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October

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HUGO GERNSBACK EDITOR

THE AIRCRAFT RADIO SERVICE MAN

See Page 202

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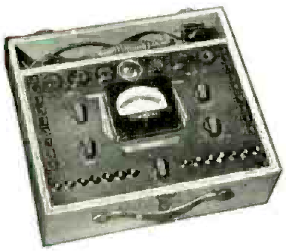

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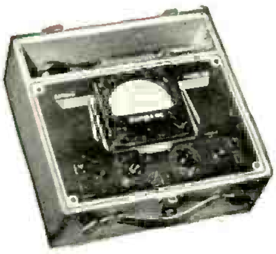

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Radio-Craft
FOR THE SERVICE MAN · DEALER · RADIOTRICIAN

SPECIAL TEST EQUIPMENT NUMBER

HUGO GERNSBACK, Editor-in-Chief
N. H. LESSEM, Associate Editor
C. P. MASON, Associate Editor
R. D. WASHBURNE, Managing Editor

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Volume IX Number 4

NOVEMBER RADIO-CRAFT—RADIO VOCATION NUMBER!

Facts and figures show that radio facilities are rapidly being expanded into numerous fields. Radio program reception and transmission, public address, and electronics all have been put to new uses. The innumerable money-making possibilities of these 3 major fields will be evident to the radio man who reads the technical and semi-technical articles in the forthcoming November issue of RADIO-CRAFT—

—on the newsstands October 1.

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INDEX

Check this easy to follow Index. See the tremendous number of sets and models covered. Note, too, that this Index proves what we say—"that information on every set is instantly found." A time saver and a convenience for you. This Index of about 118 pages covers all eight Rider Manuals and goes with every copy of Volume VIII.

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Radio-Craft
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"Takes the Resistance out of Radio"
Editorial Offices: 99 Hudson St., New York, N. Y. HUGO GERNSBACK, Editor Vol. IX, No. 4, October 1937

MARCONI

An Editorial by HUGO GERNSBACK

ON JULY 20th, there died in Rome, Guglielmo Marconi who may turn out to be the greatest radio figure the world has ever seen.

Marconi . . . wireless . . . radio, all are used synonymously and you cannot very well think of wireless or radio without the accomplishments of that indefatigable genius who was the first to capture the public's imagination by an accomplishment, which in the early years of wireless well nigh bordered on the miraculous.

Marconi no doubt will go down in history as one of the race's great benefactors, as great or greater than any other benefactor who ever lived. The debt which the world owes to Marconi is staggering—if you figure only one single result of his accomplishments—the saving of tens of thousands of lives which would have perished in the sea and otherwise, if it had not been for Marconi.

But the saving of untold lives is only one of the things that the world is indebted for to Marconi. The wireless, later the radio age, has brought to life not only a huge industry, but has brought all humans closer together, has made rapid communication, particularly between fixed and mobile stations, a possibility and lately in broadcasting has given the human voice wings such as it never before dreamt of having.

Yet great as Marconi's accomplishments are, he was not the pure inventor type of man, although his name is frequently linked with the word "inventor." Without trying to detract from Marconi's greatness—there could be nothing further from my mind—Marconi was really not the man who invented wireless or radio. He admitted this freely in his own lectures. The credit for the original invention belongs to Heinrich Hertz, who, long before Marconi, investigated in pure scientific terms the electro-magnetic waves, and indeed to Hertz belongs the honor of being the real Father of Radio.

Hertz it was who in his laboratory actually transmitted and received wireless signals. By means of a spark coil he let loose into free space wireless waves. For a receiver he merely used a small loop of copper wire and observed a small spark which appeared between the two open ends of the loop every time the key of the transmitter was depressed. These experiments were made by Hertz while Marconi still was a boy, but, Hertz was a pure physicist and had little imagination. Marconi, reading of Hertz's experiments, promptly started to experiment on his own behalf, and soon he had a wireless transmitter and receiver going on his father's estate in Bologna, Italy. Even Marconi's "coherer" was not his own invention, but Branley's. Others before had noted that loose metallic filings in a glass tube became conductive to the electric current when exposed near the wave effect of a spark coil or high-power induction coil.

As for the elevated aerial used by Marconi, this also was not an invention of his own as Nikola Tesla had already patented a wireless system years before the youthful Marconi began his own experiments. It was Tesla too, who seems to be the first to show the use of an elevated conductor for inter-communication purposes without wires.

All of this should not detract anymore from the glory of Marconi's accomplishments than the parallel facts that Edison was not the original inventor of either the electric light, motion picture or other inventions usually accredited to him. Neither Marconi nor Edison were pure research men who discovered new principles and used them.

Why then Marconi's greatness? It is one thing to discover an important and record-making discovery, but it is quite another thing to find a practical use for it. The two, as a rule, have little relation, and it is usually the man with the imagination, and the hard-working experimenter who, knowing certain principles, applies them to practical use. If it had not been for Marconi, Hertz's discovery might have lain dormant for decades, but the highly original experiments and the terrifically hard work coupled with boundless enthusiasm which Marconi applied to a well-known principle, gave him the credit which rightfully belongs to him.

And let no one think that it was all easy and that wireless communication sprang into life overnight. It was always hard work in the face of an incredulous world. Indeed, after his first experiments in Italy were successful, the Italian government in their shortsightedness would have nothing to do with Marconi's "contraption" as they termed it. This made it necessary for Marconi to go to England and continue his experiments there. Soon his signals had reached across the English channel to France, and from then on wireless communication required no further proofs of its practicability.

But still wireless in those days was very crude and far from universal. In the meanwhile Marconi surrounded himself with good technical talent; he also knew where to get needed finances, and finally he availed himself of every new invention that came along to make his system more practical. While he devised many radio circuits, he did not himself discover the fundamental tuning principle, yet he improved existing methods of tuning—*syntony*—as it was then called, and soon it became possible to operate many wireless stations without too much interference from each other.

But Marconi was not content. He never rested on his laurels. He always was a modest worker who gave credit to whom credit was due, and the honors for dreaming about trans-Atlantic wireless and the courage to actually start experimenting with it in the face of an incredulous world, certainly belong to Marconi. It should not be forgotten that it took a tremendous amount of courage and belief in himself to think that a new and untried system of transmitting electromagnetic waves over almost 2,000 miles of curved ocean surface was within the realm of even a remote possibility. That took more than courage. It was really a supreme heroic gesture, and it is probably for this one outstanding accomplishment, more than any other, that the world is paying homage to the dead inventor today.

In his later years, Marconi again was responsible for great improvements in radio communication, particularly in the shortwave range and his final researches in the microwave field which hold great promise, were cut short by his untimely death.

Marconi was truly an international figure, and if there is one man who ever trod the earth, who is entitled to have a monument erected in his honor in every civilized country on the globe, that man without a shadow of a doubt is the illustrious Marconi.

Photo—Consulate General, Kingdom of Yugoslavia

Nikola Tesla, wizard of high-frequency electricity and prophet of radio, was honored on his 80th birthday by his native land, Yugoslavia, with the stamp reproduced above. (The characters in the right vertical column spell his name in the Serbian alphabet.)

THE RADIO MONTH

It may be that short-wave apparatus will be developed, and generally adopted, to facilitate distress calls; but its very range militates against its being heard by the nearby relievers—and, in that waste of water around the islands lately visited only by eclipse observers, the most powerful of apparatus would have been none too strong for a call for help.

RADIO PROVED AIR NECESSITY

BY its use, as well as by its absence, radio last month again showed strikingly its paramount importance in the development of modern travel. Again a flight was made over the Pole, with continual ground communication; two great boats (both illustrated at the bottom of page 199) made the first trip of what will develop into regular commercial transatlantic schedules, with radio as their safeguard—and a famous aviatrice disappeared into the silence.

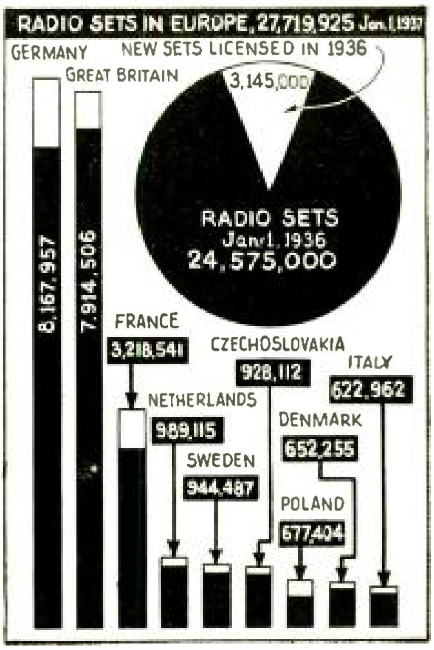
Amelia Earhart and her navigator, Capt. Noonan, may have met some disaster in which radio could not have helped; we do not know. But they *did* wilfully discard a standard ship set which, if they had been living, and *known the code*, could have brought relief straight to them from the Navy, equipped with directional finders operating on this frequency. It seems still doubtful whether any messages were actually received from them; and on July 19 the search was abandoned after 17 days of feverish excitement.

WAR ON "GYP" MIDGET SALES

RAIDS were made, simultaneously, last month by the District Attorney of New York, on a group of dealers, charged with selling midget sets to which well-known nameplates had been attached. A New York law specially prohibits the practice. During the preceding weeks, the Federal Trade Commission also had issued orders to stop imitation of radio set makes.

A HUNDRED YEARS OF RADIO?

IN estimating the period between first conceptions of famous inventions and their reduction to practice, a recently-publicized report from Washington gave the average period as 176 years, and that for radio as 70 years. It is true that communication at a distance is a very old idea. (At one time, it was supposed that 2 needles magnetized together would be "sympathetic" and that one would turn as the other did, at any distance. This was disproved by Sir Thomas Browne, who showed that the effect could not be obtained, even in the next room.) It is also true that inductive effects were observed during the early 19th Century, but not explained. However, the first conception of radio, as such, came with Hertz' experiments; and within 10 years, Marconi had made the first practical demonstrations. Television (by wire) as a concept preceded radio some years.

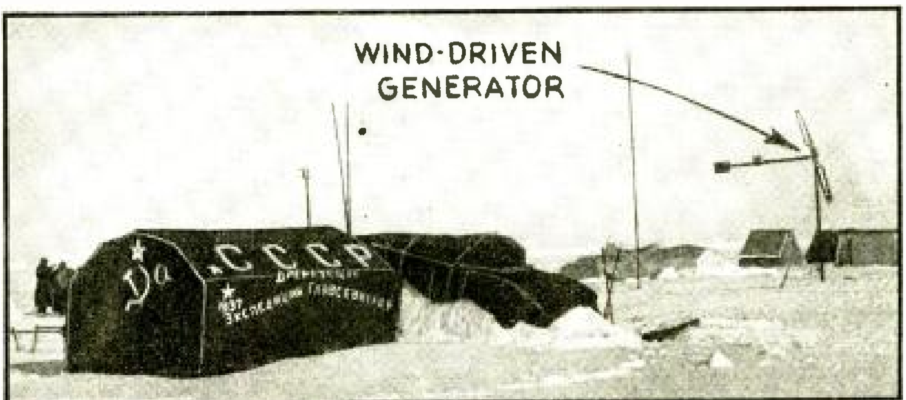


Figures of International Broadcasting Union, Geneva, show Europe Licensed 3,000,000 new radio sets last year. The proportionate growth was greatest in countries like Greece, which more than doubled the number. (Spain and U.S.S.R. omitted, and some colonies included in the total.)

LOWER RATES FOR CHEAPER TUBES

SINCE the freight rates on radio tubes were fixed in 1934, there has been a "reduction in the value per pound of glass tube shipments, while the value per pound of metal tubes has also gradually reduced since their introduction", the R.M.A. announced last month; and for that reason it has applied for a reduction in rates on this classification of goods.

America's Ladybird No. 1 shown at the controls of her famous "flying laboratory" in which (minus the 500 kc. radio installation, after leaving Miami) she and her navigator Captain Noonan flew into the great mysterious silence of the unknown.



Sofoto via North Pole-Moscow Plane

Photograph of the northernmost radio station in the world, UPOL, Lat. 90 deg. North. It was established exactly at the North Pole but, since it is based on ice drifting in the Arctic Ocean, it changes position slightly from day to day. Behind the black (to pass the heat rays, and afford best visibility to airplanes) station tent with Soviet emblems can be seen aerial masts, wind-driven generator, and other tents of the party. The station operates on amateur 20- and 40-meter bands at 1900 and 2130 GMT (which is also NPT).

IN REVIEW

Radio is now such a vast and diversified art it becomes necessary to make a general survey of important monthly developments. RADIO-CRAFT analyzes these developments and presents a review of those items which interest all.

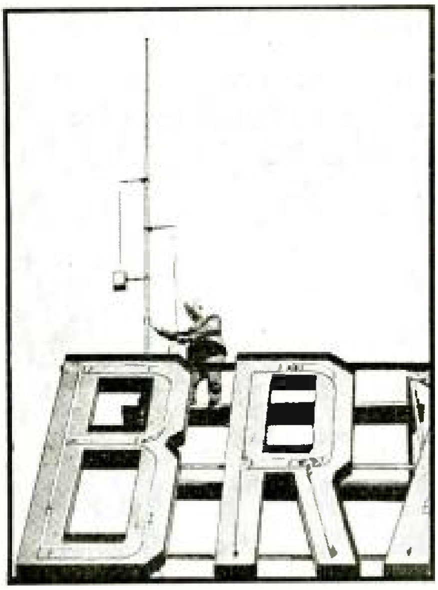


Photo Westinghouse Co.

The new antenna of WIXKA (Boston) is unique in being used simultaneously for receiving, while broadcasting on ultra-short waves. It is grounded to the Bradford Hotel sign, as a lightning surge protector.

RADIO ALARM WORKS

FIRST instance in which RCA's new automatic radio alarm served an American vessel in distress occurred last month when an emergency signal was received by the Ensley City from the Sandgate Castle's newly-installed *automatic alarm*. Charles J. Pannill, president of Radiomarine Corp., was informed the alarm had worked perfectly.

As previously stated in *Radio-Craft* (April 1937, "SOS Robot Threatens Radio Operators"), commercial operators have not taken very kindly to the new idea.

SOVIET INSTITUTE FOR TELEVISION

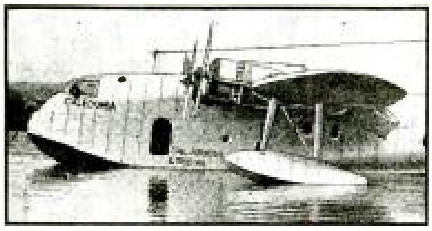
TELEVISION in the Soviet Union is somewhat behind the stage reached in the United States, Germany and Great Britain, it would seem from an announcement, last month, that its transmissions are with 120-line mechanical lens-discs; but with the setting up of an Institute of Television officially, and the dispatch of engineers to study foreign methods, considerable advance can be expected soon. It is estimated that the Soviet Union has now 3½ million receiving sets, typically of the 4-tube variety; and 400 amateur transmitters.

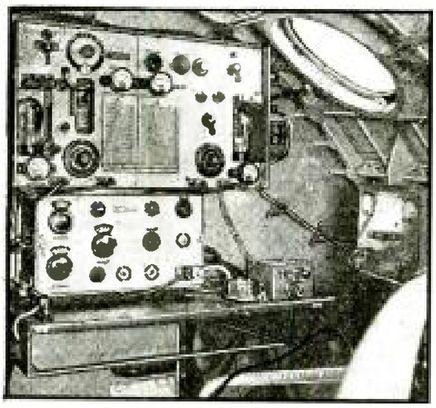
MUSICIANS AGAINST DISCS AND PICKUPS

ANOTHER "headache", of the kind so common, is promised to the radio industry by the ultimatum issued last month by the American Federation of Musicians that it will strike against the "indiscriminate" use of phonograph records or transcriptions at broadcast stations, and also to prohibit its members from furnishing music to be picked up for broadcast by radio from places outside the studios. The deadline for action was set at Aug. 14. The action is stated to be the reaction of musicians to increasing unemployment, and their blaming "canned" music for the condition.

RADIO PLAYS IMPORTANT ROLE IN PIONEER TRANS-ATLANTIC FLIGHTS

THE two great flying ships "Pan-American Clipper III", eastbound, and the "Caledonia" of English Imperial Airways, westbound—on July 6 crossed the Atlantic simultaneously, preparing the course for commercial 1-day travel between Europe and America. They passed, midway in flight, and exchanged radio greetings and weather information, while invisible to each other. Right, the "Clipper", and an operator at the radio equipment; left, the "Caledonia", and her radio equipment, more fully shown.





Photos—The Aeroplane (London) and Marconi's Wireless Telegraph Co., Ltd.

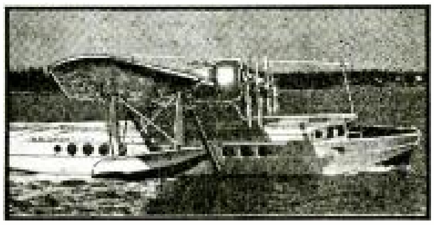
S Photo

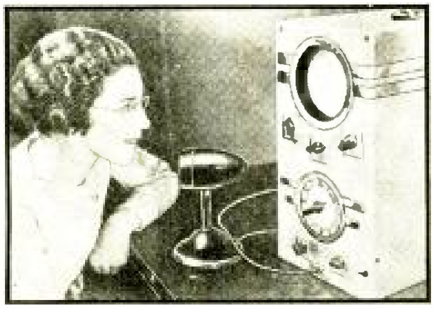
Transpolar flights are now becoming the regular thing. Radio communication, maintained over the course, adds greatly to their certainty. Radio apparatus being set up in the cabin of the "ANT-25" —the radio compass loop is seen ahead.

DRAMATIC PROGRAM CAUSES ERRORS

WHILE the ingenuity of program directors is of great interest when applied to current events in a realistic manner (Shakespeare did it on the stage), it nevertheless causes much misapprehension from listeners who hear but a bit of it. Such a program, last

(Continued on page 247)





Singer testing pitch of her voice by observing waveform on cathode-ray screen of resonoscope.

THE "RESONOSCOPE" NEW ELECTRONIC DEVICE DETECTS "OFF-KEY" NOTES

Vocalists and instrumentalists now have available an inexpensive instrument that far outstrips human skill in detecting deviations in the pitch of a musical note.

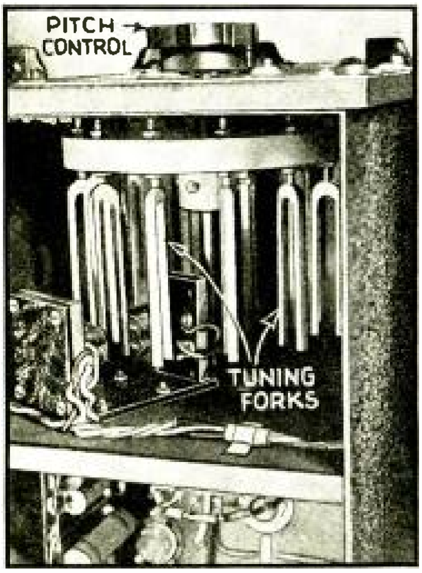
ALLEN B. DuMONT

> **SOME OF THE USES OF THE NEW "ELECTRONIC MUSIC ROBOT"**
>
> (1) Facilitates tuning reed and string instruments not only for fundamental notes but for all octaves.
>
> (2) Each instrument in a band may be tuned to produce new ensemble effects.
>
> (3) Singers may actually "see" and quickly correct errors in pitch.
>
> (4) Broadcast stations use this "robot" to quickly pitch musical groups.
>
> (5) Music teachers now may "demonstrate" a student's tone-quality and pitch.

AN INGENIOUS electronic "robot" is now available which not only sounds the Simon-pure tone for guidance, but also checks a voice or musical instrument and indicates its pitch and its quality! In other words, the note under examination is made to write its own harmonics on the cathode-ray screen, in direct comparison with the pure note. The eye, far more critically than the most musical of ears, determines the musical quality at a glance.

OBTAINING HORIZONTAL- AND VERTICAL-SWEEP FREQUENCIES

The "resonoscope," as this new electronic instrument is called, is a development of the Allen B. DuMont Laboratories. It comprises a special cathode-ray oscilloscope used in conjunction with a standard set of musical frequencies representing the 12 notes of the chromatic musical scale. These standard frequencies, produced by 12 electrically-driven tuning forks (see Fig. B), are utilized to synchronize a sawtooth oscillator in step with them. The oscillator is employed to provide a *horizontal-sweep frequency* for the C.-R. tube.



Underneath side of resonoscope chassis, showing master tuning forks and driving solenoids.

Meanwhile, a voltage amplifier is employed to pick up the music of any single musical tone by means of a sensitive microphone. The amplifier output, which constitutes the *vertical-sweep frequency*, is placed on the vertical plates of the cathode-ray tube.

These horizontal- and vertical-sweep frequencies combine to provide a visual image of the waveform of the musical note under observation. See Fig. A. If that musical note is of the same "pitch" or *frequency* as the standard being used, *or any harmonic of same*, the waveform will appear to stand still on the screen. If the note is "flat" or lower in pitch than the horizontal-sweep standard, the waveform will appear to be moving to the *left*. If higher in pitch or "sharp," it will move to the *right*. The speed with which the waveform moves across the screen is a direct indication of the extent to which the instrument or voice is off-pitch.

OBTAINING FREQUENCY "STANDARDS"

Any of the 12 standard frequencies in this new "robot" may be selected one at a time by the turn of the large control knob on the front panel. The positions are marked C, C#, D, D#, and so-on. These 12 frequencies represent the 12 notes of the chromatic scale. Each setting of the control accommodates all octaves of the particular note. The middle-octave notes appear as simple waveforms on the cathode-ray screen. The higher octaves appear as multiple waves, while lower octaves are simply portions of the waves. See Fig. 2.

One of the special features of the circuit of this oscilloscope is that the horizontal-sweep circuit is automatically changed in frequency to compensate for the change in frequency in going from one note to another. See Fig. 1. This allows the sweep circuit to be readily synchronized at all times by the standard frequency of the tuning forks, and assures the observer that the number of waveforms on the screen is a direct indication of the octave to which he or she is playing or tuning.

The frequencies of the standard

(*Continued on page 245*)

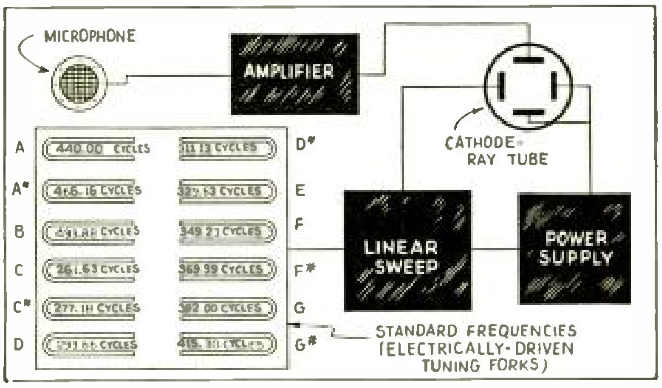


Fig. 1. Tuning forks determine the horizontal-sweep-circuit frequencies.

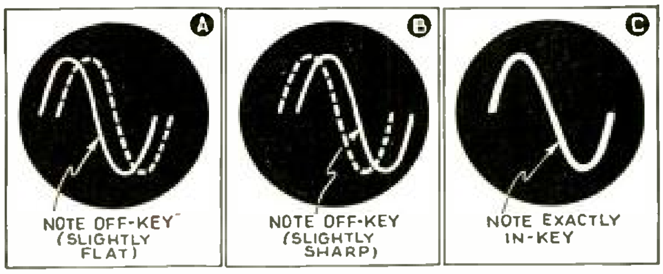


Fig. 2. The vocalist (or instrumentalist) provides vertical-sweep-circuit frequencies by singing (or playing) into the microphone; which is connected through an amplifier to the "resonoscope." "Drifting" of the waveform left or right from a central position indicates, respectively, "flat" or "sharp." *Radio-Craft* editors have witnessed demonstrations of this amazing device which prove quite definitely that even professional singers and musicians seldom realize when they are off-key. In fact, other tests show, skilled instrument tuners may vary 1/3-cycle from fundamental notes; but this new, uncanny, "electronic robot" is precise to about 0.002 per cent!

NEW "RESOLUTION TESTER" FOR CATHODE-RAY TUBES

Here is a simplified description of "the initial nucleus of the instrument which the Service Man of the future who intends to do television work will require." Its complicated pattern facilitates testing television receiving tubes.

W. E. SHRAGE

ONE WHO GLANCES superficially over the column-full of patterns, Fig. B, shown at right probably will not hesitate to assume that the summer's heat has caused the editors to go "haywire." Nevertheless these illustrations *do* belong in *Radio-Craft*. The patterns concern every progressive Service Man and amateur who in a few years hence intends to be as much up to date as he is today with modern principles of radio.

"A CIRCUIT FOR STUDYING KINESCOPE RESOLUTIONS"

Those among us who are familiar with the operation of the Service Man's cathode-ray oscilloscope will probably recognize some waveform designs as those resembling somehow a number of the complex figures which, once in a while, appear on the screen of their "magic box"; especially when voltages having odd frequency relations are applied to the terminals of the oscilloscope.

But one glance at Figs. A and C, showing, respectively, a complicated block diagram, and the inside and outside views of an obviously complicated master oscillator, will immediately exclude the thought that these patterns are the incidental product of work performed with a cathode-ray tube.

Mr. C. E. Burnett (of RCA's television laboratory), the originator of these patterns, and the designer of the master oscillator illustrated in Fig. A, calls it: "a circuit for studying Kinescope resolutions" which makes the issue by no means clearer.

However, the same facts, when presented in simplified language resolve themselves into something which, after all is not so very complicated; in fact it is not hard to foresee that a considerably simplified form of this elaborate master-oscillator equipment will, in the near future grace the Service Man's workbench just as the tube tester and cathode-ray oscilloscope do today!

THE "FLYING SPOT" HAS "STREAMLINE" SHAPE!

Now here are the actual reasons for this odd experiment! Television engineers observed that Kinescope (a type of cathode-ray tube designed especially

(Continued on page 252)

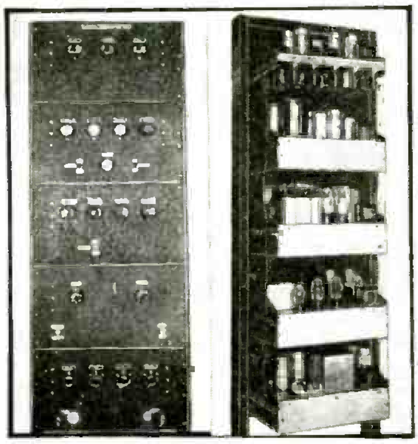


Fig. A. Front and rear views of the master-oscillator equipment used.

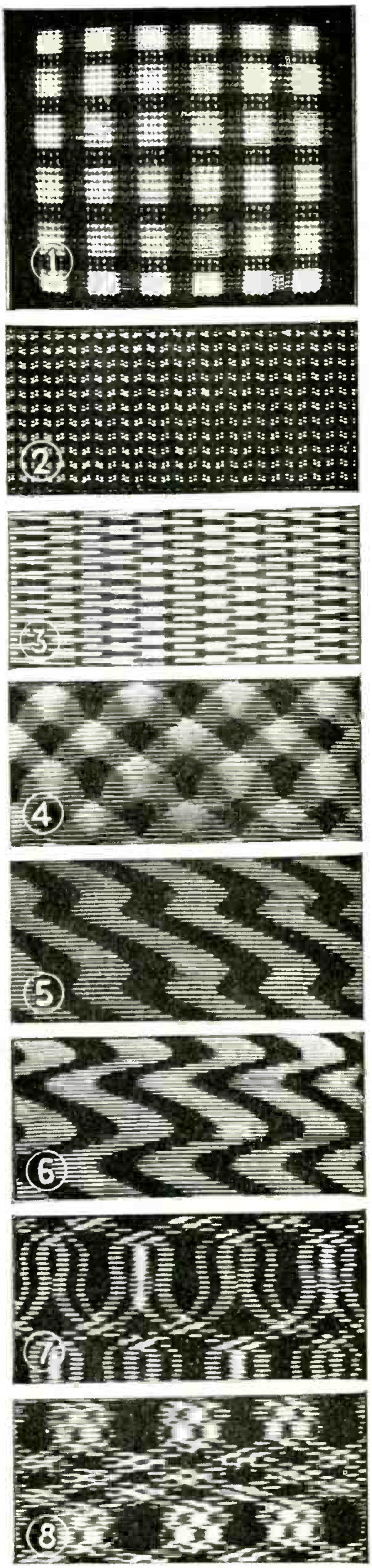


Fig. B. Patterns obtained with tester (see Table I).

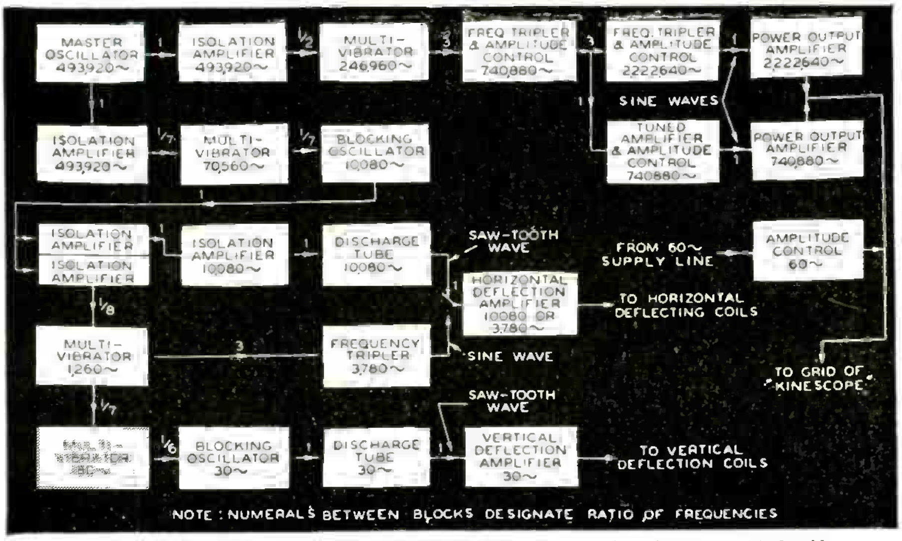


Fig. C. Block diagram of the "resolution tester" showing the various frequency relationships.

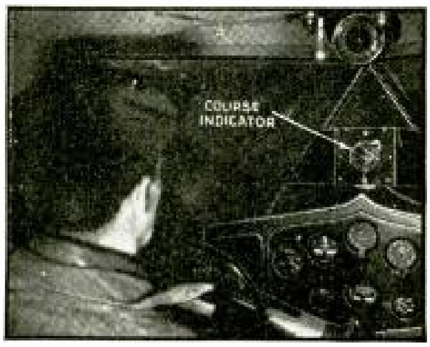


Fig. A. Note "cross-pointer" (course indicator) meter on instrument board.

"AIR-TRACK" SYSTEM OF BLIND LANDING

CHARLES E. PLANCK

THE FAMILIAR "curved beam" radio safe landing system has been developed by the Washington Institute of Technology to the point where it is now ready for commercial use on any airport. Figure A is an action view of the system shown in Fig. B. (Figure B is a phantom diagram prepared by staff artist T. D. Pentz.)

(Continued on page 248)

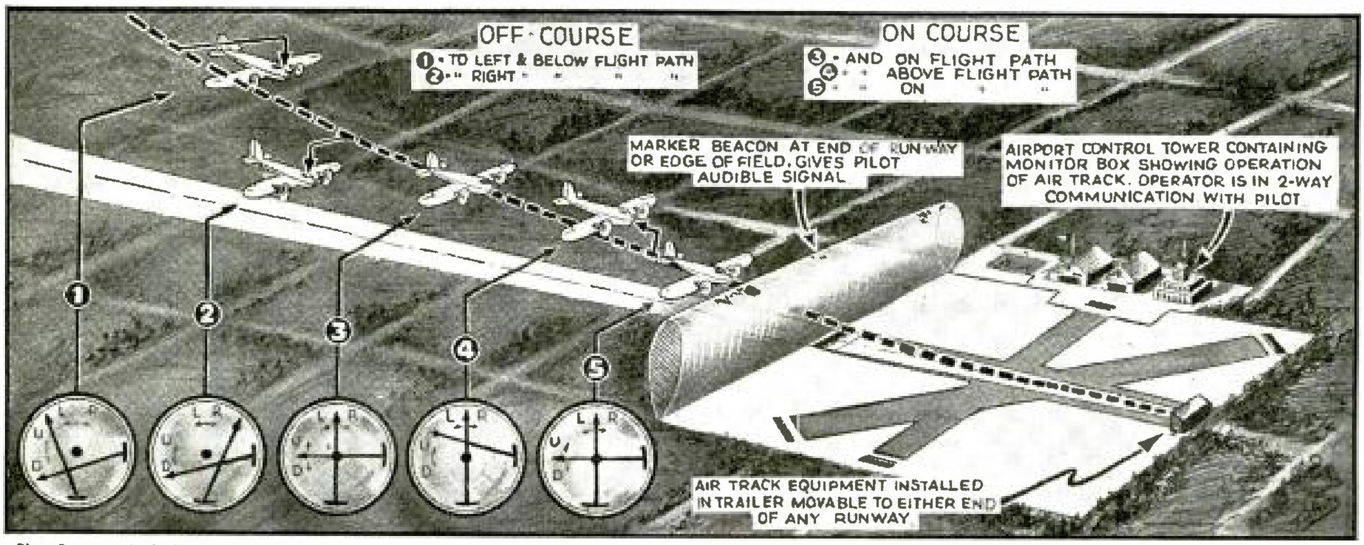


Fig. B. Any deviation of the plane from the sloping "air track" while landing is instantly recorded on the "cross-pointer" meter on instrument board.

THE AIRCRAFT-RADIO SERVICE MAN

N. H. LESSEM

Most radio Service Men fail to realize the excellent business prospects that lie in "private" aviation—per the author's Table I.

MILLIONS of dollars have been spent and are being spent in developing aviation; radio facilities constitute one of the major factors in dependable aircraft operation that has received more than its share of financial backing.

As a result, intensive work by "flying laboratories" and land crews connected with the larger transport companies has produced discoveries and equipment of great importance. Radio has greatly increased the dependability of commercial air travel, and the basic new developments of the large aviation companies are gradually being adapted to the needs of the private flyer.

THE AIRCRAFT-RADIO SERVICE MAN

At left is reproduced a suggestion, by *Radio-Craft*, that appears in colors on the cover of this month's issue, which portrays only one activity of the aircraft-radio Service Man. (See Table I—"Sources of Revenue for the Aviation-Radio Service Man"—for a more representative visualization of the subject.)

We wish to point out at this time that, merely because the number of aviation-radio receivers in use is small compared with the number of home-radio sets, it should not be presupposed an excellent living cannot be made servicing aviation-radio equipment. In the first place it is almost a matter of life and death to maintain the radio equipment in perfect operation; regardless of the cost, within reasonable limits, this apparatus *must* be kept in perfect shape, and therefore since the servicing demands are relatively limited it becomes evident that this type of radio servicing *commands* considerably better prices.

(Continued on page 230)

Guglielmo Marconi
1874 = 1937

Photo—Wide World via the Macmillan Co.
The late Guglielmo Marconi, "Father of Radio" who died of a heart attack at his Rome estate early Tuesday morning July 20th, 1937 at the age of 63. The entire world mourns his loss.

NEVER before has the lifetime of a single man been so identified with a change in the conditions of life on the globe, of which he was the most conspicuous creator, as that of Marconi. Five centuries since the discovery of printing have been required to spread its efficacy over the globe. The electric light had been known 50 years before Edison made it a commercial success; the steamboat had been demonstrated 250 years before Fulton found a backer for his dream. But the mathematical conception of radio waves had hardly been published before Marconi was born; he was a growing boy, active in the study of science, when they were first definitely discovered. He was still young in years when he converted their possibilities into demonstrable fact. On the anniversary of the organization of his company to exploit the invention of practical "wireless"—40 years to a day—he died. And his invention carried the news of his passing to discoverers seated on the Pole, to nomads in the desert, to ships on remote seas, to aviators flying above the clouds, and into a myriad homes in every city in the land. The monument of Guglielmo Marconi, for all time, is the "ether" vibrant about us—even within us—with the messages of all humanity.

Of the man's personality, little need be said: he was modest, self-effacing in his work; maintaining the spirit of scientific inquiry until his last moments. The first and most characteristic thought in his mind, as triumphs and honors were showered upon him, was that he was able to make his genius helpful to others, as no other man had done upon so wide a scale. His internationalism was joined with a pride in his country, which had initiated modern science with Galileo, and for whom he could speak with a voice that was heard and inspired confidence throughout the inhabited globe.

The Father of Radio has ended his share of the great work. But, as Pupin said, a quarter of a century ago: "Marconi could die, and wireless development would inevitably and continuously continue. His work lives on and grows, whether he lives or not. And that means that his work is immortal. His genius gave the idea to the world; and the further perfecting of his idea needs no genius."

New radio "homing device" and inter-cockpit communication help U. S. Coast Guard answer distress calls.

NEW U. S. COAST GUARD AVIATION RADIO

ONE OF THE NEWEST additions to the radio equipment of the U.S. Coast Guard airplanes is the installation here illustrated of the equipment aboard the amphibian "Dolphin" of the Coast Guard base at Floyd Bennett Airport.

