HUGO GERNSBACK, Editor

RADIO CRAFT

In this issue —

Converting an Oscilloscope

Building a 5-tube Super

Electromagnets in Radio

SERVICING AIRLINE RADIO EQUIPMENT

SEE PAGE 20

OCT 1946

25¢

CANADA 30¢

RADIO-ELECTRONICS IN ALL ITS PHASES

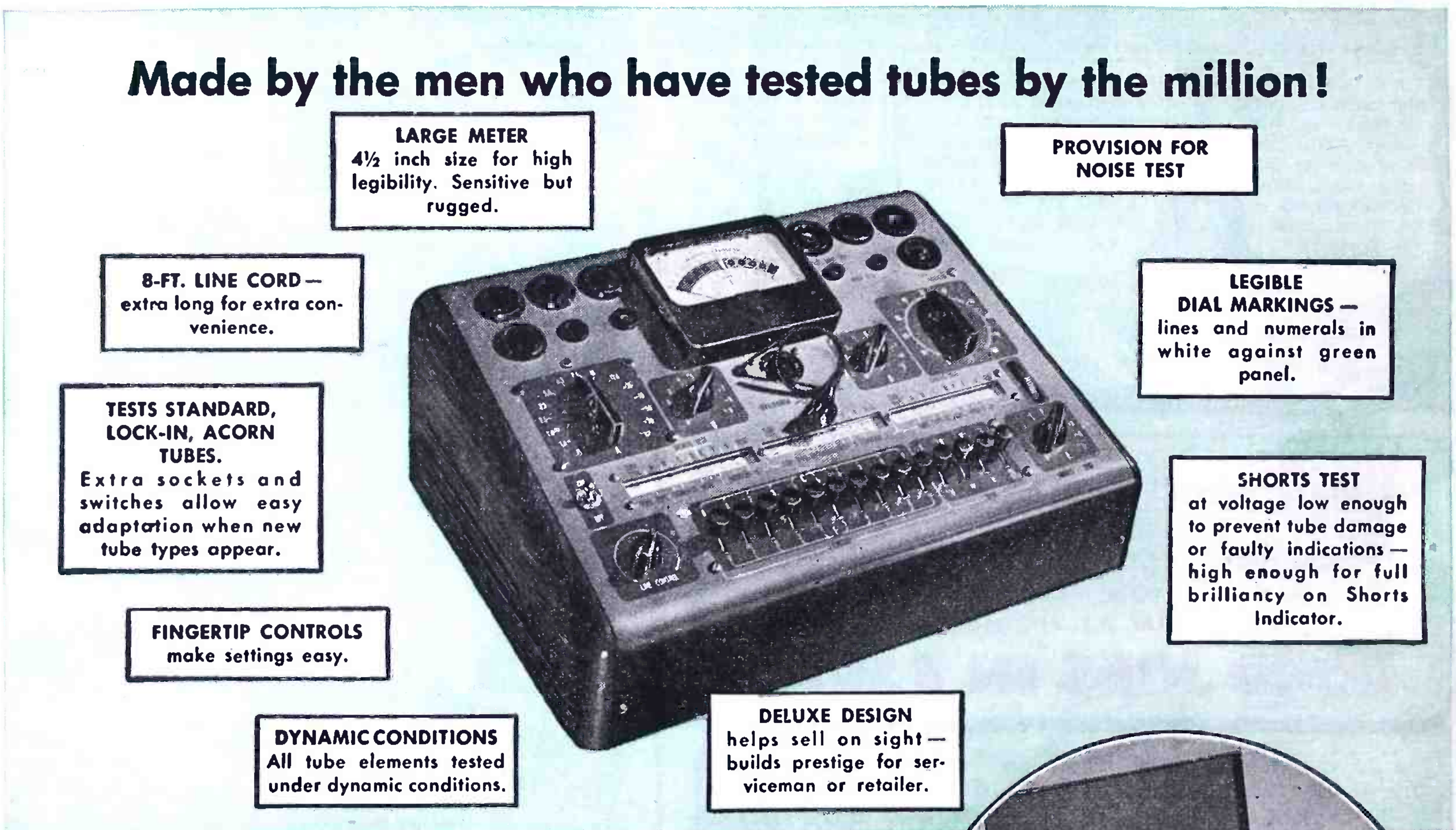

2
1
3

SYLVANIA NEWS

RADIO SERVICE EDITION

OCT. *Prepared by* **SYLVANIA ELECTRIC PRODUCTS INC., Emporium, Pa.** 1946

NEWEST AND FINEST IN TUBE TESTERS NOW READY FOR RADIO SERVICEMEN



Here's the "last word" in tube testers made for discriminating radio servicemen by Sylvania Electric.

Remain up to date easily, economically with this modern tube testing equipment. Now, this advanced type testing unit can be yours — smartly styled, scientifically designed, attractively priced. Besides all the special features, indicated above, the Sylvania tester has been provided with extra sockets and switch contacts to insure quick, inexpensive further modernization as new tube types are developed.

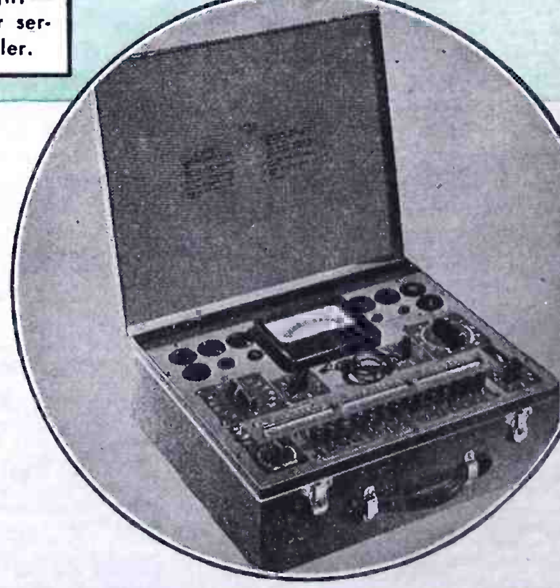
SEE YOUR SYLVANIA TUBE DISTRIBUTOR TODAY!

COUNTER TESTER

Type 139 (shown above) 5½" x 12" x 16¼". Net weight 15¾ lbs. Steel cabinet, wooden ends. Two-tone green panel. Power supply: 105-125 volts, 50-60 cycles, 20 watts.

PORTABLE TESTER

Type 140 (shown at right). 5¼" x 13" x 15". Net weight 19¼ lbs. Steel carrying case, sturdy leather handle. Other features same as Counter Type.



SYLVANIA ELECTRIC

Emporium, Pa.

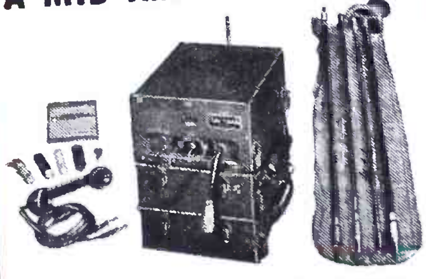
MAKERS OF RADIO TUBES; CATHODE RAY TUBES; ELECTRONIC DEVICES; FLUORESCENT LAMPS, FIXTURES, WIRING DEVICES; ELECTRIC LIGHT BULBS

SCARCE RADIO PARTS
TRANSMITTERS, ELECTRICAL EQUIPMENT AT MONEY-SAVING PRICES!

DEALERS JOBBERS QUANTITY BUYERS

Dealers, Jobbers, Industrials, Schools, and other quantity buyers—write for special trade discounts on items illustrated as well as condensers, resistors, tubes, transformers, sockets, jacks, wire and hundreds of other items.

A MID-AMERICA SCOOP!

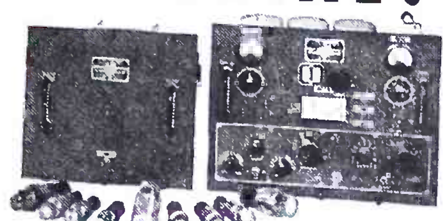


Portable and Mobile FM Transmitter and Receiver, SCR-510

FM transmitter and receiver for short range communication. Lightweight. Operate from 6 or 12 volt DC source. Freq. range 20 to 27.9 mc, crystal controlled for operation on any two of 80 channels. Either of two pre-setfrequencies can be chosen by the channel switch. Change from receive to transmit by switch-on telephone hand set. Tubes: one 1LH4, one 1LC6, four 1LN5, two 1291, one 1294, four 1299. Complete with 80 crystals, tubes, telephone hand set, instructions, accessories, ready to operate, less batteries.

SPECIAL, **$79.50 ea.**
$59.50 in lots of 50

SPECIAL!



RAK-7 Long Wave Receiver

A real commercial receiver for experimenters, marine, aviation, hams, etc. 110 volt AC operated, regulated power supply. Frequency range, 15-600 kc. Two tuned RF stages. Panel has band switching, DB meter, AVC level control, Antenna, and RF controls, audio tuning control, sensitivity controls, including an AC-DC Filament Voltmeter with a range of 10 volts. Tubes: four 6D6, two 41, one 5Z3, one 874, one 876. Comes complete with *extra* set of tubes and parts. MA #RAK-7.

SPECIAL, **$64.50 ea.**
$55.00 in lots of 50

INTERPHONE SET

Sensational buy! Look at these parts:
125 feet—3 conductor cable
75 feet—#72 Seine Twine
1 roll—6 ft. red acetate tape
1 roll—6 ft. white acetate tape
2 —Cable clamps
1 —4 prong Jones plug in aluminum jacket
1 —4 contact Jones socket in aluminum jacket
2 —Pull chain assemblies
MA #Tow-3
SPECIAL, **98c per kit**
75c per kit in lots of 50

WHILE THEY LAST!

ALNICO 5" SPEAKERS

5" Alnico PM Speaker with 4 ohm voice coil, less output transformer. Limited supply—order at once! MA #7580.

$1.70 ea.
$1.45 in 50 lots

Telephone Handset TS-13

With listen and talk switch. Incorporates 200 ohm carbon mike and 2000 ohm ear 'phone. Supplied with 6 ft. cord and one each PL-55 and PL-68 plugs.
SPECIAL, **$2.95 ea.**
$2.50 each in lots of 50

A TERRIFIC VALUE!

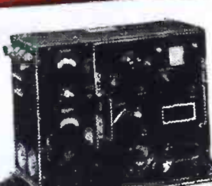
T-17-B 200 Ohm Carbon Mike

Lightweight, with press-to-talk button. Built-in filter to suppress carbon hiss. 5 ft. rubber covered cable and PL-68 three-circuit plug supplied.
MA #17-B.
SPECIAL PRICE, **$1.75 ea.**
$1.50 each in lots of 100

UNIVERSAL OUTPUT TRANSFORMER

Will match voice coil to any tube, single or push-pull. Strap mounting, on 2⅞" centers. Size 2¼" high, 2" wide, 2" deep.
MA #UOT-15.
SPECIAL, **$1.20 ea.**
95c each in lots of 50

WE GOT EM!



80 Meter Transmitter BC-223-A

80 meter transmitter, phone, CW, or ICW, 25 watt output. Use as regular transmitter or as exciter: 2000 kc to 5250 kc. Requires external power supply (not supplied) that can deliver 500 plate voltage. Tubes: 801 osc, 801 PA, 46 speech amp, and two 46 class B modulation. Panel switch selects M.O.P.A. or any of four crystal frequencies. Unit supplied less tubes.
MA #3233-A. SPECIAL, **$22.50 ea.**
$17.50 in lots of 50

UNBEATABLE PRICES ON ANTENNAS

(A) TEN METER COLLAPSIBLE, SPRING-ACTION VERTICAL ANTENNA—8 sections totaling 120 inches. ⅜" threaded base shank.

(B) VERTICAL ANTENNA, 32½ in. long. Flexible spring base with threaded stud. Top section pulls out for storage. ⅜" threaded base shank.

(C) ANTENNA ELEMENTS—set of six. Screw in antenna section approximately 38" long, totaling 18', tapering from 9/16" base to 3/16" tip.

(D) 12½ FOOT TELESCOPIC ANTENNA—pulls out to 12½ feet and telescopes down to 12 inches. Base is ⅞" diameter with ⅜" threaded base shank.

SPECIAL PRICES	EACH	Lots of 50
A—MA No. CVA-1	$1.49	$1.19
B—MA No. AN-130	.49	.39
C—MA No. AE-6	3.45	2.90
D—MA No. TE-12	1.95	1.40

Here Are More Typical MID-AMERICA VALUES

POTENTIOMETERS:

50000 ohm W.W. with switch 3" shaft	34¢
400 ohm W.W. 3" shaft	24¢
750 ohm W.W. 2" shaft	24¢
50000 ohm carbon 3" shaft	24¢
Dual carbon 20000 ohm frt 40000 ohm rear	32¢
Socket std acorn for 954,955 tubes, etc.	$9.50/C
Socket octal ceramic 1½" mtg ctrs	4.50/C
MILLIAMMETERS:	**EACH**
GE, West'hs 0-20 DC, 2⅝" dia. flange	$2.49
GE, 0-300 DC 2⅝" dia. flange	2.49
Simpson 127, 0-5 DC	2.49
POWER RHEOSTATS:	
H.H.F.—500 watt, 10 ohms, 7 amps	$3.95
Ward Leon. 500 watt, 12.5 ohms, 10 amps	3.95
West'hs 800 watt, 175 ohms, 3.7 amps	4.95
ELECTROLYTIC CONDENSERS:	
30 mfd, 15 mfd, 10 mfd, at 250 VDCW	75¢
80 mfd, 40 mfd, 40 mfd, at 250 VDCW	75¢
1 mfd, 500 vdcw, GE #26F466 pyranol	39¢
1 mfd, 600 vdcw, GE #22F281 pyranol	49¢
.25 mfd, 1000 vdcw, GE #26F467 pyranol	39¢
10 mfd, 1000 vdcw, GE#23F17G2 pyranol	$2.95
3 mfd, 4000 vdcw, pop. makes, oil filled	4.50
MISCELLANEOUS PARTS:	
Headphone 8000 ohm HS23	$1.50
Bliley crystal holder FT-171-B	30¢
DPDT high volt. antenna knife switch	39¢
Circuit breaker .5 amps at 1000 volts	4.50
Circuit breaker 220 milliamps at 115 v.	2.40

TUBES On hand for immediate shipment. Write for low prices in lots of 100.

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TRANSMITTING TUBES: 2X2/879 2C26A 211 3D21A HY114B HY615 RK34 801A 803 803B 954 955 957 958A 9002 9003 9004 1201 1203A 1613 1624 1625 1632 1633 1634 1635 1644 3BP1 5CP1

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The hat that became a headset . . .

Telephone operators in New York, Atlanta and Montreal wore the strange head-dress you see pictured above. It's a specially devised gauging instrument — Bell Laboratories' scientists used it to measure head contours in designing the new operator's headset.

With the new set, the telephone user can hear the operator more clearly, and she in turn hears better too—through the improved receiver and transmitter. Her voice enters the transmitter at an even level because, as she turns, the mouthpiece moves with her. Neckstrap and horn are eliminated. The whole thing weighs less than six ounces.

The new Bell System headset brings together the latest techniques in voice transmission and the ideas of the operators themselves — offering comfort, convenience, and electrical efficiency.

Out of new knowledge has come this novel head telephone fitted to the operator and designed to improve your telephone service.

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IN AN EARLY ISSUE

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Theater Sound Servicing
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Contents — October, 1946 — Volume XVIII No. 1

Biographical Portrait drawings by Constance Joan Naar

ON THE COVER

Our cover this month shows a shielded room in the radio department of the Pan-American Airways at La Guardia Field, New York City. Direction finding apparatus may be checked in this room without being interfered with by radio signals from outside.

Chromatone by Alex Schomburg from Pan-American Airways photograph

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Plan your future the way business men do: Watch the headlines! Pick a field that's *"in the news"*—one with many opportunities for interesting, PROFITABLE EMPLOYMENT or a good chance for establishing a BUSINESS OF YOUR OWN with little capital. Pick a field that offers a variety of interesting opportunities—a field with one of America's most promising futures . . . and see how you may MAKE YOUR START TOWARD A PLACE IN THIS FIELD BEFORE JOB COMPETITION BECOMES ACUTE. *Write for our Big, Free, Illustrated Book*—"VICTORY FOR YOU." Learn how DeForest's Training, Inc. prepares you at home, in your leisure time—without interfering with the work you are now doing—then helps you make your start in the vast BILLION DOLLAR Radio-Electronics field.

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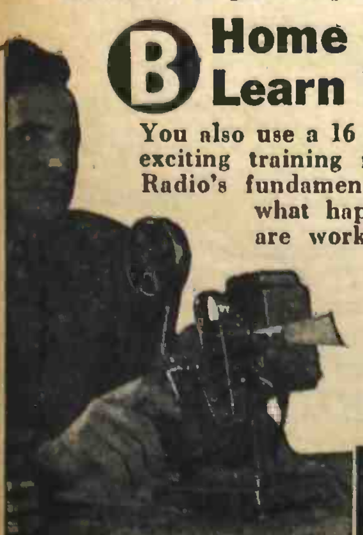

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5. How to Trace the Circuit and Prepare Skeleton Diagram.
6. How to Test and Measure Voltages.
7. How to Test Speaker in Audio Stages.
8. How to Test Detector, I. F., R.F., and Mixer Stages.
9. Complete Reference Table for Quickly Locating Receiver Troubles.

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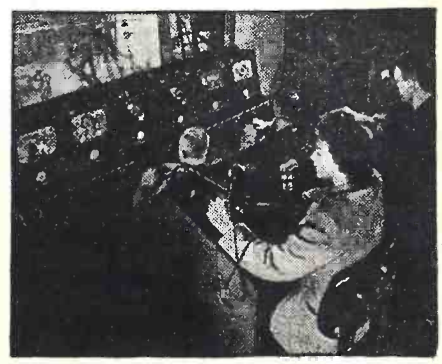

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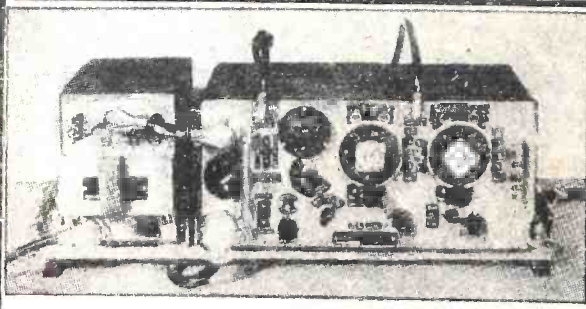

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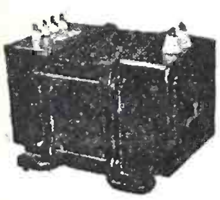

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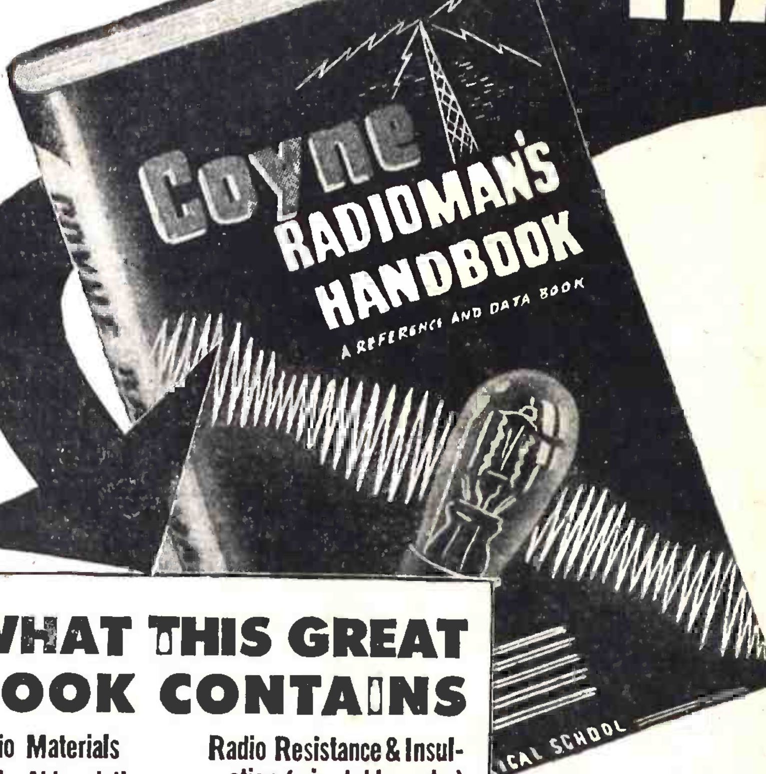

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By HUGO GERNSBACK

RADIOLESS TRAIN HAZARDS

Passenger Trains Are Still Isolated from News of Accidents

RAILROADING is a most complex undertaking, the complexity increasing as time goes on. Due mainly to the competition from the airplane, railroads in recent years have greatly stepped up their speeds. Express trains, which did not move at a greater average speed than 40 to 50 miles ten years ago, now travel between 60 to 80 miles hourly. Modern passenger trains now have more cars and run under reduced headway, often only minutes apart. This is particularly true of commuter trains near crowded centers.

The safety factor due to these conditions has been greatly decreased, yet little has been done to rectify it. The hazards of the human factor do not improve the situation, but often worsen it.

While this is being written there have been two serious wrecks of commuter trains within two days, in the vicinity of New York. Let us take a single case and see what happens during such wrecks.

On August 2 a major wreck occurred on the Central Railroad of New Jersey at Bayonne, N. J., near New York City. A coastal train bound South made an unscheduled stop at Bayonne, picking up two passengers. Another Southbound train following, ran past a red light and while rounding a curve smashed into the rear of the first train, killing the fireman. Over 100 persons were injured.

This sort of thing is commonplace nowadays. Wrecks occur frequently all over the country. They are likely to increase for some time to come before conditions get better.

There are a number of railroads whose signalling system is of a very high order where rear-end collisions seldom occur. Several of our major railroads have a protective system on their right of way which operates in such a manner, that should the engineer run past the danger red light, a lever rises and contacts a projecting arm extending from the speeding engine. This automatically puts on the emergency brakes and stops the train.

Good as such a safeguard is, it is never perfect. The reason: you cannot stop a train weighing many thousands of tons, speeding at 75 miles an hour, instantly. Even with safety brakes set, the train will coast, often for several thousand yards, before it finally comes to a stop. During a fog, or where visibility is greatly reduced, there may still be rear-end collisions, even with the best safeguards.

Should railroads adopt radar or a radar modification, this would still not reduce rear-end or head-on collisions to zero, but would reduce accidents considerably. By some radar means, specially developed for railroads, the warning could be given over a much greater distance. No doubt railroads will adopt such a system in time, although so far they have not been very enthusiastic about it. This is chiefly because not enough experimental work has been done with railroad-radar so far.

This, however, is only a single phase of the problem; there are many others. To appreciate how far-reaching the problem is and how archaically our railroads are run today, let us turn back to the suburban railroad wreck mentioned above.

Within a short time after the wreck occurred, at 5:27 pm, on August 2, the New York metropolitan radio stations fulfilled their obligation to the public in broadcasting the occurrence of the wreck. The radio announcements were brief, just giving the main facts, although most of the broadcasts did not give the exact time of the wreck. Several hours after the wreck had occurred, two stations still broadcast the erroneous time of 6 pm instead of the correct time, namely: 5:27 pm. The radio stations, however, informed the listeners what particular trains had been involved. The hundreds of thousands of radio listeners whose relatives or friends routinely patronize the particular railroad, therefore, had an indication as to whether or not any relatives or friends were involved in the wreck. Such information, however, was not entirely positive—there always being a chance that someone takes the wrong train.

The wreck occurred at 5:27 pm. Yet as the evening wore on thousands of commuters who travel on the line remained unreported. This caused an enormous strain on relations and friends who, not understanding railroading, naturally could not comprehend why they had not heard from their dear ones, or friends.

When 11:00 pm came around, anxiety increased further. Thousands of perturbed people naturally tried to contact the railroad to find out what had happened. This proved futile because the line's switchboards were swamped. It was impossible for many to get an answer at all.

What the anxious relatives and friends did not know was that it would take from 5:27 pm until after 11:00 pm to clear the tracks so that traffic—piled up in front and in back of the wreck—could move once more. Radio broadcasts were silent on this point, because evidently the railroad had not warned the broadcast stations to emphasize this phase at all.

Now let us go back to the stalled trains on both sides of the wreck and see what happened there. The thousands

(Continued on page 68)

RADIO-ELECTRONICS

Items Interesting

NUCLEAR REACTION was the principle on which a secret Army infra-red signalling device operated, it was reported last month in a release from Electronic Laboratories, who developed the sniperscope and snooperscope.

Little sister to the above devices, the *metascope* could not present clear images on its screen, and was originally intended simply as a countermeasure against enemy use of infra-red light. Lighter and smaller than the snooperscope, it could be carried easily by field units, to determine whether the enemy was using infra-red apparatus.

While full details of how the metascope works are still unavailable for publication, it can be revealed that a type of nuclear reaction is the operating principle. A small lead-sheathed compartment in the base of the metascope, containing a radio-active material, furnishes the power source for the device. When a control switch on the outer hull of the metascope is set on "charge," energy from the radio-active material is used to charge a viewing screen which is thus made sensitive to infra-red radiation. A periscope-like mirror with an infra-red filter, located in the cover of the metascope, is raised to pick up the infra-red light and in use faces the direction the operator is looking.

Small enough to be held in one hand, the metascope is used to detect the presence of infra-red light and was employed in Europe to facilitate paratroop operations. By looking through the eyepiece of the little "snooper," paratroopers in planes could detect infra-red radiation which signaled them where to land. While this detective ability is also possessed by the snooperscope, the comparatively heavy power pack needed for that equipment prohibited its use where weight was a critical factor.

When used in paratroop operations, the metascope was credited by the Army for having collected troops in 15 minutes—a job which otherwise would have taken three hours. The device was also used for reading an infra-red blinker signal utilized by the Navy.

The Metascope, detector of infra-red light.

SUBMARINE RECEPTION of radio signals from Germany by undersea craft as far away as the Caribbean was brought to light in a Department of Commerce report last month. The transmitting station, at Calbe, Germany, used a very low frequency and had an unusual antenna system, the report stated. Distance of penetration was not given in the report, though it is stated that messages were received with the craft fully submerged. Apparently fairly consistent reception of messages and instructions could be depended on by submarine craft engaged in Caribbean operations.

The German Navy transmitter had a power output of 1,000 kw, using four large tubes in parallel push-pull as an output stage. Tuning range was from 15 to 60 kilocycles.

The aerial system consisted of three 820-foot towers, arranged in a large triangle. Each was surrounded by six 720-foot towers. A flat-top was formed on each tower group, and the feed-point was in the center of the triangle. A ground resistance of 0.01 ohm for the system as a whole was achieved through an extensive grounding system. The efficiency of the system was said to range from 50 to 80 percent, depending on the frequency.

A DX RECORD for v.h.f. communication between fixed and mobile stations is believed to have been established last month between a Cleveland railroad radio station and a train 63 miles distant. A 10-watt transmitter installed on the top of Cleveland's Terminal Building contacted the train at various points up to Bellevue, Ohio. Frequency was in the 152-162 megacycle band allotted to railroads by the FCC. Standard Farnsworth FM mobile communications equipment was used.

Engineers pointed out that the significant feature of the test was that "solid" communication covered 35 miles of the 63-mile range, and that this marked the distance over which reliable communication could be maintained on a 24-hour, 365-day schedule.

Another purpose of the test was to compare the range of the station's 600-foot-high antenna with that of one 60 feet above ground in a railroad yard of the Nickel Plate Road at Fort Wayne.

In Fort Wayne, consistent two-way communication with the train was maintained for a distance of 17 miles, with "solid" communication limited to 14.2 miles. This, Farnsworth engineers pointed out, indicated that the mounting of antennas 60 to 100 feet above ground would enable reliable freight yard coverage of 14 miles in each direction, depending on height of antenna and the type of terrain adjacent to the station.

TELEVISION broadcasters, manufacturers and others interested in the new art, meet for their second annual conference at the Waldorf-Astoria in New York on October 10 and 11. The intense interest in the new industry is seen in the sellout of exhibition space, the committee in charge of exhibitions having been compelled to hang out the SRO sign early in the summer.

A number of interesting demonstrations have been promised, and a call for early registrations has been sent out, as shortage of hotel space is feared.

"RADIOPAGING" service will become available to doctors, executives and others who may wish to be called at need, no matter where they may be at the time. The FCC issued a license last month authorizing establishment of such a system on an experimental basis.

The heart of the radiopaging system is a small portable receiver about one and a half times the size of a package of cigarettes. Using the miniature tubes perfected during the war, it would contain a very small speaker that would be audible only when held against the ear.

Each subscriber to the service would receive a code number. When a doctor was enjoying a night off at a Broadway musical, for instance, he could put the receiver to his ear. If he heard his code number, he could go to a telephone and receive his message.

Once the subscriber had responded to the electronic summons, his code number would be dropped from the list continually being announced from the central transmitter.

WARNING SIGNALS which can be picked up five miles in both directions from a moving train but will not interfere with ordinary train radio were announced last month by L. L. White of Chicago and North Western Railway.

The new *slowtone* device, designed by Bendix Radio Division, is a unique safety measure involving the broadcasting of a series of high-pitched notes at four-second intervals, allowing for voice communication at the same time. The purpose of the slowtone signals from any particular train is to warn other approaching trains from all directions of its presence. The signals can be heard at a distance of at least five miles from their transmitting point by radio receivers of other trains of the railroad. In addition to audible signals, a flashing light appears on the slowtone unit in the locomotive cab of the train, indicating the signals are going out. Both the slowtone signals and radio telephone communications in the current tests are designed to prove the practicability of very high frequencies for railroad use.

MONTHLY REVIEW

to the Technician

THE FM PARADOX, in which broadcasters are waiting till high-frequency FM sets are in the hands of the public before putting on programs and listeners are waiting for programs to become available before buying receivers, is about to be broken if a plan announced last month is put into effect.

The plan, presented by the International Ladies Garment Workers Union, is simply to construct an FM broadcast station and supply would-be listeners with receiving equipment simultaneously. Officials of United Broadcasting Corporation, a subsidiary of the union, stated that they expect to have at least 25,000 combination AM-FM sets in the hands of members by Christmas, if their application for an FM license is granted.

Originator of the plan is said to be Morris Novik, for several years head of New York's broadcast station WNYC.

DESTRUCTION of war surplus radio equipment has led to drastic reforms in the system of disposing of such supplies, according to a number of reports issued last month.

Over 10,000 veterans are seeking scarce radio testing equipment in an effort to get into the radio business, WAA said. Heretofore the agents have gobbled up most of the usable property and the veterans, with priorities, were left out in the cold. Robert M. Littlejohn, War Assets Administrator, said that this would be stopped and that the WAA was now making every effort to fill the 10,000-application backlog.

Among the incidents leading up to the proposed reform was the use of a bulldozer on a quantity of surplus radio equipment at Robbins Field, Georgia. An amateur radio operator, later purchasing radio material from an Atlanta junk dealer, said he was able to make "tremendous profits" from electronic equipment bought for as little as 20 cents per pound.

Another voice was that of Dr. Joseph Needham, English chemist and senior councillor in charge of the natural science division of the United Nations Educational, Scientific and Cultural Organization, who appealed to the governments of the United States and the United Kingdom to cease destruction of technical equipment such as radios, radar sets and chemicals.

Dr. Needham proposed that a fund be made available to UNESCO to purchase some of these wartime surpluses and make them available to research workers.

While much of the material has little or no market value, he reported that it could be used by scientists in experiments or transformed into useful equipment.

WOMEN RADIO WORKERS will become a permanent feature of the industry which employed them as a temporary wartime measure, a Chicago report stated last month.

Manufacturers have found that women have the dexterity to work with the countless tiny parts in a modern radio chassis. Even after the strains of reconversion, and the employment of numerous returned men, the set makers find their need for women greater than ever.

Zenith Radio Corporation, for example, reported that it has more women on its payroll than it ever had in wartime, yet 500 more are needed because of heavy production schedules.

A "TALKING LAMP," which emits infra-red radiations enabling secret two-way conversation over an invisible searchlight beam, was disclosed last month by the Westinghouse Lamp Division, Bloomfield, N. J.

The source of the unseen radiations is caesium vapor. Although efficient generator of the infra-red, caesium is a poor visible illuminant, thereby qualifying it for confidential telephonic assignments. It is possible to transmit words practically instantaneously with true telephone quality and at normal conversational speed with this lamp.

The caesium vapor lamp was designed by Dr. Beese, Westinghouse research engineer, and at the request of the United States Navy for convoy duty and for issuing troop landing directions. A feature particularly attractive to the Navy is that, unlike radio, there can be no eavesdropping or jamming of infra-red "beamcasting." Jamming would require the use of a shutter device within the limited 25 degree beam as the message is restricted to listeners within the beam spread.

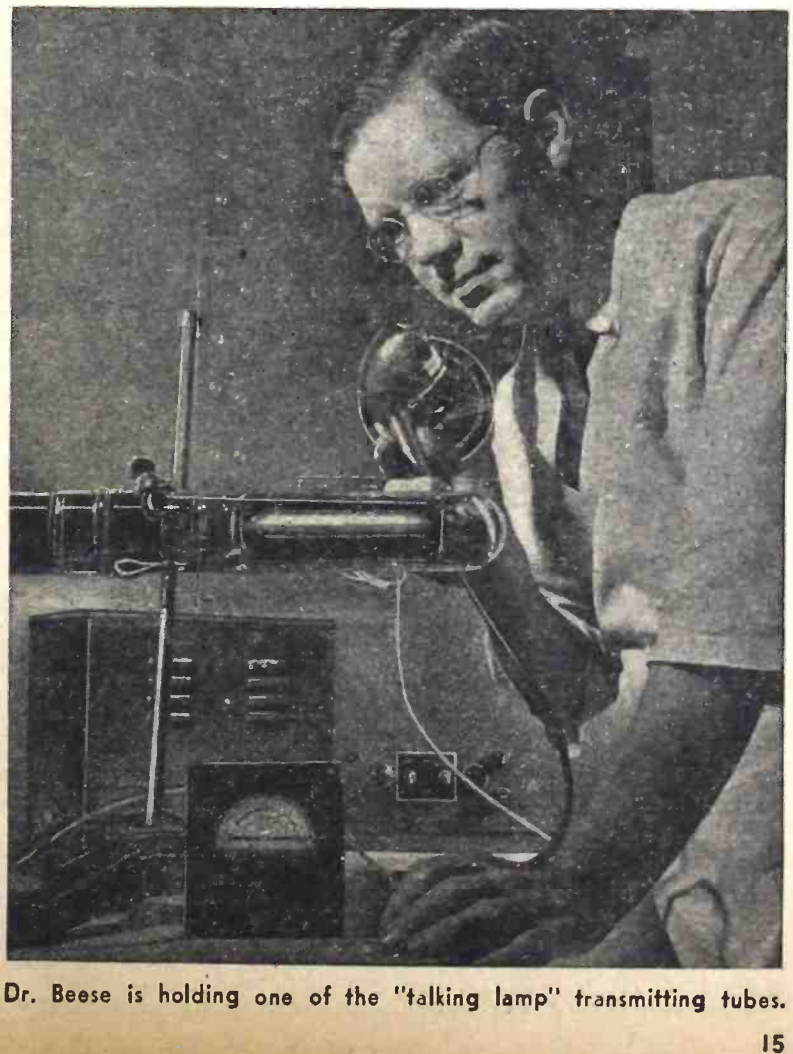
By V-J Day, about 3,500 of the 100-watt lamps had been shipped to the Navy but the auxiliary equipment was not obtained in time for use in combat.

Suggesting peacetime uses, Dr. Beese said the lamp is expected to prove useful in confidential ship-to-shore communications where radio wavebands might be objectionable; in conveying messages among pilots flying through radio "blackouts" in close formation or a few miles apart; or in disaster areas where telephone lines are cut and climatic conditions make radio broadcasting impossible. Infra-red beamcasting is unaffected by static and all weather except extremely soupy fog or smoke.

