax, Va.	WEEL	1310	
Fairfield, Ill.	WFIW	1390	
Fairfield, Iowa	KMCD	1570	
Fairmont, Minn.	KSUM	1370	M
Fairmont, N.C.	WFMO	860	
Fairmont, W.Va.	WMMN	920	C
	WTCS	1490	A
Fajardo, P.R.	WMDD	1490	
Falfurrias, Tex.	KPSO	1260	
Fallon, Nev.	KULV	1250	
Fall River, Mass.	WALE	1400	M
	WSAR	1480	A
Falls Church, Va.	WFAX	1220	
Falls City, Nebr.	KTNC	1230	
Fargo, N.Dak.	WDAY	970	N
	KFNW	900	
	KXGO	790	A
Faribault, Minn.	KDHL	920	
Farmington, Me.	WKTJ	1380	
Farmington, Mo.	KREI	800	
Farmington, N.M.	KENN	1390	
	KWYK	960	
	KZUM	1280	
Farmville, N.C.	WBTL	1050	
	WBTC	1250	
Farmville, Va.	WFLO	870	
Farrell, Pa.	WFAR	1470	
Fayette, Ala.	WWWF	990	
Fayetteville, Ark.	KHOG	1450	
	KFAY	1250	M
Fayetteville, N.C.	WFAI	1230	C
	WFNC	1390	M
	WFLB	1490	A
	WIDU	1600	
Fayetteville, Tenn.	WEKR	1240	M
Fergus Falls, Minn.	KOTE	1250	M
Fernandina Beach, Fla.	WPAP	1570	
Ferriday, La.	KFNV	1600	
Festus, Mo.	KXEN	1010	
Findlay, Ohio	WFIN	1330	
Fisher, W.Va.	WELD	690	A
Fitchburg, Mass.	WEIM	1280	M
	WFGM	960	
Fitzgerald, Ga.	WBHB	1240	M
Flagstaff, Ariz.	KCLS	600	N
	KVNA	690	A
	KEOS	1290	
Flat River, Mo.	KFMO	1240	M
Flin Flon, Man.	CFAR	590	
Flint, Mich.	WFDF	910	N
	WTRX	1330	A
	WAMM	1420	
	WMRP	1570	
	WKMF	1470	
	WTAC	600	A
Flomaton, Ala.	WTCB	990	
Florence, Ala.	WJOI	1340	M
	WOWL	1240	A
Florence, S.C.	WJMX	970	A
	WOLS	1230	
Floydada, Tex.	KFLD	900	
Foley, Ala.	WHEP	1310	
Fond du Lac, Wis.	KFIZ	1450	M
Fordyce, Ark.	KBJT	1570	
Forest, Miss.	WMAG	860	
Forest City, N.C.	WBBO	780	
	WAGY	1320	
Forest Grove, Oreg.	KGGG	1570	
Forrest City, Ark.	KXJK	950	
Ft. Bragg, Calif.	KDAG	1230	
Ft. Collins, Colo.	KCOL	1410	
Ft. Dodge, Iowa	KVFD	1400	M
	KWMT	540	A
Ft. Frances, Ont.	CFOB	800	
Ft. Knox, Ky.	WSAC	1470	
Ft. Lauderdale, Fla.	WFTL	1400	
	WWIL	1580	
Ft. Lupton, Colo.	KHIL	800	
Ft. Madison, Iowa	KXGI	1360	
Ft. Morgan, Colo.	KFTM	1400	
Ft. Myers, Fla.	WINK	1240	C
	WMYR	1410	
Ft. Payne, Ala.	WFPA	1400	
	WZOB	1250	
Ft. Pierce, Fla.	WARN	1330	
	WIRA	1400	
Ft. Scott, Idaho	KMDO	1600	
Ft. Smith, Ark.	KFPW	1230	C
	KFSA	950	A
	KTCS	1410	M
	KWHN	1320	
Ft. Stockton, Tex.	KFST	860	
Ft. Valley, Ga.	WFPM	1150	
Ft. Walton Beach, Fla.	WFBS	950	
	WFTW	1260	
Ft. Wayne, Ind.	WGL	1250	A
	WOWO	1190	
	WANE	1450	C
	WKJG	1380	N
Ft. William, Ont.	CKPR	580	
	CJLX	800	
Ft. Worth, Tex.	KJIM	870	
	KCUL	1540	
	KFJZ	1270	
	KNOK	970	
	WBAP	570	A
	WBAP	820	N
	KXOL	1360	
Fostoria, Ohio	WFOB	1430	
Fountain Inn, S.C.	WFIS	1600	
Framingham, Mass.	WKOX	1190	
Frankfort, Ind.	WILO	1570	
Frankfort, Ky.	WFKY	1490	M
Franklin, Ky.	WFKN	1220	
Franklin, N.C.	WFSC	1050	
Franklin, Pa.	WFRA	500	
Franklin, Tenn.	WAGG	950	
Franklin, Va.	WYSR	1250	
Frederick, Md.	WFMD	930	C
Frederick, Okla.	KTAT	1570	
Fredericksburg, Tex.	KNAF	910	M
Fredericksburg, Va.	WFVA	1230	A
Fredericton, N.B.	CFNB	550	
Fredonia, N.Y.	WBUZ	1570	
Freeport, Ill.	WFRL	1570	
Freeport, N.Y.	WGBB	1240	
Freeport, Tex.	KBRZ	1460	
Fremont, Mich.	WCBQ	1490	
Fremont, Nebr.	KHUB	1340	
Fremont, Ohio	WFRO	900	
Fresno, Calif.	KARM	1430	A
	KBIF	900	
	KEAP	980	
	KFRE	940	C
	KGST	1600	
	KMAK	1340	
	KMJ	580	N
	KYNO	1300	
Front Royal, Va.	WFTR	1450	M
Frostburg, Md.	WFRB	740	
Fulton, Ky.	WFUL	1270	
Fulton, Mo.	KFAL	900	
Fulton, N.Y.	WOSC	1300	
Fuquay Sprgs., N.C.	WFVG	1460	
Gadsden, Ala.	WGAD	1350	A
	WETO	930	M
	WAAX	570	
Gaffney, S.C.	WFGN	1570	
Gainesville, Fla.	WDVH	980	
	WGGG	1230	A
	WRUF	850	M
Gainesville, Ga.	WGGA	550	M
	WDUN	1240	
	WLBA	1580	
Gainesville, Tex.	KGAF	1580	
Galax, Va.	WBOB	1360	M
Galesburg, Ill.	WGIL	1400	
	WAIK	1590	
Gallatin, Tenn.	WHIN	1010	
Gallipolis, Ohio	WJEH	990	
Gallup, N. Mex.	KGAK	1330	A
	KYVA	1230	
Galt, Ont.	CKGR	1110	
Galveston, Tex.	KILE	1400	
	KGBC	1540	
Gander, Nfld.	CBG	1450	
Garden City, Kans.	KNCO	1050	
	KIUL	1240	M
Gardner, Mass.	WGAW	1340	
Gary, Ind.	WWCA	1270	
	WGRY	1370	
Gastonia, N.C.	WGNC	1450	A
	WLTC	1370	
Gate City, Va.	WGAT	1050	
Gaylord, Mich.	WATC	900	
Geneva, Ala.	WGEA	1150	
Geneva, N.Y.	WGVA	1240	A
Georgetown, Del.	WJWL	900	
Georgetown, Ky.	WAXU	1580	
Georgetown, S.C.	WGTN	1400	M
Gettysburg, Pa.	WGET	1450	
Gillette, Wyo.	KIML	1490	
Gilroy, Calif.	KPER	1290	
Gladewater, Tex.	KSIJ	1430	
Glasgow, Ky.	WKAY	1490	
Glasgow, Mont.	KLTZ	1240	
Glendale, Ariz.	KRUX	1360	
Glendale, Calif.	KIEV	870	
Glendive, Mont.	KXGN	1400	
Glen Falls, N.Y.	WWSC	1450	A
Glenwood Sprgs., Colo.	KGLN	980	M
Globe, Ariz.	KZOW	1240	A
Gloucester, Va.	WDDY	1420	
Gloversville-Johnston, N.Y.	WENT	1340	C
Golden, Colo.	KXXI	1250	
Golden Meadow, La.	KLFT	1600	
Golden Valley, Minn.	KEVE	1440	M
Goldsboro, N.C.	WFMC	730	

Location	C.L.	Kc.	N.A.
	WGBR	1150	A
	WGOL	1300	
Gonzales, Tex.	KCTI	1450	
Goodland, Kans.	KBLR	730	M
Goose Bay, Nfld.	CFGB	1340	
Goshen, Ind.	WKAM	1460	
Grafton, N.D.	KGPC	1340	
Grafton, W.Va.	WVVW	1260	
Graham, Tex.	KSWA	1330	
Granby, Que.	CHEF	1450	
Grand Falls, Nfld.	CBT	990	
Grand Forks, N.Dak.	KFJM	1370	
Grand Coulee, Wash.	KFDR	1360	
	KILO	1440	C
	KNOX	1310	M
Grand Haven, Mich.	WGHN	1370	
Grand Island, Nebr.	KMMJ	750	A
	KRGI	1430	
Grand Junction, Colo.	KREX	920	M
	KEXO	1230	
	KSTR	620	
Grande Prairie, Alta.	CFGP	1050	
Grand Prairie, Tex.	KKSN	730	
Grand Rapids, Mich.	WJEF	1230	C
	WFUR	1570	
	WGRD	1410	
	WLAV	1340	A
	WMAX	1480	M
	WOOD	1300	N
Grand Rapids, Minn.	KOZY	1490	M
Grangeville, Idaho	KORT	1230	
Grants, N.Mex.	KMIN	980	
Grants Pass, Oreg.	KAGI	1340	M
	KAJO	1270	
Gravelbourg, Sask.	CFGR	1230	
	CFRG	710	
Grayson, Ky.	WGOH	1370	
Gt. Barrington, Mass.	WSBS	860	
Gt. Bend, Kans.	KVGB	1590	N
Gt. Falls, Mont.	KFBB	1310	C
	KUDI	1450	
	KMON	560	M
	KARR	1400	N
Greeley, Colo.	KFKA	1310	
	KYOU	1450	
Green Bay, Wis.	WBAY	1360	C
	WJPG	1440	M
	WDUZ	1400	A
Green Cove Springs, Fla.	WGRC	1580	
Greeneville, Tenn.	WGRV	1340	
Greenfield, Mass.	WHAI	1240	M
Greensboro, N.C.	WBIG	1470	C
	WCOG	1320	
	WGBG	1400	A
	WPET	950	
Greensburg, Pa.	WHJB	620	
Greenville, Ala.	WGYV	1380	
Greenville, Miss.	WJPR	1330	
	WDDT	900	
	WGVM	1260	
Greenville, N.C.	WGTC	1590	M
Greenville, S.C.	WESC	660	
	WFBC	1330	N
	WMRB	1490	A-M
	WMUU	1260	
	WQOK	1440	C
Greenville, Tex.	KGVL	1400	
Greenwood, Miss.	WABG	960	A
	WGRM	1240	N
Greenwood, S.C.	WCRS	1450	N
	WGSW	1350	
Greer, S.C.	WEAB	800	
	WCKI	1300	A
Grenada, Miss.	WNAG	1400	M
Gresham, Oreg.	KGRO	1230	
Gretna, Va.	WMNA	730	
Griffin, Ga.	WKEU	1450	M
	WHIE	1320	
Grinnell, Iowa	KGRN	1410	
Groton, Conn.	WSUB	980	
Grove City, Pa.	WSAJ	1340	
Grundy, Va.	WNRG	1250	
Guayama, P.R.	WXRF	1590	
Guelph, Ont.	CJOY	1450	
Gulfport, Miss.	WROA	1390	
	WGCM	1240	A
Guntersville, Ala.	WGSV	1270	
Guthrie, Okla.	KWRW	1490	
Guymon, Okla.	KGYN	1220	
Hagerstown, Md.	WARK	1490	C
	WJEJ	1240	A-M
Haleyville, Ala.	WJBB	1230	M
Halifax, N.S.	CBH	1330	
	CHNS	960	
	CJCH	920	
Hamilton, Ala.	WERH	970	
Hamilton, Ohio	WMOH	1450	
Hamilton, Ont.	CHML	900	
	CKOC	1150	
Hamilton, Tex.	KCLW	900	
Hamlet, N.C.	WKDX	1400	
Hammond, Ind.	WJOB	1230	
Hammond, La.	WFPR	1400	
Hampton, S.C.	WBHC	1270	
Hampton, Va.	WVEC	1490	
Hancock, Mich.	WMPL	920	
Hanford, Calif.	KNGS	620	
Hannibal, Mo.	KHMO	1070	
Hanover, N.H.	WTSL	1400	
	WDCR	1340	
Hanover, Pa.	WHVR	1280	
Harlan, Ky.	WHLN	1410	
Harlingen, Tex.	KGBT	1530	
Harriman, Tenn.	WHBT	1600	
Harrisburg, Ill.	WEBQ	1240	
Harrisburg, Pa.	WHGB	1400	A
	WCMB	1460	M
	WHP	580	C
	WKBO	1230	N
Harrison, Ark.	KHOZ	900	
Harrisonburg, Va.	WHBG	1360	
	WSVA	550	N
Harrodsburg, Ky.	WHBN	1420	
Hartford, Conn.	WDRC	1360	C
	WCCC	1290	
	WPOP	1410	M-A
	WTIC	1080	N
Hartford, Wis.	WTKM	1540	
Hartselle, Ala.	WHRT	860	
Hartsville, S.C.	WHSC	1450	M
Hartwell, Ga.	WKLY	980	
Harvard, Ill.	WMCW	1600	
Harvey, Ill.	WBEE	1570	
Hastings, Mich.	WBCH	1220	
Hastings, Nebr.	KHAS	1230	
Hattiesburg, Miss.	WBKH	950	
	WFOR	1400	N
	WHSY	1230	A
	WXXX	1310	
Haverhill, Mass.	WHAV	1490	
Havre, Mont.	KOJM	610	M
Havre de Grace, Md.	WASA	1330	
Hawkinsville, Ga.	WCEH	610	
Haynesville, La.	KLUV	1580	
Hays, Kans.	KAYS	1400	
Hayward, Wis.	WHSM	910	
Hazard, Ky.	WKIC	1390	M
Hazlehurst, Miss.	WMDC	1220	
Hazleton, Pa.	WAZL	1490	N-M
Helena, Ark.	KFFA	1360	M
Helena, Mont.	KCAP	1340	M
	KXLJ	1240	N
Hemet, Calif.	KHSJ	1320	
Hempstead, N.Y.	WHLI	1100	
Henderson, Ky.	WSON	860	
Henderson, Nev.	KBMI	1400	
	KTOO	1280	
Henderson, N.C.	WHNC	890	M
	WHVH	1450	
Henderson, Tex.	KJAT	1000	
	KWRD	1470	
Hendersonville, N.C.	WHKP	1450	A
Henryetta, Okla.	KHEN	1590	
Hereford, Tex.	KPAN	860	
Herkimer, N.Y.	WALY	1420	
Hermiston, Oreg.	KOHU	1570	
Herrin, Ill.	WJPF	1340	M
Hettinger, N.Dak.	KNDC	1490	
Hibbing, Minn.	WMFG	1240	N
Hickory, N.C.	WHKY	1290	A
	WIRC	630	
High Point, N.C.	WMFR	1230	A
	WNOS	1590	
	WHPE	1070	
Hillsboro, Ohio	WSRW	1590	
Hillsboro, Oreg.	KUIK	1360	
Hillsboro, Tex.	KHBR	1560	
Hillsdale, Mich.	WCSR	1340	
Hilo, Hawaii	KHBC	970	C
	KIPA	1110	
	KIMO	850	M
Hobart, Okla.	KTJS	1420	
Hobbs, N.Mex.	KWEW	1480	M
	KHOB	1280	
Holbrook, Ariz.	KDJI	1270	
Holdredge, Nebr.	KUVR	1380	
Holland, Mich.	WHTC	1450	
	WJBL	1260	
Hollywood, Fla.	WGMA	1320	
Holyoke, Mass.	WREB	930	
Homer, La.	KVHL	1320	
Homestead, Fla.	WSDB	1430	
Homestead, Pa.	WAMO	860	
Homewood, Ala.	WJLD	1400	
Honolulu, Hawaii	KGMB	590	C
	KPOI	1380	
	KIKI	830	
	KGU	760	N
	KHVH	1040	
	KOHO	1170	
	KOOD	990	
	KPOA	630	M
	KULA	690	A
Hood River, Oreg.	KIHR	1340	
Hope, Ark.	KXAR	1490	
Hopewell, Va.	WHAP	1340	
Hopkinsville, Ky.	WHOP	1230	C
	WKOA	1480	
Hornell, N.Y.	WWHG	1320	
	WLEA	1480	M
Hot Springs, Ark.	KAAB	1350	A
	KBHS	590	
	KBLO	1470	M
Hot Springs, S. Dak.	KOBH	580	
Houghton, Mich.	WHDF	1400	
Houghton Lake, Mich.	WHGR	1290	
Houlton, Maine	WHOU	1340	
Houma, La.	KCIL	1490	N
Houston, Miss.	WCPC	1320	
Houston, Tex.	KCOH	1430	
	KILT	610	
	KNUZ	1230	
	KPRC	950	N
	KTHT	790	
	KTRH	740	C
	KXYZ	1320	A
	KYOK	1590	
Howell, Mich.	WHMI	1350	
Hudson, N.Y.	WHUC	1230	
Hugo, Okla.	KIHN	1340	
Hull, Que.	CKCH	970	
Humacao, P.R.	WALO	1240	
Humboldt, Tenn.	WIRJ	740	
Huntingdon, Pa.	WHUN	1150	
Huntington, Ind.	WHLT	1300	
Huntington, N.Y.	WGSM	740	
Huntington, W.Va.	WPLH	1470	M
	WKEE	800	M-A
	WSAZ	930	N
Huntsville, Ala.	WBHP	1230	M
	WEUP	1600	
	WFUN	1450	
	WAAY	1550	A
Huntsville, Ont.	CKAR	590	
Huntsville, Tex.	KSAM	1490	
Huron, S.Dak.	KIJV	1340	
Hutchinson, Kans.	KWBW	1450	N
	KWHK	1260	
Hutchinson, Minn.	KDUZ	1260	
Idabel, Okla.	KBEL	1240	
Idaho Falls, Idaho	KID	590	C
	KIFI	1260	A-M
	KUPI	980	
Independence, Kans.	KIND	1010	M
Independence, Mo.	KANS	1510	
Indiana, Pa.	WDAD	1450	C
Indianapolis, Ind.	WFBM	1260	A-M
	WGEE	1590	
	WIBC	1070	
	WIRE	1430	N
	WISH	1310	C
	WXLW	950	
Indianola, Miss.	WDLT	1380	
Indio, Calif.	KREO	1400	A
Inglewood, Calif.	KTYM	1460	
Inkster, Mich.	WCHB	1440	
International Falls, Minn.	KGHS	1230	
Ionia, Mich.	WION	1430	
Iowa City, Iowa	KXIC	800	
	WSUI	910	
Iron Mtn., Mich.	WMIQ	1450	A
Iron River, Mich.	WIKB	1230	M
Ironton, Ohio	WIRO	1230	M
Ironwood, Mich.	WJMS	630	M
Ishpeming, Mich.	WJPD	1240	
	WJAN	970	
Islip, N.Y.	WBIC	540	
Ithaca, N.Y.	WHCU	870	C
	WTKO	1470	A
Jackson, Ala.	WTHG	1290	M
Jackson, Mich.	WIBM	1450	A
	WKHM	970	M
Jackson, Miss.	WJDX	620	N
	WJQS	1400	C
	WJXN	1450	
	WOKJ	1590	
	WRBC	1300	M
	WSLI	930	
Jackson, Ohio	WLMJ	1280	
Jackson, Tenn.	WDXI	1310	
	WJAK	1460	
	WTJS	1390	A
Jacksonville, Fla.	WJAX	930	
	WAPE	690	
	WZOK	1320	A
	WIVY	1050	
	WMBR	1460	C
	WOBS	1360	
	WPDQ	600	
	WQIK	1280	
	WRHC	1400	
Jacksonville, Ill.	WLDS	1180	
Jacksonville, N.C.	WJNC	1240	M
	WLAS	910	
Jacksonville, Tex.	KEBE	1400	
Jacksonville Bch., Fla.	WZRO	1010	
Jamestown, N.Dak.	KEYJ	1400	M
	KSJB	600	C
Jamestown, N.Y.	WJTN	1240	A
	WJOC	1340	M
Jamestown, Tenn.	WCLC	1260	
Janesville, Wis.	WCLO	1230	M
Jasper, Ala.	WWWB	1360	
	WARF	1240	
Jasper, Ind.	WITZ	990	
Jasper, Tex.	KTXJ	1350	
Jefferson City, Mo.	KLIK	950	
	KWOS	1240	M
Jennings, La.	KJEF	1290	
Jerome, Idaho	KART	1400	
Jesup, Ga.	WBGR	1370	
Johnson City, Tenn.	WJCW	910	C
	WETB	790	M
Johnstown, Pa.	WJAC	1400	N
	WARD	1490	C
	WCRO	1230	M
Joliet, Ill.	WJOL	1340	
Jonesboro, Ark.	KBTM	1230	M
	KNEA	970	
Jonesboro, La.	KTOC	920	
Jonesboro, Tenn.	WJSO	1590	
Jonquiere, Que.	CKRS	590	
Joplin, Mo.	WMBH	1450	M
	KFSB	1310	
	KODE	1230	C
Junction, Tex.	KMBL	1450	
June. City, Kans.	KJCK	1420	
Juneau, Alaska	KINY	800	C-A
	KJNO	630	A-M-N
Kailua, Hawaii	KANI	1240	
Kaimuki, Hawaii	KAIM	870	
Kalamazoo, Mich.	WKZO	590	C
	WKLZ	1470	M
	WKMI	1360	
Kalispell, Mont.	KGEZ	600	M
	KOFI	930	
Kamloops, B.C.	CFJC	910	
Kane, Pa.	WADP	960	
Kankakee, Ill.	WKAN	1320	
Kannapolis, N.C.	WGTL	870	
Kans. City, Kans.	KCKN	1340	
Kansas City, Mo.	KCMO	810	C
	KMBC	980	A
	KPRS	1590	
	KUDL	1380	
	WDAF	610	N
	WHB	710	
Kearney, Nebr.	KGFW	1340	M
	KRNY	1460	
Keene, N.H.	WKNE	1290	M
	WKBK	1220	
Kelowna, B.C.	CKOV	630	
Kelso, Wash.	KLOG	1490	
Kendallville, Ind.	WAWK	1570	
Kenedy, Tex.	KAML	990	
Kenmore, N.Y.	WYSL	1080	
Kennett, Mo.	KBOA	830	
Kennewick-Pasco-Richland, Wash.	KEPR	610	C
Kenora, Ont.	CJRL	1220	
Kenosha, Wis.	WLIP	1050	
Kentville, N.S.	CKEN	1350	
Keokuk, Iowa	KOKX	1310	
Kermit, Tex.	KERB	600	
Kerrville, Tex.	KERV	1230	
Ketchikan, Alaska	KTKN	930	C-A
Kewanee, Ill.	WKEI	1450	
Keyser, W.Va.	WKYR	1270	
Key West, Fla.	WKWF	1600	M
	WKIZ	1500	
Kilgore, Tex.	KOCA	1240	
Killeen, Tex.	KLEN	1050	M
Kimball, Nebr.	KIMB	1260	
King City, Calif.	KRKC	1570	
Kingman, Ariz.	KAAA	1230	A
Kings Mountain, N.C.	WKMT	1220	
Kingsport, Tenn.	WKIN	1320	
	WKPT	1400	N
Kingston, N.Y.	WKNY	1490	M
Kingston, Ont.	CFRC	1490	
	CKLC	1380	
	CKWS	960	
Kingstree, S.C.	WDKD	1310	
Kingsville, Tex.	KINE	1330	
Kinston, N.C.	WELS	1010	
	WFTC	960	A
	WISP	1230	M
Kirkland, Wash.	KNBX	1050	
Kirkland Lake, Ont.	CJKL	560	
Kirksville, Mo.	KIRX	1450	A
Kissimmee, Fla.	WKBX	1220	
Kitchener, Ont.	CKCR	1490	
	CKKW	1320	
Kittanning, Pa.	WACB	1380	
Klamath Falls, Oreg.	KAGO	1150	M
	KFLW	1450	A-C
	KLAD	960	
Knoxville, Tenn.	WBIR	1240	A
	WIVK	860	
	WATE	620	N
	WKGN	1340	M
	WKXV	900	
	WNOX	990	C
Kokomo, Ind.	WIOU	1350	C
Kosciusko, Miss.	WKOZ	1350	A
Laconia, N.H.	WLNH	1350	
LaCrosse, Wis.	WKBH	1410	N
	WLCX	1490	
	WKTY	580	A
Ladysmith, Wis.	WLDY	1340	
Lafayette, Ga.	WLFA	1590	
Lafayette, Ind.	WASK	1450	M
	WBAA	920	
Lafayette, La.	KPEL	1420	A
	KVOL	1330	N
Lafayette, Tenn.	WEEN	1460	
LaFollette, Tenn.	WLAF	1450	
LaGrande, Oreg.	KLBM	1450	
LaGrange, Ga.	WLAG	1240	M
	WTRP	620	
LaGrange, Ill.	WTAQ	1300	
LaGrange, Tex.	KVLG	1570	
LaJunta, Colo.	KBZZ	1400	M
Lake Charles, La.	KLOU	1580	
	KPLC	1470	N
	KAOK	1400	M
Lake City, Fla.	WDSR	1340	
	WGRO	960	
Lake City, S.C.	WJOT	1260	
Lakeland, Fla.	WLAK	1430	N
	WONN	1230	M
	WYSE	1330	
Lake Providence, La.	KLPL	1050	
Lake Tahoe, Calif.	KOWL	1490	
Lakeview, Oreg.	KQIK	1230	
Lake Wales, Fla.	WIPC	1280	
Lakewood, Colo.	KLAK	1600	
Lakewood, Wash.	KAYG	1480	
Lake Worth, Fla.	WLIZ	1380	
Lamar, Colo.	KLMR	920	M
Lamesa, Tex.	KPET	690	
Lampasas, Tex.	KCYL	1450	