This equipment resolves itself into 2 major divisions. One is the "homing device" or *direction-finding loop antenna* which may be rotated, by the radio operator, by remote control. In emergencies where minutes are precious this

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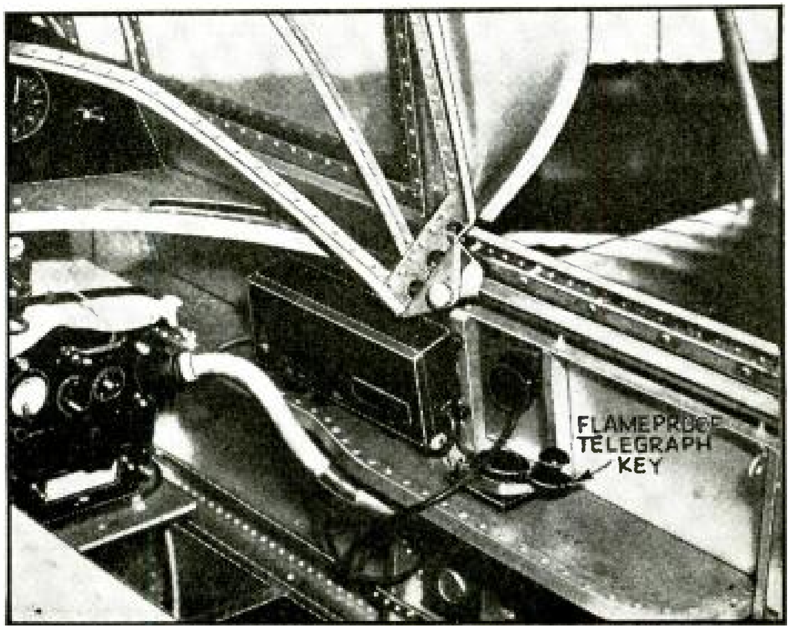

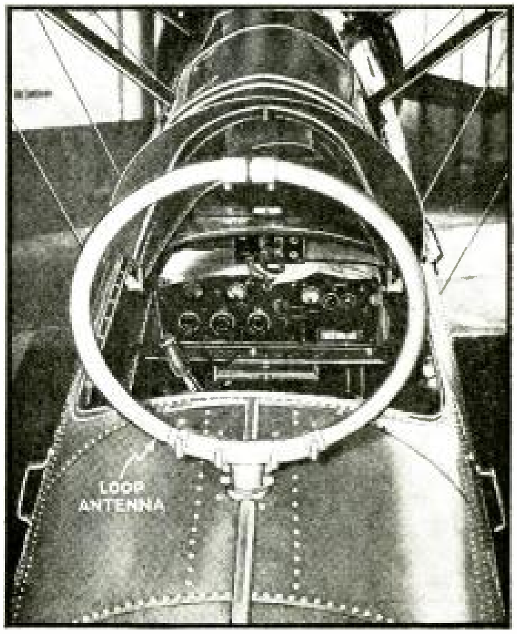

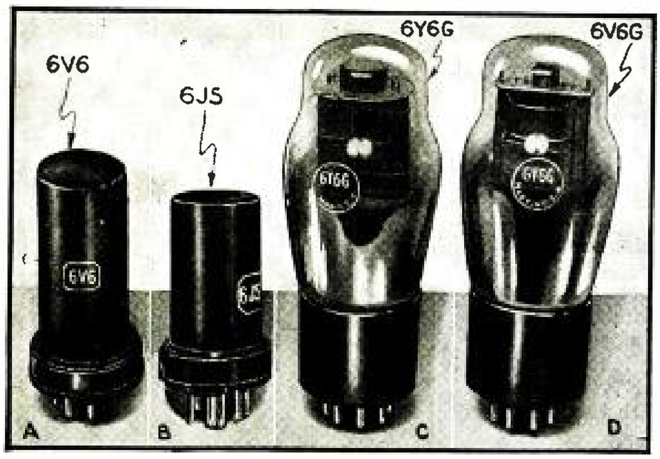

Fig. A. Four of 6 new tubes described in this article are illustrated.

NEW TUBES FOR THE RADIO EXPERIMENTER

All the tubes described this month, oddly enough, are amplifiers. Filament voltage range is from 2 V. to 25. One of the most interesting developments is the use of suppressor grids, in place of deflector plates, in a beam power tube.

PART II

R. D. WASHBURNE

LAST MONTH we told you about the types 6C8G, 6W5G, 6G5/6H5, 6T5, 2-RA-6 and WL-461 tubes. This month we add to the list the following types: 6V6, 6J5, 6Y6G, 6V6G, 1G5A, and 25L6G. Next month we'll have some more tube types to discuss with you but at the moment let us see what sort of devices have most recently been added to the "electronic family."

AMPLIFIERS

6V6 Unipotential-Cathode Tetrode Power Amplifier. The 6V6 and 6V6G (the latter is described elsewhere in this article) tubes were designed by one company primarily for use in the output stage of auto-radio receivers. Both have similar characteristics, the chief advantages being (1) use of the beam principle introduced first in the 6L6 and (2) a relatively low heater drain of only 450 milliamperes. Its features permit high output power to be realized in the automobile-type radio receiver without any appreciable increase in the drain from the storage battery. In fact, some manufacturers of deluxe auto sets are using two 6V6G tubes in push-pull in the output stage of their receivers. (See Fig. 1A.)

The 6V6 is similar to the 6F6 in size (and the 6V6G compares with the 6F6G and 42 in size and general appearance).

(Data courtesy Raytheon)

6J5 Detector and Amplifier Triode. Except for its higher transconductance this tube is similar to the type 6C5 tube. More detailed data follow. See Fig. 1B.

The 6J5 is a new addition to the line of metal receiving tubes. This new tube, a detector-amplifier triode, has an exceptionally high value of transconductance—2,600 micromhos. The other characteristics of the tube are similar to those of the 6C5. Because of the high transconductance of the 6J5, the tube makes an excellent oscillator for superheterodyne receivers. The high transconductance also gives the tube advantages for use as the frequency-control tube in A.F.C. circuits.

Characteristics

Heater voltage (A.C. or D.C.)	6.3 V.
Heater current	0.3-A.
Direct interelectrode capacities*	
(approx.)—grid-plate	3.4 mmf.
grid-cathode	3.4 mmf.
plate-cathode	3.6 mmf.
*With shell connected to cathode.	
As Class A' Amplifier	
Plate voltage (max.)	250 V.
Control-grid voltage	-8 V.
Plate current	9 ma.
Plate resistance	7,700 ohms
Amplification factor	20
Transconductance	2,600 mmhos.

(Data courtesy RCA Radiotron)

6Y6G Heater-Type Tetrode Power Amplifier. The usual A.C. radio receiver operates with fairly high plate voltages. The A.C.-D.C. receivers operate at considerably lower voltages. The recent introduction of 2 tubes, the 25B6G and 25L6, for A.C.-D.C. receivers has made possible receivers giving approximately 2 W. output at about the same cost as the previous A.C.-D.C. receivers which gave about 0.9-W. output.

The 2 W. A.C.-D.C. receivers are thus giving about the same performance as the small A.C. receivers using a 42-type output tube with about 220 V. available for plate and bias voltages. It would be necessary, using conventional tubes, to increase the cost of the small A.C. receivers considerably to make them give appreciably better performance than the 2 W. output A.C.-D.C. receivers.

The performance of the small A.C. receivers may be improved in economy as well as power output by using an output tube similar to the 25B6G or 25L6 at lower voltages and larger currents than would be the case with the 42-type output tube.

The 6Y6G tube is being introduced to fill the need for an output tube which will give even more output at 135 V. on the plate and screen-grid than the type 42 with 250 V. on plate and screen-grid. The high mutual conductance of the 6Y6G results in a fairly low input voltage requirement for full power output, and permits some degeneration to be used where desired. See Fig. 1C.

Characteristics

Heater voltage (A.C. or D.C.)	6.3 V.
Heater current	1.25 A.
Plate voltage (max.)	135 V.
Screen-grid voltage (max.)	135 V.
As Class A' Amplifier	
Plate voltage	135 V.
Screen-grid voltage	135 V.
Control-grid bias	-13.5 V.
Transconductance	7,000 mmhos.
No-signal plate current	58 ma.

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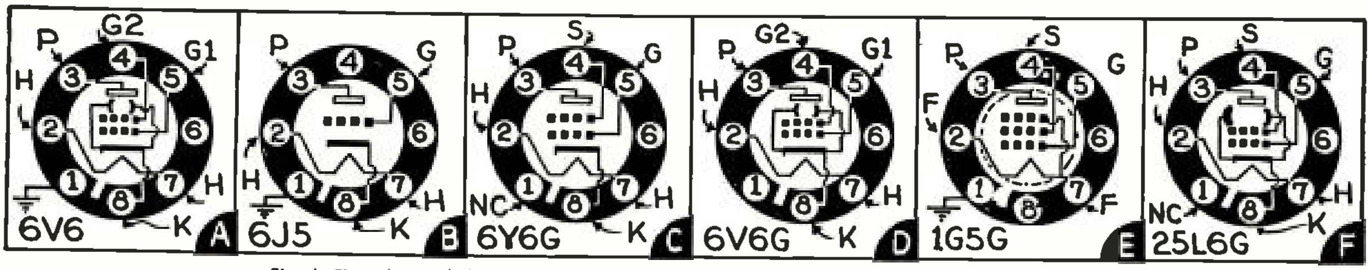

Fig. 1. The tube symbols and socket connections of the entire group of 6 new tubes are given.

NEW SET TESTER FEATURES LOW-OHM SCALE

This instrument will measure resistance as low as 0.01-ohm and with comparatively little current drain. It also has other interesting features you should know about.

B. O. BURLINGAME

A COMPACT, businesslike set-tester with a clean, "professional" appearance has been designed to meet the modern requirements of fast, convenient, accurate test procedure on all types of radio receivers, P.A. and theatre amplifiers, television receivers and industrial vacuum-tube devices.

The new 5-in.-square meter with long-scale, dead-beat, high-accuracy, solid forged steel magnet, and real sapphire bearings is critically designed, adequately to meet the severe demands of portable service and the maintenance of high accuracy over a long period of time. A high ratio of normal to overload capacity is provided to minimize the possibilities of accidental damage in this very sensitive instrument. Sensitivity: 1,000 ohms/volt.

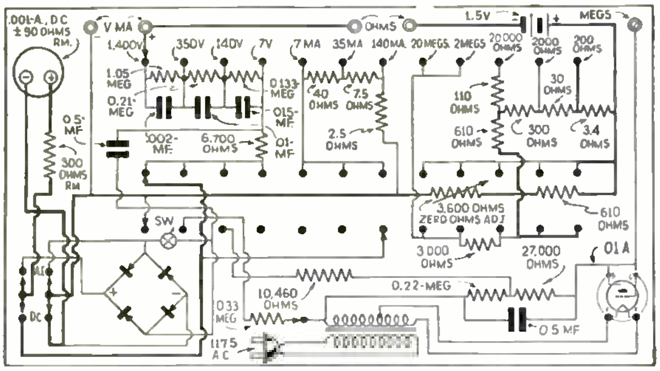

Fig. 1. Circuit diagram of the new tester illustrated above.

Any of the 20 ranges is chosen with an indexed selector switch. A "zero-ohms" adjuster is provided. Ranges: 0/7/140/350/1,400 V., D.C.; 0/7/140/350/1,400 V., A.C.; 4 output-meter ranges; and, 0/200/2,000/20,000 ohms.

IMPORTANCE OF THE LOW-OHM RANGE

The 200-ohm range of the ohmmeter is of especial interest to the Service Man and electrical trouble shooter as many difficulties are experienced in circuits of such low resistance that the problem will not yield to ordinary types of ohmmeters wherein the low end of the scale is badly cramped.

One-half of the scale of this instrument is used to read from 0 to 3.5 ohms, with the first division reading 0.1-ohm. It is very easy to read resistance values to an accuracy of 0.01-ohm as the divisions are large and clear. It is recommended that resistance values over 10 ohms be read on the

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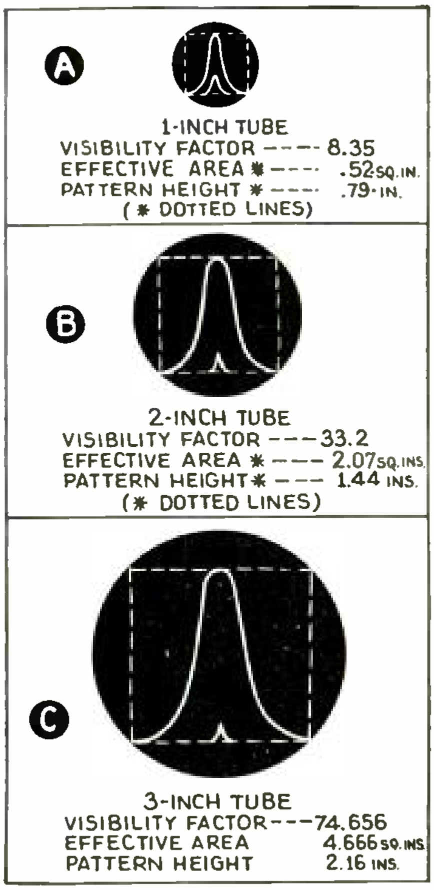
WHAT SIZE OSCILLOSCOPE?



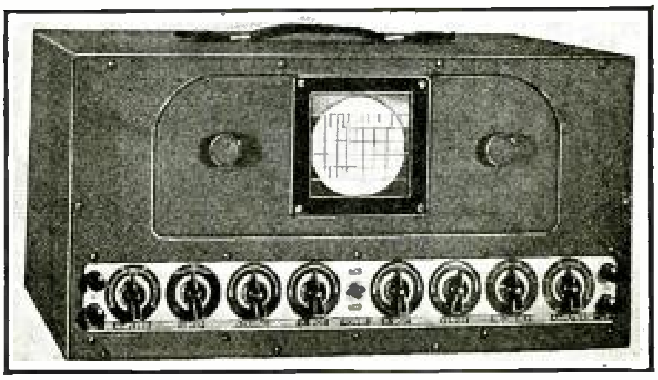
What with 3 sizes of cathode-ray tubes being used in oscilloscopes, the question is—which one to choose? The facts are in this article.

G. M. BUCHARD

OSCILLOSCOPE equipment for service work has now become fairly well standardized into 3 distinct sizes. These are—(1) oscilloscopes having tubes with 1-in. screen; and large-size equipment with tubes of (2) 2-in., or (3) 3-in. screen size.

Similarity. It is well at this point to consider the actual construction of the instrument and lay aside for the moment the matter of tube size.

Regardless of tube size the complete oscilloscope contains at least the following elements: (1) Vertical amplifier, (2) Horizontal amplifier, (3) Linear time sweep, (4) Spot and focus controls, (5) Adequate power supply.



Now notice that regardless of tube size the oscilloscope instrument must have the above 5 features. In fact, with the exception of power supply the 3 sizes of oscilloscopes are almost identical in construction insofar as features 1, 2, 3 and 4 are concerned.

It is true that a certain amount of economy in power supply is possible when the oscilloscope is designed for the 1-in. tube (as compared to 3-in. tube), however it can readily be seen that this economy is of a minor order

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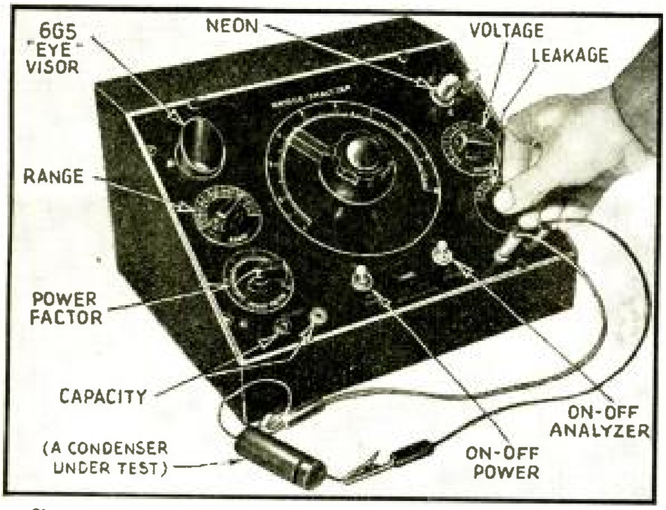

Fig. A. A typical condenser analyzer using a bridge-balance circuit.

IMPORTANCE OF MODERN TEST EQUIPMENT

In this pithy article Mr. Browning (remember? —the famous "Browning-Drake" receiver?) relegates "screwdriver and plier" radio repair men to the discard, and shows WHY modern test equipment and procedure are essential.

GLENN H. BROWNING

IN THE SERVICE industry, as well as in many other lines of engineering, there has been great advancement in the tools employed. It was only some 10 years ago that the cathode-ray oscilloscope was more or less a luxury and only to be found in the exceptionally-equipped laboratory. Today, however, many wide-awake Service Men employ this method of analysis which, in many cases, saves time and is capable of rendering a real service in the precise analysis of receiver performance.

A few years ago, most Service Men had little more than a speaking acquaintance with vacuum-tube voltmeters, but in recent years this apparatus has become an almost everyday piece of test equipment. New types of testing apparatus are appearing on the market almost every month, with the result that some of the less-informed are in a quandary as to what pieces of service equipment (1) are most valuable from the standpoint of customer satisfaction and what pieces of equipment (2) are capable of producing real income from the standpoint of time saved.

It is not within the scope of this article to go into a detailed analysis regarding the uses of all the various pieces of equipment which the modern Service Man could employ to advantage if his finances were ample. However, it *is* the purpose of this article to discuss some of the complexities of modern radio receivers and the test equipment best adapted to render customer service at reasonable cost, and to point out various types of apparatus which will produce a return

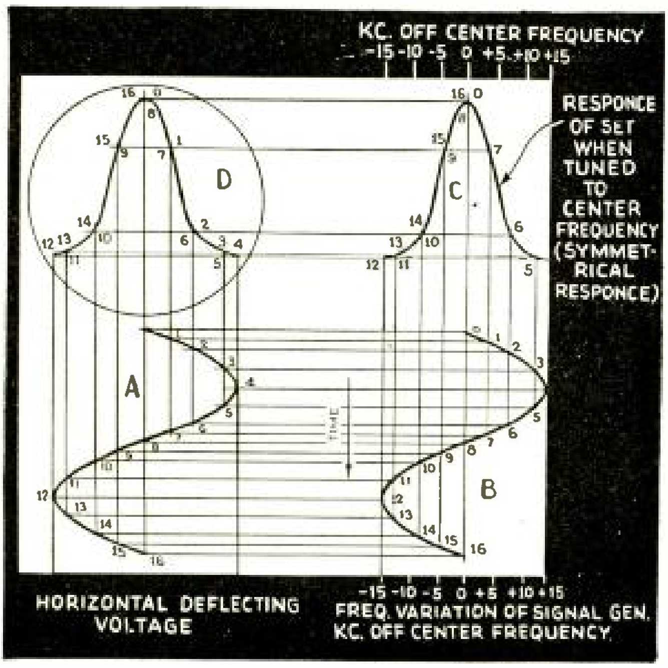

Fig. 1. Analysis of resonance curves of a set obtained on an oscilloscope.

more than comparable with the cost of the equipment—*provided* the the volume of business is sufficient.

In a recent radio service class the writer, as a part of the examination, asked each member of the class what equipment he deemed absolutely essential for the servicing of modern radio receivers. Naturally, a good *volt-ohmmeter* of wide range was the first selection. The second selection was almost a toss-up between an *all-wave signal generator* and a *tube tester*. The next choice was a device for testing accurately the condition of condensers. The writer certainly agrees that no modern service work can be done without the aid of the first 3 pieces of equipment. Consequently, we will pass on to other, more specified equipment.

USES OF THE CONDENSER ANALYZER

It is generally agreed that condensers cause as many service calls as any other single component part entering into the radio set, though resistors will run a close second. Consequently, a good *condenser analyzer* will save the Service Man a great deal of time and trouble. Many make the practice of testing all the condensers in the radio receiver to determine their condition, for as most work is guaranteed, this may save a return call at the expense of the Service Man.

Paper condensers of small capacity have a somewhat prevalent fault of becoming open-circuited, though actual breakdowns are far from unknown. Electrolytic condensers, on the other hand, either fail or increase in power factor to such an extent that their filtering efficiency is impaired. Intermittent reception in the radio receiver, which is the general bugaboo, is usually due to paper or electrolytic condensers becoming intermittently open.

A *bridge* analyzer, such as the one manufactured by the Tobe Deutschmann Corp., is a typical condenser analyzer which gives a rather complete analysis of the condition of the condensers, for not only does it check the leakage of electrolytic and paper condensers at operating voltages ranging from 50 to 550, but also measures their power factors and capacity by means of a suitable bridge network. Intermittent condensers may readily be determined by obtaining a bridge balance and manipulating leads, whereupon an intermittent condenser will cause the electron-ray tube or "eye", used as a null indicator, to give a definite indication of such defect. Practically every Service Man will find such a device for obtaining the complete characteristics of condensers a time saver and a financial asset to his business.

USES OF THE FREE POINT TESTER

Free point testers (which permit making tests of any two tube elements) are many times a great convenience, especially where work is being done at the customer's residence, which is, by the way, not recommended as general procedure when any major troubles are involved. Even in the shop, however, the free point tester in many cases will weed out defective tubes which no tube tester is able to definitely indicate.

By means of free point testers, plate, cathode, and other currents may be measured and, consequently, biases calculated on resistance-coupled amplifier tubes, etc. When free point testers are used in conjunction with the radio-frequency amplifier or intermediate-frequency amplifier, erroneous indications may result due to the fact that the capacity introduced in the cord leading from the tube socket to the free point tester may start spurious oscillations in tuned circuits and thus the currents at which the tubes actually operate will differ markedly from the normal values.

In receivers having automatic volume control it is sometimes essential to measure the bias on the various R.F. and I.F. tubes which are being controlled. Poor quality in a radio receiver will often result from some part of the automatic volume control circuit being inoperative. The writer has known of cases where the automatic bias, although obtained satisfactorily in the diode detector tube (when measured across the timing condenser) was not delivered to an I.F. amplifier tube, causing faulty operation of the receiver.

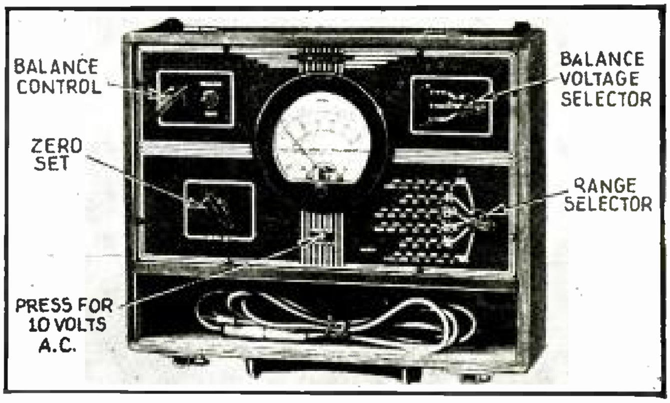

Fig. 8. Representative type of infinite-resistance, bridge-circuit voltmeter.

USES OF THE INFINITE-RESISTANCE D.C. VOLTMETER

Recently there has been introduced on the market by the Hickok Company an *infinite-resistance D.C. voltmeter* which seems to answer a long-felt need, for by its means the D.C. bias on any tube can be readily determined without introducing resistance in the circuit which would materially vary the bias and thus the operating conditions.

The *potentiometer-type* infinite-resistance voltmeter operates on a well-known principle of obtaining a balance between two voltages, one the voltage developed in the apparatus itself, and the other the unknown voltage. After the 2 voltages have been adjusted so as to be equal (this adjustment is made by means of a balancing system), the unknown voltage is measured by actually placing a voltmeter across the balancing voltage developed in the apparatus itself.

This may sound somewhat complicated but in actual practice it is very simple, for the leads to the voltmeter are placed across the unknown D.C. voltage and a knob is adjusted until a meter reads zero, whereupon a button is pressed which throws the voltmeter into the circuit and the unknown voltage is read directly from this meter. The A.V.C. voltages may thus be measured (on each tube controlled) with various inputs from the signal generator. The actual bias on resistance-coupled amplifiers may be determined with accuracy. A faulty bias resistance, of course, may cause distortion. It may be necessary to unsolder one end of this resistor to measure its value accurately with a volt-ohm-meter since an electrolytic condenser is usually connected in parallel which will have some leakage, and this leakage may be sufficient to give incorrect resistance values. By means of a very high-resistance voltmeter these biases may be measured directly. Of course it probably will be necessary to disconnect the condensers for test purposes anyway, so that the above argument for a high-resistance voltmeter as a time-saving device does not always hold true.

USES OF THE VACUUM-TUBE VOLTMETER

In receivers embodying automatic frequency control, it is almost essential to have an infinite-resistance voltmeter or a *vacuum-tube voltmeter* which will measure D.C. voltages, as well as A.C., in order to align the tuned circuit of the discriminator with sufficient accuracy. This adjustment in most receivers is extremely critical and it is necessary, after aligning the I.F. amplifier by means of a signal generator and an output meter, to accurately set the tuned circuit which is an input into the diode plates. This circuit should be so adjusted that the voltage appearing across the 2 resistors connected in the cathode circuits of the diodes will be equal; otherwise the A.F.C. discriminator circuit will not function as it should.

While we are on the subject of vacuum-tube voltmeters, it might be pointed out that there are good, bad, and indifferent types on the market, and a considerable amount of discrimination should be exercised by the Service Man in purchasing this equipment. The Service Man can readily check up to see whether a vacuum-tube voltmeter is suitable for general work by the following procedure: If the vacuum tube voltmeter measures both D.C. and A.C., it should be able to measure the voltage of, for instance, an ordinary drycell, and give the correct value (1.5 V.) with a resistance of 2 or 3 megohms in series with the drycell. When used on A.C., it should have a sufficiently high resistance so that it may be placed across oscillator circuits without stopping oscillation. It should have an input capacity at least as low as 25 mmf., and preferably much lower.

It would be very advantageous if a reasonably-priced vacuum-tube voltmeter could be built for the Service Man which would be sufficiently sensitive so that by placing the prod near to but not touching the oscillatory circuit in a superheterodyne, a reasonable meter reading could be obtained. By means of this instrument the oscillations could be checked in a superheterodyne without de-tuning the circuit to any appreciable extent.

Many times it is difficult to determine the trouble in a superheterodyne where the oscillatory circuit has either developed a high-resistance connection or has been shorted, causing the oscillations to cease. Of course by carefully checking the circuits with a volt-ohmmeter (using the low-ohm scale) the resistance of the oscillator coil can usually be detected on the broadcast and some of the short-wave bands on an all-wave superheterodyne. However, when a short occurs in the very-high frequency oscillator coils, this condition is difficult to detect since the normal resistance of these coils is extremely low. Superheterodynes which use a 6A7, 6A8, etc., sometimes refuse to oscillate in specific regions of the bands, causing the receiver to "go dead" throughout these regions. Tube tests do not in general indicate that the tube is defective. However, replacing the faulty tube with another usually remedies the trouble. For these reasons a quick method of checking oscillations through all bands is certainly a time saver.

USES OF THE CATHODE-RAY OSCILLOSCOPE

The *cathode-ray oscilloscope*, especially one of those containing a *frequency-modulated signal generator* as an integral part of the apparatus, is desirable if the clientele served by the Service Man is of a very high-grade type that is willing to pay for meticulous alignment of their high-fidelity receivers. This applies particularly to sets having band-pass I.F. transformers. Of course the cathode-ray oscilloscope can be, and is, used as a very handy tool around the service laboratory and the ownership of such an instrument places the Service Man in a favorable position as regards customer acceptance.

USES OF THE SIGNAL GENERATOR

There are many customers who could be very readily sold the idea of having their high-priced sets checked frequently for alignment, quality, etc. Checking for quality throughout the receiver and loudspeaker requires elaborate equipment. In fact, an automatic recording device has only recently been placed on the market. This device puts into the radio receiver a signal which is modulated at various audio frequencies, and records automatically on a chart the sound pressure delivered from the loudspeaker at these audio frequencies. Undoubtedly future signal generators designed and manufactured for the Service Man will have their signal modulated not only by a fixed 400-cycle note, but will be so designed that the carrier from the signal generator may be modulated by various frequencies over the complete

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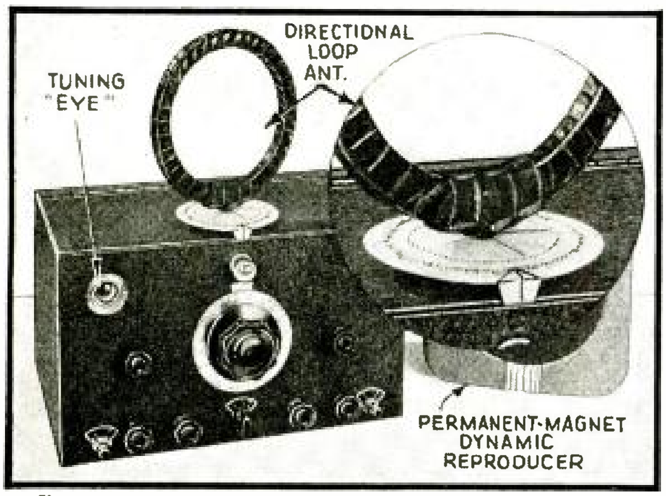


Fig. A. The Boat Radio Set and (inset) relationship of loop to scale.

HOW TO MAKE "THE SEAFARER" LOOP-TYPE BOAT RADIO SET

Part I described the construction of this marine direction-finder and broadcast set. Here are the loop details and operating data.

PART II .... RAYMOND P. ADAMS

LOOP-ANTENNA building is a matter of trial and error. We have used a very small one for general broadcast—one which works very well. Some builders may prefer to experiment somewhat before deciding upon definite jobs for service—but we shall describe the construction of the one shown in Figs. A, 1 and 2, with the comment that it will do a very good job as a *direction finder*.

LOOP CONSTRUCTION DETAILS

Secure 2 ordinary embroidery hoops, one about 8 ins. and one about 7½ ins. in dia. To the larger, securely affix a phone plug. Around the entire rim of the smaller one, drill a series of size No. 27 holes ½-in. apart. Insert small, round matches in these holes, with an inch or so of each match protruding outwardly, and then stagger-wind about 50 ft. of No. 24 D.S.C. wire around the loop—working back and forth between the sticks (as shown in Fig. 2) and in one direction until the winding is completed. Cut off the ends of the matches so that the smaller loop will fit tightly into the larger, tie the 2 hoops securely together, connect the leads to the phone plug.

See that the jack on the lift cover (described in Part I of this article) is connected to the input control-grid—ground binding posts. Plug in the loop and tune in a signal somewhere around 1,400 kc. using the tuning dial control. Vary the setting of the auxiliary loop trimmer and note whether or not resonance for the R.F. circuit is obtained and where it is obtained. If not enough capacity is had to tune the loop circuit to resonance with the signal, add wire to the loop itself until a "hit" is made with the trimmer set for approximately minimum setting. If too much capacity is indicated—then reduce the number of turns until a proper condition obtains.

Now tune to a 550 kc. signal. Nearly maximum trimmer capacity should be required for resonance here. If the tuning will NOT go up to resonance—your trimmer is too small, and a larger capacity will be required. Much depends, of course, upon loopsize and number of turns.

OBTAINING DIRECTIONAL OPERATION

With the loop built and found tunable to broadcast band limits, tape it securely together and give it a couple coats of protective lacquer. Try it out on weak signals.

When pointed *directly at* such signals—that is, *endwise*—the broadcast signal will come in at maximum level. With the loop *broadside* to the signals, the signal level should be noticeably less, at times inaudible and unreadable on the 6E5 "eye". Even on strong locals—loop turning should afford a definite point of maximum and minimum reading on the tuning "eye"—with the point of minimum pick-up being the more easily and accurately defined.

Build a loop for the long-wave band— making it somewhat larger in size and of such inductance that with available trimmer capacity input resonance with the detector circuit is obtained. Sometimes it is good policy—and easy construction—to simply work out a job with a minimum number of turns and load it up to high-frequency resonance with the trimmer at zero setting by means of fixed capacities bridged across it. Build a loop for the selected short-wave band or bands—or, if you prefer, add antenna coils for these bands and a chassis binding post to which an antenna may be connected.

(Continued on page 240)

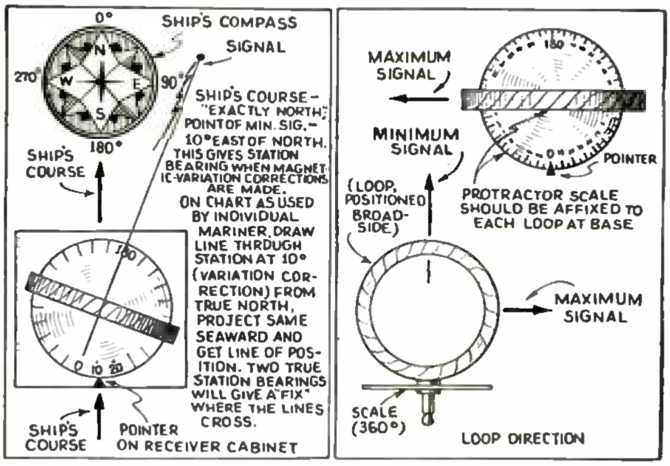


Fig. 1. Details of how the direction-finding loop antenna operates.

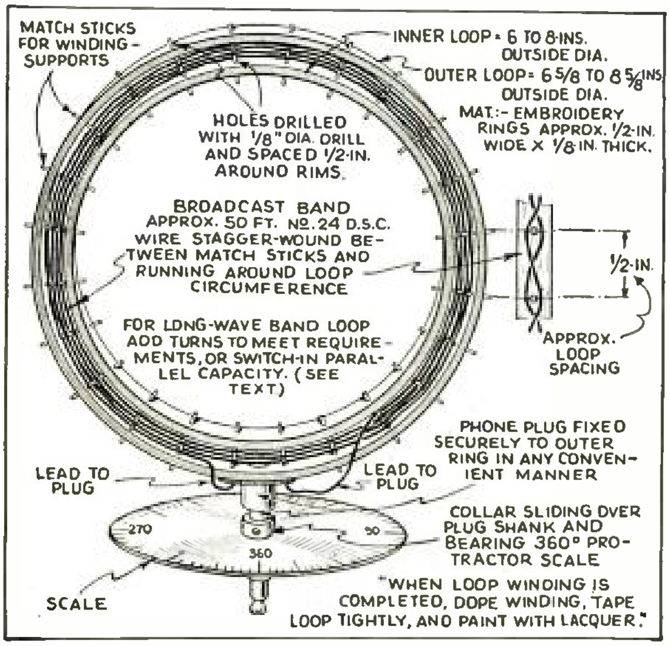


Fig. 2. Detailed specifications on the construction of the loop.

BUILD THIS "OPTIMUM TEST" TUBE CHECKER

Service Men—A pioneer in the design and construction of radio test equipment tells you how to make an ultra-modern tube, resistance and capacity tester at low cost.

MILTON REINER

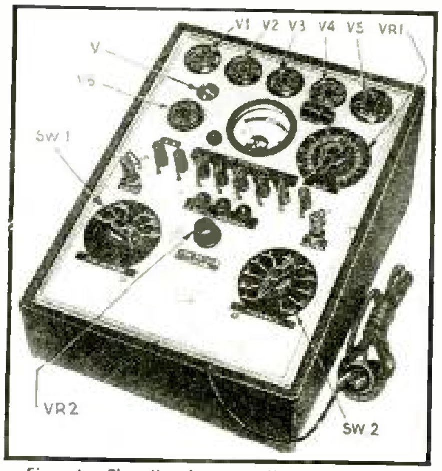


Fig. A. The "optimum-test" tube checker.

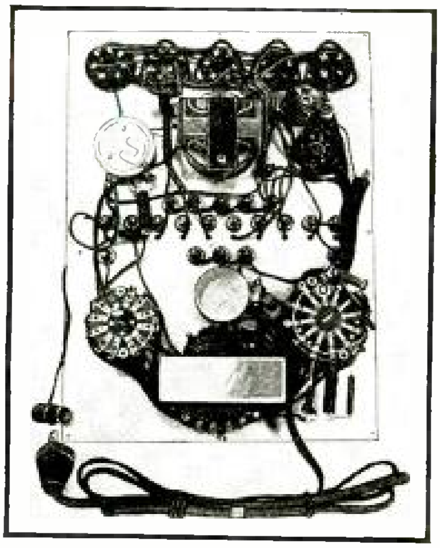


Fig. B. Underside view of the tube checker.

THE MOST important instrument for the radio dealer and one of the most important for the Service Man is a Tube Tester. The design and construction details of an improved type will be described and illustrated, incidentally, the same components are utilized to make several types of tests other than those of tubes.

This tube tester (which incidentally is commercially available as the Dependable model 306 instrument) has finally passed with flying colors all requirements for an "optimum" (best all-around) test unit that would quickly and accurately test *all* the present-day tubes; and in addition provide for forthcoming types! The same unit also makes *resistance* and *capacity* tests!!

The general appearance of the completed device, in a counter-type case, is shown in Fig. A (underside, Fig. B); the wiring diagram is given in Fig. 1.

(Continued on page 242)

TABLE I

FEATURES OF THE "OPTIMUM-TEST" TUBE CHECKER

(1) Accuracy (circuit error is held to optimum value).
(2) Protection against obsolescence.
(3) Ability to test all tubes (emission test; and improved type of hot interelement short and leakage tests).
(4) Optimum-quality parts.
(5) Simplicity of operation.
(6) Low cost ($18).
(7) Ohmmeter ranges (low-ohms: 0/10,000 ohms; high-ohms scale: 0/1 meg.).
(8) Capacity-meter ranges (0.001-mf. to 10 mf.).

BUSINESS-LIKE "SILENT" SERVICING

"Let the customer see you work, but don't let him hear you!" is the advice of Mr. J. P. Kennedy, who introduced himself to RADIO-CRAFT readers in September 1931 as a business-getting Service Man.

J. P. KENNEDY

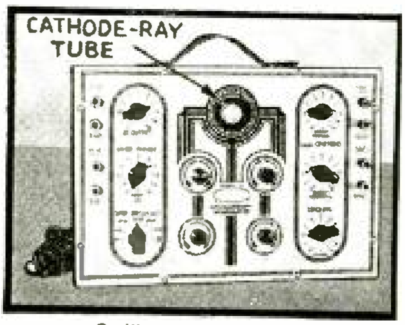
BACK WHEN the daily papers carried radio circuits and you could buy all the parts at a "dime store," whistles, howls, snaps, and buzzes disclosed many of the ordinary faults of a radio receiver. Several million people became extremely clever in analyzing radio trouble by ear—and repairing radio sets with a screw-driver. Service Men found it hard to command "respectable" service fees.