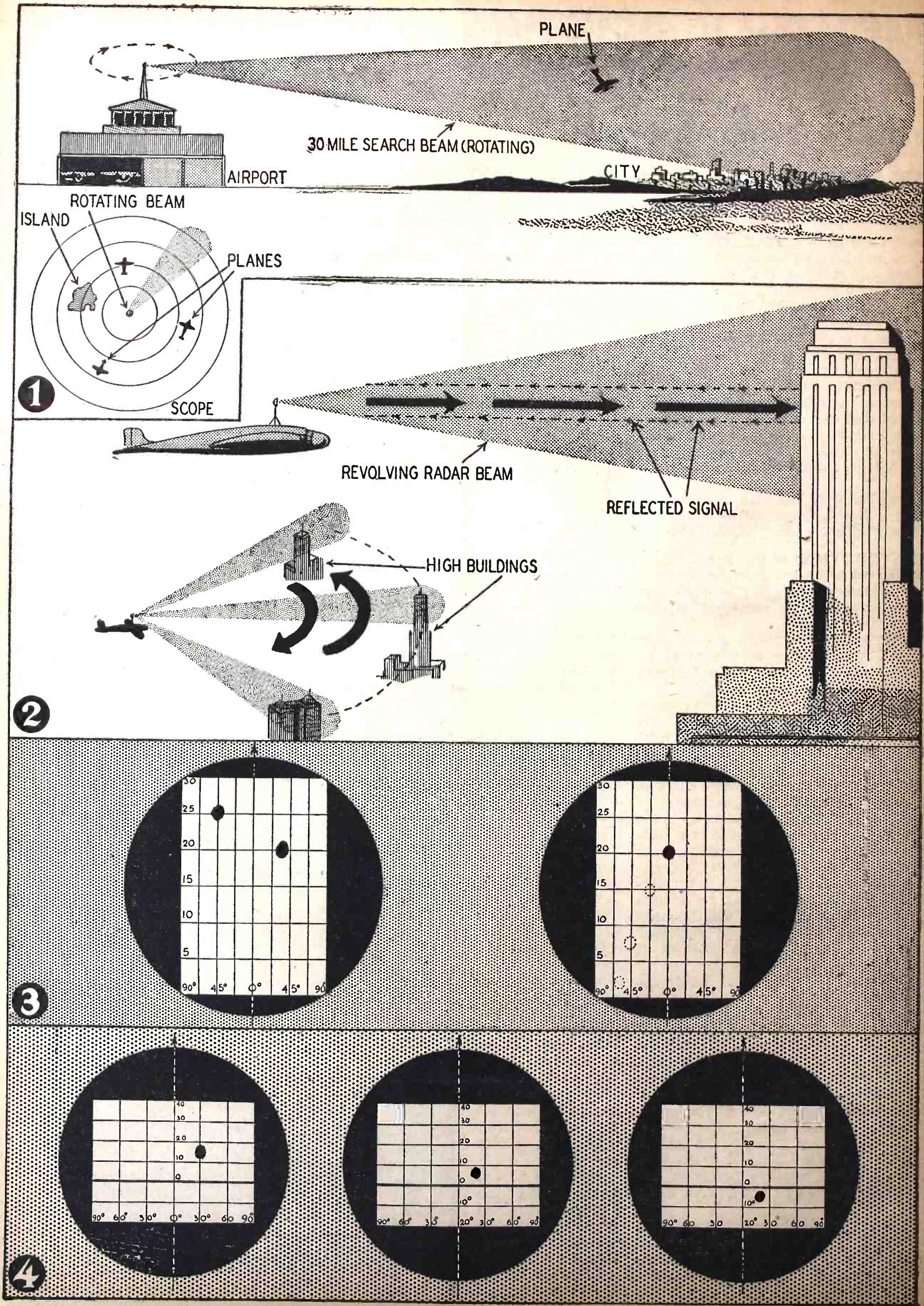
The lamp itself serves as the transmitter. When mounted on a ship's mast in a parabolic searchlight-like reflector, it picks up words spoken into a microphone from the ship's pilothouse or deck and provides invisible wings for the voice to reach the receiving station on another ship or a shore station. At the receiving station, a photoelectric cell mounted in another parabolic reflector picks up the infra-red rays, and with suitable amplification converts them into a reproduction of the words spoken at the transmitter.

The key to broadcasting with light beams is the ability of the lamp to alternately dim and brighten thousands of times a second, a requirement necessary in order to truly reproduce by wave lengths the varying tonal qualities of the human voice, which range in pitch, or frequency, up and down the musical scale.

In this characteristic, called modulability, the caesium vapor lamp has maximum efficiency, reaching a peak of 100 percent at some points in the entire usable audio-frequency range of 200 to 3,000 cycles a second. By contrast, a 60-watt lamp can be modulated to a maximum of one-tenth percent.



Dr. Beese is holding one of the "talking lamp" transmitting tubes.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REVOLVING RADAR BEAM
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HIGH BUILDINGS
2
3
4

By H. W. SECOR and ERIC LESLIE

ANTI-COLLISION RADIO

Radio and Radar Will Prevent Future Airplane Accidents

RECENT crashes of planes into tall buildings have roused much public sentiment. Residents of large cities demand safeguards against such accidents. Less spectacular but equally important have been occasional crashes—in fog, storm or darkness—on remote mountains. Radar has been the remedy most often advocated. Other radio devices could also be used to prevent recurrence of these disasters.

Most prominent in the news as a means of preventing collisions such as the Empire State Building tragedy, July, 1945, and the crash of an Army transport plane into a 67-story building at New York City last May, is the GCA (Ground Control Approach). This system was described in some detail in the April issue of RADIO-CRAFT. Its great advantage is that it is entirely self-contained and does not require that the plane carry any special equipment. All the pilot needs is the usual radio receiver over which he hears instructions given verbally from the ground.

The GCA system is a PPI (Plan-Position Indicator) radar installation. With its 30-mile long-range search beam sweeping over the skies of New York, the planes which crashed head-on into skyscrapers could have been located and guided safely to one of the airports near the city. Fig. 1 gives an idea of the protection that such a beam would give to a city within its range.

The usefulness of GCA to the pilot would not stop with warning him away from danger areas. He would be given a course to fly that would bring him to the approaches to the field. At six miles, the image of the plane would appear on the scope of a *high-precision* radar used for landing the craft.

The pilot, by following the instructions of the ground operator, can bring his plane safely down on the field, though it be so covered with fog that he cannot see the ground.

A strong argument for GCA is that many units are already available—some actually on the fields on which they would be used. The Army insisted on GCA for landing certain military craft, but with the coming of peace its use was generally abandoned. Little work would be needed to get this system working on many airfields.

GCA is limited to a range of about 30 miles from the airfield on which it is installed. It can give no protection to planes lost at great distances from airports—planes which often crash into mountainsides not suspected to be in their path. Radar aboard the plane itself is the answer suggested by some experts. With radar equipment, the plane could discover any obstacles whatever, if they were close enough to the line of flight to be within the beam. This could be fairly wide, and in more elaborate installations, the beam might be made to oscillate (mechanically or electronically) to cover a wider area.

The indicators most suited to obstacle detection are the B and C scopes. These were standard types of military radar, if not as well known to the public as the simpler A scope or the more complex PPI. Presenting the maximum amount of information with the minimum of weight, plane-borne equipment using these scopes would weigh about 145 pounds.

The face of the B scope is laid out in a grid, as shown in Fig. 3. The vertical line up the center is the line of flight. The vertical scale is calibrated in feet or yards and indicates the dis-

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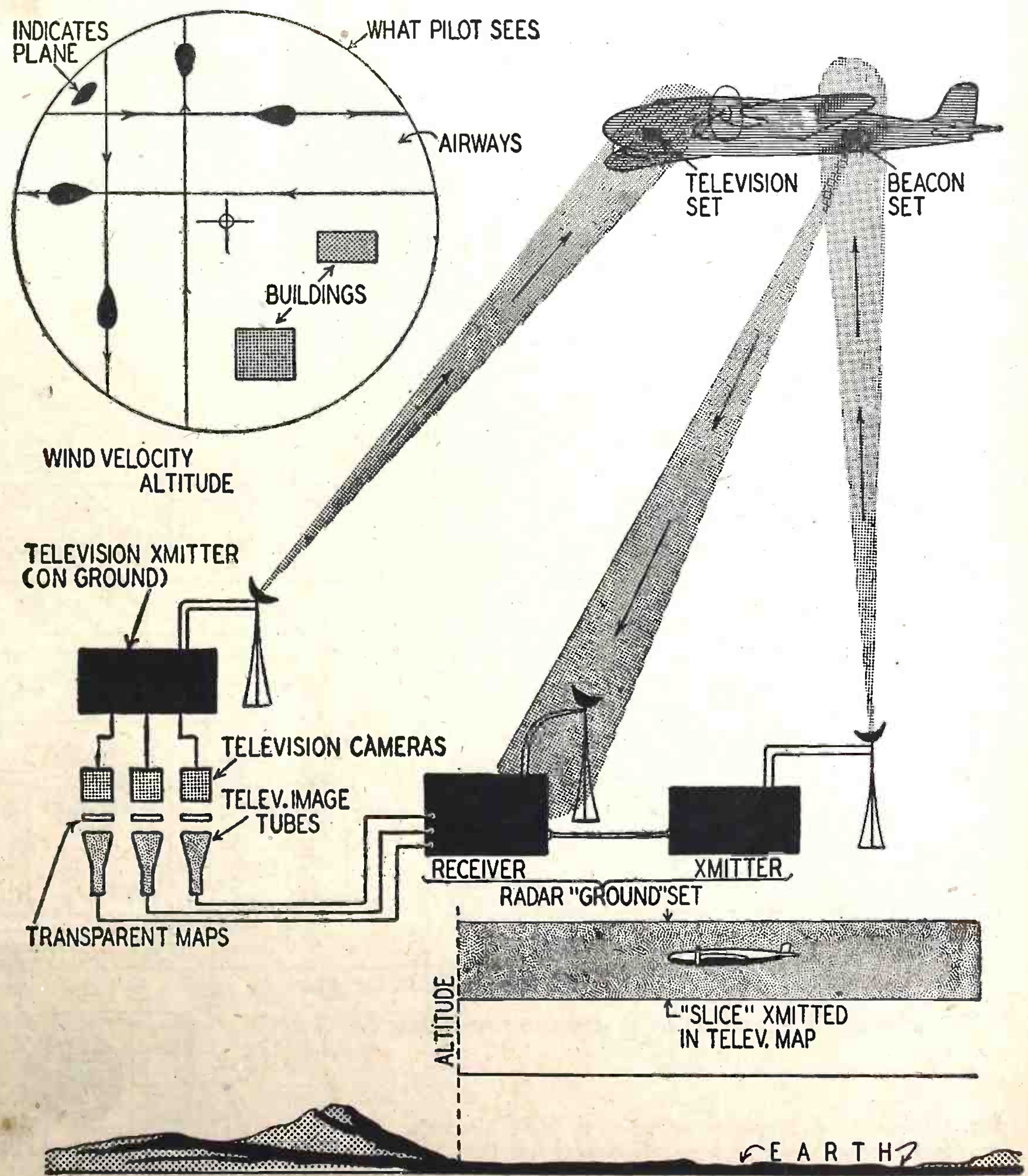

Fig. 1—How GCA guides planes in its area.
Fig. 2—Plane radar would be more effective. Radar beam could either rotate or oscillate.
Fig. 3-a, left—Typical B-scope radar screen.
Fig. 3-b, right—Pilot turns slightly to right and obstacle drops to left and down.
Fig. 4—C-scope shows height and distance. At A, left, obstacle is 15 degrees above the line of flight. At B, center, plane rises and obstacle drops to 8 degrees. At C, right, the plane has risen safely above the object.

Fig. 5—The Teleran system. Upper left is the field as it appears to the pilot. Upper right, the plane, receiving television signals and exchanging them with the rangefinding beacon set. Simplified version of the ground equipment is at center and vertical projection at bottom.

By LYMAN GREENLEE

CONVERTING THE BC-412

How to Put a Popular War Surplus Stock Item to Work

BC-412 oscilloscope, used in an Army radar.

A LARGE number of the Signal Corps Radar Oscilloscopes are now available as war surplus. These are well-made pieces of equipment and if properly converted, make excellent general-utility 'scopes that will stand a lot of abuse.

While this data was worked out for the conversion of Model BC-412-A, similar changes will apply to BC-412-B and to other types as well, as the same general principles may be followed in modernizing any oscilloscope using a 5AP1, 5AP4, 5BP1, 2, 3, 4, or 5HP1 cathode ray tube.

Compare Fig. 1 with the original wiring diagram for the BC-412-A, which will be found glued to the cathode-ray tube shield of these sets. It will be noted that power supplies, intensity, position, and focus controls, will require virtually no change. When working on this equipment, be sure to take the proper precautions to avoid contact with any part of the circuit as the voltages will run well over 2,000 and are DANGEROUS. Better pull the a.c. line plug before making any changes or adjustments in wiring.

Fig. 1 is the wiring diagram for the first modification. This conversion is adequate for observing phenomenon within the audible range and slightly beyond, and was planned to require a minimum number of additional tubes and parts. Two of the original 6L6's are removed and replaced by a 6SN7GT and an 884. Otherwise, the tube layout will remain unchanged. Three additional controls will be required for the front panel for coarse sweep, external synchronization or locking, and vertical gain. Pin jacks may be used for the various input circuits.

The vertical input is coupled through a type 1852 tube connected as a triode and used as cathode follower to the 6SJ7 which drives a pair of 6L6's in

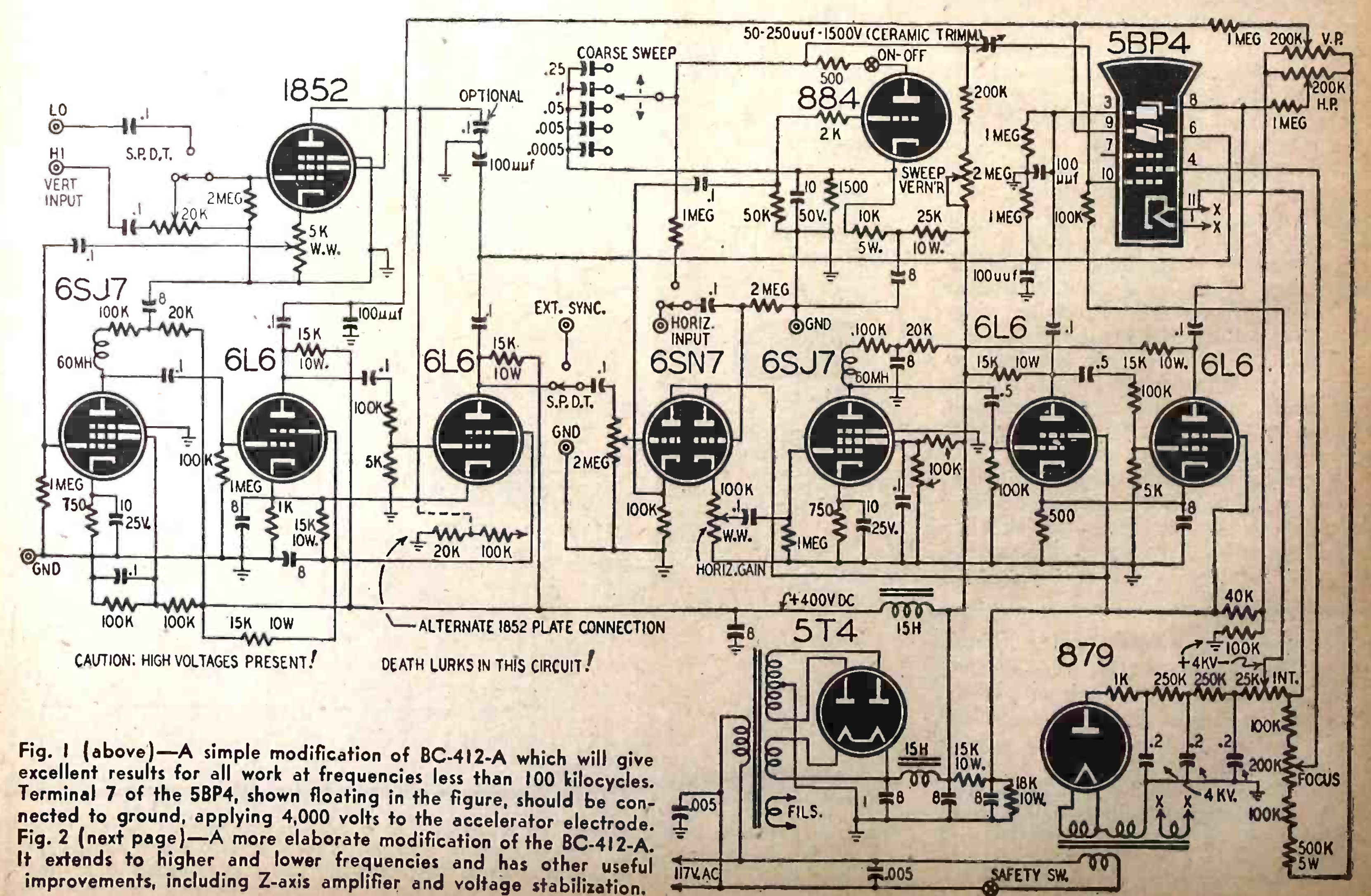

Fig. 1 (above)—A simple modification of BC-412-A which will give excellent results for all work at frequencies less than 100 kilocycles. Terminal 7 of the 5BP4, shown floating in the figure, should be connected to ground, applying 4,000 volts to the accelerator electrode. Fig. 2 (next page)—A more elaborate modification of the BC-412-A. It extends to higher and lower frequencies and has other useful improvements, including Z-axis amplifier and voltage stabilization.

push-pull resistance-coupled to the vertical deflection plates. This circuit will be found satisfactory for observations of frequencies up to 20,000 cycles, but the gain at higher frequencies will fall off rapidly. The 1852 is used as a cathode follower in this circuit simply because it is available from the original circuit, but a 6J5 or similar triode would do just as well. The 6SJ7 will give a voltage gain of about 100, which is sufficient to drive the two 6L6's and gives adequate deflections with inputs of .01 volt and up. For greater simplicity, the input circuit may be modified slightly by omitting the high and low voltage controls and substituting a higher cathode (100,000 ohms) resistance for the 5000-ohm potentiometer in the 1852 cathode circuit so that a wider voltage range may be secured with one control.

The horizontal amplifier is a duplicate of the vertical amplifier with the exception that a 6SN7GT is used for cathode coupling. This dual-triode serves the purpose of a double cathode follower, with one section coupled to the 884 linear sweep generator for external synchronization, and the other section coupled to the 6SJ7GT. Use of cathode coupling for the external synchronizing voltages is advantageous in

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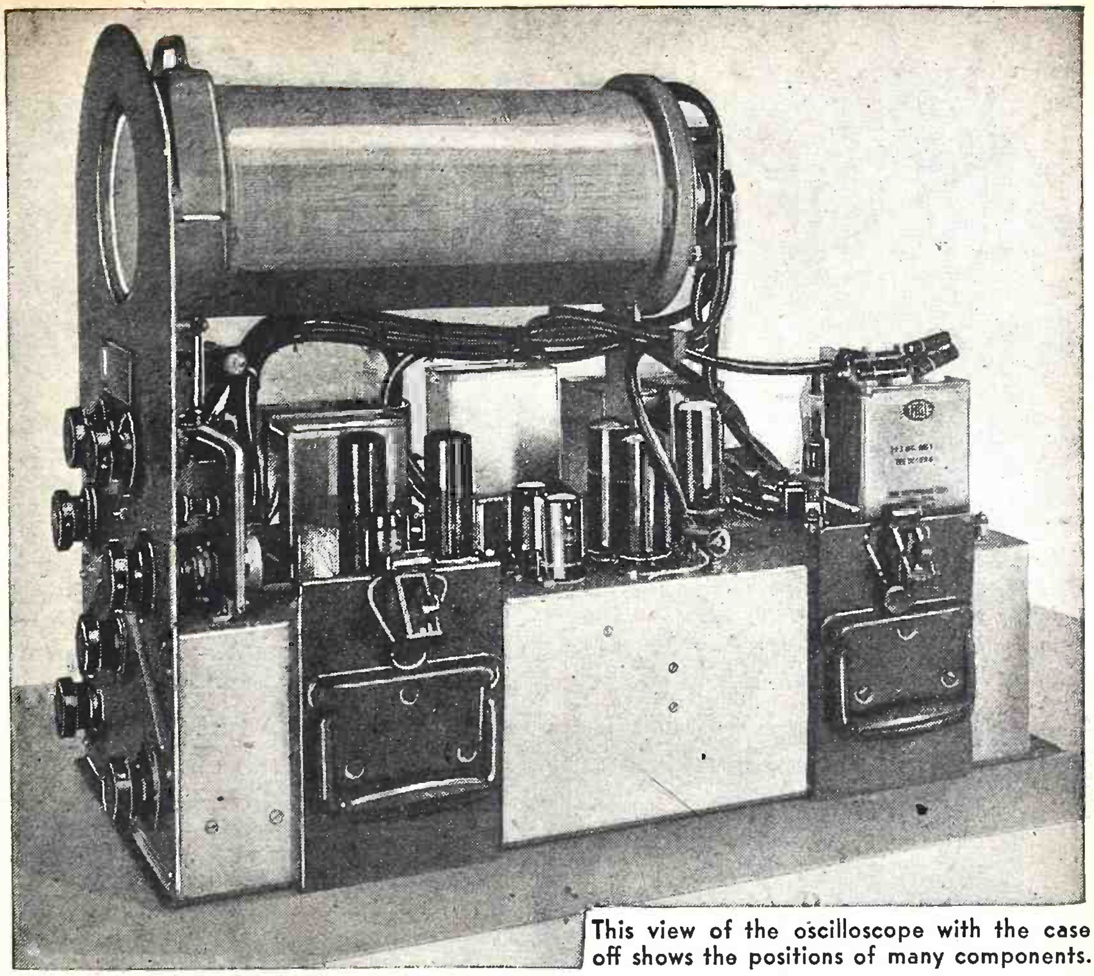


This view of the oscilloscope with the case off shows the positions of many components.

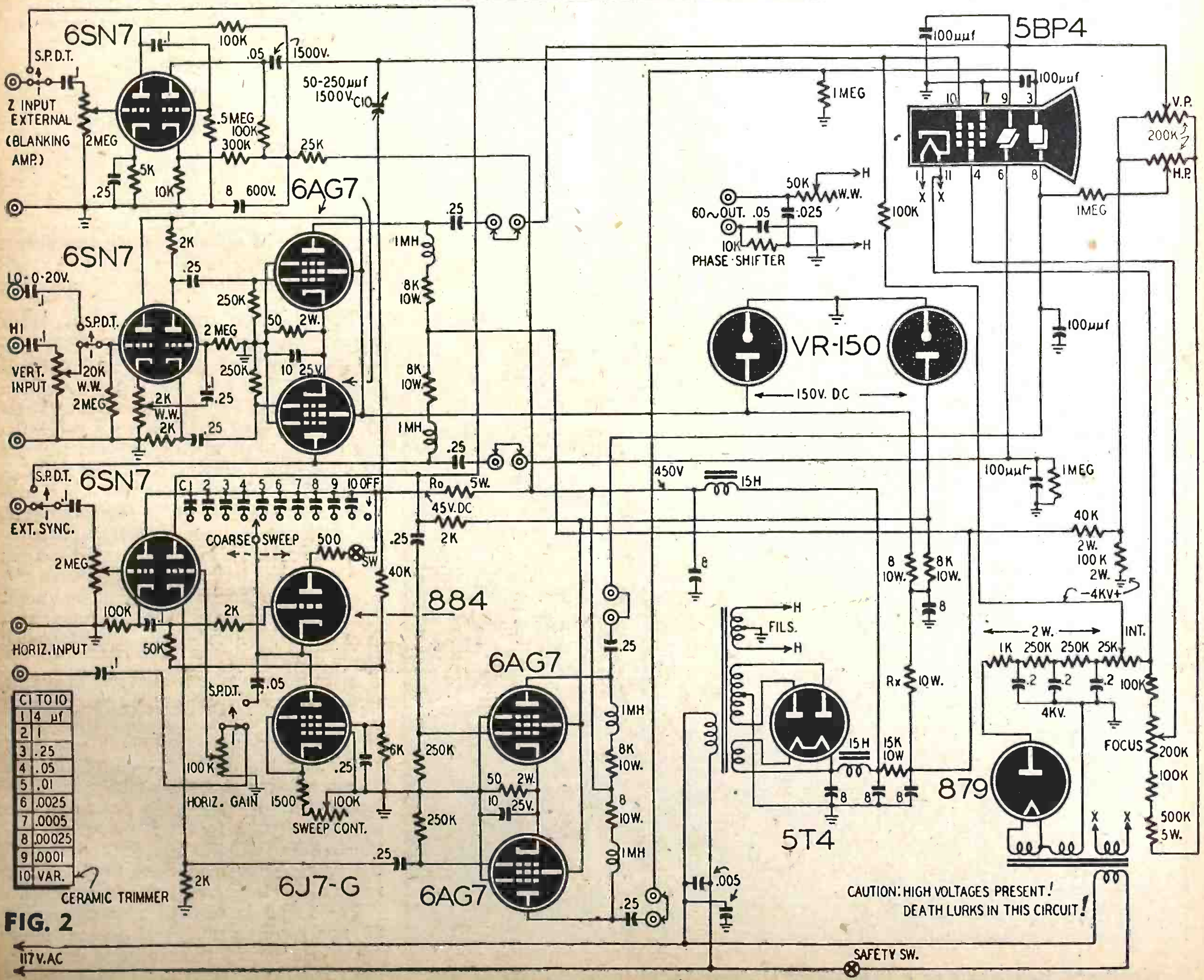


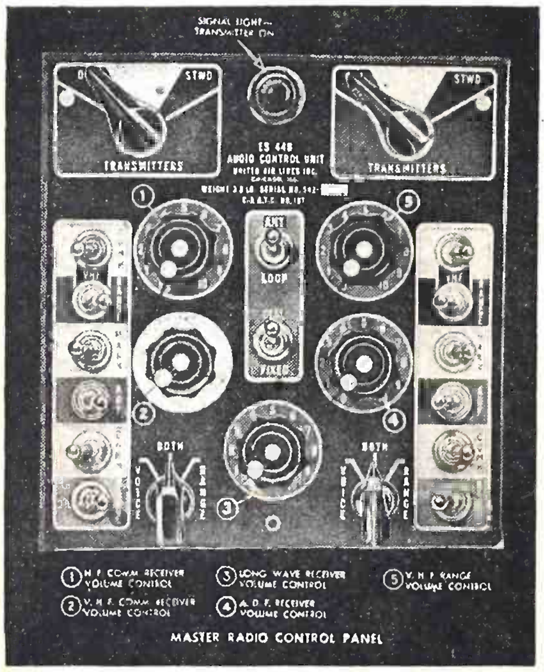
FIG. 2

By EDWARD D. PADGETT

AIRLINE RADIO SERVICE

Preventive Maintenance Rather than Repair Is Stressed

THE primary aim of airline radio maintenance is to eliminate failure of radio equipment in flight. Consequently the air transport corporations have developed periodic schedules for the inspection and servicing of aircraft radio apparatus. A *properly planned and executed "preventive maintenance" program anticipates radio failures* by showing the weakening of vacuum tubes, the deterioration of wiring, condensers and other components, and discloses reasons for each failure.



Standard United Air Lines control panel.

Air line radio maintenance personnel are highly trained and those handling radio transmitters must be licensed by the F.C.C. Persons engaged in this work must have a knowledge of shielding, bonding, vibration, aerodynamics, aircraft antennae and radio equipment. "An airline radio maintenance man is a jack of all trades."

Oscillatory disturbances, ambiguously called "noise," enter a receiver either through its feed from the aircraft electrical system or through direct pick-up by the antenna system. Filters at the receiver feed and engine "harnesses" reduce interference from the electrical system while electrostatic shielding and short antenna lead-ins minimize the pickup inside the airplane.

Radio equipment is protected from the effects of vibration by the use of "shock mounts." These vibration-absorbing units are a part of the shelved rack in which the radio components are housed. Chassis and cases slide into their compartments and are firmly attached by slide fasteners. Shock mounts should be spread about the center of gravity of an equipment rack being shock mounted so that the rack may take shock and vibration from any direction without creating eccentric forces that cause rotational or three dimensional movement.

Occasionally tubes will be found in which shock causes the elements to open or to vibrate against each other, resulting in noise or complete failure of a radio unit. This defect may show up in the form of a microphonic tube which may be located by tapping the tubes with a finger.

An airliner contains several antenna installations. Long range communication is carried out by means of either a fixed antenna or a trailing wire antenna.

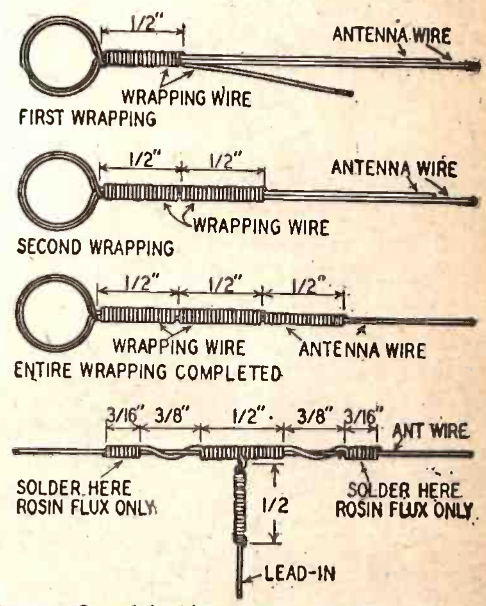
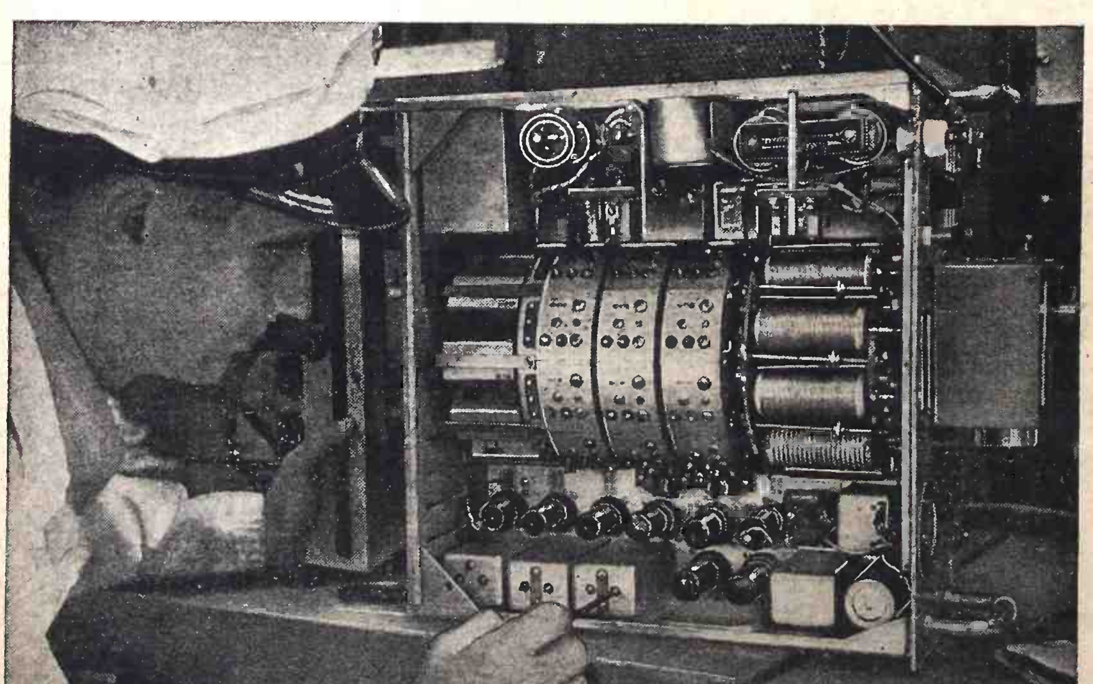


Fig. 1—Careful splices are needed on planes.

The fixed antenna is usually run from a mast on the forward end of the fuselage to a high point on the vertical stabilizer. The antenna may be mounted underneath or on top of the fuselage. A trailing wire antenna on a retractable reel is used when reception is poor or over great distances. If the reeling-in speed is not controlled there is a tendency for the weight to oscillate as it nears the in position. Therefore, the antenna fair-lead should be located so that the swinging weight will not strike the propellers or foul the control surfaces. Electrically operated reels automatically control reeling speeds and decrease these dangers.

Loop antennas are used for direction finders and for reception during periods of poor weather and precipitation static. Shorter vertical antennas are used to "sense" the direction finders and for 75 mc marker stations and "cone of silence" indications; whip antennas are sometimes used to receive marker stations. Small dipoles placed underneath the fuselage or wings are used for the radio altimeter and u.h.f. applications.

The trend is toward antenna masts of non-metallic material which must withstand sharp temperature changes, icing conditions, and the breaking load



Photographs courtesy United Air Lines.

Aligning i.f. transformers on a 10-frequency crystal-controlled transmitter-receiver unit.

of the antenna wire. The airlines prefer a stranded silicon-bronze antenna wire with a breaking strength of around 200 pounds, while the Army Air Force uses a copper coated steel wire with a breaking strength of 150 pounds. An aerodynamically clean antenna system, consisting of a *polyethylene*-coated solid antenna wire, porcelain insulators, and phenolic masts, greatly reduces the effects of precipitation static. The elimination of sharp edges and corners on the exterior fittings of an airplane helps reduce corona and static discharge. Although the static problem has not been solved the latest trend is to place "static discharge wicks" at intervals along the trailing edges of the vertical and horizontal stabilizers and along the wings. Such a wick consists of a piece of graphite treated rope about one-fourth inch in diameter and one foot long in an aluminum base and provides a high resistance discharge path for static.

Splicing is especially important in airplane antennas. Two splices for solid antenna wire are shown in Fig. 1. For stranded antenna wire the wrapping is done with soft annealed steel wire; soldering is required to obtain a firm joint. Proper splicing will distribute the strain at the fitting and minimize breakage. When servicing antenna wire avoid kinks and do not crimp wire with pliers; cut wrapping wire a little longer than necessary and grasp the end with pliers, or fingers, and bend it firmly, several times, around itself and then snip off any excess. Crimping with pliers increases crystal strain within the wire. Then vibrational effects, weather and pressure changes result in a fatigue failure. Flying gravel which strikes the wire will cause crystallization and subsequent failure; "belly" antennas are particularly vulnerable.

A PLANE'S EQUIPMENT

A modern ocean-spanning airliner may have the following radio complement: two direction finders; a loran navigational installation; 2 v.h.f. range receivers; a combination v.h.f. transmitter-receiver communication unit; duplicate conventional range station receivers; 2 v.h.f marker receivers; duplicate glide-path instrument-landing receivers; a combination high-frequency company transmitter-receiver communications unit; radio altimeter; and associated dynamotor power supplies.

These instruments are serviced in the airline radio laboratories, which contain a number of work benches neatly laid out with power supplies and meters for visual indication of currents and voltages when work checks are in progress. Screen rooms are provided for transmitter and direction finder tests (See cover picture). Transmitters placed in these rooms for servicing will not, when operated, interfere with local airline communications operations. Direction finders may be tested in these shielded booths as deviation errors, caused by nearby metallic objects which bend and distort incoming r.f. test signals, electrical interference and noise, are eliminated by the grounded screen.

While separate military aircraft receivers and transmitters are the rule, commercial trends are toward combination receiver-transmitter units (Fig. 2-a). One or two commercial receivers, in an aircraft installation, may be manually tuned while others (company) are crystal controlled and contain from 4 to 10 channels. Likewise, company transmitters have 4 to 10 crystal controlled channels. A number of channels are necessary because of the different facilities involved (CAA, airport and airline) and the necessity of changing from day to night frequencies as the airplane proceeds along its route. Obviously the antenna resistance will vary for the different frequencies. For receiver-transmitter bench tests a number of dummy antennas are required whose respective impedances must exactly match the respective antenna resistances. For example, a small 100-μμf mica condenser is a suitable dummy antenna for coupling between a signal generator and a range station receiver. Several methods for coupling aircraft antennas to transmitters and receivers are shown in Fig. 2-b.

Occasionally trouble will be encountered in tuning a transmitter to an aircraft antenna. For low-frequencies a 100 μμf high-voltage mica condenser from the antenna post to ground will help, or if the difficulty is on a higher

(*Continued on page* 52)

TROUBLE LOCATION CHART FOR AIRPLANE RADIO MAINTENANCE

TROUBLE	PROBABLE CAUSE	PROBABLE REMEDY
R—All receivers dead and all dial lights out.	Main fuse blown. Power failure	Replace fuse. Switch batteries
R—One receiver dead; dial light OK; dynamotor dead	Dynamotor fuse blown; defective dynamotor	Replace fuse. Inspect brushes or replace dynamotor
R—Receiver noisy with antenna connected	Antenna open or rubs. Poor receiver case bonding; defective magneto or spark plug shielding; generator noisy	Check antenna connections; check bonding; clean, tighten, or replace shielding; check generator brushes
R—Receiver noisy with antenna disconnected	Defective band switch; defective tube; defective dynamotor; loose tube sockets and parts	Change bands; clean switch; replace tubes; clean commutator with paper; check connections
R—Receiver alive: weak signals; distortion; dead spots	Defective tube; weak oscillator tube; incorrect bias; open filter condenser; shorted tuning condenser; high filament voltage; out of alignment; moisture in i.f. transformers	Replace tubes; check operating voltages; bias resistors and filter condensers; clean and realign unit; check switches and clean relays; replace bad i.f. transformers; check headphones
T—No plate or antenna current.	High voltage fuse blown; defective tuning unit or tube	Replace fuse; try another tuning unit; replace tubes
T—Plate current OK; antenna does not tune normally	Defective antenna	Check antenna; try condensers in antenna circuit; try another antenna
T—Plate current OK; antenna tuned; no antenna current	PROBABLY NONE	CHECK ANTENNA TERMINAL WITH **WOOD** PENCIL FOR R.F.
T—Low transmitter output	Defective oscillator or modulator tube; low plate and filament voltages	Replace tubes; check power supply and antenna connections
T—Total plate current does not increase when transmitter is switched to voice or tone	Defective a.f. tubes; defective c.w.-voice switch; modulator bias too high	Replace a.f. tubes; check switch; decrease bias
T—Antenna current does not increase with modulation; antenna current decreases with modulation	Audio gain too low; improper coupling— Audio gain too high; improper coupling or poor antenna tuning	Increase audio gain; change antenna coupling Change input, coupling, and retune antenna
T—Normal on "tone"; no modulation on "voice"	Defective microphone or microphone jack; short in a.f. or modulator circuit	Check microphone jack; use another microphone; check circuit for foreign matter and defective parts
D—Reception on 278 kc is weak	DF. receiver on loop; moisture in loop	Switch to ANT.; replace loop and moisture filter cartridge
D—No D.F. sense	Defective sense antenna or sense circuit	Check sense antenna and sense circuit

T—Transmitter R—Receiver D—Direction finder

A supply of spare fuses shall be carried in all airplanes; see that these spares are in their compartments. New parts are often defective. Test Them Before Using.