Location	C.L.	Kc.	N.A.
Lancaster, Calif.	KAVL	610	
	KBVM	1380	
Lancaster, Ohio	WHOK	1320	
Lancaster, Pa.	WGAL	1490	N
	WLAN	1390	A-M
Lancaster, S.C.	WLCM	1360	
Lander, Wyo.	KOVE	1330	M
Lanett, Ala.	WRLD	1490	A
Lansford, Pa.	WLSH	1410	
Lansing, Mich.	WILS	1320	
	WJIM	1240	A-N
Lapeer, Mich.	WMPC	1230	
LaPorte, Ind.	WLOI	1540	
Laramie, Wyo.	KOWB	1340	M
Laredo, Tex.	KVOZ	1490	M
LaSalle, Ill.	WLPO	1220	
LaSarre, Que.	CKLS	1240	
LasCruces, N.Mex.	KOBE	1450	
	KGRT	570	
Las Vegas, Nev.	KENO	1460	A
	KLAS	1230	C
	KORK	1340	M
	KRAM	920	
	KRBO	1050	
Las Vegas, N.Mex.	KFUN	1230	A
Latrobe, Pa.	WSHH	1570	M
	WTRA	1480	
LaTuque, Que.	CFLM	1240	
Laurel, Miss.	WAML	1340	N
	WLAU	1600	A
	WNSL	1260	
Laurens, S.C.	WLBG	860	
Laurinburg, N.C.	WEWO	1080	
Lawrence, Kans.	KFKU	1250	
	KLWN	1320	
Lawrence, Mass.	WCCM	800	M
Lawrenceburg, Tenn.	WDXE	1370	
Lawrenceville, Ga.	WLAW	1360	
Lawrenceville, Ill.	WAKO	910	
Lawton, Okla.	KSWO	1380	A
	KCCO	1050	
Leadville, Colo.	KLVC	1230	
Leaksville, N.C.	WLOE	1490	M
Leamington, Ont.	CJSP	710	
Leavenworth, Kans.	KCLO	1410	
Lebanon, Ky.	WLBN	1590	
Lebanon, Mo.	KLWT	1230	
Lebanon, Oreg.	KGAL	920	
Lebanon, Pa.	WLBR	1270	
Lebanon, Tenn.	WCOR	900	
Leesburg, Fla.	WLBE	790	M
	WBIL	1410	
Leesburg, Va.	WAGE	1290	
Leesville, La.	KLLA	1570	
Leitchfield, Ky.	WMTL	1580	
Leland, Miss.	WESY	1580	
LeMars, Iowa	KLEM	1410	
Lenoir, N.C.	WJRI	1340	M
Lenoir, Tenn.	WLIL	730	
Leonardtown, Md.	WKIK	1370	
Lethbridge, Alta.	CJOC	1220	
	CHEC	1090	
Levelland, Tex.	KLVT	1230	
Levittown, Pa.	WBCB	1490	
Lewisburg, Pa.	WITT	1010	
Lewisburg, Tenn.	WJJM	1490	M
Lewiston, Idaho	KRLC	1350	M
	KOZE	1300	
Lewiston, Maine	WCOU	1240	M
	WLAM	1470	A
Lewistown, Mont.	KXLO	1230	M
Lewistown, Pa.	WKVA	920	
	WMRF	1490	N
Lexington, Ky.	WLAP	630	
	WBLG	1300	A
	WVLK	590	M
Lexington, Miss.	WXTN	1150	
Lexington, Mo.	KLEX	1570	
Lexington, Nebr.	KRVN	1010	
Lexington, N.C.	WBUY	1440	
Lexington, Tenn.	WDXL	1490	
Lexington, Va.	WREL	1450	N
Lexington Pk., Md.	WPTX	920	
Libby, Mont.	KLCB	1230	M
Liberal, Kans.	KSCB	1270	
Liberty, N.Y.	WVOS	1240	
Liberty, Tex.	KWLD	1050	
Lihue, Hawaii	KTOH	1490	
Lima, Ohio	WIMA	1150	A
Lincoln, Ill.	WPRC	1370	
Lincoln, Nebr.	KFOR	1240	A
	KLIN	1400	
	KLMS	1480	
Lincolnton, N.C.	WLON	1050	
Lindsay, Ont.	CKLY	910	
Linton, Ind.	WBTO	1600	
Litchfield, Ill.	WSMI	1540	
Litchfield, Minn.	KLFD	1410	
Little Falls, Minn.	KLTF	960	
Little Falls, N.Y.	WLFH	1230	
Littlefield, Tex.	KZZN	1490	
Little Rock, Ark.	KARK	920	N
	KAJI	1250	M
	KLRA	1010	A
	KOKY	1440	
	KTHS	1090	C
	KVLC	1050	
Littleton, Colo.	KMOR	1510	
Live Oak, Fla.	WNER	1250	
Livingston, Mont.	KPRK	1340	M
Livingston, Tenn.	WLIV	920	
Livingston, Tex.	KETX	1440	
	KLBS	1220	
Lloydminster, Alta.	CKSA	1150	
Lock Haven, Pa.	WBPZ	1230	M
Lockport, N.Y.	WUSJ	1340	
Lodi, Calif.	KCVR	1570	
Logan, Utah	KVNU	610	M
	KLGN	1390	
Logan, W.Va.	WLOG	1230	M
	WVOW	1290	
Logansport, Ind.	WSAL	1230	M
Lompoc, Calif.	KNEZ	960	
London, Ky.	WFTG	1400	
London, Ont.	CFPL	980	
	CKSL	1290	
Long Beach, Calif.	KFOX	1280	
	KGER	1390	
Longmont, Colo.	KLMO	1050	
Long Prairie, Minn.	KEYL	1400	
Longview, Tex.	KFRO	1370	A
	KLUE	1280	
Longview, Wash.	KEDO	1400	A
	KBAM	1270	
Lorain, Ohio	WWIZ	1380	A
Loris, S.C.	WLSC	1570	
Los Alamos, N.Mex.	KRSN	1490	A
Los Angeles, Calif.	KABC	790	A
	KFI	640	N
	KHJ	930	M
	KFSG	1150	
	KFWB	980	
	KGFJ	1230	
	KFAC	1330	
	KLAC	570	
	KMPC	710	
	KNX	1070	C
	KPOL	1540	
	KPOP	1020	
	KRKD	1150	
Louisburg, N.C.	WYRN	1480	
Louisville, Ky.	WAVE	970	N
	WAKY	790	M
	WHAS	840	C
	WKLO	1080	A
	WINN	1240	
	WKYW	900	
	WLOU	1350	
	WTMT	620	
Louisville, Miss.	WLSM	1270	
Loveland, Colo.	KLOV	1570	
Lovington, N.Mex.	KLEA	630	
Lowell, Mass.	WCAP	980	
	WLLH	1400	
Lubbock, Tex.	KCBD	1590	M-N
	KDAV	580	
	KDUB	1340	
	KFYO	790	C
	KLLL	1460	M
	KSEL	950	A
Ludington, Mich.	WKLA	1450	A
Lufkin, Tex.	KRBA	1340	A
	KTRE	1420	M
Lumberton, N.C.	WAGR	580	
	WTSB	1340	M
Lynchburg, Va.	WLVA	590	A
	WWOD	1390	M-N
	WBRG	1050	
Lynn, Mass.	WLYN	1360	
Lyons, Ga.	WBBT	1340	
Macomb, Ill.	WKAI	1510	
Macon, Ga.	WBML	1240	
	WCRY	900	
	WIBB	1280	
	WMAZ	940	C
	WNEX	1400	A-M
Macon, Miss.	WMBC	1400	
Madera, Calif.	KHOT	1250	
Madison, Fla.	WMAF	1230	
Madison, Ga.	WYTH	1250	
Madison, Ind.	WORX	1270	
Madison, Wis.	WHA	970	
	WIBA	1310	N
	WISM	1480	A-M
	WKOW	1070	C
Madison, Tenn.	WENO	1430	
Madisonville, Ky.	WFMW	730	
	WTTL	1310	
Magee, Miss.	WSJC	1280	
Magnolia, Ark.	KVMA	630	M
Malden, Mo.	KTCB	1470	
Malone, N.Y.	WICY	1490	M
Malvern, Ark.	KBOK	1310	
Manassas, Va.	WPRW	1460	
Manchester, Conn.	WINF	1230	
Manchester, Ga.	WFDR	1370	
Manchester, Ky.	WWXL	1450	
Manchester, N.H.	WFEA	1370	
	WGIR	610	C
	WKBR	1240	
Manchester, Tenn.	WMSR	1320	
Manhattan, Kans.	KSAC	580	
	KMAN	1350	
Manistee, Mich.	WMTE	1340	
Manitou Springs, Colo.	KCMS	1490	
Manitowoc, Wis.	WCUB	980	
	WOMT	1240	M
Mankato, Minn.	KYSM	1230	N
	KTOE	1420	A
Manning, S.C.	WYMB	1410	
Mansfield, La.	KDBC	1360	
Mansfield, Ohio	WMAN	1400	A
	WCLW	1570	
Maquoketa, Iowa	KMAQ	1320	
Marianna, Fla.	WTYS	1340	M
	WTOT	980	
Marietta, Ga.	WFOM	1230	
	WBIE	1050	
Marietta, Ohio	WMOA	1490	M
Marine City, Mich.	WDOG	1590	
Marinette, Wis.	WMAM	570	N
Marion, Ala.	WJAM	1310	
Marion, Ill.	WGGH	1150	
Marion, Ind.	WBAT	1400	A
	WMRI	860	
Marion, N.C.	WBRM	1250	
Marion, Ohio	WMRN	1490	A
Marion, S.C.	WATP	1430	
Marion, Va.	WMEV	1010	A
Marked Tree, Ark.	KPCA	1580	
Marksville, La.	KAPB	1370	
Marlborough, Mass.	WSRO	1470	
Marlin, Tex.	KMLW	1010	
Marquette, Mich.	WDMJ	1320	M
Marshall, Minn.	KMHL	1400	A
Marshall, Mo.	KMMO	1300	
Marshall, N.C.	WMMH	1460	
Marshall, Tex.	KMHT	1450	
	KADO	1410	
Marshalltown, Iowa	KFJB	1230	
Marshfield, Wis.	WDLB	1450	
Martin, Tenn.	WCMT	1410	
Martinsburg, W.Va.	WEPM	1340	
Martinsville, Va.	WHEE	1370	
	WMVA	1450	N
Marysville, Calif.	KMYC	1410	M
Marysville, Kans.	KNDY	1570	
Maryville, Mo.	KNIM	1580	
Maryville, Tenn.	WGAP	1400	
Mason City, Iowa	KGLO	1300	C
	KRIB	1490	
	KSMN	1010	
Massena, N.Y.	WMSA	1340	A
	WSTS	1050	
Massillon, Ohio	WTIG	990	
Matane, Que.	CKBL	1250	
Matawan, W.Va.	WHJC	1360	
Mattoon, Ill.	WLBH	1170	
Mayaguez, P.R.	WAEL	600	
	WKJB	710	
	WORA	1150	
	WPRA	990	
	WTIL	1300	
Mayfield, Ky.	WNGO	1320	
Mayodan, N.C.	WMYN	1420	
Maysville, Ky.	WFTM	1240	M
McAlester, Okla.	KTMC	1400	
	KNED	1150	
McAllen, Tex.	KRIO	910	M
McCamey, Tex.	KCMR	1450	
McComb, Miss.	WHNY	1250	A
	WAPF	980	
McCook, Nebr.	KBRL	1300	M
McGehee, Ark.	KVSA	1220	
McKeesport, Pa.	WEDO	810	C
	WMCK	1360	
McKenzie, Tenn.	WHDM	1440	
McKinney, Tex.	KMAE	1600	
McMinnville, Oreg.	KMCM	1260	
McMinnville, Tenn.	WBMC	960	
	WMMT	1230	M
McPherson, Kans.	KNEX	1540	
McRae, Ga.	WDAX	1410	
Meadville, Pa.	WMGW	1490	
Medford, Mass.	WHIL	1430	
Medford, Oreg.	KMED	1440	N
	KDOV	1300	
	KBOY	730	
	KYJC	1230	A-C
Medford, Wis.	WIGM	1490	M
Medicine Hat, Alta.	CHAT	1270	
Melbourne, Fla.	WMMB	1240	M
Memphis, Tenn.	WHBQ	560	M
	WHER	1430	
	WMC	790	N
	WDIA	1070	
	WMPS	680	
	WHHM	1340	A
	WLOK	1480	
	WREC	600	C
	KWAM	990	
Mena, Ark.	KENA	1450	
Menominee, Mich.	WAGN	1310	A
Menomonie, Wis.	WMNE	1360	
Merced, Calif.	KYOS	1480	M
	KWIP	1580	
Meriden, Conn.	WMMW	1470	
Meridian, Miss.	WCOC	910	C
	WDAL	1330	
	WMOX	1240	
	WOKK	1450	A
	WQIC	1390	
Mesa, Ariz.	KBUZ	1310	
Metropolis, Ill.	WMOK	920	
Mexia, Tex.	KBUS	1590	
Mexico, Mo.	KXEO	1340	M
Mexico, Pa.	WJUN	1220	
Miami, Ariz.	KIKO	1340	
Miami, Fla.	WGBS	710	C
	WCKR	610	N
	WFFC	1220	
	WAME	1260	
	WMIE	1140	
	WQAM	560	
	WSKP	1450	
	WINZ	940	
Miami, Okla.	KGLC	910	
Miami Beach, Fla.	WMET	1490	
	WKAT	1360	M-A
	WMBM	800	
Michigan City, Ind.	WIMS	1420	
Middleport-Pomroy, Ohio	WMPO	1390	
Middlesboro, Ky.	WMIK	560	
Middletown, Conn.	WCNX	1150	
Middletown, N.Y.	WALL	1340	
Middletown, Ohio	WPFB	910	
Midland, Mich.	WMDN	1490	
Midland, Ont.	CKMP	1230	
Midland, Tex.	KCRS	550	A
	KJBC	1150	
	KWEL	1600	
Milan, Tenn.	WKBJ	1600	
Miles City, Mont.	KATL	1340	M
Milford, Del.	WKSB	930	
Milford, Mass.	WMRC	1490	
Milledgeville, Ga.	WMVG	1450	M
Millen, Ga.	WGSR	1570	
Millington, Tenn.	WHEY	1220	
Millville, N.J.	WMVB	1440	
Milton, Fla.	WEBY	1330	M
	WSRA	1490	
Milton, Pa.	WMLP	1570	
Milwaukee, Wis.	WEMP	1250	
	WFOX	860	M
	WRIT	1340	
	WISN	1150	A
	WMIL	1290	
	WOKY	920	
	WTMJ	620	N
Minden, La.	KASO	1240	
Mineral Wells, Tex.	KORC	1140	
Mineola, N.Y.	WFYI	1520	
Minneapolis, Minn.	WCCO	830	C
	WLOL	1330	
	WMIN	1400	
	WDGY	1130	
	WPBC	980	
	WTCN	1280	A
	KTIS	900	
	KUOM	770	
Minot, N.Dak.	KLPM	1390	M
	KQDY	1320	
	KCJB	910	C
Mission, Kans.	KBKC	1480	
Mission, Tex.	KIRT	1580	
Missoula, Mont.	KGVO	1290	C
	KXLL	1450	N
	KQTE	1340	M
	KYSS	910	
Mitchell, S.Dak.	KORN	1490	M
Moab, Utah	KURA	1450	
Moberly, Mo.	KNCM	1230	
Mobile, Ala.	WALA	1410	N
	WABB	1480	A
	WGOK	900	
	WKAB	840	
	WKRG	710	C
	WMOZ	960	
Mobridge, S.Dak.	KOLY	1300	
Modesto, Calif.	KTRB	860	
	KBEE	970	
	KFIV	1360	A
Moline, Ill.	WQUA	1230	A
Monahans, Tex.	KVKM	1340	M
Moncton, N.B.	CBAF	1300	
	CKCW	1220	
Monett, Mo.	KRMO	990	
Monmouth, Ill.	WRAM	1330	
Monroe, Ga.	WMRE	1490	
Monroe, La.	KMLB	1440	A-N
	KLIC	1230	M
	KNOE	1390	
Monroe, Mich.	WMIC	560	
Monroe, N.C.	WMAP	1060	
Monroe, Wis.	WEKZ	1260	
Monroeville, Ala.	WMFC	1360	
Monterey, Calif.	KIDD	630	
	KMBY	1240	C
Montevideo, Minn.	KDMA	1450	A
Monte Vista, Colo.	KSLV	1240	
Montgomery, Ala.	WBAM	740	
	WCOV	1170	C
	WAPX	1600	A
	WHHY	1440	N
	WMGY	800	
	WRMA	950	
Montgomery, W.Va.	WMON	1340	M
Monticello, Ark.	KHBM	1430	
Monticello, Ky.	WFLW	1360	
Montmagny, Que.	CKBM	1490	
Montpelier-Barre, Vt.	WSKI	1240	A
Montreal, Que.	CBF	690	
	CBM	940	N
	CFCF	600	A
	CJAD	800	
	CJMS	1280	
	CKAC	730	C
	CKGM	980	
Montrose, Colo.	KUBC	580	
Montrose, Pa.	WPEL	1250	
Mooresville, N.C.	WHIP	1350	
Moorhead, Minn.	KVOX	1280	M
Moosejaw, Sask.	CHAB	800	
Morehead, Ky.	WMOR	1330	
Morehead City, N.C.	WMBL	740	
Morgan City, La.	KMRC	1430	M
Morganton, N.C.	WMNC	1430	
Morgantown, W.Va.	WAJR	1440	N
	WCLG	1300	
Morrilton, Ark.	KVOM	800	
Morris, Minn.	KMRS	1570	
Morristown, N.J.	WMTR	1250	
Morristown, Tenn.	WCRK	1150	M
	WMTN	1300	
Moscow, Idaho	KRPL	1400	
Moses Lake, Wash.	KSEM	1470	
	KWIQ	1260	
Moultrie, Ga.	WMGA	1400	A
	WMTM	1300	
Moundsville, W.Va.	WMOD	1370	
Mountain Grove, Mo.	KLRS	1360	
Mountain Home, Ark.	KTLO	1490	
Mt. Airy, N.C.	WPAQ	740	
	WSYD	1300	M
Mt. Carmel, Ill.	WVMC	1360	