MODERN "SILENT SERVICING" TECHNIQUE

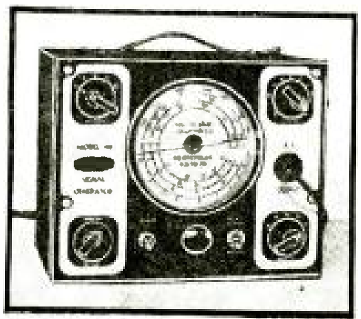
As circuits became more complex, and test instruments were designed to probe the mysteries of automatic volume control, band expansion circuits, dual I.F. channels and phase inversion systems, customers still recalled their old familiarity with the noises emanating from the speaker and protested against reasonable service fees.

Now instrument manufacturers have eliminated the last psychological barrier to good service fees. With an oscilloscope and frequency modulator or "wobbulator", a good signal generator, and a multirange volt-ohm-milliammeter, every circuit of a receiver may be analyzed without a sound emanating from the loudspeaker! These instruments, plus a good tube tester, will

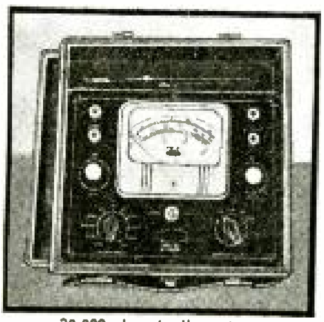
(Continued on page 251)



Oscilloscope wobbulator.



Signal generator.



20,000-ohms/volt meter.

Tube checker.

BIGGER SERVICE PROFITS FROM BETTER TOOLS!

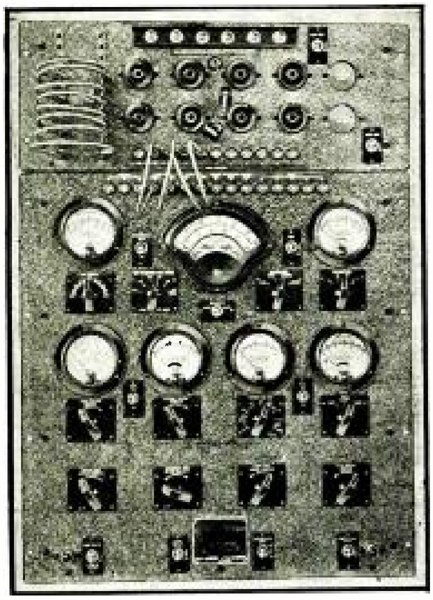


Fig. A. A high-grade set analyzer designed against obsolescence. Note the replaceable selector block. Built-in current jacks automatically place the instrument in series with any tube element. The exceptional usefulness of the *series-connected* meter is discussed by Mr. Morelock in detail.

Locating and correcting radio receiver faults in the minimum amount of time results in proportionately increased profits. The author describes in detail the manner in which proper servicing technique and tools make this result possible.

O. J. MORELOCK

IN THE RADIO repair business, irrespective of the individual or company, the profits accrued or the salaries paid depend on the number of sets correctly repaired that leave the service bench for delivery each day.

Salaries and profits are a direct interest in any business, especially in service work and, therefore, an increase in turnover of receivers is vital to any radio repair man. Of course, in attempting to increase the turnover, no change in quality of repair work is suggested, as this must be kept of the first class in order to continue a satisfactory business. From the standpoint of turnover, what factors govern the Service Man's ability to accomplish an increase?

There are, generally speaking, 2 factors: (1) a simplified procedure for locating the trouble and correcting it in the minimum elapsed time; and, (2) the use of simplified and accurate service tools of known quality and dependability.

Fig. B. The *total-emission* method of testing tubes, used in this specially-designed tube tester, is recommended by R.M.A. as the most economical, flexible and best method of testing tubes.

2 SERVICING PROCEDURES

As to procedure in locating trouble 2 methods appear best from the standpoint of quick results, preference being entirely open to argument in each case.

(1) Stage Analysis. The first of these is the locating of the defective stage by making use of an *oscillator* and a *vacuum-tube voltmeter* or, possibly an *output meter*. This procedure calls for measurement of "gain" (amplification), working through the receiver stage by stage, from antenna to speaker. This can be carried out with an oscillator and a vacuum-tube voltmeter, of low-input-capacity design, making connections to the grid caps of the tubes all the way through to the 1st-detector and carried on through the receiver by connecting under the chassis to the socket grid terminals. Location of a defective stage or one supplying incorrect gain calls for a further examination of the tube and component parts in the circuit surrounding that tube.

(2) Free-Reference Analysis. The other general method, involves *analyzer* or "point-to-point" ("free point") measurement. Voltages and currents at each tube socket followed by resistance readings where incorrect potentials or currents appear, will segregate the defective part. There are other methods employed by some Service Men or organizations, but these are, in general, modifications of these two procedures and may be classed under one or the other.

There is no argument more strongly in favor of the Service Man than the use of simple, direct-reading, compact service instruments. A multiplicity of gadgets on test units is not only conducive to confusion but often causes incorrect interpretation of readings, and considerable delay. Many such "gadget units" appear spasmodically on the market to attract attention in advertisements, but if purchased are usually found to be confusing or of no value. The money used in construction of test units should be concentrated on the basic needs for accuracy, dependability through all kinds of weather and working conditions, durability and avoidance of obsolescence instead of on useless controls and devices. What then should Service Men look for in each test instrument needed for direct receiver analysis?

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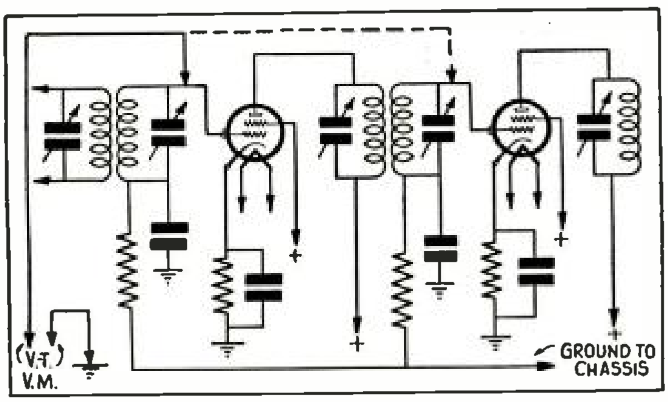

Fig. 1. Circuit for measuring gain-per-stage in radio equipment by means of a conventional vacuum-tube voltmeter.

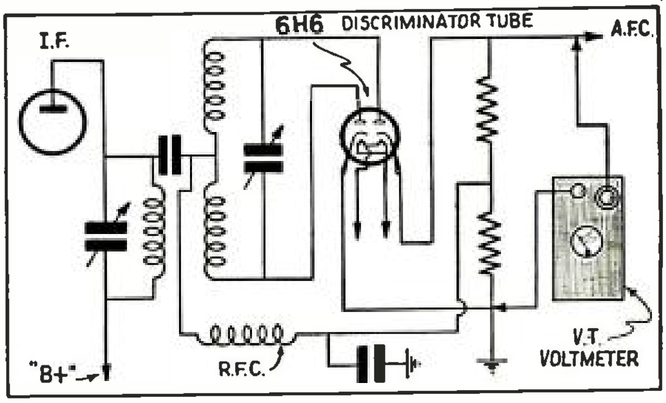

Fig. 2. Circuit for measuring automatic frequency control discriminator voltages with a conventional vacuum-tube voltmeter.

NEW CIRCUITS
IN MODERN RADIO RECEIVERS

The details of the modern radio receiver circuits that make them "different" from previous designs are illustrated and described by a well-known technician.

Watch for this department as an exclusive feature in forthcoming issues of RADIO-CRAFT.

F. L. SPRAYBERRY .... No. 1

(1) Improved Transrectification.

Zenith Chassis No. 5521. Zenith has used the circuit of Fig. 1A in many late models to improve 1st-detector action at high signal levels where the A.V.C. tends to bias the converter tube near cut-off.

A lead is brought from the control-grid end of the oscillator coil to the converter signal-grid lead, around which it is wrapped thus coupling the oscillator signal into the signal control-grid. On high bias values where the signal control-grid is near the cut-off point, the oscillator shifts the control-grid's operating point closer to the region on the grid-voltage—plate-current curve which produces detection.

(2) Separate Discriminator 2nd-Detector Circuit.

Fairbanks-Morse 12A Chassis. As per Fig. 1B, the last I.F. primary is coupled to 2 secondaries, and each in turn is connected to diodes. One actuates the A.F.C. discriminator while the other acts as a conventional detector. The benefit of this arrangement lies in the resulting circuit simplification.

(3) Self-Inverter Circuit.

Philco Models 38-4, 38-5 Code 121. Philco has found a practical way around using a phase-inverter tube which adds no gain to the amplifier. The result is shown in Fig. 1C. To one screen-grid is added a small load resistor (57) and a signal-coupling capacity to the control-grid of the other push-pull tube. Operating as an amplifier, but having no gain the screen-grid duplicates the control-grid voltage of the tube in which they both are, in reverse phase, and feeds this voltage to the control-grid of the other tube.

In this way, a signal is fed to only one grid of the push-pull tube and this tube feeds the other push-pull tube; thus, the need for an extra phase-inverter is eliminated.

(4) Tuning-Indicator Sensitivity Adjustment.

General Electric Models E-91 and E-95. The General Electric models E-91 and E-95, Fig. 1D, have 2 A.V.C. levels, one high level for the R.F. amplifier and a lower level for the converter and I.F. amplifier. For the 2 high-frequency bands, where DX of low signal intensity is most likely, the colorama tuning sensitivity is fixed at maximum by the 2 connected lugs at the bottom of band switch Sw.2. For the broadcast band, where much higher signal intensities are available, as a rule switch Sw.4 provides a choice of lowering the colorama sensitivity corresponding to the lower level A.V.C. supplied to the converter and 1st I.F. tubes, or using it on maximum as usual. This provides more selective tuning, while the A.V.C. voltages are undisturbed.

(5) Novel A.V.C. Signal Delay.

Philco Model 38-3. One diode plate of the 6Q7G 2nd-detector—1st audio amplifier (Fig. 1E) is used without bias for signal rectification, while the other diode is used to supply 2 separate A.V.C. voltages. It is biased through a 0.33-meg.—0.1-mf. filter at -3 V. by the drop across the 19-ohm (section) power resistor (87). This also biases all foregoing signal control-grids for proper tube operation and the R.F. and I.F. suppressor-grids for better tube efficiency.

(Continued on page 235)

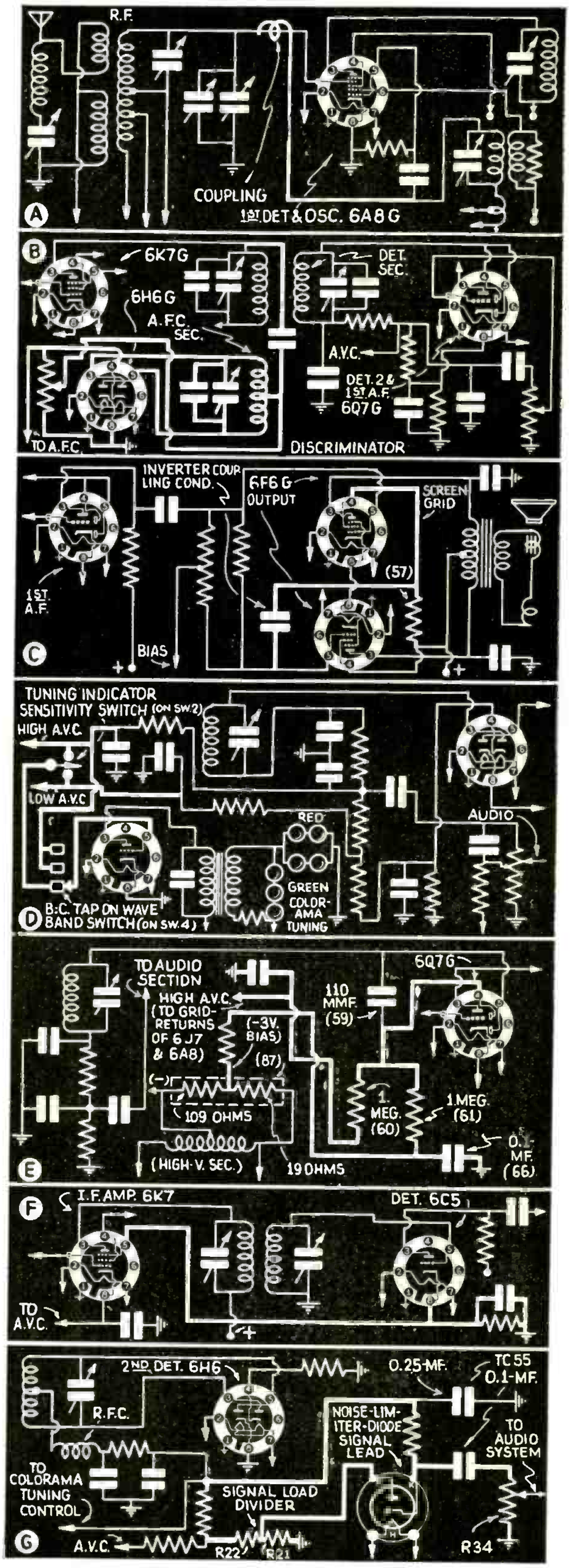

Fig. 1. Heavy lines in circuits are those discussed in text.

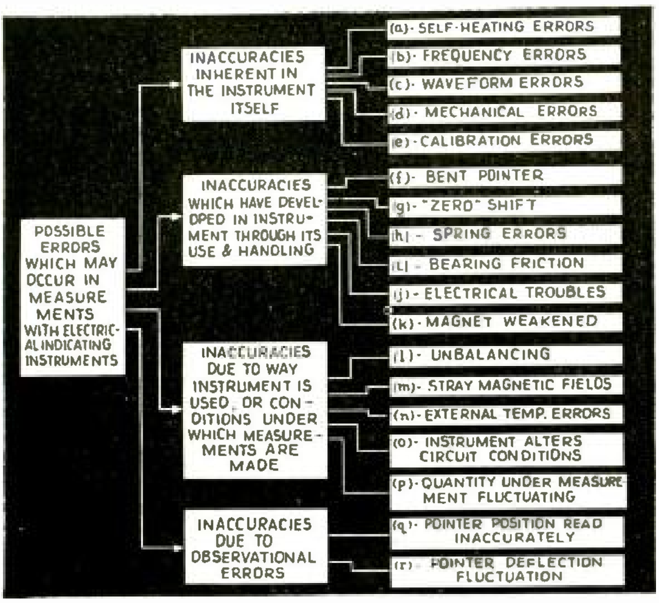

Fig. 1. Breakdown chart of the various causes of errors in test meters.

HOW DEPENDABLE ARE YOUR METER READINGS?

Rare indeed is the Service Man who realizes just *how, why,* and *to what extent* his service meter readings may be inaccurate—and how much it really matters! This article explains, simply and expertly, the entire subject of meter accuracy. The author's published works include his well-known "Radio Physics Course," "Modern Radio Servicing," etc.

ALFRED A. GHIRARDI ———— PART I

HOW ACCURATE is the voltage reading you just took on that receiver? How accurate are the meters you are using in your service work, anyway?

Are you one of those trusting Service Men who think that just because a meter is fairly new or expensive, it will give readings that are 100 per cent accurate at any point on the scale? Or, on the other hand, are you one of the suspicious but disillusioned type who has tried to check the accuracy of the meters in his test instruments, only to find that no two readings agree exactly? In either case, you (in common with most radio Service Men) are the victim of an incomplete, or inaccurate knowledge of electrical instrument construction and operating characteristics, for, anyone closely associated with electrical instrument design and manufacture is well aware that errors exist in all instruments, and will admit it freely. Fortunately, the entire subject of meter accuracy is fairly simple—and interesting. Perhaps we can clear up, in this series of articles, some of the more troublesome difficulties.

NO METER IS 100 PER CENT ACCURATE

First of all, get this fundamental fact firmly in your mind: **no commercial type electrical indicating instruments are guaranteed to read 100 per cent correctly at every point on the scale—only very expensive laboratory-type instruments approach such perfection.**

That means that you cannot, and should not, expect the readings you take on your servicing meters to be 100 per cent accurate. They really don't have to be—but that's another part of our story. What you should know is, how large the errors are, what their origin is, how you can minimize them, and whether they will seriously affect the usefulness of your measurements.

The accuracy, sensitivity, and reliability of an electrical instrument are determined by its *design*, the quality of the materials used in it, the *care* taken in its construction, the *accuracy* with which it has been assembled and calibrated at the factory, and how *roughly* it has been handled since made. In order to make meters that can be priced within the reach of the average user, accuracy has to be sacrificed somewhat.

Meters can be purchased for from less than a dollar up to several hundred dollars. Naturally, the more one pays for an instrument, the better the quality of materials used in it and the more accuracy and care exercised in its workmanship and calibration. The general run of meters used in present-day high-grade servicing instruments represent a good common-sense compromise between accuracy and price—they provide sufficient accuracy (around 98 per cent for D.C. instruments and 95 per cent for rectifier type A.C. instruments) for the general run of servicing measurements to be made, and are priced within the limits of the Service Man's pocketbook. Their manufacturers deserve unstinted praise, for by working out clever designs, careful selection of materials, and taking advantage of every technical advance and possible manufacturing economy, they have succeeded in making really fine, rugged, instruments available to the Service Man at reasonable cost.

But the Service Man should realize that these instruments are not *perfect*—no manufacturer claims them to be! Practical construction difficulties make absolutely precise instruments unobtainable. A knowledge of the errors likely to occur, the origin of these errors, and the means used to make them negligible (or as small as possible) is of value in enabling one to use electrical instruments intelligently and obtain the best results from them under working conditions.

WHAT CAUSES THE ERRORS?

Now that we are reconciled to the fact that errors *do* exist in measurements made with electrical instruments, let us see what they are and what may cause them.

All of the common inaccuracies have been grouped and arranged for quick reference in a convenient chart in Fig. 1. Notice that there are 4 main sources of inaccuracy: (1) those which are inherent in the instrument itself due to its design and construction, and which may be present even in brand new instruments; (2) those which have developed in the instrument as a result of its constant usage, rough handling, etc.; (3) those which occur because of the particular way the instrument is used, or the conditions under which the measurement is made; and, (4) those which occur through inaccurate reading of the pointer position by the observer. In the chart, each of these is further broken down into its contributing causes.

Let us review these contributing causes of error briefly, so that we may understand why they may be present and what effects they have on the readings.

(1) Inaccuracies Inherent in the Instrument Itself

(A) Temperature errors due to self-heating. Most instruments contain sources of heat, such as moving coils of fine wire, springs, shunts, multiplier resistors, rectifiers, etc., through which the currents flow. This heat tends to cause a rise in the temperature of the various parts of the instrument —resulting in a change in the resistance of these parts, a consequent change in the current flowing, and a change in the deflection of the pointer. ("Carbon" resistors have a *negative coefficient* and hence *decrease* in resistance value.)

Naturally, the error which may result depends upon the value of the current or voltage under measurement and upon the length of time that the instrument is kept in the circuit. Fortunately, since the currents involved in the measurements made in radio service work are fairly small and the instruments are kept in the circuit only for a very short time, this source of error is not a very great problem.

By making the shunts and multiplier resistors of resistance materials which have a very low temperature coefficient of resistance, their resistance change due to heating is minimized. The increase in resistance of the copper movable coil is compensated-for by using a control-spring material which produces a restraining spring that *weakens* just the right amount with change of temperature so as to offset the effect of the resistance *increase* of the movable coil. By employing these refinements in design, the actual error due to self-heating in commercial instruments is kept so low that it is negligible.

(B) and (C) Frequency and waveform errors. Errors due to variation of frequency (A.C. measurements), seldom bother the Service Man, because these errors are negligible for the frequencies of the A.C. circuits he has occasion to make measurements on. The same is true of waveform variation, which is, to a certain extent, analogous to variation of frequency.

(D) Mechanical errors. The quality of the control springs used in an electrical instrument has a very important bearing on its permanency and accuracy. The springs are such important items in the meter, that the rigid inspection they undergo before the meter leaves the factory of any reliable manufacturer makes them almost certain to be in perfect condition. What may happen to them later will be discussed.

Another mechanical error may be caused by friction in the jeweled bearings. This trouble also, has been reduced to insignificant proportions by proper inspection at the factories. However, as we shall see presently, rough handling, or excessive wear may cause this trouble later.

(E) Calibration errors. The scales for very inexpensive instruments are engraved or printed all in one batch, on the assumption of a particular deflection law for a given type instrument; generally the individual instruments are then adjusted by trial to make their deflections fit the scales as closely as possible. Naturally, such meters do not give accurate readings; but since the sale price is so low, the cost of individually calibrating each instrument would be prohibitive, and there is no other alternative.

For the better grade instruments, it is common practice to calibrate the scale of each instrument individually. It is not necessary, of course, to determine every scale division by test, especially on direct-current instruments with nearly uniform scales. It is usually considered sufficient to check at only a few points on the scale of a D.C. instrument by actual test. The intermediate points are filled-in, sometimes by hand, preferably by a mechanical method. Of course, if the shunts, multiplier resistors, or condensers used in the instrument are not accurate in value, this will affect the accuracy of the entire instrument. Any subsequent changes in these values due to "aging" of the resistors, condensers, control-springs or magnets, will also affect the accuracy. (Scales, even, are preferably of metal, for permanence.)

(2) Inaccuracies Developed Through Use and Handling of the Instrument

A good electrical instrument is as fine and delicate a piece of mechanism as a fine jeweled watch. It should be handled with just as much care as such a watch, if its original accuracy is to be maintained; for many things may happen to it at any time, impairing its accuracy and reliability. Such a simple thing as a bump, or a fall, always possible with portable instruments, may have serious consequences. With permanently-installed instruments, a knock or a blow, continual vibration, effect of powerful nearby magnetic fields, overloads or other disturbances—any of these may affect instruments to such an extent as to make their readings unreliable.

(F) Bent pointer and overload. If too great a voltage is applied across the meter terminals (or stated in another way, too much current is allowed to flow through the meter coil), the pointer may strike against the end stop with sufficient violence to bend it. See Fig. 2A. If this occurs, *never* bring the pointer back to zero by means of the *zero-adjusting* screw, for this will not bring the indications into even approximate agreement with the scale markings. It will bring the moving coil into an initial position far different from that which it occupied when the initial calibration was made. See Fig. 2B. The correct thing to do is to straighten the pointer itself, in order to bring it back to zero. (Fig. 2C.) Errors due to bent pointers are quickly detected (in most instruments) by a lack of parallelism between the pointer

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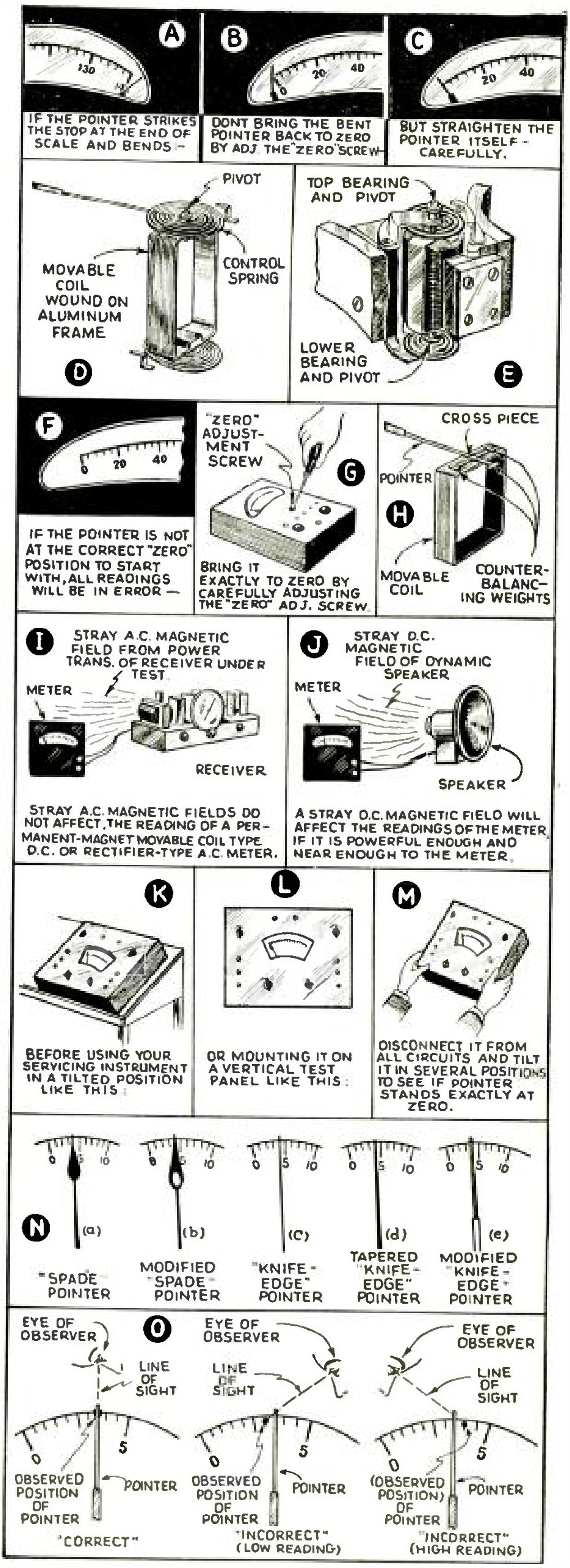


Fig. 2. Illustrations detailing the points discussed in the text.

HOW TO MAKE A CLASS A¹ PUSH-PULL NEGATIVE-FEEDBACK 60-W. AMPLIFIER

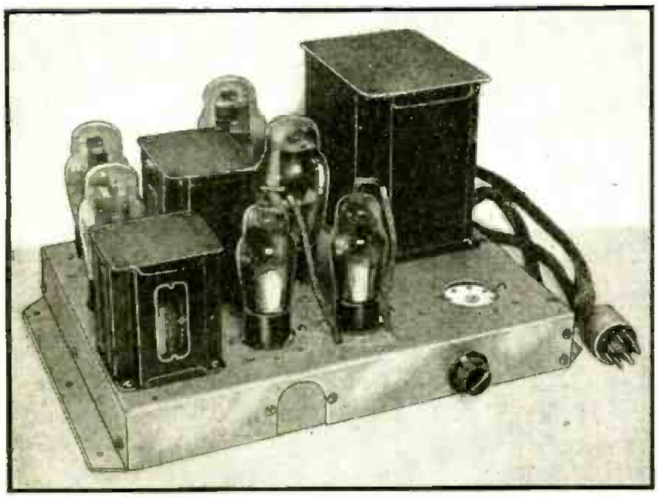


Fig. A. Appearance of the 60-W. push-pull negative-feedback amplifier.

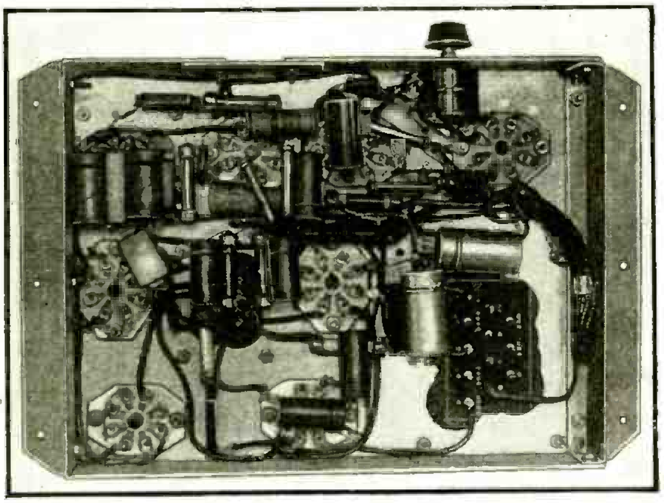


Fig. B. Under chassis view of the amplifier showing wiring and small parts.

Unlike previous types of negative-feedback amplifiers described in RADIO-CRAFT this new unit incorporates 3 stages utilizing this circuit arrangement. New tubes are featured.

WALTER J. BRONSON

THE BEAM-TUBE high-fidelity dual amplifier to be described incorporates 3 well-worked out stages of *negative feedback*.

Distortion, due to incorrect plate and screen-grid voltage regulation, is a very serious condition—particularly, in high-power amplifiers that incorporate negative feedbacks. Proper methods and carefully-designed feedback systems with well-designed power supplies will correct this fault and ward off all possible troubles generally encountered in this type of audio amplifier design. (A more detailed discussion of feedback amplifiers in general covering their operation and construction will not be taken up in this article, since much has been published in previous issues of *Radio-Craft* magazine.) Let us now see how these requirements are met.

CIRCUIT DETAILS

First, a portion of the signal is fed back from the control-grids of the 6F6 push-pull A-prime stage to the cathode of the 6C8 push-pull voltage amplifier tube V2. (See Fig. 1.) This tube is the driver stage in push-pull combination to the 6F6 grids.

Second, feedback is accomplished in the following stage by taking part of the signal from the control-grids of the 6L6s through C13 and C14 including R15 and R16 which are connected to the grid-returns of the 6F6 input transformer T1.

It is well to mention at this point that T1 is especially designed where feedback was a prime factor in the design of the amplifier. The secondary is constructed with 2 separate windings making this an ideal component for this particular type of audio work. Although, this transformer can be used for the more straightforward audio systems by simply making a jumper connection from one secondary section to the other.

Third, negative feedback is again fed through a resistance-capacity network from the plates of the 6L6s to the negative grid-returns of the same stage. This not only compensates for certain deficiencies in the "B" voltage supply regulation, but also aids in the correction of 3rd harmonic distortion of the 6L6s.

NOTES ON CONSTRUCTION

In constructing the amplifier and power supply for this system, care should be exercised in closely following the original layout of components. It is imperative, however, if preamplifiers are to be used in conjunction with this amplifier, that they should be perfectly shielded. Although ample gain is available at the 2 primary stages driving the inter-stage driving tubes.

To simplify construction and wiring the system is incorporated into separate units, that is, all audio parts and tubes

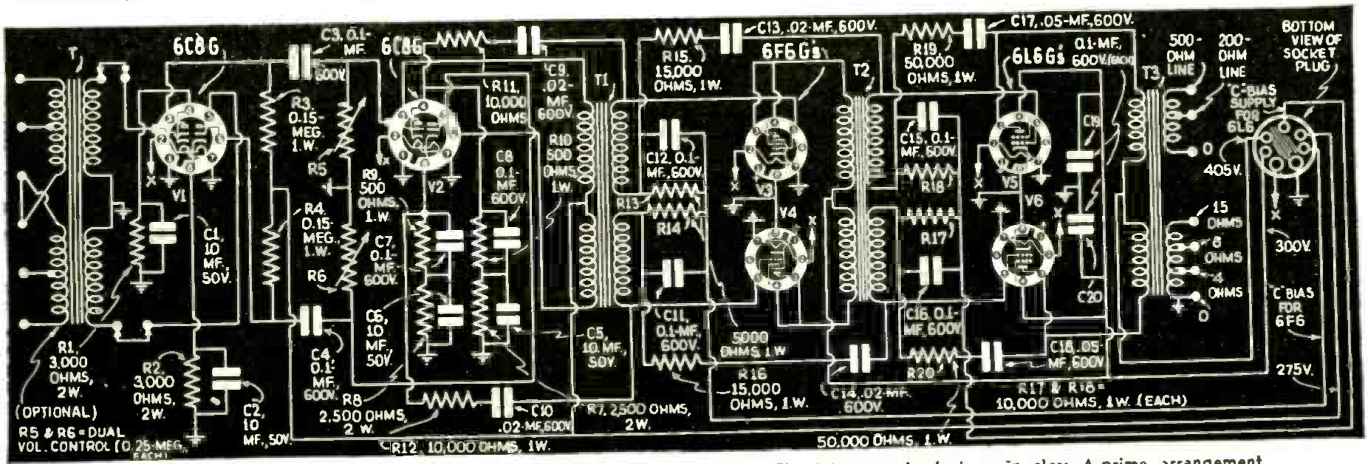


Fig. 1. Schematic diagram of the 60-W. push-pull negative-feedback amplifier. The tubes are hooked up in class A-prime arrangement.

are on one chassis; and power transformers, including their filter systems and rectifier tubes, are on a separate chassis. The dimensions of foundation chassis are as follows, 9 x 14 x 1½ ins. deep; 3/32-in.-thick aluminum is used. This material was selected for the foundations to minimize weight and for its inherent qualities in the effect of shielding all possible stray hums from audio components and wiring.

TUBE SEQUENCE

The 6C8s. The primary input stages are comprised of two 6C8Gs, V1 and V2. These tubes are classified as *double triodes* with the exception of having a separate cathode for each triode section of the tube. Due to the development of this new tube, voltage amplifier circuits are greatly simplified, and especially suited where push-pull operation throughout the entire audio system is desired. In the arrangement on the schematic diagram, the reader will note that 1 tube is equivalent to 2 tubes in a straightforward class A push-pull arrangement.

Improvement in quality reproduction of the 2 input stages is obtained by employing separate bias resistors and filter networks to each individual cathode.

Tube V1 is shown in the schematic diagram with an open-circuited input: this increases the possibilities of varied types of input couplings and multiple mixer stages. By having a throw-over switch special detector combinations of the phase-inverter type can easily be directly coupled to the input of this amplifier. Simplification of volume control is procured by using a dual 0.25-meg. volume control having an audio taper operating in tandem. The location of this control is in the control-grid circuit of the following 6C8 which is V2.

The 6F6s. Driver voltage for the 6F6 control-grids is accomplished by utilizing the 2 plates of V2 connected at the interstage transformer in push-pull class A. Ample driving power is obtained at this point when the 6C8 plates are operated at approximately 275 V. The grid-returns of the 6F6s operated in class A-prime are taken out with a lead to the negative return of the power transformer P.T.2 having the proper dropping resistor to ground. Bias voltage for the two 6F6s should be approximately 28 V. negative. However, it is best recommended to use a semi-variable resistor at this point for obtaining "C"-bias in cases where the bias voltages are apt to be abnormal; this also simplifies the adjustments and insures correct tube operation.

V3 and V4 6F6s are triode-connected (plate and screen grid tied together at socket). For V3 and V4, "B" voltage is 300 from mid-tap of driver transformer to ground. This voltage is taken from a 300-V. point at the P.T.2 power supply. These tubes are operated at strictly class A-prime driving the control-grids of the final stage.

The 6L6. This output stage utilizes 6L6s operated in class A-prime. Negative "C"-bias voltage for the 6L6 stage is approximately 36 V. for both tubes. A semi-variable resistor similar to the one used in the 6F6 stage is also employed at this point for correcting bias voltage and simplifying adjustments. Supply voltage for the screen-grids of the 6L6s is secured from a 300-V. point of the P.T.2 power supply. Supplying the plates of the 6L6s is "B" voltage, taken directly from P.T.1, having exactly 405 V. D.C. from mid-tap of output transformer to ground. Unit P.T.1 is solely the power supply including filament supply for the 6L6 plates and filament.

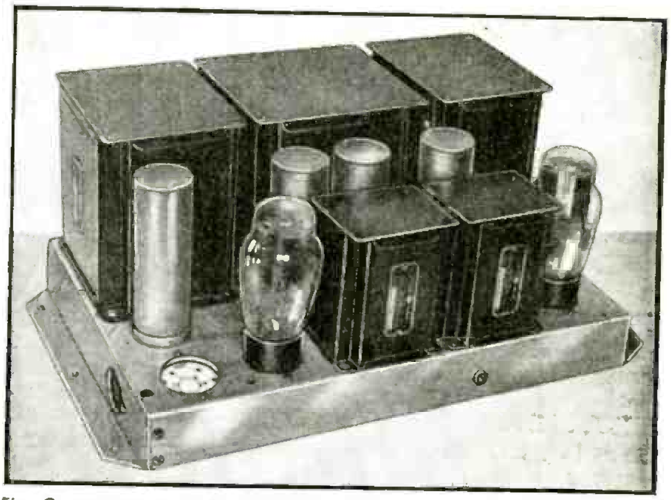


Fig. C. Appearance of the heavy-duty power supply of the 60-W. amplifier.

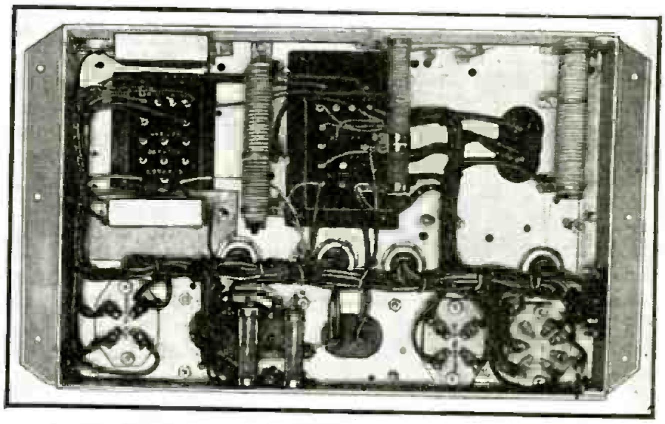


Fig. D. Under chassis view of the power supply showing wiring.

"B"-POWER SOURCE

A glance at the schematic diagram, Fig. 2, will reveal an unusual method in securing plate and screen-grid voltages for all tubes. Two heavy-duty power transformers are effectively put to use, each transformer having its own individual rectifier and "B" filter networks insuring against possible current over-loading when the operation of the amplifier is susceptible to long hours of grueling work.

Rectifier tubes consist of an 83 for plate rectification of P.T.1 supplying plate voltage and current only to the 6L6 plates.