OIL-FILM TELEVISION

Completely New Swiss System Produces Large Images

A RADICALLY new large-screen television system is reported from Switzerland. Instead of attempting to increase the brightness of the modulated cathode ray which paints the picture to a point where it can cover a large screen, this method uses the modulated ray to control or modulate a strong beam of light from a local (arc-lamp) source. Acting not unlike the grid in DeForest's famous tube, the television signal is thus able to control large quantities of locally-generated light, and thus could theoretically produce pictures equal in size and brightness to those of the standard movie screen.

Experiments made along this line in the past have not been able to produce images comparable in quality to those of the standard cathode-ray tube as used in home television receivers. The new method, evolved under the direction of Professor Dr. F. Fischer, of the Division for Industrial Research of the Swiss Federal Institute of Technology has satisfactorily solved many hitherto unconquerable problems of point-to-point control of a ray of light for television purposes. The instrument has been fully described by Dr. W. Amrein of Zurich, from whose paper most of the following is taken.

The apparatus is based on a totally new principle, the point-to-point deformation of the surface of a stratum of liquid by means of electrostatic forces. The light passing through the liquid stratum is deflected by the deformed points of the surface, and the fasces of light-rays corresponding to every single deformed point of the surface are made visible by projection. Cathode rays charge the surface of the liquid with electricity, which gives rise to the forces needed to effect the deformation. The sketch in Fig. 1 should help to explain this novel method of light-steering.

The liquid stratum (1) which, in the absence of electrostatic forces, presents a smooth surface and is about 0.1 mm. thick, rests on a glass plate (2). Under the glass plate is a system of lenses (3), called Schlieren-objective, which serves to focus the slits between the lower bars (4) exactly on the upper bars (5). All the light-rays, a few of which are represented by dotted lines on the right-hand side of the drawing, are constantly interrupted by the upper bars, as long as the surface is smooth and undeformed. The whole arrangement lets no light pass through under these conditions.

Conditions are altered as soon as the surface of the liquid is deformed in any point, as is represented on the left-hand side of the figure by a minute indentation of the surface. All the fasces of light-rays which pass through the oblique sides of the indentation (three of them are represented in the figure by full lines) are deflected in proportion to the depth of the indentation, and in consequence are able to pass between the upper bars and thus be used for the projection of the television picture.

Let us first, however, get an idea of how the surface of the liquid is charged with electricity, and how this causes the deformation. In the upper left-hand corner of Fig. 1 there is an electron gun (6), which in combination with a focusing coil (7) directs a very finely focused cathode (electronic) ray (8) on to the surface of the liquid. Two pairs of coils placed at right angles (9) to each other are used to deviate the cathode ray with such velocity that it describes the whole portion of the surface of the liquid utilized for the projection, after the manner of a line-scanner, fifty times in a second. During its rapid motion the cathode ray is modulated by the incoming television signals, with the help of amplifiers and oscillators, with a frequency of 7.5 mc per second. Thus the surface of the liquid receives a patterned (scanned) distribution of the electric charge corresponding to the television image transmitted. It should be mentioned that the electrons of the cathode ray, despite their enormous velocity of 60,000 km/sec (they are accelerated by an electric tension of 10,000 volts) penetrate with their impact only very slightly into the liquid—less than 0.01 mm.

Lack of space precludes a detailed description of the production, focusing, deflection and modulation of the cathode ray; this would also be partly superfluous, for all these processes, as well, as the amplifiers, oscillators, coils, etc. used, vary but slightly from the processes and devices utilized in the operation of the standard television tube, which has been known for a long time. It is, however, worthy of note that the focusing of the cathode ray in the Division for Industrial Research large-screen projector is remarkably sharper than in the usual cathode-ray tube. As it strikes the surface of the liquid, the ray has a section 0.2 mm. in height by only 0.05 mm. in breadth.

The intensity of the electric current carried by the cathode ray is about 20 microamps. This small amount of current, combined with the great velocity of deflection (1,200 meters sec.) makes it possible to deposit only a very small electric charge on any point of the surface of the oil, with the result that a sufficiently deep indentation of the surface of the liquid by the electrostatic force is obtained only by adopting two further measures. First of all a thin, transparent, electro-conducting stratum (10) is deposited on the glass plate. This stratum, lying as it does directly under the liquid, acts as a counter-electrode for the charge existing on the surface. For each electric charge on the surface of the liquid a charge equal in size but of contrary sign is induced on this electrode. It is easy to understand,

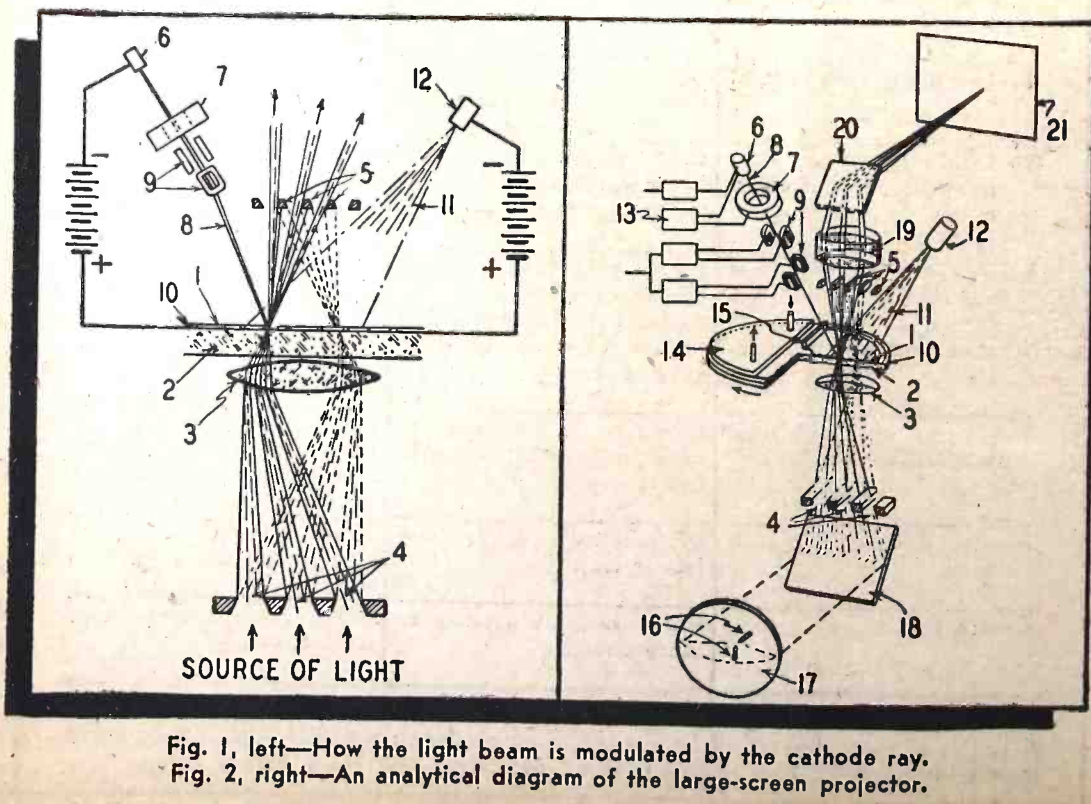


Fig. 1, left—How the light beam is modulated by the cathode ray.
Fig. 2, right—An analytical diagram of the large-screen projector.

according to Coulomb's well-known Law, that this increases the electrostatic force, as the induced amount of electricity of contrary sign is brought extremely close to the charge lying on the surface of the liquid.

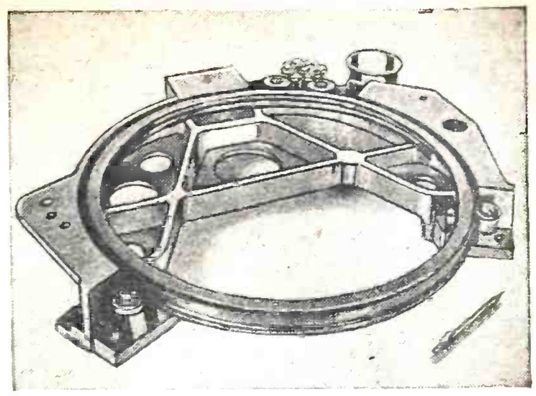
The second measure consists in a supplementary uniform charging of the whole surface of the liquid by means of a second, diffused cathode ray (11), which is produced by the electron gun (12) in the top right-hand corner of Fig. 1 and thence directed towards the liquid. The electric charges emanating from this cathode ray are distributed in a perfectly uniform manner over the surface of the liquid, and in consequence give rise to no deformation. On the other hand, they submit the liquid to a uniform pressure depending on the electrostatic forces. The efficacy of the electrostatic force of the charges produced by the first electron gun is essentially increased by this means.

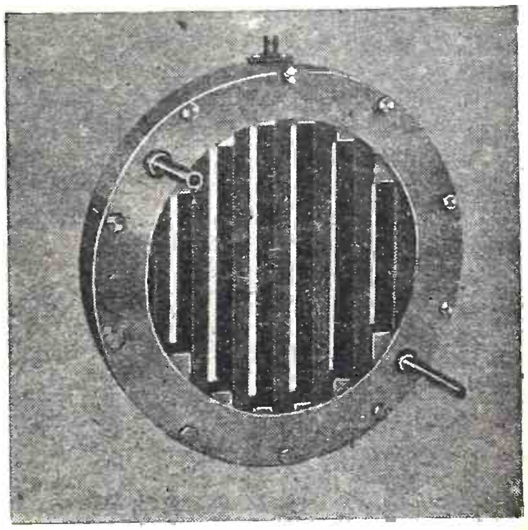
Finally, it should be noted that the charges distributed over the surface of the liquid and corresponding to a certain television picture must always disappear to make way for those producing the next picture. In this method a liquid having a certain degree of conductivity is used. This allows the charges to flow to the counter-electrode within the prescribed time.

In spite of the simplicity of this light-control principle, its realization was hampered by theoretical and practical difficulties of no small importance. It must be borne in mind that all the above-described processes have to take place in a vacuum of very high degree. A whole series of studies and experiments with specially constructed apparatus was necessary in order to produce the light-steering fluid—we have to deal with an oily liquid—possessing characteristics of viscosity, capillarity, dielectric coefficient, electric conductivity and vapor pressure, such as to satisfy the theoretical requirements.

The general construction of the large-screen projector is illustrated in Fig. 2. Here only the most important parts of the apparatus are represented, those which are in fact essential for its complete comprehension. On the upper left we may recognize the gun of the focused cathode ray (6) with the focusing coils (7), the deflecting coils (9) and the amplifier, oscillator and voltage suppliers (13); the gun of the diffused cathode ray (12) is to be found on the right. (4) are the lower bars with their slits, (3) the Schlieren-objective and (5) the upper bars. The glass plate (2) supporting the liquid takes the form of a disc rotating slowly and constantly in a fixed direction. Glass plate, Schlieren-objective, lower and upper bars are drawn in section.

As a result of the rotation of the glass plate, after a certain time the portion of the liquid utilized for the projection is brought under cooling plate (14), where it loses the heat produced by the cathode and light rays, and is cooled off to a fixed temperature. On leaving the cooling-plate, the liquid is stroked smooth by the scraper (15), and so made ready for the next exposure.





Above—Lower bars of Schlieren-optic with water cooling. Upper right—Rotating glass plate which carries the light-control fluid. Lower right—Upper bars of the light-control.

Finally, the complete optical course of the rays must be explained. The light penetrating from below between the bars is produced by the carbons of an arc-lamp (16) and directed by concave mirror (17) and the oblique plane mirror (18) to the proper place. Between the lower and upper bars the course of the rays is identical with that of Fig. 2. Above the upper bars we find projection objective (19), represented in section, which collects the fasces of light coming from a deformed point of the surface of the liquid and passing between these bars, and focuses it over mirror (20) on to projection screen (21). Each deformed point of the liquid stratum thus gives rise to a bright point on the projection screen, and the brightness of each point is in direct proportion to the degree of deformation of the corresponding point on the surface of the liquid.

With the exception of a very small number of parts, the whole apparatus was built in the workshops of the Swiss Federal Institute of Technology, or in Swiss mechanical, optical and electrical plants.

DID YOU KNOW THAT?

In certain parts of India, whenever a radio serviceman enters the home of a radio set owner to make necessary repairs, he begins the transaction with a prayer to his gods that the repairs will not be too difficult to make. At the end of his service call he makes still another prayer which is supposed to keep the radio in fine fettle for a number of months.

In France, whenever a radio repairman appears at a customer's home, he is served a glass of wine before commencing his activities, so that he may be in the proper frame of mind to cope with circuit difficulties.

In Denmark radiomen form cooperative organizations. Four, five or even a dozen radio shops in a large community operate as one organization. Each organization purchases test equipment for all the shops belonging to it. All members of the cooperative group share in advertising costs and all members receive a share of the total profits from all service calls made to any shop member during a given month.

In Switzerland all radio servicemen must take an examination twice yearly. These examinations cover the latest developments in radio repairing and include questions on television, frequency modulation, and electronics. If a Swiss radioman fails an examination he is disbarred from business for a 90 day period, during which time he may "bone up" in preparation for another trial.

In U.S.S.R. any citizen who desires to become a radio repairman may receive training at government expense in trade schools which require three to six months for graduation. After graduation a radioman may be sent to any community where he or she may remain until otherwise transferred. U.S.S.R. radiomen are classed as professional workers and receive expanded food ration cards. They are also assured of a comfortable home. In U.S.S.R., when a radio goes sour, the owner merely calls the nearest government radio shop and has the repairs made at a very low rate indeed. The government pays each radio repairman a weekly stipend considerably greater than many other workers receive because it is anxious that citizens have access to a radio loud speaker at all times.

The Chinese serviceman gets no wine or food out of his occupation, but may be greeted with a polite cup of tea and left with the radio.—*E.A.C.*

By H. A. NICKERSON

BUILDING A SET IS EASY

Problems Underlying Construction of a 5-Tube Superhet

FOR a first attempt, start with a one-tube regenerative receiver, or even a crystal set, until some skill in wiring and soldering is developed. If a more elaborate set is to be built, the choice depends on availability of parts, results wanted and cost. Sets using a power transformer are likely to have a greater power output, so they will give louder and usually deeper-toned loud speaker response, but reasonable volume and excellent selectivity can be obtained with the "standard" 5-tube superheterodyne, a.c.-d.c. type. The 4-tube tuned radio frequency set lacks selectivity, although it is easy to construct and less expensive for parts than the 5-tube superhet. Construction of a typical 5-tube super will be described.

First step is buying the parts. It is a lot easier to buy a complete "kit," but if saving is an object, the mail order radio houses (or local radio stores, if you live in a big city) will supply all parts, with some shopping around. By mail order shopping, all parts except tubes and cabinet should cost less than twelve dollars for a 5-tuber. Keep in mind that a filter condenser regularly wholesaling at 75 cents if sold at 29 cents may not be fresh stock.

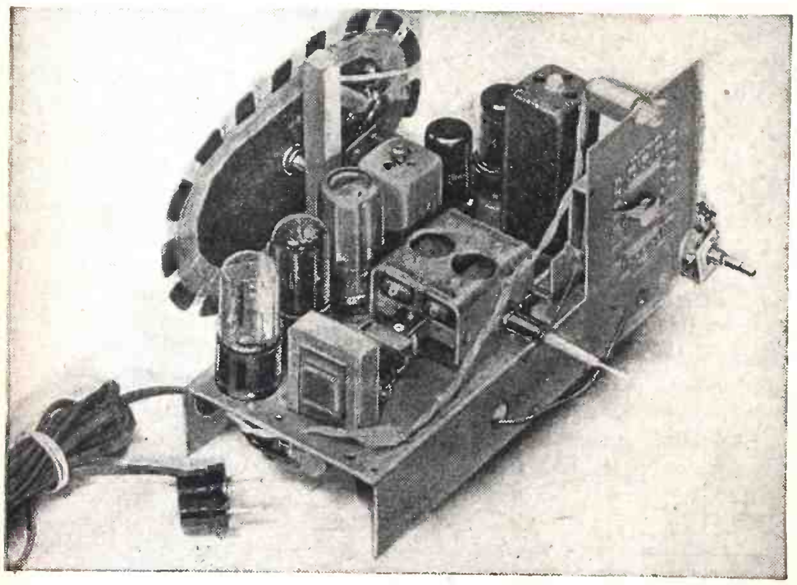


Photo A—Front view of set, showing support for the loop antenna.

It is much simpler and cheaper in the long run to buy a chassis already prepared with socket openings, etc. Unless one has a regular socket punch cutting out openings for sockets is tedious work. The 5-tuber has five socket openings, two places for intermediate frequency transformers; possibly a choke coil and loud speaker, mounted on the top. Note that the arrangement of the tubes is 12SA7, 12SK7, 12SQ7, 50L6, 35Z5. The i.f. transformers are mounted as shown in Photo A. The oscillator coil in this type of set is a three-connection (one-tap) type designed for use with 12SA7. There are at least two different spacings of wafer socket mounting holes, so that before buying sockets it is well to know the distance between mounting holes on the chassis and buy the right sockets. Other sockets mount with a ring underneath, and require no side mounting holes.

The simplest condenser is the "cut-plate" type, one part of which is usually .000365 µf to match the particular loop, and the other a section of fewer plates, to match the oscillator coil.

The capacity of each filter condenser should be 20 µf. The working voltage used in these sets is usually 150, but the condenser nearest the 35Z5 may well be a 200-volt or 250-volt type for a greater safety factor. Small by-pass condensers are usually 400-volt, but 600-volt working are well worth using. Resistors are ¼-watt or ½-watt, larger current carrying capacity adding to the *size*. It is important that the resistance of the choke be kept low, because it is in series with the high voltage, and if too high, there will be a loss on the already rather low effective voltage, which at the output of the choke may be only about 85 volts. The choke may be the field of a dynamic speaker, or a separate choke of 5 to 20 henries, if the permanent-magnet speaker is used.

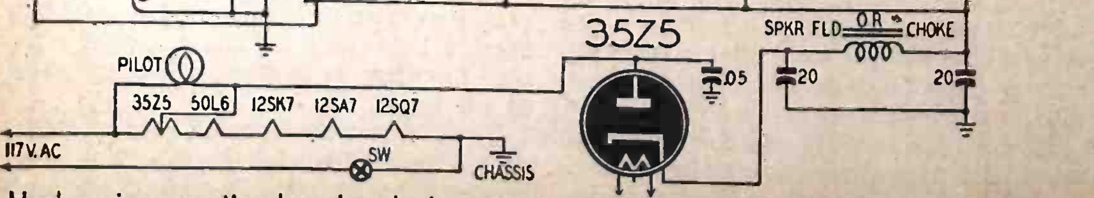
Remember that the larger the diameter of the speaker cone, the deeper the bass; the larger the permanent magnet, the greater the power handling ability; the larger the cabinet, the better the bass. The reason so many of these small a.c.-d.c. 5-tubers sound like rattletraps is of course due to small cheap speakers, tiny cabinets and operation at such volume that either the second detector or output tube overload. Give these sets a good-sized cabinet and speaker and they would sound like different radios.

Since this set has automatic volume control, you should not be surprised if local stations do not come in as loud as on a well-built 4-tube tuned TRF.

WIRING THE RECEIVER

It is desirable to use stranded hook-up wire. Use of vari-colored wires will aid in tracing circuits—black (or yellow) for filament, green for grid and blue for plate. In any event, use red for B-plus. A few inches of spaghetti are needed and should be used wherever there is a possibility of uninsulated wires shorting. Wiring should be short and direct, and kept (as a rule) close to chassis. Plate and grid leads should be kept separate. Usually filament wires should be soldered in place, tubes inserted, switch and 117-volt line-cord attached, and switch thrown to "on" position, to see if the filaments light. If they do, take off the line cord and proceed with the other wiring. The speaker, loop and line cord should be connected last. Before the supposedly completed

(*Continued on page 56*)



Hook-up is conventional, and author's instructions may be applied to any standard circuit.

By J. CARLISLE HOADLEY

USE YOUR AUTO RADIO!

Automobile Sets Make Very Sensitive A.C. Receivers

NOW that new cars and new radios are on their way to the consumer market, older auto radios will be purchasable for a song. They usually contain highly sensitive tuners. We can convert these older models into better-than-average home radios, particularly for rural use where the high sensitivity is valuable.

The average auto receiver contains six tubes and consists of a superheterodyne circuit with a tuned radio frequency amplifier; a mixer-oscillator; an intermediate frequency amplifier; a combination detector, a.v.c., audio frequency amplifier; and an output amplifier stage. Power is supplied by a *vibropack* which usually, but not always, contains a rectifier tube, such as OZ4 or 6X5. Some radios use synchronous self-rectifying vibrators, but they are in the minority.

For 110-volt operation, we discard the vibrator power supply and add, in its stead, a conventional power pack. We need 6.3 volts at several amperes and about 250 volts at from 60 to 90 milliamperes, depending on the particular receiver. This is presupposing that the audio system in the receiver is adequate for our needs. We can, of course, add a larger amplifier if we desire higher power.

The first step is to disassemble the auto radio, removing the case and the vibrator power supply. We can remove the dial reduction gears if we are not going to use the instrument panel dial that was a part of the radio in the car. If it is one of the newer ones with a dial built as an integral part of the radio, so much the better. Many dials are available from radio supply houses, and if you desire, you can acquire a National ACN dial which can be hand-calibrated on cardboard blank scale provided.

The circuit diagram would be handy, although not entirely necessary. The diagram of nearly any auto radio can be copied from a service manual, which your local radio service man is sure to have, or you can write to the manufacturer of your particular radio.

When you have the radio out of its case and have removed the power supply, a little planning will be in order. If the vibropack was an integral part of the receiver, you can mount the 110-volt power supply in the identical positions that the 6-volt counterparts occupied. The power transformer needed for the average 6-tube auto receiver will be no larger than its 6-volt counterpart was. The filter system will have to be a little better than the original one, as it will have to remove hum of a lower frequency. A pair of 20μf electrolytic condensers and a 10-henry choke will be adequate if a PM speaker is used. If you desire a field-coil model, select one with a 1000-ohm field and use the field for the choke.

If you cannot find a diagram for your receiver, it is still not difficult to connect the power supply. Nearly all auto receivers have a pentode in the output stage and a few have push-pull pentodes. In any case, locate the screen and connect B-plus from the power supply. The negative side of the power supply is connected to the chassis. The 6.3-volt winding can be connected to the heater pins on the output tube. Fig. 1, the diagram of the power supply, shows how it is connected to the auto radio.

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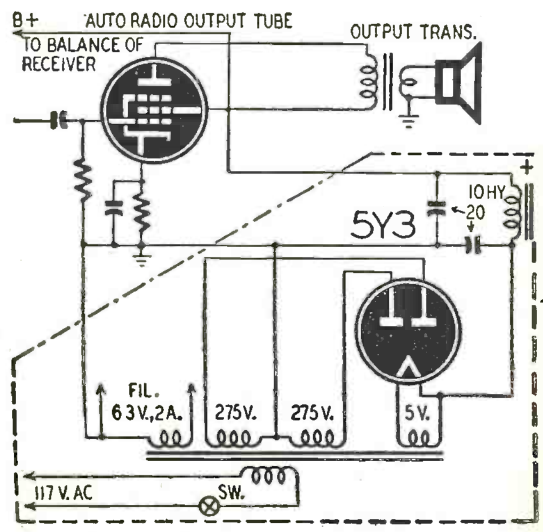


Fig. 1—How a power supply can be connected.

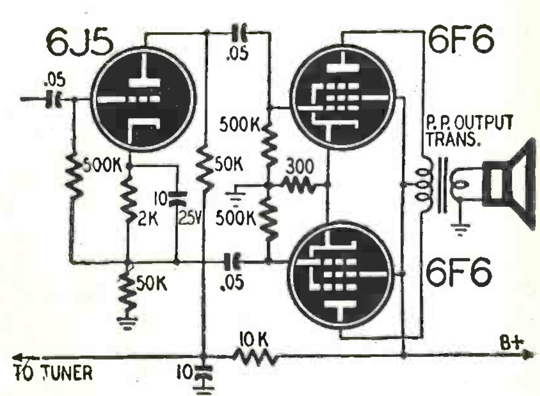
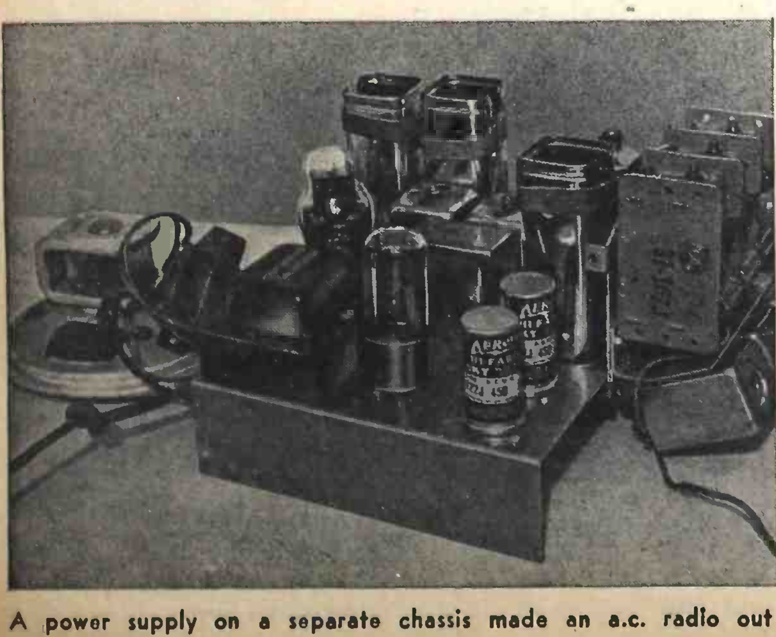
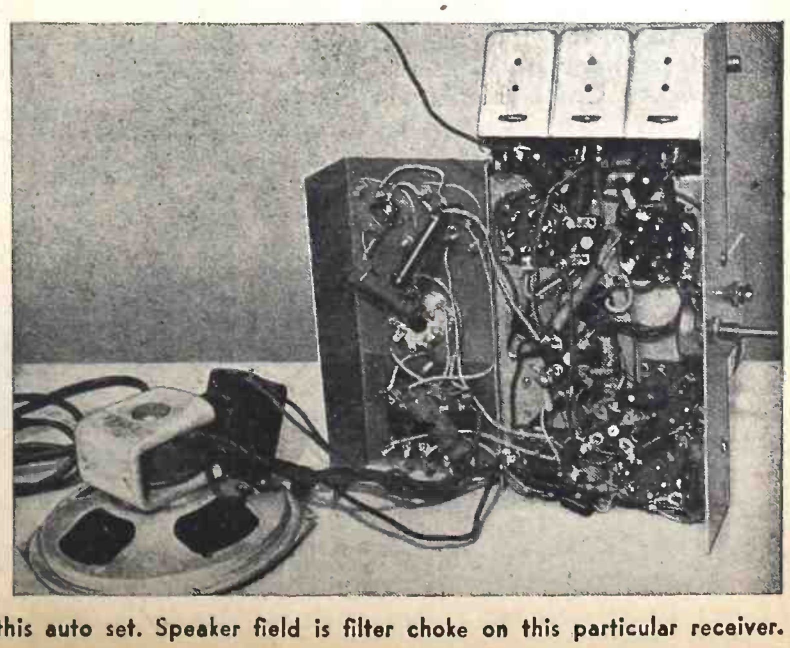


Fig. 2—Method of adding a push-pull stage.





A power supply on a separate chassis made an a.c. radio out of this auto set. Speaker field is filter choke on this particular receiver.

By "TON"

FIGHTING AMATEURS

Many Netherlands "Hams" Gave Their Lives for Liberty

TWO years have now passed since our Homeland—after five years of oppression, five years of terror, five years of systematic starvation and impoverishment during which almost daily our best sons were murdered—was liberated; the day when our national (tricolor) flag could again fly in all liberty and we could again walk about adorned with orange colors; the day which meant the complete end of the insolent "unconquerable" master race. And finally, the day which gave the Dutch people the opportunity to get hold of all these parasites and traitors of their own flesh and blood. I could not be in Netherland on the day of liberation, as I was still detained in a German prison liberated by the Americans. But a radio set made by us in prison permitted us—the 150 Dutch political prisoners deep inside the hated Germany—to live intensely through all the happenings of that day.

On March 8th of this year—the anniversary of the mass murders, when hundreds of our compatriots were cowardly shot in retaliation for an attack on the Gestapo chief Rauter, a small group of us assembled at one of the mass-graves in Hague, where two of my best radio-amateur friends were buried, to commemorate these heroes.

COMMUNICATION WITH ALLIES

I don't think there is another group in Holland, where such a percentage participated in the active resistance as among the radio amateurs. Radio had a most important part to play in this war. Think just of the radio communications with England through which the Dutch Government in England was kept so well informed about the activities of the oppressor and his henchmen in the occupied Homeland.

This permitted the Dutch Government to take certain steps and also to instruct the Dutch people via Radio-Oranje.

We have to think of the contacts established with the Intelligence Service and through which the most important espionage reports and information were passed in connection with existing or planned military objectives.

Let us remember the underground press which would not have been in a position to work without radio communication, and last, think of the final phase of the war when the south was already liberated and when the radio helped to keep up contact with the still occupied west and north for the exchange of valuable information. It can be stated with great pride that many of our Dutch radio-amateurs participated in this most important, but also vulnerable and therefore highly dangerous work.

I had the privilege of working in the resistance with a great number of radio-amateurs and I have the deepest respect and greatest appreciation for their contribution.

These fellows never hesitated to stake their lives for the liberation of our homeland and the fight with the subduer. That was the fighting radio amateur at his best.

MARTYRS TO THE CAUSE

To many, alas, it was not given to see the results of their work. Others had to suffer loneliness and privations in deportation, prison and concentration camps. Thanks to God many succeeded in escaping from the grip of the Gestapo.

In this commemorative article I have to limit myself to friends with whom I have worked together and also to those who have made the highest sacrifice, who gave their lives for us. Later I hope to mention the important work of those who had the luck to be spared.

My first thoughts go to my great and true friends and fellow workers PA0RS—G. Reijns of the Hague, PA0GA—Th. C. van Braak of Varsseveld and PA0XK—A. van Mansum of Delft with whom I came in contact in 1941. Many of you will probably know these friends. GA, the sympathetic man of Achterhoek who gave his services gallantly to the homeland in every field and every capacity; RS, the man who knew no fear and who, together with the quiet but determined XK, continued their so important radio contribution after I was arrested, but who were also arrested on February 18, and shot on March 8, 1945—so short a time before the liberation. GA, who gave me numerous and important data, and so often gave me and my fellow workers shelter, was taken to Germany and died in the Concentration Camp Gross-Rosen near Breslau on December 31, 1944.

My thoughts are also with my friend PA0MO—Meertens of Zwolle, who was arrested in 1942 and had to give his young life in the German hell. I think of PA0XI—C. L. J. van Lent, Jr., of Heemstede, and PA0XL — Broeder Klingen of Heemstede, who also lost their lives as victims of the hated Germans.

I think of PA0QQ—C. Gehrels, of Eindhoven, and PA0OZ—J. H. op den Velde, of Zaandam, who were like myself, locked up in the Police Prison in Haaren, and with whom I could converse on several occasions in Morse

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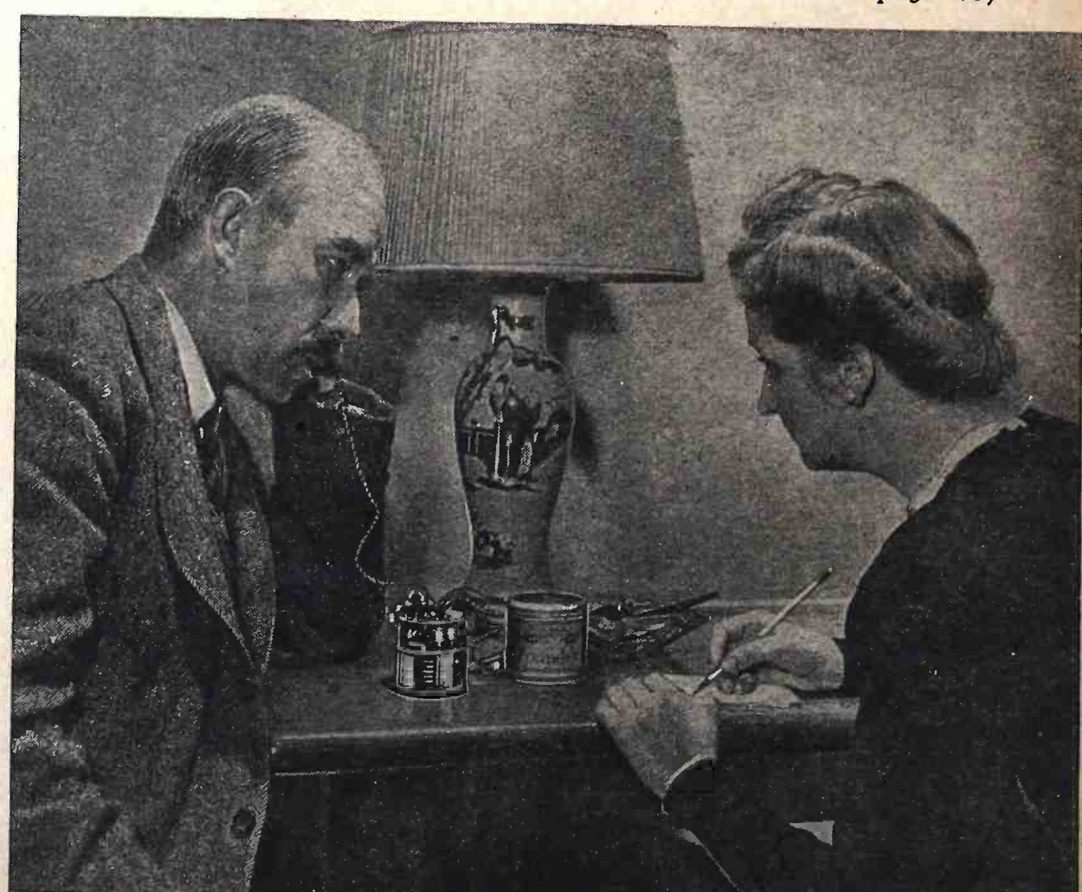


Photo Courtesy North American Philips

The Dutch Underground used sets like these to copy foreign broadcast news and messages.

By MILTON S. KIVER

TELEVISION FOR TODAY

Part V—Oscillators, R.F. and I.F. Stages

IN THE previous article we investigated the various types of high-frequency oscillators commonly used in television receivers. Instability in these oscillators, even if only slight, has the effect of shifting the frequency of the video i.f. signals, thereby producing distortion through the off-center positioning of the signal in the i.f. channel. To correct this situation, which is immediately obvious on the screen, a "fine tuning" control is incorporated in the receiver. It permits the observer to correct these minor frequency shifts during the broadcast. In fact, it is due to recognition of this shifting, especially when the set is first turned on, that many television stations transmit their distinctive station call letters for 15 minutes to a half hour before the start of the evening's program. This period is generally sufficient for the set to become stable.

This additional control could be eliminated if the oscillator remained in position. One solution is the use of a crystal-controlled oscillator. Such oscillators, of course, are not new, but they have not been used in AM receivers because of the unpracticability of providing a separate crystal for each possible station. With television, however (and even FM) the number of stations in any one community is limited and six or seven crystals would be sufficient.

The oscillator frequency for each of the first six channels is shown in the table. On these frequencies, it would be economically impractical or physically impossible to operate crystals at their fundamental frequency. Harmonic operation is thus indicated. It is toward this end that the circuit of Fig. 1 is designed. This is a grid-plate electron-coupled oscillator. The oscillating circuits consist of the grid (with its crystal), and the r.f. choke with the parallel .0001 µf condenser in the cathode leg. The screen-grid functions as the plate. The resonant frequency of the r.f. choke and .0001 µf condenser is lower in frequency than the crystal fundamental and this aids in the production of harmonics. To accentuate and strengthen the particular harmonic desired, a semi-fixed tuned tank circuit is inserted in the plate circuit of the tube. The frequency of L_1 and C_1 has no effect upon the oscillating action of the crystal. L_1 and C_1 would be pre-tuned by the manufacturer and thereafter ignored until a complete realignment was necessary. There would be one such tank set for every crystal in the set, brought into circuit by means of the selector switch SW2. The 10 µµf condenser aids oscillation. The 50,000-ohm resistor is a grid leak.

The type of tube to use will depend, to a large extent, upon the harmonic of the crystal. With each succeeding harmonic, the output voltage decrease is proportional to $\frac{1}{f}$. Hence, for the ninth or tenth harmonic, it is necessary that a power tube be employed. 6V6, 6L6, 6AG7 are typical power tubes that would prove satisfactory. For a lower harmonic, a 6AC7 could be substituted instead.

I.F. SIGNAL SEPARATION

The difference-frequency voltages present in the mixer plate circuit contain both the video and audio signals. It is desirable that they be separated as soon as possible for several reasons. First, both together require a bandwidth close to 5 mcs. If one i.f. system is used for both, the widened frequency response would adversely affect the gain. Secondly, it is important that none of the audio voltages reach the cathode-ray tube. Should this occur, alternate dark bands across the image result, their intensity dependent upon the strength of the audio voltage. Finally, FM and AM signals are not at all comparable and separate detectors must be provided for each. The clipping action of a limiter, so necessary for conventional discriminators, would completely destroy the video signal, which is amplitude-modulated.