Location	C.L.	Kc.	N.A.
Mt. Clemens, Mich.	WBRB	1430	
Mt. Dora, Fla.	WMDF	1580	
Mt. Jackson, Va.	WSIG	790	
Mt. Kisco, N.Y.	WVIP	1310	
Mt. Pleasant, Mich.	WCEN	1150	
Mt. Pleasant, Tex.	KIMP	960	
Mt. Shasta, Calif.	KWSD	620	
Mt. Sterling, Ky.	WMST	1150	
Mt. Vernon, Ill.	WMIX	940	
Mt. Vernon, Ind.	WPCO	1590	
Mt. Vernon, Ky.	WRVK	1460	
Mt. Vernon, Ohio	WMVO	1300	
Mt. Vernon, Wash.	KBRC	1430	
Muleshoe, Tex.	KMUL	1380	
	KZOL	1570	
Mullins, S.C.	WJAY	1280	
Muncie, Ind.	WLBC	1340	C
Munfordville, Ky.	WLOC	1150	
Munising, Mich.	WMAB	1400	
Murfreesboro, Tenn.	WGNS	1450	
	WMTS	860	
Murphy, N.C.	WCVP	600	
	WKRK	1390	
Murphysboro, Ill.	WINI	1420	
Murray, Ky.	WNBS	1340	
Murray, Utah	KMUR	1230	
Muscatine, Iowa	KWPC	860	
Muscle Shoals City, Alabama	WLAY	1450	
Muskegon, Mich.	WKBZ	850	A
	WTRU	1600	
	WMUS	1090	
Muskogee, Okla.	KBIX	1490	A
	KMUS	1380	
Myrtle Beach, S.C.	WMYB	1450	
Nacogdoches, Tex.	KEEE	1230	A
	KSFA	860	
Nampa, Idaho	KFXD	580	
Nanaimo, B.C.	CHUB	1570	
Nanticoke, Pa.	WNAK	730	
Napa, Calif.	KVON	1440	
Naples, Fla.	WNOG	1270	
Narrows, Va.	WNRV	990	
Nashua, N.H.	WOTW	900	
	WSMN	1590	
Nashville, Ark.	KBHC	1260	
Nashville, Tenn.	WKDA	1240	
	WLAC	1510	C
	WMAK	1300	
	WNAH	1360	M
	WSIX	980	A
	WSM	650	N
	WVOL	1470	
Natchez, Miss.	WMIS	1240	N
	WNAT	1450	M
Natchitoches, La.	KNOC	1450	M
Nebraska City, Nebr.	KNCY	1600	
Needles, Calif.	KSFE	1340	
Neenah, Wis.	WNAM	1280	
Neillsville, Wis.	WCCN	1370	
Nelson, B.C.	CKLN	1390	
Neon, Ky.	WNKY	1480	
Neosho, Mo.	KBTN	1420	
Nevada, Mo.	KNEM	1240	
New Albany, Ind.	WOWI	1570	
New Albany, Miss.	WNAU	1470	
Newark, N.J.	WNTA	970	
	WHBI	1280	
	WNJR	1430	
	WVNJ	620	
Newark, N.Y.	WACK	1420	
Newark, Ohio	WCLT	1430	
New Bedford, Mass.	WBSM	1420	
	WNBH	1340	M
New Bern, N.C.	WHIT	1450	M
	WRNB	1490	
Newberry, S.C.	WKDK	1240	
New Boston, Ohio	WIOI	1010	
New Braunfels, Tex.	KGNB	1420	
New Britain, Conn.	WHAY	910	A
	WKNB	840	
New Brunswick, N.J.	WCTC	1450	
Newburgh, N.Y.	WGNY	1220	
Newburyport, Mass.	WNBP	1470	
New Carlisle, Que.	CHNC	610	
Newcastle, N.B.	CKMR	790	
New Castle, Pa.	WKST	1280	
Newcastle, Wyo.	KASL	1240	
New Glasgow, N.S.	CKEC	1320	
New Haven, Conn.	WAVZ	1300	
	WELI	960	
	WNHC	1340	A
New Iberia, La.	KANE	1240	
	KVIM	1360	
New Kensington, Pa.	WKPA	1150	
New London, Conn.	WNLC	1490	M
New Martinsville, W.Va.	WETZ	1330	M
Newnan, Ga.	WCOH	1400	M
New Orleans, La.	WDSU	1280	N
	WJBW	1230	
	WJMR	990	
	WBOK	800	
	WNOE	1060	
	WSMB	1350	A
	WNPS	1450	
	WTIX	690	
	WWL	870	C
	WWOM	940	
	WYLD	940	M
Newport, Ark.	KNBY	1280	
Newport, Ky.	WNOP	740	
Newport, Oreg.	KNPT	1310	
Newport, R.I.	WADK	1540	
Newport, Tenn.	WLIK	1270	
Newport, Vt.	WIKE	1490	
Newport News, Va.	WGH	1310	A
	WYUO	1270	
New Rochelle, N.Y.	WVOX	1460	
New Smyrna Beach, Fla.	WSBB	1230	M
Newton, Iowa	KCOB	1280	
Newton, Kans.	KJRG	950	
Newton, Miss.	WBKN	1410	
Newton, N.J.	WNNJ	1360	
Newton, N.C.	WNNC	1230	
New Ulm, Minn.	KNUJ	860	
New Westminster, B.C.	CKNW	980	
New York, N.Y.	WABC	770	A
	WBNX	1380	
	WCBS	880	C
	WEVD	1330	
	WHOM	1480	
	WINS	1010	
	WLIB	1190	
	WMCA	570	
	WMGM	1050	
	WNEW	1130	
	WNYC	830	
	WOR	710	M
	WADO	1280	
	WPOW	1330	
	WQXR	1560	
	WNBC	660	N
Niagara Falls, N.Y.	WHLD	1270	
	WJJL	1440	
Niagara Falls, Ont.	CHVC	1600	
Niles, Mich.	WNIL	1290	
Nogales, Ariz.	KNOG	1340	A
Norfolk, Nebr.	WJAG	780	
Norfolk, Va.	WTAR	790	C
	WCMS	1050	
	WNOR	1230	
	WRAP	850	
Norman, Okla.	WNAD	640	
	KNOR	1400	
Norristown, Pa.	WNAR	1110	
N. Adams, Mass.	WMNB	1230	
N. Augusta, S.C.	WGUS	1600	
N. Battleford, Sask.	CJNB	1460	
North Bay, Ont.	CFCH	600	
North Bend, Oreg.	KFIR	1340	C
Northfield, Minn.	WCAL	770	
Northampton, Mass.	WHMP	1400	M
N. Little Rock, Ark.	KDXE	1380	A
	KXLR	1150	
	KVLC	1050	
North Platte, Nebr.	KJLT	970	
	KODY	1240	N
No. Syracuse, N.Y.	WJMK	1220	
No. Vancouver, B.C.	CKLG	730	
N. Vernon, Ind.	WOCH	1460	
No. Wilkesboro, N.C.	WKBC	810	
Norton, Va.	WNVA	1350	M
Norwalk, Conn.	WNLK	1350	
Norwich, Conn.	WICH	1310	
Norwich, N.Y.	WCHN	970	
Oakdale, La.	KREH	900	
Oakes, N.Dak.	KEYD	1220	
Oak Grove, La.	KWCL	1280	
Oak Hill, W.Va.	WOAY	860	
Oakland, Calif.	KEWB	910	
	KABL	960	
	KDIA	1310	
Oak Park, Ill.	WOPA	1490	
Oak Ridge, Tenn.	WATO	1290	
Oakville, Ont.	CHWO	1250	
Ocala, Fla.	WMOP	900	
	WTMC	1290	N
	WHYS	1370	
Oceanlake, Oreg.	KBCH	1380	
Oceanside, Calif.	KUDE	1320	
Odessa, Tex.	KECK	920	
	KOSA	1230	C
	KOYL	1310	
	KRIG	1410	M
Oelwein, Iowa	KOEL	950	
Ogallala, Nebr.	KOGA	930	
Ogden, Utah	KLO	1430	M
	KSVN	730	
	KVOG	1490	
Ogdensburg, N.Y.	WSLB	1400	M
Oil City, Pa.	WKRZ	1340	
Okla. City, Okla.	KBYE	890	A
	KLPR	1140	
	KOCY	1340	
	KOMA	1520	
	KTOK	1000	M
	KJEM	800	
	WKY	930	
Okmulgee, Okla.	KOKL	1240	
Old Saybrook, Conn.	WLIS	1420	
Olean, N.Y.	WMNS	1360	
	WHDL	1450	A
Olney, Ill.	WVLN	740	
Olympia, Wash.	KGY	1240	M
	KITN	920	
Omaha, Nebr.	KBON	1490	
	KFAB	1110	N
	KOIL	1290	
	KOOO	1420	
	KMEO	660	
	KSWI	1560	M-A
	WOW	590	C
Omak, Wash.	KOMW	680	
Oneida, N.Y.	WONG	1600	
Oneida, Tenn.	WBNT	1310	
O'Neill, Nebr.	KBRX	1350	
Oneonta, Ala.	WCRL	1570	
Oneonta, N.Y.	WDOS	730	
Ontario, Calif.	KASK	1510	
Ontario, Oreg.	KSRV	1380	
Opelika, Ala.	WPHO	1400	M
Opelousas, La.	KSLO	1230	A
Opp, Ala.	WAMI	860	
Opportunity, Wash.	KZUN	630	
Orange, Mass.	WCAT	1390	
Orange, Tex.	KOGT	1600	
Orange, Va.	WJMA	1340	
Orangeburg, S.C.	WDIX	1150	A
	WBPD	1580	
	WTND	920	
Oregon City, Oreg.	KGON	1520	N
Orillia, Ont.	CFOR	1570	
Orlando, Fla.	WDBO	580	C
	WHOO	990	M
	WHIY	1270	
	WLOF	950	
	WKIS	740	N
Ormond Bch., Fla.	WQXQ	1380	
Orofino, Idaho	KLER	950	
Ortonville, Minn.	KDIO	1350	
Osage Bch., Mo.	KRMS	1150	
Osceola, Ark.	KOSE	860	
Oshawa, Ont.	CKLB	1350	
Oshkosh, Wis.	WOSH	1490	A
Oskaloosa, Iowa	KBOE	740	
Othello, Wash.	KRSC	1400	
Ottawa, Ill.	WCMY	1430	
Ottawa, Kans.	KOFO	1220	
Ottawa, Ont.	CBO	910	
	CFRA	560	
	CKOY	1310	
Ottumwa, Iowa	KBIZ	1240	A
	KLEE	1480	
Owatonna, Minn.	KRFO	1390	
Owego, N.Y.	WEBO	1330	
Owensboro, Ky.	WOMI	1490	M
	WVJS	1420	A
Owen Sound, Ont.	CFOS	560	
Owosso, Mich.	WOAP	1080	
Oxford, Miss.	WSUH	1420	
Oxford, N.C.	WOXF	1340	
Oxnard, Calif.	KOXR	910	
Ozark, Ala.	WOZK	900	
Paducah, Ky.	WKYB	570	N-M
	WDXR	1560	
	WPAD	1450	C
Pahokee, Fla.	WRIM	1250	
Painesville, Ohio	WPVL	1460	
Paintsville, Ky.	WSIP	1490	M
Palatka, Fla.	WWPF	1260	
	WSUZ	800	
Palestine, Tex.	KNET	1450	
Palm Bch., Fla.	WQXT	1340	A
Palm Sprgs., Calif.	KCMJ	1010	C
	KDES	920	
	KPAL	1450	
Palmdale, Calif.	KUTY	1470	
Palo Alto, Calif.	KIBE	1220	
Pampa, Tex.	KPDN	1340	M
	KHHH	1230	
Panama City, Fla.	WDLP	590	
	WPCF	1430	M
Panama City Beach, Fla.	WTHR	1480	
	WSCM	1290	
Paragould, Ark.	KDRS	1490	
Paris, Ark.	KCCL	1460	
Paris, Ill.	WPRS	1440	
Paris, Ky.	WKLX	1440	
Paris, Tenn.	WTPR	710	
Paris, Tex.	KPLT	1490	A
	KFTV	1250	
Parkersburg, W.Va.	WCEF	1050	
	WPAR	1450	C
	WTAP	1230	A
Park Falls, Wis.	WPFP	1450	
Parry Sound, Ont.	CKAR-1	1340	
Parsons, Kans.	KLKC	1540	
Pasadena, Calif.	KALI	1430	
	KPPC	1240	
	KRLA	1110	
	KWKW	1300	
Pasadena, Tex.	KLVL	1480	
Pascagoula, Miss.	WPMP	1580	A
Pasco, Wash.	KORD	910	
	KPKW	1340	
Paso Robles, Calif.	KPRL	1230	M
Patchogue, L.I., N.Y.	WALK	1370	
	WPAC	1580	
Paterson, N.J.	WPAT	930	
Pauls Valley, Okla.	KVLH	1470	
Pawtucket, R.I.	WPAW	550	A
Payette, Idaho	KEOK	1450	
Peace River, Alta.	CKYL	630	
Pecos, Tex.	KIUN	1400	M
Peekskill, N.Y.	WLNA	1420	
Pekin, Ill.	WSIV	1140	
Pell City, Ala.	WFHK	1430	
Pembroke, Ont.	CHOV	1350	
Pendleton, Oreg.	KKID	1240	A
	KUBE	1050	
	KUMA	1290	A
Pennington Gap, Va.	WSWV	1570	
Pensacola, Fla.	WBOP	980	
	WDEB	610	
	WBSR	1450	C
	WNVY	1230	A
	WCOA	1370	N
	WPFA	790	
Penticton, B.C.	CKOK	800	
Peoria, Ill.	WAAP	1350	N
	WMBD	1470	C
	WIRL	1290	M
	WPEO	1020	
Perry, Fla.	WPRY	1400	
Perry, Ga.	WBBN	980	
Perryton, Tex.	KEYE	1400	M
Peru, Ind.	WARU	1600	
Petaluma, Calif.	KAFP	1490	
Peterborough, Ont.	CHEX	980	
	CKPT	1420	
Petersburg, Va.	WSSV	1240	M
Petoskey, Mich.	WMBN	1340	
Phenix City, Ala.	WPNX	1460	A
Philadelphia, Miss.	WHOC	1490	
Philadelphia, Pa.	WCAU	1210	C
	WDAS	1480	
	WFIL	560	A
	WFLN	900	
	WHAT	1340	
	WIBG	990	
	WIP	610	
	WJMJ	1540	
	WPEN	950	
	WRCV	1060	N
	WTEL	860	
Philipsburg, Pa.	WPHB	1260	
Phoenix, Ariz.	KIFN	860	
	KXIV	1400	
	KHAT	1480	
	KHEP	1280	
	KOY	550	A
	KOOL	960	C
	KPHO	910	A
	KUEQ	740	
	KRIZ	1230	
	KTAR	620	N
Picayune, Miss.	WRJW	1320	
Piedmont, Ala.	WPID	1280	
Pierre, S.Dak.	KGFX	630	
	KCCR	1590	
Pikeville, Ky.	WLSI	900	
	WPKE	1240	M
Pine Bluff, Ark.	KCLA	1400	
	KOTN	1490	M
	KPBA	1590	
Pine City, Minn.	WCMP	1350	
Pineville, Ky.	WMLF	1230	
Pineville, W.Va.	WWYO	970	
Pipestone, Minn.	KLOH	1050	
Piqua, Ohio	WPTW	1570	
Pittsburg, Calif.	KKIS	990	
Pittsburg, Kans.	KOAM	860	N
	KSEK	1340	
Pittsburgh, Pa.	KDKA	1020	
	KQV	1410	C
	WCAE	1250	
	WEEP	1080	
	WAMP	1320	N
	WPIT	730	
	WWSW	970	
Pittsfield, Ill.	WBBA	1580	
Pittsfield, Mass.	WBEC	1420	A
	WBRK	1340	M
Pittston, Pa.	WPTS	1540	
Plainview, Tex.	KVOP	1400	M
Plant City, Fla.	WPLA	910	
Platteville, Wis.	WSWW	1590	
Plattsburg, N.Y.	WEAV	960	A
	WIRY	1340	M
Pleasanton, Tex.	KBOP	1380	
Pleasantville, N.J.	WOND	1400	
Plymouth, Mass.	WPLM	1390	
Plymouth, N.C.	WPNC	1470	
Plymouth, Wis.	WPLY	1420	
Pocahontas, Ark.	KPOC	1420	
Pocatello, Idaho	KSEI	930	N
	KWIK	1240	M
	KYTE	1290	
Pocomoke City, Md.	WDMV	540	
Pointe Claire, Que.	CFOX	1470	
Pomona, Calif.	KWOW	1600	
Pompano Beach, Fla.	WLOD	980	
	WPOM	1470	A
Ponca City, Okla.	WBBZ	1230	M
Ponce, P.R.	WPRP	910	
	WEUC	1420	
	WPAB	550	
	WLEO	1170	
	WISO	1260	
Pontiac, Mich.	WPON	1460	
Poplar Bluff, Mo.	KWOC	930	
Portage, Wis.	WPDR	1350	
Portage la Prairie, Man.	CFRY	1570	
Port Alberni, B.C.	CJAV	1240	
Portales, N.Mex.	KENM	1450	
Port Angeles, Wash.	KONP	1450	
Port Arthur, Ont.	CFPA	1230	
Port Arthur, Tex.	KOLE	1340	
	KPAC	1250	M
Porterville, Calif.	KTIP	1450	A
Port Hope, Ont.	CHUC	1500	
Port Hueneme, Calif.	KACY	1520	
Port Huron, Mich.	WHLS	1450	
	WTTH	1380	A
Port Jervis, N.Y.	WDLC	1490	
Portland, Ind.	WPGW	1440	
Portland, Maine	WCSH	970	N
	WGAN	560	C
	WLOB	1310	
	WPOR	1490	A-M
Portland, Oreg.	KBPS	1450	
	KLIQ	1290	
	KEX	1190	
	KGW	620	
	KOIN	970	C
	KPAM	1410	

Location	C.L.	Kc.	N.A.
	KPDQ	800	
	KPOJ	1330	M
	KWJJ	1080	A
	KXL	750	
Port Neches, Tex.	KPNG	1150	
Portsmouth, N.H.	WHEB	750	
Portsmouth, Ohio	WPAY	1400	C
	WNXT	1260	A
Portsmouth, Va.	WLOW	1400	A
	WAVY	1350	N
Post, Tex.	KUKO	1370	
Poteau, Okla.	KLCO	1280	
Potosi, Mo.	KYRO	1280	
Potsdam, N.Y.	WPDM	1470	
Pottstown, Pa.	WPAZ	1370	
Pottsville, Pa.	WPAM	1450	
	WPPA	1360	M
Poughkeepsie, N.Y.	WEOK	1390	
	WKIP	1450	A
Powell, Wyo.	KPOW	1260	M
Poynette, Wis.	WIBU	1240	
Prairie du Chien, Wis.	WPRE	980	
Pratt, Kans.	KWSK	1570	
Prescott, Ariz.	KYCA	1490	N
	KNOT	1450	A
	KZOK	1340	
Presque Isle, Me.	WAGM	950	
Preston, Idaho	KPST	1340	
Prestonsburg, Ky.	WPRT	960	
	WDOC	1310	
Price, Utah	KOAL	1230	M
Prichard, Ala.	WAIP	1270	
Prince Albert, Sask.	CKBI	900	
Prince George, B.C.	CKPG	550	
Prince Rupert, B.C.	CFPR	1240	
Princeton, Ind.	WRAY	1250	
Princeton, Ky.	WPKY	1580	
Princeton, W.Va.	WLOH	1490	A
Prineville, Oreg.	KRCO	690	
Prosser, Wash.	KARY	1310	
Providence, R.I.	WEAN	790	M
	WHIM	1110	
	WICE	1290	
	WJAR	920	N
	WPRO	630	C
	WRIB	1220	
Provo, Utah	KIXX	1400	A
	KEYY	1450	
	KOVO	960	M
Pryor, Okla.	KOLS	1570	
Pueblo, Colo.	KDZA	1230	
	KAPI	690	
	KFEL	970	
	KGHF	1350	A-M
	KCSJ	590	
	KTUX	1480	
Pulaski, Tenn.	WKSR	1420	A
Pulaski, Va.	WPUV	1580	
Pullman, Wash.	KWSC	1250	
	KOFE	1150	
Punxsutawney, Pa.	WPME	1540	
Putnam, Conn.	WPCT	1350	
Puyallup, Wash.	KAYE	1450	
Quanah, Tex.	KOLJ	1150	
Quebec, Que.	CBV	980	
	CHRC	800	
	CJLR	1060	
	CJQC	1340	
	CKCV	1280	
Quesnel, B.C.	CKCQ	570	
Quincy, Fla.	WCNH	1230	M
Quincy, Ill.	WGEM	1440	A
	WTAD	930	C
Quincy, Mass.	WJDA	1300	
Quincy, Wash.	KPOR	1370	
Quitman, Ga.	WSFB	1490	
Racine, Wis.	WRAC	1460	
	WRJN	1400	A
Radford, Va.	WRAD	1460	
Raleigh, N.C.	WKIX	850	A
	WPTF	680	N
	WSHE	570	
	WRAL	1240	
Rapid City, S.Dak.	KOTA	1380	C
	KRSD	1340	
	KEZU	920	
Raton, N.Mex.	KRTN	1490	A
Ravenswood, W.Va.	WMOV	1360	
Rawlins, Wyo.	KRAL	1240	M
Raymond, Wash.	KAPA	1340	
Raymondville, Tex.	KSOX	1240	
Rayville, La.	KRIH	990	
Reading, Pa.	WEEU	850	A
	WHUM	1240	C
	WRAW	1340	N
Redding, Calif.	KRDG	1230	M
	KPAP	1270	
	KSDA	1400	
	KVCV	600	C
	KVIP	540	
Red Bluff, Calif.	KBLF	1490	
Red Deer, Alta.	CKRD	850	
Redlands, Calif.	KCAL	1410	
Red Lion, Pa.	WGCB	1440	
Redmond, Oreg.	KPRB	1240	
Red Wing, Minn.	KCUE	1250	
Redwood Falls, Minn.	KLGR	1490	
Reedsburg, Wis.	WRDB	1400	
Regina, Sask.	CBK	540	
	CJME	1300	
	CKCK	620	
	CKRM	980	
Reidsville, N.C.	WFRC	1600	A
	WREV	1220	
Remsen, N.Y.	WREM	1480	
Reno, Nev.	KOH	630	N
	KBET	1340	M
	KOLO	920	C
	KONE	1450	
	KDOT	1230	
Renton, Wash.	KUDY	910	
Rexburg, Idaho	KRXK	1230	
Rhinelander, Wis.	WOBT	1240	
Rice Lake, Wis.	WJMC	1240	
Richfield, Utah	KSVC	980	
Richland, Wash.	KALE	960	
Richland, Wis.	WRCO	1450	
Richlands, Va.	WRIC	540	
Richmond, Ind.	WKBV	1490	A
Richmond, Ky.	WEKY	1340	M
Richmond, Va.	WANT	990	
	WBBL	1480	
	WEZL	1590	
	WLEE	1480	N
	WEET	1320	
	WMBG	1380	A
	WRNL	910	M
	WRVA	1140	C
	WXGI	950	
Richmond Hill, Ont.	CJRH	1310	
Richwood, W.Va.	WVAR	1280	
Ridgecrest, Calif.	KRCK	1360	
	KRKS	1240	
Rimouski, Que.	CJBR	900	
Rio Piedras, P.R.	WRIO	1320	
	WWWW	1520	
Ripley, Tenn.	WTRB	1570	
Ripon, Wis.	WCWC	1600	
Riverhead, N.Y.	WRIV	1390	
Riverside, Calif.	KPRO	1440	
	KACE	1570	
Riverton, Wyo.	KWRL	1450	M
Riviera Beach, Fla.	WHEW	1600	
Riviere du Loup, Que.	CJFP	1400	
Roanoke, Ala.	WELR	1360	
Roanoke, Va.	WDBJ	960	C
	WRIS	1410	M
	WHYE	910	
	WROV	1240	A
	WSLS	610	N
Roanoke Rapids, N.C.	WCBT	1230	M
Roaring Sprgs., Pa.	WKMC	1370	
Roberval, Que.	CHRL	910	
Robinson, Ill.	WTAY	1570	
Rochester, Minn.	KROC	1340	N
	KWEB	1270	
Rochester, N.H.	WWNH	930	
Rochester, N.Y.	WBBF	950	M
	WHAM	1180	N
	WHEC	1460	C
	WRVM	680	
	WSAY	1370	
	WVET	1280	A
Rockford, Ill.	WROK	1440	A
	WRRR	1330	
Rock Hill, S.C.	WRHI	1340	M
	WTYC	1150	
Rockingham, N.C.	WAYN	900	
Rock Island, Ill.	WHBF	1270	C
Rockland, Maine	WRKD	1450	A
Rockmart, Ga.	WPLK	1220	
Rock Springs, Wyo.	KVRS	1360	M
Rockville, Md.	WINX	1600	
Rockwood, Tenn.	WRKH	580	
Rocky Ford, Colo.	KAVI	1320	
Rocky Mount, N.C.	WCEC	810	
	WEED	1390	A
	WRMT	1490	
Rocky Mount, Va.	WYTI	1570	
Rogers, Ark.	KAMO	1390	
Rogers City, Mich.	WHAK	960	
Rogersville, Tenn.	WRGS	1370	
Rolla, Mo.	KTTR	1490	
Rome, Ga.	WLAQ	1410	A
	WRGA	1470	M
	WROM	710	
Rome, N.Y.	WKAL	1450	A
	WRNY	1350	
Ronceverte, W.Va.	WRON	1400	
Roseburg, Oreg.	KRNR	1490	C
	KQEN	1240	A
Rosenberg, Tex.	KFRD	980	
Rossville, Ga.	WRIP	980	
Roswell, N.Mex.	KSWS	1230	
	KGFL	1400	M
	KBIM	910	
Rouyn, Que.	CKRN	1400	
Roxboro, N.C.	WRXO	1430	
Royal Oak, Mich.	WEXL	1340	
Rumford, Me.	WRUM	790	
Rupert, Idaho	KAYT	970	
Rushton, La.	KRUS	1490	
Rusk, Texas	KTLU	1580	
Russell, Kans.	KRSL	990	
Russellville, Ala.	WWWR	920	
Russellville, Ark.	KXRJ	1490	
Russellville, Ky.	WRUS	610	
Rutland, Vt.	WHWB	1000	
	WSYB	1380	M
Sackville, N.B.	CBA	1070	
Sacramento, Calif.	KCRA	1320	N
	KFBK	1530	A
	KGMS	1380	M
	KROY	1240	C
	KXOA	1470	
Safford, Ariz.	KGLU	1480	A
Saginaw, Mich.	WKNX	1210	
	WSAM	1400	N
	WSGW	790	M
St. Albans, Vt.	WWSR	1420	
St. Albans, W.Va.	WKLC	1300	
Ste. Anne de la Pocatiere, Que.	CHGB	1350	
St. Augustine, Fla.	WFOY	1240	C
	WSTN	1420	
St. Boniface, Man.	CKSB	1050	
St. Catherines, Ont.	CKTB	610	
St. Charles, Mo.	KADY	1460	
St. Cloud, Minn.	KFAM	1450	N
	WJON	1240	
St. George, Utah	KDXU	1450	
St. Helen, Mich.	WMIC	1590	
St. Hyacinthe, Que.	CKBS	1240	
St. Jean, Que.	CHRS	1090	
St. Jerome, Que.	CKJL	900	
Saint John, N.B.	CFBC	930	
	CHSJ	1150	
St. John's, Nfld.	CBN	640	
	CJON	930	
	VOAR	1230	
	VOCM	590	
	VOWR	800	
St. Johnsbury, Vt.	WTWN	1340	
St. Joseph, Mich.	WSJM	1400	
St. Joseph, Mo.	KFEQ	680	
	KRES	1550	M
	KUSN	1270	
St. Joseph d'Alma, Que.	CFGT	1270	
St. Louis, Mo.	KATZ	1600	
	KFUO	850	
	KMOX	1120	C
	KSD	550	N
	KSTL	690	
	KWK	1380	
	KXOK	630	
	WEW	770	M
	WIL	1430	A
St. Louis Park, Minn.	KRSI	950	
St. Mary's, Pa.	WKBI	1400	
St. Paul, Minn.	KSTP	1500	N
	KDWB	1590	M
St. Peter, Minn.	KRBI	1310	
St. Petersburg, Fla.	WPIN	680	
	WSUN	620	A
	WLCY	1380	M
St. Petersburg Beach, Fla.	WILZ	1590	
St. Thomas, Ont.	CHLO	680	
Ste. Genevieve, Mo.	KSGM	980	
Salamanca, N.Y.	WNYS	1590	
Salem, Ill.	WJBD	1350	
Salem, Ind.	WSLM	1220	
Salem, Mass.	WESX	1230	M
Salem, Mo.	KSMO	1340	
Salem, Oreg.	KSLM	1390	A
	KBZY	1490	N
	KGAY	1430	
Salem, Va.	WBLU	1480	
Salida, Colo.	KVRH	1340	M
Salina, Kans.	KSAL	1150	M
Salinas, Calif.	KDON	1460	
	KSBW	1380	M
Saline, Mich.	WOIA	1290	
Salisbury, Md.	WBOC	960	
	WICO	1320	A
	WJDY	1470	
Salisbury, N.C.	WSTP	1490	M
	WSAT	1280	A
Salmon, Idaho	KSRA	960	
Salt Lake City, Utah	KALL	910	M
	KCPX	1320	N
	KLUB	570	A
	KNAK	1280	
	KSL	1160	C
	KSOP	1370	
	KWHO	860	
	KWIC	1570	
San Angelo, Tex.	KTXL	1340	
	KGKL	960	A
	KPEP	1420	
	KWFR	1260	
San Antonio, Tex.	KCOR	1350	
	KENS	680	C
	KUKA	1250	
	KUBO	1310	
	KMAC	630	A
	KONO	860	
	KTSA	550	
	WOAI	1200	
San Bernardino, Calif.	KCKC	1350	
	KFXM	590	
	KRNO	1240	
	KITO	1290	M
Sandersville, Ga.	WSNT	1490	
San Diego, Calif.	KCBQ	1170	
	KFMB	540	C
	KFSD	600	N
	KGB	1360	A
	KSON	1240	
	KSDO	1130	
Sandpoint, Idaho	KSPT	1400	
Sandusky, Ohio	WLEC	1450	M
San Fernando, Calif.	KGIL	1260	
Sanford, Fla.	WTRR	1400	
	WIOD	1360	
Sanford, Me.	WSME	1220	
Sanford, N.C.	WEYE	1290	
	WWGP	1050	
San Francisco, Calif.	KFRC	610	M
	KCBS	740	C
	KFAX	1100	
	KNBC	680	N
	KOBY	1550	M
	KSAY	1010	
	KSAN	1450	
	KSFO	560	
	KYA	1260	
San Jose, Calif.	KLOK	1170	
	KLIV	1590	
	KEEN	1370	
	KXRX	1500	
San Juan, P.R.	WAPA	680	M
	WHOA	1400	
	WIPR	940	
	WKAQ	580	C
	WKVM	1230	
	WITA	1140	
San Luis Obispo, Calif.	KATY	1340	
	KVEC	920	M
San Marcos, Tex.	KCNY	1470	
San Mateo, Calif.	KOFY	1050	
San Rafael, Calif.	KTIM	1510	
San Saba, Tex.	KBAL	1410	
Santa Ana, Calif.	KWIZ	1480	
Santa Barbara, Cal.	KDB	1490	
	KIST	1340	N
	KTMS	1250	A-M
Santa Cruz, Calif.	KSCO	1080	
Santa Fe, N.Mex.	KTRC	1400	A
	KVSF	1260	C
Santa Maria, Cal.	KCOY	1400	
	KSMA	1240	
Santa Monica, Cal.	KDAY	1580	
Santa Paula, Calif.	KSPA	1400	
Santa Rosa, Calif.	KSRO	1350	
	KJAX	1150	
Santurce, P.R.	WIAC	740	
	WKAQ	589	C
Saranac Lake, N.Y.	WNBZ	1240	A
Sarasota, Fla.	WKXY	930	
	WSPB	1450	C
Saratoga Springs, N.Y.	WSPN	900	
	WRSA	1280	
Sarnia, Ont.	CHOK	1070	
Saskatoon, Sask.	CFQC	600	
	CFNS	1170	
	CKOM	1420	
Saugerties, N.Y.	WGHQ	920	
Sault Ste. Marie, Michigan	WSOO	1230	
Sault Ste. Marie, Ontario	CJIC	1050	
	CKCY	1400	
Savannah, Ga.	WCCP	1450	M
	WJIV	900	
	WSAV	630	N
	WSGA	1400	
	WTOC	1290	C
	WSOK	1230	A
Savannah, Tenn.	WORM	1010	
Sayre, Pa.	WATS	960	
Schefferville, Que.	CFKL	1230	
Schenectady, N.Y.	WGY	810	N
	WSNY	1240	
Scottsbluff, Nebr.	KNEB	960	M
	KOLT	1320	C
Scottsboro, Ala.	WCRI	1050	
	WROS	1330	
Scottsdale, Ariz.	KPOK	1440	
Scottsville, Ky.	WLCK	1250	
Scranton, Pa.	WARM	590	A
	WEJL	630	
	WGBI	910	C
	WICK	1400	
	WSCR	1320	N
Seaford, Del.	WSUX	1280	
Seattle, Wash.	KAYO	1150	
	KING	1090	A
	KIRO	710	C
	KJR	950	
	KOL	1300	
	KOMO	1000	N
	KTIX	1590	
	KTW	1250	
	KXA	770	
Searcy, Ark.	KWCB	1300	
Sebring, Fla.	WJCM	960	
	WSEB	1340	
Sedalia, Mo.	KDRO	1490	
	KSIS	1050	
Seguin, Tex.	KWED	1580	
Selma, Ala.	WGWC	1340	C
	WHBB	1490	
	WRWJ	1570	
Seminole, Tex.	KSML	1250	
Seneca Township, S.C.	WSNW	1150	
Sevierville, Tenn.	WSEV	930	
Seward, Alaska	KIBH	1340	C-A
Seymour, Ind.	WJCD	1390	
Seymour, Tex.	KSEY	1230	
Shamokin, Pa.	WISL	1480	
Shamrock, Tex.	KBYP	1580	
Sharon, Pa.	WPIC	790	
Shawano, Wis.	WTCH	960	
Shawinigan, Que.	CKSM	1220	
Shawnee, Okla.	KGFF	1450	M
Sheboygan, Wis.	WHBL	1330	A
	WKTL	950	
Shelby, Mont.	KSEN	1150	M
Shelby, N.C.	WOHS	730	M
	WADA	1390	
Shelbyville, Tenn.	WHAL	1400	
	WLIJ	1580	
Shenandoah, Iowa	KFNF	920	
	KMA	960	A
Sherbrooke, Que.	CHLT	630	
	CKTS	900	
Sheridan, Wyo.	KWYO	1410	M
Sherman, Tex.	KRRV	910	M
	KTXO	1500	
Show Low, Ariz.	KVWM	1050	