It is not necessary to use a high-current-delivering rectifying tube for P.T.2 since only the plates of the smaller tubes including screen-grid supply for 6L6s is being drawn from this source; a 5Z3 affords ample output. The total current drain from this power supply is approximately 125 ma. Transformer P.T.2 is rated at 200 ma., therefore, "B" voltage and filament supply for a large-size radio tuner can be easily drawn from this source. Due to the fact that the "B" voltage supply is taken from P.T.2 supplying the input

(*Continued on page 251*)

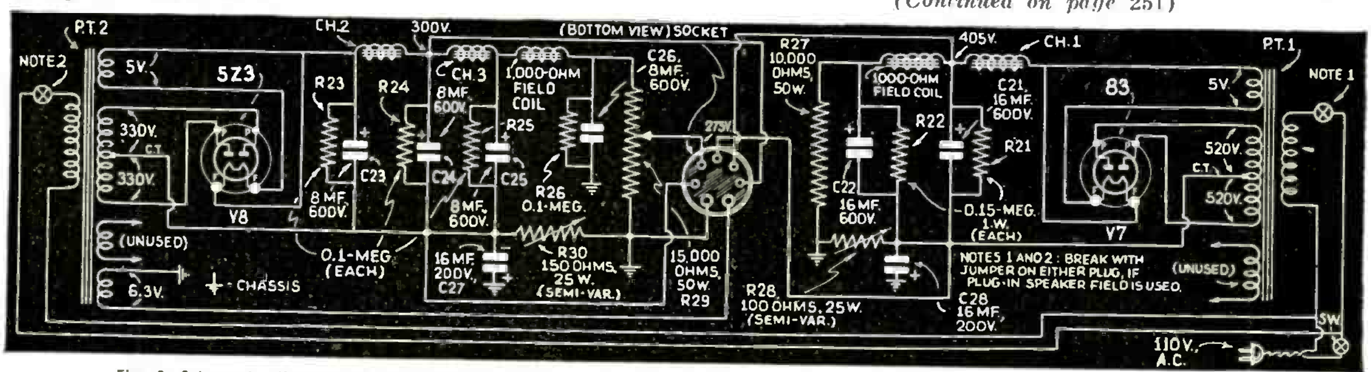


Fig. 2. Schematic diagram of the heavy-duty power supply. Actually there are 2 separate supplies, each with its own filter network.

Fig. A. The "Cyclops" 9-in. volt-ohmmeter in use.

LATEST TEST APPARATUS FOR THE SERVICE MAN

"CYCLOPS" VOLT-OHMMETER IS 9 INS. IN DIAMETER!

THE AVERAGE shop Service Man with his array of tools, hot soldering iron, test equipment, etc., spread before him and with test prods in his hands probing at certain voltage sources, must crane his neck and squint his eyes in order to get a reading on his small volt-ohmmeter; and while he does this one of the prods very often slips and he loses contact. Follows "cuss words", etc.

All this fuss and bother can be eliminated, according to the manufacturer of the new 9-inch "Cyclops" Volt-Ohmmeter shown in Fig. A. It has a scale which is more than 6½ ins. long, enabling accurate readings from a distance of 3 or 4 ft.

Furthermore, because of its special construction, only a 4-in. hole is required for mounting. It has a good "business-like" appearance, which will impress most set owners. Its main job, however, which it does very nicely, is to afford quick, accurate meter indications, easily readable. In this sense it is a real time saver and will be appreciated in every service shop.

(1303)

AN R.F. SIGNAL GENERATOR WITH AN ACCURACY OF ½%

KNOWN AS the model 110, this direct-reading, silver-finish dial may be estimated to ¼ of 1 per cent. See Fig. B. Its accuracy is claimed to be ½ of 1 per cent and its frequency range is 100 kc. to 31 mc.

The radio-frequency output is continuously variable through vernier control and a 4-step ladder attenuation from minimum to 100,000 microvolts (0.1-volt) on all bands. (There is no uncontrollable, high-output tap.) A uni-selector switch provides 400-cycle internally-modulated R.F., unmodulated R.F., externally-modulated R.F., and 400-cycle push-pull sinusoidal audio voltage for amplifier tests that is adjustable 0-1.2 V. The rotor-inductor switching is done by making all coil contacts direct to the oscillating circuit.

To exclude strays, the entire R.F. circuit is enclosed in a separate, copper-shielded box. Power supply and modulator circuits are independently shielded, and the power chassis, power supply cord, and R.F. units are completely isolated by shielded, multi-section filters. The outer interlocking case is uni-welded and finished in a rich, dark green baked crystalac trimmed with etched silver designation plates. The tube complement is one 76 oscillator, one 6X5 rectifier, and one 6N7 modulator.

(The Clough-Brengle Co.)

ENGLISH-READING COMPACT VIBRATOR CHECKER

KNOWN AS the model 4100, this newly-developed instrument checks all types of auto or 6-V. household vibrators, regardless of whether they are half-wave, full-wave, synchronous, non-synchronous, etc., and regardless of what the prong arrangement might be. A universal adapter takes care of the latter.

The meter used is of the direct-reading type, indicating "good", "weak" or "bad" vibrators. It tests for shorts, sticking contacts, unsteady output, low output and poor starting. Only 2 switches and a meter compensator need be "wiggled", affording simplicity of operation. See dia. Fig. 3 (pg. 217).

It is furnished in a portable case with overall dimensions of 7½ x 8½ x 2½ ins. Its total carrying weight is 5½ lbs. See illustration at Fig. C.

(1304)

HIGH-SPEED FUSES PROTECT METERS IN NEW PRACTICAL WAY

A SIMPLE METHOD of protecting commercial or home-made volt-ohm-milliammeters is suggested by a laboratory that has long specialized on this subject. It consists merely of the substitution of a double-pole selector switch for the commonly used single-pole type; in conjunction with special *meter-type fuses.*

The one pole is connected to various shunts as in the original hook-up and the other arm is connected to various meter fuses of a limited range. Usually, the range from 1/100- to ¼-A. can be split up most effectively by 4 types of fuses: the 1/100-, the 1/32-, the ⅛- and the ¼-A. ratings. This covers the range from 1 ma. to 100 ma. which is the commonly-used scale. See Fig. 1.

By using the method described and illustrated in Fig. 1, the Service Man can speed up the time used in checking by quick insertion of the test prod. If, by accident, a damaging potential is contacted it merely means the blowing of inexpensive meter fuses, thereby saving the cost of replacing expensive shunts and delicate meter movements.

(1305)

MUTUAL-CONDUCTANCE TUBE AND MULTI-TEST METER

THIS TUBE TESTER not only tests all tubes but also indicates *volts, ohms, milliamperes, output, microfarads, ca-*

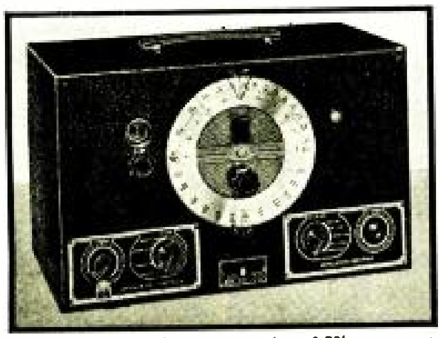


Fig. B. This signal generator has 0.5% accuracy.

Fig. C. This new vibrator checker tests all types of auto or 6 V. household vibrators. Can be used on counter, in the service shop, or carried around. Weighs but 5½ lbs.

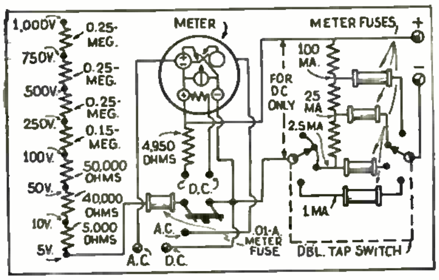


Fig. 1. The simple but very practical method of protecting expensive volt-ohm-milliammeters utilizes a 2-deck switch and fast-acting "meter" fuses. Extra deck carries the fuses.

Name and address of any manufacturer will be sent on receipt of self-addressed, stamped envelope. Kindly give (number) in above description of device.

Work's more profitable when the Service Man uses the radio equipment described on these pages. Extended ranges feature some of the test instruments here illustrated; others bid for attention via other advantages. In several instances schematic circuits have been made available to the technician so that he may determine for himself the relative merits of the respective instruments.

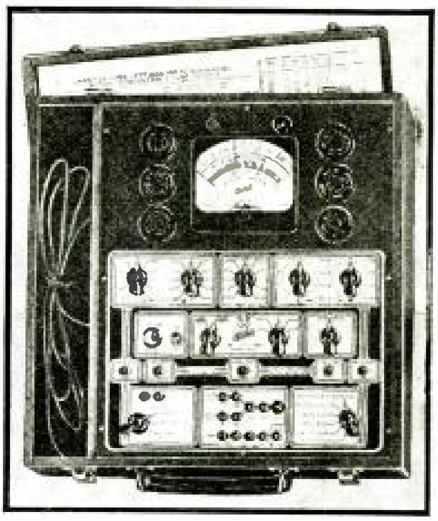


Fig. D. New mutual-conductance tube tester.

pacity, leakage and *decibels!*

As a tube tester it has a dual-reading scale, one marked POOR and REPLACE and the other graduated in micro-ohms of mutual conductance. See Fig. D.

In addition to the quantities listed above it also indicates the amount of hum in filter systems and checks the inductance of chokes with or without the D.C. component of current.

The A.C. voltmeter is accurate on all commercial and audio frequencies. The ohmmeter uses no batteries, operates from the built-in power pack.

The meter used is a d'Arsonval type, scale length over 4 ins., with etched dial easily readable, owing to color grouping of ranges. The same scale is used for reading A.C. and D.C. volts, and it is uniform. No copper-oxide rectifiers are used anywhere in the circuit; all rectification is accomplished by vacuum-tube circuits.

The unit is contained in a compact case through careful arrangement of the component parts. Case is rubbed walnut, operating panel is etched chromium finish. All necessary leads are furnished. Instrument is the model AC-51X.

(Hickok Electrical Inst. Co.)

SIGNAL GENERATOR OR "STATION SETTER" FOR PHILCOS 1938-LINE RADIO SETS

AN A.C.-OPERATED signal generator—a precision-built, laboratory-type instrument—has been especially developed to meet the needs of those Service Men who may be called upon to service the new line of Philco "Cone-Centric Automatic Tuning" radio receiver models. See Fig. E. It is essential that these radio sets be properly set-up to the stations printed on the dial, before delivery to the customer.

To get the maximum benefit from Automatic Tuning, the setting of each individual station must be exactly on its correct frequency. If this setting-up is attempted simply hy tuning-in a broadcast station, it will be found that probably no two people will tune the radio set to the same point, when listening to the same station. To prevent this possibility, this new signal generator and "station setter" was developed to guarantee 100% accuracy on every station.

A few of the many features of the 1938 model 077 signal generator or Station Setter are:

Operates from A.C. outlet; covers highest and lowest frequencies (115 kc. to 37 mc.), in *fundamentals*, not harmonics; generous overlap of bands; combined on-off and modulation switch; new knife-edge pointer for accurate readings; 3 output connections; exceptionally high R.F. output; full attenuation on all bands controllable in steps or continuously; 400-cycle audio signal provided; equipped with 6 ft. cable and plug having extra outlet built-in; unaffected by line-voltage variations.

(1306)

Fig. E. Signal generator or "station setter".

AC-DC MULTIMETER FOR RADIO, P.A. AND AMATEUR USE

THE A.C.-D.C. MULTIMETER described below has been primarily designed to cover all the ranges required in modern radio servicing. Its adaptability to P.A. and amateur transmitting needs is due to an additional high-voltage range (2.500 V. A.C. and D.C.) accessible through a separate set of twin tip-jacks. An individually-cali-

(Continued on page 246)

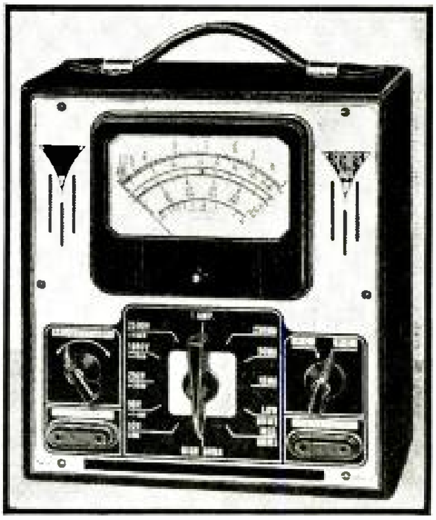


Fig. F. A universal A.C.-D.C. multimeter.

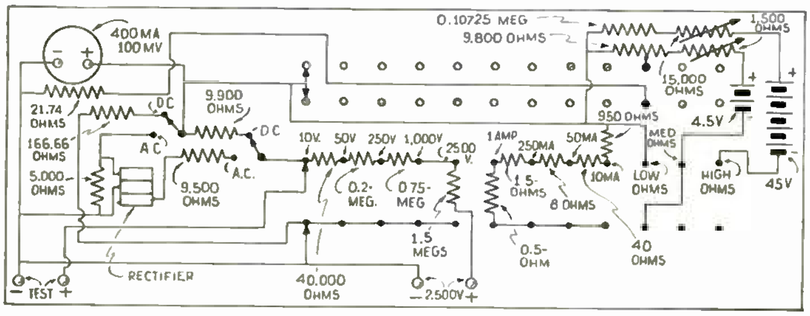


Fig. 2. Schematic circuit of the A.C.-D.C. meter illustrated in Fig. F.

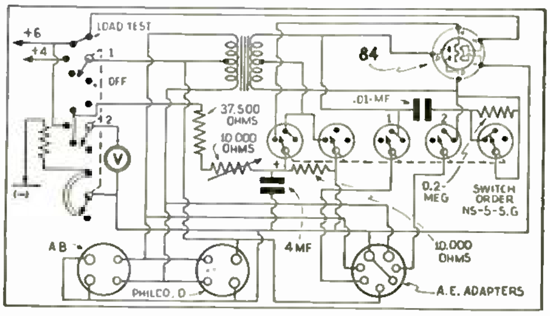


Fig. 3. Schematic circuit of vibrator tester shown in Fig. C.

"LEARN-BY-EXPERIMENTING"

BEGINNERS' PRACTICAL RADIO COURSE

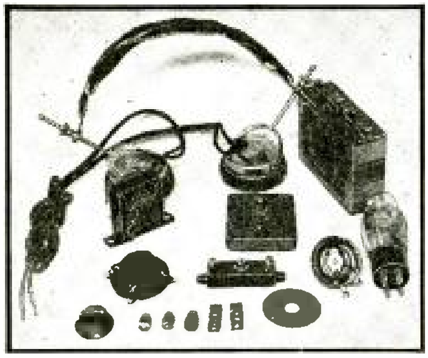


Fig. A. The parts needed for Experiment No. 1.

EXPERIMENT NO. 1

AUDIBLE TONE GENERATOR

("RADIO WHISTLE")

Here is an entirely new way of learning radio! You learn basic principles while building useful radio units!

CONDUCTED BY

SOL D. PRENSKY

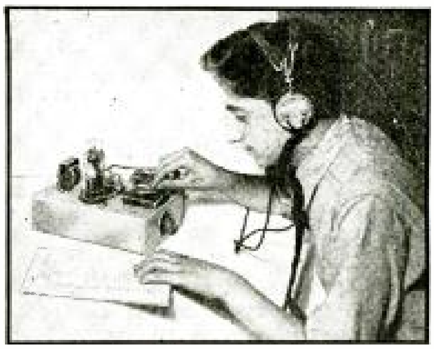


Fig. B. The audible tone generator for code work.

IT IS THE AIM of these Experiments to show fundamental principles of Radio in their practical applications, with the additional thought in mind of using commercially-available parts, selected and adapted, so that they will serve as general-purpose construction material. In this way, much of the apparatus used in one Experiment may be used again and again for other Experiments, *thus keeping the cost of the apparatus within reasonable limits.*

VOCATIONAL POSSIBILITIES

As radio develops, the need for well-trained men becomes much greater. The lack of proper training has become all the more pronounced with the many new developments like automatic frequency control and the like. Many, who are sincere in their desire to follow new developments, find themselves badly handicapped by the fact that no amount of practical experience can make up for the gap left in their training by poor grounding in the basic principles of their field.

In a recent talk, Mr. J. K. Whitteker, Chief Instructor at R.C.A. Institutes, said, "Opportunities for Service Men and other radio workers are increasing considerably as a large number of those in the field drop out because of their inadequate training in the fundamentals of the science of radio."

It therefore is a matter of first importance to beginners and experienced men alike to bend every effort to master fundamental principles. These Experiments will go far to answer that purpose if the reader actually performs them, and in addition, consults a standard text book on principles of radio* for explanations of the many topics and terms encountered in the Experiments. It is to be emphasized that any explanations given here in the course of the Experiment, are not to be regarded as complete, but simply as guides to the principles involved.

The material to be covered by these Experiments will be presented in a sequence of individual Experiments, each of which will be a unit in itself, and will assume no previous knowledge of radio to any extent, except that which can be obtained directly from a text book. Generous use will be made of pictorial aids in the beginning. The wood chassis in the first Experiment, which can be any *cigar box*, will be found very convenient at first, before it is replaced by work with a metal chassis in later Experiments.

***Suggestions for Texts**

"Radio Physics Course" by A. A. Ghirardi—very comprehensive in the fundamentals and quite a large book.

"Elementary Principles of Radio" by Burns—a much smaller book than above.

"Principles of Radio" by Henney—a general text.

"Practical Radio Communication" by Nilson and Hornung—a good reference book.

"How to Become a Radio Service Man" by Louis Martin—a *Radio-Craft* Red Book for those interested in service work and a good start to get an idea of what is to be done, and how.

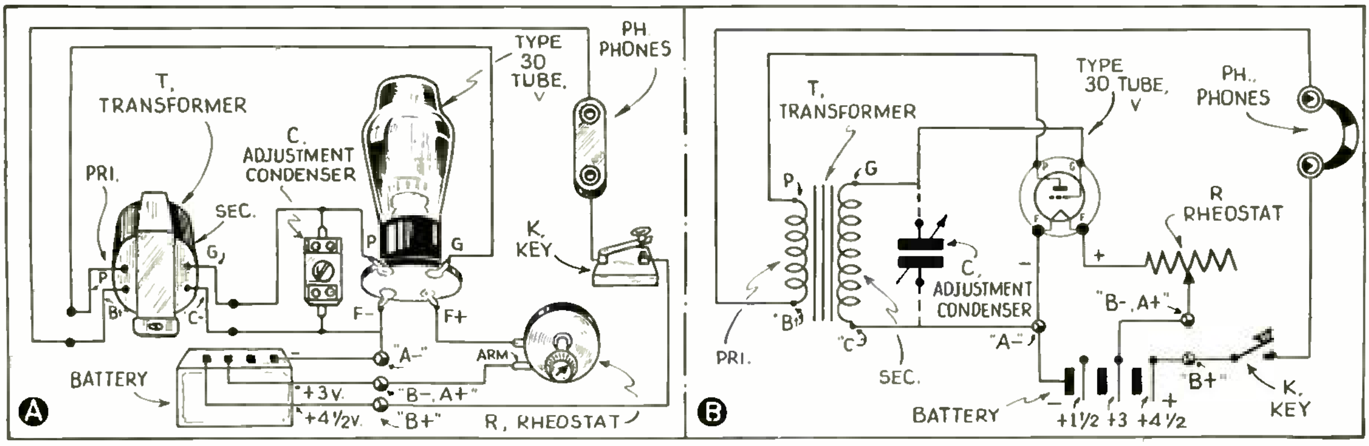


Fig. 2. The wiring diagram in section A is for the convenience of those who cannot easily follow the schematic diagram in section B.

GENERAL PRINCIPLES—THE VACUUM TUBE

Since practically all radio work centers about the *vacuum tube*, it is necessary that we start with a simple picture of how this exceedingly versatile device works.

A *radio tube* (or "vacuum tube") is inherently an amplifier or booster device which can increase the strength of any given *signal* (radio program, static, dots and dashes, etc.), which is passed through it properly. It can also easily be modified to produce its own signal, which can be translated by *headphones* into sound, as will be seen in this experiment. However, no matter to what use the tube is put, its fundamental operation is the same, and it will be exceedingly helpful, therefore, to carefully consider this basic operation.

The vacuum tube, used in radio, is shown (see Fig. 1B and C) to consist of 3 elements, which are labeled according to their physical appearance as follows:

Filament—a thin wire which is heated by an *electric current* (from a battery or other source) to a point where it gives off small particles of electricity called *electrons*, which (when in motion) constitute an electric current.

Plate—a small sheet of metal which is connected externally to the *positive side* of a *battery* (or other source of electric current) and thus made to attract the electrons from the filament, which have a *negative charge*. The similarity of this electric attraction to the well-known magnetic attraction between magnets is shown in Fig. 1D and E.

Here it is seen that when a magnet is presented to another magnet suspended by a string, the first magnet when held in one position will cause the suspended one to be *attracted* to it (since then, the "unlike poles" [North-South, North-South] face each other). When the first magnet, however, is turned over so that it is reversed, right to left, it will be found to *repel* the suspended magnet (since now the "like poles" [North-North, South-South] are facing each other).

Grid—a mesh or open lattice-work of wire (placed between the filament and plate) with spaces between the wire, through which the electrons must travel on their path to the plate. When this grid is connected to the positive side of a battery, or other source of electrical supply, it will increase the flow of electrons since, being positive, it will also attract the negative electrons because of their "opposite charge." However, the same grid, if connected to the negative side of an electrical source, will now repel the negative electrons back to the filament, since "like charges of electricity repel each other." In this case the number of electrons available to flow to the plate becomes smaller.

Thus, as shown in Fig. 1B, when the grid is positive, the total number of electrons flowing to the plate becomes greater, since the grid is now *helping* the current (electrons).

When the grid is negative (see Fig. 1C), the total number of electrons flowing to the plate becomes less, since the grid now *retards* the flow of current (electrons) to the plate.

In this manner, the grid acts as a "control valve" or "trigger" so that a small change in the electrical charge of the grid controls a large change in the flow of electrons (which *is* the current) to the plate.

The *vacuum tube*, in operation, consists of 3 complete electrical paths, each a completely closed "loop", called *circuits*, as shown dotted in Fig. 1F.

(A) The *filament* loop is fed by the "A" battery or other form of (low or filament) *voltage* supply which heats the filament, causing it to give off electrons.

(B) The *grid* loop (*input circuit*) contains the signal which is to be amplified. The electric charge (or available energy) from a battery which is applied to this circuit is called the "C" (low, to medium, grid) voltage.

(C) The *plate* loop (*output circuit*) contains the signal, which has been amplified. The voltage supplied to this circuit is called the "B" (high or plate) voltage and the positive side of it is connected to the plate to furnish "plate voltage."

The tube operates in the following manner: The *input signal*, by means of the electric charge it gives to the grid, is able to control the large stream of electrons which travel from the filament to the positive plate. By means of such a "trigger action" the tube acts as an amplifier.

The tube and the other radio parts which will be used in the first Experiment are shown in photographic form in

(*Continued on page* 232)

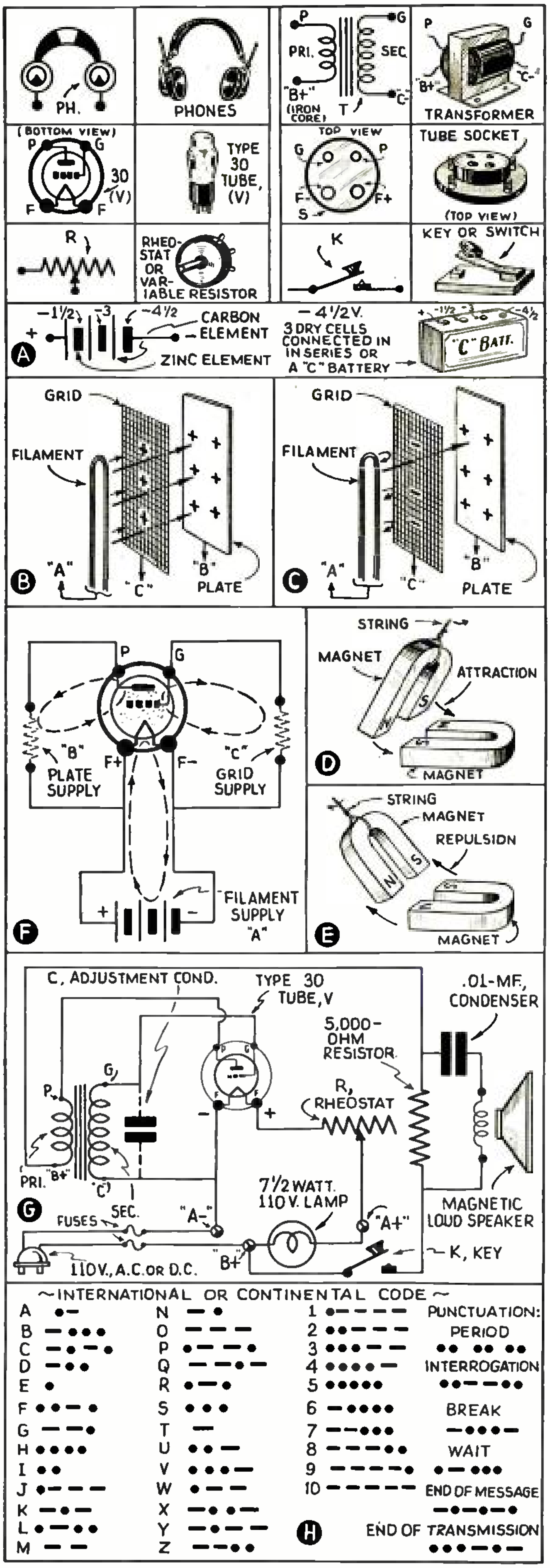


Fig. 1. A, Symbols of parts used in this experiment; B and C, The action of the grid in a radio tube; D and E, Illustrating attraction and repulsion; F, Fundamental circuits of a radio tube; G, See text; H, The code.

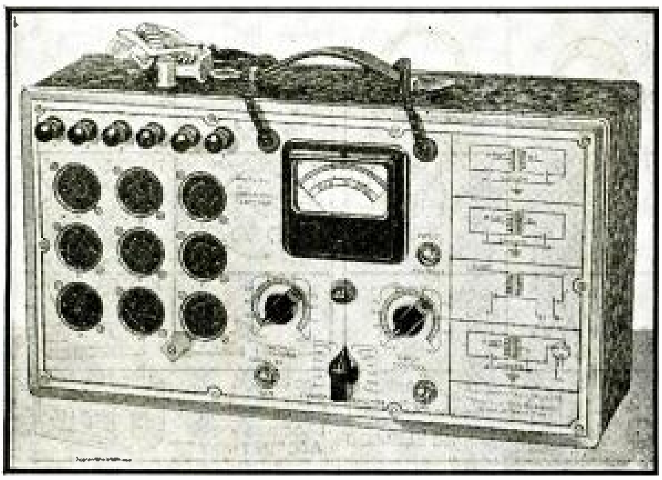


Fig. A. New modern tester designed to test all types of vibrators.

ABC OF MODERN VIBRATOR SERVICING

Fundamental theory concerning the operation of the interrupter-type and synchronous-type vibrators, and the construction of suitable test units, are discussed.

F. E. WENGER

AUTOMOBILE-RADIO servicing today, can be greatly speeded up by the use of a Vibrator Tester. Before describing the testing of vibrators, I believe it is well to take the "mystery" out of the operation of vibrators. Successful servicing of auto-radio sets is entirely dependent upon the Service Man's understanding of the fundamentals of vibrators and their associated circuits.

Vibrators should be called automatic switches whose time constants are governed largely by the mechanical construction of the vibrator or switch.

INTERRUPTER-TYPE VIBRATOR

Figure 1A shows the *interrupter-type vibrator* connected in full-wave circuit.

Current from the "A" battery flows through the center-tap of the transformer in the lead marked "A HOT," and with the reed in the upper position, the current flows with the arrows. The reed remains momentarily in the upper position until the electromagnet draws the reed to the lower position and current is interrupted through the upper section and starts flowing in the lower section of the transformer. The contact with the reed is made momentarily until the electromagnet again returns the reed to the top position. (The electromagnet is not shown in the circuit as this can be either a series or a shunt type coil.) It is easily seen how the speed of the reed and the dwell of the contacts will produce pulsating D.C. voltage in the primary of the transformer. This pulsating current is reflected as A.C. voltage on the secondary. The transformer ratio is generally 40-to-1. Thus, we have an alternating voltage in the secondary of the transformer 40 times that of the battery.

After we have A.C. in the secondary, this is rectified the same as A.C. is rectified in the conventional A.C. power pack. Filtering is substantially the same as that for home-type radio receivers and is designed for the frequency of the vibrator.

SYNCHRONOUS-TYPE VIBRATOR

Figure 1B shows the *synchronous-type vibrator*. Note that the current in the primary takes the same path as it did in the interrupter-type vibrator. However, the reflected voltage in the secondary is rectified somewhat differently, inasmuch as it does not use a tube, but uses the same reed to interrupt the current in the primary and to pass current only in one direction.

During the first part of the cycle one-half of the secondary is delivering current to the reed, and during the second half of the cycle, the other half of the secondary is delivering current to the reed. Thus, we have accomplished the purpose of rectification and passing current in one direction only, without the use of a tube. The center-tap of the secondary in this instance becomes "B+". The 2 reeds can be electrically insulated from each other as is necessary in some radio sets where the negative return is below (less than) ground potential. However, the reed works in synchronism with the primary, hence, we have self-rectification.

By the foregoing description and a study of the action of the vibrator and a study of the circuits, it will be noted that the transformer and filter systems are separate parts of the vibrator proper and should be tested and analyzed the same as similar circuits are in conventional home-radio sets.

(Continued on page 247)

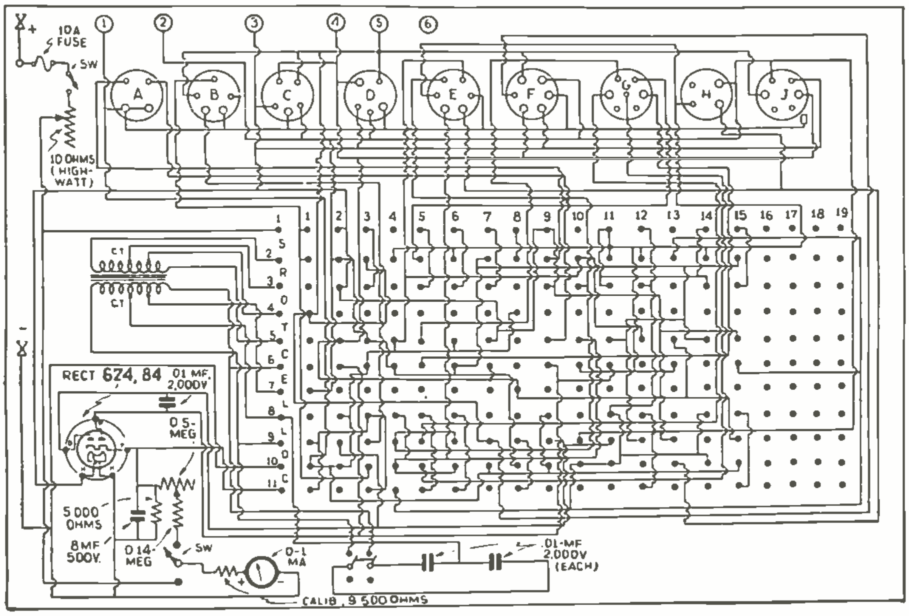


Fig. 2. Schematic circuit of the vibrator tester illustrated in Fig. A.

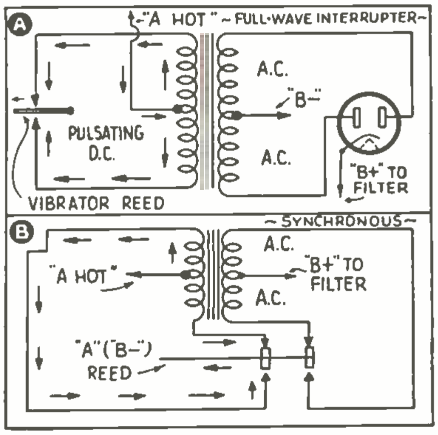
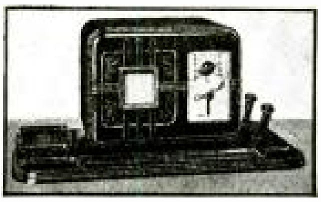


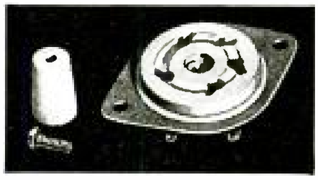
Fig. 1. Section A shows the *interrupter-type vibrator* working "full-wave." The pulsating D.C. in the primary is transformed into A.C. in the secondary at a voltage 40 times greater than that in the primary. A rectifier tube is then required to obtain D.C. Section B shows the *synchronous-type vibrator*, also working "full-wave." Here, however, the A.C. in the secondary is rectified through the medium of contacts on the vibrator reed. A separate rectifier tube is not required.

This department brings to you each month the newest developments in electronic, radio and public-address equipment. Aggressive technicians use this department to keep posted on the newer and better ways of doing things.

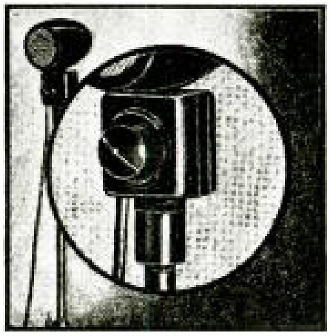
THE LATEST RADIO EQUIPMENT



The newest in office intercommunicating units includes, in this all-bakelite apparatus, 2 pen-wells and 4 ashtrays. (1286)



A cleverly-designed socket that will appeal to the radio man is here illustrated. The isolantite top rotates on a metal baseplate to any desired position in order to facilitate wiring. (1287)



A dynamic microphone in a bullet-shape housing; a volume control is built-on. Frequency response, 20 to 9,000 cycles, it is said. (1288)

The earphone supplied in addition to the loudspeaker affords, in this unusually fine-appearing interphone, the facility of privacy. (1289)

ULTRA-MODERN DESK-SET INTERPHONE (1286)

(The Webster Company)

FOR THE BUSY business man there is now available a combination desk set and wire-type inter-office communication system. The desk set incorporates 4 nested ash-trays, 2 fountain-pen funnels, and troughs for pens, erasers, pencils and clips. Like this desk equipment the A.C.-D.C. "Amplicall" interphone is made of molded black bakelite. Both 2-way and multiple-station systems are available in apparatus having the same general appearance.

IMPROVED TUBE SOCKETS (1287)

MADE PARTLY of isolantite these new sockets feature in addition a prong-grip that extends the whole length of the tube prong. The face of the socket is electrically "dead"—no metal extends through it. Still another feature is the design which permits rotation, of the isolantite body to any one of 6 positions on a metal holder, to facilitate wiring. An isolantite stand-off pillar is provided; except for the octal socket which is supplied with 2 metal pillars.

NEW BULLET-SHAPE MICROPHONE (1288)

THE NEWEST in bullet-shape dynamic microphones features the use of a built-on volume control. The response characteristic is said to be from 20 to 9,000 cycles. Particularly recommended for use with a "guitar" amplifier. The bakelite case is available in black, Chinese-red or ivory.

FAST-ACTION ARTISTIC INTERPHONE (1289)

(United Sound Engineering Co.)

IN THE "personal call-phone" system illustrated an earphone provides comparative privacy; raising the earphone from its rest makes conversation confidential by bringing the remote party's voice over the earphone instead of the loudspeaker. A busy signal is provided. Every station is a master. The finish is black with aluminum trim.

3-IN. INTERPHONE CRYSTAL SPEAKER-MIKE (1290)

(The Brush Development Co.)

ALTHOUGH somewhat greater amplification is required, the new crystal-type speaker-mike here illustrated affords a greater frequency response range than is available from the ordinary run of magnetic and dynamic transducers designed for interphone service.

As a microphone, its output level is approximately -40 db. (0 ref. equals 1 V. per dyne per sq. cm.) and it is worked directly into the control-grid of the first tube with a grid resistor of 1 meg. When switching the unit to loudspeaker position, it is not necessary to use an output transformer between the last stage and the speaker. It is common practice to shunt-feed the last tube plate through a typical load resistor; and to couple the speaker to the plate by means of a 0.05-mf. condenser (to shunt a ½-meg. resistor across the speaker).

RACK-PANEL COORDINATED SOUND SYSTEM (1291)

(Wholesale Radio Service Co., Inc.)

SCHOOLS, offices, factories, churches, community centers, etc., will be particularly interested in the self-contained sound system here illustrated. It permits personal calling, mass announcements and the rebroadcasting of radio programs or phonograph records. All components are carefully coordinated with each other. Includes an all-wave radio receiver.

MICROPHONE HANDSET FOR TRANSCEIVERS, ETC. (1292)

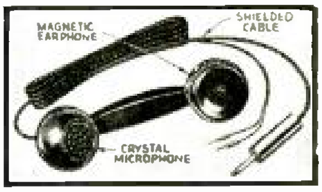
IMPROVEMENTS in earphones and microphones have been combined in a new handset for communicating systems, radiophone equipment, monitoring set-ups, etc.

Earphone is modernistic type. 2,000 ohms D.C. resistance (for plate circuit of a type 56, 76, etc.).

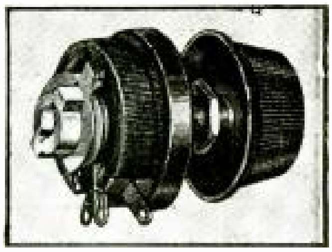
Microphone is a crystal unit that peaks at 3,500 cycles for improved speech intelligibility. Damping prevents blasting in close-talking.