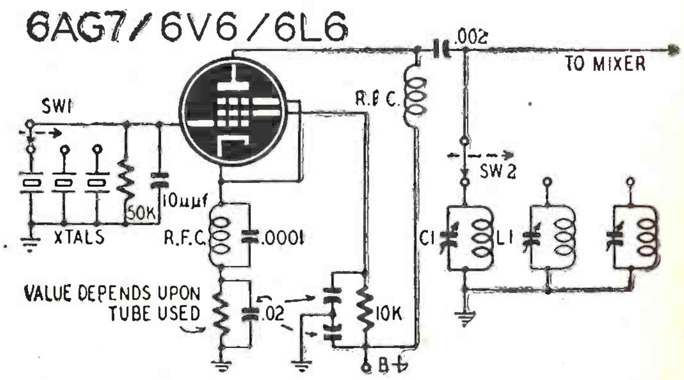
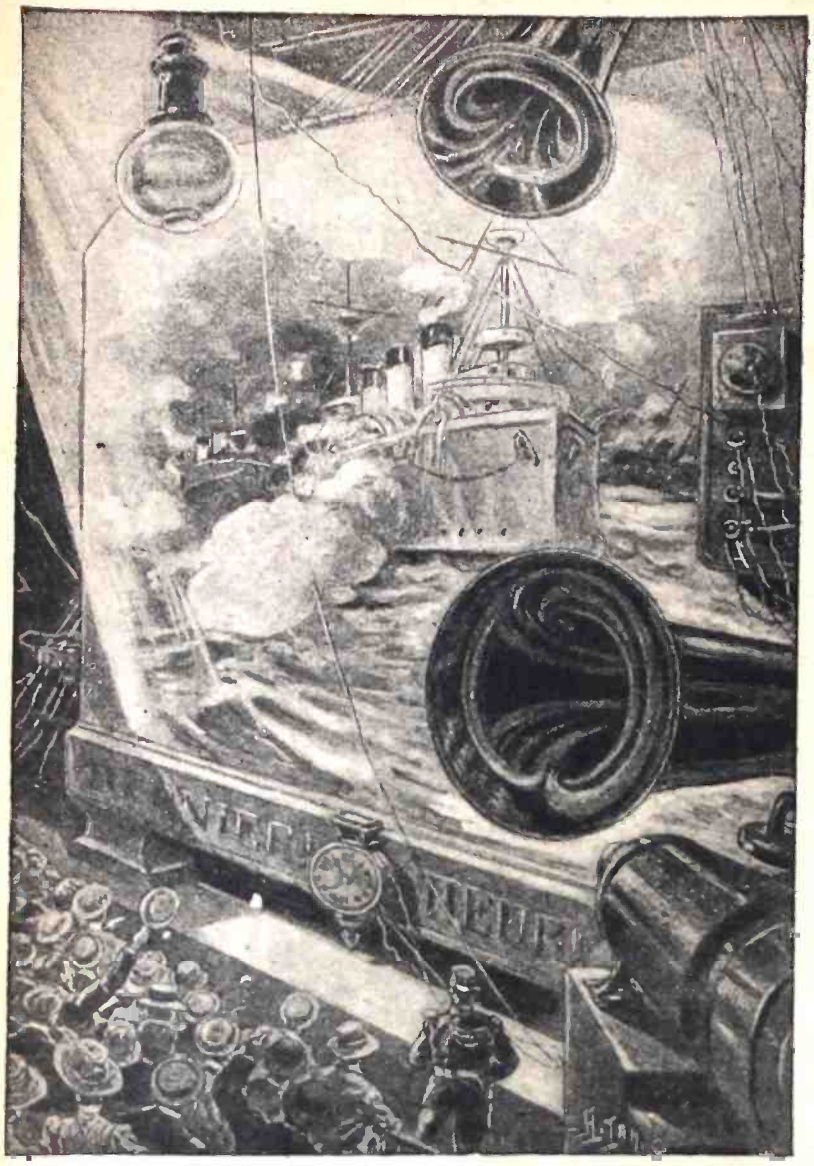


Fig. 1—Crystal-controlled circuit for television receivers.

Separation methods vary with each manufacturer, but all are basically similar. In previous G. E. models, the audio i.f. voltage was extracted through the suppressor grid of the 1st i.f. video amplifier tube. See Fig. 2. A positive voltage is placed on the suppressor grid

A 1906 prediction of television, in which it would be possible not only to see, but to shake hands with a friend electronically.



Photos from Three Lions

The 1906 televisor had sound, too! This was a newsreel, though it is not quite clear whether the screen shows a review or a naval battle.

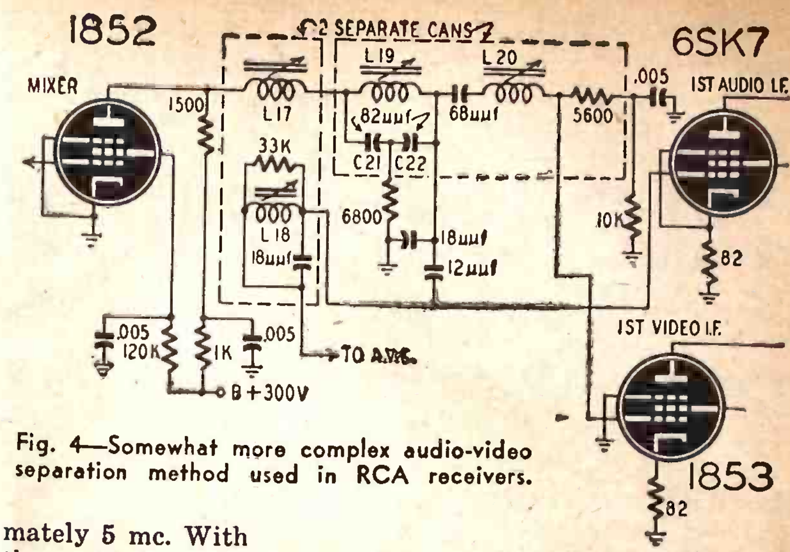


Fig. 4—Somewhat more complex audio-video separation method used in RCA receivers.

through the primary of the i.f. coupler leading to the audio i.f. stages. Due to the positive voltage, there is current flow in the suppressor grid circuit, a current containing frequencies of the audio and video i.f. signals. The tuned transformers of the audio system reject (or attenuate) the video signals and permit only the audio voltages to pass. Note that the input loading resistor of the 1st video i.f. stage is 1500 ohms while the output loading resistor is 2700 ohms. The reason is the difference in bandwidth of the incoming and outgoing signals. At the input we have both video and audio signals, requiring approximately 5 mc. With the audio voltages eliminated, output response reduces to 4 or possibly 3.5 mc.

In the Meissner television circuit, Fig. 3, the video and audio signals are separated simply by attaching a 2µµf condenser from the top of the mixer plate coil to the audio i.f. input.

The RCA network shown in Fig. 4 is much more extensive, requiring the use of a complex arrangement. L_{17} and L_{18} are enclosed in one shield and are inductively coupled. L_{18} connects to the audio i.f. system while L_{17}, which contains both video and audio signals, transfers its voltage to L_{19} and L_{20}, C_{21}, and C_{22}, and from the end of L_{20} to the 1st video i.f. amplifier.

As a final example, the two voltages are separated inductively by link coupling in the arrangement of Fig. 5. These four circuits are representative of the various methods used, in one modification or another, by practically all manufacturers.

It should be obvious that although we feed the audio i.f. voltage to a separate channel, yet this audio i.f. voltage, being close to the 21.75 mc end of the video signal, could quite possibly pass through the video stages and reach the screen. Since this can be very annoying, special wave traps are inserted to greatly increase the attenuation at the audio intermediate frequency of 21.25 mc. The wave traps may be either in series with the grid or cathode, as shown in Fig. 6 These are sharply tuned parallel resonance circuits, pre-set at the factory, but capable of adjustment by the service-man in the event of a complete alignment. A series resonant circuit between grid and ground of any of the video i.f.

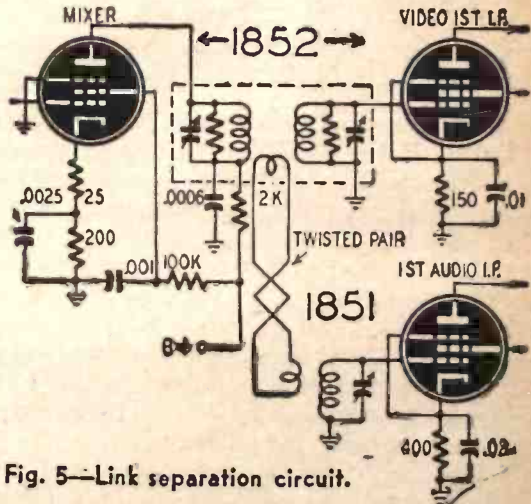


Fig. 5—Link separation circuit.

amplifiers will also accomplish the same purpose. See Fig. 7.

Wave traps may be aligned by placing a d.c. voltmeter across the detector load resistor (to be described in the next

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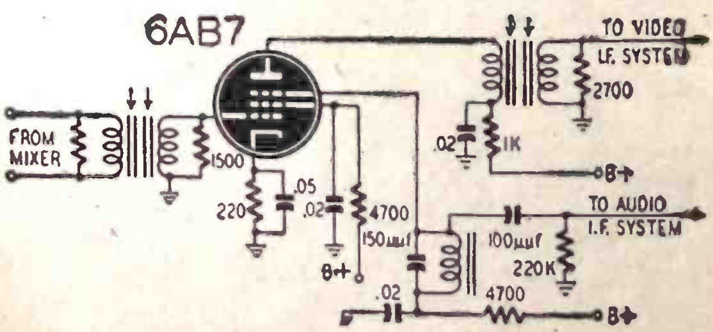
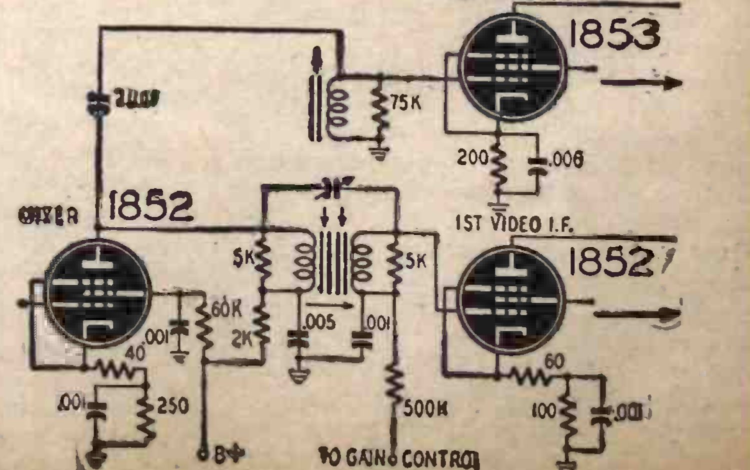


Fig. 2, above—Method used in some G. E. sets to separate audio and video i.f.'s. Fig. 3, right—Method used in Meissner receivers.



TRANSATLANTIC NEWS

From our European Correspondent, Major Ralph Hallows

THE British Broadcasting Corporation, sole provider of radio programs in Britain, has a network of low frequency and medium high-frequency high-power stations whose service areas cover about 90 percent of our population. The remaining 10 percent have always been a big problem. These people live in thinly inhabited parts of the country, mostly in valleys separated from one another by hills and mountains 1,000 to 3,000 feet high. The only possible solution is to erect considerable numbers of relay stations. There are no available channels for these on low, medium or high frequencies; therefore they must use v.h.f. With a view to obtaining comparative data for AM and FM and for horizontal and vertical polarization, the BBC research department has been conducting field tests during the past few years.

The tests were carried out on 45 and on 90 mc. The 90 mcs results are particularly interesting, since so little data on broadcasting on such frequencies has hitherto been available either here or in the U. S. A.

In Great Britain, certainly, opinion has been divided over the relative merits of FM and AM. Many believed that on 90 mc and above, where interference is much less severe than on lower frequencies, AM would be at least as good as FM, besides having the advantage of requiring a much narrower working channel. They have been proved by the tests to be entirely wrong. FM has emerged triumphant.

One of the reasons is that with the use of a limiter combined with a balanced discriminator, receiver noises can be so suppressed that a field strength as low as 50 microvolts/meter gives acceptable reception. The measured advantage of FM over AM for receiver noise is 25 db.

The most serious interference encountered on v.h.f is from automobile ignition systems. Here comparative measurements made with horizontal and vertical polarization have given particularly valuable results. There has been a belief on both sides of the Atlantic that horizontal polarization was the better, but precise measurements have been lacking. Those now made prove that for equal freedom from ignition interference on both 45 mc and 90 mc horizontal polarization requires a field strength only one third of that needed with vertical.

The following table shows the range of ignition interference with FM and AM on 45 mc, with horizontal polarization in both cases and using a half-wave dipole aerial 30 feet above ground.

Field Strength (micro-volts/meter)	Range of Ignition Interference	
	FM	AM
50	200 yards	Receiver noise very high.
100	150 "	Ignition noise very distorting at 100 yards, but
300	80 "	merging into set noise.
500	60 "	At 100 yds. ignition noise above receiver noise.
1,000	40 "	190 yards.
5,000	25 "	120 yards.

Similar tests made on 90 mc show that with FM the same degree of freedom from ignition interference is given with about one third the field strength needed on 45 mc. Thus with FM first-class urban reception with entire freedom from ignition interference can be provided by a field strength of 5 millivolts/meter on 45 mc or 2 millivolts/meter on 90 mc.

PRE-EMPHASIS COMPARISONS

Tests were conducted to ascertain optimum amount of pre-emphasis. Comparative measurements were made with pre-emphasis of 100, 75, 50 and 25 microseconds. These show that the choice lies between 75 and 50 microseconds. These indicated that with 75 microseconds a considerable reduction in modulation must be made in order to avoid distortion; this brings down the net gain in signal-noise ratio to about 5 db for receiver noise and very little indeed for ignition noise. For 50 microseconds the figures are: receiver noise reduction 7.5 db; ignition noise 4.5 db. It was, however, necessary to reduce modulation by 3 db; the net gain is thus 4.5 db for receiver noise and 1.5 db for ignition noise. A degree of pre-emphasis of 50 is therefore regarded as better than 75 microseconds.

SERVICE AREAS

Aerial height 500 ft. Aerial power 10 kw. Horizontal polarization. Height of receiving dipole 30 ft.

Freq.	Radius of Service Area in Miles			
	Grade I	Grade II	Grade III	Grade IV
45 mc	19	35	55	75
90 mc	26	38	49	57

Measurements made in the London area and in country districts of the north of England give the following figures for service areas on 45 and 90 mc. Grade I is a first-class service for urban areas sufficient to override practically all interference. Grade II is sufficient to override most ignition interference. Grade III is a first-class and grade IV a second-class rural-district service.

The corresponding field strengths are:

	Grade I	*Grade II*	*Grade III*	*Grade IV*
45 mc	5mv/m	1mv/m	200µv/m	50µv/m
90 mc	2mv/m	500µv/m	200µv/m	100µv/m

It appears, then, that frequencies of the order of 90 mc are going to be very useful for FM broadcasting, though considerable problems are presented by the "shadows" cast by intervening high ground. It is partly for this reason and partly because the receiving dipole for 90 mc is only half the electrical length of that for 45 mc (which means that a given field strength produces only half the voltage in the former) that the radius of the Grades III and IV service areas is less on 90 mc than on 45 mc.

SILENT SWITCH

Probably you dislike the ordinary noisy type of switch just as much as I do. To me the loud click that accompanies the switching on and off of radios, lights or power has always been an annoyance and I've often thought of designing a silent type, when I could find time to get down to it. Now the job has been done by somebody else and a very good job it is. In future all mains switches in my laboratory and on every piece of radio apparatus I build are going to be of the silent kind.

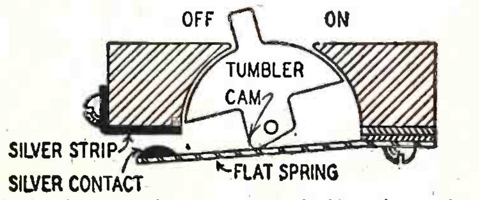


Fig. 1—This switch causes no click in the radio.

Fig. 1 shows how the Mutac switch, marketed by the British G.E.C., operates. The cam of the tumbler bears on a leaf spring, which carries at its free end a silver contact. With the knob of the switch in the on position, this contact closes the circuit since the action of the leaf spring presses it hard against a silvered strip. Turn the switch to the left in the drawing; the cam of the tumbler forces the contacts apart. There is no click as the switch is turned on or off.

Experiments have shown that the 50-cycle a.c. which is standard here can be interrupted efficiently by silver contacts actuated at comparatively low speeds. The speed imparted by the cam is amply sufficient to prevent arcing through restriking at the end of one cycle. The separation between the contacts when the switch is open is 0.025 inch. Though rated at 250 volts, 5 amperes, the switch will deal perfectly with currents up to 8 amperes.

By H. W. SCHENDEL

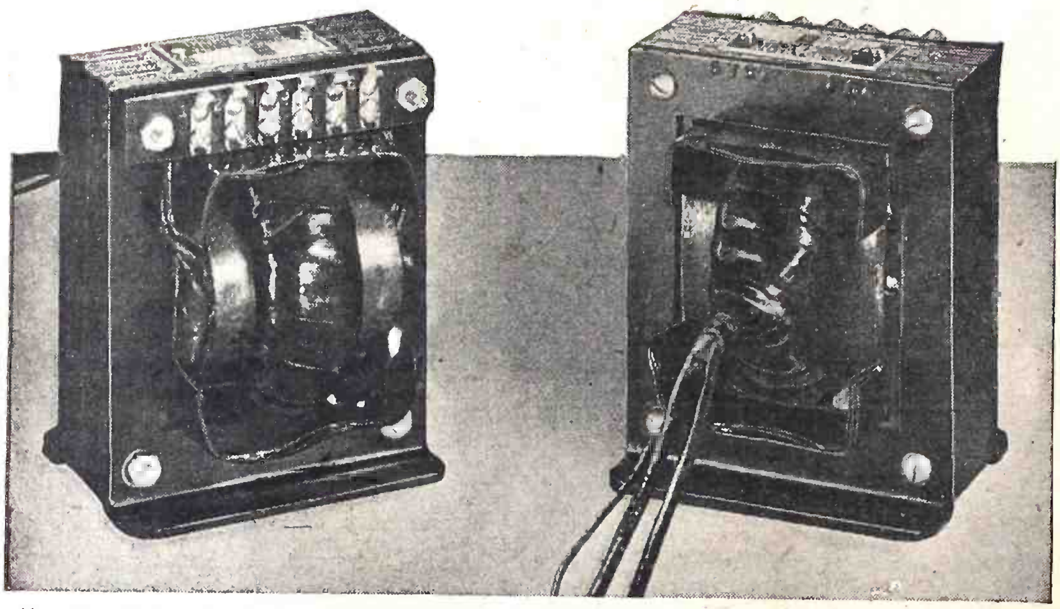
COILS, CORES AND MAGNETS

Part I—Magnetic Design Factors of Modern Radio Components

PROBABLY at some time or another most experimenters and amateurs as well as some servicemen have wished they could use the cores of some of those old electromagnets, filter chokes, or audio transformers in the junk box and rewind them to suit different conditions.

In rewinding power transformers to obtain new voltages it is possible to determine the essential final characteristics with a fairly small percentage of error even when all data on the core material are not available. Characteristics of other devices, especially those of reactors, filter chokes, audio chokes, and audio transformers, are more difficult to change. If due allowances are made for the many variables, it is possible to rewind the units for new operating conditions and obtain reasonably satisfactory results. This is true only when exact values of inductance are not critical.

In order to better understand the principles of magnetic devices let us get acquainted first with magnetic terms and symbols, magnetic effects and circuits, and the production of magnetic lines of force by electricity. Many beginners have much difficulty in remembering magnetic terms and the magnetic effects which the terms describe. These will be explained as clearly as possible as we go along.



Knowing design fundamentals, the radio man often may re-adapt commercial components.

Some confusion also arises from the fact that various systems use the same symbols but in each system the symbols have a different value. In this article all symbols and measurements will be in the English system with the inch as standard. Iron best exhibits the magnetic properties but a few other alloys and substances also do. There is no effective *insulator* for magnetism, but magnetism does travel more easily through some materials than others. Those materials may be used to *keep the magnetic effects confined to certain areas.* For such reasons we see heavy iron or alloy shields on transformers, chokes, and similar devices.

The attractive and repulsive effect of magnets is due to "magnetic lines of force" commonly called *magnetic flux* or just flux (Φ). A single line of force is called a *maxwell.*

Maxwells are measured by their effects. One method is to attach the ends of a single wire to a voltmeter. Then move the wire through a field of flux (as across the pole of a magnetic or electromagnet). If one volt is induced in the wire during a movement time of one second it would indicate the wire has just gone through, or cut, 100,000,000 (10^8) maxwells. More practical methods are usually used to obtain greater accuracy though the principles are the same.

An important point is that one maxwell is one unit magnetic line of force or flux and that *moving the field of flux* or changing its density (the number of lines of force per unit area) around a wire *has the same effect as moving the wire.*

To produce a strong field of magnetic flux, one having many lines of force or maxwells, with a single wire would require too much current and would not be practical for most applications. Therefore the wire is formed into a loop concentrating the flux within it. Then if we connect many loops in series, forming the turns of a coil, the magnetic flux of one turn will add to that of the next. This is the basic principle of the electromagnet.

The current flowing through a coil is the force which sets up the magnetic flux. This is *magnetomotive force* (m.m.f.) and may be compared to electromotive force in electricity. It is

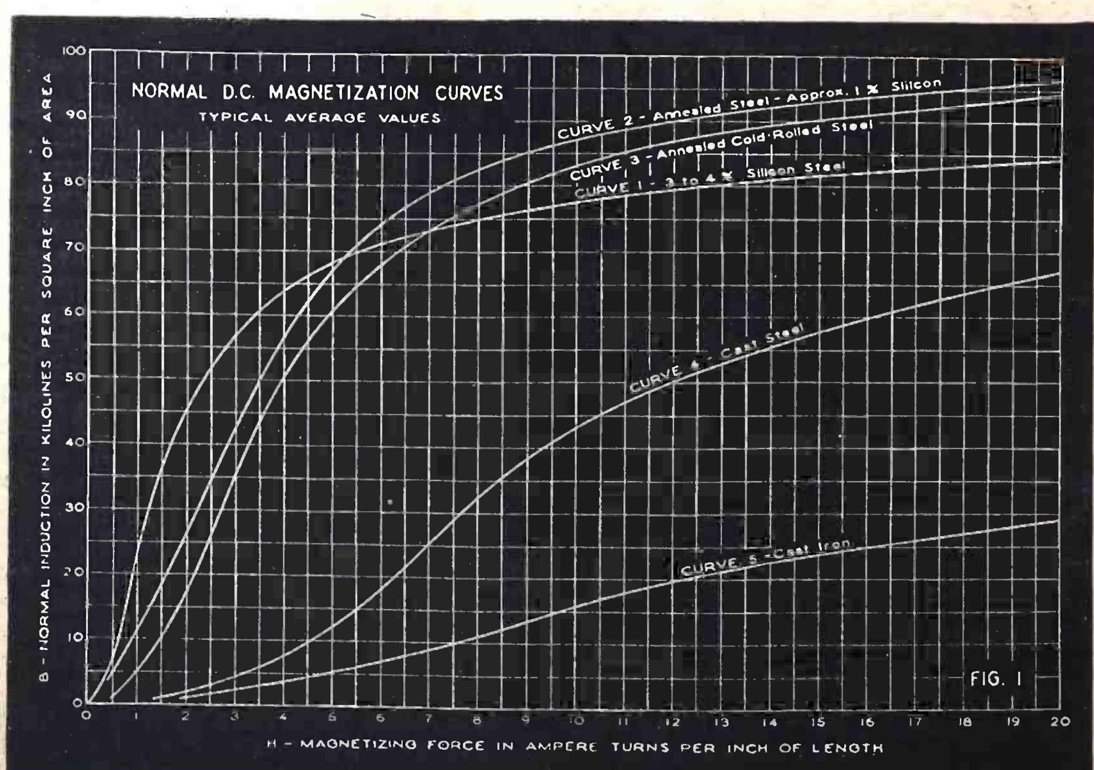


Fig. 1—The curves of the magnetic properties of steel are a prime design requisite.

measured by the number of *ampere turns* (NI). This number is obtained by multiplying the number of turns (N) in the coil by the amperes (I) flowing through the turns. For example, one ampere flowing through one hundred turns will produce one hundred ampere turns. Many other combinations will give the same product or whatever product is required.

Just as electrical resistance hinders the flow of electricity, magnetic resistance, or *reluctance* (R), hinders the flow of flux in a magnetic circuit. Therefore a formula similar to that for Ohm's Law is applicable to magnetic circuits. It is:

$$NI = R\Phi \text{ or, } \frac{NI}{\Phi} = R \text{ or } \Phi = \frac{NI}{R}$$

where symbols have the meanings explained above.

Permeance (P) is a term describing the ease with which flux may travel through a substance. It is the reciprocal (opposite effect) of reluctance ($P = 1/R$). In a magnetic circuit having different reluctances in series, the ampere turns—like voltage drops across series resistors—must be figured individually for each reluctance and then all added together for the total m.m.f.

Closely related to permeance is *permeability* (μ). Permeability is a value used to express the flux multiplying power of a material. If a certain m.m.f. produces one maxwell in an air core but will produce 5000 maxwells in an equal size core of some other material, the permeability of this other material is 5000. To simplify comparisons air is considered to have a permeability of one ($\mu = 1$) and all other materials are commonly rated to this base.

Magnetic induction (B), or flux density, is the number of lines of force, or maxwells, induced in each square inch of cross-sectional area (A) of the magnetic circuit. Thus $B = \frac{\Phi}{A}$ where Φ is the total flux of the entire area under consideration. Note closely that B refers to *a specific value of area*. This distinction must be remembered. Similar ones will appear in other terms to follow.

Previbusly we learned that ampere turns is a measure of magnetomotive force for an entire magnetic circuit. If we divide the ampere turns (NI) by the length (l) in inches of magnetic circuit we obtain a value of *magnetizing force* (*H*) for each inch length of the magnetic circuit. Therefore,

$$H = \frac{NI}{l}$$

THE MAGNETIC CIRCUIT

We now have definite magnetic terms covering units of volume, area, and length.

It has been proven by experiment that one ampere flowing through one turn of wire (one NI) enclosing exactly one square inch of area will force 3.19 maxwells through an air path one inch in length. With that as a base we have a magnetizing force, $H = 1$, a magnetic induction or flux density, $B = 3.19$. With $\mu = 1$ we can form a basic formula, $\mu = \frac{B}{3.19H}$, suitable for any material. Rearrangement of previous formulas will show the reluctance, R, of air to be .313 per cu. in.

The permeability, $\mu = 1$, for air has a constant value for all strengths of magnetic induction. As the ampere turns per inch is varied the lines of force per square inch, or magnetic induction, will vary in direct proportion. In iron the permeability is a variable and may go from one to over 10,000 depending on both the type of iron and the normal induction (the name for magnetic induction in a ferromagnetic material.) As the normal induction is increased from zero until the iron is saturated with flux the permeability will vary from a low value through a maximum to a final low approaching the μ of air.

Occasionally no information is available on the original coils. In those cases and in new designs it is desirable to have electrical and magnetic data on the steel or other material to be used. This information is obtained either by measuring the qualities of the material or from average curves furnished by most manufacturers of electrical steel. Most useful are *normal d.c. magnetization* curves, typical ones being shown in Fig. 1.

Curves vary not only with each different steel and alloy but also with the way the material is handled. Punching, shearing, machining, heat-treating, core shape, and other factors contribute to variations. Therefore it would be practically impossible to show curves for all steels under all conditions. Fig. 1 is intended to show only *average* magnetization curves.

In rewinding magnetic devices the induction will have an important effect on satisfactory results. The ampere turn product NI, once it has been carefully determined in the original design, is the main consideration in rewinding relays, speaker fields and similar devices for different d.c. voltages or currents.

The amperes and the turns may be varied through wide limits as long as the product of the two is kept the same. If we have .010 ampere flowing through 1000 turns our NI product equals 10 ampere turns. Our magnetic effect would be exactly the same if we had one ampere flowing through 10 turns.

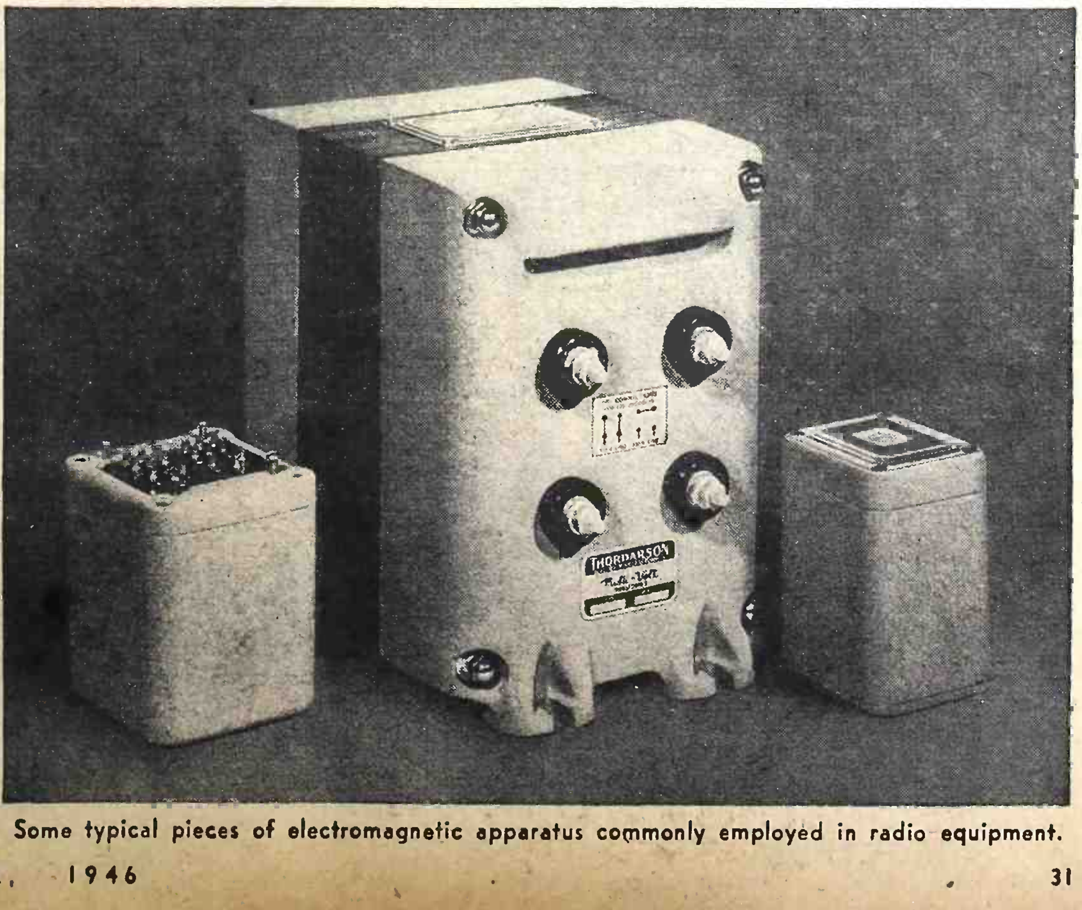
DESIGNING RELAY COILS

When the turns in the old winding are known or can be counted and the amperes for correct operation are known the rewinding problem is simplified. Otherwise it is necessary to know the original voltage or voltage drop, count the turns, obtain the size and length of wire to estimate the total resistance, then apply Ohm's Law to obtain the current, and finally determine the ampere turns. A reversal of the procedure with proper juggling of the values will enable you to rewind the coil for some specific current or voltage.

To find the wire length, add length of an inside turn to the length of an outside turn; divide by two; then multiply the answer by the number of turns in the coil.

A wire table may be consulted to estimate resistance, space required and other data for coil rewinding. In most cases relay, solenoid, speaker, and similar coils may be jumble wound with enamel wire unless extremely high voltage is used. Fine wires should have flexible leads attached. An article in the September 1942 RADIO-CRAFT gave many pointers on handling windings.

(*Continued on page 42*)



Some typical pieces of electromagnetic apparatus commonly employed in radio equipment.

Edited by A. C. SHANEY

SOUND ENGINEERING — No. 24

> This department is conducted for the benefit of RADIO-CRAFT subscribers. All design, engineering, or theoretical questions of general interest on PA installation, sound equipment, and audio amplifier design will be answered in this section. No circuit diagrams can be supplied by mail, all answers being printed in order of their receipt.
> (Note: when questions refer to circuit diagrams published in past issues of technical literature, the original, or a copy of the circuit should be supplied in order to facilitate reply.)

RADIO NURSE

The Question . . . .

1—I want to build an amplifier which will operate with a crystal mike, to use for a radio nurse to keep tab on my son isolated in his crib on the third floor while I am on the first floor.

2—How much gain would such an amplifier have?

Thanks, hope you can handle this.

R. H. WATKINS,
Chicago, Illinois

The Answer . . . .

Prewar, and postwar work has kept me from answering your questions sooner. You probably don't need this data now, but your question is being answered for the benefit of other readers who may desire to build a simple Radio Nurse.

1—Fig. 1 is a simple all-around amplifier that can be used for listening to sounds in remote rooms. A crystal microphone should be employed in the input and a suitable cable run to the speaker. If the distance between the loudspeaker and the amplifier is over 50 feet, a 500-ohm line transformer should be used at the speaker and coupled to a 500-ohm output transformer at the amplifier.

> RADIO-CRAFT is happy indeed to be able to again present Mr. A. C. Shaney and the Sound Engineering Department to its readers. Mr. Shaney returns from a war-enforced absence of more than four years (during which time readers continued to demand that the section be re-installed). From now on the Department will continue as in the past to answer all questions of general interest in the sound engineering field. Send your queries to Sound Engineering, RADIO-CRAFT, 25 West Broadway, New York 7, N. Y.

2—The overall gain of this amplifier is approximately 100 db.

ADDING AUTOMATIC PEAK LIMITER

The Question . . . .

I use a 6B5 20-watt amplifier (Fig. 2) for recording speeches, lectures, committee meetings, etc.

1—My problem is to get maximum intelligibility (voice) and maximum even volume so as to be able to understand each and every word spoken.

2—Can you show me how to incorporate a.v.c. or automatic peak limiter (whichever is simpler). I wish to do this in the simplest way consistent with good results. I have in mind a 6SJ7 and 6H6 tube, but I can't figure out how to incorporate them in this amplifier. Can you help me?

SCHUPP RADIO SHOP,
Redondo Beach, Calif.

The Answer . . . .

1—To obtain maximum intelligibility of voice, it is necessary to discriminate against the low frequencies (below 400 cycles). This may most easily be done by decreasing the size of the coupling condenser between the first and second stage. The use of a .006 μf condenser should produce the desired effect. If the amplifier is to be used for subsequent musical reproduction, it may be desirable to switch the original .05 condenser back into place.

2—Fig. 3 shows the circuit revisions which may be added to your amplifier to attain automatic peak limiter action. The usual method is to utilize a variable-mu tube whose gain is automatically changed (by a change of bias voltage obtained from some portion of the output of the amplifier) to compensate for increases in output level above some reference point. Usually, a 6K7 or 6L7 type of tube is employed. A 6J7 may be used in a special circuit wherein the suppressor grid voltage is altered to accomplish the effect.

To revise your amplifier, it will be necessary to replace the first 6C6 with a 6J7, and add the 6H6 as indicated. You will note that both 6B5 plates are coupled in a full-wave rectifier circuit through the 6H6. The negative voltage produced is then filtered and fed to the suppressor of the 6J7. If insufficient peak limiter action is obtained, you may reduce the size of the 2-meg coupling resistors to 50,000 ohms each. The 50,000-ohm potentiometer in the cathode circuit of the 6H6 determines the level at which rectification takes place.