Location	C.L.	Kc.	N.A.
Shreveport, La.	KANB	1300	
	KCIJ	1050	
	KEEL	710	
	KENT	1550	M
	KJOE	1480	
	KOKA	980	
	KRMD	1340	A
	KWKH	1130	C
Sidney, Mont.	KGCX	1480	M
Sidney, Nebr.	KSID	1340	A
Sierra Vista, Ariz.	KHFH	1420	A
Sikeston, Mo.	KSIM	1400	
Siler City, N.C.	WNCA	1570	
Siloam Sprgs., Ark.	KUOA	1290	M
Silsbee, Tex.	KKAS	1300	
Silver City, N.Mex.	KSIL	1340	C
Silver Sprgs., Md.	WQMR	1050	
Simcoe, Ont.	CFRS	1560	
Sinton, Tex.	KTOD	1590	
Sioux City, Iowa	KSCJ	1360	A
	KMNS	620	
	KTRI	1470	
Sioux Falls, S.Dak.	KISD	1230	
	KELO	1320	
	KIHO	1270	
	KSOO	1140	A
Sitka, Alaska	KIFW	1230	C-A
	KSEW	1400	
Skowhegan, Maine	WGHM	1150	
Smithfield, N.C.	WMPM	1270	
Smiths Falls, Ont.	CJET	630	
Snyder, Tex.	KSNY	1450	M
Socorro, N.Mex.	KSRC	1290	
Soda Sprgs., Idaho	KBRV	540	
Somerset, Ky.	WSFC	1240	M
	WTLO	1480	
Somerset, Pa.	WVSC	990	
Sonora, Calif.	KROG	1450	
Sorel, P.Q.	CJSO	1320	
So. Bend, Ind.	WNDU	1490	A
	WJVA	1580	M
	WSBT	960	C
Southbridge, Mass.	WESO	970	
So. Boston, Va.	WHLF	1400	A
South Daytona Beach, Florida	WELE	1590	
So. Gastonia, N.C.	WGAS	1420	
So. Paris, Me.	WKTQ	1450	
So. Pittsburg, Tenn.	WEPG	910	
So. St. Paul, Minn.	WISK	630	M
So. Williamsport, Pa.	WMPT	1450	
Sparta, Ill.	WHCO	1230	
Sparta, Tenn.	WSMT	1050	
Sparta, Wis.	WCOW	1290	
Spartanburg, S.C.	WTHE	1400	M
	WORD	910	N
	WSPA	950	C
Spencer, Iowa	KICD	1240	
Spokane, Wash.	KGA	1510	A
	KLYK	1230	
	KPEG	1380	
	KHQ	590	N
	KNEW	790	M
	KREM	970	
	KXLY	920	C
	KCFA	1330	
Springdale, Ark.	KBRS	1340	A
Springfield, Ill.	WCVS	1450	A-M
	WMAY	970	N
	WTAX	1240	C
Springfield, Mass.	WBZA	1030	
	WHYN	560	C
	WMAS	1450	M
	WSPR	1270	
Springfield, Mo.	KGBX	1260	N
	KICK	1340	
	KTTS	1400	C
	KWTO	560	A
Springfield, Ohio	WIZE	1340	A
	WBLY	1600	
Springfield, Oreg.	KEED	1050	
Springfield, Tenn.	WDBL	1590	
Springfield, Vt.	WCFR	1480	
Springhill, La.	KBSF	1460	
Spruce Pine, N.C.	WTOE	1470	
Stamford, Conn.	WSTC	1400	A
Stamford, Tex.	KDWT	1400	
Starke, Fla.	WRGR	1490	
Starkville, Miss.	WSSO	1230	
State College, Pa.	WMAJ	1450	M
Statesboro, Ga.	WWNS	1240	
Statesville, N.C.	WSIC	1400	
	WDBM	550	
Staunton, Va.	WTON	1240	A
	WAFC	900	
Stephenville, Tex.	KSTV	1510	
Sterling, Colo.	KGEK	1230	
	KOLR	1490	
Sterling, Ill.	WSDR	1240	
Steubenville, Ohio	WSTV	1340	M
Stevens Point, Wis.	WSPT	1010	
	WLBL	930	
Stillwater, Minn.	WAVN	1220	
Stillwater, Okla.	KSPI	780	
Stockton, Calif.	KJOY	1280	
	KRAK	1140	
	KSTN	1420	
	KWG	1230	A-M
Storm Lake, Iowa	KAYL	990	
Stratford, Ont.	CJCS	1240	
Streator, Ill.	WIZZ	1250	
Stroudsburg, Pa.	WVPO	840	
Stuart, Fla.	WSTU	1450	M
Sturgeon Bay, Wis.	WDOR	910	
Sturgis, Mich.	WSTR	1230	
Stuttgart, Ark.	KWAK	1240	M
Sudbury, Ont.	CKSO	790	
	CFBR	550	
	CHNO	900	
Suffolk, Va.	WLPM	1450	A
Sulphur, La.	KIKS	1310	
Sulphur Sprgs., Tex.	KSST	1230	
Summerside, P.E.I.	CJRW	1240	
Summerville, Ga.	WGTA	950	
Sumter, S.C.	WFIG	1290	M
	WSSC	1340	A
Sunbury, Pa.	WKOK	1240	C
Sunnyside, Wash.	KREW	1230	
Superior, Nebr.	KRFS	1600	
Superior, Wis.	WDSM	710	N
	WQMN	1320	
Susanville, Calif.	KSUE	1240	
Swainsboro, Ga.	WJAT	800	
Sweetwater, Tenn.	WDEH	800	
Sweetwater, Tex.	KXOX	1240	
Swift Current, Sask.	CKSW	1400	
Sydney, N.S.	CBI	1570	
	CJCB	1270	
Sylacauga, Ala.	WFEB	1340	M
	WMLS	1290	
Sylva, N.C.	WMSJ	1480	
Sylvania, Ga.	WSYL	1490	
Syracuse, N.Y.	WHEN	620	C
	WFBL	1390	A
	WNDR	1260	M
	WOLF	1490	A
	WSYR	570	N
Tabor City, N.C.	WTAB	1370	
Tacoma, Wash.	KMO	1360	
	KTAC	850	
	KTNT	1400	
	KVI	570	M
Taft, Calif.	KTKR	1310	
Tahlequah, Okla.	KTLQ	1350	
Talladega, Ala.	WJHB	1580	
	WNUZ	1230	M
Tallahassee, Fla.	WMEN	1330	
	WRFB	1580	
	WTAL	1270	
Tallassee, Ala.	WTLS	1300	
	WTNT	1450	A-M-C
Tallulah, La.	KTLD	1360	
Tampa, Fla.	WALT	1110	
	WDAE	1250	C
	WFLA	970	N
	WHBO	1050	
	WTMP	1150	
	WSOL	1300	
Tarboro, N.C.	WCPS	760	
Tarpon Sprgs., Fla.	WDCL	1470	
Tasley, Va.	WESR	1330	
Taunton, Mass.	WPEP	1570	
Tawas City, Mich.	WIOS	1480	
Taylor, Tex.	KTAE	1260	
Taylorville, Ill.	WTIM	1410	
Tell City, Ind.	WTCJ	1230	
Temple, Tex.	KTEM	1400	
Terre Haute, Ind.	WBOW	1230	N
	WMFT	1300	
	WTHI	1480	C
Terrell, Tex.	KTER	1570	
Texarkana, Ark.	KOSY	790	M
Texarkana, Tex.	KCMC	1230	A
	KTFS	1400	
Texas City, Tex.	KTLW	920	
Thayer, Mo.	KALM	1290	
The Dalles, Oreg.	KODL	1440	
	KRMW	1300	
Thermopolis, Wyo.	KRTR	1490	M
	KTHE	1240	
Thief River Falls, Minn.	KTRF	1230	
Thetford Mines, Que.	CKLD	1230	
Thibodaux, La.	KTIB	630	
Thomaston, Ga.	WSFT	1220	
Thomasville, Ala.	WJDB	630	
Thomasville, Ga.	WPAX	1240	
	WKTG	730	
Thomasville, N.C.	WTNC	790	
Thomson, Ga.	WTWA	1240	M
Three Rivers, Que.	CHLN	550	
	CKTR	1150	
Ticonderoga, N.Y.	WIPS	1250	
Tiffin, Ohio	WTTF	1600	
Tifton, Ga.	WTIF	1340	
	WWGS	1430	
Tillamook, Oreg.	KTIL	1590	
Tillsonburg, Ont.	CKOT	1510	
Timmins, Ont.	CFCL	620	
	CKGB	680	
Titusville, Fla.	WRMF	1050	
Toccoa, Ga.	WLET	1420	M
	WNEG	1320	
Toledo, Ohio	WOHO	1470	M
	WSPD	1370	N
	WTOD	1560	C
	WTOL	1230	A
Tooele, Utah	KDYL	990	
Topeka, Kans.	WIBW	580	C
	KJAY	1440	
	WREN	1250	A
	KTOP	1490	M
Toppenish, Wash.	KENE	1490	
Toronto, Ont.	CBL	740	N
	CFRB	1010	C
	CHUM	1050	
	CJBC	860	
	CKEY	580	M
	CKFH	1430	
Torrington, Conn.	WBZY	990	
	WTOR	1490	M
Torrington, Wyo.	KGOS	1490	
Towson, Md.	WAQE	1570	
Trail, B.C.	CJAT	610	
Traverse City, Mich.	WTCM	1400	
Trenton, Mo.	KTTN	1600	
Trenton, N.J.	WAAT	1300	
	WBUD	1260	
	WTTM	920	N
Trinidad, Colo.	KCRT	1240	M
Troy, Ala.	WTBF	970	M
Troy, N.Y.	WHAZ	1330	
	WTRY	980	
Truckee, Calif.	KHOE	1400	
Truro, N.S.	CKCL	600	
Truth or Consequences, New Mexico	KCHS	1400	
Tryon, N.C.	WTYN	1580	
Tucson, Ariz.	KTUC	1400	A
	KAIR	1490	
	KCEE	790	
	KTAN	580	A
	KCUB	1290	N
	KEVT	690	
	KMOP	1330	
	KTKT	990	
	KOLD	1450	C
Tucumcari, N.Mex.	KTNM	1400	M
Tulare, Calif.	KCOK	1270	M
	KGEN	1370	
Tulia, Tex.	KTUE	1260	
Tullahoma, Tenn.	WJIG	740	
Tulsa, Okla.	KAKC	970	
	KOME	1300	
	KRMG	740	
	KTUL	1430	C
	KVOO	1170	N
	KFMJ	1050	
Tupelo, Miss.	WELO	580	M
	WTUP	1490	A
Turlock, Calif.	KTUR	1390	
Tuscaloosa, Ala.	WJRD	1150	
	WACT	1420	
	WNPT	1280	A
	WTUG	790	
	WTBC	1230	M
Tuscumbia, Ala.	WVNA	1590	
Tuskegee, Ala.	WABT	580	
Twin Falls, Idaho	KTFI	1270	N
	KLIX	1310	M
	KEEP	1450	
Two Rivers, Wis.	WTRW	1590	
Tyler, Tex.	KDOK	1330	
	KGJB	1490	M
	KTBB	600	A
	KZEY	690	
Tyrone, Pa.	WTRN	1290	
Ukiah, Calif.	KUKI	1400	
Union, Mo.	KLPW	1220	
Union, S.C.	WBCU	1460	
Union City, Tenn.	WENK	1240	
Uniontown, Pa.	WMBS	590	C
Urbana, Ill.	WILL	580	
	WKID	1580	
Utica, N.Y.	WIBX	950	C
	WRUN	1150	
	WTLB	1310	A
Uvalde, Tex.	KVOU	1400	
Val D'Or, Que.	CKVD	1230	
Valdosta, Ga.	WGOV	950	M
	WGAF	910	A
	WJEM	1150	
	WVLD	1450	
Vallejo, Calif.	KNBA	1190	
Valley City, N.Dak.	KOVC	1490	M
Valparaiso-Niceville, Fla.	WNSM	1340	
Van Buren, Ark.	KFDF	1580	
Van Wert, Ohio	WERT	1220	
Vanceburg, Ky.	WKKS	1570	
Vancouver, B.C.	CBU	690	
	CFUN	1410	
	CHQM	1320	
	CJOR	600	
	CKWX	1130	M
Vancouver, Wash.	KKEY	1150	
	KISN	910	
Ventura, Calif.	KVEN	1450	M
	KUDU	1590	
Verdun, Que.	CKVL	850	
Vermillion, S.Dak.	KUSD	690	
Vernal, Utah	KVEL	1250	
Vernon, B.C.	CJIB	940	
Vernon, Tex.	KVWC	1490	
Vero Beach, Fla.	WAXE	1370	
	WTTB	1490	A
Vicksburg, Miss.	WQBC	1420	M
	WVIM	1490	
Victoria, B.C.	CJVI	900	
	CFAX	810	
	CKDA	1220	
Victoria, Tex.	KNAL	1410	
	KVIC	1340	M
Victoriaville, Que.	CFDA	1380	
Vidalia, Ga.	WVOP	970	
Vieques, P.R.	WIVV	1370	
Ville Marie, Que.	CKVM	710	
Ville Platte, La.	KVPI	1050	
Ville St. Georges, Que.	CKRB	1460	
Vincennes, Ind.	WAOV	1450	M
Vineland, N.J.	WWBZ	1360	
	WDVL	1270	
Vinita, Okla.	KVIN	1470	
Virginia, Minn.	WHLB	1400	N
Virginia Bch., Va.	WBOF	1600	
Virouqua, Wis.	WISV	1360	
Visalia, Calif.	KONG	1400	
Vivian, La.	KLVI	1600	
Waco, Tex.	WACO	1460	A
	KWTX	1230	M
Wadena, Minn.	KWAD	920	M
Wadesboro, N.C.	WADE	1210	
Wailuku, Hawaii	KMVI	550	N
Waipabu, Hawaii	KAHU	920	
Walhalla, S.C.	WGOG	1460	
Wallace, Idaho	KWAL	620	M
Wallace, N.C.	WLSE	1400	
Walla Walla, Wash.	KHIT	1320	
	KUJ	1420	M
	KTEL	1490	A
Walnut Ridge, Ark.	KRLW	1320	
Walsenburg, Colo.	KFLJ	1380	
Walterboro, S.C.	WALD	1220	M
Waltham, Mass.	WCRB	1330	
Walton, N.Y.	WDLA	1270	
Ward Ridge, Fla.	WJOE	1570	
Ware, Mass.	WARE	1250	M
Warner Robbins, Ga.	WRPB	1350	
Warren, Ark.	KWRF	860	
Warren, Ohio	WHHH	1440	
Warren, Pa.	WNAE	1310	
Warrensburg, Mo.	KOKO	1450	
Warrenton, Mo.	KWRE	730	
Warrenton, Va.	WEER	1570	
	WKCW	1420	
Warsaw, Ind.	WRSW	1480	
Warsaw, Va.	WNNT	690	
Warwick-E.Greenwich, R.I.	WYNG	1590	
Wasco, Calif.	KWSO	1050	
Washington, D.C.	WGMS	570	
	WMAL	630	A
	WOL	1450	M
	WOOK	1340	
	WWDC	1260	
	WRC	980	N
	WTOP	1500	C
Washington, Ga.	WKLE	1370	
Washington, Ind.	WAMW	1580	
Washington, N.J.	WCRV	1580	
Washington, N.C.	WOOW	1340	
	WRRF	930	A
Washington, Pa.	WJPA	1450	M
Washington Court House, Ohio	WCHO	1250	
Waterbury, Conn.	WATR	1320	A
	WBRY	1590	C
	WWCO	1240	M
Waterbury, Vt.	WDEV	550	M
Waterloo, Iowa	KXEL	1540	A
	KNWS	1090	
	KWWL	1330	M
Watertown, N.Y.	WATN	1240	
	WOTT	1400	
	WWNY	790	C
Watertown, S.Dak.	KWAT	950	M
Watertown, Wis.	WTTN	1580	
Waterville, Me.	WTVL	1490	A
Watsonville, Calif.	KOMY	1340	
Wauehula, Fla.	WAUC	1310	
Waukegan, Ill.	WKRS	1220	
Waukesha, Wis.	WAUX	1510	
Waupaca, Wis.	WDUX	800	A
Wausau, Wis.	WRIG	1400	N
	WSAU	550	A
	WHVF	1230	
Waverly, Iowa	KWVY	1470	
Waverly, Ohio	WPKO	1380	
Waxahachie, Tex.	KBEC	1390	
Waycross, Ga.	WACL	570	
	WAYX	1230	M
Waynesboro, Ga.	WBRO	1310	
Waynesboro, Miss.	WABO	990	
Waynesboro, Pa.	WAYZ	1380	
Waynesboro, Va.	WAYB	1490	M
Waynesburg, Pa.	WANB	1580	
Waynesville, N.C.	WHCC	1400	
Weatherford, Tex.	KZEE	1220	
Webster City, Iowa	KJFJ	1570	
Weirton, W.Va.	WEIR	1430	
Weiser, Idaho	KWEI	1260	
Welch, W.Va.	WELC	1150	
	WOVE	1340	M
Welland, Ontario	CHOW	1470	
Wellsboro, Pa.	WNBT	1490	M
Wellston, Ohio	WKOV	1330	
Wellsville, N.Y.	WLSV	790	
Wenatchee, Wash.	KPQ	560	A
	KUEN	900	
	KMEL	1340	M
Weslaco, Tex.	KRGV	1290	N
W. Bend, Wis.	WBKV	1470	
Westbrook, Me.	WJAB	1440	
W. Frankfort, Ill.	WFRX	1300	
West Jefferson, N.C.	WKSK	1600	
W. Monroe, La.	KUZN	1310	
W. Palm Beach, Fla.	WEAT	850	N
	WJNO	1230	C
	WIRK	1290	M
West Plains, Mo.	KWPM	1450	
West Point, Ga.	WBMK	1310	
West Point, Miss.	WROB	1450	M
Westport, Conn.	WMMM	1260	
W. Springfield, Mass.	WTXL	1490	A
W. Yarmouth, Mass.	WOCB	1240	M
Westerly, R.I.	WERI	1230	M
Westfield, Mass.	WDEW	1570	
Westminster, Md.	WTTR	1470	
Weston, W.Va.	WHAW	980	M
W. Warwick, R.I.	WWRI	1450	
Wetumpka, Ala.	WETU	1250	
Wewoka-Seminole, Okla.	KWSH	1260	A
Weyburn, Sask.	CFSL	1340	
Wheaton, Md.	WDON	1540	