(Continued on page 238)

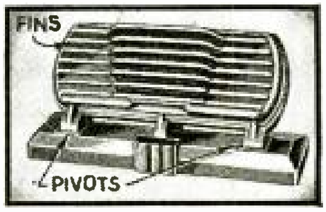
Compact audio rack-panel. (1291)



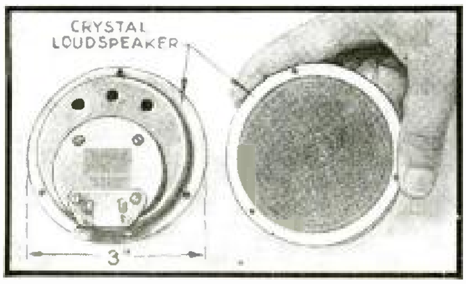
Handset has crystal microphone and magnetic earphone. (1292)



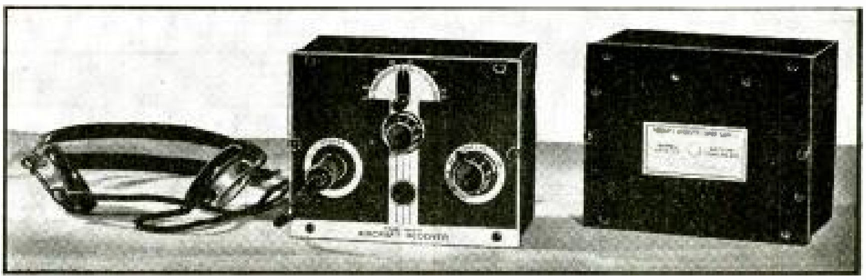
A.C. filament rheostat. (1293)



Pulpit-type velocity mike. (1294)



Crystal "interphone" transducer has good fidelity. (1290)



An aircraft radio receiver that obtains 4-tube efficiency with only 2 tubes. (1295)

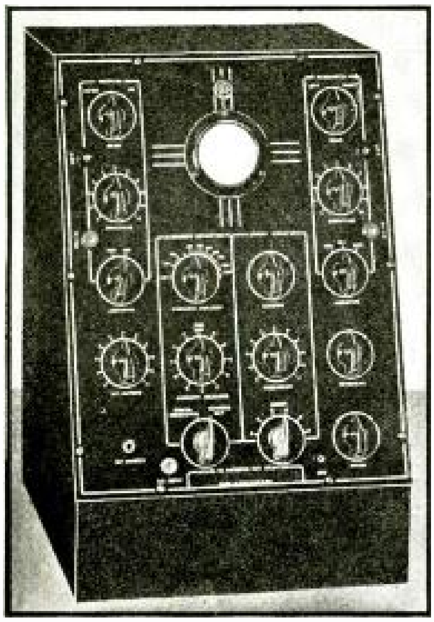


Fig. A

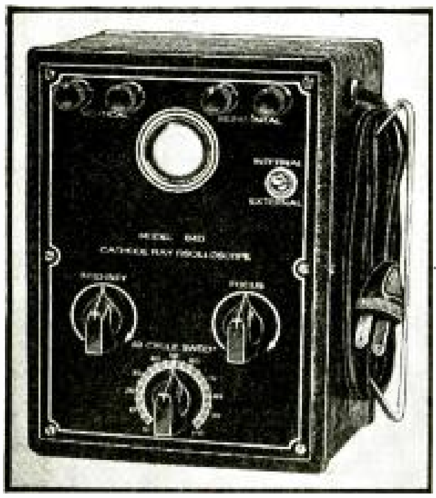


Fig. B

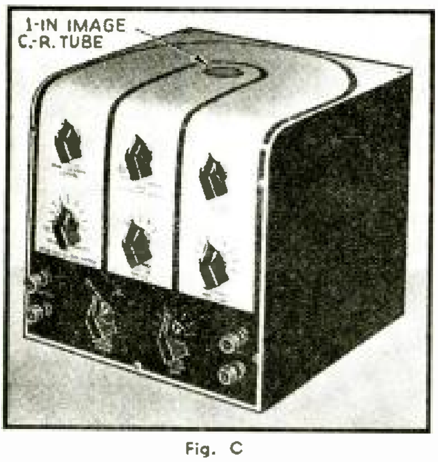


Fig. C

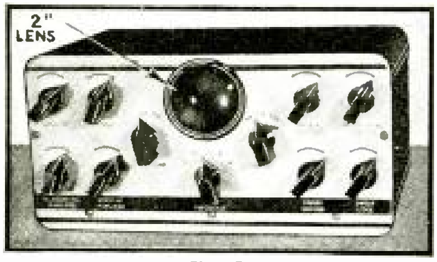


Fig. D

MODERN SERVICING OSCILLOSCOPES

Increase in oscilloscope sales prove that they are becoming more and more popular as regular servicing instruments. Outlined in this article are the features of some of the latest commercial units.

CATHODE-RAY "ANALYZER" IS NEWEST SERVICE TOOL

THIS INSTRUMENT contains the following sections: a 2-in. oscilloscope (cathode-ray tube and its power supply), separate amplifiers for the horizontal and vertical deflecting plates, an electronic "wobbler" (frequency modulator) of improved design, a linear-sweep circuit, and a group of variable and fixed alignment capacities.

An all-wave signal generator, either external or built-in, is a necessity when using any cathode-ray equipment for radio receiver alignment. In order to prevent obsolescence of modern equipment which the engineer might already own, this instrument was designed to operate with an external signal generator.

All the sections of the block diagram (Fig. 1) enclosed by the dotted lines are contained in the single attractive metal case shown in Fig. A. The controls have been divided into 4 groups—(1) Horizontal, (2) Vertical, (3) Linear Sweep, and (4) Alignment Capacities—so that the analyzer is easily operated and the necessary adjustments may be quickly made.

The fixed oscillator (A, in Fig. 1) which operates at a frequency of 800 kc., is frequency modulated ± 15 kc. by the "wobbler" (B), thus producing a bandwidth of 30 kc.

This frequency-modulated wave is mixed with the unmodulated output of the signal generator (C) in the frequency changer (D), the output of which has a contact bandwidth (30 kc.) regardless of the signal-generator frequency. The signal generator must be adjusted to a frequency which is either 800 kc. higher or lower than that desired. For example, to align a receiver at 1,000 kc. the generator must be set for either 1,800 kc. (1,000 + 800) or 200 kc. (1,000 — 800).

The output of the frequency changer is fed into the attenuator (E) which in turn feeds into the alignment capacities (F). The variable capacity has a range of 125-950 mmf. (it is calibrated with the special shielded coaxial cable [G] which connects the instrument to the receiver being tested), and is used to align the antenna and R.F. stages of both home- and car-radio sets. This feature enables the engineer to correctly align car-radio receivers which require a variety of accurate "dummy antenna" values for best results. Fixed condensers of 0.1- and 0.5-mf. are included for I.F. alignment. Spare switch positions are available should other values be needed.

The coaxial cable is connected to the control-grid of an I.F. tube or to the antenna of the receiver (H) (the correct alignment capacity being used), and the "high" side of the diode-load resistor of the receiver 2nd-detector is connected to the vertical amplifier (I), as shown. The horizontal amplifier (J) is internally connected to a source of 60-cycle voltage.

A few of the many applications in which this model 96 instrument will save the service engineer time and trouble are: aligning R.F. or I.F. stages of home- and car-radio sets, adjusting low-frequency padders without the necessity of rocking the receiver gang condenser, aligning A.F.C. circuits (virtually impossible any other way), and correctly aligning "flat-topped" high-fidelity circuits. Hum and distortion may be easily located and corrected when using the linear sweep (K).

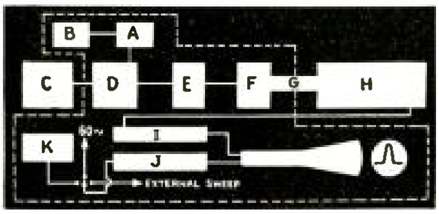


Fig. 1. Block diagram of the oscilloscope illustrated in Fig. A showing circuit sequence.

COMPACT FOUNDATION OSCILLOSCOPE USES 1-INCH C.-R. TUBE

WITH PROPER external addition, this basic oscilloscope offers facilities for the study and adjustment of numerous circuit problems. It may be adapted for R.F. and I.F. alignment, resistor, condenser, vibrator and many other tests. See Fig. B.

The oscilloscope incorporates an RCA type 913 cathode-ray tube with 1-in. fluorescent screen; has vertical and horizontal deflector-plate terminals on the front panel, as well as controls for intensity, focus, and sweep amplitude; incorporates a built-in 60-cycle sweep circuit. The instrument is housed in a metal case with black "electro-enamel" finish and measures only 5⅞ x 7⅞ x 4⅛ ins. deep. The front panel of this model 840 Ranger Examiner is finished in silver and black.

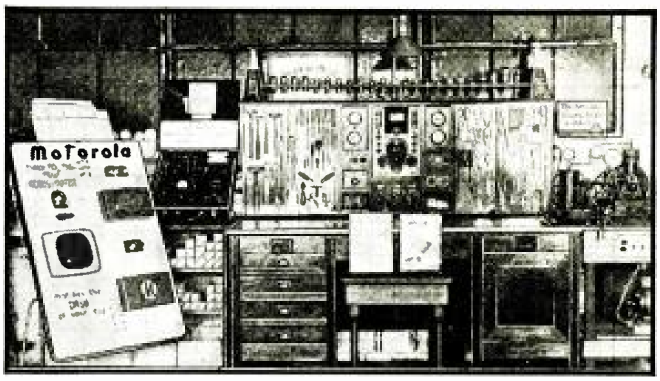
READRITE METER WORKS

(Continued on page 234)

BUSINESS PROBLEMS OF THE SERVICE MAN

The problems confronting a Service Man just branching out "on his own" are many and ofttimes unforeseen. This series of articles treat of these problems in a thorough-going, practical and personal manner. Don't miss them!

Conducted by JACK GRAND



SERVICE BENCH OF SUCCESSFUL SERVICE MAN

The service bench illustrated above is that of a successful Service Man, F. C. Weckman, of Pittsburgh, Pa., who started on a small scale and gradually expanded until now he occupies a total floor space of 6,500 sq. ft.

The picture shows a very small portion of the 6,500 sq. ft. of floor space, which is used for auto-radio installation and service, *quite a bit of which is sent in by dealers who do not install or service their radio sets.* On the extreme left is a display board which speaks for itself. This board partially hides from view the tube shelves. The analyzer shown at left of the bench is the new Triplett 4-unit case made up of (1) point-to-point tester, (2) tube

(Continued on page 246)

"ALL IS not gold that glitters," nor is every idea a howling success! We humans have a great weakness, we get an idea and build it up in our imaginations until it is beyond reasonable attainment. Data is collected from all sources. We argue the possibilities of the idea from all angles trying to convince anyone who will listen that the idea is fundamentally sound.

Should anyone disagree, then in our opinion, they just don't get the right slant. Criticism, even if sound, is disregarded because of the extreme enthusiasm on our part.

It is just too bad—in fact, brutal—what a pencil and a piece of paper will do. Putting an idea on paper allows scrutiny and study. It is surprising how things change when imagination is eliminated.

When two or more men get together, invariably, discussions arise. Qualifications and abilities are discussed, opportunities and the success of various enterprises are the topics of conversations. Ofttimes the desire for a business career and a partnership is the outcome.

The type of discussion just described was instrumental in the creation of an idea whereby a partnership arrangement was created. The "idea" which these two men built up in their imagination will be our topic for discussion this month.

The names used are, of course, fictitious. We shall call these men Mr. Jerod and Mr. Holtz.

Mr. Jerod, a young, unmarried man, is employed by a large chain organization at a fair salary as a refrigeration engineer. During his spare time he had taken a resident course in radio servicing and had graduated. Upon completing the course, he continued working for the chain, and after working hours, he would study and experiment further on radio subjects and servicing.

Mr. Holtz, middle-aged and married, is employed by the same chain organization as an electrician. He had been with this concern for 12 years. Previous to this time his home had been in one of the north-western states.

THE PROBLEM

As mentioned in the beginning of the text with reference to group conversations, these two men had ideas in common. They both wanted to go into business for themselves. Mr. Jerod was a "knock-out" at electrical refrigeration and radio servicing, while Mr. Holtz considered himself a "cracker-jack" as an electrical contractor. Mr. Holtz also stressed his popularity and large acquaintance in his home town. He felt that better opportunities presented themselves in the North-West than here in the East.

The seed was there and the idea grew. They decided on a partnership and proceeded to make plans accordingly.

No sooner said than done. They went to the superintendent, presented their case and tendered their resignations. The superintendent had known these men for a long time and thought well of them. He offered his good wishes and at the same time, in a spirit of friendship, offered them the following proposition.

If Mr. Jerod and Mr. Holtz would take care of the refrigeration plant in the chain branch of that city he would secure for them space in the basement of that store, rent free. They could also put a sign in one corner of the window. The only stipulation being that one of them had to be on duty all the time. To this Mr. Jerod and Mr. Holtz agreed.

The picture described is beautiful—prospects looked bright. Combining refrigeration and radio servicing with electrical contracting as an all-year-'round business was a master stroke—and on top of it all—rent free!

In summation—the following points are outstanding:

(1) Mr. Jerod is a good man on radio and refrigeration service.

(2) Mr. Holtz is a good electrician.

(3) Both men are good workers, they are congenial and have worked together for a number of years.

(4) A place of business has been provided—rent free.

(5) Mr. Jerod has a circle of friends and acquaintances as prospective customers.

(6) The combined financial resources are over $1,000.

Again I repeat—the picture is good. Now let us analyze their problem.

ANALYZING THE PROBLEM

What in your opinion are the possibilities of success for Mr. Jerod and Mr. Holtz?

After you have formed your opinion, put it down on paper, and see how it compares with the following (illustrated) analysis.

First—neither has had any business experience.

Mr. Holtz has not been in his home town for 12 years, and is depending upon friends and acquaintances that he has not seen for years.

I learned that neither one knew how many electrical contractors were in that town, nor could they inform me as to the number of radio service shops located there. They did not know the type or number of industries in the vicinity nor did they know whether the homes were in congested or scattered areas. They made no effort to determine the competitive conditions.

From this point on, lack of business experience becomes noticeable.

By studying the sketch (Fig. 1) of the store and the space allocated to these men, it became apparent that in order for a customer to get to the service department they would have to go through the store, downstairs and to the rear. True, the space is large, but not readily accessible.

Although a sign is permitted in the window, no merchandise could be displayed, therefore, possible sales of

(Continued on page 246)

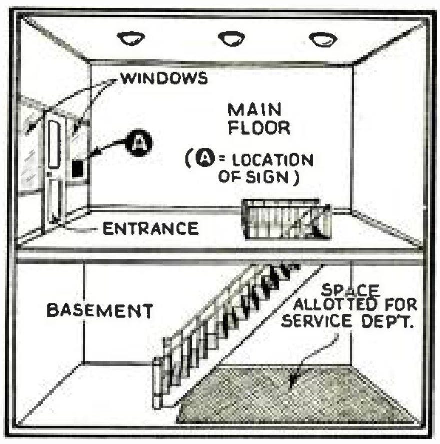
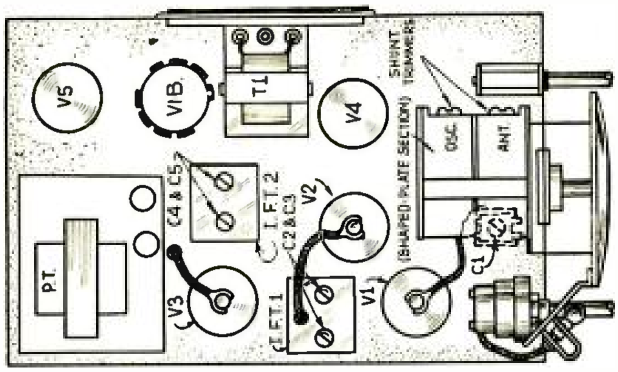
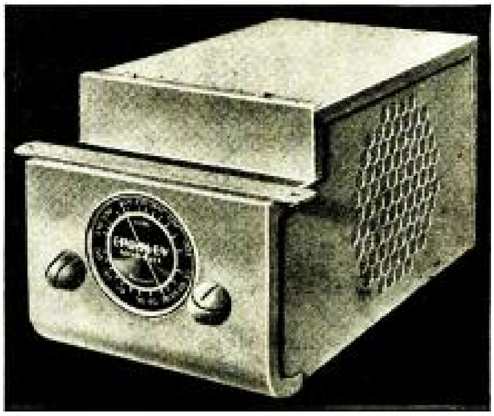


Fig. 1. The rent-free space offered as "fair exchange" for one man's full-time services.

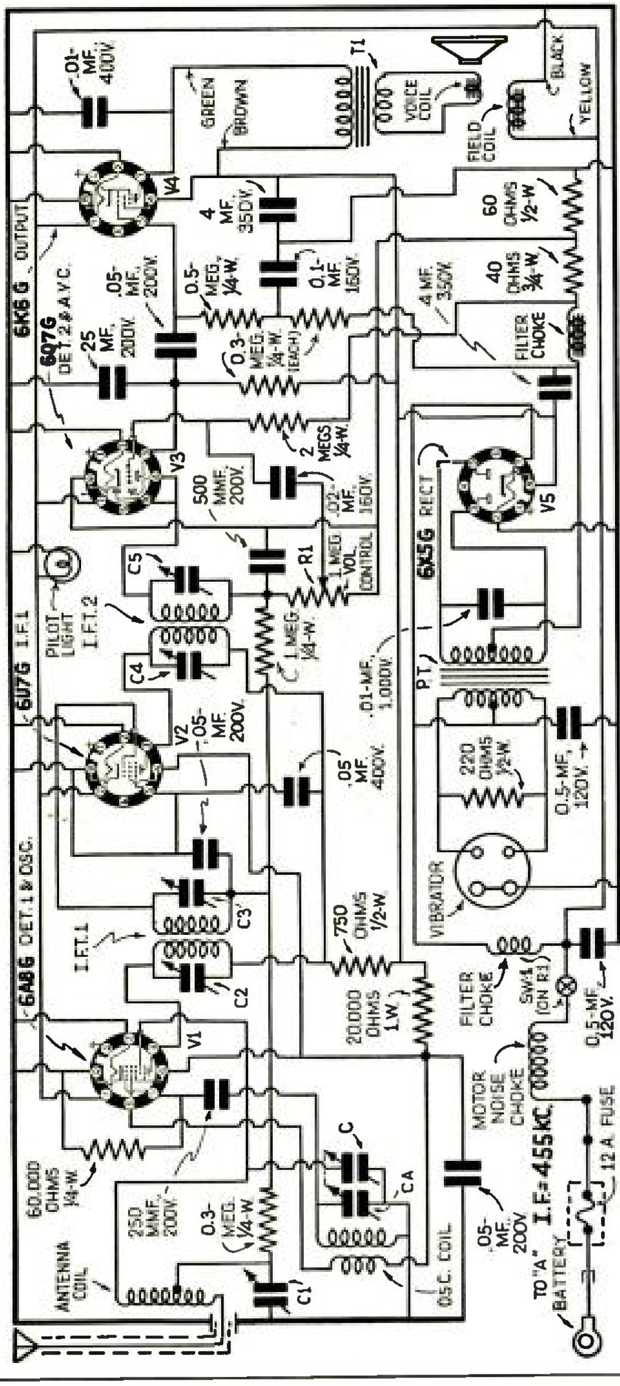
CROSLEY MODEL A-157 (FIVER ROAMIO) AUTO RADIO

5-Tube Superheterodyne; Automatic Volume Control; Direct Tuning





The Fiver Roamio direct-tuning, auto-radio superheterodyne. The power supply and speaker are self-contained, the latter being mounted on the left side of the housing.



The Crosley Model A-157 auto-radio set is a single unit, 5-tube superheterodyne receiver, incorporating A.V.C. and many advanced features in circuit design. The power supply unit is an integral part of the receiver chassis and uses a primary-type vibrator.

Tubes and Voltage Limits. The following table gives the functions of the tubes used, together with the voltage readings between the tube socket contacts and the receiver chassis. Voltage readings taken with a 1,000 ohms/volt, 500-V. voltmeter (except filaments) with receiver in operating condition and no signal input.

TUBE SOCKET VOLTAGE READINGS

Tube	Function	H	P	S	Su	K	Ga	Go
6A8G	Osc.-Mod.	6.0	220	90	—	0	90	0
6Z7G	I.F. Amplifier	6.0	220	90	0	0	—	—
6Q7G	Diode Det. & A.F. Amp.	6.0	110	—	—	0	—	—
6K6G	Output	6.0	200	220	—	0	—	—
6X5G	Rectifier	6.0	—	—	—	220	—	—

Power Output approx. 4 W.
Battery Drain approx. 5.7 A. at 6 V.

Connect the output meter to 3 and 4 of the 6K6G output tube socket. Be sure the meter is protected from D.C. by connecting a condenser (0.1-mf. or larger—not electrolytic) in series with one of the leads.

1. Tuning I.F. Amplifier to 455 kc.

(a) Connect the output of the signal generator through a 0.02-mf., or larger, condenser to the top cap of the 6A8G Osc.-Mod. tube, leaving the tube's control-grid clip in place. Connect the ground lead from the signal generator to the receiver chassis frame. *Keep the generator leads as far as possible from the control-grid leads of the other screen-grid tubes.*

(b) Adjust the station selector so that the rotor plates of the tuning condenser are completely disengaged and turn volume control to max.

(c) Set the signal generator to 455 kc.

(d) Adjust both trimmers located on the 2nd I.F. transformer for maximum output.

(e) Adjust both trimmers located on the 1st I.F. transformer for maximum output.

(f) Repeat operations (d) and (e) for more accurate adjustments.

In order to prevent A.V.C. action always use the lowest signal generator output that will give a reasonable output meter reading.

2. Aligning R.F. Amplifier.

(a) Connect the output lead from the signal generator through a 250 mmf. condenser to the "ANT." connection of the receiver.

(b) Set the signal generator to 1,400 kc.

(c) Adjust the station selector to 140 on the dial.

(d) Adjust the trimmer on the "OSC." section of the tuning condenser for maximum output.

(e) Adjust the trimmer on the "ANT." section of the tuning condenser for maximum output.

(f) Readjust the station selector for maximum output. *Do not readjust the OSC. trimmer.*

(g) Repeat operation (e) for more accurate adjustment.

3. Adjusting Antenna Compensating Condenser.

(a) Set the signal generator to 600 kc.

(b) Tune in a 600 kc. signal with the station selector for maximum output.

(c) Adjust the antenna compensating condenser, C1.

(d) Repeat operations (b) and (c) alternately until no further improvement can be obtained.

(e) Set the signal generator to 1,400 kc. again.

(f) Tune-in the 1,400 kc. signal with the station selector for maximum output.

(g) Readjust the trimmer on the "ANT." section of the tuning condenser for maximum output.

It will be necessary to adjust the antenna compensating condenser to the car antenna after the receiver has been installed in the car.

(a) After the installation is complete, tune-in a WEAK station between 55 and 65 on the dial.

(b) Adjust the antenna compensating condenser for maximum volume in the speaker.

BUILD THIS "INTERMITTENT OPEN" CONDENSER TESTER

A factory-type "breakdown-test oscillator" is described.

JOSEPH MOSIO

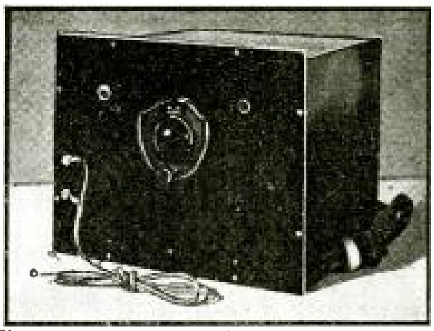


Fig. A. Appearance of the "intermittent open" condenser tester.

ONE OF THE MOST difficult condenser troubles to detect is the problem of open, or "intermittent open" paper condensers. To detect these conditions quickly and efficiently a special type of tester has been designed and is in use in a well-known condenser factory. Service Men may wish to duplicate it. See Fig. A.

The tester consists of a push-pull oscillator circuit that will deliver approximately 8 watts of R.F. power. This current is sufficient to tend to break down any intermittent contact between the condenser terminal, or wire, and the condenser foil. In some cases this break-down will occur immediately, and in others it may be necessary to allow the condenser to "cook" for 5 or 10 minutes. If such a weak contact is present it is certain that the heavy R.F. current, which passes through the condenser, will produce the desired permanent open and thereby the faulty condensers can be eliminated. See Fig. 1 for schematic circuit.

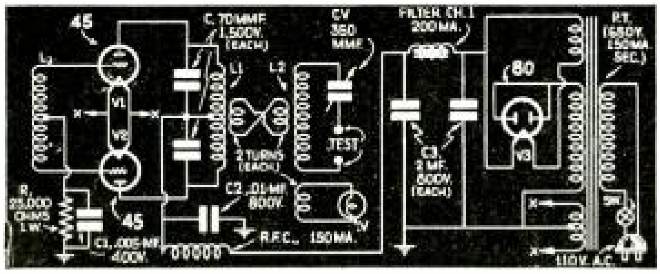


Fig. 1. Schematic circuit of the condenser tester shown above.

HOW TO USE THE INTERMITTENT-OPEN CONDENSER TESTER

The circuit is so arranged that the condenser under test is placed in a series resonant circuit with the variable condenser of the tester. By varying the capacity of the variable condenser, CV, with the test condenser in the circuit at terminals TEST, resonance is indicated by maximum glow of the pilot light, V. Also, it is possible to have a capacity indicator by calibrating the variable condenser with standard condensers of known capacitance. Intermittent-open condensers can be detected by the flicker of the pilot light; and no-glow indicates a completely-open condition.

In construction of the tester, it may be necessary to adjust the coupling of the coils in the resonant circuit to obtain maximum glow of the pilot light, however, after a few trials this condition can be obtained satisfactorily. Use

(*Continued on page* 241)

NEW INSTRUMENT SPEEDS FREE-POINT TESTING

A new device permits breaking various tube circuits to obtain *current* instead of *voltage* measurements.

G. H. KOCH

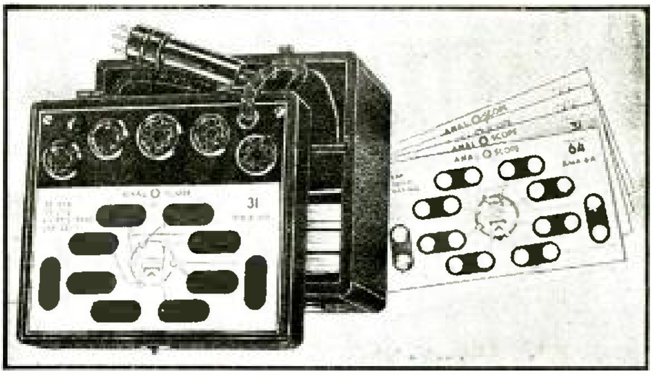


Fig. A. The new instrument which facilitates free-point testing. Its "series-circuit" jacks permit current readings of any circuit.

A NEW INSTRUMENT has made it possible to quickly and conveniently make the very important current measurements and point-to-point voltage and resistance tests through the cord-and-plug method of analysis. Also, it eliminates the confusion caused by the great number of tube types now in use, in new and old receivers.

Through the use of machined cards (see Fig. A), placed over the jack switches, covering the internal connections and designations of all types of tubes, the operator has an ideal set-up for making a complete analysis without interruption of his trend of thought. Tube manufacturers can arrange the elements in any sequence they see fit for it is no longer necessary to refer to a complicated chart or to try to remember the connections or numerology of the various elements.

This instrument, which has been given the name of "Anal-O-Scope," when used with any volt-ohm-milliammeter is a practical and convenient device for taking current readings. Due to the complexity of the present-day receiver with its complicated and high-value resistance networks, the current method of analysis is becoming a very practical

(*Continued on page* 249)

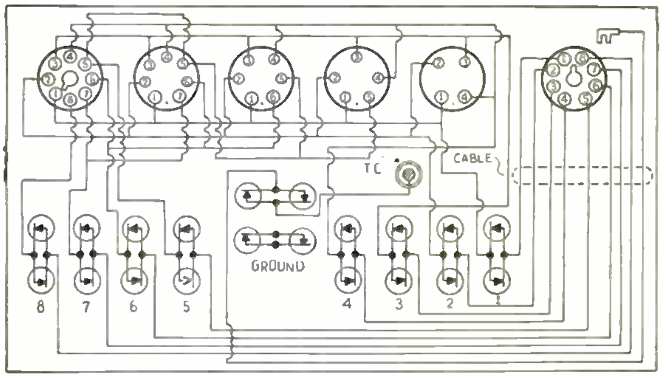


Fig. 1. Schematic diagram of the instrument illustrated above. Note the "series-circuit" jacks for insertion of a current-reading meter.

CORRECT PLAYBACK OF SPOT RECORDINGS

Proper playback of spot recordings is equally if not more important than the actual recording. Here are some interesting facts.

RALPH L. POWER — PART I

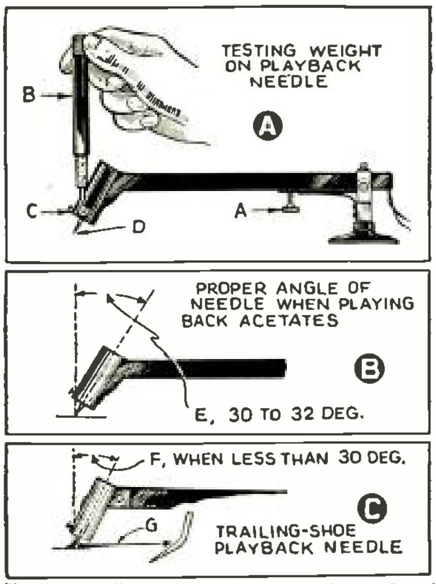


Fig. 1. A, Adjustments of the phono pickup; B and C, Proper playback angle of needle and head.

NUMEROUS articles have been written in the matter of exact recording procedure for the making or cutting of instantaneous records on both aluminum and the so-called acetates. But articles covering the subject of *correct playback* have been rare.

WAX, ACETATE AND ALUMINUM RECORDINGS

Close examination of recordings on *wax, acetates* and *aluminum* show that the ordinary playback pickup totally fails to reproduce many of the recorded frequencies!

The average playback set-up is entirely unsuitable for use on instantaneous recordings, for the following reasons:

(1) Excessive head weight results in excessive needle pressure (which causes tearing of the groove bottom and sides);

(2) Too-short an arm results in excessive side-wall pressure at the extreme end of the arc in the swing of the arm across the record.

While not so serious on cellulose-coated material, its most aggravated form shows up on aluminum, where there is of necessity, a very shallow groove together with a soft, pliable playback needle which quickly wears its point out of the groove and onto the record space, or lands between the grooves when there is any appreciable side pressure. Naturally, the remedy is to use an arm the greatest longest possible length, together with a frictionless pivot bearing.

Further examination discloses that a great number of pieces of equipment used to playback instantaneous records not only fail to reproduce for the listener the frequencies and quality recorded on the discs, but very often the modulated groove in a single playing is not only seriously deteriorated but in many cases completely ruined.

ACETATE RECORDS VS. COMMERCIAL PRESSINGS

It must be borne in mind that there is a vast difference between *acetate records* and *commercial pressings.*

(Continued on page 244)

RADIO WITTIQUIZ

FREE — A 1-year subscription to RADIO-CRAFT to each person who submits a WITTIQUIZ that in the opinion of the Editors is suitable for publication in RADIO-CRAFT. Read the following WITTIQUIZZES; can you spot the correct answers? Now send in YOUR idea of one or more good WITTIQUIZZES based on some term used in radio, and win an award. (Contest rules appear on page 235.)

(10) Did you ever know that *ampere-hour* is—

(a) A popular radio program. (b) A quantity of electricity. (c) A fractional part of an hour. (d) A particular kind of time. (e) An astronomical expression of distance. (f) The speed of an electric current.

(11) *Radio-frequency currents* travel along the surface of a wire because—

(a) The shortest distance between 2 points is a straight line. (b) $2\pi R$ is the circumference of a conductor. (c) Centrifugal force drives it there. (d) "Skin-effect" is characteristic of high-frequency currents in a solid conductor. (e) Skip-distance effects arise at high-frequencies.

(12) You may not know offhand, but *E. M. F.* means—

(a) Equipment Manufacturers Fraternity. (b) Electromagnetic force. (c) Electrical motor friction. (d) Electromotive force. (e) Electrical microfarad.

(13) Did it ever occur to you that *grid bias* is—

(a) A grid, cut on the diagonal. (b) A direct component of the grid voltage. (c) A neutral voltage on the grid of a tube. (d) An intermediate component of the grid voltage.

(14) A *haywire hookup* necessarily must be—

(a) A circuit wired carelessly. (b) A cross-connected radio network program. (c) A farm-type radio set. (d) A radio set connected by means of wire from a bale of hay.

(15) *Volume control.* Are you thoroughly familiar with these words? Would you say that they referred to—

(a) A device for reducing signal intensity. (b) A dietician. (c) A weak radio tube. (d) A low-loss potentiometer.

(16) If you overheard a conversation in which you caught only the words *power factor* would you know this was a reference to—

(a) An electricity generating station. (b) The ratio of true to apparent power. (c) The nomograph crossover point of amplification versus percentage curves. (d) The amplification factor of a power tube.

(17) Most radio fans know that a *voltage divider* is—

(a) An official appointed by the F.C.C. to see that radio voltages are evenly divided among licensed broadcast stations. (b) A voltage-measuring instrument. (c) An electrical mathematician. (d) A resistor provided with contacts for obtaining desired voltages when a voltage exists across the entire resistor. (e) A resistor which generates various voltages.

(18) It is now definitely established that the *Luxemburg Effect* is:

(a) The peculiar property of micro-waves hastening the "souring" of a particular cheese. (b) Cross-modulation of radio waves in the ether. (c) A frequency drift of the transmitter due to a high cheese content in the casein insulating parts.

(Continued on page 235)

OPERATING NOTES
ANALYSES of
RADIO RECEIVER SYMPTOMS

Pilot 114, 115. When the complaint of fading, intermittent reception or oscillator drift is received on these models, determine whether the fading exists on all bands or only over the low-frequency portion of the broadcast band.

Since an inter-station noise suppressor stage is employed, a shift or frequency drift of only 4 or 5 kc. will produce an inoperative condition when the silencing stage is switched on and being used. Reception can again be obtained by re-tuning to the carrier. An intermittent oscillator plate coupling condenser, a 0.01-mf. unit (see Fig. 1E), has been found at fault in this case. This condenser connects between the type 76 oscillator tube plate, and the arm contact of the rear section of the wave-band switch. Upon replacement mount the unit firmly to remove the possibility of vibration and consequently microphonics.

RCA Victor RAE-79, RE-81. Although these two models use entirely different chassis, they are both radio-phonograph combinations wherein the phonograph pickup is employed for home and radio recording as well as record reproduction.

After some period of use, in every case where the home recorded records are produced, it will be found that not only will record reproduction become weak and distorted but that home or radio recordings cannot be made with the same volume and clarity as before. Since an additional weight is placed upon the phonograph pickup when producing home recorded records, the pickup device is subjected to a good deal of strain, inasmuch as it is not especially manufactured for this purpose, and generates an unusual amount of heat when used for any length of time. *This causes the wax with which the pickup coil is impregnated, to melt and run down between the pole pieces and armature, and upon the rubber damping blocks.* Of course, this action does not take place until several months of operation when the loss in phono output becomes markedly apparent.

The only method of effecting a repair is that of dismantling the entire pickup unit, being *sure* to place a keeper across the magnet *before* its removal and noting its polarity in relation to the pole-pieces. The armature and pole-pieces should be carefully cleaned so as to be entirely free from the impregnating compound. In some instances, it is necessary to replace the rubber dampers, which have become well "soaked," so to speak, before satisfactory operation can be obtained. These rubber dampers may be made from the rubber of an ordinary baby bottle nipple.

After all parts have been cleaned and the rubber dampers installed, the pickup should be re-assembled, the magnet remagnetized, if possible, and the armature adjusted so that it is equi-distant between the pole-pieces. This adjustment must be made with the permanent magnet in place, although the latter may be turned down in order to gain access to the adjusting screws. It should be remembered that the keeper bar must not be removed until *after* the magnet has been returned to its position across the pole-pieces.

BERTRAM M. FREED

Majestic 130. Fading on these models is usually traced to the grid-return bypass condensers. These condensers are in small metal cans located under the gang condenser shield. See Fig. 1A.

Majestic 90. Fading on these models is caused by cathode bypass condensers in the R.F. and detector stages. Another complaint on this model is inability to get stations on portion of dial caused by shorted gang condensers.

Majestic 70. Weak and distorted reception on the Majestic 70, which clears up when putting the aerial on the grid of the 2nd or 3rd R.F., but gets weak and distorted when putting the aerial back to the aerial post, is caused by an "open" in the volume control. See Fig. 1B.

IRVING ISKOWITZ

Philco 54 A.C.-D.C. Distortion. Check wire-wound resistor on rear-right of chassis. The lower portion of this unit develops high resistance (contact), and gives the type 75 tube triode-grid an incorrect bias. Remedy—clean the terminals and wire thoroughly, and resolder or replace unit. Distortion can also be caused by gradual increase in volume control resistance, due to wear, which changes the diode load. See Fig. 1C.

RCA Model R-10. When noise, similar to a noisy tube or loose connection, is encountered on this model, it may be caused by the metal grommet through which passes the control-grid wire to the 1st-detector being loosely fastened to chassis. A minute potential, which shorts intermittently to chassis, due to mechanical vibration, is developed in this small metal loop. This results in a varying voltage being superimposed on the signal voltage going to the control-grid of the tube. As there is a great deal of amplification present, the noise resulting is very objectionable. See Fig 1D.

ALEX PLAKADIS

Wet Electrolytic Condensers. It has been called to our attention that occasionally, the electrolyte from wet electrolytic condensers will leak out of the container, run down the side and harden, leaving an unpleasant deposit. This is entirely natural due to the chemical action in condensers of this type.

In the manufacture of these condensers, sev-

(Continued on page 249)

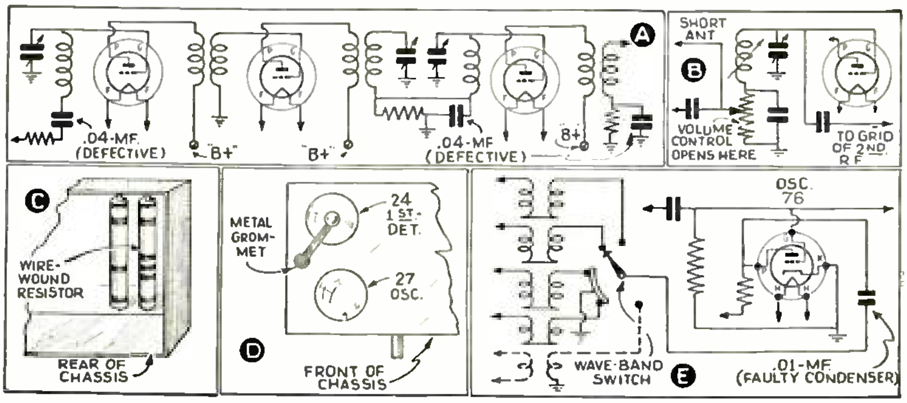


Fig. 1. Operating notes on: A, Majestic 130; B, Majestic 70; C, Philco 54; D, RCA R-10; E, Pilot 114-15.

SERVICING QUESTIONS & ANSWERS

Service Men may write, requesting answers to specific service questions. Address inquiries to Service Editor. For questions answered by mail, a service fee of 25c per question is made. Only questions of wide interest can be published.

Note: An effort is being made to maintain 48-hour service on mail inquiries, from Service Men, addressed to "Servicing Questions & Answers." Let us help you on that rush job.