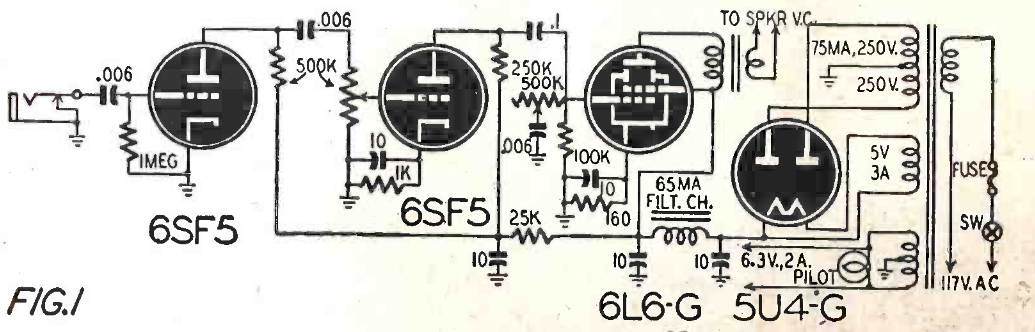


FIG. 1

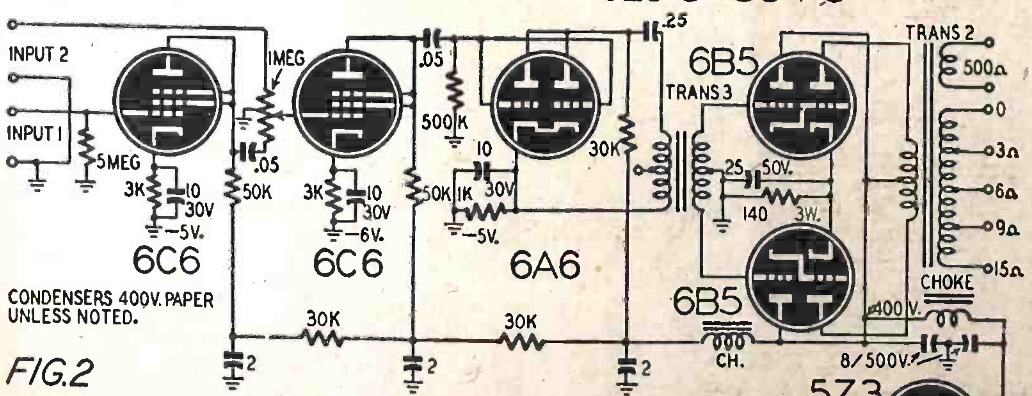


FIG. 2

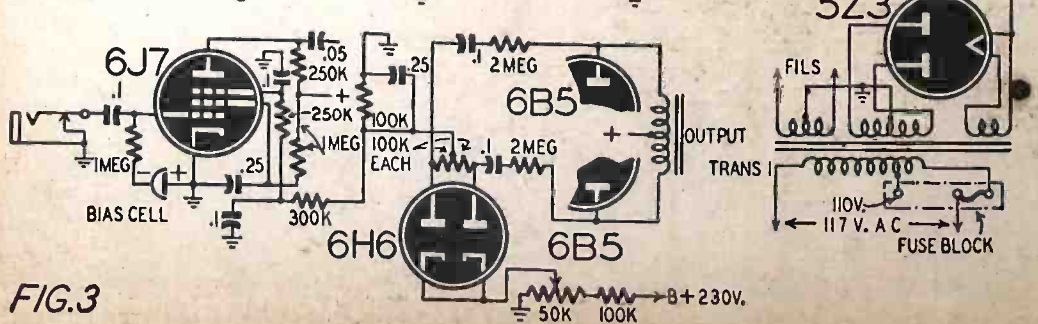


FIG. 3

Edited by ELMER R. FULLER

WORLD-WIDE STATION LIST

SHORT WAVE reception seems to have been improving slightly for the past few months, and it is hoped that by early winter, some really good dx can be pulled in. Several new stations have been reported lately, although some are only returns to former frequencies. PCJ is now being heard on 11.730 megacycles as well as on 9.590 megacycles. Schedule is not known yet, but they have been heard from 3:30 to 7 pm at various times.

Brussels, Belgium, has been heard lately signing on at 12:55 pm on 17.845 megacycles. Reception on this frequency is fair with signal strength about S-7 to 8. Radio Brazzaville now comes on the air at 11 am on 17.530 megacycles with an S-5 to 7 signal. Radio Moscow has been heard several times lately signing off at about 3:15 pm on 15.140 megacycles with a signal strength of S-8 to 9. The Australians are being heard again at 17.840 megacycles with VLC9 at Shepparton. They sign on at 7:30 pm; signal strength of S-7. At the same time, VLB8 has a program for eastern U. S. and Canada on 21.600 megacycles, but reception on this frequency has been very poor to bad.

ZFY on 6.000 megacycles in Georgetown, British Guiana, is heard from 5:15 about 8:30 pm when they start bad fading. They are on daily except Saturday. "Radio Macao" in China is heard about 7:30 am on 7.530 megacycles, with a good signal about S-6 to 7 with very little QRM. XCOA in Chungking, China, is heard on 9.730 megacycles from 11:30 pm to 12:45 am and 4:30 to 7:15 am. Vienna, Austria, is heard on 9.825 megacycles at midnight to 1 am; 6 to 11 am, and 10 am to 4:30 pm. XGOY in Chungking is heard on 11.900 megacycles at 7 to 8 pm; 5 to 5:30 am, and 5:45 to 6 am. CE1174 in Santiago, Chile, is heard on 11.750 megacycles at 7 am to 11:30 pm. VLC4 is heard from Australia on 15.315 megacycles beamed to North America from 8:45 to 9:45 am; and 12:15 to 12:45 pm. At times they are heard on this frequency as late as 9 pm before they sign off for the evening.

Next month we will have a story for you on station ZOY, located at Accra, British Gold Coast. Readers' correspondence is always welcome. Address all mail to Shortwave Editor, c/o RADIO-CRAFT, 25 West Broadway, New York City 7. Best of luck and lots of fb dx until next month.

All Schedules are Eastern Standard Time

Location	Station	Frequency	Schedule
PORTUGAL			
Lisbon	CSW	12.070	heard 1:30 to 3 pm
PORTUGUESE GUINEA			
Bissau		7.100	5 to 5:30 pm
RHODESIA			
Lusaka	ZQP	3.914	10:30 am to 1 pm
SOUTH AFRICA			
Capetown	ZRK	5.879	11:45 pm to 1:30 am; 10 am to 4 pm
Johannesburg	ZRH	6.028	11:45 pm to 1:30 am
Capetown	ZRL	9.608	3 to 7 am; 9 am to 4 pm
Johannesburg	ZRH	6.007	11 pm to 2 am; except Saturdays
Johannesburg	ZRG	9.520	3 to 7 am
Johannesburg	ZTJ	9.900	7:15 to 7:45 am
SPAIN			
Alicante		7.950	off at 6 pm
Madrid	EAQ	9.370	2 to 3 am; 7 to 9 am; 10 am to 5 pm; 6:30 to 9 pm
SPANISH MOROCCO			
Tetuan		6.065	5 to 6:15 pm
SURINAM			
Paramaribo	PZX3	5.750	6 to 8:45 pm
Paramaribo	PZX5	15.405	11:30 am to noon
SWEDEN			
Stockholm	SBU	9.535	1:30 to 5 pm; 8 to 9 pm; Sundays, only, 5 to 9 am
Stockholm	SDB2	10.780	3:15 to 5 pm
Stockholm	SBP	11.705	8 to 9 pm; 1:45 to 2:15 am; 6 to 7 am
Stockholm	SBT	15.155	6 to 7 am; 10 am to 1:15 pm; Sundays, 2:45 to 1:15 pm
SWITZERLAND			
Berne	HER3	6.165	1 to 3 pm
Berne	HEI2	6.345	12:30 to 1:45 am; 2:45 to 7 am; 1 to 5:15 pm; 8:30 to 10 pm
Berne	HET3	7.360	6:30 to 8 pm
Berne	HEK3	7.380	10 am to 12:30 pm; 3:15 to 3:30 pm; 8:30 to 10 pm
Berne	HEF4	9.185	North American beam, 7:15 to 7:45 am; 4:20 to 5:20 pm; 6.30 to 8 pm; 8:30 to 10 pm
Geneva	HBL	9.345	1 to 3 pm
Berne	HEI5	11.715	Tuesday and Saturday, 10 am to noon
Berne	HEK4	11.960	Tuesday and Saturday, midnight to 1:30 am
Berne	HEO4	15.875	2:15 to 2:50 pm
SYRIA			
Damascus		8.000	11 pm to midnight
TAHITI			
Papeete	FO8AA	6.980	Fridays and Saturdays 10 to 11:30 pm
TURKEY			
Ankara	TAP	9.465	11 am to 4:45 pm
Ankara	TAP	9.510	1 to 2 pm
Ankara	TAQ	15.195	4:15 to 8 am
UNITED STATES			
Boston	WRUW	6.040	Central American beam, 8:30 pm to 1 am
Boston	WRUA	9.570	European beam, 4:30 to 6 pm
Boston	WRUS	9.700	Central American beam, 6:30 pm to 1 am
Boston	WBOS	9.897	European beam, midnight to 3:15 am; 1 to 5:45 pm
Boston	WRUL	11.730	North African beam, 6 to 8:45 am; Mexican beam, 6:30 pm to 1 am
Boston	WRUW	11.730	European beam, 1 to 5 pm; Caribbean beam, 5:15 to 5:45 pm
Boston	WRUS	11.790	European beam 6 am to 4:15 pm; 4:30 to 6 pm
Boston	WRUW	15.130	European beam, 6 to 8:45 am
Boston	WBOS	15.210	European beam, 6 am to 12:45 pm
Boston	WRUL	15.290	North African beam, 9 am to 5 pm; Caribbean beam, 5:15 to 5:45 pm
Boston	WRUA	15.350	European beam, 6 am to 4:15 pm
Boston	WRUW	17.750	Central American beam, 6:30 to 8:15 pm; European beam, 9 am to 12:45 pm
Cincinnati	WLWK	6.080	South American beam, 7:30 pm to 12:15 am
Cincinnati	WLWO	9.590	European beam, 3 to 4:45 pm; South American beam, 6 pm to 12:15 am
Cincinnati	WLWRI	9.750	North African beam, 3:15 to 6 pm
Cincinnati	WLWK	11.710	European beam, 7:30 am to 4:30 pm
Cincinnati	WLWS2	11.710	South American beam, 5 to 7:15 pm; 7:30 to 9:30 pm
Cincinnati	WLWSI	11.810	South American beam, 5 to 7:15 pm
Cincinnati	WLWSI	15.200	European beam, 6 to 7:45 am; 1 to 5:45 pm
Cincinnati	WLWL2	15.230	North African beam, 6 to 7:45 am; 8 am to 12:45 pm; 1 to 5:45 pm
Cincinnati	WLWK	15.250	South American beam, 5 to 7:15 pm
Cincinnati	WLWRI	15.250	North African beam, 7:30 am to 3 pm
Cincinnati	WLWO	17.800	South American beam, 5 to 5:45 pm; European beam. 7:30 am to 2:30 pm
Cincinnati	WLWLI	17.955	European beam, 8 am to 12:45 pm
Los Angeles	KCBR	9.700	Oriental beam, 2 to 4:45 am; 5 to 11 am
Los Angeles	KCBF	9.750	South American beam, 11 pm to 1 am; East Indies beam, 4 to 9:45 am
Los Angeles	KCBR	15.270	Oriental beam, 4 to 10 pm; 10:15 pm to 1 am
Los Angeles	KCBF	17.850	South American beam, 5 to 10:45 pm
New York	WCBN	6.060	Mexican beam, 6:30 pm to 1 am
New York	WOOW	6.120	European beam, midnight to 3:15 am
New York	WNRE	7.565	European beam, midnight to 3:15 am; 4:30 to 6 pm
New York	WOOC	7.805	European beam, midnight to 3:15 am; 3:30 to 5:45 pm
New York	WCBX	9.490	Brazilian beam, 4 to 10:30 pm
New York	WRCA	9.670	Brazilian beam, 7 to 10:30 pm
New York	WNRA	9.750	European beam 1:45 to 6 pm
New York	WCBN	11.145	European beam, 1 to 5:45 pm
New York	WCRC	11.826	European beam, 6 to 10:30 am
New York	WCRC	11.830	European beam, 10:45 to 4:30 pm; South American beam, 5 to 11 pm
New York	WNBI	11.870	South American beam, 6:30 to 11 pm
New York	WOOW	11.870	European beam, 6 am to 5:45 pm
New York	WNBI	11.893	European beam, 1:15 to 4:45 pm
New York	WNRI	13.050	European beam, 6 am to 6 pm
New York	WNRX	14.560	European beam, 6 am to 3:45 pm
New York	WRCA	15.150	European beam, 7:30 am to 3:30 pm; Brazilian beam, 4 to 6:45 pm
New York	WOOC	15.200	European beam, 6 am to 3:15 pm
New York	WCBX	15.270	European beam, 6 am to 3:45 pm
New York	WNRE	15.280	European beam, 7:30 am to 4:15 pm
New York	WNBI	17.780	South American beam, 5 to 6:15 pm; European beam, 7:30 am to 1 pm
New York	WCBN	17.830	European beam, 6 am to 12:45 pm

(Continued on page 61)

RADIO TERM ILLUSTRATED

Suggested by Leslie F. Boner, Christopher, Ia.

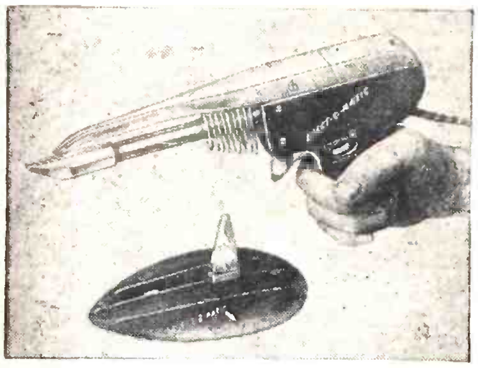
Baffled Speaker

NEW RADIO-ELECTRONIC DEVICES

AUTO SOLDERING IRON

Multi-Products Tool Co.
Newark, N. J.

The EJECT-O-MATIC is a new automatic-feed soldering tool designed for industrial and workshop use. It is trigger-operated and ejects a measured amount of solder from a reel concealed in the handle. The actual amount of solder deposited each time the trigger

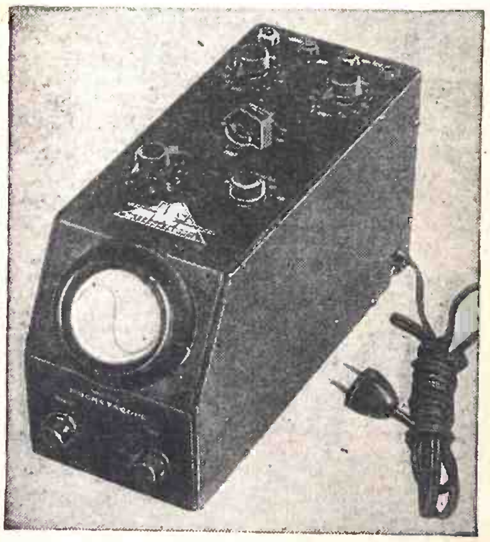


is pulled is regulated by a micrometer adjusting wheel mounted in the handle of the iron easily accessible to the operator's thumb.—RADIO-CRAFT

SMALL OSCILLOSCOPE

Waterman Products Co.
Philadelphia, Penna.

A new postwar development, the Pocketscope embodies all the functions of a conventional instrument but is so compact as to be easily held in one hand. It weighs only five and one-half pounds, is six and three-eighths inches high, three and three-quarters inches wide and 10 inches deep.



Vertical and horizontal deflection sensitivity is 1 volt RMS/inch and fidelity -2 db from 20 cycles to 100 kilocycles. The input resistance is half a megohm and input shunt capacitance 36 μμf. The time base oscillator ranges from 10 cycles to 50 kc.

The small oscilloscope has a complement of four tubes: one 6AU6, one 6J6, one 6X4 and the 2AP1A cathode-ray tube, and has a power consumption of 23 watts at 117 watts 60 cycles a.c.—RADIO-CRAFT

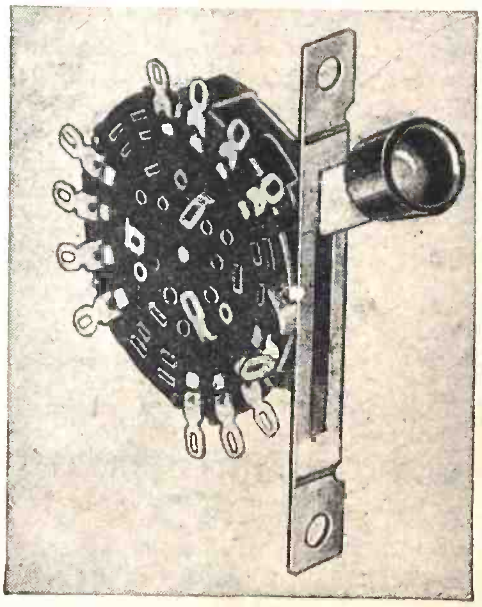
LEVER SWITCHES

P. R. Mallory & Co.
Indianapolis, Ind.

These lever action switches, known as the 5000 and 6000 series, accommodate a wide range of applications in industrial fields and test equipment, but are particularly adapted to intercommunication, centralized radio, sound distribution and public address equipment.

Switches offer a total of 26 circuit combinations, including two, three and four positions, all with positive indexing at 20 degrees between positions.

Switch contacts will make and break 120 milliamperes at 110 volts d.c. and 50 milliamperes at 250 volts d.c. Contacts will carry 10 amperes without excessive heating.—RADIO-CRAFT



MASTER TESTER

Reiner Electronics Co.
New York, N. Y.

The Master Tester is equivalent to 61 individual single-range meters, with eight types of testers in one instrument: 1. Insulation Tester. 2. Capacity Meter. 3. Ohmmeter. 4. A.c. Voltmeter. 5. D.c. Voltmeter. 6. A.c. Ammeter. 7. D.c. Ammeter. 8. Impedance - Inductance Meter. Ranges of the Model 456 are: Alternating current 6-15-30-60-150-300-600-1500-3000-6000 - 15,000 - 30,000 ma. Direct Current 6-15-30-60-150-300-600-

1500-3000-6000-15,000-30,000 ma. A.c. volts 3-6-15-30-60-150-300-600-1500-3000-6000. D.c. volts 6-15-30-60-150-300-600-1-500-3,000-6,000. Ohms 0-1,000-10,000-100,000-1 meg-10 meg-100 meg-1,000 meg. Insulation Tests 500 volt/0-10,000 megohms; 1,000 volt/0-20,000 megohms. Capacity High 5-2,000 .5-200, .05-20 .005-2 .0005-.2 .00005-.02 microfarads. Capacity Low 1-100 micro-microfarads. Resistance measurements can be made from 0.1 to 1000 megohms. —RADIO-CRAFT

ELECTRONIC VOLT-OHMMETER

General Electric Co.
Schenectady, N. Y.

The Type PM-17 electronic volt-ohmmeter is capable of measuring a.f. and r.f. voltages, from 60 cycles to over 100 megacycles.

The a.c.-r.f. voltage ranges are 0-1-3-10-30-100. The input capacity of the r.f. probe is 6.6 μμf.

D.c. ranges are 1 and 10 times the ranges of the a.c.-r.f. scale. The input impedance varies from 30 to 10 megohms at voltages up to 100 volts. It is constant at 10 megohms between 100 and 1000 volts.

The basic resistance scale is from 2 to 1000 ohms with 10 ohms center scale. Three additional ranges permit multiplying the basic range by 100, 1000 and 100,000 to extend the high ohms range to 100 megohms.—RADIO-CRAFT

RECORD CHANGER

Webster-Chicago Corp.
Chicago, Ill.

The model 70 is an automatic record changer that will play a 1⅛-inch stack of 10- and 12-inch records intermixed in the same stack.

An automatic "disengage" device relieves pressure on the rubber drive wheel when the machine is not in use. This model also uses velocity trip, automatic shut-off, improved rim drive, and 4-pole shaded pole motor. The stainless steel spindle is spring cushioned to prevent center hole wear of records.—RADIO-CRAFT

RADIO DATA SHEET 340

CROSLEY MODEL 106CP

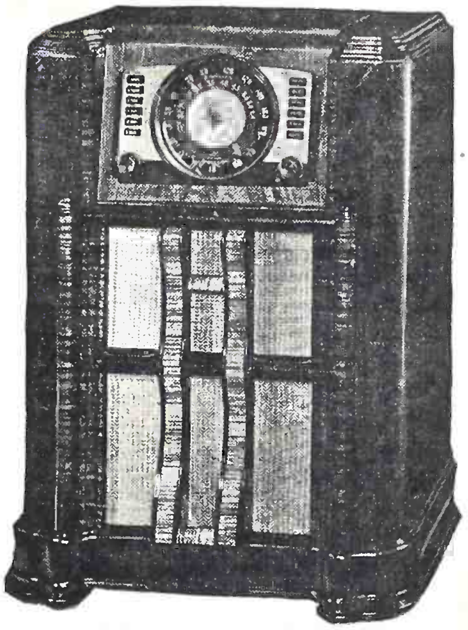
TYPE: Ten-tube, three-band, superheterodyne.

FREQUENCY RANGE: American Broadcast Band, 540 to 1600 kc. (Selector Switch at AMERICAN position.)

Police Broadcast Band, 2.2 to 6 mc. (Selector Switch at POLICE position.)

Overseas Short-wave Band, 5.8 to 18 mc. (Selector Switch at O'SEA position.)

INTERMEDIATE FREQUENCY: 455 kc.
POWER SUPPLY: 60 cycle a.c. only.
VOLTAGE RATING: 105-125 volts.
POWER CONSUMPTION: 85 watts
POWER OUTPUT: 8.5 watts minimum.
VOLTAGE DROP ACROSS SPEAKER FIELD: 130 volts.
RESISTANCE OF SPEAKER FIELD: 2100 ohms.



ALIGNMENT CHART

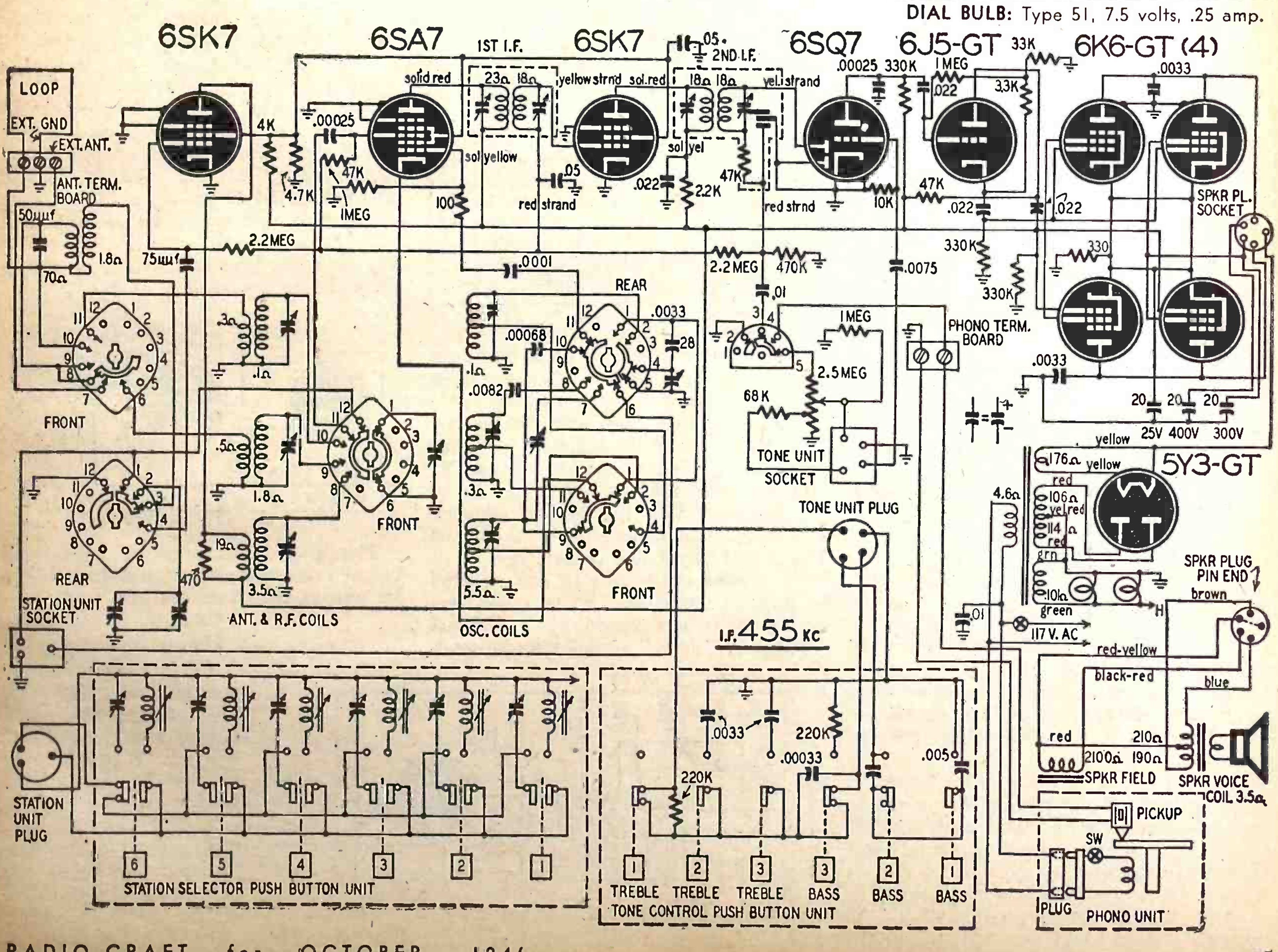
Alignment Sequence	Signal Generator Output: Frequency in kc.	In Series With	To	Position of: Band Switch	Tuning Dial	Adjust for Maximum Output
1	455	200 mmf.	Rear Gang Section	American BC	Fully Open	Both I.F.'s
2	1400	200 mmf.	Ext. Ant.	American BC	1400	B.C. osc
3	1400	200 mmf.	Ext. Ant.	American BC	1400	B.C. R.F.
4	600	200 mmf.	Ext. Ant.	American BC	600	B.C. Pad.
5	6500	400 ohms	Ext. Ant.	Police	Fully Open	Police osc
6	6000	400 ohms	Ext. Ant.	Police	6000	Police ant.
*7	18,300	400 ohms	Ext. Ant.	Overseas	Fully Open	S-W osc
8	18,000	400 ohms	Ext. Ant.	Overseas	18,000	S-W ant.

The American Broadcast Band must be aligned with the loop antenna connected.
***NOTE: When aligning the short-wave oscillator trimmer, be sure that the circuit is aligned at the correct frequency and not at the image frequency which is 910 kilocycles lower as indicated by the receiving dial.**

TUBE COMPLEMENT

Type	Function
6SK7 (or GT/G)	R.F. Amplifier
6SA7 (or GT/G)	Converter
6SK7 (or GT/G)	I.F. Amplifier
6SQ7 (or GT/G)	Detector AVC, 1st A.F. Amplifier
6J5 (or GT/G)	Phase Inverter
6K6 GT/G)	(4) Push Pull Parallel Output
5Y3 GT/G	Rectifier

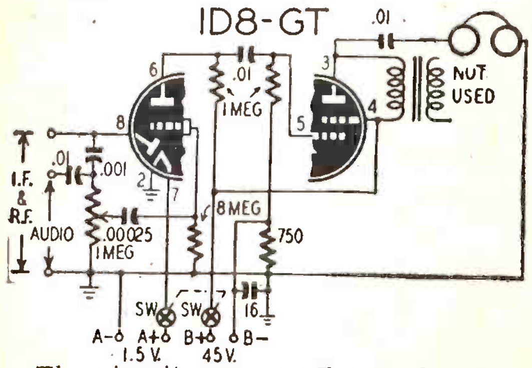
DIAL BULB: Type 51, 7.5 volts, .25 amp.



RADIO-ELECTRONIC CIRCUITS

ONE-TUBE TRACER

A handy signal tracer can be built with only one tube and a few spare parts. It is battery powered and is ready for use at the turn of a switch. It may be used without causing hum in the set and no special precautions are necessary when testing a.c.-d.c. receivers.



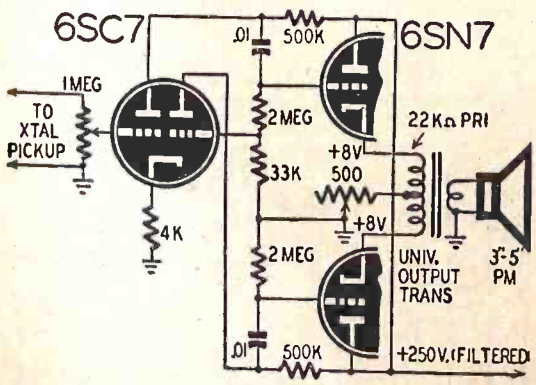
The circuit uses a 1D8 as detector, 1st. a.f. and power amplifier. Audio signals are applied to the grid of the triode amplifier through a .01 condenser. R.f. and i.f. voltages are picked up with a suitable probe and fed to the detector diode. The pentode section of the tube is the power amplifier and is impedance coupled to a pair of headphones.

Power is supplied by a 1½-volt cell and a small 45-volt B battery.

A. Malinick,
White Plains, N. Y.

LOW-DRAIN AMPLIFIER

Here is a circuit of a unique phono amplifier. The tubes draw only about 17 ma from the B supply, yet output is sufficient to give comfortable room volume. A good speaker should be used to take advantage of the excellent quality.



Distortion is reduced to a negligible value by using a cathode follower output stage. Cathode bias is adjusted to 8 volts by a variable 500-ohm cathode resistor.

An old power transformer is used as the output transformer. If several transformers are available each should be tried, with various winding combinations, for the best match.

Ralph H. Rethoret,
Montreal, Que.

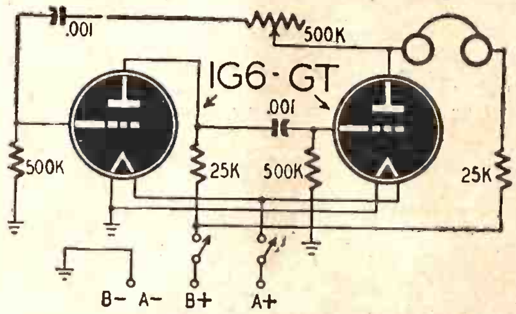
CODE OSCILLATOR

Here is a diagram of a simple code practice oscillator. It uses a 1G6GT twin triode. Variable pitch control over a wide range is possible through the use of a 500,000 ohm potentiometer in the feedback circuit.

Filament and battery power are supplied from a 1½-volt flashlight cell and 67½-volt Minimax respectively. A d.p.s.t. switch on the tone control is used in the positive side of the A and B leads.

Arthur A. Day,
Los Angeles, Calif.

(Note—If a d.p.s.t. switch is not available, a s.p.s.t. switch in the common negative lead will be satisfactory.—*Editor)*

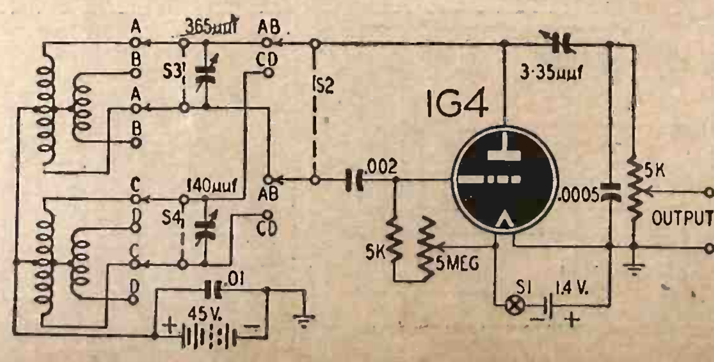


Radio-Craft welcomes new and original radio or electronic circuits. Hookups which show no advance on or advantages over previously published circuits are not interesting to us. Send in your latest hook-ups—Radio-Craft will extend a one-year subscription for each one accepted. Pencil diagrams—with short descriptions of the circuit—will be acceptable, but must be clearly drawn on a good-sized sheet.

BATTERY SIG GEN

A few parts from the junk box may be assembled into an efficient portable signal generator. The circuit is a standard Hartley oscillator using a 1G4 or 30 tube. It covers from 160-kc to 15-mc using fundamentals. Frequencies as high as 60 mc may be covered by using the harmonics of the high frequency coil. It is compact enough to be housed in a metal box 6x6x5 inches.

Four coils are used and are selected by ganged switches. The two low frequency coils are tuned by a 365-μμf condenser. The r.f. signal may be modulated at will by adjusting the variable grid-leak to give grid-blocking action. Power for the plate and filament is supplied by a single flashlight cell and a small 45-volt B battery.



All coils are "jumble-wound" on ½-inch diameter wooden dowel and are center-tapped. They are wound to cover approximately ½-inch of winding space. The coils are wound as follows:

A-A	450 turns	No. 32 d.s.c
B-B	175 turns	26 d.c.c
C-C	65 turns	22 enamel
D-D	25 turns	18 enamel

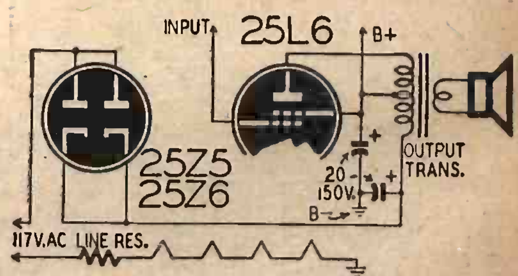
Oric Lefebvre,
Trois-Rivieres, Que.

(Note: A single tuning control may be used by ganging the tuning condensers. The same effect may be had by removing half of the rotor plates from one section of a ganged broadcast tuning condenser, thus making a unit which will have one 365-μμf section and one with a capacity of approximately 180 μμf.—*Editor)*

NOVEL FILTER CIRCUIT

Here is an idea that I used when building a small a.c.-d.c. receiver. Instead of using a separate filter choke and output transformer, I used a push-pull output transformer for a single-ended amplifier.

The pulsating voltage from the cathode of the rectifier is connected to one end of the primary of the output transformer and the power amplifier plate was connected to the other. Two filter condensers, connected as shown, will supply adequate filtering. Positive voltage for other parts of the set are taken from the center tap.



The same idea may be used with larger receivers and amplifiers if heavier output transformers are used.

Carl H. Schuppee,
Milwaukee, Wis.

(This experimenter was no doubt fortunate in getting just the right output transformer for his job. However, the general idea has been used in commercial sets, and may be worth trying, especially if several output transformers are available.—*Editor)*

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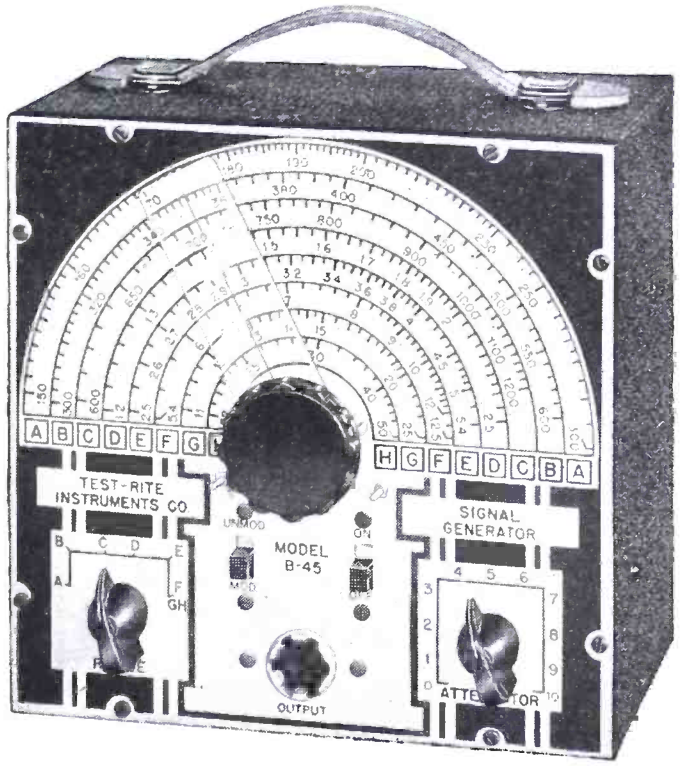

Model B-45 uses a beautifully processed dual-tone front panel. Comes housed in a heavy-gauge crystalline steel cabinet complete with shielded test lead, self-contained batteries and instructions.

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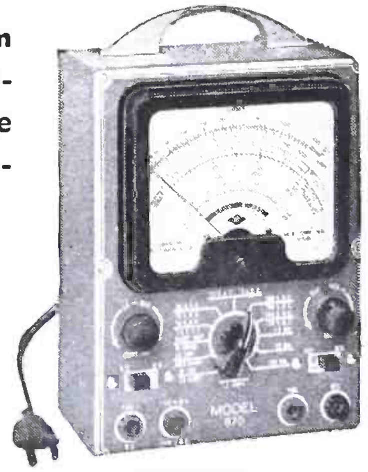

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COILS, CORES AND MAGNETS

(Continued from page 31)

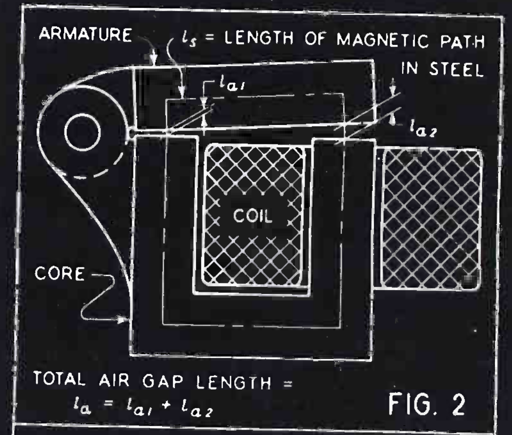
Let us suppose we are to find the ampere turns for a coil to excite the magnetic circuit of a relay or electromagnet constructed along the lines shown in Fig. 2. The coil is to be operated from a d.c. circuit. The steel usually used for this type of application has magnetic properties similar to that of Curve 2, Fig. 1.

Assume the core is laminated, .75-inch wide, and is stacked to a height of .89 inch. Because scale, varnish, and other variations cause minute spaces between laminations the stacked height should be multiplied by a *stacking factor*, usually about 0.9, to obtain the effective value of solid metal. Thus, 0.9 x .89 = .80 inch effective stack, and .80 x .75 inch = 6 square inches, the effective cross-sectional area of metal in the core. The average or effective length l_s of the core is nine inches while the effective length of series air gap l_a is assumed to be .005 inch. This is the sum of l_{a1} plus l_{a2} (Fig. 2). The effective cross-sectional area of the air gap will be equal to the gross area of the core or, .75x.89″ = .67 square inch.

The ampere turns will have to be computed separately for the steel and for the air gap. The results are added because the reluctances are in series.

Lines of force in magnetic circuits always travel through the complete circuit just as electricity does. This means we have the same number of lines of force or flux across our air gap as through the steel.