Location	C.L.	Kc.	N.A.
Wheeling, W.Va.	WHLL	1600	
	WKWK	1400	A
	WWVA	1170	C
White Castle, La.	KEVL	1590	
White Plains, N.Y.	WFAS	1230	
White River Junc., Vt.	WWRJ	910	
Whitehorse, Y.T.	CFWH	1240	
Whitesburg, Ky.	WTCW	920	
Whiteville, N.C.	WENC	1220	
Wichita, Kans.	KAKE	1240	M
	KLEO	1480	
	KFBI	1070	N
	KFH	1330	C
	KSIR	900	
	KWBB	1410	
Wichita Falls, Tex.	KSYD	990	M
	KTRN	1290	
	KWFT	620	C
Wildwood, N.J.	WCMC	1230	
Wilkes-Barre, Pa.	WBAX	1240	M
	WBRE	1340	N
	WILK	980	A
Williamsburg, Ky.	WEZJ	1440	
Williamson, W.Va.	WBTH	1400	M
Williamsport, Pa.	WLYC	1050	
	WRAK	1400	N
	WWPA	1340	C
Williamston, N.C.	WIAM	900	
Willimantic, Conn.	WILI	1400	
Williston, N.D.	KEYZ	1360	
Willmar, Minn.	KWLM	1340	A
Willow Springs, Mo.	KUKU	1330	
Wilmington, Del.	WAMS	1380	M
	WDEL	1150	N
	WILM	1450	A
	WTUX	1290	
Wilmington, N.C.	WMFD	630	A
	WKLM	980	
	WGNI	1340	M
Wilson, N.C.	WGTM	590	C
	WVOT	1420	M
Winchester, Ky.	WWKY	1380	
Winchester, Tenn.	WCDT	1340	
Winchester, Va.	WINC	1400	A
Winder, Ga.	WIMO	1300	
Windom, Minn.	KDOM	1580	
Windsor, N.S.	CFAB	1450	
Windsor, Ont.	CBE	1550	
	CKLW	800	M
Wingham, Ont.	CKNX	920	
Winnemucca, Nev.	KWNA	1400	
Winnfield, La.	KVCL	1270	
Winner, S.Dak.	KWYR	1260	
Winnipeg, Man.	CBW	990	
	CKRC	630	
	CKY	580	
	CJOB	680	
Winnsboro, La.	KMAR	1570	
Winona, Minn.	KWNO	1230	A
	KAGE	1380	
Winona, Miss.	WONA	1570	
Winslow, Ariz.	KVNC	1010	A
Winston-Salem, N.C.	WAAA	980	
	WAIR	1340	
	WSJS	600	N
	WTOB	1380	M-C
Winter Garden, Fla.	WOKB	1600	
Winter Haven, Fla.	WSIR	1490	M
	WINT	1360	
Winter Park, Fla.	WABR	1440	M
Wisconsin Rapids, Wis.	WFHR	1340	M
Wolf Pt., Mont.	KVCK	1450	M
Woodside, N.Y.	WWRL	1600	
Woodstock, N.B.	CJCJ	920	
Woodstock, Ont.	CKOX	1340	
Woodward, Okla.	KSIW	1450	
Woonsocket, R.I.	WNRI	1380	
	WWON	1240	
Wooster, Ohio	WWST	960	
Worcester, Mass.	WAAB	1440	M-N-A
	WNEB	1230	
	WORC	1310	
	WTAG	580	C
Worland, Wyo.	KWOR	1340	M
Worthington, Minn.	KWOA	730	
Worthington, Ohio	WRFD	880	
Wynne, Ark.	KWYN	1400	
Wytheville, Va.	WYVE	1280	
Yakima, Wash.	KIT	1280	
	KIMA	1460	C
	KUTI	980	
	KYAK	1390	M
Yankton, S.D.	KYNT	1450	
	WNAX	570	C
Yarmouth, N.S.	CJLS	1340	
Yazoo City, Miss.	WAZF	1230	
Yellowknife, N.W.T.	CFYK	1340	
York, Nebr.	KAWL	1370	
York, Pa.	WNOW	1250	
	WORK	1350	N
	WSBA	910	A-M
York, S.C.	WYCL	1580	
Yorkton, Sask.	CJGX	940	
Youngstown, Ohio	WBBW	1240	A
	WFMJ	1390	N
	WKBN	570	C
Yreka, Calif.	KSYC	1490	
Yuba City, Calif.	KUBA	1600	
	KAGR	1450	
Yuma, Ariz.	KOFA	1240	
	KBLU	1320	
	KVOY	1400	A
	KYUM	560	N
Zanesville, Ohio	WHIZ	1240	N
Zarephath, N.J.	WAWZ	1380	

United States FM Stations

Abbreviations: Mc., megacycles, asterisk (*) indicates educational station

ALABAMA

Location	C.L.	Mc.
Albertville	WAVU-FM	105.1
Alexander City	WRFS-FM	106.1
Andalusia	WCTA-FM	98.1
Anniston	WHMA-FM	100.5
Athens	WJOF	104.3
Birmingham	WAPI-FM	99.5
	WBRC-FM	106.9
	WSFM	93.7
Clanton	WKLF-FM	100.9
Cullman	WFMH-FM	101.1
Decatur	WHOS-FM	102.1
Homewood	WJLN	104.7
Huntsville	WAHR	99.1
Mobile	WKRG-FM	99.9
Tuscaloosa	WTBC-FM	95.7
	WUOA	*91.7

ARIZONA

Location	C.L.	Mc.
Globe	KWJB-FM	100.3
Mesa	KBUZ-FM	104.7
Phoenix	KELE	95.5
	KFCA	*88.5
Tucson	KFMM	99.5

ARKANSAS

Location	C.L.	Mc.
Blytheville	KLCN-FM	96.1
Ft. Smith	KFPW-FM	94.9
Jonesboro	KBTM-FM	101.9
	KASU	91.9
Mammoth Springs	KAMS	103.9
Pine Bluff	KOTN-FM	92.3
Siloam Springs	KUOA-FM	105.7

CALIFORNIA

Location	C.L.	Mc.
Alameda	KJAZ	92.7
Arlington	KNFP	*89.7
Atherton	KPEN	101.3
Bakersfield	KERN-FM	94.1
	KQXR	101.5
Berkeley	KPFA	94.1
	KPFB	*89.3
	KRE-FM	102.9
Claremont	KSPC	*88.9
El Cajon	KUFM	93.3
Eureka	KRED-FM	96.3
Fresno	KARM-FM	101.9
	KMJ-FM	97.9
	KRFM	93.7
Glendale	KFMU	97.1
	KUTE	101.9
Inglewood	KTYM-FM	103.9
Long Beach	KFOX-FM	102.3
	KLON	*88.1
	KNOB	97.9
Los Angeles	KABC-FM	95.5
	KBBI	107.5
	KBCA	105.1
	KBMS	105.9
	KCBH	98.7
	KFAC-FM	92.3
	KGLA	*103.5
	KHJ	101.1
	KMLA	100.3
	KNX-FM	93.1
	KBIQ	104.3
	KPOL-FM	93.9
	KRHM	94.7
	KRKD-FM	96.3
	KUSC	*91.5
	KXLU	*88.7
	KHOF	99.5
Marysville	KMYC-FM	99.9
Modesto	KBEE-FM	103.3
	KTRB-FM	104.1
Mountain View	KFJC	*88.5
Oakland	KAFE	98.1
Ontario	KASK-FM	93.5
Oxnard	KAAR	104.7
Palm Springs	KPSR	92.1
Pasadena	KPCS	89.3
Riverside	KPLI	99.1
	KACE-FM	92.7
	KDUO	97.5
Sacramento	KCRA-FM	96.1
	KFBK-FM	96.9
	KEBR	100.5
	KJML	95.3
	KSFM	96.9
	KXRQ	98.5
	KXOA-FM	107.9
San Bernardino	KVCR	*91.9
	KFMW	99.9
San Diego	KFSD-FM	94.1
	KFMB-FM	100.7
	KGB-FM	101.5
	KITT	105.3
	KSDS	*88.3
San Francisco	KALW	*91.7
	KBAY-FM	104.5
	KCBS-FM	98.9
	KDFC	102.1
	KEAR	97.3
	KGO	103.7
	KNBC-FM	99.7
	KRON-FM	96.5
	KSFR	94.9
	KYA-FM	93.3
San Jose	KSJO-FM	92.3
	KRPM	98.5
San Luis Obispo	KATY-FM	96.1
San Mateo	KCSM	*90.9
Santa Ana	KWIZ-FM	96.7
Santa Barbara	KRCW	97.5
Santa Clara	KSCU	*90.1
Santa Maria	KEYM	99.1
	KSMA-FM	102.5
Santa Monica	KCRW	*89.9
Stockton	KCVN	*91.3
	KRAK-FM	92.9
West Covina	KDWC	98.3

COLORADO

Location	C.L.	Mc.
Boulder	KRNW	97.3
Colorado Springs	KRCC	*91.3
	KFMH	96.5
	KSHS	*90.5
Denver	KFML-FM	98.5
	KDEN-FM	99.5
	KLIR-FM	100.3
	KTGM	105.1
Manitou Springs	KCMS-FM	102.7

CONNECTICUT

Location	C.L.	Mc.
Brookfield	WGHF	95.1
Danbury	WLAD-FM	98.3
Hartford	WHCN	105.9
	WDRC-FM	102.9
	WRTC-FM	*89.3
	WTIC-FM	96.5
Meriden	WBMI	95.7
New Haven	WNHC-FM	99.1
Stamford	WSTC-FM	96.7
Storrs	WHUS	*90.5

DELAWARE

Location	C.L.	Mc.
Dover	WDOV-FM	94.7
Wilmington	WDEL-FM	93.7
	WJBR	99.5

D. C.

Location	C.L.	Mc.
Washington	WASH-FM	97.1
	WFAN	100.3
	WGMS-FM	103.5
	WMAL-FM	107.3
	WOL-FM	98.7
	WRC-FM	93.9
	WTOP-FM	96.3
	WWDC-FM	101.1

FLORIDA

Location	C.L.	Mc.
Coral Gables	WVCG-FM	105.1
Daytona Beach	WNDB-FM	94.5
Fort Lauderdale	WWIL-FM	103.5
Gainesville	WRUF-FM	*104.1
Jacksonville	WJAX-FM	95.1
	WZFM	96.9
	WMBR-FM	96.1
Miami	WAFM	93.1
	WCKR-FM	97.3
	WGBS-FM	96.3
	WTHS	*91.7
	WWPB-FM	101.5
Miami Beach	WKAT-FM	93.1
	WMET-FM	93.9
Orlando	WDBO-FM	92.3
	WHOO-FM	96.5
	WKIS-FM	100.3
Palm Beach	WQXT-FM	97.9
Tallahassee	WFSU-FM	*91.5
Tampa	WDAE-FM	100.7
	WFLA-FM	93.3
	WPKM	104.7
	WTUN	*88.9
Winter Park	WPRK	*91.5

GEORGIA

Location	C.L.	Mc.
Athens	WGAU-FM	102.5
Atlanta	WABE	*90.1
	WPLO-FM	103.3
	WGKA-FM	92.9
	WSB-FM	98.5
Augusta	WAUG-FM	105.7
	WBBQ-FM	103.7
Columbus	WRBL-FM	93.3
Gainesville	WDUN-FM	103.9
Lagrange	WLAG-FM	104.1
Macon	WMAZ-FM	99.1
Marietta	WBIE-FM	101.5
Newnan	WCOH-FM	96.7
Savannah	WTOC-FM	97.3
Swainsboro	WJAT-FM	101.7
Toccoa	WLET-FM	106.1

HAWAII

Location	C.L.	Mc.
Honolulu	KAIM-FM	95.5
	KUOH	*90.5
	KVOK	*88.1

ILLINOIS

Location	C.L.	Mc.
Anna	WRAJ-FM	92.7
Arlington Heights	WNWC	92.7
Bloomington	WJBC-FM	101.5
Carmi	WROY-FM	97.3
Champaign	WDWS-FM	97.5
Chicago	WBBM-FM	96.3
	WBEZ	*91.5
	WCLM	101.9
	WDHF	95.5
	WEBH	93.9
	WEFM	99.5
	WEHS	97.9
	WENR-FM	94.7
	WFMF	100.3
	WFMQ	107.5
	WFMT	98.7
	WKFM	103.5
	WMAQ-FM	101.1
	WNIB	97.1
	WSEL	104.3
Decatur	WSOY-FM	102.9
DeKalb	WNIC	*91.1
Effingham	WSEI	95.7
Elgin	WEPS	*88.1
Elmwood Park	WXFM	105.9
Evanston	WEAW	105.1
	WNUR	*89.3
Harrisburg	WEBQ-FM	99.9
Jacksonville	WLDS-FM	100.5
Joliet	WJOL-FM	96.7
Macomb	WWKS	*91.3
Mattoon	WLBH-FM	96.9
Mt. Vernon	WMIX-FM	94.1
Oak Park	WOPA-FM	102.7
Olney	WVLN-FM	92.9
Paris	WPRS-FM	98.3
Park Ridge	WMTH	*88.5
Peoria	WMBD-FM	92.5
Quincy	WGEM-FM	105.1
	WTAD-FM	99.5
Rockford	WROK-FM	97.5
Rock Island	WHBF-FM	98.9
Springfield	WTAX-FM	103.7
Urbana	WILL-FM	*90.9

INDIANA

Location	C.L.	Mc.
Bloomington	WFIU	*103.7
Columbus	WCSI-FM	98.3
Connersville	WCNB-FM	100.3
Crawfordsville	WBBS-FM	106.3
Elkhart	WCMR-FM	95.1
	WTRC-FM	100.7
Evansville	WIKY-FM	104.1
	WEVC	*91.5
	WPSR	90.7
Fort Wayne	WPTH	95.1
Gary	WGVE	*88.1
Goshen	WGCS	91.1
Greencastle	WGRE	*91.7
Hammond	WJOB-FM	92.3
Hartford City	WHCI	*91.9
Huntington	WVSH	*91.9
Indianapolis	WAJC	*104.5
	WFBM-FM	94.7
	WFMS	95.5
	WIAN	*90.1
Jasper	WITZ-FM	104.7
Madison	WORX-FM	96.7
Marion	WMRI-FM	106.9
Muncie	WMUN	104.1
	WWHI	*91.5
New Albany	WNAS	*88.1
New Castle	WCTW-FM	102.5
	WYSN	*91.1
South Bend	WETL	*91.9
Terre Haute	WTHI-FM	99.9
Wabash	WSKS	*91.3
Warsaw	WRSW-FM	107.3
Washington	WFML	106.5

IOWA

Location	C.L.	Mc.
Ames	WOI-FM	*90.1
Boone	KFGQ	*99.3
Clinton	KROS-FM	96.1
Davenport	WOC-FM	103.7
Des Moines	KDPS	*88.1
	WHO-FM	100.3
Dubuque	WDBQ	103.3
Iowa City	KSUI	*91.7
Mason City	KGLO-FM	101.1

Location	C.L.	Mc.
Muscatine	KWPC-FM	99.7
Storm Lake	KAYL-FM	101.5
Waverly	KWAR	89.1

KANSAS

Emporia	KSTE	*88.7
Kansas City	KCJC	98.1
Lawrence	KANU	*91.5
Manhattan	KSDB-FM	*88.1
Newton	KJRG-FM	92.1
Ottawa	KTJO-FM	*88.1
Wichita	KFH-FM	100.3
	KMUW	*89.1

KENTUCKY

Ashland	WCMI-FM	93.7
Central City	WNES-FM	101.9
Fulton	WFUL-FM	104.9
Hazard	WKIC-FM	96.5
Henderson	WSON-FM	99.5
Hopkinsville	WRLX	98.7
Lexington	WBKY	*91.3
	WLAP-FM	94.5
Louisville	WFPK	*91.9
	WFPL	*89.3
	WLVL	97.5
Madisonville	WFMW-FM	93.9
	WNGO-FM	94.7
Owensboro	WOMI-FM	92.5
	WVJS-FM	96.1
Paducah	WPAD-FM	96.9
	WKYB-FM	93.3

LOUISIANA

Alexandria	KALB-FM	96.9
Baton Rouge	WJBO-FM	98.1
Monroe	KMBL-FM	104.1
New Orleans	WBEH	89.3
	WDSU-FM	105.3
	WRCM	97.1
	WMMT	95.7
Shreveport	KRMD-FM	101.1
	KBCL-FM	96.5
	KWKH-FM	94.5

MAINE

Brunswick	WBOR	*91.1
Caribou	WFST-FM	97.7
Lewiston	WCOU-FM	93.9

MARYLAND

Annapolis	WNAV-FM	99.1
Baltimore	WBJC	*88.1
	WCAO-FM	102.7
	WBAL-FM	97.9
	WITH-FM	104.3
Bethesda	WJMD	106.3
Bradbury Heights	WPGC	95.5
Cumberland	WCUM-FM	102.9
Hagerstown	WJEJ-FM	104.7
	WARK-FM	106.9
Oakland	WBUZ	95.5
Westminster	WTTR-FM	100.7

MASSACHUSETTS

Amherst	WAMF	*88.1
	WMUA	*91.1
Boston	WBUR	*90.9
	WBCN	104.1
	WBZ-FM	106.7
	WCOP-FM	100.7
	WEEI-FM	103.3
	WERS	*88.9
	WHDH-FM	94.5
	WRKO-FM	98.5
	WXHR	96.9
Brockton	WBET-FM	97.7
Brookline	WBOS-FM	92.9
Cambridge	WGBH-FM	*89.7
	WHRB-FM	107.1
Framingham	WKOX-FM	105.7
Greenfield	WHAI-FM	98.3
Lowell	WLLH-FM	99.5
New Bedford	WBSM-FM	97.3
	WNBH-FM	98.1
S. Hadley	WMHC	88.5
Springfield	WHYN-FM	93.1
	WEDK	91.7
	WMAS-FM	94.7
Waltham	WCRB-FM	102.5
W. Yarmouth	WOCB-FM	94.3
Williamstown	WCFM	*90.1
Winchester	WHSR-FM	*91.9
Worcester	WTAG-FM	96.1

MICHIGAN

Ann Arbor	WUOM	*91.7
Benton Hrbr.	WHFB-FM	99.9
Coldwater	WTVB-FM	98.3
Dearborn	WKMH-FM	100.3
Detroit	WDET-FM	*101.9
	WDTR	*90.9
	WHFI	94.7
	WJBK-FM	93.1
	WMUZ	103.5
	WMZK	97.9
	WJR-FM	96.3
	WWJ-FM	97.1
	WXYZ-FM	101.1

Location	C.L.	Mc.
E. Lansing	WKAR-FM	*90.5
	WSWM	99.1
Flint	WFBE	*95.1
Grand Rapids	WFRS	92.5
	WJEF-FM	93.7
	WLAV-FM	96.9
Highland Pk.	WHPR	*88.1
Jackson	WQIX	94.1
Kalamazoo	WMCR	*102.1
Oak Park	WLDM	95.5
Royal Oak	WOAK	*89.3
	WOMC	104.3
Saginaw	WSAM-FM	98.1
Sturgis	WSTR-FM	103.1

MINNESOTA

Mankato	KYSM-FM	103.5
Minneapolis	KTIS-FM	*98.5
	KWFM	97.1
	WLOL-FM	99.5
St. Cloud	KFAM-FM	104.7

MISSISSIPPI

Jackson	WJDX-FM	102.9
Meridian	WMMI	*88.1

MISSOURI

Clayton	KFUO-FM	99.1
Joplin	WMBH-FM	96.1
Kansas City	KCMO-FM	94.9
	KCMK	93.3
	KCUR-FM	89.3
	KXTR	96.5
Kennett	KBOA-FM	98.9
Poplar Bluff	KWOC-FM	94.5
St. Louis	KCFM	93.7
	KSLH	*91.5
Springfield	KTTS-FM	94.7
West Plains	KWPM-FM	93.9

NEBRASKA

Lincoln	KFMQ	95.3
Omaha	KQAL-FM	94.3
	KOIL-FM	96.1

NEVADA

Reno	KNEV	95.5

NEW HAMPSHIRE

Berlin	WMOU-FM	103.7
Claremont	WTSV-FM	106.1
Manchester	WKBR-FM	95.7
Mt. Washington	WMTW-FM	94.9
Nashua	WOTW-FM	106.3

NEW JERSEY

Asbury Park	WJLK-FM	94.3
Bridgeton	WSNJ-FM	98.9
E. Orange	WFMU	*91.1
Hackettstown	WNTI	*91.9
Newark	WNTA-FM	94.7
	WBGO	*88.3
New Brunswk.	WCTC-FM	98.3
Paterson	WPAT-FM	93.1
Princeton	WPRB	103.9
South Orange	WSOU	*89.5
Trenton	WTOA	97.5
Wildwood	WCMC-FM	100.7
Zarephath	WAWZ-FM	99.1

NEW MEXICO

Albuquerque	KANW	*89.1
	KHFM	96.3
Aztec	KNDE-FM	94.9
Los Alamos	KRSN-FM	98.5
Mountain Park	KMFM	97.9
Roswell	KBIM-FM	97.1

NEW YORK

Albany	WAMC	*90.7
Auburn	WMBO-FM	96.1
Babylon	WGLI-FM	103.5
Binghamton	WNBF-FM	98.1
	WKOP-FM	95.3
Brooklyn	WNYE	*91.5
Buffalo	WBEN-FM	106.5
	WGR-FM	96.9
	WBNY-FM	92.9
	KWOL-FM	104.1
Cherry Valley	WRRC	101.9
Corning	WCLI-FM	106.1
Cortland	WKRT-FM	99.9
DeRuyter	WRRD	105.1
Elmira	WECW	*88.1
Floral Park	WSHS	*90.3
Hempstead	WHLI-FM	98.3
Hornell	WWHG-FM	105.3
Ithaca	WHCU-FM	97.3
	WICB	*91.7
	WRRA-FM	103.7
	WVBR-FM	101.7
Jamestown	WJTN-FM	93.3
Kenmore	WYSL-FM	103.3
Massena	WMSA-FM	105.3
New Rochelle	WVOX-FM	93.5

Location	C.L.	Mc.
New York	WABC-FM	95.5
	WBAI	99.5
	WBFM	101.9
	WCBS-FM	101.1
	WEVD-FM	97.9
	WFUV	*90.7
	WHOM-FM	92.3
	WKCR-FM	*89.9
	WNCN	104.3
	WNEW-FM	102.7
	WNYC-FM	93.9
	WNYE	91.5
	WOR-FM	98.7
	WQXR-FM	96.3
	WNBC-FM	97.1
	WRFM	105.1
Niagara Falls	WHLD-FM	98.5
Olean	WHDL-FM	95.7
Patchogue	WALK-FM	97.5
	WPAC-FM	106.1
Peekskill	WLNA-FM	100.7
Poughkeepsie	WKIP-FM	104.7
Rochester	WHFM	98.9
	WROC-FM	97.9
Schenectady	WGFM	99.5
South Bristol	WRRE	95.1
Springville	WSPE	*88.1
Syracuse	WAER	*88.1
	WDDS-FM	93.1
	WONO	100.9
	WSYR-FM	94.5
Troy	WFLY	92.3
	WRPI	91.5
Utica	WRUN-FM	105.7
Wethersfield	WRRL	107.7
White Plains	WFAS-FM	103.9

NORTH CAROLINA

Albemarle	WABZ-FM	100.9
Asheboro	WGWR-FM	92.3
Asheville	WLOS-FM	104.3
Burlington	WBBB-FM	101.1
	WFNS-FM	93.9
Chapel Hill	WUNC	*91.5
Charlotte	WSOC-FM	103.5
Clingman's Pk.	WMIT	106.9
Durham	WDNC-FM	105.1
Elkin	WIFM-FM	100.9
Fayetteville	WFNC-FM	98.1
Forest City	WBBO-FM	93.3
Gastonia	WGNC-FM	101.9
Goldsboro	WEQR	96.9
Greensboro	WGPS	*89.9
	WMDE	98.7
Greenville	WWWS	*91.3
Henderson	WHNC-FM	92.5
	WHKP-FM	102.5
Hendersonville	WHKP-FM	102.5
Hickory	WHKY-FM	102.9
High Point	WHPE-FM	95.5
	WHPS	*89.3
	WMFR-FM	99.5
	WNOS-FM	100.3
Laurinburg	WEWO-FM	96.5
Leaksville	WLOE-FM	94.5
Lexington	WBUY-FM	94.3
Raleigh	WKIX-FM	96.1
	WPTF-FM	94.7
	WRAL-FM	101.5
Reidsville	WREV-FM	102.1
Rocky Mount	WEED-FM	92.1
	WFMA	100.7
Roxboro	WRXO-FM	96.7
Salisbury	WSTP-FM	106.5
Sanford	WWGP-FM	105.5
Shelby	WOHS-FM	96.1
Statesville	WFMX	105.7
Tarboro	WCPS-FM	104.3
Thomasville	WTNC-FM	98.3
Winston-Salem	WAIR-FM	93.1
	WSJS-FM	104.1

OHIO

Akron	WAKR-FM	97.5
	WAPS	*89.1
Alliance	WFAH-FM	101.7
Ashland	WNCO-FM	101.3
Ashtabula	WICA-FM	103.7
Athens	WOUB-FM	*91.5
Bellaire	WOMP-FM	100.5
Berea	WBWC	*88.3
Bowling Green	WBGU	*88.1
Canton	WHBC-FM	94.1
Cincinnati	WCPO-FM	105.1
	WAEF-FM	104.3
	WKRC-FM	101.9
	WSAI-FM	102.7
Cleveland	KYW-FM	105.7
	WBOE	*90.3
	WDOK-FM	102.1
	WERE-FM	98.5
	WGAR-FM	99.5
	WHK-FM	100.7
	WJW-FM	104.1
Cleveland Hts.	WSRS-FM	95.3
Columbus	WCBE	*90.5
	WBNS-FM	97.1
	WCOL-FM	92.3
	WOSU-FM	*89.7
	WTVN-FM	96.3
	WVKO	94.7
Dayton	WHIO-FM	99.1
Delaware	WSLN	*91.1
East Liverpool	WOHI-FM	104.3
Elyria	WEOL-FM	107.3
Findlay	WFIN-FM	100.5
Fostoria	WFOB	96.7