P.A. FADER

(26) D. J. Fink, Long Beach, L. I.

(Q.) What is meant by a "fader" as applied to a P.A. system? How is same used and why?

(A.) A fader system that is usually associated with P.A. work is a means of regulating the intensity of the input signals (voice or music) by the operator of the system in order to permit a mixing of voices, or phonograph recordings, or both.

A series of potentiometers, connected to the various inputs, is so arranged that, by rotating the controls, mixing is accomplished.

BURNED-OUT AUDIO TRANSFORMER

(27) H. C. Johnson, Springfield, Mass.

(Q.) I have a Silver-Marshall model 730 "Round-the-World 4," battery operated. In the schematic circuit of this receiver a No. 255 Silver-Marshall unit is used in the 1st audio stage, and a potential between 45 V. and 135 V. is specified. I am using a "B" eliminator in place of the "B" batteries. On the 90-V. tap of the "B" eliminator I get a voltage reading of 135 at the plate prong of the UX 222 socket. In an effort to improve reception, I stepped up the voltage regulator on the "B" eliminator, and as a result burned-out the primary side of the No. 255 transformer. I replaced it with a straight audio transformer having a ratio of 3-to-1 and it works, but not very satisfactorily. Please advise me how I can correct this trouble.

(A.) The reason that the voltage reading on the plate of the type 222 R.F. tube seems to be excessive is primarily due to a minimum drain of your set; in other words, the "B" eliminator was designed to supply more plate current—approximately from 60 to 100 Ma.

Therefore, you can readily understand why, with very little plate current being drawn by

(Continued on page 254)

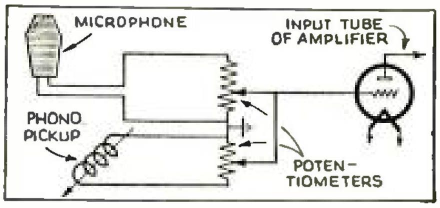


Fig. Q26. Fader-mixer for P.A. systems.

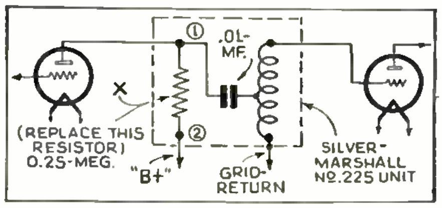


Fig. Q27. Open resistor in S-M model 730 set.

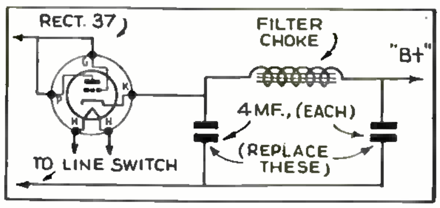


Fig. Q28. Defective electrolytics in RCA 4-17-M.

BIGGER SERVICE PROFITS FROM BETTER TOOLS

(Continued from page 210)

IN ANALYZERS

Devices of this type are and probably always will be the most important dollar earners of the radio service business. These devices when fundamentally built depend on the basic units of the radio industry, namely—*volts, ohms* and *amperes.* An analyzer should be built around a high-grade meter incorporating a properly-treated magnet, sapphire jewels and the hardest pivots obtainable. Poor treatment of magnet steels may cause a drop of 10 per cent or more in an instrument sensitivity after a period of weeks or months; soft jewels will soon wear sloppy and cause errors when the analyzer is used in different positions such as at 45 deg. angles or when mounted upright in a test panel; and blunt pivots result in bad friction. Any one of these defects may not just make the meter inaccurate but may render it entirely useless and $1 or $2 more spent on the instrument can be entered in the "well assigned cost" column.

Since all voltmeters are *adjusted milli-or micro-ammeters* with accurate series resistors and, therefore, the accuracy of a voltmeter is directly dependent upon the construction and tolerance of the resistor used. No voltmeter can ever be better than the grade of resistance unit incorporated with the instrument. Accordingly, manganin-wire-wound spools or other types of high-grade precision resistors are vital if any reasonable accuracy is expected from the device.

Commercial carbon resistors will function all right in receivers where 10 per cent tolerances are sufficiently accurate for general receiver operation, but in voltmeters they add considerably to the overall tolerance in the form of inaccurate adjustment and differences in resistance with temperature and humidity. These resistors are commonly made up of carbon particles held together with a binder of glue, or some similar substance which is in itself hygroscopic, attracting and holding moisture under wet weather conditions. This substance will also expand and contract, changing the position of the carbon particles in contact and, therefore, it is very difficult to expect any sustained accuracy for meter work on resistors of this type. For a few cents more per resistor, ½-per cent-adjusted precision resistors can be used with the instruments and maintain the basic meter accuracy over each of the voltage scales.

Rectifiers for A.C. ranges should always be of the full-wave type if uniform results on various waveforms and frequencies are expected. These units depend upon the current density used in the discs for accuracy over wide temperature and humidity limits, and therefore, where 1 milliampere or lower sensitivities are used, the discs should be as small as possible. In addition, all of these full-wave meter rectifiers come under the Weston Instrument Company's patents and a great deal of research has been done by this company on the method of construction of the discs for meter work.

High sensitivities in analyzers are becoming more important daily due to the high impedance and resistance circuits used in many of the modern receivers. Analyzers of 20,000 ohms/volt type have been placed on the market by the Weston Company and these analyzers have a great many advantages over the former 1,000 ohms/volt types. Not only are high-sensitivity voltage ranges available for accurate direct-reading measurements of plate, screen-grid and control-grid voltages with minimum instrument drain, but current readings down to 0.5-micro-ampere can easily be measured with these new instruments. The current readings thus obtainable are just as important as the high-sensitivity voltage ranges in measuring detector diode currents, oscillator grid currents, high-mu triode plate currents, and output pentode distortion grid currents. The Service Man in purchasing his equipment should not afford to overlook these extended advantages in the advancement of the radio instrument art.

Current readings are as vital as they ever were in servicing the modern receivers. Analyzers with attached cord and plug, and built-in sockets are, however, not obsolescence-proof and it is highly advisable to purchase an analyzer with a detachable selector block. Instruments of this kind have been on the market 4 years with no change whatsoever in the analyzer proper; a small skirted adapter unit being the only purchase required to carry through a complete gamut of octal tubes announced during the last 2 years. This in itself is an enviable record for any piece of equipment and should point out the advisability of purchasing an analyzer unit dependent only on volts, ohms and milliamperes, and mechanically independent of all tube base connections.

For accurate service work, current readings are indispensable and should always accompany point-to-point analyses to protect all parts in receivers from overload. Tubes may draw excessive currents under conditions not directly obvious such as incorrect grid bias potentials, and these in turn may cause excessive currents to be drawn through output transformers or other parts that may not stand the overload. Where well-regulated power supplies are incorporated in the receiver, these overloads may be overlooked without a direct-current measurement being made directly at the plate; excessive current often causes a transformer failure to occur a week or two after delivery of the receiver. A photograph of the selector block detachable from an analyzer with built-in current jacks which automatically put the instrument in series with any of the tube electrodes, is shown in Fig. A. Plate currents, control-grid currents, screen-grid currents, diode A.V.C. and A.F.C. currents can all be measured quickly and effectively with such a device.

IN TUBE CHECKERS

In tube testers the method of standard measurement, the flexibility of circuit, the construction of the instrument and the grade of other parts used are primarily important.

With the large number of tubes on the market today the *total emission* method of measurement as worked out by the sub-committee on tube testers of the Radio Manufacturers Association has proved to be the most economical, most flexible and best method of testing tubes both for the Service Man and the dealer.

There was always argument with regard to *mutual conductance* versus *emission* readings and, in general, mutual conductance readings are best where they can be measured accurately. To make correct measurements, however, requires most definitely a patch-cord system of jacks and plugs to handle the multitude of tubes encountered today. Potentials directly proportional to the ratings as released by the R.C.A. License Bureau must be applied to each of the electrodes and this in turn requires several instruments for the electrode potentials in addition to a direct-reading mutual conductance meter. Testers such as this are available on the market and are continually sold to certain organizations and to some of the larger service concerns, but at prices in the order of $300 or $400, and in general, the margin of profit on tubes handled by the Service Man will not warrant an expenditure of this amount. Furthermore, in testing a large number of tubes patch cords are rather complicated to handle and the average Service Man or dealer could not take the time to set up each tube base for test while the customer waited. This R.M.A. circuit as mentioned above, with maximum flexibility of switching for the tube bases incorporated in a tester of high grade construction, is the best answer for the tube tester problem as far as Service Men are concerned. A typical tester of this calibre is illustrated in Fig. B.

Accurate measurement of transformer potential is vital as read directly on the tester instrument; coupled with a method of line voltage control that will afford good regulation and complete adjustment all the way from the lowest to the highest line voltages encountered. Sockets that do not grip the tube too tightly and thus wear out easily should be used, this requirement being very different from that found in the average radio set where tubes must be gripped tightly and inserted only 3 or 4 times during the lifetime of the receiver. A single tube tester contact may have to outwear 100,000 tube pins inserted during the life of the tube checker and this requires special design.

IN VACUUM-TUBE VOLTMETERS

These are basically radio-frequency and audio-frequency tubes, and should in general be so considered, except where actual A.V.C. direct-current potentials are to be measured. A vacuum-tube voltmeter is the type of R.F. voltmeter needed for gain-per-stage measurements right at the control-grids of the tubes, audio measurements across grid windings and bypass conden-

(Continued on page 230)

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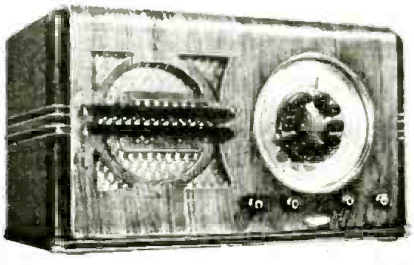

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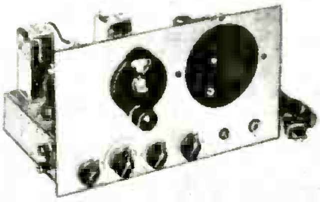

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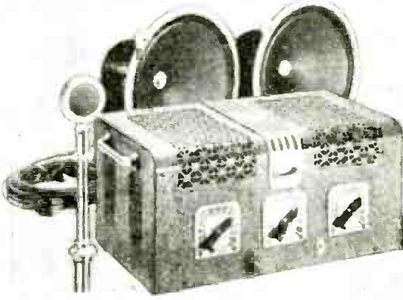

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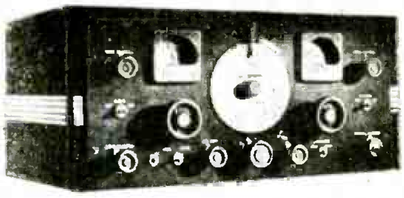

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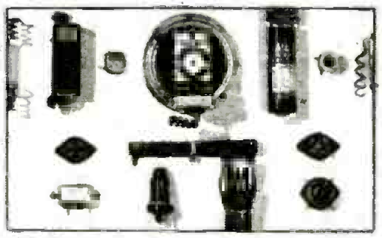

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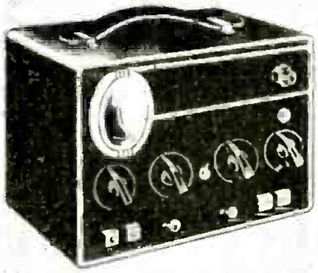

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BIGGER SERVICE PROFITS FROM BETTER TOOLS

(Continued from page 228)

sers, R.F. potentials in superheterodyne oscillator circuits, in trap circuit adjustments and in response-curve measurements.

Copper-oxide rectifier instruments cannot be used to advantage on R.F. resonant circuits because of frequency limitations and due to the fact that any loading of these circuits tends to pull them out of resonance. The direct insertion of a vacuum tube is about the only other method of measuring the potentials across these circuits. In this regard, a well-designed voltmeter should have a minimum input capacity, connections being made directly to the tube with no voltage divider or selector switch being used in the circuit. Such component parts will shift the capacity a few micro-microfarads each time a new section of the voltage divider or a new position on the rotary switch is used, thus shifting the resonant frequency of the circuit on which the measurement is being made. This will, of course, cause a direct error in the readings as the voltage thus read will differ on each range.

IN OSCILLATORS

Accuracy of calibration, frequency stability and shielding should be looked-for. Accuracy of frequency calibration is important in alignment work both at intermediate frequencies where it is vital and on the various wave bands where specific alignment points are mentioned by the manufacturer. No oscillator regardless of how well it is calibrated will maintain sustained accuracy without good coil construction and air-dielectric condensers. Trimmer or compression-type padders have very poor humidity coefficients and are, in general, the very parts that cause drift in alignment of receivers. They, therefore, should be eliminated in oscillator construction and air condensers used throughout. Carefully-constructed coils, preferably on molded bakelite forms, should be used to assist in maintaining good accuracy. The Service Man should expect individual calibration of each oscillator that he purchases if such a unit is worthy at all of maintaining any kind of a frequency tolerance throughout its useful life.

Battery operation has several advantages coupled with some disadvantages, but allows very complete shielding as the energy source is completely enclosed within the shielded case. A.C. operation can be used but must be very carefully filtered so that signals will not feed back through the line into the receiver under test thus making it impossible to attenuate the signal in the receiver to a point where it later can be aligned. In any event shielding must be completely incorporated so that alignment below the A.V.C. level on all receivers can be carried out in case it is difficult or impractical to eliminate A.V.C. action during the alignment procedure.

Input impedance must be as high as possible and should be limited only by the measuring tube itself, as this impedance will load the circuit under measurement. Stability of readings is essential as devices, especially line-operated types, will fluctuate with line voltage potentials and cause incorrect meter readings unless some form of regulation is used. Without regulation on the lower ranges the instrument pointer will vibrate with small line potential surges and make it extremely difficult to obtain any kind of a reading.

The vacuum-tube voltmeter will be sold continually in parallel with the oscilloscope as there are definite advantages in each type of instrument. For service work the vacuum-tube voltmeter with its direct readings in *volts* is much easier to understand and simpler to operate and, in general, will handle all the measurements required of the Service Man. The A.V.C. or any direct-current potentials cannot be read on the oscilloscope, as, an axis shift only will result and in turn, actual gain-per-stage readings in volts cannot be taken. Furthermore, the resistance-coupled amplifiers used in oscilloscopes are notoriously poor on radio frequencies, some of them completely distorting the waveform; direct connection to the tube plates appears to be the only answer where R.F. measurements are concerned. Sensitivity, however, directly at the plates is not sufficient for many operations and here again vacuum-tube voltmeters can be built with much higher sensitivities.

The oscilloscope will, however, be used where an image of the waveform is required but this in general, is not a definite requirement for Service Men in regular repair work. In any event, the operator should be quite familiar with the oscilloscope before attempting to make a large number of measurements with it.

Two circuits showing methods of measuring automatic frequency control discriminator voltage, and gain per stage, appear in Figs. 1 and 2.

THE AIRCRAFT-RADIO SERVICE MAN

(Continued from page 202)

EQUIPMENT REQUIRING SERVICE

The itinerant flyer may have in his plane only the simplest of radio equipment—perhaps only an aviation weather broadcast receiver and not even a transmitter. On the other hand, his equipment may be so comprehensive as to include a beacon receiver, aviation weather receiver, and a so-called auxiliary beacon receiver capable of all-wave reception and thus permitting reception of broadcast programs; and, a directional-loop antenna that in conjunction with one or another receiving sets permits taking cross-bearings from either beacons or broadcast-station signals. This receiving equipment plus a 1- or 2-way transmitter for both code and telephone operation may comprise the more inclusive radio set-up.

The Department of Commerce reports that there are approximately 1,000 private and public landing fields (soon, many more—including emergency landing fields—will dot the land); and approximately 4,750 privately-operated airplanes. Since all the commercial airplanes have their own radio service crews it is unlikely that the average aviation-radio Service Man will have much opportunity to make repairs to the radio equipment of such installations—except, perhaps, in a case of extreme emergency.

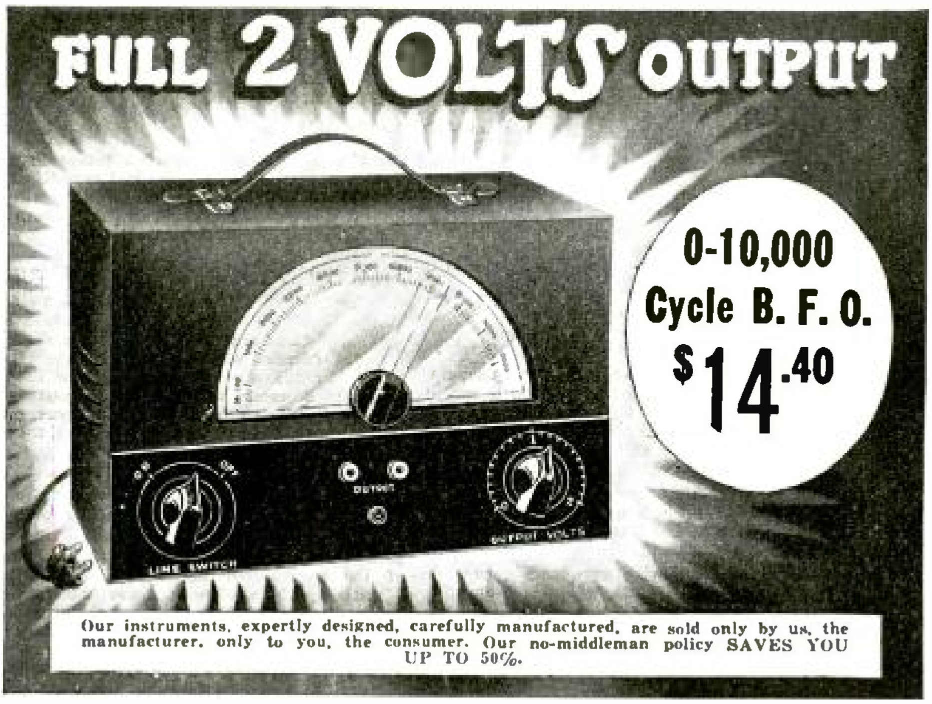
Space does not permit the lengthy discussion that would be necessary to completely analyze the faults and remedial measures connected with *private-aviation* radio servicing—books have been written on this subject alone—suffice it to say that antenna and counterpoise systems, battery- and generator-operated radio transmitters and receivers and their respective types of current-supply systems; and even in the more modern installations, private communication systems between pilot and co-pilot or passenger, all come within the range of equipment that *must* be kept in top-notch condition, regardless of (reasonable) expense, by competent radio Service Men.

TABLE I
SOURCES OF REVENUE FOR THE AVIATION-RADIO SERVICE MAN

(1) Servicing existing radio receiving and transmitting equipment, including the power supplies and antenna systems.
(2) Modernizing existing radio equipment to include additional services, such as pilot-to-copilot (or passenger) communication system, directional-loop antenna, extended frequency range, etc.
(3) Locating and minimizing or eliminating ignition interference.
(4) Sale of replacement components.
(5) Sale of new transmitting and receiving equipment.
(6) Custom construction of radio transmitting and receiving equipment.

NEW TRANSMITTER AND PUBLIC ADDRESS MANUAL

Not only radio amateurs and public address men (to whom it is dedicated) but anyone at all interested in radio will welcome this excellently-prepared manual. It is chock-full of theory, diagrams and practical data on transmitters and P.A. Some of its chapter headings are: R.F. Circuits; Audio Circuits; High-Fidelity Audio Circuits; Controlled-Carrier Modulation; Plate-Supply Design; Typical Rectifier Circuits; Power Supply Filters, and others. The book is available from United Transformer Co. for 25c.



AUDIO BEAT OSCILLATOR

Based on Developments of H. J. BERNARD

INCORPORATING the original developments of H. J. BERNARD, managing editor of "Radio World," this Audio Beat Frequency Oscillator, our AUDIOMETER, combines stability with enormity of output voltage. Direct-reading in audio frequencies, 0-10,000 cycles, and also direct reading in output volts, 0-2 volts. Other beat frequency oscillators cost twice as much or more, yet provide only ¼ volt output or less.

The audio beat frequency oscillator heretofore has been restricted largely to laboratory use, due to prohibitive prices. However, we specialize in producing precision equipment at a price servicemen can afford. So for the first time servicemen can check the fidelity of audio amplifiers in receivers, of public address systems, of speakers and other acoustic devices. Also, because of the high output, dead amplifiers can be tracked right down to their offending short or open.

The AUDIOMETER is provided with dial scale 7.5 inches in diameter (extraordinary size), 8-1 vernier dial and costly planetary drive, also closely calibrated scale, so that even the necessary frequencies for tuning musical instruments may be read exactly.

The instrument is equipped with an adjuster, so generated frequencies are always right. Works on line a.c. of any commercial frequency (25, 40, 50 or 60 cycles) and also on d.c. (90-130 V.). Complete with five tubes and test cords. Shipping weight 8 lbs. Net price..................$14.40

INFINITE IMPEDANCE A-C and D-C VOLTMETER

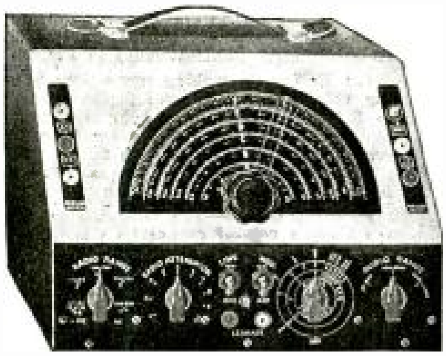
INFINITE resistance voltmeters enable very accurate d-c measurements of circuits in which hardly any current flows, such as diode loads and a-v-c supplies. Infinite impedance volt-meters permit a-c measurements of tuned circuits or any other networks. Here is a remarkable answer to the serviceman's crying need for such an instrument. Not only does the INFINOMETER draw *absolutely no current* in making d-c measurements, but it is also a vacuum tube voltmeter that duplicates the same feat on a.c., measuring voltage of any frequency. Despite this double service—measurement of *both* a.c. and d.c. without loading—the price is less than half that of most current-drawing instruments that measure only d.c.

JUST to show what an astonishing instrument this is, we have a 0-500 microammeter of d'Arsonval movement. Moreover, the meter has nearly five inches of spread clear across—enormous visibility. Then there are six scales, 0-1.5-5-15-50-150 volts, a.c. or d.c.

The INFINOMETER has a bucking circuit for zero meter reading, two input tip jacks, and a six-position range switch. It works on any frequency a.c., also on d.c., 90-130 v., shpg. wt. 10 lbs. Complete with three tubes, low-capacity test prod cable, net price $14.40

GENEMETER WITH VARIABLE AUDIO FREQUENCIES

Our superlative signal generator, direct reading fundamental frequencies, 100 kc. to 22 mc., and direct reading also to 100 mc., has modulation on-off service, with bandspread audio frequencies 25-10,000 cycles. Audio, in three bands, is saw-tooth wave and useful also for oscilloscope sweep. Complete with four tubes. Shipping weight, 10 lbs. $14.40



TUBE TESTER

Emission type perfected tube tester for any and all types receiver tubes, including metal and metal-glass. Tests shorts and leakage. Accurate, simple, sturdy, direct — English — reading (Bad-?-Good). Shipping weight, 9 lbs. $10.40

ALLMETER 20 INSTRUMENTS ALL IN ONE

The Allmeter, a 1,000-ohms-per-volt d'Arsonval instrument, instead of being just a volt-ohm-ammeter, is such an instrument, *plus* a.c. readings for voltages and currents, also accurately measuring very low resistance, from below one ohm, also high resistance, capacity, henries and decibels, comprising twenty instruments in one. For a.c. 60 cycles for all 20 uses. Shipping weight 6 lbs. 40 cy. $2 extra; 25 cy. $3 extra. 0-15-150-750-volts and milliamperes, a.c. and d.c. −12 to + 30 decibles. .03—500 ohms. 500—500,000 ohms. 5—1,000 henries .01—50 mfd. Continuity Tester. $10.40

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"LEARN-BY-EXPERIMENTING"
BEGINNERS' PRACTICAL RADIO COURSE
AUDIBLE TONE GENERATOR

(Continued from page 219)

Fig. A; and the corresponding *symbols* for these parts, in Fig. 1A.

EXPERIMENT—AUDIBLE TONE GENERATOR ("RADIO WHISTLE")

OBJECT: To study the Operation of the Vacuum Tube in Producing Audible Tones, known as *audio frequency oscillations.*

PRINCIPLES INVOLVED

In this Experiment, the operation of the vacuum tube as an amplifier of an input signal is modified so as to have the tube produce its own signal which can be heard in the phones. Such a "generator of tones" which can be heard may be called a "Radio Whistle" or more correctly an Audible Tone Generator.

The purpose for which each part, other than the tube, is used in this Experiment is explained in the following listing:

Rheostat (R). A moving arm making contact with *resistance wire*, that is, wire which opposes the passage of the electric current through it. By turning the rheostat knob to the right, we include less and less of this resistance in the circuit, and thus allow more current to flow.

Transformer (T). A unit consisting of 2 *coils* of many turns per layer and many layers of *insulated wire* wound around an *iron core.* Current is sent through the first coil, called the *primary* (marked p and b in diagram, Fig. 2A and B). When this current is caused to change in any way, such as by electrical vibrations, these changes are transferred by the iron core to the second coil wound on it, called the *secondary* (marked c and g, in diagrams). Although these 2 coils are in no way electrically connected, the fact that they are wound on the same core gives the result that any changing current in the primary winding produces corresponding changes in the secondary winding. When, as in this case, the number of turns of the secondary is much greater than the number of turns in the primary, the changes produced in the secondary are also much greater than the original changes in the primary. This accounts for the name "step-up" *transformer*, and, since it is used here in connection with audible sounds, it is technically known as an *audio transformer.*

Variable Condenser (C adj.). A condenser consists, in general, of 2 conducting plates (usually, of brass or aluminum) separated by an *insulator* (mica, air, etc.). Its effectiveness in any circuit is judged by the amount of its *capacity*, which means its ability to store an electric charge. In this case we can make the capacity greater by turning the adjustment screw to the right, which brings the 2 metal plates closer together, though they are still separated by the insulator which is a sheet of mica. Its use here is optional, since its effect of making the pitch lower, which is obtained by increasing the capacity, can be obtained without it, to a smaller degree, by using the rheostat to increase the filament current which (by indirectly effecting the "tube capacity") has the same effect.

Key (K). Has the same action as a pushbutton switch in closing a break in the circuit thus forming a complete path (*a closed circuit*) and allowing the current to flow.

Phones (Ph.). A device for converting the varying flow of electricity into audible sounds. This device will be considered in detail in the next Experiment.

Battery (4½ V.). A unit composed of a number of *cells* which generate electricity by chemical action. Each cell contains a *zinc* and *carbon element* operating in a chemical paste. Since this paste, though always moist, is not in liquid form, the cell is called a *drycell.* Such a drycell could, for example, light a small flashlight bulb, since each cell is rated at 1½ *volts*, which signifies its effectiveness in supplying the "electric pressure" required to force the current through the circuit against the opposition or resistance of the wire in the bulb. By connecting 3 such cells, as shown in the diagram, we have a *series* connection and the *voltage* of the entire battery is then 4½ V. (or volts). A "C" battery of 4½ V. is simply a unit containing 3 small cells already connected internally, and thus is equivalent to 3 individual drycells of the same small size. Although larger cells will last longer, this size is sufficient, in this Experiment, for operation over a few months.

ANALYZING THE CIRCUITS OF A TUBE

Referring to Fig. 2B, let us trace the 3 circuits of the tube in this arrangement. We will start with the "filament circuit" (or "loop"). The filament current which heats the tube is controlled by the rheostat. Turning the knob to the right decreases the amount of resistance of the rheostat being used, and so the current in the filament becomes greater, heating the filament more.

The "grid circuit" contains the secondary winding of the transformer in which "electrical vibrations" (or *oscillations*) will be produced.

In the "plate circuit," when the key is pressed, plate current flows through the primary winding of the transformer setting up the electrical vibrations. These vibrations are transferred to the secondary winding in the grid circuit, because—as previously stated—both primary and secondary coils are wound on the same iron core. These vibrations, in the grid circuit appear in turn, in amplified form, in the plate circuit. Since the plate circuit is continually feeding back energy to the grid circuit the electric vibrations do not die out but are sustained so as to be continuous at a certain rate (or *frequency*). For this reason this device may be called an "audible tone generator" or more technically an *audio-frequency oscillator.*

The sound in the headphones caused by these continuous vibrations can be controlled by the key to send signals in the International (or Continental, as it is also called) Code, which is shown in Fig. 1H.

We can also change the *pitch* of this tone by adjusting either the rheostat or the optional adjustable condenser. For example, by turning the rheostat knob to the right, the increased filament current causes a lower pitch; this same effect can be obtained to a greater degree by adding the greater capacity of the condenser to the circuit. This lower pitch indicates that the vibrations are taking place at a lower frequency. The principle involved in this case is that in any such "oscillating circuit," if the characteristics of the coil (*its inductance*) are kept constant, the frequency of oscillation will then depend upon the amount of capacity (condenser effect) in the circuit; the frequency, and therefore the pitch, becoming lower as the amount of capacity is increased.

PROCEDURE AND RESULTS

A—Code Signaling

(1) *Assembling.* The appearance of the parts, before and after mounting, is shown in the photographs, Figs. A and B. The wiring between these parts is shown pictorially in Fig. 2A and in symbol form (schematically) in Fig. 2B.

(2) *Wiring.* In making connections by soldering (The reader is referred to the article "How to Solder" which appeared in the July, 1937, issue of *Radio-Craft.*) the order in which the connections are made should follow the plan, shown in Fig. 2A and B, as made up of the following 3 "loops" or circuits:

Filament Circuit—The wiring, starting from the *binding post* or connection terminal marked "A+", will include the 2 terminals of the rheostat: "f+" and "f–" terminals of the socket into which the tube is later to be plugged; and back to the "A–" binding post.

Grid Circuit—The wiring, starting from the G terminal of the socket includes the g and c terminals of the transformer secondary; and back to the "A–" binding post. If condenser C adj., is used across the transformer secondary, leave one wire unconnected until later. After the set-up has been worked without it, it can then be connected to determine its effect on the circuit.

Plate Circuit—The wiring, starting from the p terminal of the socket includes the transformer primary p and b terminals; (*NOTE:* If any transformer, other than the one suggested, is used, it may be necessary to reverse these p and b terminals to get the device to work. To allow for this possibility, use long leads on these 2 terminals.) The circuit also includes the phone (that is, headphone) binding posts; the key (or pushbutton); and the "B+" binding post. The circuit is completed by the "B−" terminal joining the "A+" terminal; if a "C" battery is used, it is connected as in Fig. 2A in which case the "B−" is already connected within the battery to the "A+", thus completing the circuit. Notice that when using a "C" battery, which has the terminal designation shown in Fig. 1A, use the (−4½) terminal for *minus* (−); the (−1½) terminal for +3 V., and the (+) terminal for +1½ V.

(3) *Operation.* Turn the rheostat to the right up to about the first of the 10 divisions indicated on the *dial plate.* (*CAUTION:* When the filament of the type 30 tube is operating at its correct temperature, there is no perceptible glow visible. Be sure to keep the rheostat turned well down [to the left] to avoid a bright glow on the filament, since this is injurious to the life of this type of battery tube.)

Pressing the key should cause a note to be heard in the phones. If nothing, or only a "click" is heard, the circuit connections must be checked, before anything else is done, since the primary of the transformer may have to be reversed, as explained before. Practice sending a short word, such as some name, by the code signals shown in Fig. 1H.

B—Changing the Pitch of the Note

(1) Increase the filament current, noting precaution mentioned above. A change in the frequency of oscillation will be indicated by a change in the pitch of the note. Determine whether the filament current must be increased or decreased in order to give a lower pitch.

(2) Connect the adjustable condenser, as shown in the diagram and determine the effect (of introducing this condenser) on the pitch; then note the effect of increasing its capacity (by turning the adjusting screw to the right), on the pitch of the tone.

OPTIONAL ADDITION

An additional diagram, Fig. 1G, is given for using this device from the A.C. or D.C. socket power. Although it may be found convenient to use this method in some practical applications, where it is desired to operate a *loudspeaker* without the use of more batteries, it is not as suitable as the battery-operated outfit for the purpose of this Experiment, because, in the power-operated case, a strong "hum" (humming sound) from the commercial power lines is super-imposed on (added to) the pure note of the generator. However, for any who wish to use it, the diagram is given in a self-explanatory form, so that it may be considered separately from the List of Parts for the battery-operated unit.

CONCLUSION

Statement of Fundamental Principle. An audible note is produced in the phones by the electrical vibration of the vacuum tube at an audible rate (that is, at a rate or frequency which is within the range of hearing). This device, therefore, is called an *audio-frequency oscillator.*

**Questions on Principles of Experiment No. 1*

Ques. 1. When the rheostat is turned to the right to decrease its resistance, the filament current becomes (greater) (less).

Ques. 2. Increasing the filament current causes the tone to become (higher) (lower) in pitch, and therefore, indicates a (greater) (less) frequency.

Ques. 3. Increasing the capacity of the condenser causes the pitch to become (higher) (lower) and therefore indicates a (greater) (less) frequency.

Ques. 4. Producing signals by interrupting the note is accomplished in this Experiment by breaking the (grid) (plate) (filament) circuit.

Ques. 5. The pitch, and therefore the frequency of oscillation depends on both the coil effect (amount of inductance), and the condenser effect (amount of filament) in the grid circuit.

*Answers to these questions appear on page 241 of this issue.

School Radio Clubs are invited to write to *Radio-Craft,* attention of this department, concerning the use of these Experiments for club groups.

(*Continued on page 241*)

Turn to Page 249 of this issue and read about the RADIO-CRAFT Special Offer!

MODERN SERVICING OSCILLOSCOPES

(Continued from page 222)

KIT-TYPE SERVICING OSCILLOSCOPE UTILIZES A 2-IN. LENS (1500-A)

THE INSTRUMENT, back and front views of which are illustrated in Figs. D and E, is a servicing oscilloscope available in kit form.

The design, it is claimed, incorporates every feature of the larger 3-in. oscilloscopes, such as vertical and horizontal beam centering controls, built-in linear and 60-cycle sweeps, provision for external sweep for alignment, both vertical and horizontal amplifiers and an efficient sweep lock circuit for perfect synchronization. See Fig. 2 for circuit. (Component values are given in Table I at the end of this department.)

An outstanding feature of this kit is the use of a 2-in. magnifying lens. This increases the size of the image on the 913 screen to a full 2 ins. with unusually good definition.

The arrangement of parts of this model T-11K16 kit oscilloscope has resulted in an ideal shape and size—6¾ x 10½ x 5 3/16 ins., just right for rack and panel mounting or easy portability. The use of an etched panel and crackle-finish case give the completed unit a truly professional appearance.

NEW KIT-TYPE OSCILLOSCOPE HAS VERTICAL C.-R. TUBE (1500-B)

BUILDING the oscilloscope from the kit of its parts naturally affords a keener insight into its possibilities, and the details of its operation, at the same time cutting its cost to a minimum.

The oscilloscope shown in Fig. C was particularly designed for radio servicing. It uses the Dumont 2 in. cathode-ray tube. A feature of particular importance, seldom included in low-cost oscilloscopes, is the internal amplifier for increasing the sensitivity of the instrument to minute voltages. The saw-tooth sweep frequency (60 cycle line A.C., for example) substituted at will. Eight external controls are provided: vertical beam centering control; intensity control (and A.C. on-off switch); focusing control; frequency vernier (and sweep oscillator on-off switch); frequency selector switch; frequency amplitude control; vertical amplifier on-off switch, and vertical amplifier gain control.

Greater familiarity with his instrument, and very much lower cost, are the advantages the Service Man derives from buying his cathode-ray oscilloscope in kit form and assembling it himself.

TABLE I (1500A)
Cathode-Ray Oscilloscope Controls
R1, R22, 0.5-meg.;
R2, 1 meg.;
R10, R11, 0.1-meg.;
R12, 50,000 ohms;
R13, 25,000 ohms;
R14, 3 megs.;
S1, 2-pole, 2-position switch;
S2, 2-pole, 3-position switch;
S3, 1-pole, 5-position switch.
Resistors
R3, R4, R20, 5,000 ohms;
R5, R6, 0.5-meg.;
R7, R8, 2 megs.;
R9, 75,000 ohms;
R15, 50,000 ohms;
R16, 0.75-meg.;
R17, 40,000 ohms;
R18, 8,000 ohms;
R19, 800 ohms;
R21, 200 ohms.
Condensers
C1, C4, C5, C6, C18, 0.1-mf.;
C2, C3, 0.003-mf.;
C7, C8, C9, C10, 8 mf.;
C11, 25 mf.;
C12, C13, 0.5-mf.;
C14, 0.13-mf.;
C15, 0.04-mf.;
C16, 0.007-mf.;
C17, 0.0014-mf.

Names of manufacturers will be supplied upon receipt of a stamped and self-addressed envelope. Kindly give (number) in above description of device.

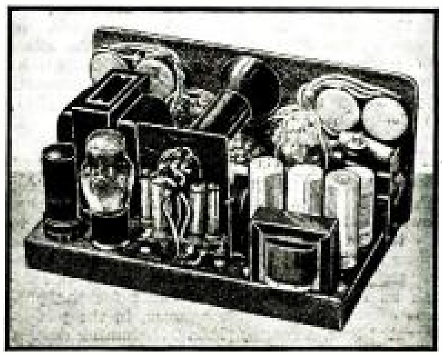


Fig. E

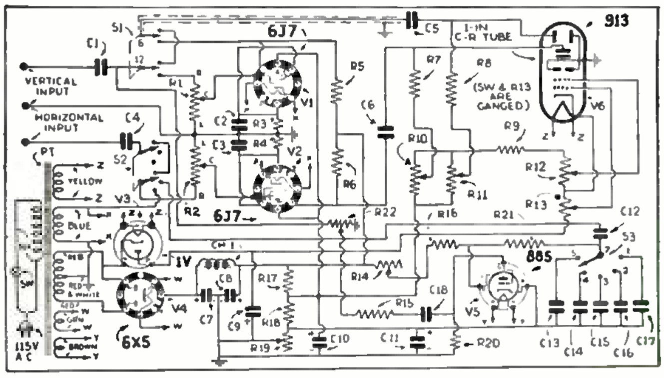


Fig. 2
Schematic diagram of the new oscilloscope rear view of which is shown in the illustration above, right. Figure D on page 222 illustrates its front appearance. A 2-inch C.-R. tube is used.