Magnetic induction for any specified area determines the total flux to be used throughout the magnetic circuit. Usually a normal induction of 45,000 to 100,000 lines per square inch is common for



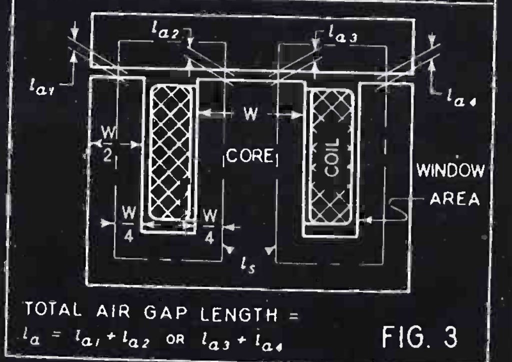


Fig. 2 (above)—The air gap shown here, and in Fig. 3 (below), are functions of the induction.

steel, depending on the type of steel, overall efficiency, and the necessary magnetic pull, if any. Magnetic efficiency is best at the highest permeability $\left(\frac{B}{3.19H}\right)$. The steel of Curve 2, Fig. 1 has highest permeability at a normal induction B between 50,000 and 55,000 lines per square inch. For Fig. 2 we will use a B of 55,000 for the steel. As the core area is only 0.6 square inch, the total flux will be 0.6 times 55,000 or 33,000 maxwells.

The same number of maxwells will have to be forced across the air gap where the magnetic induction *B* will be 33,000/.67 or 49,250 lines per square inch.

Again referring to Curve 2, Fig. 1, we find at a *B* point of 55,000 that *H* will be 3.9, the ampere turns necessary to force the flux through each inch length of the steel. As the steel core has an average length of 9 inches we will need a total of 9 x 3.9 = 35.1 ampere turns for the steel.

In the air gap, Fig. 2, the magnetic induction is 49,250 as explained previously. Applying the formula, $\mu = \frac{B}{3.19H}$ ($\mu = 1$, for air) we find the magnetizing force *H* to be 15,440, the ampere turns per inch. As the air gap has a length of only .005 inch we will need a total of .005 x 15, 440 = 77.2 ampere turns for it.

You will notice that a small change in the effective length of air gap will produce a great change in ampere turns needed. For an air gap length of .2 inches we would need .2 x 15, 440 = 3,088 ampere turns to force 33,000 maxwells across the gap. The ampere turns for the steel would be small compared to this.

Summing up the ampere turns for the steel, 35.1, and air gap, 77.2, shows we would need a coil having about 112 ampere turns, the total MMF. It is well to allow some extra ampere turns for flux leakage.

The following formula, a combination of previous formulas, which may be applied to any material and cross-section, may simplify calculation of ampere turns. Thus $NI = \frac{H\Phi l}{BA}$ where NI equals ampere turns for a specified material of uniform cross-sectional area and length, *H* is magnetizing force per inch length, Φ is the total flux in the magnetic circuit, *l* is length of uniform cross-section in inches, A is area of cross-section in square inches, and *B* is the induction per square inch. For air the formula would become $NI = \frac{\Phi l_a}{3.19A}$ where l_a would be length of air gap in inches.

In new or rebuilt designs consideration must be given to the maximum watts (W_{max}) which a coil can safely dissipate. These may be determined

(Continued on page 47)

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KENTUCKY

Lexington
Kentucky Radio Supply Co.
519 Georgetown St.

Radio Equipment Co.
377 East Main St.
Louisville
Peerless Electronic Equipment Co.
912-914 So. Second St.
Newport
Apex Distributing Co.
506 York St.

LOUISIANA

Lafayette
Radio-Electronic Supply
1419-21 Cameron St.
Monroe
Hale & McNeil
301 Pine St.
New Orleans
Radio Parts, Inc.
807 Howard Ave.

Walther Bros. Co.
714 Howard Ave.

MAINE

Bangor
Radio Service Laboratory
45 Haymarket Sq.

MARYLAND

Baltimore
Henry O. Berman Co., Inc.
12 E. Lombard St.

D & H Distributing Co.
31 E. Lee St.

Royal Radio
941 Penna. Ave.

Wholesale Radio Parts Co., Inc.
311 W. Baltimore St.

MASSACHUSETTS

Boston
Hub Cycle & Radio Co., Inc.
596 Commonwealth Ave.

Sager Electrical Supply Co.
201 Congress St.
Lawrence
Hatry & Young of Mass., Inc.
639 Essex St.
Melrose
Melrose Sales Co.
407 Franklin St.
New Bedford
C. E. Beckman Co.
Commercial St.
Springfield
Springfield Radio Co., Inc.
405 Dwight St.
Worcester
Radio Electronic Sales Co.
46 Chandler St.

Radio Maintenance Supply Co.
19-25 Central St.

MICHIGAN

Ann Arbor
Purchase Radio & Camera Shop
605 Church St.
Berkley
The J. M. Morel Co.
1949 Woodward Ave.
Detroit
M. N. Duffy & Co.
2040 Grand River Ave.

Hershel Radio
5249 Grand River Ave.

Radio Supply & Eng'er'ng Co., Inc.
129 Selden Ave.
Flint
Radio Tube Mdse Co.
508 Clifford

Shelton Radio & Appliance
2914 North Saginaw St.
Jackson
Fulton Radio Supply Co.
707 S. Blackstone St.
Lansing
Electric Products Sales Co.
427 E. Michigan Ave.
Muskegon
Industrial Electric Supply Co.
1839 Pack St.
Saginaw
Orem Distributing Co.
801 E. Genesee Ave.

Radio Parts Co.
234 S. Second St.

MINNESOTA

Duluth
Northwest Radio
109 E. First St.
Minneapolis
Lew Bonn Co.
1211 LaSalle Ave. So.

Northern Radio Laboratory
3927 East Lake St.

Ron's Radio Supply
4001 Bryant Ave. So.

MISSOURI

Cape Girardeau
Suedakum Electronic Supply Co.
902 S. Sprigg St.
Springfield
Harry Reed Radio & Supply Co.
833-37 Boonville Ave.

MONTANA

Butte
Geo. Steele & Co.
126 W. Broadway

NEBRASKA

Omaha
Alco Radio, Inc.
411 Cuming St.

All-State Distributing Co.
2857 Farnam St.

H. C. Noll Co.
2226 Harney St.

Omaha Appliance Co.
18th & St. Mary's

Radio Equipment Co.
2820-22 Farnum St.

NEW HAMPSHIRE

Concord
Evans Radio
18 N. Main

NEW JERSEY

Bridgeton
Joe's Radio Shop
67-69 S. Pearl
Newark
Radio Wire Television, Inc.
24 Central Ave.

Variety Electric Co.
601 Broad St.
Passaic
Nidisco Passaic, Inc.
205 Madison St.
Red Bank
Bradleys Radio Service
Newman Springs Rd.
Trenton
Carl B. Williams
25 S. Warren St.

NEW YORK

Albany
E. E. Taylor Co.
465 Central Ave.
Binghamton
Broome Dist. Co.
221 Washington St.
Brooklyn
Electronic Equipment Co., Inc.
1460 Bushwick Ave.

Green Radio Distributors
482 Sutter Ave.

Hornbeam Distributing Co.
1639 Bedford Ave.
Buffalo
Buffalo Radio Supply
219 E. Genesee St.

Dymac, Inc.
2929-31 Main St.

Genesee Radio & Parts Co.
205 E. Genesee St.
Elmira
Fred C. Harrison Co.
108 W. Church St.
Jamaica
Harrison Radio Corp.
172-31 Hillside Ave.

Norman Radio Dist.
94-29 Merrick Road

Peerless Radio Dist. Co.
92-32 Merrick Rd.

Radio Dealers' Service & Supply Co.
172-24 Jamaica Ave.
Middletown
Roskin Bros., Inc.
23 W. Main St.
Mount Vernon
Davis Radio Dist. Co.
66-70 E. 3rd St.
New York City
Federated Purchaser, Inc.
80 Park Place

Grand Central Radio, Inc.
124 E. 44th St.

Harrison Radio Corp.
12 West Broadway

Harvey Radio Co.
105 W. 43rd St.

Highbridge Radio Television & Appliance Co.
340 Canal St.

Niagara Radio Supply Corp.
160 Greenwich St.

Radio Wire Television, Inc.
100 Sixth Ave.

TAB
6 Church St.
Poughkeepsie
Chief Electronics
104 Main St.
Rochester
Masline Radio & Electric Equipment
192-196 Clinton Ave., N.
Syracuse
Broome Dist. Co.
912 Erie Blvd. E.

Syracuse Radio Supply
238-40 W. Willow St.
Watertown
Beacon Electronics, Inc.
108 Lincoln Bldg.
White Plains
Westchester Electronic Sup. Co.
333 Mamaroneck Ave.

NORTH CAROLINA

Charlotte
Henry V. Dick & Co., Inc.
311 E. 5th St.
Goldsboro
Signal Radio Supply
124 S. James St.
Wilmington
Gregory Radio Co.
223 North 7th St.

NORTH DAKOTA

Fargo
Radio Equipment Co.
624 2nd Ave. No.

OHIO

Cincinnati
Chambers Radio Supply
1104 Broadway

Holub & Hogg
500 Reading Rd.

Radio & Refrigeration Supply
1220-6 Jackson St.

See Other Side For Additional Listings

Cleveland
Northern Ohio Labs.
2073 West 85th St.
Radio Surplus Co.
648 Prospect Ave.
Strong, Carlisle & Hammond Co.
2801 St. Clair Ave.
Winterradio, Inc.
1468 W. 25th St.
Columbus
Electronic Supply Corp.
219 North 4th St.
Warren
Radio Specialties
136 S. Pine St.
Dayton
Standard Radio & Elect. Prods.
135 E. Second St.
Steubenville
D. & R. Radio Supply
156 S. 3rd St.

OKLAHOMA
Oklahoma City
Radio Supply, Inc.
724 N. Hudson, Box 597

OREGON
Portland
Appliance Wholesalers of Oregon
600 N.W. 14th Ave.

PENNSYLVANIA
Altoona
Hollenback's Radio Supply
2221 8th Ave.
Kennedy Radio Supply
1500 Fifth Ave.
Beaver Falls
Reliable Motor Parts Co.
1700 7th Ave.
Erie
Jordan Electronic Co.
201 W. 4th St.
Harrisburg
D. & H. Distributing Co., Inc.
311 S. Cameron St.
Lancaster
Eshelman Supply Co.
110 N. Water St.
Philadelphia
A.G. Radio Parts Co.
3515 N. 17th St.
Flanagan Radio Corp.
N.E. Cor. 7th & Chestnut Sts.
M & H Sporting Goods Co.
512 Market St.
Radio Electronics Service Co.
7th & Arch Sts.
Reading
Geo. D. Barbey Co.
432 Walnut St.
Scranton
Broome Dist. Co.
26 Lackawanna Ave.
Sharon
Helges Bros., Inc.
73 Central Way
York
J. R. S. Distributors
646 W. Market St.

RHODE ISLAND
Providence
William Dandreta & Co.
Regent Ave.
Powell Radio Supply
49 Atwells Ave.

SOUTH CAROLINA
Charleston
Radio Laboratories
215 King St.

SOUTH DAKOTA
Sioux Falls
Power City Radio Co.
209 So. First Ave.
United Radio Supply
211 W. 10th St.

TENNESSEE
Knoxville
C. M. McClung & Co.
Jackson Ave.
Memphis
Bluff City Dist. Co.
905 Union Ave.
Shobe, Inc.
1117 Union Ave.
Nashville
Frost Electric Inc.
1922 West End Ave.

TEXAS
Amarillo
Amarillo Electric Co.
418 W. 10th Ave.
R & R Electronic Co.
412 W. 10th St.
Dallas
All-State Dist. Co.
2405-07 Ross Ave.
Southwest Radio Supply
1820 N. Harwood
Fort Worth
Ft. Worth Radio Supply Co.
1201 Commerce
The Electronic Equip. Co.
301 E. 5th St.
Houston
R.C. & L.F. Hall
1015 Caroline St.
Sterling Radio Products Co.
1602 McKinney
Laredo
Radio & Electronics Supply Co.
1219 Lincoln St.
Lubbock
R. & R. Supply Co., Inc.
706 Main St.
Port Arthur
Lapham Radio Co.
309½ Proctor St.
San Antonio
Tom Hopkins Radio
324 Nacogdoches St.
R. L. Ross Co.
118 Seventh St.
South Texas Radio Supply Co.
445 E. Commerce
Tyler
Radio Service Supply Co.
111 University Place
Waco
The Hargis Co., Inc.
1305 Austin Ave.

UTAH
Ogden
Ballard & Carter Co.
203 24th St.
Salt Lake City
O'Loughlin's Radio Supply Co.
113 East Broadway
Radio Supply Co.
45 East 4 South
Standard Supply Co.
531 So. State St.

VIRGINIA
Norfolk
Ashman Distributing Co.
807 Granby St.
Radio Parts Dist. Co.
128 W. Olney Rd.
Radio Supply Co.
711 Granby St.
Salem
Richie Radio Supply
306 E. Main St.
Staunton
Southern Electric Corp.
14 E. Johnson St.

WASHINGTON
Bellingham
Waitkus Supply Co.
110 Grand Ave.
Seattle
Harper-Megee
960 Republican St.
Spokane
Columbia Electric & Mfg. Co.
P.O. Box 1441 S. 123 Wall St.
Inland Radio Co.
W. 923 First Ave.
Tacoma
C. & G. Radio Supply Co.
714 St. Helens Ave.
A. T. Stewart Co.
743 Broadway
Wible Radio Supply
909 Tacoma Ave.

WEST VIRGINIA
Clarksburg
Trenton Radio Co.
791-93 W. Pike St.
East Charleston
Hicks Radio Supply
10 Virginia St.
Parkersburg
John A. Cox Radio Supplies
554 7 St.
Wheeling
General Distributors
21 10th St.

WISCONSIN
Appleton
Valley Radio Distributors
518 N. Appleton St.
Hudson
J. H. Larson Co.
109 Walnut St.
Madison
Satterfield Radio Supply Inc.
326 W. Gorham St.
Manitowac
Harris' Radio Company
115 N. 10th St.
Milwaukee
Acme Radio Supply Corp.
510 N. State St.
Central Radio Parts Co.
1723 West Fond Du Lac Ave.
Taylor Electric Co.
112 N. Broadway
Racine
Standard Radio Parts Co.
1244 State St.

WYOMING
Casper
Golden Power Oil & Supply Co.
260 S. Center
Cheyenne
Houge Radio & Supply Co.
2008 Carey Ave.

CANADA
Radio Supply Co., Ltd.
Grd. Floor McLeod Bldg.
Edmonton, Alberta
Electronic Supply Co. (Ottawa), Ltd.
244 Slater St.
Ottawa, Ont.
Hygrade Radio, Ltd.
673 Homer St.
Vancouver, B. C.

DEALERS: If you are not receiving RADIO-CRAFT, please ask for our Special Consignment Proposition.

POSTWAR MINIATURE TUBES

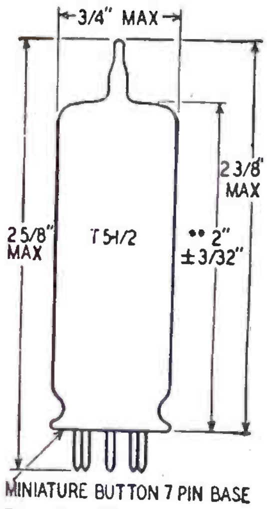


Fig. 1—Dimensions of 35- and 50-volt tubes.

THE design of compact radio sets has long been a problem for the set designer because of the physical dimensions of even some of the smaller popular tube types.

Nine new miniature tubes have been released by RCA and it is likely that they will be incorporated into more compact home and portable radios. These tubes are designed as miniature equivalents of the more popular standard size tubes used throughout the radio industry today.

Four of these tubes are designed with six-volt, three-tenth-ampere heaters that will make them applicable to home and automobile receiver design. The other five types are designed for a.c.-d.c. service.

Fig. 1 is the physical outline of the 35 and 50-volt tubes. Fig. 2 shows the dimensional outline of the six and twelve-volt series.

The r.f. amplifier pentodes are particularly applicable to use in FM and television receivers. The high mutual conductance of the 6BA6 and 12BA6 reduces the signal-to-noise ratio while the low grid-to-plate capacity adds to the inherent stability of the tube. The sharp-cutoff feature of the 6AU6 makes it an ideal tube for FM limiters.

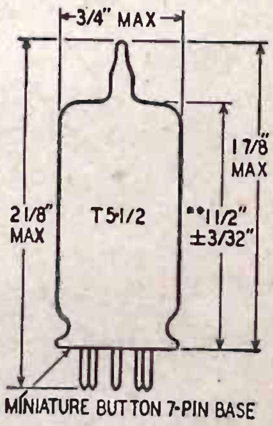
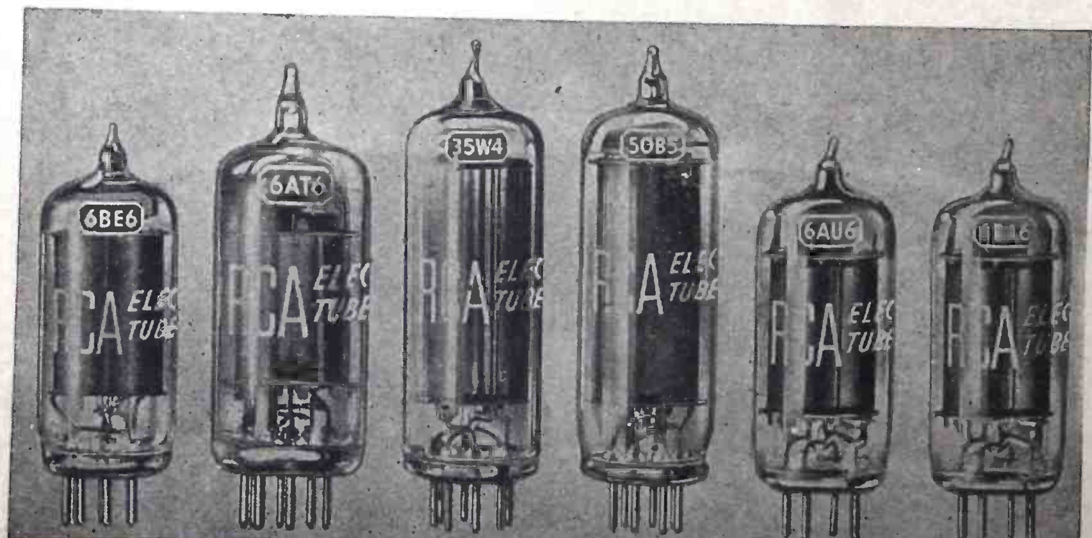


Fig. 2—Dimensions of 6- and 12-volt series.

The miniature types and their "big brother" equivalents are listed below. Voltage and current characteristics are the same as in the standard-size tubes.

Miniature Type	Standard-size equivalent
6AT6	6SQ7
6AU6	6SH7
6BA6	6SG7
6BE6	6SA7
12AT6	12SQ7
12BA6	12SG7
12BE6	12SA7
35W4	35Z5-GT/G
50B5	50L6-GT



COILS, CORES AND MAGNETS

(Continued from page 43)

from the formula (W_{max}) = m.d. x l_c x 5.6, where m.d. is the mean or average diameter of the coil and l_c is its length.

The watts (W) actually used by any d.c. coil can be found from W = EI where E is the voltage across the coil and I is the current flowing through it. For safe design W_{max} will be larger than W. Preferred size of coil is one whose length is about 1½ times its outside diameter. This may be varied.

Thus far d.c. coils have been discussed but many relays and electromagnets must operate on a.c. The pull of the a.c. type also depends on the maximum flux in the air gap and is determined the same as for d.c. types. If a.c. and d.c. ampere turns are the same, results would be about the same except that in a.c. types the pull stroke is more uniform. This is due to the varying inductance and varying current consumption throughout a pull stroke.

When used on a.c. it is imperative that the core be laminated. Usually No. 26 to No. 29 gauge steel is used. This is done to lower the eddy current losses and reduce the core heating to a minimum. Hysteresis losses (energy expended to reverse the magnetism) depend on and vary with the a.c. frequency.

The number of turns in an a.c. coil is determined by the voltage, frequency, and maximum flux, so

$$N = \frac{10^8E}{4.44f\Phi_{max}} = \frac{10^8E}{4.44fAB_{max}} \text{ or } E = \frac{4.44fN\Phi_{max}}{10^8}$$

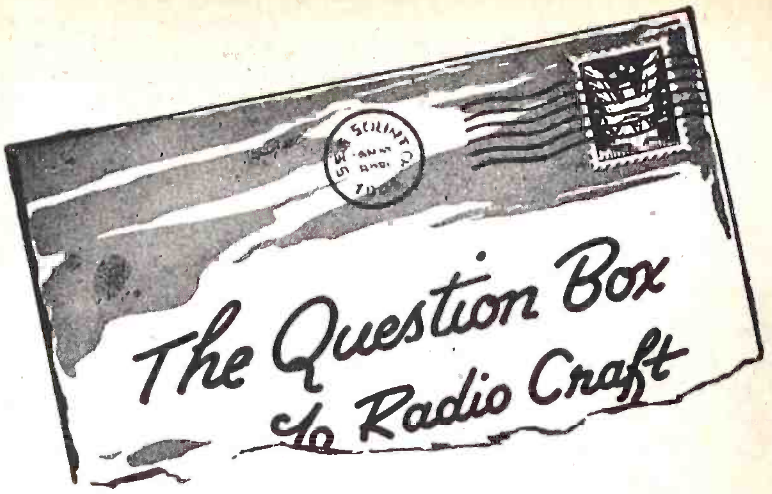
where N = turns in a.c. coil, E = a.c. volts across coil, Φ_{max} = maximum flux, f = frequency in cycles per second, B = induction, and A = cross-sectional area of core in square inches.

Wire size is not very important because resistance is not considered in a.c. applications. It is well, though, to use a wire size as large as can be conveniently wound in the space allotted. If the pull is known the wire size may be, c.m. = $10\sqrt{F}$, where c.m. = circular mils area of wire, and F = pull in pounds.

Any appreciable load applied to the armature of a single-phase a.c. electromagnet will result in a chattering sound. To overcome this a device called a *pole shader* is used. This device produces a flux of its own somewhat out of phase with the main flux, the result being similar to two-phase action.

A pole shader is a short-circuited loop or turn, usually of brass or copper, sized to give the resistance needed, imbedded in the pole or armature face, and covering about ½ to 2/3 of its cross-sectional area. The pole faces must make good mechanical contact in the pole shader area. Exact pole shader design is too involved to explain here in detail.

Part II of this article—to be published in an early issue—will tell how to calculate and design filter chokes and audio reactors and describe apparatus for measuring characteristics of magnetic circuits.

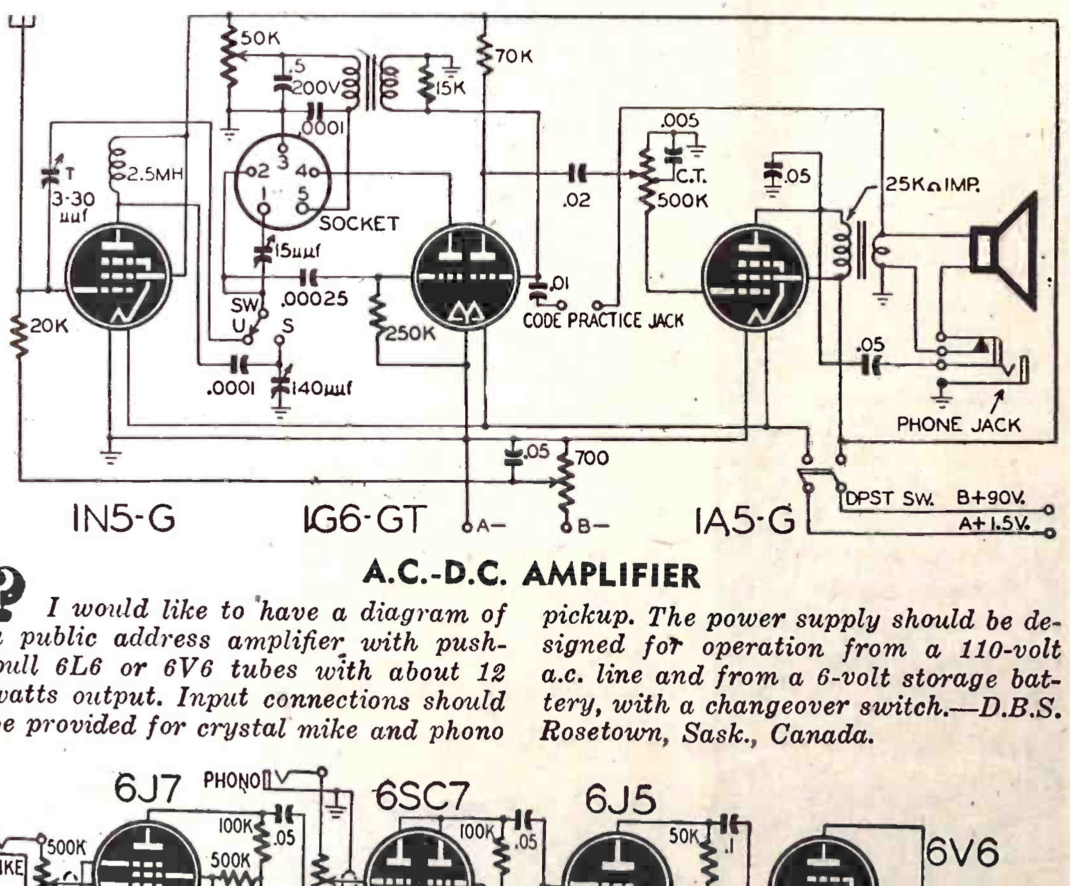


The Question Box is again undertaking to answer a limited number of questions. Queries will be answered by mail and those of general interest will be printed in the magazine. A fee of 50c will be charged for simple questions requiring no schematics. Write for estimate on such questions as may require diagrams or considerable research.

ALL-WAVE EXPLORER

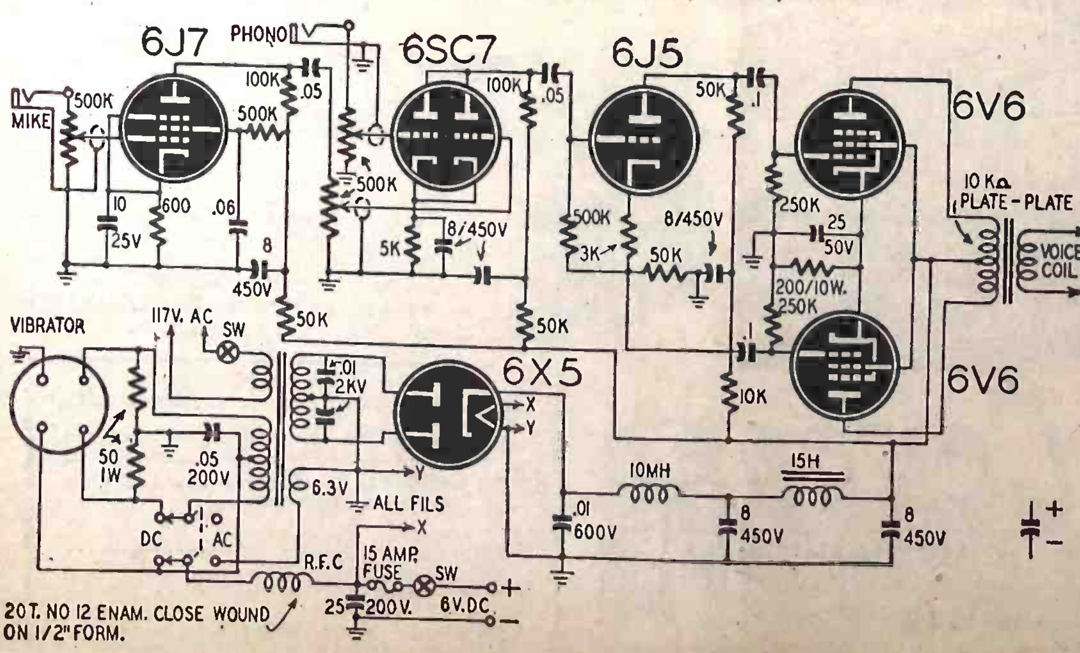
? *Please print a diagram showing how the All-Wave Explorer, described by Mr. White, in the November, 1945, issue, may be converted for battery operation. I would like to use low-drain tubes so that small batteries may be used. Please insert a phone jack in the output circuit so that the speaker will be silenced when the phones are plugged in —C.A.K., Corte Madera, Calif.*

A. The diagram shows the All-Wave Explorer converted for battery operation. A 1N5-G replaces the 6K7 r.f. amplifier. A 700-ohm variable resistor in the negative high voltage lead supplies bias for the 1N5-G and serves as a sensitivity control. A 1G6-GT replaces the 6C8 detector and first a.f. amplifier. The amplifier section of the 32L7 has been replaced by a 1N5-G. A circuit-opening phone jack is used to open the voice coil leads when phones are plugged in.



A.C.-D.C. AMPLIFIER

? *I would like to have a diagram of a public address amplifier with push-pull 6L6 or 6V6 tubes with about 12 watts output. Input connections should be provided for crystal mike and phono pickup. The power supply should be designed for operation from a 110-volt a.c. line and from a 6-volt storage battery, with a changeover switch.—D.B.S. Rosetown, Sask., Canada.*



A. This diagram is drawn to meet your specifications. It uses a 6J7 mike amplifier, 6SC7 phono amplifier-mixer, 6J5 phase inverter, and push pull 6V6's operated in Class AB1 with 14 watts output.

The power supply is designed to work with a vibrator from a storage battery or from a 110-volt a.c. line. A heavy duty d.p.d.t. switch is used to change from a.c. to d.c. operation. Separate switches are included in the primary power leads to control the input voltage. The power supply should be mounted on a separate chassis that is equipped with a bottom cover plate.

All grid leads should be shielded to prevent them from picking up vibrator "hash" when using a d.c. power source. The power transformer is designed for "universal" input and its high voltage secondary should supply 350 volts c.t. at 135 ma. The two condensers marked .01 (in the high-voltage secondary) should be varied till the correct size for lowest battery drain and minimum hash is found.

A.C.-D.C. MULTITESTER

? *I am planning to construct the multitester that appeared in the Question Box of the April issue. I have a 1-ma meter but the resistance is 27 instead of 50 ohms. Please tell me what changes are necessary. Also, explain the meaning of Rx100 etc. when measuring resistances.—A.D.L., Petersburg, Va.*

A. Your 27-ohm meter may be used by changing the shunts as follows: Change the 5.5-ohm resistor to 31 ohms, 0.5 ohms to 0.27 ohms and the 0.05 ohm resistor to 0.027 ohms.

The symbols Rx100, Rx10 and Rx1 mean that the basic ohms scale reading is multiplied by 100 when the range switch is in the Rx100 position, by 10 in the Rx10 position and is read directly when in Rx1 position.

If you do not have an ohms scale on your meter, you may calibrate it by measuring known resistances. With a 3-volt battery, there will be exactly 3000 ohms in the circuit when the test leads are shorted and the needle adjusted for full scale. With a 3000-ohm resistor across the test leads, the meter will read half-scale. The dial is calibrated at other points by dividing the battery voltage (3 volts) by the scale reading and subtracting 3000 from the results. For example: At 0.4 ma, the resistance equals 3/.0004 minus 3000, which equals 4500 ohms.

ANTI-COLLISION RADIO

(Continued from page 17)

tance to the object detected. The horizontal scale, calibrated in degrees, shows whether it lies to the right or left of the line of flight. The pilot sees any building or obstruction which reflects back the beams from his radar antenna as bright spots or pips of light, their position giving the distance and bearing of the obstruction (Fig. 3-b).

The type C scope gives the altitude instead of the distance of the obstacle. The pilot thus knows the direction and approximate altitude of the object with reference to his own plane. He can see—by watching the pip of light on his screen—whether he is veering away from or toward it and if he is rising safely out of the danger area. Fig. 4-a shows an obstruction fifteen degrees above the line of flight and 30 degrees to the pilot's right. Rising, he brings the obstruction down to five degrees above his line of flight—in 4-b—but has drifted nearer, so that it is only 25 degrees to his right. In Fig. 4-c, he has risen eight degrees above the obstruction, which is still about 25 degrees to the right. If the plane continues to rise, the pilot may consider himself safe.

Proponents of plane radar point out that GCA and other systems depend on a plane being within reach of a ground station. Radar will indicate any obstacle, *anywhere!* A plane lost in fog or driven far from its course in a storm needs indications of nearby obstacles far more than one which is on course and knows its approximate location. GCA may offer protection to the inhabitants of large cities; plane-borne radar offers that protection to the occupants of the plane itself. This is a feature that will go far to offset the extra weight of radar equipment.

THE TELERAN SYSTEM

Another blind flying system, *Teleran*, has been developed by RCA. It consists of transmitting to the plane a television image of the airport he is approaching. By an ingenious method of using a combination of transparent maps, television pickup, and information obtained by radio, the incoming pilot sees on his television screen a complete map of the

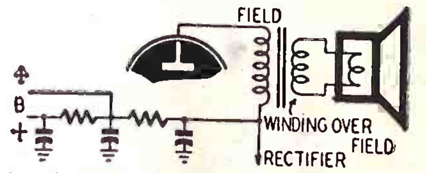
(Continued on page 51)

The Patent Office reports an 81 percent increase in patent applications awaiting action during the past year. Pending applications in the radio field more than doubled during the year.

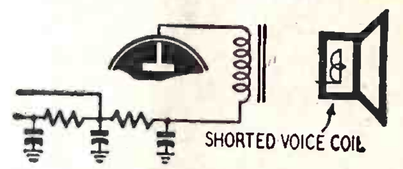
TRY THIS ONE

INDUCTOR SPEAKER

After reading "New Repair Stunt for Output Transformer", on page 288 of the January issue, I recalled a stunt that I used while overseas.



Novel substitute for an output transformer.



Shorted voice coil acts as an inductor motor.

While stationed at a Signal Depot in Italy, I was able to construct a number of small sets from salvaged materials. We were able to get all parts except output transformers. The voice coil winding was wound on the speaker field in the same manner as described by Mr. Copley. After some thought, I decided to see if it was possible to make the speaker operate as an induction motor by shorting the voice coil. Whenever this trick was tried, the results ranged from fair to adequate. The variation in performance was probably caused by a mismatch between the plate impedance and the reflected load.

I believe that a closed loop of light metal may be substituted for the shorted voice coil. It would seem that the inertia of the loop could be kept low so that the speaker would have good frequency response.

ROBERT S. SELLECK,
Los Angeles, Calif.

FADING TUBE NUMBERS

I have a kink that I feel is an improvement over the one, Faded Tube Numbers, in the July issue. I prevent the tube numbers from fading or wearing off of the surface of glass tubes by covering the tube number with a small piece of Scotch tape.

H. T. BROWN,
Jacksonville, Fla.

HAND CAPACITY

Hand capacity is one of the most troublesome "bugs" in home-built regenerative receivers. It is particularly annoying to tune in an elusive station only to have it fade out as the hand is removed from the tuning control.

Hand capacity may be overcome by using two- or three-gang tuning condensers in lieu of the more commonly used single gang condenser. The tuning is done by the rearmost section of the condenser and the other gangs are used to isolate the tuning gang from the front panel and dial. The stators and rotors of the unused sections of the condenser are grounded.

WALLACE BUSBY,
Port-of-Spain, B.W.I.

TRIMMER REPAIRS

The radio serviceman or experimenter is often confronted with padder or trimmer condensers that have cracked or broken mica insulation.

Satisfactory repairs may be made by applying Scotch tape firmly to each side of the mica. The excess tape should be trimmed from the edges. The hole for the adjusting screw may be punched out with a round ticket punch.

HOMER J. C. BURNS,
Detroit, Mich.

(A better repair may be made by cutting new insulators from sheet mica, using the old piece as a pattern.—*Editor)*

RADIO-CRAFT wants original kinks from its readers, and will award a one year subscription for each one published. To be accepted, ideas must be new and useful. Send your pet short-cut or new idea to RADIO-CRAFT today!

NOISE ELIMINATOR

A bottle of carbon tetrachloride on the service bench may prove useful in locating the source of intermittent noises in many radios.

Many erratic noises are caused by dirty or corroded movable contacts on tone controls, band switches and tuning condensers. In most cases, noises from these sources may be eliminated by cleaning all switch points and movable contacts with a liberal application of "carbon tet." A pipe cleaner makes a good applicator for the cleaning solution as it may be bent so that it will reach into any narrow or crowded space.

H. LEEPER,
Canton, Ohio

ANTI-COLLISION RADIO

(Continued from page 49)

airport, with all temporary obstructions (such as trucks) on the ground, plus the position of all planes approaching the port. He sees his own plane in its correct position, and reads his altitude, as well as wind direction and velocity, surprinted on a part of the screen. With Teleran, a pilot could bring his plane down just as if he could see the field.

Apparatus used in the Teleran system is shown in Fig. 5. The plane's radio beacon set is actually a *transponder* similar to the military IFF. On receiving a signal from the ground radar station, it automatically transmits the plane's altitude, which is noted by the ground control and also flashed to the pilot with the other information mentioned.

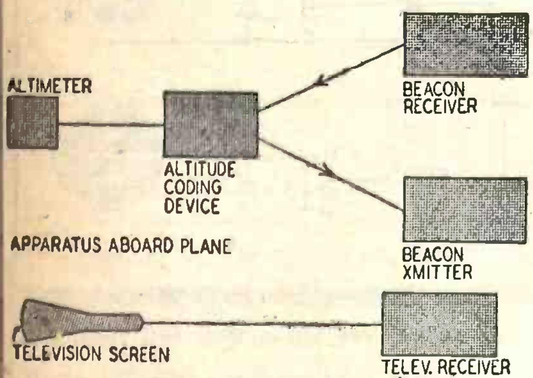


Fig. 6—Proposed Teleran plane equipment.