Location	C.L.	Mc.
Fremont	WFRO-FM	99.3
Hamilton	WQMS	96.7
	WHOH	103.5
Kent	WKSU-FM	*88.1
Lancaster	WHOK-FM	95.5
Lima	WIMA-FM	102.1
Marion	WMRN-FM	106.9
Middletown	WPFB-FM	105.9
Mt. Vernon	WMVO-FM	93.7
Newark	WCLT-FM	100.3
Oxford	WMUB	*88.5
	WOXR	97.7
Portsmouth	WPAY-FM	104.1
Salem	WSOM-FM	105.1
Sandusky	WLEC-FM	102.7
Springfield	WBLY-FM	103.9
Steubenville	WSTV-FM	103.5
Toledo	WSPD-FM	101.5
	WMHE	92.5
	WTDS	*91.3
	WTOL-FM	104.7
	WTRT	99.9
Wooster	WWST-FM	104.5
Youngstown	WKBN-FM	98.9
	WBBW-FM	93.3
	WRED	101.1

OKLAHOMA

Durant	KSEO-FM	107.3
Norman	WNAD-FM	*90.9
Oklahoma City	KOKH	*88.9
	KEFM	94.7
	KYFM	98.9
Shawnee	KBGC	*89.9
Stillwater	KAMC-FM	*91.7
	KSPI-FM	93.9
Tulsa	KWGS	*90.5
	KOCW	97.5

OREGON

Eugene	KRVM	*91.9
	KEED-FM	93.1
	KUGN-FM	99.1
	KWAX	*91.1
Grants Pass	KGPO	96.9
Medford	KBOY-FM	95.3
Oretech	KTEC	*88.1
Portland	KEX-FM	92.3
	KOIN-FM	101.1
	KPFM	97.1
	KPOJ-FM	98.7
	KQFM	100.3
	KRRC	*89.3

PENNSYLVANIA

Allentown	WFMZ	100.7
Altoona	WVAM-FM	100.1
Bethlehem	WGPA-FM	95.1
Bloomsburg	WHLM-FM	106.5
Braddock	WLOA-FM	96.9
Butler	WBUT-FM	97.7
Carlisle	WHYL-FM	102.3
Chambersburg	WCHA-FM	95.1
Dubois	WCED-FM	102.1
Easton	WEST-FM	107.9
	WEEX-FM	99.9
Erie	WERC-FM	99.9
Glenside	WIFI	92.5
Harrisburg	WHP-FM	97.3
Havertown	WHHS	*89.3
Hazleton	WAZL-FM	97.9
Johnstown	WARD-FM	92.1
	WJAC-FM	95.5
Lancaster	WGAL-FM	101.3
	WLAN-FM	96.9
Lebanon	WLBR-FM	100.1
Meadville	WMGW-FM	100.3
Oil City	WDJR	98.5
Palmyra	WJWR	92.1
Philadelphia	WCAU-FM	98.1
	WDAS-FM	105.3
	WFIL-FM	102.1
	WFLN	95.7
	WHAT-FM	96.5
	WHYY	*90.9
	WIBG-FM	94.1
	WIP-FM	93.3
	WPEN-FM	102.9
	WPWT	*91.7
	WRTI-FM	*90.1
	WXPN	*88.9
Pittsburgh	KDKA-FM	92.9
	WDUQ	*91.5
	WFMP	99.7
	WKJF	93.7
	WWSW-FM	94.5
Pottsville	WPPA-FM	101.9
Scranton	WGBI-FM	101.3
	WUSV	*88.9
Sharon	WPIC-FM	102.9
State College	WDFM	*91.1
Sunbury	WKOK-FM	94.1
Towanda	WTTC-FM	92.7
Warren	WRRN	92.3
Washington	WJPA-FM	104.3
Waynesboro	WAYZ-FM	101.5
Wilkes-Barre	WBRE-FM	98.5
	WYZZ	103.3
Williamsport	WLYC-FM	105.1
	WRAK-FM	100.3
York	WNOW-FM	105.7

RHODE ISLAND

Location	C.L.	Mc.
Cranston	WLOV	99.9
Providence	WPJB-FM	105.1
	WPFM	95.5
	WPRO-FM	92.3
	WXCN	101.5
Woonsocket	WWON-FM	106.3

SOUTH CAROLINA

Location	C.L.	Mc.
Anderson	WCAC	101.1
Charleston	WCSC-FM	96.9
	WTMA-FM	95.1
Columbia	WCOS-FM	97.9
	WNOK-FM	104.7
	WUSC-FM	*89.9
Dillon	WDSC-FM	92.9
Greenville	WESC-FM	92.5
	WFBC-FM	93.7
Rock Hill	WRHI-FM	98.3
Seneca	WSNW-FM	98.1
Spartanburg	WSPA-FM	98.9

TENNESSEE

Location	C.L.	Mc.
Bristol	WOPI-FM	96.9
Chattanooga	WDOD-FM	96.5
Greeneville	WGRV-FM	94.9
Jackson	WTJS-FM	104.1
Johnson City	WJHL-FM	100.7
Kingsport	WKPT-FM	98.5
Knoxville	WBIR-FM	93.3
	WKCS	*91.1
	WUOT	*91.9
Memphis	WMCF	99.7
	WMPS-FM	97.1
	WQMM	95.5
Nashville	WFMB	105.9
	WSIX-FM	97.5
Abilene	KACC-FM	*91.1

TEXAS

Location	C.L.	Mc.
Amarillo	KGNC-FM	93.1
Austin	KHFI	98.3
	KAZZ	95.5
Beaumont	KRIC-FM	97.5
Brownwood	KHPC	88.1
Cleburne	KCLE-FM	94.9
Corpus Christi	KDMC	95.5
Dallas	KIXL-FM	104.5
	KNER	*88.1
	KRLD-FM	92.5
	WRR-FM	101.1
	KVTT	*91.7
Denton	KDNT-FM	106.3
El Paso	KVOF-FM	*88.5
	KHMS	94.7
Ft. Worth	WBAP-FM	96.3
	KFJZ-FM	97.1
Gainesville	KGAF-FM	94.5
Houston	KHGM	102.9
	KHUL	95.7
	KFMK	97.9
	KRBE	104.1
	KTRH-FM	101.1
	KUHF	*91.3
Lubbock	KRKH-FM	93.7
	KBFM	96.3
Midland	KNFM	92.3
Plainview	KHBL	*88.1
Port Arthur	KFMP	93.3
San Antonio	KISS	99.5
	KEEZ	97.3
	KONO-FM	92.9
Texarkana	KCMC-FM	98.1
Waco	KEFC	95.5
Waxahachie	KBEC-FM	93.5

UTAH

Location	C.L.	Mc.
Ephraim	KEPH	*88.9
Logan	KVSC	*88.1
Salt Lake City	KCPX-FM	98.7
	KSL-FM	100.3

VIRGINIA

Location	C.L.	Mc.
Arlington	WARL-FM	105.1
Charlottesville	WINA-FM	95.3
	WTJU	91.3
Crewe	WSVS-FM	104.7
Harrisonburg	WEMC	*91.7
	WSVA-FM	100.7
Lynchburg	WWOD-FM	100.1
Martinsville	WMVA-FM	96.3
Newport News	WGH-FM	97.3
Norfolk	WMTI	*91.5
	WRVC	102.5
	WYFI-FM	99.7
Richmond	WCOD	98.1
	WRFK	91.1
	WRVA-FM	94.5
	WRNL-FM	102.1
Roanoke	WDBJ-FM	94.9
	WROV-FM	103.7
	WSLS-FM	99.1
South Norfolk	WFOS	*90.5
Staunton	WAFC-FM	93.3
Williamsburg	WCWM	89.1
Winchester	WRFL	92.5
Woodbridge	WBVA	105.9

WASHINGTON

Location	C.L.	Mc.
Bellingham	KGMI	92.9
Cheney	KEWC-FM	*89.9
Seattle	KING-FM	98.1
	KETO-FM	101.5
	KIRO-FM	100.7
	KISW	99.9
	KMCS	98.9
	KUOW	94.9
Spokane	KREM-FM	92.9
	KXLY-FM	99.9
Tacoma	KCPS	90.9
	KLAY-FM	106.3
	KTNT-FM	97.3
	KTOY	*91.7
	KTWR	103.9

WEST VIRGINIA

Location	C.L.	Mc.
Beckley	WBKW	99.5
Charleston	WKAZ-FM	97.5
Huntington	WKEE-FM	100.5
Martinsburg	WEPM-FM	94.3
Morgantown	WAJR-FM	99.3
Oak Hill	WOAY-FM	94.1
Parkersburg	WAAM-FM	106.5
Wheeling	WKWK-FM	97.3
	WWVA-FM	98.7

WISCONSIN

Location	C.L.	Mc.
Appleton	WLFM	*91.1
Chilton	WHKW	*89.3
Colfax	WHWC	*88.3
Delafield	WHAD	*90.7
Eau Claire	WIAL	94.1
Fort Atkinson	WFAW	107.3
Greenfield Twp.	WWCF	94.9
Highland	WHHI	91.3
Highland Twp.	WHSA	*89.9
Janesville	WCLO-FM	99.9
La Crosse	WHLA	*90.3
Madison	WHA-FM	*88.7
	WISZ-FM	98.1
	WMFM	104.1
	WRVB-FM	102.5
Merrill	WLIN	100.7
Milwaukee	WFMR	96.5
	WQFM	93.3
	WTMJ-FM	94.1
Monroe	WEKZ-FM	93.7
Racine	WRJN-FM	100.7
Rice Lake	WJMC-FM	96.3
Sparta	WCOW-FM	97.1
Wausau	WHRM	*91.9
West Bend	WBKV-FM	92.5
Wisc. Rapids	WFHR-FM	103.3

Canadian FM Stations

Location	C.L.	Mc.
Brantford, Ont.	CKPC-FM	92.1
Cornwall, Ont.	CJSS-FM	104.5
Edmonton, Alta.	CFRN-FM	100.3
	CJCA-FM	99.5
	CKUA-FM	98.1
Ft. William, Ont.	CKPR-FM	94.3
Halifax, N.S.	CHNS-FM	96.1
Kingston, Ont.	CFRC-FM	91.9
	CKLC-FM	99.5
	CKWS-FM	96.3
Kitchener, Ont.	CKCR-FM	96.7
Lethbridge, Alta.	CHEC-FM	100.9
London, Ont.	CFPL-FM	95.9
Montreal, Que.	CBF-FM	95.1
	CBM-FM	100.7
	CFCF-FM	106.5
Oshawa, Ont.	CKLB-FM	93.5
Ottawa, Ont.	CBO-FM	103.3
	CFRA-FM	93.9
Quebec, Que.	CHRC-FM	98.1
Rimouski, Que.	CJBR-FM	101.5
St. Catharines, Ont.	CKTB-FM	97.7
Sydney, N.S.	CJCB-FM	94.9
Timmins, Ont.	CKGB-FM	94.5
Toronto, Ont.	CBC-FM	99.1
	CFRB-FM	99.9
	CHFI-FM	98.1
	CJRT-FM	91.1
Vancouver, B.C.	CBU-FM	105.7
Verdun, Que.	CKVL-FM	96.9
Victoria, B.C.	CKDA-FM	98.5
Windsor, Ont.	CKLW-FM	93.9
Winnipeg, Man.	CJOB-FM	103.1

United States Television Stations

(Territories and possessions follow states). Chan., channel number; asterisk (*) indicates educational station.

ALABAMA

Location	C.L.	Chan.
Andalusia	WAIQ	*2
Birmingham	WAPI-TV	13
	WBIQ	*10
	WBRC-TV	6
Decatur	WMSL-TV	23
Dothan	WTVY	9
Florence	WOWL	15
Huntsville	WAFG-TV	31
Mobile	WALA-TV	10
	WKRG-TV	5
Montgomery	WCOV-TV	20
	WSFA-TV	12
Munford	WCIQ	*7
Selma	WSLA	8

ALASKA

Location	C.L.	Chan.
Anchorage	KENI-TV	2
	KTVA	11
Fairbanks	KFAR-TV	2
	KTVF	11
Juneau	KINY-TV	8

ARIZONA

Location	C.L.	Chan.
Phoenix	KOOL-TV	10
	KPHO-TV	5
	KTVK	3
	KVAR	12
Tucson	KGUN-TV	9
	KOLD-TV	13
	KVOA-TV	4
	KUAT	*6
Yuma	KIVA	11

ARKANSAS

Location	C.L.	Chan.
El Dorado	KTVE	10
Ft. Smith	KFSA-TV	5
Little Rock	KARK-TV	4
	KTHV	11
	KATV	7
Texarkana	KCMC-TV	6

CALIFORNIA

Location	C.L.	Chan.
Bakersfield	KBAK-TV	29
	KERO-TV	10
	KLYD-TV	17
Chico	KHSL-TV	12
El Centro	XEM-TV	3
Eureka	KIEM-TV	3
	KVIQ-TV	6
Fresno	KFRE-TV	12
	KJEO	47
	KMJ-TV	24
Los Angeles	KABC-TV	7
	KCOP	13
	KHJ-TV	9
	KNXT	2
	KRCA	4
	KTLA	5
	KTTV	11
Oakland	KTVU	2
Redding	KVIP-TV	7
Sacramento	KXTV	10
	KCRA-TV	3
	KVIE	*6
Salinas	KSBW-TV	8
San Diego	KFMB-TV	8
	KFSD-TV	10
(Tijuana, Mex.)	XETV	6
San Francisco	KGO-TV	7
	KPIX	5
	KQED	*9
	KRON-TV	4
San Jose	KNTV	11
San Luis Obispo	KSBY-TV	6
Santa Barbara	KEY-T	3
Stockton	KOVR	13

COLORADO

Location	C.L.	Chan.
Colorado Springs	KKTV	11
	KRDO-TV	13
Denver	KBTV	9
	KLZ-TV	7
	KOA-TV	4
	KRMA-TV	*6
	KTVR	2
Grand Junction	KREX-TV	5
Montrose	KREY-TV	10
Pueblo	KCSJ-TV	5

CONNECTICUT

Location	C.L.	Chan.
Bridgeport	WICC-TV	43
Hartford	WTIC-TV	3
	WHCT	18
New Britain	WHNB-TV	30
New Haven	WNHC-TV	8
Waterbury	WATR-TV	53

DIST. OF COLUMBIA

Location	C.L.	Chan.
Washington	WMAL-TV	7
	WRC-TV	4
	WTOP-TV	9
	WTTG	5

FLORIDA

Location	C.L.	Chan.
Daytona Beach	WESH-TV	2
Fort Myers	WINK-TV	11
Gainesville	WUFT	*5
Jacksonville	WFGA-TV	12
	WJCT	*7
	WJXT	4
Miami	WCKT	7
	WPST-TV	10
	WTHS-TV	*2
	WTVJ	4
Orlando	WDBO-TV	6
	WLOF-TV	9
Palm Beach	WPTV	5
Panama City	WJDM-TV	7
Pensacola	WEAR-TV	3
St. Petersburg	WSUN-TV	38
Tampa	WFLA-TV	8
	WEDU	*3
	WTVT	13
W. Palm Beach	WEAT-TV	12

GEORGIA

Location	C.L.	Chan.
Albany	WALB-TV	10
Athens	WGTV	*8
Atlanta	WAGA-TV	5
	WSB-TV	2
	WETV	*30
	WLW-A	11
Augusta	WJBF	6
	WRDW-TV	12
Columbus	WRBL-TV	3
	WTVM	9
Macon	WMAZ-TV	13
Savannah	WSAV-TV	3
	WTOC-TV	11
Thomasville	WCTV	6

HAWAII

Location	C.L.	Chan.
Hilo	KHBC-TV	9
	KHJK	13
Honolulu	KGMB-TV	9
	KONA	2
	KULA-TV	4
Wailuku	KMAU	3
	KALA	7
	KMVI-TV	12

IDAHO

Location	C.L.	Chan.
Boise	KBOI	2
	KTVB	7
Idaho Falls	KID-TV	3
Lewiston	KLEW-TV	3
Nampa	KCIX-TV	6
Pocatello	KTLE	6
Twin Falls	KLIX-TV	11

ILLINOIS

Location	C.L.	Chan.
Champaign	WCIA	3
	WCHU	33
Chicago	WBBM-TV	2
	WBKB	7
	WGN-TV	9
	WNBQ	5
	WTTW	*11
Danville	WDAN-TV	24
Decatur	WTVP	17
Harrisburg	WSIL-TV	3
La Salle	WEEQ-TV	35
Peoria	WEEK-TV	43
	WMBD	31
	WTVH	19
Quincy	WGEM-TV	10
Rockford	WREX-TV	13
	WTVO	39
Rock Island	WHBF-TV	4
Springfield	WICS	20
Urbana	WILL-TV	*12

INDIANA

Location	C.L.	Chan.
Bloomington	WTTV	4
Elkhart	WSJV-TV	28
Evansville	WFIE-TV	14
	WEHT	50
	WTVW	7
Ft. Wayne	WANE-TV	15
	WKJG-TV	33
	WPTA	21
Indianapolis	WFBM-TV	6
	WLWI	13
	WISH-TV	8
	WFAM-TV	18
Muncie	WLBC-TV	49
South Bend	WNDU-TV	16
	WSBT-TV	22
Terre Haute	WTHI-TV	10

IOWA

Location	C.L.	Chan.
Ames	WOI-TV	5
Cedar Rapids	KCRG-TV	9
	WMT-TV	2
Davenport	WOC-TV	6
Des Moines	KRNT-TV	8
	KDPS-TV	*11
	WHO-TV	13
Fort Dodge	KQTV	21
Mason City	KGLO-TV	3
Ottumwa	KTVO	3
Sioux City	KTIV	4
	KVTV	9
Waterloo	KWWL-TV	7

KANSAS

Location	C.L.	Chan.
Ensign	KTVC	6
Garden City	KGLD	11
Goodland	KBLR-TV	10
Great Bend	KCKT	2
Hays	KAYS-TV	7
Hutchinson	KTVH	12
Pittsburg	KOAM-TV	7
Topeka	WIBW-TV	13
Wichita	KAKE-TV	10
	KARD-TV	3

KENTUCKY

Location	C.L.	Chan.
Lexington	WLEX-TV	18
	WKYT	27
Louisville	WAVE-TV	3
	WFPK-TV	*15
	WHAS-TV	11
	WQXL-TV	41
Paducah	WPSD-TV	6

LOUISIANA

Location	C.L.	Chan.
Alexandria	KALB-TV	5
Baton Rouge	WAFB-TV	28
	WBRZ	2
Lafayette	KLFY-TV	10
Lake Charles	KPLC-TV	7
	KTAG-TV	25
Monroe	KNOE-TV	8
	KLSE	*13
New Orleans	WDSU-TV	6
	WVUE	13
	WWL-TV	4
	WYES	*8
Shreveport	KSLA-TV	12
	KTBS-TV	3

MAINE

Location	C.L.	Chan.
Bangor	WABI-TV	5
	WLBZ-TV	2
Poland Spring	WMTW-TV	8
Portland	WCSH-TV	6
	WGAN-TV	13
Presque Isle	WAGM-TV	8

MARYLAND

Location	C.L.	Chan.
Baltimore	WJZ-TV	13
	WBAL-TV	11
	WMAR-TV	2
Salisbury	WBOC-TV	16

MASSACHUSETTS

Location	C.L.	Chan.
Adams	WCDC	19
Boston	WBZ-TV	4
	WGBH-TV	*2
	WHDH-TV	5
	WNAC-TV	7
Greenfield	WRLP	32
Springfield	WHYN-TV	40
	WWLP	22
Worcester	WWOR-TV	14

MICHIGAN

Location	C.L.	Chan.
Bay City	WNEM-TV	5
Cadillac	WWTV	13
Cheboygan	WTOM-TV	4
Detroit	WJBK-TV	2
	WTVS	*56
	WWJ-TV	4
	WXYZ-TV	7
(Windsor, Ont.)	CKLW-TV	9
Flint	WJRT	12
Grand Rapids	WOOD-TV	8
Kalamazoo	WKZO-TV	3
Lansing	WJIM-TV	6
Marquette	WLUC-TV	6
Onondaga	WILX-TV/WMSB	10
Saginaw	WKNX-TV	57
Traverse City	WPBN-TV	7

MINNESOTA

Location	C.L.	Chan.
Alexandria	KCMT	7
Austin	KMMT	6
Duluth	KDAL-TV	3
	WDSM-TV	6
Minneapolis	KMSP	9
	WCCO-TV	4
	WTCN-TV	11
Rochester	KROC-TV	10
St. Paul	KSTP-TV	5
	KTCA-TV	*2

MISSISSIPPI

Location	C.L.	Chan.
Columbus	WCBI-TV	4
Greenwood	WABG-TV	6
Jackson	WJTV	12
	WLBT	3
Laurel	WDAM-TV	7
Meridian	WTOK-TV	11
	WCOC-TV	30
Tupelo	WTWV	9

MISSOURI

Location	C.L.	Chan.
Cape Girardeau	KFVS-TV	12
Columbia	KOMU-TV	8
Hannibal	KHQA-TV	7
Jefferson City	KRCG-TV	13
Joplin	KODE-TV	12
Kansas City	KCMO-TV	5
	KMBC-TV	9
	WDAF-TV	4
Kirksville	KTVO	3
St. Joseph	KFEQ-TV	2
St. Louis	KETC	*9
	KMOX-TV	4
	KSD-TV	5
	KTVI	2
	KPLR-TV	11
Sedalia	KMOS-TV	6
Springfield	KTTS-TV	10
	KYTV	3

MONTANA

Location	C.L.	Chan.
Billings	KOOK-TV	2
	KGHL-TV	8
Butte	KXLF-TV	4
Glendive	KXGN-TV	5
Great Falls	KFBB-TV	5
	KRTV	3
Helena	KXLJ-TV	12
Kalispell	KULR	9
Missoula	KMSO-TV	13

NEBRASKA

Location	C.L.	Chan.
Hastings	KHAS-TV	5
Hay Springs	KDUH-TV	4
Hayes Center	KHPL-TV	6
Kearney	KHOL-TV	13
Lincoln	KOLN-TV	10
	KUON-TV	*12
McCook	KOMC	8
North Platte	KNOP	2
Omaha	KMTV	3
	KETV	7
	WOW-TV	6
Scottsbluff	KSTF	10

NEVADA

Location	C.L.	Chan.
Henderson	KLRJ-TV	2
Las Vegas	KLAS-TV	8
	KSHO-TV	13
Reno	KOLO-TV	8

NEW HAMPSHIRE

Location	C.L.	Chan.
Durham	WENH	*11
Manchester	WMUR-TV	9

NEW JERSEY

Location	C.L.	Chan.
Newark	WNTA-TV	13

NEW MEXICO

Location	C.L.	Chan.
Albuquerque	KGGM-TV	13
	KNME-TV	*5
	KOAT-TV	7
	KOB-TV	4
Carlsbad	KAVE-TV	6
Clovis	KVER-TV	12
Roswell	KSWS-TV	8

NEW YORK

Location	C.L.	Chan.
Albany	WTEN	10
	WAST	13
Binghamton	WINR-TV	40
	WNBF-TV	12
Buffalo	WBEN-TV	4
	WBUF	17
	WGR-TV	2
	WKBW	7
Carthage	WCNY-TV	7
Elmira	WSYE-TV	18
New York	WABC-TV	7
	WNEW-TV	5
	WCBS-TV	2
	WOR-TV	9
	WPIX	11
	WNBC-TV	4
Plattsburg	WPTZ-TV	5
Rochester	WHEC-TV	10
	WROC-TV	5
	WVET-TV	10
Schenectady	WRGB	6
Syracuse	WHEN-TV	8
	WSYR-TV	3
Utica	WKTV	2

NORTH CAROLINA

Location	C.L.	Chan.
Asheville	WISE-TV	62
	WLOS-TV	13
Chapel Hill	WUNC-TV	*4
Charlotte	WBTV	3
	WSOC-TV	9
Durham	WTVD	11
Greensboro	WFMY-TV	2
Greenville	WNCT	9
Raleigh	WRAL-TV	5
Washington	WITN	7
Wilmington	WECT	6
Winston-Salem	WSJS-TV	12

NORTH DAKOTA

Location	C.L.	Chan.
Bismarck	KBMB-TV	12
	KFYR-TV	5
Dickinson	KDIX-TV	2
Fargo	WDAY-TV	6
	KXGO-TV	11
Grand Forks	KNOX-TV	10
Minot	KXMC-TV	13
	KMOT	10
Valley City	KXJB-TV	4
Williston	KUMV-TV	8

OHIO

Location	C.L.	Chan.
Akron	WAKR-TV	49
Cincinnati	WCET	*48
	WCPO-TV	9
	WKRC-TV	12
	WLW-T	5
	WCIN-TV	54
Cleveland	KYW-TV	3
	WEWS	5
	WJW-TV	8
Columbus	WBNS-TV	10
	WLW-C	4
	WOSU-TV	*34
	WTVN-TV	6
Dayton	WHIO-TV	7
	WLW-D	2
Lima	WIMA-TV	35
Oxford	WMUB-TV	14
Steubenville	WSTV-TV	9
Toledo	WSPD-TV	13
	WGTE-TV	*30
	WTOL-TV	11
Youngstown	WFMJ-TV	21
	WKBN-TV	27
	WKST-TV	45
Zanesville	WHIZ-TV	18