NEW U. S. COAST GUARD AVIATION RADIO

(Continued from page 203)

homing device has and is proving itself of inestimable value in bad weather out at sea, etc.; since no time is lost in taking complicated bearings the plane for instance can proceed quickly to the aid of a ship in distress.

The radio operator aboard the plane wants to locate a freighter sending distress signals, let us say. The loop is turned until it points at the source of the signals; though unlike a compass needle which due to the earth's magnetism operates automatically the radio compass must be operated manually to maintain this directional indication. However from then on as in the instance of using a magnetic compass the plane has only to follow the direction indicated by the radio compass.

Most of the equipment involved in the Coast Guard's new direction-finding loop antenna equipment appears in one of the views which shows the directional loop in the foreground.

The second development of interest is the *intercommunicating* feature; the radio operator is able to utilize the audio system of the radio set for voice amplification in a "private" telephone connection to the pilot. The earphone that is used for both the radio receiver and intercommunication services is shown in the second photograph in its mounting directly above the transmitter's flameproof telegraph key.

NEW CIRCUITS IN MODERN RADIO RECEIVERS

(Continued from page 211)

Up to 3 V. peak signal across the last I.F. secondary (51) the receiver operates normally without A.V.C. at maximum sensitivity. When a peak exceeding +3 V. reaches the lower diode plate through the coupling capacity (50), this diode will start drawing current, building an A.V.C. voltage across the 1-meg. diode load resistor (61) and the 0.33-meg. filter resistor. At the junction of these (61 and 58) about ¼ of the total A.V.C. developed is conveyed to the control-grid of the 6K7G I.F. amplifier. The total is conducted to the other grids through resistance-capacity filters.

(6) Suppressor Volume Expander

General Electric Model F-53. Making use of an ordinary triode power detector as the 2nd-detector as shown in Fig. 1F, advantage is taken of the fact that the cathode becomes positive in proportion to the average modulation intensity of the signal. The cathode is, therefore, connected to the suppressor-grid of the I.F. amplifier and as it becomes more positive, the signal is given additional amplification. When the signal is lower, the amplification is decreased and volume expansion is accomplished by varying the amplification in proportion to the signal strength.

(7) Noise-Limiter Circuit

General Electric Model E-155. This receiver makes use of an additional 6H6 tube to function for delay bias in A.V.C. and a noise-limiter circuit. See Fig. 1G. The signal voltage is taken from the 2nd-detector diode load at the junction of R21 and R22, the drop across R21 being the desired signal. This is fed to the first audio amplifier through a diode plate circuit (11-13), coupling condenser TC-55 and volume control R31.

The cathode of section (11-13) of the 6H6 noise limiter is maintained somewhat more negative than the plate of the same section due to its connection at a more negative point in the 2nd-detector load and hence a constant current flows in this diode circuit as soon as any signal is tuned-in. This current may rise to a predetermined maximum allowing full volume output, but at this point the diode is drawing near-saturation current. A noise impulse or any signal disturbance having greater amplitude will drive the diode into saturation. Above this point to reasonable limits, all additional signal drop will occur across the diode and hence be diverted from the A.F. system as the saturation current tends to remain constant in spite of increased plate voltage.

In this way any noise which is above the desired signal level is effectively eliminated.

Well, fellows, how do you like this new department in *Radio-Craft*? Constructive criticisms will be mutually advantageous.

RADIO WITTIQUIZ

(Continued from page 226)

Answers

(10b)	(13b)	(16b)
(11d)	(14a)	(17d)
(12d)	(15a)	(18b)

Contest Rules

(1) An award of a 1-year subscription to *Radio-Craft* will be given to each person who submits a WITTIQUIZ that the Editors consider suitable for publication in *Radio-Craft*.

(2) WITTIQUIZZES must be typed; use only one side of paper.

(3) Submit as many WITTIQUIZZES as you care to—the more you submit the more chance you have of winning—but each should be good.

(4) Each WITTIQUIZ must incorporate humorous elements, and must be based on some term used in radio, public address or electronics.

(5) All answers must be grouped, by question number and correct-answer letter, on a separate sheet of paper.

(6) All contributions become the property of *Radio-Craft*. No contributions can be returned.

(7) This contest is not open to *Radio-Craft* employees or their relatives.

(8) The contest for a given month closes on the 15th of the 3rd month preceding magazine-issue date. (For instance, contributions to December, 1937, *Radio-Craft*, on the newsstands about Nov. 1, must be received at *Radio-Craft* editorial offices not later than Sept. 15th, 1937.)

BE SURE TO READ THE ANNOUNCEMENT WHICH APPEARS ON PAGE 250 OF THIS ISSUE

HOW DEPENDABLE ARE YOUR METER READINGS?

(Continued from page 213)

shaft and the scale markings.

How much overload a given meter will stand depends upon its design, and how the overload is applied. Overloads of reasonable magnitudes will not harm properly-designed instruments. If the overload is applied for only a short time, and *gradually*, so there is no violent movement of the pointer, the instrument will most likely stand considerable overload without damage. (The meters of at least one prominent test instrument manufacturer are designed to stand overloads as high as *10 times* the normal value.) However, if the overload is applied suddenly, so the movement is violent, a much smaller amount of overload will surely bend the pointer and also possibly dull the pivots or pit the jeweled bearings with resultant lagging and sticky action.

Incidentally, an overload of the wrong polarity, forcing the meter needle BACKWARD off-scale is very hard on meters and should be cautioned against. It is always good policy to start measuring an unknown quantity with the range selector of the instrument in the HIGHEST range position, gradually backing it down until a range is reached where the needle deflects without going off-scale to the right. This, of course, is the range where the user will receive his most accurate results, and this policy of working down to the proper range will save many a meter from a burn-out due either to too much deflection forward or, a disastrously high voltage or current of the wrong polarity (as far as the meter connections are concerned).

(G) "Zero" shift. If accurate readings are desired, it is apparent that the pointer must stand exactly at the "zero" point on the scale when no current or voltage is applied to the instrument.

If the pointer is not at the zero position to start with, it is evident that all indications at other points on the scale will be in error. Practically all commercial-type meters are provided with a zero-adjustment screw (see Fig. 2G), which varies the tension of one of the control springs, allowing the meter pointer's "at rest" position to be adjusted over several scale divisions, so that it may be centered exactly over the position marked "zero" on the meter scale.

Always make sure that the pointers on your instruments are in the correct "zero" position before taking readings! If the zero error is found to be beyond the range of the adjusting screw, or if a sudden zero error of considerable magnitude is observed, it is safe to assume that the instrument needs checking and possible repair.

When "zero"-adjusting a meter be careful to avoid "parallax error" (explained later). This is particularly important when "zero"-adjusting most ohmmeters, for in these instruments the "zero"-adjustment screw does not adjust the meter pointer position directly but usually adjusts a resistor which compensates for variations in the potential of the battery supplied with the instrument. A fresh battery will, of course, apply a higher voltage to the instrument circuits than after it is partially discharged. Furthermore, because the resistors used in these meter circuits are not absolutely precise in value, there is some variation between the accuracy of the various ranges of the instrument. Therefore, each range of the instrument should be "zero"-adjusted separately—just before using.

The *Megohm* ranges of ohmmeters are usually powered by a miniature power supply working from the house or shop line voltage. Variations in this line voltage can be, and should be compensated-for by means of the Ohms Zero Adjuster, or whatever the manufacturer calls the "zero"-adjusting control.

Do not confuse simple "zero error" with that due to a bent pointer. If the pointer is very much off-zero because it is bent, it should *not* be brought back to zero *by manipulating the zero-adjusting screw;* for such an adjustment brings the moving coil into an initial position far different from that which it occupied when the initial calibration was made. The bent pointer itself should be straightened!

(H) Spring errors. The springs play one of the most important parts in maintaining the accuracy of the instrument; for they not only conduct the current to the movable coil, but also supply the "restoring" torque (or twist) which resists the "actuating" torque of the movable coil, and then returns the coil and pointer to the "zero" position when the current is shut off. Any change in the "restoring" torque produced by the springs will cause a change in the position of the movable coil and pointer—causing an error in the readings.

Within the past few years, phenomenal metallurgical advances have been made in spring design which almost eliminate the "fatigue" and "aging" of springs which manifested themselves in a "drift" of calibration in older instruments. The improved springs used in instruments of reliable manufacture render negligible any probable error from this source, so long as they are not subjected to mechanical or electrical abuse.

Of course, if the springs have become overheated by prolonged abnormal current flow, they will lose some of their "temper". This will *decrease* their "restoring torque", and make the instrument *more sensitive*. (See Fig. 2, D and E.) Consequently, its readings become inaccurate insofar as its original scale calibration is concerned—and such errors may often be of considerable magnitude. This abuse of the springs by prolonged overload is difficult to detect because, as a rule, the meter seems to operate in a perfectly normal manner, no sluggishness or stickiness being evident.

The springs may also become "kinked". This fault will frequently manifest itself by the fact that the reading at a certain point of the scale will be different on "increasing" from "decreasing" values. Another error may creep in from "softened" springs which sag. These cause uneven torque, and an abnormal "zero error" of the pointer.

In general, the control springs of an instrument should be maintained in as nearly perfect a mechanical condition as possible by not abusing the instrument by serious overload, rough handling, etc. If the springs of an instrument have received any form of damage, it should be returned to the manufacturer, or an authorized repair shop, for repair, if accurate measurements are to be made with it.

(I) Bearing friction. The hardened and highly-polished steel pivots and the almost-frictionless sapphire jewel bearings which support the movable coil are subject to wear and damage. (See Fig. 2E.) They are finely shaped and polished, and accurately adjusted before the instrument leaves the factory; but friction may develop, due to excessively worn or damaged jewels or pivots. Rough handling of the instrument, overloading, dropping and tampering are all common causes of damage to the bearings.

Friction in the bearings usually manifests itself in a stickiness and lag of pointer movement, and a noticeable uncertainty in its zero position. Bearing friction will not usually cause errors in the readings, provided the instrument is gently tapped when the readings are being taken; but since its causes are likely to be productive of more serious results, they should be eliminated whenever possible.

Friction may also be caused by rubbing of the pointer on the scale, or on fine fibres loosening from the substance of a paper scale and projecting out so the pointer touches them. This trouble may become evident only during certain atmospheric conditions, and usually at certain parts of the scale; and it may be difficult to discover.

Small particles of foreign matter which have worked their way into the short air gaps of the magnet generally cause "sticky" operation and make the pointer indications erratic.

It is interesting to note that "sticky" meters due to foreign substances lodging themselves in the movement seem to rank highest among the most frequent meter repairs not due to owner negligence or carelessness. Sticky action is apt to occur even in new instruments, due to the jarring and shaking received during shipment. Although manufacturers take extreme care to insure receipt of the instrument in perfect condition and despite the care taken in assembling the meters, "trash" in the form of minute metal filings and bits of insulation or fibre may work into the movement. A meter service station should remedy this because the average radio Service Man is not capable of handling the delicate job of cleaning out and adjusting the movement. Anyway, the usual manufacturer's guarantee will generally cover the cost of the adjustment, if it becomes necessary, within about 90 days of the purchase date.

A "sticky" meter may be detected immediately. Sticky or defective meters should be repaired at once rather than "borne with" as a man who uses an instrument which is not in 100% working order will subconsciously build up a psychological "mad" at the instrument's manufacturer. If it is repaired, he soon forgets that there was anything wrong with it.

"Backlash" in the moving parts is due primarily to loose fits in them. This trouble is not common, nor serious, since errors due to it may be materially reduced by gently tapping the instrument while taking the readings.

(J) Electrical troubles. Under this classification are those troubles which may develop in the electrical circuits of the instrument after it has been assembled, tested and calibrated. Poorly-soldered joints, loose or broken conductors, and partial or complete "short-circuits" or "grounds" are some of them. It is surprising how many loose or badly-soldered joints develop in supposedly well-made instruments, unless the manufacturers are careful to inspect them rigidly at the factory.

"Opens" due to breakage of the fine wire comprising the movable coil or that employed for the multiplier resistors in voltmeters, have given trouble in some models of instruments. Of course, in such cases, the meter fails to operate either on one or more ranges—or altogether, so the trouble quickly makes itself evident. These electrical troubles can usually be detected by observation of the instrument for erratic action. When they are detected, they usually require a careful and complete repair before the instrument can again be considered reliable for service.

The copper-oxide rectifiers used in rectifier type A.C. instruments can cause an increase in meter inaccuracy. These copper-oxide rectifiers are inherently delicate and can be easily overloaded. The average rectifier of this type will pass a maximum of but a few milliamperes, above which the rectifier "breaks down." This condition appears to be present in any A.C. measuring-meter circuit whether it be strictly a series-dropping resistor type or one in which condensers and resistors are used. Care should therefore be exercised in the application of A.C. voltages to these meters, for overload often results in a damaged rectifier and lowered A.C. voltage readings. The rectifiers cannot be repaired and are never guaranteed by the original manufacturer. Therefore, damaged rectifiers should be replaced by the instrument manufacturer, or by some reliable meter repair firm, for they sometimes go bad even while being placed in the instrument. The copper-oxide rectifiers should never be touched with the hands as chemicals in one's perspiration will usually cause early rectifier failure.

The *ratio* of the rectified current to the applied current may change for a given rectifier. Troubles such as the above cause this ratio to drop to sometimes half the original ratio. Variations are also possible due to variations of temperature, humidity and the amount of current applied to the rectifier each time it is used for a measurement. In other words, the rectifier will have one ratio when say 0.1-ma. is applied, another when 0.5-ma. is applied, etc.

(K) Magnet weakened. Properly-designed permanent magnets of the types which are being used in recent high-grade instruments will stand a surprisingly large amount of rough handling before their magnetic strength will change sufficiently to result in incorrect readings. Other parts, such as the jewels and pivots, springs, etc., which are more susceptible to damage by mechanical shock, are more troublesome in this respect. However, the safe rule is to handle your instruments carefully and avoid all mechanical jolts and shocks.

(3) Inaccuracies Due to Way Instrument Is Used, Or Conditions Under Which Measurements Are Made

There are several inaccuracies which are apt to creep into measurements made with electrical instruments simply because of the way the instrument is used, or the conditions under which the measurements are made. Errors which may be present when a particular instrument is used for one measurement may not occur when it is used again under different operating conditions—and vice versa! Some things to watch for will be pointed out in Part II.

(Continued on page 247)

THE LATEST RADIO EQUIPMENT

(Continued from page 221)

RHEOSTAT FOR PRIMARY CONTROL ON SECONDARY VOLTAGE (1293)

(Ohmite Mfg. Company)

A PARTICULARLY convenient control of filament-transformer secondary voltages, in order to obtain maximum tube life (as in transmitters, etc.), is afforded by means of a power rheostat connected in series in the primary circuit. An improved vitreous enamel heavy-duty rheostat suitable for this purpose is illustrated. It is constructed entirely of porcelain and metals and thus contains nothing which can char or burn.

ORATOR-TYPE VELOCITY MICROPHONE (1294)

A VELOCITY microphone which has been especially designed for pulpit and "desk work", or for all those applications where the orator generally assumes a fixed position, is illustrated. By an ingenious application of the directional "fins" developed for an earlier-type microphone of the same make (*Radio-Craft*, item No. 1438, August 1937, page 93), and by placing the motor unit horizontally, an extremely wide angle of pick-up is obtained; this allows complete freedom of motion on the part of the speaker—within a radius of 3 ft.

This design is more sightly than the earlier "banquet" stand type of mounting. The base may be tilted to obtain best sound pick-up. Available with a noiseless rotary switch. Output level is -65 db.; impedance either to grid or 200 ohms (latter-type unit is equipped with a 25-ft. length of cable); frequency response 50 to 12,000 cycles; weight, 3 lbs.; finish, gunmetal.

NEWEST RADIO SET FOR AVIATORS (1295)

(RCA Manufacturing Co., Inc.)

AVAILABLE for both 6-V. and 12-V. operation, the new aviation radio receiver here illustrated features sensitivity and light weight. Only two type 6F7 tubes are used in the receiver to afford the services of (1) R.F. amplification, (2) detection, and (3) A.F. amplification in 2 stages, in a T.R.F. circuit.

Frequency range of 200 to 400 kc. permits coverage of airport traffic control, and radio beacon-weather broadcasts. White dots spot the primary weather broadcast frequency of 236 kc., and the airport traffic control frequency of 278 kc. Feather-weight headphones are utilized. Weight of complete receiver, power supply, cable and phones is 8.5 lbs. Dimensions for both receiver and power supply—6½ x 5¼ x 3½ ins. deep for each unit.

AIRCRAFT MICROPHONE (1296)

(Universal Microphone Co.)

ANNOUNCED as being "100-per cent directional and all extraneous noises excluded" is the aircraft-type microphone here illustrated. A thumb-operated pushbutton is installed on the periphery. This is a double-contact switch, one side of which closes the circuit for microphone current, and the other side operates the relay for throwing the transmitter into action.

NEW WIDE-RANGE SERVICE OSCILLATOR (1297)

(Radio City Products Co.)

ONE OF the latest in signal generator (or "service oscillators") developments is the portable, A.C. operated instrument here illustrated (size, 8 x 11¾ x 5 ins. deep; weight, 11½ lbs.).

Five bands afford a continuous range of fundamental frequencies from 125 kc. to 15 mc.; harmonics extend the high-frequency range to 16 megacycles.

Of importance to the Service Man is the means—a full-vision direct-reading 4½-in. vernier-type airplane dial with multicolor calibration—provided for speeding the reading of frequencies without recourse to charts or tables. Another interesting feature that facilitates the alignment of supersensitive radio receivers, as for instance car-radio receivers, is the use of special lead-coated steel for the case and chassis; plus separate shielding of the coil assembly, attenuator and R.F. circuits.

The possibilities of dead-spot effects are reduced through automatic shorting of unused coils; and electrostatic shielding of the power transformer prevents R.F. feedback through the power line.

Audio modulation of 30% at 400 cycles, sine-wave, is also available externally; also, other, external frequencies may be applied to the R.F. circuit. Sweep and "wobbler" circuits of cathode-ray equipment may utilize the A.F. modulation from this signal generator.

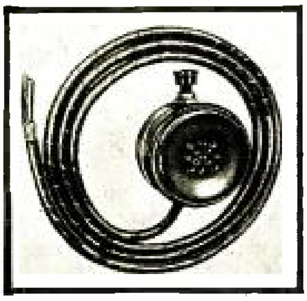
Panel and fittings are finished in chromium, aluminum and black. The cabinet is gray.

14-26 WATT PORTABLE AMPLIFIER (1298)

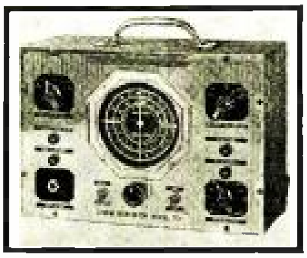
BRIEFED, the features of this amplifier are: electronic mixing of 2 microphones; provisions for mixing 2 microphones and 1 phonograph; includes velotron microphone (on banquet stand); has two 10-in. dust-proofed dynamic reproducers (said to be especially designed for P.A. work); tone control; beam power tubes.

Unit furnishes field supply; P.M. dynamics also may be used. Speaker No. 1 plugs into the amplifier. Speaker No. 2 plugs into speaker No. 1. This permits placing the second reproducer a maximum of 50 ft. from the amplifier.

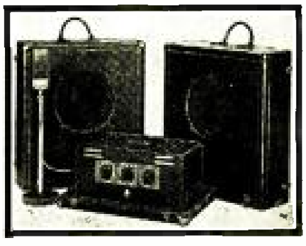
Latest emission-type tube tester makes hot emission tests of all types of tubes. (1299)



New aircraft mike. (1296)



A wide-range oscillator with continuous range of fundamentals from 125 kc. to 16 mc. (1297)



New 14-26 W. portable amplifier uses velotron microphone and 2 10-inch dynamic speakers. Input uses electronic mixing. (1298)

The new "etched-foil" electrolytics. (1301)

EMISSION-TYPE TUBE TESTER (1299)

(Million Radio & Television Laboratories)

THE TUBE TESTER illustrated on page 238 makes hot emission test of all types of tubes. English-reading indications appear on the scale of a large meter. Neon test of shorts and leakage is available up to 2 megs. Jacks provide external use of the leakage test; as well as measurements of resistance in continuity test. Operates on 110 V. A.C. The power circuit is fused; and all test circuits are insulated from the power line.

INEXPENSIVE PRIVATE PHONE (1300)

CARRYING the trade name of "Privaphone," this intercommunication system requires only a built-in battery to operate it. Consequently, unlike most previous types of such systems, it may be applied in many services that do not have available a 110 V. supply.

The unit comprises a microphone and earphone, and a buzzer—all battery operated. May be used in connection with dictating, detective work, temporary point-to-point communication, etc.

COMPLETE RANGE OF ETCHED-FOIL ELECTROLYTICS (1301)

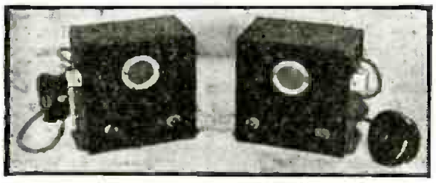
(Cornell-Dubilier Corp.)

BOTH THE types KR metal container and JR silvered cardboard container small-space etched-foil condensers are now available in a complete capacity range from 4 to 16 mf. at 200 to 525 V. rating. As a protection against excessive humidity and abnormal temperatures these units are triple-sealed.

NEW LINE OF REPLACEMENT CONDENSERS (1302)

IN ADDITION to the number of special universal-service condensers one manufacturer

(Continued on page 247)



Private interphone system. (1300)

New line of replacement condensers. (1302)

HOW TO MAKE "THE SEAFARER" LOOP-TYPE BOAT RADIO SET

(Continued from page 208)

LOOP-POSITION INDICATION

For each loop, secure or accurately draw a 360-degree protractor of convenient size. (See Fig. 1.) Cardboard affairs will do nicely. Center the protractor on the loop plug and fix it in position in such a way that its 0- and 180-deg. markings are broadside to the loop (90 and 270 deg. markings therefore in line with the endwise plane of the loop antenna). Make definitely sure that the scale will not slip and will turn *only* when loop and plug are turned.

Place a pointer on the front of the cabinet's cover so that it will record against the scale. Adjust the position carefully, making sure that when the loop is turned to read zero (deg.) or 360 (deg.) against the pointer, the finder is *exactly* parallel—endwise—to the length, left to right, of the cabinet.

OPERATION

In operation, the radio-direction finder is positioned in direct line with the course of the vessel. That is, the instrument heads directly toward the ship and the pointer indicates this line of direction of travel.

A chart of local waters will be required—a knowledge of magnetic variation figures for these particular waters, and a ship's compass. These, of course, are common enough to any mariner's store of seafaring apparatus and intelligence.

All bearings and positions are taken with reference to a ship's course.

Bearing-station on-course. Is station ZZZZ, which is coming in strongly, known to be exactly in line with a desired course? Is its position right where we want to go? Then we simply take a bearing on it with our finder, adjusting the loop for *minimum* reading or inaudibility. (The *maximum*-response reading is not as accurate.) Our pointer will read against the scale and indicate the number of degrees this station lies away from our present line of direction. We note our course on the ship's compass and then simply correct our heading until course and signal are in line. We may now "ride the signal" into port without "much of any" trouble.

Bearing-station off-course. Is the bearing of station ZZZZ unknown and do we wish this bearing? Then we note our course of direction, as shown by our ship's compass, correct it for magnetic variation, get a direction reading on the signal with our finder, find out its bearing from our present course by noting the degrees difference between the 2 lines of direction, add our own bearing from true-North to this difference—and get an actual true bearing on the signal. By extending this line seaward on our chart we will have something to work on, for we'll at least know we are on this line!

Do we want a "true position"? Then we take a bearing on 2 stations, if such bearings are not known, "triangulate" or extend both lines seaward, and note on our chart where they cross. That cross or "fix" is our true position and we know exactly where we are!

But these are matters for mariners. Your job as a radio builder will be to construct a model receiver, get it into proper working order, and scamper down to the nearest yacht club for an exhibition. When you do—if you do—make such a trip, you may take along plenty of advance assurance of an immediate sale and some profitable orders for the season.

NEW TUBES FOR THE RADIO EXPERIMENTER

(Continued from page 204)

Max.-signal plate current	60 ma.
No-signal screen-grid current	3 ma.
Load resistance	2,000 ohms
Power output	3.6 W.
2nd-harmonic	2.5%
3rd-harmonic	9%

(Data courtesy Raytheon)

6V6G (glass) Unipotential-cathode Tetrode Power Amplifier. Transformed or impedance input are recommended for use with this tube. If resistance-capacity coupling is used the D.C. resistance in the control-grid circuit must not exceed 0.5-meg. with self-bias, or 0.1-meg. with fixed-bias. Note that the voltage between heater and cathode should be kept as low as possible. A direct connection is recommended. See Fig. 1D.

Characteristics

Heater voltage	6.3 V.
Heater current	0.45-A.
Plate voltage (max.)	300 V.
Screen-grid voltage (max.)	300 V.
Plate and screen-grid dissipation (total)	12.5 W.
Control-grid voltage	-12.5 V.
Amplification factor	218
Plate resistance	52,000 ohms
Mutual conductance	4,100
Plate current	45 ma.
Screen-grid current	4.5 ma.

Operating Conditions, Class A Amplifier

Plate voltage	250 V.
Screen-grid voltage	250 V.
Control-grid voltage	-12.5 V.
Peak signal	12.5 V.
Plate current (no signal)	45 ma.
Plate current (max. signal)	47 ma.
Screen-grid current (no signal)	4.5 ma.
Screen-grid current (max. signal)	6.5 ma.
Load resistance	5,000 ohms
Power output	4.25 W.
2nd-harmonic	4.5%
3rd-harmonic	3.5%

Operating Conditions, Class AB (2 tubes)

Plate voltage	250	300 V.
Screen-grid voltage	250	300 V.
Control-grid (see item in text concerning input systems)	-15	-20 V.
Peak signal (grid-to-grid)	30	40 pk. V.
Plate current (no signal)	70	78 ma.
Plate current (max. signal)	79	90 ma.
Screen-grid current (no signal)	5	5 ma.
Screen-grid current (max. signal)	12	13.5 ma.
Load resistance (plate-to-plate)	10,000	8,000 ohms
Power output	8.5	13 W.
3rd-harmonic	3.5	3.5%
Total harmonic	4	4%

(Data courtesy Raytheon)

1G5G Low-Plate-Voltage Power Output Pentode. This tube is designed especially for operation from a 90 V. "B" supply and will be used mainly in battery receivers, particularly where current limitations are a factor.

Resistance coupling may be employed and the rated output obtained under class A operation. Larger power output is available by employing 2 tubes in push-pull service. (See Fig. 1E.)

Characteristics

Filament voltage	2 V.
Filament current	0.12-A.
Over-all length (max.)	4 11/16 ins.
Diameter (max.)	1 13/16 ins.
Bulb	ST-14
Base	Medium G Type Octal No. 6-X

Operating Conditions and Characteristics

Filament voltage	2 V.
Filament current	0.12-A.
Plate voltage	90 V. max.
Screen-grid voltage	90 V. max.
Control-grid voltage	-6 V.
Plate current	8.5 ma.
Screen-grid current	2.7 ma.
Plate resistance	0.135-meg.
Mutual conductance	1,500 umhos
Amplification factor	200
Load resistance	8,500 ohms
Power output	300 mw.
Total harmonic distortion	9%

(Data courtesy Hygrade-Sylvania Corp.)

25L6G (Glass) Beam Power Tube. This tube has electrical characteristics that are identical to those of its metal counterpart the 25L6 described in the April, 1937, issue of *Radio-Craft*. However unlike the 25L6 which uses beam deflector plates the newer tube incorporates suppressor grids. (See Fig. 1F.)

(Tube is now available from RCA Radiotron, Raytheon, Sylvania, etc.)

"LEARN-BY-EXPERIMENTING" BEGINNERS' PRACTICAL RADIO COURSE

(Continued from page 233)

LIST OF PARTS FOR EXPERIMENT NO. 1

*One general purpose, audio microphone transformer, T;
*One adjustable condenser (*optional*), 0.0003- to 0.001-mf. (equivalent to 300 to 1,000 mmf.);
One rheostat, 20 ohms, R;
*One 4-prong socket, with screw terminals for type 30 tube;
*One knob and dial-plate;
Five binding posts;
One type 30 tube; or, type 01A tube may be used, with rheostat advanced to full, since this tube requires a greater operating current;
Three drycells, or one 4½ V. "C" battery;
One pair of standard headphones, 2,000 ohms resistance, Ph.;
One key, may be home-made, as shown, or push-button, K.

*Names of manufacturers will be supplied upon receipt of a stamped and self-addressed envelope.

The author of this course has been identified with the teaching of radio for many years in both private and public schools, and at present is an Instructor in Radio in a New York City High School. His experience qualifies him admirably for presenting the technical material of radio from the learner's viewpoint.

ANSWERS TO PROBLEMS ON EXPERIMENT No. 1

(See page 233)

(1) Filament current becomes *greater*.
(2) Tone becomes *lower* in pitch indicating a *slower* or *lower* frequency.
(3) Pitch becomes *lower* indicating *slower* or *lower* frequency.
(4) Breaking the *plate* circuit.
(5) The amount of *capacity* in the grid circuit.

BUILD THIS "INTERMITTENT OPEN" CONDENSER TESTER

(Continued from page 225)

will-insulated test prods and keep safely away from the R.F. output of this "breakdown-test oscillator" in order to avoid high-frequency burns.

Coil L consists of 76 turns of No. 24 enam. wire wound on a form (preferably, air-core) 1½ ins. in dia. Coils L1 and L2 each consist of 50 turns of No. 14 enam. wire wound on a form 1½ ins. in dia.

The following List of Parts is suggested to builders who may want to try out this idea in a lab. set-up. Substitutions may be made by the experienced radio man as necessary to suit individual convenience.

LIST OF PARTS

One Standard Transformer Corp. power transformer, 650 V., 150 ma. sec. and a 2.5 V. sec., T;
One Standard Transformer Corp. filter choke, 200 ma., Ch.1;
One Hammarlund R.F. choke, 150 ma., Ch.;
One Hammarlund variable condenser, 350 mmf., CV;
Two Tung-Sol type 45 tubes, V1, V2;
One Tung-Sol type 80 tube, V3;
Two Sprague condensers, No. TX-24-70, 70 mmf., 1,500 V., C;
One I.R.C. resistor, 25,000 ohms, 5 W. (no less), R;
One Sprague condenser, No. TC-25, 0.005-mf., 400 V., C1;
One Sprague condenser, No. TR-11, 0.01-mf., 800 V., C2;
Two Sprague condensers, No. OT-21, 2 mf., 800 V., C3;
One R.F. coil unit (see text for construction data) L, L1, L2;
One S.P.S.T. toggle switch, X;
One bulb (and socket), 2.5 V. filament, V.;
Three 4-prong sockets.

This article has been prepared from data supplied by courtesy of Sprague Products Co.

BUILD THIS "OPTIMUM TEST" TUBE CHECKER

(Continued from page 209)

The features incorporated in this unit are grouped in Table I. The reasons as to just WHY these various elements were considered essential in the design of this new tube-resistance-capacity tester make interesting and instructive reading.

DESIGN FEATURES

(1) Accuracy. This is determined by the type of test circuit used, as well as the accuracy of the component parts which comprise the circuit.

A review of the R.M.A. recommendations and consultation with the engineering departments of the largest and most progressive tube manufacturers emphatically concludes that the most accurate test which can be made in a practical commercial instrument is the *emission-type test under applied voltages and loads* as recommended by the R.M.A. This circuit was therefore adopted after investigating power output and medium-price transconductance circuits. It is true that a finer, more elaborate transconductance tester could be built but it would be a very costly laboratory instrument, difficult to operate, and impractical for a dealer or Service Man.

The meter selected is a d'Arsonval moving-coil type with an accuracy guaranteed within 2%. The tolerance of each of the resistors as well as the regulation of the transformer must be guaranteed within 5%. Even under extreme circumstances the total circuit error will not be as much as 5% as the tube under test has a relatively high resistance compared to the other circuit constants. With all that, we would feel highly flattered if *any* commercial tube tester (including this one) could achieve an accuracy of 5% in grading tubes.

The accuracy of line-voltage indication is important and here a time-tested circuit is employed utilizing the 6H6 tube as a rectifier. *This special circuit* (described in detail in past issues of *Radio-Craft*) *was developed by the writer and to-day is in use in many fine measuring instruments.*

Hot interelement short and leakage tests and *hot cathode leakage tests* are fundamental requirements, yet, most instruments use only the neon lamp indication for both measurements! It is essential to note that *interelement* leakages—as differentiated from *cathode* leakage—have very high resistance values which necessitate the use of a highly-sensitive neon lamp. However, there is always a permissible limit of cathode leakage which would cause a sensitive neon lamp to glow and erroneously indicate that a *good* tube should be discarded!

The usual practice, in order to overcome this defect of the "neon test," is to decrease the sensitivity of the lamp indication so as to be safe on cathode leakage indication; but this automatically would show as OK some tubes having troublesome high-resistance interelement leakage!

This fault is overcome by keeping the neon indication highly sensitive and then making an additional cathode leakage meter test; this procedure is considered by the tube manufacturers to be far more desirable.

(2) Protection against obsolescence. Some assurance that the apparatus will not be out-of-date in a short time is essential when considering the construction or purchase of a modern tube tester.

During the past 5 years there has been a great deal of ballyhoo in the claims of tube-tester manufacturers as to their designs providing for future changes and additions. With an occasional exception it was necessary for the manufacturer to bring out one new model, and sometimes two, every year as the previous model would be obsolete. It would not meet all of the requirements that were necessary for properly testing the tubes of the following year.

One of the primary factors is the complete *free-point, free-reference* of both filament leads to all sockets without being tied into any active circuit bus at the same time. This design as can readily be seen from the wiring diagram enables the complete isolation of the filament supply to any 2 desired terminals of the tube including shell and cap. (There is not to my knowledge another tube tester regardless of price that has this feature.)

Furthermore any other individual element can be isolated, as desired, so that it need not be tied to the cathode or plate bus; which is not the case with all other emission-type testers. The flexible plug in connectors A, B, C, etc., provide this unusual and comprehensive protection and are operated the same as the conventional method for toggle switches.

There is provided a spare circuit (see diagram) with full switching capacity as for any present element so that an additional element or a 9-prong tube presents no problem. (No commercial emission tester on the market seemingly has such provision.) Space is also available on the panel for the addition of several new sockets should future tubes require new types of sockets.

(3) Tests all tubes. A good tube tester must be sufficiently comprehensive to test all types of tubes that are now in use including metal, glass, M.G. (metal-glass), obsolete battery and A.C. types, as well as *cold*-cathode rectifiers. Very few modern testers if any will test cold-cathode

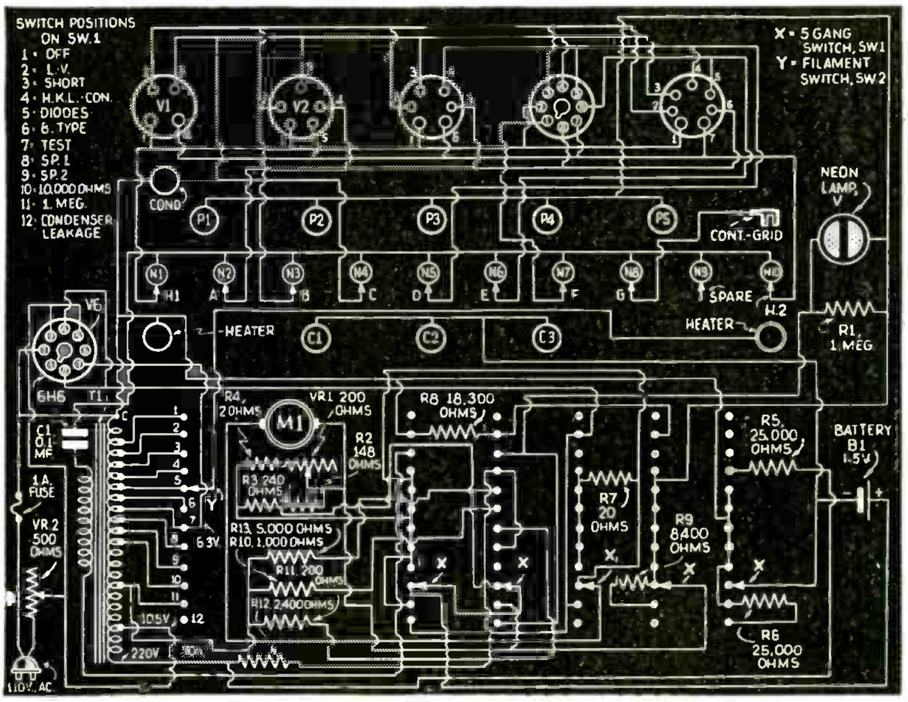


Fig. 1. Schematic diagram of the "optimum-test" tube checker.

rectifiers although there are a number of these tubes in use.

This design provides suitable voltage and load for proper test of such tubes at position "special No. 1" as seen in the diagram. An additional spare switch position is provided for some future special voltage and load requirement.

"Comprehensiveness" must also include the complete number of tests for properly determining the worth of a tube. This involves the quality emission test and sensitive inter-element leakage indication with a less-sensitive cathode leakage indication. Shorts, opens and loose elements should be readily detected as is easily done with this instrument because of the feature of isolating any element at will.

In addition the instrument also serves as an accurate ohmmeter and capacity meter, and also as a condenser leakage indicator. These extra features have been incorporated because they are so necessary in service work and on the dealer's counter, and involve very little in additional cost and no additional space to the tube tester.

(4) Optimum-quality parts. It is just as much of a fallacy to follow the assumption that "the best is cheapest in the long run" as it is to believe that "the cheapest price is the most economical." Here is where the *optimum* value plays the important role.