Teleran would use a 50-mile search beam for locating planes, a 15-mile airport search radar and a precision approach radar for bringing the plane down on the field. Chief objection to the system is that special television and IFF apparatus would have to be carried by any plane making full use of the system. Equipment to be carried aboard the plane appears in Fig. 6.

A system somewhat similar to Teleran has been developed by International Telephone and Telegraph Co. under the name of *Navar*.

THE PANORAMIC STRATOSCOPE

This new approach to the problem was worked out by the Panoramic Radio Corporation. It differs from radar in that no reflected wave or beam is used; a pulse signal is radiated from a transmitter installed on the obstacle.

A special receiver installed on the plane picks up the transmission. Plane may also have a Stratoscope transmitter as protection from collisions with other planes. The receiver uses panoramic reception, and altitude of the obstacle is indicated by the signal's frequency. The

(Continued on page 55)

AIRLINE RADIO SERVICE

(Continued from page 21)

frequency a condenser of like value may be used in series with the antenna. Mica and bathtub condensers are used in airplane radio instruments; tubular paper and electrolytic condensers are unsatisfactory because they do not stand up under vibration. In adjusting transmitters to antennas the plate current should be dipped after each antenna circuit adjustment. Transmitter adjustment may be correct even though the antenna current meter gives a negligible reading for the day frequency while the night frequency antenna current reads .9 amp. This is because the antenna resistance is about 500 ohms on the day frequency and approximately 50 ohms on the night frequency. Touching the antenna terminal with a WOOD pencil will show that r.f. is present.

Transmitters having 24-28 volt electrical systems usually operate pairs of 12-volt tube filaments in series. If one filament is out neither tube will light. In this case either a filament or a filament fuse has burned out. Glass-cased fuses may be tested either by an ohmmeter or by using the fuse to complete the circuit between the unscrewed cap of a flashlight and the battery. In the larger planes, DC-4s and others, circuit breakers instead of fuses are now being used.

If the normal voltage of a transmitter is 1000 volts the instrument should be bench tested for a short time with about 1400 volts. Components that are deteriorating will break down. At lower frequencies particularly, voltage sparkovers occur at higher altitudes, consequently this test simulates flight conditions.

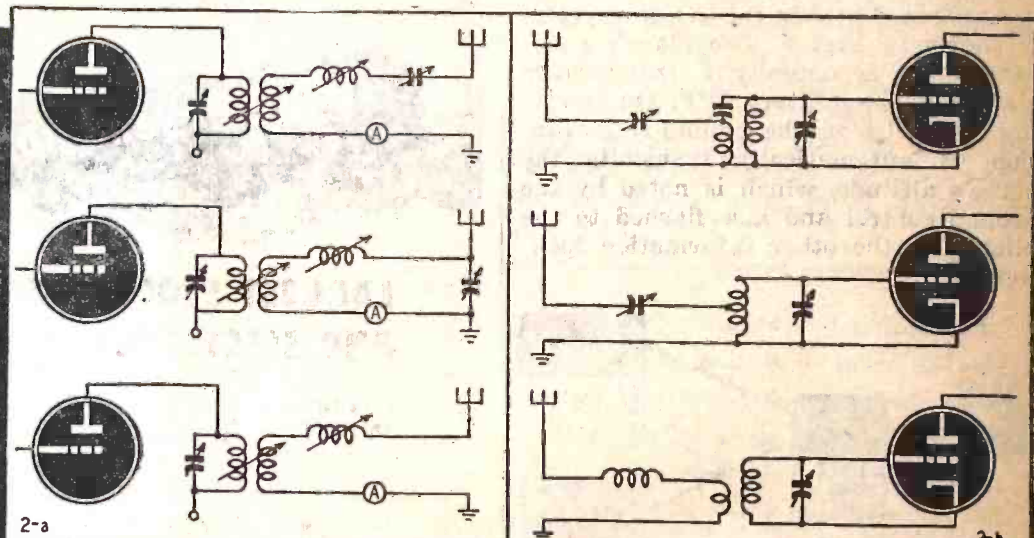
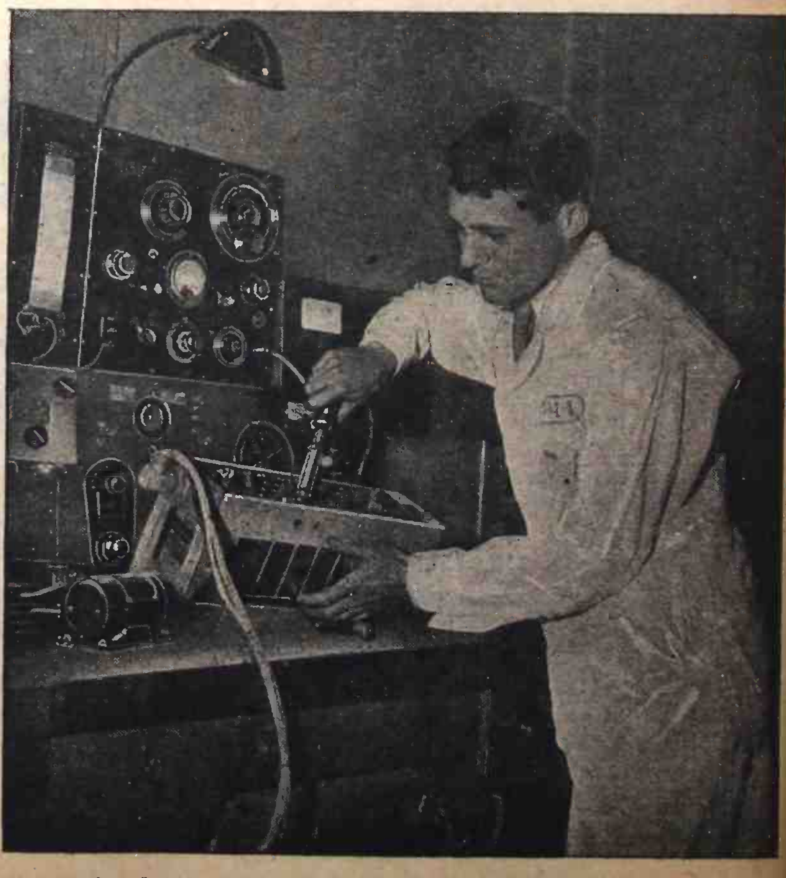


Fig. 2—Coupling and antenna tuning methods used on airplane transmitters and receivers.

Aircraft receivers are usually of the superheterodyne type. The output of such a unit must be constant for input voltages of from 1 μv to 1 volt, because it is undesirable for a pilot to continuously change a volume control to compensate for changing field strengths. Audio requirements for these receivers are not high because they are used for voice work only. A response that is flat within 4 db for frequencies between 300 and 2500 cycles is sufficient.



The service bench is the same one pictured on the cover. The room is completely shielded. *Photo courtesy of Pan-American Airways*

Receivers are difficult to service and maintain because of their complexity. "Case histories" and "trouble location and probable remedy charts" such as the one illustrated here are kept for the radio items in each airplane. These, in conjunction with test equipment for continuity, resistance, and voltage measurements, signal tracing, the laws of cause and effect, common sense and logic, are of assistance in "trouble shooting"—to tell whether the maloperation is in the antenna system; external wiring, cables, or accessories; the aircraft electrical system; or in the radio equipment itself. Having traced the trouble to a receiver check the tubes. A good tube tester narrows the trouble even though it does not always show a bad tube, for example the faulty 2A7 oscillator tubes that escaped detection when servicing the RCA 140 series of home receivers. Trouble in the receiver itself may be localized by proceeding from power supply to audio output circuit, second detector to i.f. amplifiers, and then the radio frequency input circuits.

New parts are sometimes defective and it is well to pre-test and label a whole batch of them to insure an adequate reserve. Miniature tubes, such as the 955 and 6J6 used in v.h.f. and u.h.f. applications, often vary on either side of their rated characteristics. A low Gm will cause reduced amplification, while larger interelectrode capacitances than those published result in a lower radio frequency. A simple Hartley, Colpitts, or tuned-plate tuned-grid test oscillator will show, by comparing plate currents and frequency changes to a standard tube (one that works normally in a v.h.f.-u.h.f. instrument), which tubes meet these specifications and which do not. For these reasons instruments such as the radio altimeter are hard to align and adjust. Radio altimiters, glide-bath instruments and v.h.f. transceivers utilize miniature tubes.

Some airlines check transmitter-receiver operation every 90 days and accessories, headphones and wiring, at 180-day intervals, while others perform receiver sensitivity and transmitter checkups after no more than 800 flying hours and pull out units with moving parts (dynamotors) after 400 flying hours. Flight personnel should turn off direction finders and transmitters when not in use; this eliminates excessive wear and possible heat damage to the dynamotors of heavy-duty units.

When junction boxes, terminal boards, dynamotors, and accessories are conveniently located, inspection is made easier. When placed so that they are reached only with difficulty they may not be checked as thoroughly or as frequently as desired.

Radio propagation predictions are again available to the public. Beginning with July, the CRPL-D series, "Basic Radio Propagation Predictions" will be issued monthly, copies being obtainable from the Superintendent of Documents of the Government Printing Office for 15 cents each or $1.50 per year.

TECHNOTES

. . . . PHILCO 40-504

This set was brought in with the complaint that the battery drain was excessive. The low voltage lead to the on-off switch showed a very low resistance to ground when the switch was OFF. This was cured by replacing the volume control and switch.

Lewis J. Neumin,
Iowa City, Iowa

. . . . SUBSTITUTE FOR 35L6

A temporary replacement for a 35L6 may be made by using a 50L6. This lowers the effective voltage on the filaments of the other tubes but the difference is not enough to affect the volume. Both tubes have .15-ampere heaters so no shunting resistors are necessary.

D. Van Winkle,
East Peoria, Ill.

. . . . RCA 55U

Static and crackling noises when the set is jarred was traced to the wire link between the reject control and the reject mechanism on the record changer. A flexible wire soldered to the link and to the chassis cured the trouble.

Fading and frequency shift in this model may be due to loose stator plates on the tuning condenser. The loose plates should be forced firmly against the supporting bar and sweated in place.

Lewis J. Neumin,
Iowa City, Iowa

. . . . PHILCO 38-10

Some of these sets come in with the complaint of continuous oscillation. The first analysis, faulty filter condensers, is found incorrect. The trouble can often be traced to an open by-pass condenser, part number 3 on schematic, mounted on the band switch. This condenser is in the a.v.c. circuit. It is difficult to replace this condenser in the original position and it is suggested that the replacement be mounted with lugs near the i.f. stage.

R. L. Patrick,
New Orleans, La.

. . . . RCA VICTOR Q-12

This model is often brought in dead or intermittent. C8, a .006-μf, 600-volt condenser, opens intermittently. This condenser is located under the band switch and is connected between the switch and tuning condenser. Replacing the condenser clears up the trouble.

Jorge A. Cordero,
Bayamon, Puerto Rico

. . . . BEAM-OF-LIGHT PICKUP

Distortion in record players using the Philco Beam-of-Light pickup may be traced to deterioration of the damping rubbers on the tiny mirror attached to the sapphire needle. The trouble is cleared up by replacing the unit (needle, mirror and damping rubbers) and readjusting the focus of the bulb.

Howard J. Mason,
Morehead City, N. C.

ANTI-COLLISION RADIO

(Continued from page 51)

proposed band is 148 to 154 mc. At sea level, a transmitter would operate at 154 mc. As altitude increases, frequency would decrease proportionately, reaching 148 mc at 12,000 feet.

Several advantages are claimed for this system. To indicate a tall mountain peak, it would not be necessary to maintain equipment at the top. A transmitter could be installed at the base and the frequency adjusted to indicate the correct height. Transmitters could be made to tune automatically to the correct frequency with an aneroid barometer (Fig. 7). This tuning method would be

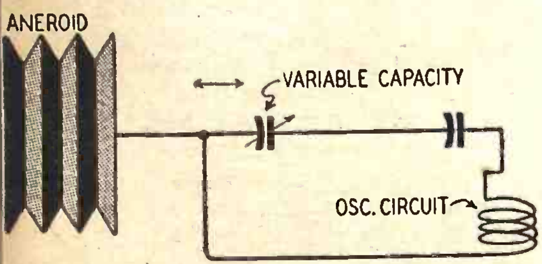


Fig. 7—Automatic tuner to indicate height.

used in transmitters installed aboard planes. Slight changes in pressure due to weather conditions would be insignificant compared with the changes due to altitude, and would introduce no noticeable error.

One form of Stratoscope is designed to land planes in foggy weather. Each plane's altitude (frequency) is simultaneously indicated on the screen of a ground instrument at the airport. The scope's vertical scale shows *all* the planes *stacked* or hovering over the field. Even a slight change in the altitude of any plane is at once detected by the ground control. Each plane can in turn be "talked down" over the ordinary plane radio, as in the GCA system.

Lightness of the plane-borne apparatus is the strongest argument for the new device. The special receiver-transmitter—which has been tested successfully between planes 140 miles apart—weighs only 40 pounds. It has the advantage of the direct-viewing screen, like the A and B scopes. The receiver tunes broadly enough to cover the whole band, in true panoramic style. Signals appear as pips, their height on the screen indicating the frequency (height of the obstacle). Their horizontal length indicates the signal strength (and thus, indirectly, the distance to the transmitter).

The receiver is so adjusted that the flying height is at the zero reference level (center of the screen). If the pilot sees a pip *above* his reference level, he knows he must rise. If it is below, he is

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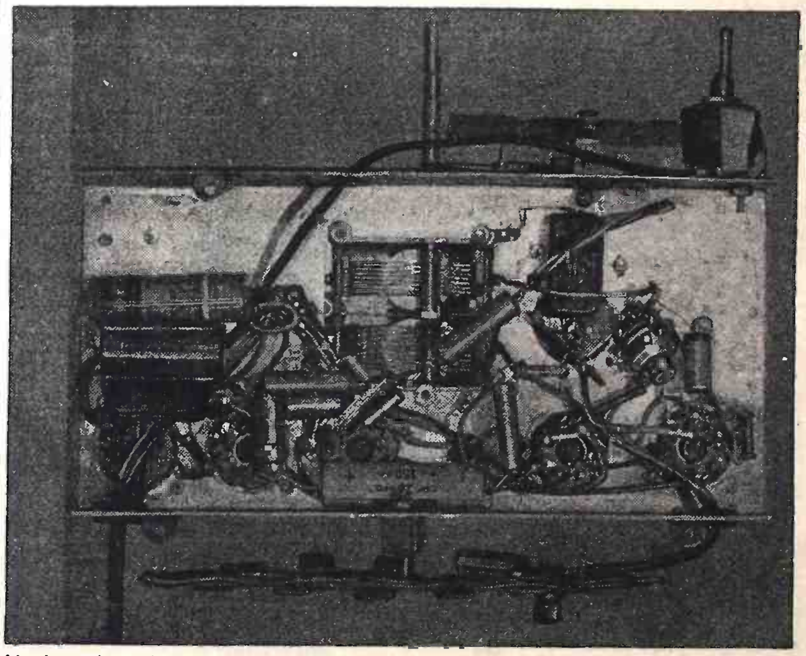
BUILDING A SET IS EASY

(*Continued from page 24*)

set is connected to the line, test the resistance between B-minus (chassis) and B-plus. If the filter condensers have not been in use for some time, the resistance may test as low as 50,000 ohms. If this is the resistance found, the filter condensers should be suspected of excessive leakage. If the resistance found is less than about 50,000 ohms, *don't turn on the power* until you have looked for a possible short circuit. A really good filter condenser of 20 μf *after use at its rated voltage* should test at least one megohm resistance.

Shunting the cathode resistor of the 50L6 with a 20 to 50 μf electrolytic condenser will give greater volume with some slight loss of quality, since the "inverse feedback" of the standard circuit has been eliminated. (See dotted lines on diagram.)

It is important that the .02 coupling condenser between pin 6 (plate) of the 12SQ7 and grid (pin 5) of the 50L6 have a very low leakage value. On ohmmeter, its resistance should be *at least* several megohms.



Under the chassis. Note interesting position of variable condenser.

Leads to pilot light connect to terminals 2 and 3 on 35Z5 socket. If the pilot does not light, the set should not be operated, or a part of the 35Z5 filament will soon burn out.

THE LOOP ANTENNA

Position of the loop with relation to chassis is important. Try about an inch separation from the back of chassis and keep the loop's lower turns as far above chassis as cabinet permits. Notice the method used for loop mounting in commercial sets. A square piece of wood screwed to the back of chassis in a vertical position will serve to hold it. If the loop has two windings, an aerial may be connected to the smaller (primary) one, with a .002 μf paper bypass condenser in series; if the loop is a one-winding type, an insulated wire may be wound around the loop end that goes to grid of the 12SA7, an inch or so of its length, for outside aerial connection. Whether the inner or outer end of loop works better connected to grid of 12SA7 may be tested by experiment. Some commercial sets use a grounded metal shield between loop and tubes. I.f. transformers should be in shield cans and the *can must make good contact* with the chassis ground connection; otherwise there may be serious "feedback" from the near-by loop.

It is a great help to quick and errorless wiring, to connect the tube sockets with keyways all going in the same direction, although this may not give the shortest grid and plate leads.

Good soldering is very important. This means that all joints will be bright (not gobby), and that either a minimum or no soldering paste will be used. Parts to be soldered are scraped or sandpapered with the sand (not emery) paper, if necessary, and a good grade of solder used. During the war, solder had too much lead. This solder heats slowly and sticks poorly. A 50-50 solder is a great help in getting strong joints. The "iron" should be filed bright and dipped in resin and solder, to "tin" the end. The parts to be soldered are heated and then the solder applied. Resin-cored solder is almost a necessity.

Hum is usually caused by poor quality filter condensers. A PM speaker and filter choke usually give less hum than a field coil dynamic speaker with field used for choke.

The simplest method of adjusting i.f., oscillator, etc., is to use a signal generator, as directed in text books on superhets, the Meissner "How to Build" instruction manual, etc. Lacking a signal generator, the beginner may spend weary minutes turning the "nasty little screws." Supposing no signal generator is available, the set builder will proceed on the assumption that the i.f. transformers are adjusted correctly at the factory, and therefore need no adjustment of the small screws reached through the openings in the cans. Try to tune in a radio signal with the volume control well on; then adjust the trimmer condenser on the oscillator variable condenser so the pointer on dial points to the proper dial figure for the radio station being heard. In other words, if you are listening to a 1400 kc station, the pointer should point to 140 on the usual dial calibrated in kilocycles. Adjust the trimmer on the larger section of the variable condenser for maximum volume. Readjust all trimmers for maximum volume.

If you have not secured a "cut-plate" variable condenser—that is, if both of the condenser sections are the same size—the circuit shown will not be satisfactory, and a "padding condenser" must be inserted between the lower end of the oscillator coil and ground. For an intermediate frequency in the neighborhood of 455 kc, this condenser will be a mica-compression type adjustable between about 300 and 500 μμf. The trimmer on the oscillator section of the gang condenser is then adjusted at the high-frequency end of the dial, and the padder at the low-frequency end.

If the set shows no signs of life, first look for wires omitted. Check off all wires and apparatus on the diagram, to see that they are properly connected. Test tubes for emission and shorted elements. Test variable condensers for shorts due to touching plates or metal filings between the plates. Test to make sure there is plate voltage on all tubes, pin 4 on 12SA7 socket, 8 on 12SK7, 6 on 12SQ7, 3 on 50L6. The loop may need to have a few turns removed; make sure its winding is continuous and is shunted by the larger section of the 2-gang variable tuning condenser. By-pass condensers should be separately tested for leakage before being wired into set, but may be retested for shorts or leakage. A known-to-be-good by-pass condenser may be rapidly shunted across the various ones in the set, while in

(Continued on page 62)

TELEVISION FOR TODAY

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article) while a signal at the frequency of the wave trap is applied at the grid of the first video i.f. tube. The slug in the wave trap coil is then adjusted for minimum reading of the voltmeter. An oscilloscope may be substituted for the

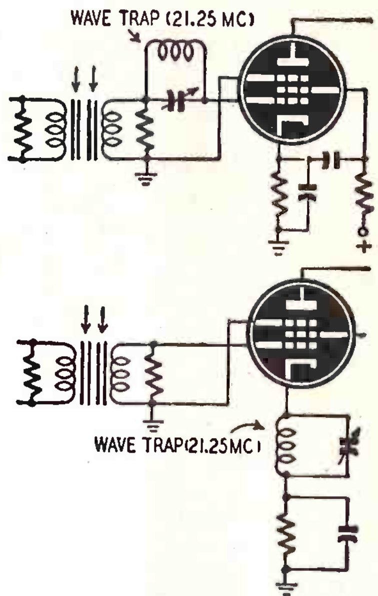


Fig. 6—Two positions for the audio wavetrap.

voltmeter and the tuning of the wave trap adjusted until the length of the vertical line is zero or a minimum.

INTERMEDIATE FREQUENCIES

Until quite recently, the intermediate frequencies used in television receivers were 8.25 mc for audio and 12.75 mc for the video signals. A change, however, has been recommended by the RMA panel on television, the newer values being

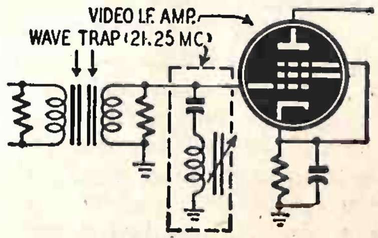


Fig. 7—Series audio wavetrap in video i.f.

21.25 mc for audio and 25.75 for the video channel.

The video signal is permitted a spread of 4 mc. This represents the actual video voltages, and does not include the audio signal or any of the vestiges of the sideband that is partially suppressed. To pass the 4 mc, the video i.f. must extend (under the previous system) from 12.75 mc to 8.75 mc. To achieve uniform response within this region requires excessive loading because the ratio of the band pass (4 mc) to 12.75 mc, the i.f., is the abnormally high value of approximately 33 percent. Resistive loading, to obtain wide response, is inversely proportional to the $\frac{\Delta F}{F}$ ratio according to the following relationship: $\frac{\Delta F}{F} = \frac{X_L}{2R_L}$

With the shift of the i.f. to 25.75 to 21.75 mc, the ratio of $\frac{\Delta F}{F}$ decreases and the loading resistor value rises proportionately. The importance of

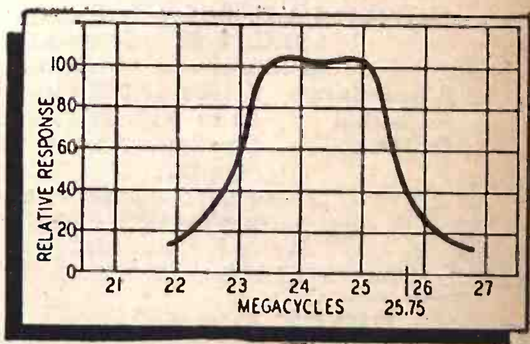


Fig. 9—Response curve, amplifier in Fig. 8.

the value of the loading resistor is quite evident from gain of stage = gmZ_L where Z_L is the load impedance of the amplifier and with a pentode, almost entirely governed by R_L.

SPURIOUS RESPONSES

The foregoing is but one aspect of the situation. Included, too, are the many spurious responses that besiege superheterodynes. A spurious response is the appearance of an undesired signal in the receiver. This does not include noise and static, but merely signals that appear in the receiver due

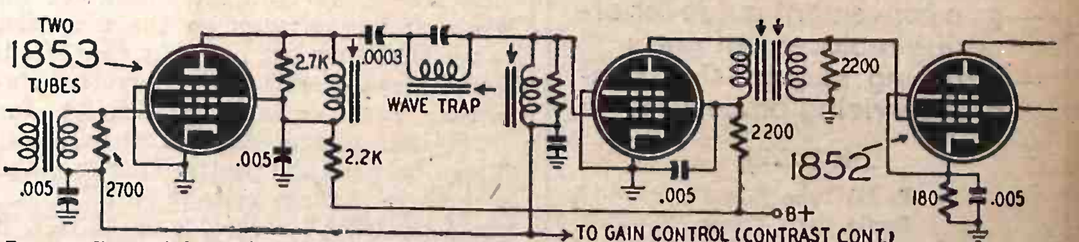


Fig. 8—Typical (G. E.) i.f. system, designed to pass video signals over a band of 2.5 to 3 mc.

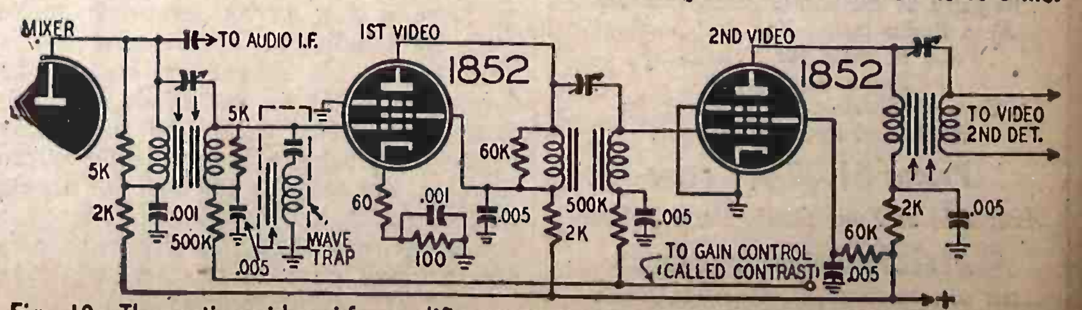


Fig. 10—The entire video i.f. amplifier system as used in Meissner television receivers.

to the receiver system. Well known among the spurious responses are image frequencies, reception of signals coming in at the intermediate frequency, harmonics of the desired signal and the oscillator combining to form difference frequencies at the i.f. value, and mixing between two signals to produce the intermediate frequency. Choice of the i.f. value has a definite bearing upon the number of such spurious responses.

Take, for example, image frequencies. These are always separated from the desired signal by twice the i.f. Thus, if the desired signal is above the oscillator operating frequency by an amount equal to the i.f., the image station is below it by the same amount.

At broadcast frequencies, the inclusion of an r.f. stage is sufficient to eliminate the image signal completely. As previously noted, r.f. stages are not quite so selective at the higher frequencies, and so their inclusion does not completely solve the problem. We can, however, remove the possibility of image interference by the proper choice of an intermediate frequency.

It will become evident, after some thought, that if we choose an intermediate frequency greater (if only slightly) than half the width of the desired band, interference from image stations within that band is no longer possible. This is a direct consequence of the twice i.f. relationship stated above For the television band 44-88 mc, this requires an i.f. in excess of 22 mc. The

(Continued on page 78)

Radio Thirty-Five Years Ago

In Gernsback Publications

HUGO GERNSBACK

Founder

Modern Electrics	1908
Electrical Experimenter	1913
Radio News	1919
Science & Invention	1920
Radio-Craft	1929
Short-Wave Craft	1930
Wireless Association of America	1908

Some of the larger libraries in the country still have copies of MODERN ELECTRICS on file for interested readers.

From the October, 1911, issue of MODERN ELECTRICS:

Thermo Electric Cells, by *Professor W. Weiler.*

Hot-Wire Meter, by *E. E. Ely.*

Resistance and the Telephone Receiver, by *B. F. Dashiell.*

Wireless Hints for the Amateur, by *Edward Werner.*

A Compact Wireless Set, by *Walter Neuman.*

Simple Variable Condenser, by *Philip E. Thulander.*

A Miniature Tesla Coil, by *Carl Dreher.*

A Sensitive Relay, by *C. J. Sedlak.*

A Range Increaser, by *Joseph E. Frisbee.*

A New Hook-Up, by *Frank Taylor.*

—

PULSES FIND FLAWS

Supersonic sound waves are being used by the newly devised "Reflectoscope" to detect flaws in solid materials it was announced last month by Dr. Floyd A. Firestone, of the University of Michigan.

The reflectoscope uses a quartz crystal to transmit short sound pulses into the material to be tested. These pulses are reradiated and received by the instrument where they are amplified and made visible on the screen of a cathode ray tube. Flaws may be detected by irregular variations in the observed patterns. In addition to locating flaws in materials, the instrument may also be used to measure the level of liquids inside tanks.

Civilian Radio Jobs Wanted

FREE WANT-AD SERVICE

By Former Soldiers, Sailors, Marines

Radio-Craft offers its help-wanted columns free for the use of honorably discharged men in the armed services. State the type of position you seek, preferred locality, your experience, education, and other details. Confine ad to 50 words, or less. Supply name and address. Army veterans send section number or photostat of discharge paper. Navy men send photostat of discharge paper. Address RADIO-CRAFT, Classified Ad. Dept., 25 West Broadway, New York 7, N. Y. Your ad will contain a box number and replies will be forwarded to you.

RADIO GRAD.; 1 yr. course; 6 mos. exp.; married. H. Botcowsky, 28 E. 200th St., Bronx 58.

RADIO-RADAR TECH. desires pos. electronics field with future; 24, married. B. Linker, 2256 Walton Ave., Bronx 53. FO 5-0586.

RADIO—Repair, 3 yrs. Army experience Radio, Radar, driver's lic. New York area. Max Brauner, Box No. OC-1, Radio-Craft, 25 West Broadway, New York City.

RADIO, 2/c Telephone & Telegraph licenses. 26, single. Mechanically inclined, anxious to get connected. Elliott Levy. Box No. 0-1.

RADIO TECHNICIAN GRADUATE seeks "on-the-job" training in radio servicing under G.I. Bill. College, trained, business background. Harry Davis, 378 Montgomery St., Brooklyn 25, N. Y.

RADIO TECHNICIAN, 22; lab., repair shop; 4 yrs. exp. electronics, radar, comm'l types. B. Siegall, 1188 Fox St., Bronx 59, N. Y.

ELECTRONICS, Radio; navy exp; 3 yrs. coll., mech. eng.; 21. P. Alper, 5 Brighton 4th ter., Brooklyn 24.

RADIO-RADAR TECH.; 3 yrs. maint., naval electronic equipment; thorough knowl. theory. A. Benau, 148 Parkside Ave., Brooklyn 26.

RADIO TELETYPE—Multi-Channel, transmitter man. 3 yrs. army experience on xmtrs up to 50 KW. 2nd class phone FCC. Southern Location preferred. Desires aircraft, or shortwave xmtr position. Married, 2 children. James C. Gattis, 1307 So. Elm Street, Paris, Arkansas.

RADIO REPAIR MAN—Knowledge foreign makes. 2 yrs. college. Start $40. Lucient R. Greif, 109 W. 98 St., New York 25, N. Y.

RADIO; 3 yrs. exp. servicing, selling, have drivers' lic.; precision; 920P, tools. S. Elsman, 513 Sheffield Ave., Brooklyn 7; DI 6-8711.

RADIO-CRAFT will pay highest rates for good articles on FM radio servicing and construction of high-frequency FM tuners which can plug into the audio end of an AM radio receiver.

A new radio device, manufactured by International Business Machines, permits an audience to hear translations of speeches in as many as seven different languages, simultaneously with the speaker's delivery.

WORLD-WIDE STATION LIST

(Continued from page 33)

Location	Station		Frequency and Schedule
New York	WNRA	18.160	European beam, 6 am to 1:30 pm
San Francisco	KWID	7.230	Oriental beam, 6:45 to 11 am
San Francisco	KGEX	7.250	Philippine beam, 5 am to noon
San Francisco	KNBA	7.565	Oriental beam, 4 to 9:45 am
San Francisco	KCBA	7.575	East Indies beam, 4 to 9:45 am
San Francisco	KNBX	7.805	Oriental beam 5 to 11 am
San Francisco	KNBX	9.490	Oriental beam, 11:15 am to 3:30 pm
San Francisco	KNBI	9.490	Oriental beam, midnight to 3:45 am; Hawaiian beam, 4 to 9:45 am
San Francisco	KGEI	9.550	East Indies beam, 4 to 10:45 am; Alaska beam 11 am to 12:45 pm
San Francisco	KWID	9.570	Oriental beam, 11:15 am to 1 pm; South American beam, 7:45 to 11:15 pm; Alaska beam, 11:30 to 1:45 am
San Francisco	KWIX	9.570	Oriental beam 2 to 11 am
San Francisco	KCBF	9.700	Oriental beam, 1 to 4:45 pm
San Francisco	KWID	9.855	South Pacific beam, 2:30 to 6:30 am
San Francisco	KGEX	11.730	Southwest Pacific beam, 2 to 4:45 am
San Francisco	KGEI	11.730	Southwest Pacific beam, 1 to 4:45 pm
San Francisco	KCBA	11.770	South American beam, 11 pm to 1 am; 5 to 10:45 pm; Oriental beam. 1 to 4:45 pm
San Francisco	KNBA	11.790	Philippine beam, midnight to 3:45 am; South American beam, 5 to 11:45 pm
San Francisco	KWIX	11.890	Hawaiian beam, 4 pm to midnight; 12:15 to 1:45 am
San Francisco	KCBR	13.050	Oriental beam, 10:15 pm to 1 am
San Francisco	KGEI	15.130	Alaska-Oriental beam, 5 to 7:45 pm; Southwest Pacific beam, 8 pm to midnight
San Francisco	KNBX	15.150	Oriental beam, 9 to 11:45 pm
San Francisco	KGEX	15.210	Philippine beam, 4 pm to 1:45 am
San Francisco	KNBX	15.240	Oriental beam, 3:45 to 8:45 pm
San Francisco	KNBI	15.340	South American beam, 5 to 11:45 pm; Oriental beam. 2 to 4:45 pm
San Francisco	KWID	17.760	South American beam, 5 to 7:30 pm
San Francisco	KNBA	17.780	South Pacific beam, 2 to 4:45 pm
Schenectady	WGEO	9.530	South American beam, 5 to 11 pm
Schenectady	WGEA	11.847	European beam, 6 am to 3:45 pm; Brazilian beam, 4 to 10:30 pm
Schenectady	WGEO	15.330	European beam, 6 to 4:30 pm
Washington	WWV	2.500	U.S. Bureau of Standards; frequency, time and musical pitch; 6 pm to 8 am
Washington	WWV	5.000	U.S. Bureau of Standards; frequency, time and musical pitch; continuously day and night
Washington	WWV	10.000	U.S. Bureau of Standards; frequency, time and musical pitch; continuously day and night
Washington	WWV	15.000	U.S. Bureau of Standards; frequency, time and musical pitch; continuously day and night
U.S.S.R.			
Moscow		5.440	8 am to 6 pm
Moscow		5.815	11 am to 6 pm
Moscow		5.960	11 am to 6 pm
Moscow		6.028	5:45 to 9:30 pm
Moscow		6.230	noon to 6:25 pm; 7 to 9:45 pm
Moscow		6.980	5:45 to 6:25 pm; 7 to 9 pm; 11.15 to 11:45 pm
Moscow		7.300	noon to 5 pm; 6:15 to 11:30 pm
Moscow		9.480	6 to 8 am; 11 to 11:30 am; midnight to 1 am
Moscow		9.650	4:30 to 9:15 pm
Moscow		9.715	6:30 to 7:30 am
Moscow		9.860	8 to 9:30 pm; 10 pm to 2 am; 8:30 to 9:30 am; 10 am to noon
Moscow		10.450	midnight to 2 am; 9:30 to 10 am
Moscow		11.780	9 to 10 am
Moscow		11.830	10 pm to 2 am; 6 to 8 am; 11 to 11:30 am; 6 to 7 pm
Moscow		11.885	6:45 to 8 am; 6:30 to 7:30 pm
Moscow		12.080	8 to 11 am
Moscow		12.175	6:45 to 7:45 am; 8:30 to 10:30 am; noon to 1 pm; 7 pm to 1 am
Moscow		12.265	4 to 5:30 pm; 8 to 9:30 pm; 10 pm to 6 am; 7 am to 1 pm
Moscow		15.320	5 to 11:30 am
Moscow		15.340	5:30 to 9:30 am
Moscow		15.230	5:45 to 6:25 pm; 6:45 to 8:15 am; 8 to 8:45 pm

(Continued on page 72)

BUILDING A SET IS EASY

(Continued from page 57)

operation, to check on whether they are open circuited. Resistors may be tested on an ohmmeter. Make sure the tube prongs are actually making contact with the metal socket contact. Test speaker voice coil and both windings of output transformer. Test the resistance between the two end contacts of the volume control; and make sure that the middle contact is in contact with the resistance element. Try a different oscillator tube; sometimes one that tests good on a tube tester will not oscillate readily.

Parts Required

Chassis, metal with 5 socket openings, about 9½x4 inches deep, height, 1½ to 2 inches. (A very small chassis means extra work in wiring).

Two 456 kc i.f. transformers shielded, double tuned.

Oscillator coil (with tap, for 12SA7).

Variable condenser (.000365 mf and cut-plate oscillator) (trimmer condenser on each section).

Loop to match condenser.

Filter condensers 2 single 20 mf or double 20 mf, working voltage at least 150.

500,000 ohm volume control with attached a.c. switch.

Dynamic loud speaker with permanent magnet, or 450-ohm field coil. (If PM type, a filter choke coil required, if possible 75 ma carrying capacity; resistance not over 450 ohms, preferably lower).

Output transformer to match 50L6 tube.

400 to 600-volt paper by-pass condensers, 2 each .02, .00025 and .05 mf; 1 each .002, .0001 mf.

¼ or ½-watt resistors, 1 each 150-ohms, 20,000 ohms, 250,000, 500,000; 3 meg., 2 15 meg. (If 15-meg resistors are not readily available 10-meg resistors will be satisfactory).

5 octal base tube sockets, a.c. line cord and socket plug.

Dial, with pointer.