OKLAHOMA

Location	C.L.	Chan.
Ada	KTEN	10
Ardmore	KXII	12
Enid	KOCO-TV	5
Lawton	KSWO-TV	7
Oklahoma City	KETA	*13
	KOKH-TV	25
	KWTV	9
	WKY-TV	4
Tulsa	KOTV	6
	KOED-TV	*11
	KTUL-TV	8
	KVOO-TV	2

OREGON

Location	C.L.	Chan.
Corvallis	KOAC-TV	*7
Eugene	KVAL-TV	13
Klamath	KOTI	2
Medford	KBES-TV	5
Portland	KGW-TV	8
	KHTV	27
	KOIN-TV	6
	KPTV	12
Roseburg	KPIC	4

PENNSYLVANIA

Location	C.L.	Chan.
Altoona	WFBG-TV	10
Erie	WICU	12
	WSEE-TV	35
Harrisburg	WHP-TV	55
	WTPA	27
Johnstown	WARD-TV	56
	WJAC-TV	6
Lancaster	WGAL-TV	8
Lebanon	WLVH-TV	15
Lockhaven	WBPZ-TV	32
New Castle	WKST-TV	45
Philadelphia	WCAU-TV	10
	WFIL-TV	6
	WHYY-TV	*35
	WPCA-TV	17
	WRCV-TV	3
Pittsburgh	KDKA-TV	2
	WIIC	11
	WQED	*13
	WQEX	*16
	WTAE	4
Scranton	WNEP-TV	16
	WDAU-TV	22
Wilkes-Barre	WBRE-TV	28
York	WSBA-TV	43

RHODE ISLAND

Location	C.L.	Chan.
Providence	WJAR-TV	10
	WPRO-TV	12

SOUTH CAROLINA

Location	C.L.	Chan.
Anderson	WAIM-TV	40
Charleston	WCSC-TV	5
	WUSN-TV	2
Columbia	WIS-TV	10
	WNOK-TV	67
Florence	WBTW	8
Greenville	WFBC-TV	4
Spartanburg	WSPA-TV	7

SOUTH DAKOTA

Location	C.L.	Chan.
Aberdeen	KXAB-TV	9
Deadwood	KDSJ-TV	5
Florence	KDLO-TV	3
Mitchell	KORN-TV	5
Rapid City	KOTA-TV	3
	KRSD-TV	7
Reliance	KPLO-TV	6
Sioux Falls	KELO-TV	11

TENNESSEE

Location	C.L.	Chan.
Chattanooga	WDEF-TV	12
	WRGP-TV	3
	WTVC	9
Jackson	WDXI-TV	7
Johnson City	WJHL-TV	11
Knoxville	WATE-TV	6
	WBIR-TV	10
	WTVK	26
Memphis	WHBQ-TV	13
	WKNO	*10
	WMCT	5
	WREC-TV	3
Nashville	WLAC-TV	5
	WSIX-TV	8
	WSM-TV	4

TEXAS

Location	C.L.	Chan.
Abilene	KRBC-TV	9
Amarillo	KFDA-TV	10
	KGNC-TV	4
	KVII	7
Austin	KTBC-TV	7
Beaumont	KFDM-TV	6
Big Spring	KEDY-TV	4
Bryan	KBTX-TV	3
Corpus Christi	KRIS-TV	6
	KZTV	10
Dallas	KRLD-TV	4
	WFAA-TV	8
El Paso	KELP-TV	13
	KROD-TV	4
	KTSM-TV	9
(Ciudad Juarez, Mex.)	XEJ-TV	5
Ft. Worth	KFJZ-TV	11
	WBAP-TV	5
Harlingen	KGBT-TV	4
Houston	KPRC-TV	2
	KHOU-TV	11
	KTRK-TV	13
	KUHT	*8
Laredo	KGNS-TV	8
Lubbock	KCBD-TV	11
	KDUB-TV	13
Lufkin	KTRE-TV	9
Midland	KMID-TV	2
Monahans	KVKM-TV	9
Odessa	KOSA-TV	7
Port Arthur-Beaumont	KPAC-TV	4
Richardson	KRET-TV	23
San Angelo	KCTV	8
San Antonio	KCOR-TV	41
	KENS-TV	5
	KONO-TV	12
	WOAI-TV	4
Sweetwater	KPAR-TV	12
Temple	KCEN-TV	6
Texarkana	KCMC-TV	6
Tyler	KLTV	7
Waco	KWTX-TV	10
Weslaco	KRGV-TV	5
Wichita Falls	KFDX-TV	3
	KSYD-TV	6

UTAH

Location	C.L.	Chan.
Provo	KLOR-TV	11
Salt Lake City	KSL-TV	5
	KCPX-TV	4
	KUED	*7
	KUTV	2

VERMONT

Location	C.L.	Chan.
Burlington	WCAX-TV	3

VIRGINIA

Location	C.L.	Chan.
Bristol	WCYB-TV	5
Hampton	WVEC-TV	13

Location	C.L.	Chan.
Harrisonburg	WSVA-TV	3
Lynchburg	WLVA-TV	13
Norfolk	WTAR-TV	3
Petersburg	WXEX-TV	8
Portsmouth	WAVY-TV	10
Richmond	WRVA-TV	12
	WTVR	6
Roanoke	WDBJ-TV	7
	WSLS-TV	10

WASHINGTON

Location	C.L.	Chan.
Bellingham	KVOS-TV	12
Ephrata	KBAS-TV	16
Pasco	KEPR-TV	19
Seattle	KCTS-TV	*9
	KING-TV	5
	KIRO-TV	7
	KOMO-TV	4
Spokane	KHQ-TV	6
	KREM-TV	2
	KXLY-TV	4
Tacoma	KTNT-TV	11
	KPEC-TV	56
	KTVW	13
Yakima	KIMA-TV	29
	KNDO-TV	23
Walla Walla	KNBS	22

WEST VIRGINIA

Location	C.L.	Chan.
Bluefield	WHIS-TV	6
Charleston	WCHS-TV	8
Clarksburg	WBOY-TV	12
Huntington	WHTN-TV	13
	WSAZ-TV	3
Oak Hill	WOAY-TV	4
Parkersburg	WTAP-TV	15
Wheeling	WTRF-TV	7

WISCONSIN

Location	C.L.	Chan.
Eau Claire	WEAU-TV	13
Green Bay	WBAY-TV	2
	WFRV	5
La Crosse	WKBT	8
Madison	WHA-TV	*21
	WISC-TV	3
	WKOW-TV	27
	WMTV	33
Marinette	WMBV-TV	11
Milwaukee	WISN-TV	12
	WMVS-TV	*10
	WTMJ-TV	4
	WXIX	18
Wausau	WSAU-TV	7
Whitefish Bay	WITI-TV	6

WYOMING

Location	C.L.	Chan.
Casper	KTWO-TV	2
Cheyenne	KFBC-TV	5
Riverton	KWRB-TV	10

PUERTO RICO

Location	C.L.	Chan.
Aquadilla	WOLE-TV	12
Caguas	WKBM-TV	11

Canadian Television Stations

ALBERTA

Location	C.L.	Chan.
Calgary	CHCT-TV	2
Edmonton	CFRN-TV	3
Lethbridge	CJLH-TV	7
Medicine Hat	CHAT-TV	6
Red Deer	CHCA-TV	6

BRITISH COLUMBIA

Location	C.L.	Chan.
Dawson Creek	CJDC-TV	5
Kamloops	CFCR-TV	4
Kelowna	CHBC-TV	2
	CHGP-TV-1	72
Oliver	CHBC-TV-3	8
Penticton	CHBC-TV	13
Vancouver	CBUT	2
Vernon	CHBC-TV	7
Victoria	CHEK-TV	6

LABRADOR

Location	C.L.	Chan.
Goose Bay	CFLA-TV	8

MANITOBA

Location	C.L.	Chan.
Brandon	CKX-TV	5
Winnipeg	CBWT	3

NEW BRUNSWICK

Location	C.L.	Chan.
Moncton	CKCW-TV	2
	CBAFT	11
Saint John	CHSJ-TV	4

NEWFOUNDLAND

Location	C.L.	Chan.
Argentia	CJOX-TV	10
Corner Brook	CBYT	5
Grand Falls	CJCN-TV	4
St. John's	CJON-TV	6
Stephenville	CFSN-TV	8

NOVA SCOTIA

Location	C.L.	Chan.
Halifax	CBHT	3
Inverness	CJCB-TV-1	6
Liverpool	CBHT-1	12
New Glasgow	CFCY-TV-1	7
Shelburne	CBHT-2	8
Sydney	CJCB-TV	4
Yarmouth	CBHT-3	11

ONTARIO

Location	C.L.	Chan.
Barrie	CKVR-TV	3
Elk Lake	CFCL-TV-2	2
Elliot Lake	CKSO-TV-1	3
Hamilton	CHCH-TV	11
Kapuskasing	CFCL-TV-1	3
Kenora	CBWAT	8
Kingston	CKWS-TV	11
Kitchener	CKCO-TV	13
London	CFPL-TV	10
North Bay	CKGN-TV	10
Peterborough	CHEX-TV	12
Ottawa	CBOFT	9
	CBOT	4
Port Arthur	CFCJ-TV	2
Sault Ste. Marie	CJIC-TV	2
Sudbury	CKSO-TV	5
Timmins	CFCL-TV	6
Toronto	CBLT	6
Windsor	CKLW-TV	9
Wingham	CKNX-TV	8

PRINCE EDWARD ISLAND

Location	C.L.	Chan.
Charlottetown	CFCY-TV	13

QUEBEC

Location	C.L.	Chan.
Clermont	CFCV-TV-1	75
Estcourt	CJES-TV-1	70
Jonquiere	CKRS-TV	12
Matane	CKBL-TV	9
Montreal	CBFT	2
	CBMT	6
New Carlisle	CHAU-TV	5
Quebec	CFCM-TV	4
	CKMI-TV	5
Rimouski	CJBR-TV	3
Rouyn	CKRN-TV	4
Sherbrooke	CHLT-TV	7
Three Rivers	CKTM-TV	13

SASKATCHEWAN

Location	C.L.	Chan.
Moose Jaw	CHAB-TV	4
Prince Albert	CKBI-TV	5
Regina	CKCK-TV	2
Saskatoon	CFQC-TV	8
Swift Current	CFJB-TV	5
Yorkton	CKOS-TV	3

World-Wide Short-Wave Stations

Most international broadcasting is done within frequency limits agreed upon at international conventions. These frequency ranges are listed here, at the right, expressed both in frequency and by meter bands (wave-length).

Reception in the various bands varies according to the time of day and season of the year. Reception in the 60, 49 and 41 meter bands is best at night during the winter months. Reception in the 31 and 25 M. bands is best at night, but all year. Reception in the 19, 16, 13 and 11 M. bands is best during the day, also at night during the summer in the 16 and 19 M. bands.

Abbr.: AIR—All India Radio; RAI—Radiotelevisione Italiana; RTF—Radiodiffusion Television Francaise; VOA—Voice of America; RFE—Radio Free Europe. •denotes stations beaming evening (U.S.) broadcasts to the U.S., †morning or afternoon broadcasts.

METER BANDS

4750 to 5060 kc/s (60 meter band)
5950 to 6200 kc/s (49 meter band)
7100 to 7300 kc/s (41 meter band)
9500 to 9775 kc/s (31 meter band)
11700 to 11975 kc/s (25 meter band)
15100 to 15450 kc/s (19 meter band)
17700 to 17900 kc/s (16 meter band)
21450 to 21750 kc/s (13 meter band)
25600 to 26100 kc/s (11 meter band)

Kcs.	Call and Location
4630	HCGBI, Quito, Ecua.
4765	HJEF, Cali, Col.
4770	ELWA, Monrovia, Lib.
4770	YVMW, Punto Fiji, Ven.
4775	Libreville, Gabon Rep.
4780	YVLA, Valencia, Ven.
4790	YVQN, Puerto La Cruz, Ven.
4795	Rangoon, Burma
4805	ZYS8, Manaus, Braz.
4810	YVMG, Maracaibo, Ven.
4830	YVOA, San Cristobal, Ven.
4835	HJKE, Bogota, Col.
4840	Lourenco Marques, Moz.
4840	YVOI, Valera, Ven.
4845	HJGF, Bucaramanga, Col.
4850	YVMS, Barquisimeto, Ven.
4870	Cotonou, Dahomey Rep.
4880	YVKF, Caracas, Ven.
4893	Dakar, Mali Fed.
4895	PRF6, Manaus, Braz.
4898	HJAG, Barranquilla, Col.
4900	YVKP, Caracas, Ven.
4905	HRQN, Puerto Cortes, Hon.
4910	HCIMI, Quito, Ecua.
4910	Conakry, Guinea
4915	Accra, Ghana
4920	VLM4, Brisbane, Aus.
4920	YVKR, Caracas, Ven.
4930	HCIRC, Quito, Ecua.
4935	HJLF, Ibague, Col.
4940	Abidjan, Ivory Coast
4940	YVMO, Barquisimeto, Ven.
4945	HJCW, Bogota, Col.
4945	Paradys, So. Afr.
4950	Dakar, Mali Fed.
4950	YVMM, Coro, Ven.
4955	CR6RZ, Luanda, Ang.
4960	YVQA, Cumana, Ven.
4970	YVLK, Caracas, Ven.
4975	Yaounde, Cameroun
4990	Lagos, Nigeria
4990	YVMQ, Barquisimeto, Ven.
5010	HCRCX, Quito, Ecua.
5010	St. George, Grenada, B.W.I.
5020	HJFW, Manizales, Col.
5020	Niamey, Niger Rep.
5030	YVKM, Caracas, Ven.
5040	YVMA, Maracaibo, Ven.
5045	Lome, Togo
5050	YVKD, Caracas, Ven.
5075	HJGC, Bogota, Col.
5873	HRN, Tegucigalpa, Hond.
5940	Moscow, U.S.S.R.
5952	TGNA, Guatemala, Guat.
5954	TIQ, Puerto Limon, C. R.
5960	HJCF, Bogota, Col.
5965	YNWW, Granada, Nic.
5980	TGAR, Guatemala, Guat.
5981	Georgetown, Br. Guiana
5982	4VB, Port-au-Prince, Haiti
5990	Andorra, Andorra
5990	TGJA, Guatemala, Guat.
5995	Fort-de-France, Mart.
6002	4VEC, Cap Haitien, Haiti
6005	RIAS, Berlin, Ger.
6006	TIHBG, San Jose, C. R.
6010	XEOL, Mexico City, Mexico
6015	PRA8, Recife, Braz.
6020	Amman, Jordan
6020	Kiev, Ukrainian S.S.R.
6025	Kuala Lumpur, Malaya
6025	Hilversum, Neth.
6030	Baghdad, Iraq
6035	Rangoon, Burma
6035	HRTL, Tegucigalpa, Hond.
6037	TIFC, San Jose, C. R.
6037	Monte Carlo, Mon.
6040	HJLB, Ibague, Col.
6045	YDF, Djakarta, Indon.
6045	HOU31, David, Pan.
6050	HCJB, Quito, Ecua.
6050	BBC, London, Eng.
6055	HJEX, Cali, Col.
6055	JOZ2, Tokyo, Japan
6060	RAI, Caltanissetta, It.
6065	XEXG, Leon, Mex.
6065	Horby, Sweden
6070	Sofia, Bulgaria
6070	BBC, London, Eng.
6075	Norden, Ger.
6080	ZL7, Wellington, N.Z.
6082	OAX4Z, Lima, Peru
6085	Munich, Ger.
6090	VLI6, Sydney, Aus.
6090	Luxembourg, Lux.
6090	XECMT, C. El Mante, Mex.
6095	ZYB7, Sao Paulo, Braz.
6100	VOA, Munich, Ger.
6100	Belgrade, Yugo.
6103	Peking, China
6105	XEQM, Merida, Mex.
6105	Tunis, Tunisia
6110	BBC, London, Eng.
6115	ZYC7, Rio de Jan., Braz.
6115	Khabarovsk, U.S.S.R.
6120	LRX1, Buenos Aires
6120	BBC, Limassol, Cyprus
6130	Port Moresby, New Guinea
6130	Madrid, Spain •
6135	HRMF, La Ceiba, Hond.
6135	Papeete, Tahiti
6135	Singapore, Sing.
6140	HCOV5, Azogues, Ecua.
6140	VLW6, Perth, Aus.
6145	Algiers, Algeria
6147	PRL9, Rio de Jan., Braz.
6150	VLR6, Melbourne, Aus.
6150	BBC, London, Eng.
6155	4VWA, Cap Haitien, Haiti
6155	VOA, Salonika, Greece
6160	HJKJ, Bogota, Col.
6160	FEN, Tokyo, Japan
6165	HER3, Bern, Switz. •
6165	XEWW, Mexico City, Mex.
6165	Saigon, Vietnam
6170	BBC, Limassol, Cyprus
6170	Cayenne, Fr. Guiana
6175	RTF, Paris, France
6180	BBC, London, England
6185	HJCT, Bogota, Col.
6190	VOA, Munich, Ger.
6190	HVJ, Vatican City
6195	HJEZ, Cali, Col.
6195	HRD2, La Ceiba, Hond.
6195	Pyongyang, N. Korea
6200	HI2LR, C. Trujillo, D.R.
6200	4VHW, Port-au-Prince, Haiti
6208	TGHC, Guatemala, Guat.
6215	Pyongyang, N. Korea
6225	Peking, China
6305	Andorra, Andorra
6327	COCF, Havana, Cuba
6345	Ulan Bator, Mong.