Miscellaneous: grommets for loop wire and line cord passing through chassis; tie lugs; 2 knobs to fit condenser shaft and dial shaft; pilot socket and wiring with 6-8-volt .15 ampere pilot light, bayonet type; about 2-dozen 6-32 screws and nuts, lockwashers (depending on type of socket mounting; about 8 feet various colors hookup wire; several soldering lugs; 1 length spaghetti; loop mounting piece of wood screwed to back of chassis will do.)

Cabinet.

5 tubes, 12SA7, 12SK7, 12SQ7, 50L6, 35Z5.

New Electronic-Radio Patents

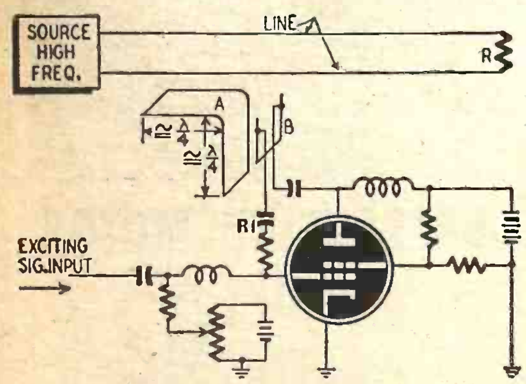
Edited by I. QUEEN

R. F. ENERGY CONTROL

Patent No. 2,401,353

Ross B. Hoffman, E. Orange, N. J.

THIS invention is adapted to control large amounts of r.f. power through the use of a simple reactance tube. The plate, grid and cathode of the tube are effectively across an R-C circuit. The resistance is due to R1, and the capacitance is that which exists between grid and cathode. As a result, the grid voltage lags the plate voltage by 90 degrees. Since the plate current is in phase with the grid voltage, it also lags by 90 degrees. Therefore the tube action is similar to



a condenser whose capacitance depends upon the signal input.

When no signal appears at the reactance tube grid, r.f. energy is induced from the line into the parallel section of the bent line. Since the horizontal section is a quarter wave long, a high voltage appears at point A, and this feeds back high voltages which block the line and prevent transmission of energy toward the load R.

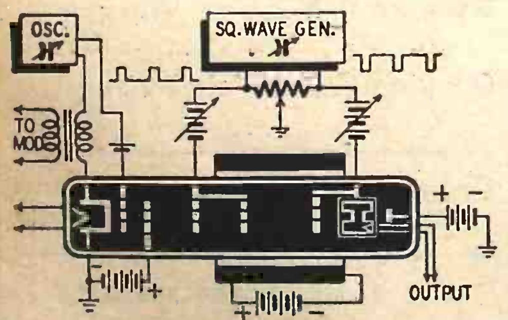
When a voltage is applied to the grid, the capacitance due to the tube resonates transmission line B to the frequency of the system. This line absorbs energy from the vertical portion of the adjacent line and therefore prevents the build-up of a high potential at A. During this interval, energy is transmitted to R.

FREQUENCY MULTIPLIER

Patent No. 2,401,945

Ernest G. Linder, Philadelphia, Pa.

THIS device can multiply an ultra-high frequency in any desired ratio, not necessarily a whole number. It makes use of a special elongated tube containing cathode, a number of grids



and a cavity resonator. An auxiliary high frequency oscillator and a square wave generator are also necessary.

The uniform electron flow from the cathode is pulsed by the first grid. Electrons pass when this grid is positive and are cut off when the electrode is negative. Therefore the electrons proceed in pulses after this grid. The second grid is an accelerating element.

The third and fourth grids are connected to a square wave voltage as shown. This voltage causes the uniform pulses to be bunched. When the grids are positive, approaching electrons are accelerated and those which have just passed

RADIO-CRAFT wants original cartoon ideas and will pay $3.00 for each one accepted. It is not necessary to send in a sketch unless you so desire. Send in your cartoon ideas today!

are slowed up. When the grids are negative, approaching electrons are retarded and those which have just passed are accelerated. Both effects tend to bunch up the electrons. Between these bunches the electrons are more or less separated according to their position between the bunches. While the total number of bunches is exactly equal to the total number of original pulses, they simply exist closer together or further apart. The number of pulses per second corresponds to a definite frequency. This frequency is uniform at first but the action of the third and fourth grids causes it to be (frequency) modulated. A close bunch of pulses corresponds to a higher frequency, for instance.

The fifth and last grid voltage is also supplied by the square wave generator but out of phase. When it is positive, the entire bunch is accelerated and upon passing through the cavity resonator, causes oscillation. The frequency of this oscillation corresponds to the density of pulses in the bunch and to the velocity of the bunch. If the bunches are highly compressed by a high voltage on the third and fourth grids, the frequency will be higher. This can also be obtained by high voltages on the last grid.

Magnetic focussing is provided by a solenoid around the tube. The target electrode at the right-hand end collects electrons. The loop coupled to the cavity resonator extracts energy of the multiplied frequency.

A SHUT-IN'S RADIO SONG

By Vivian Stratton

Although I live within four walls I hear
The finest opera, best plays of all the year;
And outdoor sports are at my beck and call.
The greatest champs? I know them, one and all.
I'm learning French; quaint foreign lands are mine
Through travelogues; I occupy my time
With lessons: how to cook and knit and sew—
These blessings all come through my radio.

CONVERTING THE BC-412

(Continued from page 19)

preventing unwanted coupling and degenerative effects otherwise encountered. It will be noted that as few changes as possible have been made in the original circuit, yet the resulting conversion is quite satisfactory for use on the lower frequencies.

The 884 gas triode is used in a conventional circuit for generating sweep voltages, and with the constants shown will cover a range of from about 10 to 30,000 cycles. Operation at the higher frequencies may be slightly erratic. It is well to carefully check all condensers used in the sweep circuit for leakage and rated capacity before using as this will avoid trouble later on.

The conversion shown in Fig. 1 will cost very little to make as practically all the required parts are already in the 'scope. While the frequency range will not go much higher than 100,000 cycles per second with the circuit constants shown, it will be adequate for most service work.

With the conversion shown in Fig. 2, the useful range of frequencies covered is extended to 2.5 or 3 megacycles, the gain is higher, a Z-axis blanking amplifier is provided for timing and blanking out portions of the trace, a phase shifting network is provided for 60-cycle input, the sweep circuit has an extended low frequency range with

(Continued on following page)

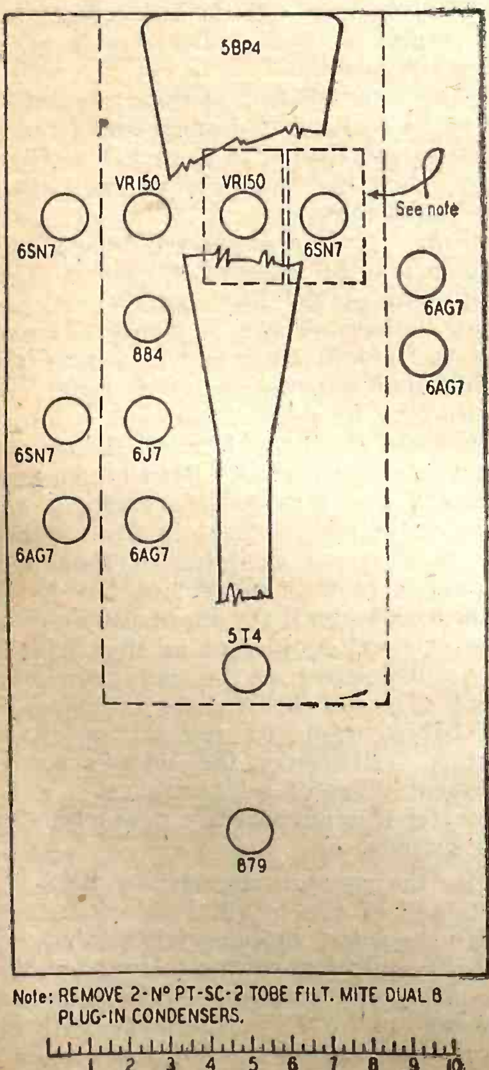


Fig. 3—Tube layout of the converted 'scope.

CONVERTING THE BC-412
(Continued from page 65)

greater linearity of charging rate of the timing condensers provided by the constant current resistor in the form of a 6J7-G tube, and voltages are better stabilized.

The Z-axis amplifier consists of a 6SN7 used as a two-stage resistance-coupled amplifier to apply voltage to the 5BP4 grid through an .05-μf coupling condenser. This condenser should be able to withstand a 2000-volt surge or preferably even higher voltage.

The vertical amplifier consists of a 6SN7 used as cathode follower and phase inverter driving a pair of 6AG7's. The 6AG7 is especially designed for oscilloscope use, and has a high voltage gain over a very wide range of frequencies. Owing to the low resistances in the input circuits, response is uniform at the higher frequencies, but the input voltage must be kept low (under 20 volts) so a second attenuator in the form of a 20,000-ohm wire wound potentiometer must be provided in the input circuit to secure adequate attenuation at input voltages above 20 volts.

The horizontal amplifier is the same as the vertical amplifier with the exception of the input circuit, which uses one side of the 6SN7 as cathode follower for coupling of external synchronizing voltages to the 884 grid. The sweep circuit is similar to the one described in the 1945 RADIO AMATEUR'S HANDBOOK on page 428. It has definite advantages, especially where low frequencies are wanted.

The two VR-150 voltage regulators may be omitted if desired and two resistors substituted in their place. However, their inclusion is desirable if they are available.

Fig. 3 gives a suggested tube layout which may be followed if desired. This will require the least number of circuit changes. There is plenty of room on the front panel for mounting the additional controls required. Input circuits may be coupled through ordinary pin jacks or through microphone connectors or phone jacks. Microphone connectors are very satisfactory for the horizontal and vertical inputs as they allow adequate shielding of these circuits. It is well to remove the Ever-Lok sockets used for input coupling on the original equipment as they will be less convenient than the microphone connectors or pin jacks. Some builders will probably want to mount an input cathode follower on the end of a probe. Several types of miniature tubes suitable for this purpose are now available as surplus.

In the second conversion, little is retained of the original circuits other than the power supplies, positioning, intensity and focus controls. However, the resulting oscilloscope is better than the average and one that its owner will be proud of after it is completed. An alternative conversion is to use the circuits of Fig. 2 with the horizontal input and sweep circuits of Fig. 1. This will be a little cheaper, requiring fewer new parts, and is just about as good for most purposes, as the extended frequency range of the horizontal amplifier is needed only occasionally.

In rewiring an oscilloscope, use wire having adequate insulation, and follow the same general layout as used in the original design, especially with regard to shielding. A good ground for the chassis should be provided. Such a ground connection will improve operation of the 'scope and may prevent getting a shock due to voltage built up between chassis and ground. Allow adequate spacing between parts and solder all connections thoroughly with a good grade of rosin core solder. Minor imperfections and loose connections will show up on the screen, as the eye is more critical than the ear. Difficulties will usually be due to defective filtering, loose connections, improperly shielded and bonded wiring, or the use of defective parts, or parts that are inadequate to carry the load imposed upon them. It is a good idea to give all condensers and resistors a voltage overload test before using them in an oscilloscope. Voltage for this purpose may be obtained from the 'scope high voltage power supply, but HANDLE IT WITH CARE!

There are an infinite number of variations possible in circuit design for rebuilding oscilloscopes like the BC-412-A. The circuits described should provide the engineer with the basis for working out a conversion suitable for the use to which the 'scope is to be put, without becoming too complicated or involved.

REFERENCES

OSCILLOSCOPES, *The Radio Amateur's Handbook*, 1945 edition, p. 427-436.

John W. Campbell, Jr., BUILDING A CATHODE RAY OSCILLOSCOPE, *Popular Science*, April, 1946, p. 188.

W. E. Gilson, A VERSATILE OSCILLOSCOPE, *Electronics* (Engineering Manual, vol. 3) p. 203.

W. A. Gebhegan, AN IMPROVED C-R OSCILLOSCOPE DESIGN, *Electronics*, November, 1940.

Rider, THE CATHODE RAY TUBE AT WORK, John F. Rider, Publisher.

CONVERSION OF ARMY RADAR OSCILLOSCOPES, *Radio-Craft*, July, 1946, p. 706.

TWO CORRECTIONS

An error appeared in the diagram of the Hi-Fi Tuner-Amplifier on page 558 of the May issue. A dot, indicating a connection between the B-plus lead and the plate load resistors of the 6N7 phase inverter stage, was omitted. The B-plus lead leaves the high voltage line between the 3750-ohm and 5,000-ohm resistors and should terminate at the junction of the 100,000-ohm plate load resistor and the 8 μf filter condenser.

We are grateful to Mr. E. M. Striplin, of Represa, California, for calling this omission to our attention.

We are grateful to Mr. R. A. Kulikowski, of Pittsburgh, Penna., for calling our attention to two errors which appeared in the conversion diagram of the Radar Oscilloscope that appeared in the Question Box of the July, 1946, issue.

Two 15-μf, 450 volt condensers are shown connected in series between the junction of the two load resistors, for the 6L6 vertical amplifiers, and ground. These two condensers should be replaced with a single 30-μf, 475 volt unit.

The resistance of the intensity control is shown as 250 ohms. This value should be 25,000 ohms.

The late President Roosevelt spoke over the radio more than 300 times while in office.

RADIOLESS TRAIN HAZARDS
(Continued from page 13)

of marooned commuters only had the vaguest information as to what had occurred. There being no radio communication in the trains they only knew that there must have been some trouble ahead and hoped that their train would soon move.

Under the circumstances few commuters got off the train to telephone their homes, where relatives anxiously awaited word of their whereabouts. Even if some commuters had been able to get off the trains, most of the trains were in positions where there would have been no access to phones or other immediate transportation.

This sort of thing is duplicated frequently with aggravating regularity all over the country. If all this occurred before the advent of radio, one could understand such a condition and make allowances for it. But with instant radio communication in the year 1946, it is no longer permissible that part of the public should needlessly wear itself into a frenzy, when wrecks do occur.

The unfortunate part is that railroads as a whole are not too progressive when it comes to adopting obvious scientific improvements, which in the long run would save thousands of lives and untold millions of dollars. The cost of equipping passenger trains with radio is insignificant if we balance the benefits, both monetary and otherwise, against such cost. Unfortunately, the railroads always have considered passenger trains, particularly commuter trains, as a nuisance. They derive comparatively little monetary benefit from such traffic. Most railroads maintain that it costs them more to operate such trains than they get in return.

Railroad psychology also is such that a serious future wreck is never contemplated. It is considered something wholly exceptional. But when it does occur, it is usually extremely expensive.

In the public interest and to give adequate service, particularly to commuter and other passenger trains, we recommend the following remedies:

The Federal Communications Commission has set aside certain frequencies (wave lengths) for the use of railroads. Some of the forward-looking railroads have already begun installing radio communication between the locomotive and the caboose of the highly profitable freight trains. This is of great help in a number of ways, all of which have been discussed at length in RADIO-CRAFT in the past.

But as far as passenger trains are concerned little has been done in a realistic way with radio. In some trains, notably New York Central Railroad, some of the club cars have radio broadcast receivers which the passengers can use to receive news, music, and other broadcast information.

The New York Central Railroad Company also has now on order a large series of new cars, particularly for commuter service, in which public address systems have been installed. Loudspeakers have been placed in these cars and the conductor announces the stations before the train reaches them. The railroad has not contemplated issuing news bulletins or other information over the same public address system. Yet it is quick information of important news events that the public is entitled to nowadays. Railroads should be conscious of that.

The following is obviously needed:

Every railroad station of any importance should have its own 2-way radio broadcast station with a moderate distance range so trains along the road in the vicinity can be instantly contacted. This could be done by FM or AM. Each train should be equipped with a radio receiver *working on the railroad's frequency*. If loudspeakers were placed in all the coaches, then the train en route—or a stalled train—could be instantly contacted. The engineer, too, could get all available train information, which he might not secure otherwise.

If a train were derailed, it could by means of its 2-way radio contact the next railroad station and inform it so that trains headed toward the wreck would be suitably warnea.

Passengers, instead of remaining in anxious ignorance as at present, could be informed both of the cause and probable duration of the delay. Thus they would be able to react intelligently to the situation; to contact relatives and friends if possible, etc.

When a train ahead has to make an unscheduled stop, that train could pass such information on to the nearest railroad station, which in turn would warn, let us say train No. 57 following, to proceed cautiously.

With such 2-way radio equipment, trains would hardly ever be out of touch with train dispatchers and wrecking trains could be alerted much faster than is possible at present. It might be countered that in case of a serious wreck the radio equipment might be damaged so that no information could be transmitted or received. The point here is that where so much is at stake no railroad in its right senses would just place a single 2-way radio on a train. There would be at least two separate units, one in front, perhaps in the engine, the second in the middle of the train.

By means of such instant communication, in a matter of minutes the railroad could evaluate the full extent of the wreck and how long it would approximately take the wrecking crew to clear the tracks. Such information would then be relayed to broadcasting stations at the nearest centers and the public would be informed not only as to the extent of the wreck and how many were injured, but the list of injured persons could also be broadcast within a comparatively short time.

The public would be informed within 15 minutes of the time of the wreck how many trains have been stalled in both directions, and how long it would take to get these trains moving again.

To radio engineers and radio men these remedies—absolute necessities today—seem wholly elementary. To the railroad people they are not. Railroad men will see many obstacles that the radio man cannot see at all. Yet the problem certainly is not insoluble. Indeed, if the railroads will investigate the idea, they will find much that is attractive about the simple suggestions mentioned.

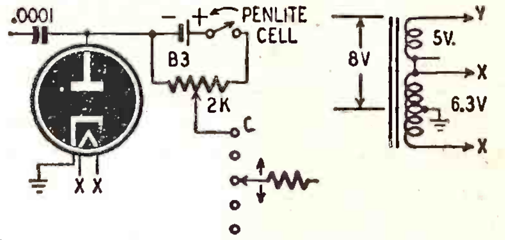
In the meanwhile we recommend that the radio industry should immediately launch an aggressive campaign inducing our railroads to install 2-way radio-communication systems in all passenger trains.

COMMUNICATIONS

OMNICHECKER WORKS WELL

Dear Editor:

Two constructive articles of the last year are of outstanding value to the reader—"Electronic Omnichecker" by Robert E. Altomare and "Better Signal Generator" by L. Lane. I have built both and both give first class performance. A photograph of the Omnichecker is enclosed. A 0-1 milliampere Triplett movement converted into a volt-ohmmeter, has been fitted into it for general



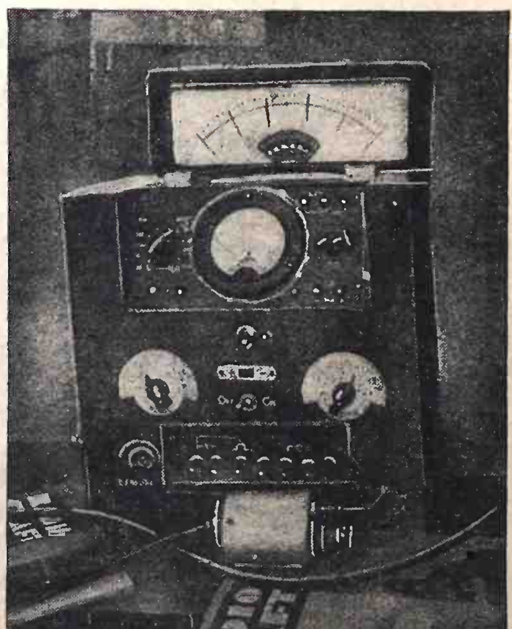
The modifications suggested by Mr. Altomare.

testing without power. An Off-On switch determines which instrument is in action.

I have eliminated the diode bucking voltage. As the heater voltages are brought to correct value, there is very little upscale deflection and this can be zeroed by the zero adjuster. This does not affect calibration or linearity. A 6H6 tube was used in the diode head, as the 9002 was unobtainable.

A little trouble was experienced on the C/1000 and C/10,000 ranges and the calibration for C7, C8 and C9 when resistances were used instead of condensers. Correspondence with the author elicited the following suggestions, which helped approximate close calibration:

"The statement suggesting substitution of resistors for C7, C8 and C9 was partly in error. Resistance will of course change the calibration, especially in the case of C7. Not much difference will be noted if a resistor is substituted for C8 or C9 since ranges Cx10 and



The Omnichecker as constructed by Mr. Patel.

Cx100 are used to check electrolytics, which have an appreciable power factor.

"The reason for trouble with the C/100 and C/10,000 ranges is too low diode input impedance. To increase diode input impedance and yet keep sensitivity high the following changes may be made:

"Increase the a.c. test voltage by connecting the X and Y filament windings in series, taking the Y winding off ground. This puts the whole 5-volt and half the 6.3-volt winding in series. Omit R14 and R15. A battery and switch, as shown, may be used to balance the contact potential. The new S6 may be ganged with S4 if desired. Only *one* diode plate and cathode is used. R7 is omitted."

Last but not least, my meter has first class stability, irrespective of *40 percent* line voltage variation.

What more? RADIO-CRAFT has paid me beyond expectation!

RAOJIBHAI J. PATEL,
Ujain, India

AMERICAN BROADCASTS

Dear Editor:

I am receiving your magazine with fair regularity. I always find it very interesting, on the whole. Your feature "World-Wide Station List" is good, especially as it is quite up to date. Why don't you print it in its entirety in a separate issue to be included in one of your numbers of RADIO-CRAFT? It is a bit impractical to have to go through various issues before finding the station.

I have a very good German receiver, all-wave (and I mean it; continuous from 72.5 kc to 27 mc!) and I want to start looking for South Americans.

By the way, couldn't you suggest in your magazine that, now the war is over, it would be a good idea to "reconvert" some of the programs American stations send to Europe. What we get is mostly news, in about 511 languages—and quite often we hear *European* news which we already heard from local stations several hours before.

Lets have more music from your stations. News from *inside* America might also be interesting. Ever hear PCJ in Holland, 9 to 10 pm at 9.590 mc.?

LEONE SENNI,
Rome, Italy

READER'S APPRECIATION

Dear Editor:

No one should appreciate a magazine as much as the writer does RADIO-CRAFT without expressing that appreciation. Hence this letter.

Your publication has adequate variety and what I do not find in one issue usually looms up in a later one. I especially enjoyed the article "A Versatile VTVM" by E. W. Harding, in the May issue. It shows originality, and new ideas or new circuits (even if interspersed with old familiar faces) are what I like to see.

KENNETH C. MACGREGOR,
Detroit, Michigan

OPPORTUNITY AD-LETS

Advertisements in this section cost 20 cents a word for each insertion. Name, address and initials must be included at the above rate. Cash should accompany all classified advertisements unless placed by an accredited advertising agency. No advertisement for less than ten words accepted. Ten percent discount six issues, twenty percent for twelve issues. Objectionable or misleading advertisements not accepted. Advertisements for November, 1946, issue must reach us not later than September 23, 1946.
Radio-Craft • 25 W. B'way • New York 7, N. Y.

WORLD-WIDE STATION LIST
(Continued from page 61)

Location	Station	Frequency	and Schedule
URUGUAY			
Montevideo	CXA6	9.623	3:30 to 8 pm
Montevideo	CXA15	9.735	
Montevideo	CXA19	11.705	7 to 8 pm
Montevideo	CXA19	11.835	6 am to 10 pm
Montevideo	CXA10	11.900	3:30 to 9 pm
VATICAN CITY			
Vatican City	HVJ	5.968	11 am to noon; 1 to 3 pm
Vatican City	HVJ	9.660	noon to 1:30 pm; 1:45 to 2:30 pm
Vatican City	HVJ	11.740	noon to 1 pm
Vatican City	HVJ	15.120	Wednesdays, midnight to 12:30 am
Vatican City	HVJ	17.445	Wednesdays and Saturdays, 8:45 to 9:15 am
VENEZUELA			
Trujillo	YVIRO	3.310	5 to 9:30 pm
Maracaibo	YVIRT	3.370	5:30 to 10:30 pm
Caracas	YV5RY	3.380	9:30 am to 10:30 pm
Maracay	YV4RK	3.390	6 to 10:30 pm
Merida	YV2RC	3.420	6 to 9:30 pm
Maracaibo	YVIRV	3.440	7 to 9:30 pm
Barquisimeto	YV3RS	3.490	4:30 to 9:30 pm
Barquisimeto	YV6RC	3.510	6 to 9:30 pm
Caracas	YV5RS	3.530	5:30 am to 10:30 pm
Maracaibo	YVIRV	4.750	6 to 9:30 pm
La Guaira	YV5RV	4.760	5 to 9:30 pm
Coro	YVIRY	4.770	4 to 10 pm
Valencia	YV4RO	4.780	4:30 to 9:30 pm
Maracaibo	YVIRL	4.810	6:30 am to 11 pm
Volera	YVIRZ	4.840	4:30 to 9:45 pm
Barquisimeto	YV3RN	4.990	6:30 am to 10:30 pm
Ciudad Bolivar	YV6RD	6.200	5 to 9:30 pm
Caracas	YV5RW	3.400	5:30 am to 10:30 pm
Caracas	YV5RX	3.500	6:30 am to 10:30 pm
Caracas	YV5RM	4.890	5:30 to 10:30 pm
Caracas	YV5RN	4.920	6 am to 10:30 pm
Puerto Caballo	YV4RQ	3.480	5 to 9:30 pm
San Christobal	YV2RN	4.830	11 am to 9 pm
Valencia	YV4RP	3.460	8 to 9:30 pm
YUGOSLAVIA			
Belgrade		6.150	1 to 6 pm
Cetinje		9.360	1:30 to 3 pm
Belgrade		9.420	midnight to 2 am; 10 to 10:45 am

NEW C-R TUBE SCREEN

A new type of German dark-trace cathode-ray tube has a screen which retains an image indefinitely or can be erased rapidly by a special thermal process. The tube was used by the Germans in search radars, in the development of central plotting systems and in sonic direction finding.

? ? WHY NOT ? ?

Why not have manufacturers of hearing aids locate the ON-OFF switch in a more accessible position? In the present models, the set is operated by a slide switch that is located on the top of the unit. This switch is often difficult to locate and operate. A push button switch on the front of the case would be more accessible and easier for the owner to reach.

JOHN CAVANAUGH,
Cohoes, N. Y.

Why not have electric cigarette lighters built into home radios? The lighter can be powered by a separate transformer winding.

S. F. BIGOWA,
Youngstown, Ohio

Why not have all table model radio cabinets made with removable bottoms for simpler servicing? The chassis can be secured to the sides and the bottom a spring catch, or can be held in place with screws or clips.

COY BULLARD,
Davenport, Iowa

Why not design all phonograph records with a built-in stroboscope to check motor speeds? This need take but little space on the record and in many cases, would prove invaluable. It is done on some foreign records.

PFC. JOHN R. SIMPSON,
Miami, Fla.

FIGHTING AMATEURS

(Continued from page 26)

through the waterpipe. We communicated like that for hours and exchanged news. These friends are also among those lost to us.

I think of PA0ZB—H. A. Touw of Princenhage, the hero of the quiet post in Breda, who after having been for hours under fire from a farm had to capitulate and was shot.

And finally I think of PA0MB—G. A. Meerhof of Apeldoorn and PA0VL—J. de Vries of Amsterdam, who also stood up for the honor of Holland before a firing squad.

On this spot I am bringing to all these heroes my thanks and my homage. Let the survivors find some consolation in the knowledge of the fact, that the radio amateurs of the world shall never forget these heroes. Their names are inscribed in the annals of the V.E.R.O.N. (Association for Experimental Radio Operation in Netherland) as a brilliant example for us and the coming generations.

Reprinted from *Electron* (Rotterdam) official organ of the V.E.R.O.N.

Electronic newspapers will be tried in twelve American cities next year, according to a report by John V. L. Hogan, in placing an order with General Electric for that number of facsimile transmitters, together with the largest order for facsimile receivers ever made.

USE YOUR AUTO RADIO!

(Continued from page 25)

If you desire more power output, you can rewire the output tube socket to constitute a phase inverter, then add a small chassis with two sockets for the push-pull output tubes. Fig. 2 is a diagram for a push-pull audio amplifier. With this amplifier you will have a really good eight-tube receiver.

There is a possibility that a 110-volt power supply will deliver too high a voltage for the tuner. Most auto radios operate on 180 to 250 volts. The voltage can be lowered by using a transformer with low-voltage secondary.

When we turn on our receiver, remember not to use too long an antenna, as the auto radio is intended to operate on a very short antenna. A long antenna will cause cross modulation and reduction of selectivity. Ten to fifteen feet of wire is adequate unless you do not live close to a high power station. In rural areas, a fifty foot outdoor aerial may be used.

Since the auto radio is constructed to work with a very small antenna system, the antenna coil will probably have to be retrimmed for such an aerial. In some cases it may be advisable to insert a small condenser (trimmer type) to make antenna coil alignment easier.

As for the cabinet, you have many choices. There are many different kinds advertised in radio magazines. You might include a phono motor and pickup so that you will have a phono combination; perhaps you would prefer to buy a console cabinet or build your own. There is plenty of room for individuality and the reward for your labor will be a fine broadcast receiver.

RADIO-ELECTRONIC QUIZ

How thoroughly have you mastered the contents of this magazine? Try the following quiz as a test:

1. How far can reliable radio communication be carried on between a moving railroad train and a fixed station? See page 14.
2. What is "radiopaging?" See page 14.
3. What effect has the end of the war had on the many women employed in radio? See page 15.
4. Can all types of collisions between airplanes and unseen obstacles be effectively reduced by GCA (ground control approach)? See page 17.
5. What means are used to combat the problem of static electricity on airplanes? See page 21.
6. In what country do radio servicemen combine in co-operatives? See page 23.
7. Does 45 or 90 mc provide an excellent quality of FM service over the larger area? See page 29.
8. What is *permeance?* See page 31.
9. What is the advantage of a higher intermediate frequency in television audio and video circuits? See page 58.
10. What difficulty is experienced with the aerial circuit when an automobile radio is adapted to power-line use? See page 74.

ANTI-COLLISION RADIO

(*Continued from page* 55)

safe. *Sudden* lengthening of the pip warns him that the transmitter is getting dangerously nearer.

Disadvantage of this system is that every obstacle must be fitted out with a transmitter. It would, however, be necessary to mark only the tallest building in a group, or the highest peak of a number of mountains close together. In avoiding the tallest, the plane would automatically rise above the others. The system could not prevent accidents to planes lost in storms over wild country not equipped with automatic transmitters.

An instrument approach landing system was developed before the war by CAA. It is now being adapted to v.h.f. and put into use on a number of airfields. It employs the familiar AN radio range, in which the pilot hears a steady tone while flying "on the beam" and the letter A or N when flying on either side of it. A *field marker* (small transmitter radiating vertically) operates lights on the instrument board as the pilot approaches the field's limits, and a *glide-path* makes it possible for him to let the plane down at the correct rate.

This system requires special apparatus on the plane, including equipment to operate indicator lights as the plane passes the field markers and cross-pointer indicators to keep it on the glide-path. It has the great advantage of being well known and already in partial use. As a means for preventing collision with tall buildings, its effectiveness is only indirect, as it cannot sweep the skies with its beam, but is available only to planes flying the correct course.

INDEX TO ADVERTISERS

The Japanese built microwave radar transmitters with a wavelength as short as 10 centimeters, a last month report of the Department of Commerce stated. Radar receivers used 10-centimeter magnetron tubes with four-segment anodes, which worked at comparatively low voltages. Experimental transmitting and receiving tubes which would work at wavelengths as short as three centimeters were also found, as well as one unit with a 20-cavity anode, which oscillated at 0.7 centimeter.

BOOK REVIEWS

REFERENCE DATA FOR RADIO ENGINEERS (Second Edition). Edited by H. T. Kohlhaas. Published by Federal Telephone and Radio Corporation. Flexible leatherette covers, 5½x8½ inches, 322 pages plus 13-page index. Price $2.00.

The second edition of this well-known reference work contains 135 more pages than its predecessor, and contains a large number of charts and tables on v.h.f. subjects.

Two new chapters, covering iron-core transformers and room acoustics, have been added, and some of those in the first edition have been almost doubled in size. The chapter on vacuum tubes and amplifiers has indeed been split in two; one chapter on vacuum tubes and a second on vacuum-tube amplifiers. The section on wave guides and resonators—in the first edition part of the chapter dealing with r.f. transmission lines—now forms a chapter by itself. The chapters on radio propagation and noise and on antennas also represented a single chapter in the old edition.

The revision has had the effect of bringing the book up to date and adding material of special interest to the engineer or technician interested in high frequencies. Illustrations are plentiful and the printing is in an interesting modern type.

THE WORKING ELECTRON, by Raymond F. Yates. Published by Harper and Brothers. Stiff covers, 5½ by 8½ inches, 247 pages. Price $2.50.

This treatise is a "down-to-earth" introduction to electronics. It is written in the simple English of the layman and is illustrated with more than a hundred photographs, diagrams and drawings.

The first two chapters open the book with a simple but thorough explanation of the electron and electric charges. Electric charges are explained with drawings of simple experiments that may be performed with a homemade electroscope and an electrophorus.

Chapter four describes the various classes of radiations produced when air and some of the gaseous elements are ionized. Instructions are given for performing simple ionization experiments with mercury lamps. Chapters five and six discuss the fundamentals and applications of the vacuum tube. The next three chapters are devoted to photoelectric phenomena, photoelectric cells and their applications.

The remaining twelve chapters describe the action of the electron in physics, photography, industrial applications and control, biological and therapeutic applications, chemistry, geophysics, geology and radar.

This book provides a wealth of useful material for the high school science student and for the home experimenter who may enlarge upon the experiments and demonstrations described.

ELECTRON OPTICS and the ELECTRON MICROSCOPE, by V. K. Zworykin, G. A. Morton, E. G. Ramberg, J. Hillier and A. W. Vance. Published by John Wiley & Sons, Inc. Stiff covers, 8½ x 6 inches, 766 pages. Price $10.00.

This book is of particular interest to users of electron microscopes and to engineers and students of electron optics.

It is divided into two parts. The first part discusses the characteristics of magnetic, electrostatic, scanning, and point and shadow microscopes. Five full chapters in this section are devoted to the magnetic microscope. These chapters present well illustrated and easily understood material on electron sources, lens systems, object and plate chambers and power supplies. This section does not resort to mathematics. It is adequately illustrated with diagrams and photographs that do much to clarify the presentation.

The second part is devoted entirely to the theory and development of electron optics. It is highly mathematical in its approach and includes a large number of formulas and equations in discussions of magnetic fields, derivation of geometrical aberrations, characteristics of lenses, limits of recognition of minute particles and other related subjects.

Many of the chapters of this book conclude with a very useful bibliography of related reference material.

TELEVISION FOR TODAY

(Continued from page 59)

video i.f., at present, extends from 25.75 mc to 21.75 mc. Since only the higher video frequencies are at 21.75 and since many of the smaller television receivers do not use all of these higher video frequencies, we find that most of the video signal is well above 22 mc and, hence, not subject to interference. The higher priced receivers which make full use of the 4 mc video voltages have sufficient selectivity preceding the mixer to reduce any possibility of interference from image signals. The audio i.f. is at 21.25 mc, but the audio, being FM, is only slightly concerned with image frequencies so far removed.

This is but one example of the relationship of spurious responses and the intermediate frequency. A higher i.f.—which would eliminate or at least minimize other spurious responses—would be desirable. Operating against it, however, is the fact that the higher frequency amplifiers, with present production engineering, are not capable of as much gain as lower frequency circuits. Stability, too, is an important factor.

While the video signal broadcast by the transmitter and received by the

TABLE

Channel Number	Frequency of Band	Oscillator Frequency
1	44-50 mc.	71.00 mc.
2	54-60 mc.	81.00 mc.
3	60-66 mc.	87.00 mc.
4	66-72 mc.	93.00 mc.
5	76-82 mc.	103.00 mc.
6	82-88 mc.	109.00 mc.

receiver contains the full 4 mc, many sets with screens of 5, 7, and a few with 9 inches, have bandpass widths extending only up to 2.5 or 3 mc. Under these conditions, the coupling circuits shown in Fig. 8 are satisfactory. The i.f. system follows conventional lines with inductive coupling and resistance loading. The response characteristic of this system is flat for approximately 2.5 mc and then slopes down quite rapidly, as shown in Fig. 9. The result of this restricted response is a loss of fine detail on the screen. This is not too noticeable on smaller screens.

For a wider response, the circuit in Fig. 10 could be used. The coupling between stages is obtained inductively and capacitively. In alignment, the adjustment on each coil and the small series condenser must be juggled back and forth for the optimum response. The two coils govern the gain of the arrangement, the condenser adjusts the spread. The advantage of such specially derived circuits is that they provide the full 4 mc bandwidth with good attenuation at both ends. Their disadvantage lies in their greatly increased cost and generally the criticalness of their adjustment.

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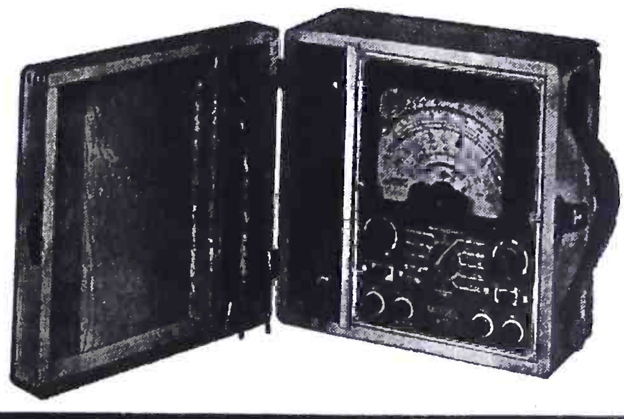

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