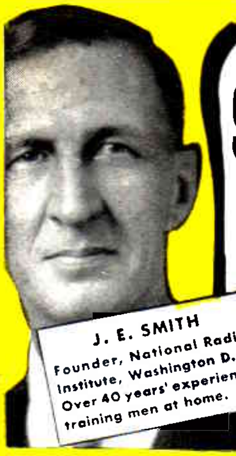
Kcs.	Call and Location
6373	Lisbon, Port.
6790	BBC, Limassol, Cyprus
7105	Madrid, Spain
7110	VOA, Colombo, Ceylon
7110	BBC, London, England
7115	Rabat, Morocco
7115	RFE, Germ.
7120	BBC, London, England
7120	BBC, Singapore
7125	Warsaw, Poland
7140	Monte Carlo, Monaco
7145	RFE, Ger.
7150	Khabarovsk, U.S.S.R.
7160	RTF, Paris, France
7160	VOA, Tangier, Mor.
7165	RFE, Germ.
7170	Algiers, Alg.
7180	Baghdad, Iraq
7185	BBC, London, Eng.
7200	BBC, London, Eng.
7200	R. Malaya, Sing.
7200	Omdurman, Sudan
7205	VOA, Salonika, Gr.
7210	BBC, London, Eng.
7210	Dakar, Mali Fed.
7210	Khabarovsk, U.S.S.R.
7220	VLD7, Melbourne, Aus.
7220	Budapest, Hung.
7230	BBC, London, Eng.
7235	Taipei, Taiwan, China
7235	VOA, Munich, Ger.
7240	RTF, Paris, France
7250	BBC, London, Eng.
7255	Sofia, Bulg.
7260	Saigon, Vietnam
7270	Motola, Sweden
7270	Magadan, U.S.S.R.
7275	RAI, Rome, It.
7280	Teheran, Iran
7280	HVJ, Vat. City
7285	Ankara, Turk.
7290	RAI, Rome, It.
7295	Makassar, Celebes
7295	RFE, Ger.
7320	BBC, London, Eng.
7398	Damascus, U.A.R.
7505	Peking, China
7650	YNMS, Leon, Nic.
7670	Sofia, Bulg.
7850	Tirana, Alb.
8002	Beirut, Leb.
8900	HCJC3, Zaruma, Ecua.
9009	Tel Aviv, Israel
9026	COBZ, Havana, Cuba
9065	Peking, China
9210	Leopoldville, Congo
9360	Madrid, Spain ●
9363	COBC, Havana, Cuba
9380	Alma Ata, Kazakh S.S.R.
9385	Leopoldville, Congo
9410	BBC, London, Eng.
9440	CP38, La Paz, Bol.
9458	Peking, China
9500	XEWW, Mexico City, Mex.
9500	Magadan, U.S.S.R.
9500	Moscow, U.S.S.R.
9505	PRB22, Sao Paulo, Braz.
9505	Rabat, Mor.
9505	HOLA, Colon, Pan.
9510	Peking, China
9510	VOA, Tangier, Mor.
9515	RAI, Caltanissetta, It.
9515	Ankara, Turkey ●
9520	Colombo, Ceylon
9520	Copenhagen, Den. ●
9520	VOA, Salonika, Gr.
9520	OAX8E, Iquitos, Peru
9523	Paradys, S. Afr.
9525	BBC, London, Eng.
9525	JOB9, Tokyo, Japan
9525	Warsaw, Poland
9530	COCO, Havana, Cuba
9530	VOA, Munich, Ger.
9530	AIR, Delhi, India
9530	VOA, Courier, Rhodes
9530	YVMZ, Maracaibo, Ven.
9535	Lagos, Nigeria
9535	VOA, Manila, P.I.
9535	HER4, Bern, Switz. ●
9540	ZL2, Wellington, N.Z.
9540	Warsaw, Poland
9540	Omdurman, Sudan
9545	ZYS43, Curitiba, Braz.
9545	HED5, Bern, Switz.
9950	Prague, Czecho. ●
9550	AIR, Bombay, India
9550	OAX1Z, Tumbes, Peru
9555	CP6, La Paz, Bol.
9555	BBC, London, Eng.
9555	XETT, Mexico City, Mex.
9560	RTF, Paris, France
9560	Tokyo, Japan
9563	OAX4R, Lima, Peru
9565	ZYK3, Recife, Braz.
9565	Radio Liberty, Ger.
9565	Khabarovsk, U.S.S.R.
9570	Bucharest, Rom. ●
9575	ZYZ27, Rio de Jan., Braz.
9575	Taipei, Formosa
9575	RAI, Rome, Italy ●
9580	VLA9, Melbourne, Aus.
9580	BBC, London, Eng.
9585	ZYR56, Sao Paulo, Braz.
9585	RTF, Paris, France
9588	Peking, China
9590	Djakarta, Indon.
9590	Hilversum, Neth.
9590	Bucharest, Rom. ●
9595	JOZ3, Tokyo, Japan
9598	CE960, Santiago, Chile
9600	BBC, London, Eng.
9605	Cologne, Ger.
9607	Athens, Greece
9610	VLX9, Perth, Aus.
9610	ZYC8, Rio de Jan., Braz.
9610	Oslo, Norway ●
9610	OAX8C, Iquitos, Peru
9615	VOA, Tangier, Morocco
9620	ZYR98, Sao Paulo, Braz.
9620	Peking, China
9620	VOA, Tangier, Mor.
9620	Saigon, Vietnam
9625	Brazzaville, Equat. Un.
9625	BBC, London, Eng.
9625	OAX8K, Iquitos, Peru
9625	Moscow, U.S.S.R.
9630	CR6RL, Luanda, Ang.
9630	VLG9, Melbourne, Aus.
9630	RAI, Rome. Italy
9630	Komsomolsk, U.S.S.R.
9635	ZYR83, Aparecida, Braz.
9635	VOA, Munich, Ger.
9635	Lisbon, Portugal ●
9640	BBC, London, Eng.
9640	Cologne, Germany ●
9640	Accra, Ghana
9640	HLK5, Seoul, Korea
9640	Moscow, U.S.S.R.
9645	TIFC, San Jose, C.R.
9645	HVJ, Vatican City
9650	BBC, Limassol, Cyprus
9655	Radio Free Europe, Ger.
9660	LRX, Buenos Aires, Arg.
9660	VLQ9, Brisbane, Aus.
9660	Radio Liberty, Ger.
9660	Teheran, Iran
9660	Komsomolsk, U.S.S.R.
9665	Moscow, U.S.S.R.
9667	Hargeisa, Somalia
9667	TGNA, Guatemala, Guat. ●
9670	COCQ, Havana, Cuba
9670	Prague, Czecho.
9675	BBC, London, Eng.
9675	RTF, Paris, France
9675	JOB9, Tokyo, Japan
9675	Warsaw, Poland ●
9680	VLH9, Melbourne, Aus.
9680	XEQQ, Mexico City, Mex.
9680	VOA, Tangier, Mor.
9680	Paradys, S. Afr.
9685	Algiers, Algeria
9690	LRA, Buenos Aires, Arg. ●
9690	BBC, London, Eng.
9690	BBC, Singapore
9700	Sofia, Bulgaria ●
9700	Rabat, Morocco
9705	Kabul, Afghan.
9705	Brussels, Belg.
9705	AIR, Delhi, India
9705	Radio Free Europe, Port.
9710	BBC, London, Eng.
9710	RAI, Rome, It.
9715	Hilversum, Neth. ●
9715	Radio Free Europe, Ger.
9720	Paradys, S. Afr.
9725	Tel Aviv, Israel
9725	RFE, Port.
9725	BBC, Singapore
9730	Brazzaville, Equat. Un.
9730	Leipzig, E. Ger.
9730	DZH7, Manila, P.I.
9735	Peking, China
9735	BBC, London, Eng.
9735	Cologne, Germany
9735	AIR, Madras, India
9740	VOA, Tangier, Mor.
9742	LRS1, Buenos Aires, Arg.
9745	Brussels, Belg.
9745	HCJB, Quito, Ecua. ●
9745	Ankara, Turk.
9745	Moscow, U.S.S.R.
9750	BBC, London, Eng.
9750	Radio Free Europe, Port.
9750	Khabarovsk, U.S.S.R.
9755	ZYW23, Goiania, Braz.
9755	RTF, Paris, France
9755	Saigon, Vietnam
9760	BBC, London, Eng.
9762	Hanoi, N. Vietnam
9765	Moscow, U.S.S.R.
9770	Brazzaville, Equat. Un.
9770	BBC, London, Eng.
9775	Moscow, U.S.S.R.
9795	Cairo, U.A.R. ●
9800	Peking, China
9800	Moscow, U.S.S.R.
9805	Cairo, U.A.R.
9825	BBC, London, Eng. ●
9833	Budapest, Hung. ●
9840	Hanoi, N. Vietnam
9850	AIR, Delhi, India
9860	Peking, China
9870	Djakarta, Indon.
9895	Bengazi, Libya
9915	BBC, London, Eng.
9973	Peking, China
10335	Ulan Bator, Mong.
10530	Alma Ata. Kazakh S.S.R.
11290	Peking, China
11570	Moscow, U.S.S.R.
11600	Peking, China
11630	Moscow, U.S.S.R.
11650	Peking, China
11665	Cairo, U.A.R.
11675	Peking, China
11675	Karachi, Pak.
11680	BBC, London, Eng.
11685	HVJ, Vat. City
11690	Moscow, U.S.S.R. ●
11700	RTF, Paris, France
11705	JOA11, Tokyo, Japan
11705	Horby, Sweden
11705	Moscow, U.S.S.R.
11710	VLB11, Melbourne, Aus. †
11710	AIR, Delhi, India
11710	WBOU, New York, N.Y.
11715	VOA, Munich, Ger.
11715	Moscow, U.S.S.R.
11717	Athens, Greece
11720	Brazilia, Brazil
11720	BBC, Limassol, Cyprus
11725	Brazzaville, Equat. Un.
11725	Prague, Czecho.
11725	BBC, Singapore
11730	Hilversum, Neth. ●
11735	Rabat, Morocco
11735	Moscow, U.S.S.R. ●
11740	VLC11, Melbourne, Aus.
11740	CE1174, Santiago, Chile
11740	Peking, China
11740	VOA, Tangier, Mor.
11745	RFE, Germ.
11750	BBC, London, Eng.
11750	FEN, Tokyo, Japan
11755	RFE, Port.
11755	Hilversum, Neth. ●
11755	Komsomolsk, U.S.S.R.
11760	VLB11, Melbourne, Aus.
11760	VOA, Munich, Ger.
11760	VOA, Tangier, Mor.
11760	Lourenco Marques, Moz.
11760	Hanoi, N. Vietnam
11765	ZYB8, Sao Paulo, Braz.
11765	Berlin, E. Germany
11770	Colombo, Ceylon
11770	BBC, London, Eng.
11775	ZYZ28, Rio de Jan., Braz.
11775	Moscow, U.S.S.R.
11780	BBC, London, Eng. ●
11785	Djakarta, Indon.
11785	VOA, Tangier, Morocco
11790	BBC, London, Eng.
11790	VOA, Manila, P.I.
11790	Moscow, U.S.S.R.
11795	Cologne, Ger. ●
11795	Djakarta, Indon.
11800	BBC, London, Eng.
11802	Warsaw, Poland ●
11805	RAI, Rome, It.
11805	VOA, Courier, Rhodes
11810	VLB11, Melbourne, Aus. †
11810	RAI, Rome, It.
11810	Amman, Jordan
11810	Bucharest, Rom. ●
11810	Horby, Sweden ●
11815	Madrid, Spain
11820	Peking, China
11820	BBC, London, Eng.
11820	XEBR, Hermosillo, Mex.
11825	ELWA, Monrovia, Lib.
11830	WRUL, Boston, U.S.A.
11880	Moscow, U.S.S.R.
11835	Algiers, Alg.
11835	VOA, Colombo, Ceylon
11835	CXA19, Montevideo, Urug.
11840	Prague, Czecho.
11840	VOA, Tangier, Mor.
11840	Lisbon, Port. ●
11840	Khabarovsk, U.S.S.R.
11840	Hanoi, N. Vietnam
11845	RTF, Paris, France
11845	Karachi, Pak.
11850	Sofia, Bulg.
11850	AIR, Bombay, India
11850	Oslo, Norway ●
11855	Brussels, Belg. ●
11855	Radio Free Europe, Ger.
11855	DZH8, Manila, P.I.
11860	Peking, China
11860	BBC, London, Eng.
11860	Moscow, U.S.S.R.
11865	PRA8, Recife, Braz.
11865	VOA, Tangier, Mor.
11865	HER5, Bern, Switz. ●
11865	Tunis, Tun.
11870	Moscow, U.S.S.R.
11875	ZYN32, Salvador, Braz.
11875	VOA, Colombo, Ceylon
11875	VOA, Tangier, Mor.
11880	BBC, London, Eng.
11880	XEHH, Mexico City, Mex.
11885	Peking, China
11885	Karachi, Pak.
11885	Radio Free Europe, Ger.
11890	Moscow, U.S.S.R.
11895	Dakar, Mali Fed.
11895	VOA, Tangier, Mor.
11895	VOA, Manila, P.I.
11900	Bucharest, Rumania ●
11900	CXA10, Montevideo, Ur.
11900	Moscow, U.S.S.R.
11905	RAI, Rome, Italy ●
11905	WDSI, New York, U.S.A.
11910	BBC, London, Eng.
11910	Budapest, Hung. ●
11910	Bangkok, Thai.
11915	HCJB, Quito Ecua. ●
11915	Hilversum, Neth.
11920	RAI, Paris, France
11920	DXF2, Manila, P.I.
11920	WLWO, Cincinnati, U.S.A.
11925	ZYR78, Sao Paulo, Braz.
11925	HLK6, Seoul, Korea †
11925	Wawsaw, Pol.
11925	Moscow, U.S.S.R.
11930	BBC, London, Eng.
11930	BBC, Singapore
11935	Radio Liberty, Ger.
11940	CE1190, Valparaiso, Chile
11940	JOB11, Tokyo, Japan
11945	Peking, China
11945	BBC, London, Eng.
11945	Cologne, Germany ●
11950	Warsaw, Poland
11950	Jidda, Saudi Arab.
11950	Moscow, U.S.S.R.
11955	BBC, London, Eng.
11955	BBC, Singapore
11960	CE1196, Santiago, Ch.
11960	Moscow, U.S.S.R. ●
11965	Radio Liberty, Ger.
11970	Caracas, Ven.
11972	Brazzaville, Equat. Un. ●
11975	Peking, China
11975	Moscow, U.S.S.R. ●
11985	Moscow, U.S.S.R.
11986	ELWA, Monrovia, Lib. ●
11990	Prague, Czecho.
12000	Moscow, U.S.S.R.
12010	Hanoi, Vietnam
12020	AIR, Delhi, India
12020	Moscow, U.S.S.R.
12040	BBC, London, Eng.
12050	Cairo, U.A.R.
12095	BBC, London, Eng.
15020	Hanoi, N. Vietnam
15030	Peking, China
15060	Peking, China
15070	BBC, London, Eng.
15085	Grenada, Windward Is., BWI
15095	Peking, China
15100	Lisbon, Port.
15100	Moscow, USSR
15105	ZYZ32, Rio de Jan., Braz.
15105	AIR, Delhi, India
15110	BBC, London, Eng.
15110	Moscow, USSR ●
15115	HCJB, Quito, Ecuador ●
15115	Peking, China
15120	Colombo, Ceylon
15120	RAI, Rome, Italy
15120	Warsaw, Poland †
15120	HVJ, Vatican City
15125	ZYN31, Salvador, Brazil
15125	Prague, Czecho.
15125	Seoul, Korea ●
15125	VOA, Manila, P.I.
15125	Lisbon, Portugal ●
15130	RTF, Paris, France
15130	VOA, Manila, P.I.
15130	KCBR, Delano, Calif.
15130	WBOU, New York, USA
15130	Moscow, USSR
15135	PRB23, Sao Paulo, Braz.
15135	JOB15, Tokyo, Japan
15135	Radio Free Europe, Port.
15140	Peking, China
15140	BBC, London, Eng.
15140	AIR, Delhi, India
15140	Komsomolsk, USSR
15145	ZYK33, Recife, Brazil
15145	Radio Free Europe, Port.
15148	CE1515, Santiago, Chile
15150	Djakarta, Indonesia
15150	Lourenco Marques, Moz.
15150	Lisbon, Portugal
15150	Moscow, USSR ●
15153	OAX4T, Lima, Peru
15155	ZYB9, Sao Paulo, Braz.
15155	Karachi, Pakistan
15155	VOA, Manila, P.I.
15155	WBOU, New York, USA
15155	Moscow, USSR
15160	VLA15, Melbourne, Aus.
15160	RTF, Paris, France
15160	XEWW, Mexico City, Mex.
15160	Ankara, Turkey
15160	Moscow, USSR
15165	ZYN7, Fortaleza, Braz.
15165	Copenhagen, Denmark
15165	Damascus, UAR
15170	Tromso, Norway
15170	OBX4C, Lima, Peru
15170	Radio Free Europe, Port.
15175	Peking, China
15175	Oslo, Norway ●
15180	BBC, London, Eng.
15180	AIR, Delhi, India
15180	Moscow, USSR
15185	VOA, Manila, P.I.
15185	Radio Free Europe, Port.
15185	WDSI, New York, USA
15190	Brazzaville, Congo Rep.
15190	Helsinki, Finland †
15190	Komsomolsk, USSR
15190	Moscow, USSR
15195	Prague, Czecho.
15195	Radio Free Europe, Ger.
15195	Ankara, Turkey
15200	Paradys, South Africa
15200	WDSI, New York, USA

Kcs.	Call and Location
15200	Moscow, USSR
15205	XESC, Mexico City, Mex.
15205	WDSI, New York, USA
15210	VLG15, Melbourne, Aus.
15210	VOA, Manila, P.I.
15210	KCBR, Delano, Cal., USA
15210	Moscow, USSR
15215	Radio Free Europe, Port.
15215	VOA, Okinawa, Ryukyu Is.
15220	Hilversum, Neth. †
15225	Taipei, Taiwan, China
15225	Radio Liberty, Germany
15225	Moscow, USSR
15230	VLH15, Melbourne, Aus.
15230	VOA, Colombo, Ceylon
15230	BBC, London, Eng.
15235	JOB15, Tokyo, Japan
15235	VOA, Tangier, Morocco
15235	Komsomolsk, USSR
15240	VLA15, Melbourne, Aus.
15240	Horby, Sweden
15240	Moscow, USSR
15240	Belgrade, Yugoslavia
15245	ZYE21, Belem, Brazil
15250	VOA, Manila, P.I.
15250	Bucharest, Rumania ●
15250	WLWO, Cincinnati, USA
15255	Radio Free Europe, Port.
15257	FEN, Tokyo, Japan
15260	BBC, London, England
15265	Colombo, Ceylon
15265	Moscow, USSR
15270	Peking, China ●
15270	AIR, Bombay, India
15270	VOA, Tangier, Morocco
15270	WBOU, New York, (VOA)
15270	WDSI, New York, USA
15275	Cologne, Germany
15275	Karachi, Pakistan
15275	VOA, Manila, P.I.
15275	Warsaw, Poland ● †
15280	ZL4, Wellington, N.Z.
15280	Moscow, USSR
15285	Brussels, Belgium
15285	Prague, Czecho.
15285	AIR, Bombay, India
15285	WBOU, New York, USA
15290	LRU, Buenos Aires, Arg.
15290	Peking, China
15290	KCBR, Delano, Cal., USA
15290	WLWO, Cincinnati, USA
15295	Rio de Janeiro, Brazil
15295	RTF, Paris, France
15295	VOA, Tangier, Morocco
15295	Moscow, USSR ●
15300	BBC, London, Eng. †
15300	DZH9, Manila, P.I.
15305	Dacca, Pakistan
15305	Moscow, USSR
15310	BBC, London, England ●
15310	BBC, Singapore
15310	KCBR, Delano, Cal., USA
15315	VLC15, Melbourne, Aus.
15315	Peking, China
15315	HEU6, Bern, Switz. ●
15315	Moscow, USSR
15320	VLC15, Melbourne, Aus.
15320	AIR, Delhi, India
15320	VOA, Tangier, Morocco
15325	ZYR228, Sao Paulo, Braz.
15325	RAI, Rome, Italy
15325	JOB15, Tokyo, Japan ●
15330	VOA, Munich, Germany
15330	VOC, Salonika, Greece
15330	WBOU, New York, USA
15330	WGEO, Schenectady, USA
15335	Brussels, Belgium †
15335	ZYU68, Porto Alegre, Braz.
15335	Karachi, Pakistan
15335	VOA, Manila, P.I.
15335	Komsomolsk, USSR
15340	Radio Liberty, Germany
15340	Moscow, USSR
15345	LRA, Buenos Aires, Arg.
15345	Taipei, Taiwan, China
15345	Athens, Greece
15345	Rabat, Morocco
15350	RTF, Paris, France
15350	WLWO, Cincinnati, USA
15355	Radio Free Europe, Port.
15360	BBC, London, England
15360	Moscow, USSR
15365	WLWO, Cincinnati, Ohio
15370	ZYC9, Rio de Jan., Braz.
15370	Radio Liberty, Germany
15375	BBC, London, Eng.
15375	Cologne, Germany †
15380	VOA, Tangier, Morocco
15380	VOA, Okinawa, Ryukyu Is.
15380	WRUL, Boston, USA
15385	DZF3, Manila, P.I.
15385	CXA60, Montevideo, Urug.
15385	Moscow, USSR
15390	BBC, London, Eng.
15390	Moscow, USSR
15395	Radio Liberty, Germany
15400	RTF, Paris, France
15400	RAI, Rome, Italy
15405	Cologne, Germany
15405	Moscow, USSR
15407	Paramaribo, Surinam
15410	Prague, Czecho. ●
15410	Radio Liberty, Germany
15410	VOA, Tangier, Morocco
15415	AFRS, Munich, Germany
15415	Budapest, Hungary ●
15417	Peking, China
15420	Brazzaville, Congo Rep.
15417	BBC, London, Eng.
15420	Madrid, Spain
15420	Moscow, USSR
15425	VLX15, Perth, Aus.
15425	Hilversum, Neth.
15430	Peking, China ●
15430	Cairo, UAR
15430	Moscow, USSR
15435	BBC, London, Eng.
15435	BBC, Singapore
15440	VOA, Munich, Germany
15440	Moscow, USSR
15445	Brazzaville, Congo Rep.
15445	Hilversum, Neth.
15447	BBC, London, Eng.
15450	Komsomolsk, USSR
15465	Paramaribo, Surinam
15470	Moscow, USSR
15475	Cairo, UAR
15480	Peking, China
15480	AIR, Delhi, India
15520	Peking, China
15555	Peking, China
15610	Peking, China
17605	Peking, China
17675	Peking, China
17690	Cairo, UAR
17695	BBC, London, Eng.
17700	BBC, London, Eng.
17700	Moscow, USSR
17705	AIR, Delhi, India
17705	VOA, Tangier, Morocco
17710	VLG17, Melbourne, Aus.
17710	WLWO, Cincinnati, USA
17710	Moscow, USSR
17715	BBC, London, Eng. ●
17715	VOA, Colombo, Ceylon
17720	Peking, China ●
17720	Brazzaville, Congo Rep.
17720	Radio Liberty, Germany
17720	Moscow, USSR
17722	San Jose dos Campos, Braz.
17725	Radio Free Europe, Port.
17725	AIR, Delhi, India
17730	BBC, London, Eng.
17730	Radio Liberty, Germany
17735	Radio Free Europe, Port.
17735	KCBR, Delano, Calif.
17735	HVJ, Vatican City
17740	WLWO, Cincinnati, USA
17740	BBC, London, Eng.
17740	Moscow, USSR
17745	BBC, London, Eng.
17745	Karachi, Pakistan
17745	VOA, Manila, P.I.
17747	Peking, China ●
17750	WRUL, Boston, USA
17750	VOA, Tangier, Morocco
17750	Moscow, USSR
17755	Prague, Czecho.
17755	BBC, Singapore
17760	WGEO, Schenectady, USA
17760	AIR, Delhi, India
17760	Moscow, USSR
17765	RTF, Paris, France
17765	Peking, China ●
17770	RAI, Rome, Italy
17770	Radio Free Europe, Port.
17770	KCBR, Delano, Cal., USA
17773	Athens, Greece
17775	Hilversum, Neth.
17780	WBOU, New York, USA
17780	VOA, Manila, P.I.
17780	Moscow, USSR
17785	HER7, Berne, Switz.
17785	AIR, Delhi, India
17788	Taipei, Formosa, China
17790	BBC, London, Eng.
17790	Prague, Czecho.
17790	AIR, Delhi, India
17795	KGEI, San Fran., USA
17795	WLWO, Cincinnati, USA
17795	Moscow, USSR
17795	CR6RZ, Luanda, Angola
17800	Helsinki, Finland †
17800	RAI, Rome, Italy
17800	Warsaw, Poland †
17805	Radio Free Europe, Port.
17805	DZI6, Manila, P.I.
17810	BBC, London, Eng. †
17810	AIR, Delhi, India
17810	Hilversum, Neth.
17810	Moscow, USSR
17815	Prague, Czecho.
17815	Cologne, Germany
17815	KCBR, Delano, Calif.
17815	Moscow, USSR †
17820	ZLI4, Wellington, N.Z.
17823	Ankara, Turkey
17825	JOA17, Tokyo, Japan ●
17825	Oslo, Norway
17825	Moscow, USSR
17830	AIR, Delhi, India
17830	WDSI, New York (VOA)
17830	WLWO, Cincinnati, USA
17835	Radio Free Europe, Port.
17840	VLB17, Melbourne, Aus.
17840	Horby, Sweden †
17840	Moscow, USSR
17840	HVJ, Vatican City
17845	Brussels, Belgium
17845	Cologne, Germany
17845	WRUL, Boston, USA
17850	RTF, Paris, France
17850	Moscow, USSR
17855	VOA, Tangier, Morocco
17855	JOA17, Tokyo, Japan ●
17855	Radio Free Europe, Port.
17860	Brussels, Belgium
17860	BBC, London, Eng.
17860	Damascus, UAR
17865	Radio Liberty, Germany
17870	BBC, London, Eng.
17870	WLWO, Cincinnati, USA
17875	PRL2, Rio de Jan., Braz.
17875	Cologne, Germany
17875	Radio Free Europe, Port.
17880	Lisbon, Portugal
17880	Tunis, Tunisia
17880	Komsomolsk, USSR ●
17880	Moscow, USSR
17885	Radio Free Europe, Port.
17888	Taipei, Formosa, China
17890	HCJB, Quito, Ecuador
17890	BBC, London, Eng.
17890	HLK42, Seoul, Korea ●
17892	Voice of Free Africa
17895	Lisbon, Port.
17895	Moscow, USSR
17900	Peking, China
17920	Cairo, UAR
18080	BBC, London, Eng.
21450	Prague, Czecho.
21455	VOA, Tangier, Morocco
21460	KCBR, Delano, Calif.
21460	WRUL, Boston, USA
21470	BBC, London, Eng.
21480	Hilversum, Neth.
21485	Radio Free Europe, Port.
21485	WLWO, Cincinnati, USA
21490	BBC, London, Eng.
21490	Cologne, Germany
21495	Lisbon, Port.
21495	DZ18, Manila, P.I.
21500	Brazzaville, Congo Rep.
21505	WDSI, New York, USA
21505	Moscow, USSR
21510	Brussels, Belgium
21515	HVJ, Vatican City
21520	HER8, Berne, Switz.
21525	Moscow, USSR
21530	BBC, London, Eng.
21535	ELWA, Monrovia, Liberia ●
21540	VLD21, Melbourne, Aus.
21540	WBOU, New York, USA
21550	BBC, London, Eng.
21550	Moscow, USSA
21560	RAI, Rome, Italy
21565	Hilversum, Neth.
21570	WBOU New York (VOA)
21575	Moscow, USSR
21580	RTF, Paris, France
21590	Karachi, Pakistan
21590	WGEO, Schenectady, USA
21600	VLG21, Melbourne, Aus.
21600	Radio Free Europe, Port.
21605	AIR, Delhi, India
21605	HEI9, Berne, Switz.
21610	WLWO Cincinnati (VOA)
21615	BBC, London, Eng.
21620	RTF, Paris, France
21620	AIR, Delhi, India
21620	JOB21, Tokyo, Japan
21625	Moscow, USSR
21630	BBC, London, Eng.
21640	BBC, London, Eng.
21650	Cologne, Germany
21650	AIR, Delhi, India
21650	WDSI, New York, USA
21655	VOA, Manila, P.I.
21660	BBC, London, Eng.
21665	Radio Free Europe, Port.
21670	Oslo, Norway
21675	BBC, London, Eng.
21680	VLC21, Melbourne, Aus.
21685	Dacca, Pakistan
21690	WDSI, New York, USA
21700	AIR, Delhi, India
21700	Lisbon, Port.
21705	VOA, Tangier, Morocco
21710	BBC, London, Eng.
21720	Radio Free Europe, Port.
21730	Brussels, Belgium
21735	Cologne, Germany
21735	WLWO, Cincinnati, USA
21740	BBC, London, Eng.
21740	KCBR, Delano, Cal., USA
21745	Radio Free Europe, Port.
25610	Hilversum, Neth.
25630	KCBR, Delano, Cal., USA
25650	BBC, London, Eng.
25670	BBC, London, Eng.
25720	BBC, London, Eng.
25735	VLY25, Melbourne, Aus.
25750	BBC, London, Eng.
25800	Paradys, S. Afr.
25840	BBC, London, Eng.
25880	VOA, Tangier, Morocco
25900	Oslo, Norway
25920	BBC, London, Eng.
26040	WBOU, New York, USA
25950	WBOU, New York, USA
26080	BBC, London, Eng.

Canadian Short-Wave—Domestic and International

*Transmitter at Sackville, New Brunswick

Kc.	C.L.	Location
5970	CBNX	St. John's, Nfld.
5970	CKNA	Montreal, Que.*
5990	CHAY	Montreal, Que.*
6005	CFCX	Montreal, Que.
6010	CJCX	Sydney, N.S.
6030	CFVP	Calgary, Alta.
6060	CKRZ	Montreal, Que.*
6070	CFRX	Toronto, Ont.
6080	CKFX	Vancouver, B.C.
6090	CBFW	Montreal, Que.
6090	CKOB	Montreal, Que.*
6130	CHNX	Halifax, N.S.
6160	CBUX	Vancouver, B.C.
6160	CHAC	Montreal, Que.*
9520	CBFR	Montreal, Que.
9585	CKLP	Montreal, Que.*
9610	CBFX	Montreal, Que.
9610	CHLS	Montreal, Que.*
9630	CBFO	Montreal, Que.
9630	CKLO	Montreal, Que.*
9710	CHLR	Montreal, Que.*
9740	CHFO	Montreal, Que.*
11705	CBFY	Montreal, Que.
11705	CKXA	Montreal, Que.*
11720	CBFL	Montreal, Que.
11720	CHOL	Montreal, Que.*
11760	CBFA	Montreal, Que.
11760	CKRA	Montreal, Que.*
11900	CKEX	Montreal, Que.*
11945	CKEX	Montreal, Que.*
15090	CKLX	Montreal, Que.*
15105	CKUS	Montreal, Que.*
15190	CBFZ	Montreal, Que.
15190	CKCX	Montreal, Que.*
15255	CKSR	Montreal, Que.*
15275	CKBR	Montreal, Que.*
15320	CKCS	Montreal, Que.*
17710	CHSB	Montreal, Que.*
17735	CHRX	Montreal, Que.*
17820	CKNC	Montreal, Que.*
17865	CHYS	Montreal, Que.*
21600	CKRP	Montreal, Que.*
21710	CHLA	Montreal, Que.*



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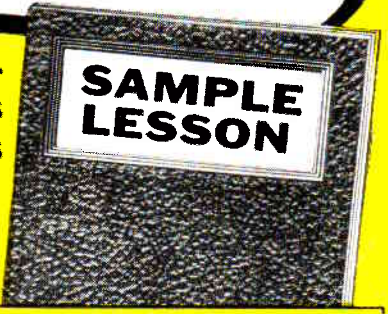

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"I am Chief Engineer with station and also have my own spare time servicing business."—R. BARNETTE, Bismarck, N. D.

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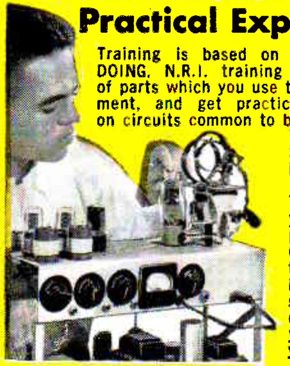

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