Only high-quality parts have been used in this instrument but not necessarily the most expensive ones. Molded wire-wound resistors are used in values below 2,500 ohms, and insulated and molded carbon resistors of ample watts rating are used for high-resistance units. The line-voltage power rheostat, rated to carry 25 W., is of the vitreous enamel type. Panel layout and design is very pleasing; *etched to give a 2-color effect.* Construction is sturdy so that the instrument should be good for at least 5 years' service if it is not abused.

(5) Simplicity of operation. This factor is realized in that there are only 2 selector switches. The operation is similar to the conventional emission-type tester only there are no special sockets or precautions that are necessary with so many other testers.

(6) Economical in Design. Economy is veritably the shining light that has automatically resulted from simplicity and efficiency in design. Just think—this unusual tester with its splendid features and high-quality parts can be constructed with little effort and at a cost to the Service Man of only about $18.

(7) Ohmmeter Tests. Resistance-test facilities, with 2 direct-reading ranges, are included. Low range: 0-10,000 ohms, with self-contained 1¼ V. flashlight cell. High range, 0-1 meg., self-contained power supply.

(8) Capacity-meter operation. Condenser-capacity tests may be made over 2 ranges from approximately 0.001-mf. to 10 mmf.

LIST OF PARTS

One Dependable milliammeter, 0-5 ma., with combination scale dial, M1;
One Dependable etched and fabricated panel;
One Dependable special tube-testing transformer, T1;
One wire-wound shunt rheostat, 200 ohms, VR1;
One Dependable vitreous enamel rheostat, 25 W., 500 ohms, VR2;
One Dependable selector switch, 6-pole 12-position, Sw.1;
One Dependable filament switch, Sw.2;
Six sockets, V1, V2, V3, V4, V5, V6;
One insulated, double control-grid cap with lead, C.-G.;
Eleven insulated tip-jacks, Red—P1, P2, P3, P4, P5, CP, Heater-Heater, Black—K1, K2, K3;
Ten metal shell tip-jacks, N1, N2, N3, N4, N5, N6, N7, N8, N9, N10;
Ten flexible lead connectors with insulation;
One line-cord and plug;
One Westinghouse neon lamp, ¼-W., NL;
One socket for neon lamp;
Three Dependable indicating knobs with insulated tips, H1, A, B, C, D, E, F, G, Spare H2;
One Dependable round knob;
One fuse holder and fuse;
One insulated carbon resistor, ¼-W., 1 meg., R1;
One molded wire-wound resistor, 1 W., 148 ohms, R2;
One molded wire-wound resistor, 1 W., 240 ohms, R3;
One molded wire-wound resistor, 1 W., 2 ohms, R4;
One molded wire-wound resistor, 1 W., 1,000 ohms, R10;
One molded wire-wound resistor, 1 W., 200 ohms, R11;
One molded wire-wound resistor, 1 W., 2,400 ohms, R12;
One molded wire-wound resistor, 1 W., 5,000 ohms, R13;
One Dependable wire-wound rheostat, 200 ohms, VR1;
Two molded carbon resistors, ¼-W., 25,000 ohms, R5, R6;
One molded carbon resistor, ¼-W., 18,500 ohms, R8;
On wire-wound resistor, 1 W., 20 ohms, R7;
One insulated carbon resistor, 1 W., 8,400 ohms, R9;
One flashlight monocell, 1½ V., B1.

This article has been prepared from date supplied by courtesy of Radio City Products Co., Inc.

WHAT SIZE OSCILLOSCOPE?

(Continued from page 205)

as compared to the total value and cost of the finished instrument. The same comment in general might be applied to a comparison between the 2-in. screen size and the 3-in. screen size.

OTHER DIFFERENCES

Although we have shown by the foregoing that the oscilloscope instrument proper (less tubes) costs nearly the same regardless of tube size, the performance of the several sizes may differ considerably.

Visibility Factor. The Visibility Factor may be defined as "the ratio of the smallest-size image useful for practical examination to the largest-size pattern which the area of the screen will permit." A pattern ¼-in. wide by ¼-in. high is considered the smallest useful for examination, while the largest pattern is governed solely by the size of the cathode ray tube screen.

It can be compared to band-spread on a radio receiver which permits micrometer adjustment of frequency for fine tuning. Likewise, the visibility factor determines the extent to which an oscilloscope pattern can be enlarged to allow precise examination of its waveform.

Figures A, B and C (on page 205) give comparative visibility factors for the several tube sizes. It is worthy of note that a "visibility factor" of 75 is obtained with the 3-in. tube, whereas a factor of only about 8 and 23, respectively, are obtainable from the 1- and 2-in. tubes. From an examination of these figures it can be seen that the 3-in. tube benefits greatly by comparison with the smaller sizes.

Effective Area. Figure 1 compares the area of the 3 tube sizes. The actual figures of effective area are given, at A, B, and C, page 205. It is well to consider a cathode ray tube screen from the angle of effective usable area, because in this way the true proportions of the image can be anticipated.

SUMMARY

It is entirely possible that servicing work in the near future will require more extensive use of full-size oscilloscope equipment. Ultra-modern receivers and the possibility of servicing work to be done on television equipment make it necessary for the wide-awake Service Man to carefully consider the type of cathode ray equipment to be purchased. Using the method outlined in this article to judge tube screen sizes will assist in making this decision.

This article has been prepared from data supplied by courtesy of The Jackson Electrical Instrument Co.

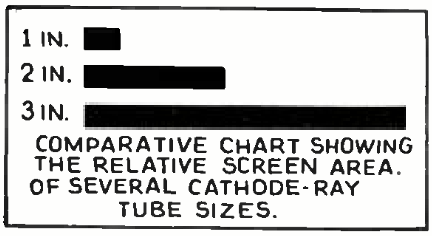


Fig. 1. Comparative C.-R. tube screen areas.

NEW SET TESTER FEATURES LOW-OHM SCALE

(Continued from page 205)

2,000-ohm scale, again to take advantage of the very open scale distribution from zero to center scale, with each division representing 1.0 ohm.

These low-resistance readings give very accurate checks of the resistance of transformer filament windings, resin joints, etc.; shorted turns in speaker voice coils; contact resistance on variable-condenser shafts; shorts and grounds in 6-V. genemotor (motor-generator) armatures used on mobile P.A. systems, also armatures of rotary converters, etc.; and many other places in electrical and radio circuits.

It is also interesting to know that the current drain from the battery on the 200-ohm range is very low, in the order of 60 to 70 ma., instead of several hundred milliamperes in the usual circuit. This low current drain is accomplished by a special combination shunt-series circuit of high accuracy, as shown in the schematic diagram of Fig. 1. It requires only a single 1.5-V. battery for operation.

The high-resistance range of this instrument provides for every ordinary contingency; the scales are: 0/2/20 megs. Requisite high voltages are obtained from an internal power pack. The D.C. scales are: 0/1/7/35/140 ma.

(For those technicians who require dimensions, etc., in order to determine whether the equipment will properly match existing apparatus, and so-on, we add the following data:

(The bronze panel assembly is mounted in a quartered oak carrying case with a slip-hinge cover, ample tool compartment and leather handle. Size 7¼ x 10½ x 4½ ins. deep. Weight, only 9 lbs., complete.)

For the Service Men who require a high-sensitivity instrument (for laboratory work, etc.) there is available the type 542 set tester. This unit is similar in all respects to the model 541, except that it employs a forged, cobalt-steel magnet, and a dead-beat, microammeter with a sensitivity of 40 microamperes at 25,000 ohms/volt; and will measure current values as low as 40 microamperes.

This article has been prepared from data supplied by courtesy of Supreme Instruments Corp.

CORRECT PLAYBACK OF SPOT RECORDINGS

(Continued from page 226)

The record's acetate coating is a tough, but only a semi-hard substance, while the pressing is what might safely be said to be flint-hard. The latter is formulated in a press under several tons pressure and is cured by the application of heat, thus producing a very hard, firm, inflexible disc with a highly glossy surface.

With the advent and use of a greater number of instantaneous records, it is essential that the user acquaint himself with, and fully recognize not only the advantages but as well, the special and very necessary requirements for proper playback. We will discuss these in the order of importance, giving in each instance, reasons for construction in the pickup to bring about maximum results both in the matter of quality of reproduction and in the life of the instantaneous record itself.

(1) **Freedom of Armature Movement.** Of first importance is the freedom of movement of armature of the pickup. Aside from the fact that it should be as small as it is possible to construct and likewise as light in weight, it also must be *damped* in the very lightest manner. The damping adjustment (point C in Fig. 1A) therefore should permit free sideward movement of the armature and should require only the very slightest pressure on the needle.

As a test, when the finger is applied to the pickup needle, D, the physical movement of the armature should be very easily and readily seen with the naked eye. The armature should be short (as stated above) and under no instances should it exceed in length that of the pickup needle itself. In other words, the damping, using the pivot of the armature as the center of a lever, would resist the side effort in the groove to move the armature between the pole pieces.

If the needle were short and the armature long, the damping would have to be lighter and far more delicate than is possible to obtain in a practical assembly, therefore the armature is made shorter from the damper to the pivot than it is from the pivot to the end of the needle. *Any pickup with a stiff or over-damped armature will destroy frequencies (on a record) directly in ratio to the excess of damping used.*

(2) Needle Pressure on Disc. The next point of importance is the matter of *weight* on the needle which should be in all cases as light as possible—never over 3 ozs., and preferably less. A pickup having a heavily-damped armature of course will require more weight on the needle to make sure that the lateral movement in the groove will actuate the armature before causing the head to jump out of the groove.

(3) Needle Angularity. The third point that must be followed for maximum reproduction and life of acetate discs is *needle angularity.* Exhaustive experiments have proven that 30° brings about longer life without affecting reproduction (point E in Fig. 1B).

In the case of certain pickups mounted at an angle of less than 30° to the vertical, a bent needle such as is shown at point G in Fig. 1C is resorted-to in order to correct the angle of the needle at its point of contact with the record.

(4) Length of Pickup Arm. The next point of importance is the arm length which should be maximum at all times. Longer arms create less side pressure on the groove, eliminating distortion in the pickup; and, in describing the arc over the record being played, are less liable to side-wall wear because the needle has greater leverage (due to the longer arm) against any friction in the pivot.

Part II will discuss many problems in selecting the correct needle for playback of spot recordings.

This article has been prepared from data supplied by courtesy of Universal Microphone Company.

THE "RESONOSCOPE" NEW ELECTRONIC DEVICE DETECTS "OFF-KEY" NOTES

(Continued from page 200)

chromatic scale are calculated for a true tempered scale, which has the most practical use for all types of tuning. The pitch of the scale is 440 cycles-per-second for A, this being the "International pitch"—musical reference point—for tuning. (This standard of pitch is the one used in the present models of the resonoscope, but any other pitch can be had by substituting a new set of tuning forks.)

UTILITY

The resonoscope seems definitely destined to become an indispensable aid to every branch of the musical art, especially so when it is noted that skilled musical instrument tuners will be off at least by 1/3-cycle on their fundamental notes, and more on the higher and lower octaves, in usual ear tuning! While such discrepancies may not be noticed in the individual notes, they produce a general discordant effect which is displeasing to critical musical ears.

The new "electronic robot", on the other hand, permits tuning to within a very minute part of a cycle. Its tuning forks are tuned to an accuracy of 0.002-per cent!

It facilitates the tuning of such musical instruments as pianos, accordion reeds, harmonic reeds, organs, and so-on, not only for fundamental notes but for all octaves. Each instrument of an orchestra or band may be so accurately tuned that an entirely new ensemble effect is obtained. Likewise a singer can determine precise pitch and adjust his or her voice accordingly. In busy broadcasting stations where musicians and artists hurriedly form various groups in various studios, the device is already being used to obtain correct pitch for individual instruments and vocalists, so that no time may be lost.

Because the resonoscope permits the vocalist to actually see just how his or her voice sounds, and to analyze its pitch and quality in the most critical manner, this instrument is being hailed as a great aid in voice culture. The singer can adjust his or her voice, while watching the screen pattern, until it matches that of a great singer who is to be emulated. Because the instrument indicates pitch, character of note and volume, in a visual manner, it becomes the first electronic music master for music lovers everywhere.

LATEST IN TEST APPARATUS FOR THE SERVICE MAN

(Continued from page 217)

brated, direct-reading decibel scale is also incorporated on the scale plate enabling db. readings from −10 to +63 db. in 5 ranges.

The instrument incorporated in this unit has a base sensitivity of 400 microamperes at 100 millivolts and is of the modern, wide-open square type, size 4 x 4½ ins., allowing all scales to be easily read. The A.C. correction scale is printed in red to readily differentiate between A.C. and D.C. voltage readings.

RANGES: A.C. voltage (at 1,000 ohms/volt), 0 10/50/250/1,000/2,500; V. D.C. voltage (at 1,000 ohms/volt). 0/10 50 250/1,000/2,500. V. D.C., 0/10/50/250/1,000 ma. Resistance. 0/400 ohms/1/10 megs. Decibel meter −10 to +63 in 5 ranges of 0/+14/+28/+40/+48 db. Output meter indications.

As noted in Fig. F and circuit diagram, Fig. 2, all A.C. and D.C. voltages (except 2,500 V.), D.C. and resistance measurements are available at only one set of polarized tip-jacks through the use of the master range selector. This rotary range selector permits speedy range change without the necessity of removing and re-inserting test leads.

The Low-Ohms circuit makes use of the *Shunt Method* (back-up scale) for low-resistance measurements. Referring to the circuit diagram, Fig. 2, it will be noted that when the range selector is rotated to the low-ohms position, a shunt is placed across the meter posts, and at the same time a section of the current-limiting resistor is shorted out, enabling full-scale adjustment to be made through the use of the Adjust Ohms control. The combined resistance value of meter and shunt is exactly 20 ohms. The current drain of the low-ohms circuit is approximately 5 ma. It therefore can readily be seen that any low value of resistance placed across the test tip-jacks of the multimeter, will cause the current flowing through the meter to drop accordingly. An individually-calibrated and direct-reading low-ohms scale is incorporated on the meter scale plate for this low-ohms range. Resistance values as low as 1/4-ohm can readily be measured. The 20-ohms indication is located at the center of this scale.

(Precision Apparatus Corp.)

BUSINESS PROBLEMS OF THE SERVICE MAN

(Continued from page 223)

accessories, tubes and whatever else could be sold is limited to those who would actually come down to the service department.

The next point to be covered is, how much is the space worth? If offered the equivalent in cash, would they service the store refrigerator for this amount? The answer was decidedly—NO! The rent was not worth over $40 a month and upon examination it was determined that they could not afford to tie up one man for that amount.

It readily becomes apparent that "something for nothing is no bargain." Free rent in this case was of no advantage, in fact it becomes a great disadvantage.

The store, of necessity, must be non-competitive, therefore, it does not attract the type of customer desired by Mr. Jerod and Mr. Holtz.

A SOLUTION

The better arrangement for Mr. Jerod and Mr. Holtz in the event that they insist on the North-West location, is to obtain the best store available for around $50 a month. This amount usually is sufficient in smaller towns for a reasonably good location. Then, use about $750 of their capital for modest store fixtures and for putting in a reasonable stock of tubes, small radio sets, replacement parts, electrical appliances, etc. The balance of their reserve is to be used as a surplus fund for emergencies. If the friends and acquaintances of Mr. Holtz come through as expected their chances of success are indeed promising.

SERVICE BENCH OF SUCCESSFUL SERVICE MAN

(Continued from page 223)

checker, (3) volt-milliameter, and (4) signal generator. The tools shown are mounted to hinged doors opening to a cabinet about 4 ins. deep and 18 ins. high, which forms the back of the bench. This cabinet is used to hold condensers, resistors, spools of wire, screws, nuts, bolts, washers, etc. The top of the bench is set off with an aerial made up of about 30 ft. of wire mounted on two stand-off insulators. To this aerial is clipped the antenna leads of the sets being tested or repaired.

The machine to the right of the bench is a small air compressor and tank which is used to blow out the dirt from condenser plates, speakers and the house sets. (There are other pieces of equipment, not shown, such as bench drill, lathe, emery wheels and portable drills.)

Directly under the antenna is the rack for spare tubes used for testing. The center of the back of the bench is built up from the Confidence tube, vibrator and condenser checker. Under this is a panel composed of jacks, which are connected to all instruments, and these, with the use of short wires and plugs as jumpers, will make most any test necessary.

The 2 meters to the left of the center are in the 6 V. D.C. circuit, one a voltmeter, the other an ammeter, showing current consumed by a given set while being tested. The meters to the right are first an A.C.-D.C. meter and second, an ohmmeter. Beneath these meters are 6 small lamps which are pilot lights, one of which lights with any equipment being used.

This prevents the soldering iron or tube checker from being left turned on when not in use. Also to the left-center is a neon lamp which can be plugged in any circuit for continuity or short tests. The two lower openings contain slides on which are mounted punches and chisels and socket wrenches of all sizes.

THE RADIO MONTH IN REVIEW

(Continued from page 199)

month, and heard in part over long distances, had much to do with the confusion attending the search for the lost Amelia Earhart, and caused reports to be sent in by listeners on short waves that they had heard signals of distress from the missing flyers. It is difficult to imagine any precaution which could guard against such a misunderstanding, unless such interpretative programs are to be delayed until the excitement of the search has died down.

ANNING S. PRALL, HEAD OF F.C.C., DEAD

CHAIRMAN Anning S. Prall of the Federal Communications Commission died at his summer home, Boothbay Harbor, Maine, last month, at the age of 66 years. In memorium, practically every radio broadcast station in the United States and its territories, at the suggestion of the National Association of Broadcasters observed a 1-minute quiet period, on noon, Monday, July 26.

Mr. Prall was appointed a member of the Radio Commission in 1934 by President Roosevelt. After the Radio Commission was merged with the Federal Communications Commission, Mr. Prall was made Chairman of the Radio Division of the Commission.

ANNING S. PRALL

THE LATEST RADIO EQUIPMENT

(Continued from page 239)

has added to his new line of condensers a series of 21 replacement units. Capacities range from ½-mf. to 65 mf. Representative styles are shown in the illustration on page 239.

HOW DEPENDABLE ARE YOUR METER READINGS?

(Continued from page 237)

Figure 2, on pg. 213, includes illustrations, of important elements in meter construction, which the Service Man may be interested to note, as, to a limited extent, they are self-explanatory. However, the detailed analysis of these elements (Figs. H to O, inclusive) constitutes important, basic knowledge which every technician should possess. This information, and considerably more, will appear in Part II of this useful article.

Read Part II of this article; it will discuss *Inherent* Meter Accuracy (or inaccuracy).

The author of this vital article is also author of "Radio Physics Course," "Modern Radio Servicing," and "Radio Field Service Data"—all of them valuable contributions to the field of literature for the practicing radio Service Man.

ABC OF MODERN VIBRATOR SERVICING

(Continued from page 220)

PURPOSE OF THE BUFFER CONDENSERS

Not shown in the drawings, but an important part of the vibrator function, are the 2 small *buffer condensers* which are either incorporated as a part of the vibrator or incorporated in the power pack of the complete unit.

These condensers form a very useful service in limiting and suppressing the arc across the contacts due to the making and breaking of the current on the primary side. These condensers are placed in the secondary instead of the primary circuit since although the voltage must be very much higher, the capacity can be very much lower as their action is reflected in the primary circuit.

The capacity of this condenser whether incorporated as an integral part of the vibrator, or in the power pack proper, should never be changed as *the entire vibrator has been designed for this particular capacity.*

In the preliminary check of the vibrator and the power pack, much guess work can be eliminated by knowing the circuit and understanding a few of the troubles, such as the following, which can occur to vibrators and their power packs.

NO "B" VOLTAGE

Shorted filter systems, shorted buffer condensers, grounded filter systems, shorted transformers, shorted wiring or shorted rectifier tubes may cause no "B" voltage. Also, no battery voltage may be delivered to the vibrator, which can be caused by a blown fuse, a burned-out switch, a broken "A" lead or any one of the numerous other suggestions which will come to mind.

After the cause for the absence of "B" voltage has been discovered, correct same and proceed to test the vibrator in a good vibrator tester, as a shorted filter system and other shorts, such as buffer condensers, rectifier tube, transformer secondaries, etc., can damage the vibrator by overloading the contacts. It might be stated here that *rarely, if ever, do the power transformers give trouble.*

LOW "B" VOLTAGES

If the "B"-battery voltages are low, the battery voltage must be checked, as well as the resistance of all leads from the battery to the vibrator.

Check for high-resistance shorts in the rectifier circuit. Check the rectifier tube and buffer condensers for worth, and for troubles which cause low voltage in the usual home-radio set. The vibrator should then be checked in a vibrator checker.

HASH

Hash is a problem of circuit design, shielding—both magnetic and electrostatic, proper radio-frequency filtering, proper ground, mechanical arrangement of the receiver, and the sensitiveness of the receiver. Engineers have taken care of the hash problem in the design of the receivers and if hash is present it should be traced to its source. Do not attempt to eliminate hash by "doctoring" the vibrator. In severe cases, manufacturers of the vibrators do furnish hash eliminators.

INTERMITTENT OPERATION

Intermittent operation can be caused by defective vibrators due to sticking contacts, loose connections in the power pack and other symptoms the same as in a conventional A.C. receiver. Eliminate these by checking the vibrator in a vibrator checker.

OTHER VIBRATOR TROUBLES

Vibrators with unusual mechanical noise are caused by the vibrator touching other parts of the housing, the internal assembly, or by loose parts which vibrate with the operation of the vibrator.

(Continued on page 255)

"AIR-TRACK" SYSTEM OF BLIND LANDING

(Continued from page 202)

Six important improvements have been incorporated in the Air-Track. Foremost among these are the facts that (1) the equipment has been so simplified and the design made so compact, that it is portable, *making it possible to lead a pilot in to a safe landing from either end of any runway on the field;* **(2) the radio signals, at first liable to deviation and instability, have been made reliable, and a monitoring system installed which indicates to the operator whether accurate signals are being broadcast; (3) both the** *localizer* **and the** *glide path* **are quickly adjustable and, (4) the equipment required in the plane has been made lighter and more efficient.**

The principles embodied in this system were originally worked out by an Aeronautics Research Division established by the Department of Commerce at the Bureau of Standards. A number of the radio scientists who developed the system at the Bureau have been at work in a laboratory at College Park Airport near Washington developing the system from its early experimental stages to the point where it is now practical for air transport. Three years of such development and improvement work have resulted in hundreds of successful landings "under the hood" and landings in fog conditions which interrupted scheduled flying.

Three experimental installations of this curved beam type of landing system have been tested by Department of Commerce pilots, airline pilots and others. These are at College Park, Newark airport, and the municipal airport at Oakland, California. In all, upwards of 1,000 safe instrument landings have been made on these installations.

ELEMENTS OF THE AIR-TRACK SYSTEM

Briefly, the Air-Track system consists of two radio beams: (1) a *runway localizer* which lies down the center of the runway to be used, and (2) a *curved glide path* which leads the plane down a sloping "track" to a gentle landing on the runway. A single "cross-pointer" instrument (2 D.C. meter movements, one operating horizontally and the other vertically, mounted in one case) on the panel (see Fig. A) indicates the plane's position, *the vertical needle pointing to the right or left* if the plane veers from the center of the runway localizer, and *the horizontal needle rising or falling* if the plane gets above or below the proper glide path.

At a distance of 10 or 15 miles from the airport (see Fig. B), the pilot picks up the *runway localizer* signal through his regular communications receiver, over which he still receives voice communication, perhaps from the operator in the airport control tower. Lining up his flight along this localizer, which can be made as wide or as narrow as comfortable flying dictates, he approaches the curved beam down which he will glide to the runway. (The receiver for this glide path is adjusted to the best "gliding angle" of that type of plane.)

Having reached this point, the pilot flies his plane so that the 2 needles cross at right-angles, and this indicates that he is approaching over the exact center of the runway and coming down at the proper, safe gliding angle.

At the edge of the field a *marker beacon* gives him a signal in his earphones which tells him he is crossing the edge of the field. At this time he is approximately 20 to 30 feet above the runway, and the balance of the landing consists merely of leveling off and letting the plane settle.

Hundreds of times, planes with landing speeds as high as 75 miles an hour have been brought down to a spot on the field a few yards square! James L. Kinney, Department of Commerce pilot, as far back as 1933, took off from Washington under the hood (that is, he could not see outside the plane, had only his instruments to guide him, and hence was flying "blind"), flew by instrument to Newark airport, and landed by instrument on the experimental installation of this system, on a day when scheduled air transport planes were grounded by impossible flying weather.

Transmitting equipment is housed in an ordinary automobile trailer which is quickly movable to concrete platforms at either end of any runway, where the wheels fit into slots to insure proper location of the apparatus. The transmitters are plugged in to a power outlet and the control tower attendant throws a switch which puts them into operation.

USEFULNESS OF "AIR-TRACK" AT CROWDED AIRPORTS

Usefulness of the apparatus for control of traffic at crowded airports has been stressed by pilots who have flown the system. Airline officials have pointed out that if all landings of air transport planes were made on this system, even in fine weather, a pilot would never make an unusual landing, no matter what the weather might be.

Despite the thoughtful and serious work of airline operations managers and traffic managers in "staggering" schedules to avoid simultaneous arrival of several airliners at one airport at the same time, the airports at large municipalities are already dangerously crowded at certain times. At one airport today, there are 18 transport planes arriving within the space of an hour. Increasing patronage will only aggravate this problem, and bad weather complicates it to the point of deadly hazard.

It is as if the engineers of a large number of trains were instructed to choose their own track and bring their trains in to a huge station with only the admonition to "be careful and not run into other trains." The airline pilot has two-way voice communication with the airport control tower, and receives all the information available, but he does not have a definite "track" or path to follow which will keep him clear of other approaching aircraft.

A correct blind landing system may have a number of duplicate "tracks", properly identified, just as are the tracks in a railroad yard, and the approaching pilot's orders will indicate the track he is to use. Eventually, these engineers believe, the "switches" may be set for the approaching pilot, and his plane may be taken over by radio when he is distant from the field, and brought in mechanically to a full instrument landing. This dream is not very nebulous, even today.

COMPARISON OF VARIOUS BLIND-LANDING SYSTEMS

There are no "preceding types" of landing systems prior to the Air-Track. It is based definitely upon the original experiments at the Bureau of Standards, which began in 1927 and 1928. An Aeronautical Development Section of the Department of Commerce, Aeronautics Branch, conducted those experiments, and carried them up through various stages of development to the demonstrations held at Newark in 1933.

As for other landing systems (Most of these systems have been described in past issues of *Radio-Craft.—Editor*), this is the story. In 1931 or 1932, visitors from Germany were shown the Bureau's developments and after their return to Germany the Lorenz system appeared. This is a refinement and development of one of the phases of the Bureau development.

At Newark, the Bureau installation was fixed in position, giving indication in only one direction. The Lorenz system today is also fixed in one position. If it is desired to give landing guidance on more than one runway, or in more than one direction, the installation must be duplicated. This means that under certain conditions, the pilot will be coming in to land *over* the antenna structure and transmitter houses. These form a positive obstacle, much disliked by pilots. There is also the consideration of the added expense necessary to duplicate these transmitters and antenna arrays and structures.

The Lorenz system also uses a European type of indication, with a kicking needle indicating off-course position. This is strange to American pilot practice and preference, and it requires an appreciable time for interpretation. There is no time available for interpretation in the job of blind landing.

The Lorenz system holds to the fundamental principles of the Bureau system, i.e. the "curved beam", localizer and marker beacons. It gives the pilot an indication of his position throughout the approach and landing. However, it is not all contained on the airport, and it has not been developed as far as Air-Track.

The success of the Bureau demonstrations at Newark prompted the duplication of the system at Oakland airport in California. Here, United Airlines, later joined by TWA and American Airlines, and still later by Bendix, have continued

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NEW INSTRUMENT SPEEDS FREE-POINT TESTING

(Continued from page 225)

means of determining circuit conditions accurately since no current is drawn from the circuit under test. Current ranges on present-day testers have been used rather infrequently because of the time and trouble required in making a series connection in the circuit.

THE "CURRENT MEASUREMENT" SYSTEM OF TESTING

One of the most difficult parts of a radio set to test and one that has become the bug-a-boo for Service Men is the A.V.C. and Q.A.V.C. circuits. Most voltmeters placed across these circuits, in order to make a *voltage measurement*, draw current from them and more or less upset the high-resistance networks present. The purpose of these circuits is to control the current in the tubes to which they connect. A *current measurement* is logical therefore, since it does not upset the A.V.C. and Q.A.V.C. networks whatsoever.

By (1) using an oscillator input at the antenna posts of the receiver, (2) plugging this new instrument into the sockets of the tubes controlled by the A.V.C. and Q.A.V.C. and (3) varying the signal strength put out by the oscillator, the plate current variation will give an absolute indication of the condition of the A.V.C. or Q.A.V A. system.

This method can be used for testing diode 2nd-detector circuits no matter how complicated the resistance networks connected to the diode may be. Fixed minimum bias, A.F.C. or any other similar circuit may be tested by this method of current testing also. Service Men who do not have an oscillator can make these tests by tuning on and off a powerful local station. In the audio end of the set, grid bias may be checked very accurately by taking plate current readings. An overloaded condition of the rectifier tube can be checked easily by the current method for the power pack circuit need not be considered. As an example, it is the usual thing to check rectifier overload conditions by voltmeter readings from chassis to rectifier filament or cathode but this does not necessarily give a correct indication for it does not take into consideration whether the negative lead from the power transformer goes directly to chassis or through a filter or resistor network before connecting to the chassis. This especially applies in A.C.-D.C. sets.

A couple of examples where current readings come in handy are first, where an audio bias resistor has been so badly burned up that its resistance value can no longer be read. A quick estimate using Ohm's Law will give the approximate value but only by taking current readings of the tube controlled by this bias resistor is it possible to be sure that the resistor value is correct. Another example is in replacing a volume control in an orphan set. By taking current readings of the tube controlled it is possible to check very quickly whether or not the taper of the new control is correct.

To sum up, by the use of the *current method* of making tests, analyses of radio receiver faults are very much simplified. By use of this instrument current readings can be taken simply and without the cutting or unsoldering of wires. (Incidentally, this device also may be used in taking the "usual" tests such as voltage and resistance.)

Our Information Bureau will gladly supply manufacturers' names and addresses of any items mentioned in RADIO-CRAFT. Please enclose a stamped and self-addressed envelope.

OPERATING NOTES

(Continued from page 227)

eral small holes are provided in the top of the container to act as safety valves, in case this action takes place. This small leakage does not affect the efficiency or change the value of the condenser in any way.

STROMBERG-CARLSON SOLDER NUGGETS

Fada KA and U. S. Radio Model 10. Gassy 27s cause trouble in different sets in different ways. In a Fada KA, 2 of these tubes in the A.F. stage caused very poor quality of reproduction. In a U. S. Radio model 10, a gassy 27 in the 1st audio stage may cause a "jumpy" volume control.

PAUL WELAND

HOW TO MAKE A CLASS A' PUSH-PULL NEGATIVE-FEEDBACK 60-W. AMPLIFIER

(Continued from page 215)

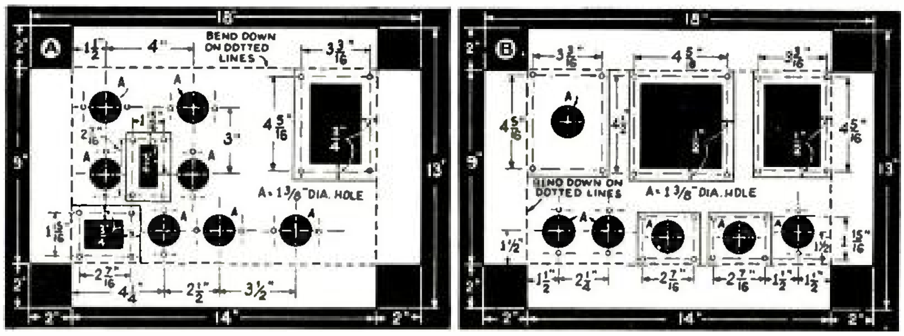
stages, more adequate filtering is therefore necessary in the filter network of this transformer. The output of the 5Z3 employs condenser input, whereas, P.T.1 employs the choke input method of filtering the rectifier system. Filtering of P.T.1 only need be sufficient to supply "B" voltage for the plates of the 6L6s; regulation should therefore be better.

Sockets for the 6L6s and the 6F6s should have high heat resistance insulation such as, isolantite. Great care should be exercised in the wiring of the plate and screen-grid supply of the 6L6s. A heavier than usual or "normal" type of insulation should be used to prevent possible arc-over between leads.

LIST OF PARTS

- Two I.R.C. resistors, 3,000 ohms, 2 W., R1, R2;
- Two I.R.C. resistors, 0.15-meg., 1 W., R3, R4;
- One Centralab dual volume control, 0.25-meg., R5, R6;
- Two I.R.C. resistors, 2,500 ohms, 2 W., R7, R8;
- Two I.R.C. resistors, 500 ohms, 1 W., R9, R10;
- Two I.R.C. resistors, 10,000 ohms, 1 W., R11, R12;
- Two I.R.C. resistors, 5,000 ohms, 1 W., R13, R14;
- Two I.R.C. resistors, 15,000 ohms, 1 W., R15, R16;
- Two I.R.C. resistors, 10,000 ohms, 1 W., R17, R18;
- Two I.R.C. resistors, 50,000 ohms, 1 W., R19, R20;
- Two I.R.C. resistors, 0.15-meg., 1 W., R21, R22;
- Four I.R.C. resistors, 0.1-meg., 1 W., R23, R24, R25, R26;
- One Electrad resistor, 10,000 ohms, 50 W., R27;
- One Electrad resistor, 100 ohms, 25 W., R28;
- One Electrad resistor, 15,000 ohms, 50 W., R29;
- One Electrad resistor, 150 ohms, 25 W., R30;
- Six Hammarlund 8-prong isolantite sockets;
- Two Hammarlund 4-prong isolantite sockets;
- One Hammarlund 7-prong isolantite socket;
- *One 7-prong special shielded plug and cable;
- One Kenyon transformer, type T255, T1;
- One Kenyon transformer, type T271, T2;
- One Kenyon transformer, type T319, T3;
- One Kenyon power transformer, type T215, T4;
- One Kenyon power transformer, type T216, T5;
- One Kenyon choke, type T166, Ch.1;
- Two Kenyon chokes, type T152, Ch.2, Ch.3;
- Four Cornell-Dubilier condensers, type ED3-100, 10 mf., 50 V., C1, C2, C5, C6;
- Ten Cornell-Dubilier condensers, type DT-6P1, 0.1-mf., 600 V., C3, C4, C7, C8, C11, C12, C15, C16, C19, C20;
- Four Cornell-Dubilier condensers, 0.02-mf., 600 V., C9, C10, C13, C14;
- Two Cornell-Dubilier condensers, 0.05-mf., 600 V., C17, C18;
- Three Cornell-Dubilier dual condensers, type PEB-6808, 8 mf., 600 V., C21, C22, C23, C24, C25, C26;
- One Cornell-Dubilier dual condenser, type JR-216, 16 mf., 200 V., C27, C28;
- Two Sylvania type 6C8 glass tubes;
- Two Sylvania type 6F6 glass tubes;
- Two Sylvania type 6L6 glass tubes;
- One Sylvania type 83 glass tube;
- One Sylvania type 5Z3 glass tube.

*Names of manufacturers will be supplied upon receipt of a stamped and self-addressed envelope.



Exact physical specifications for making the amplifier (left) and power pack chassis.

BUSINESS-LIKE "SILENT" SERVICING

(Continued from page 209)

perform every essential test required on a modern radio receiver.

The technique of using these instruments is fundamentally simple. With the speaker voice coil open and preferable a dummy load resistance equal to the speaker impedance substituted for the voice coil, a Service Man may first make a voltage analysis of the receiver using a modern 20,000 ohms/volt instrument.

Assuming that the power is properly distributed, he next attaches the vertical plates of the oscilloscope to the diode load resistor in the 2nd-detector circuit. With the signal generator feeding through the frequency wobbler in the oscilloscope and then to the control-grid of the last I.F. tube, that stage can be aligned as indicated by the resonance curve on the oscilloscope. Each preceding stage can easily be adjusted to the same frequency.

Without mechanically "rocking" the condenser, the oscillator or mixer padder can be tracked at 600 kc. or any other frequency designated in the instructions for the particular receiver. It is then quite simple to align the R.F. circuit at the high-frequency end of the dial. If the set has A.F.C., it is only necessary to change one connection of the oscilloscope from the top of the diode load resistor to the cathode of the A.F.C. diode.

Audio circuits, even with phase inverting stages and tone compensation can be quickly analyzed with the oscilloscope across the output circuit and the audio modulation from the signal generator supplying the steady sine wave. Regeneration, phase distortion, overload, hum, or "hash" from the power pack, all may be easily identified on the oscilloscope pattern. Throughout all of these tests, not a sound is heard from the speaker!

PSYCHOLOGICAL VALUE OF "SILENT SERVICING"

To the customer who wants to see this work done, this procedure is as marvelous as a major operation in a surgeon's clinic. The Service Man has no need to fear that the customer will learn the tricks of the trade because the instruments alone are more expensive than most radio sets and the technique is quite beyond comprehension.

Like the surgeon, the Service Man may charge a rate commensurate with his work. The flashy instruments serve as indication that his work is truly above the screwdriver mechanic's class. "Silent servicing" has raised the work of radio Service Men to professional levels; which means a decent living from a heretofore much abused and underpaid occupation. Furthermore the customer is assured of a first-class repair job.

This article has been prepared from data supplied by courtesy of Triumph Mfg. Co.

NEW "RESOLUTION TESTER" FOR CATHODE-RAY TUBES

(*Continued from page 201*)

for television reception) images quite frequently appeared to be entirely out of focus. *All previous efforts to correct this misbehavior were fruitless!* Exhaustive tests revealed that nothing was wrong with the "electron optics" of the cathode-ray tubes.

Finally, they hit upon the basic trouble. Those spots of light, or picture elements, which "build" the television image did not assume the circular form they had presumed, but were partly of streamline shape.

But how to verify this was the problem. To understand the difficulties involved one must consider that it takes only (see note) 1/13,230-second to "paint" one line of a television image over the full width of a fluorescent screen, and every line consists of thousands of closely arranged light dots each with a diameter of approximately 1/50,000-in.!

Mr. Burnett solved the problem in a very ingenious manner. He omitted 2/3 of the light dots by sending "blocking" impulses into the tube. The main trick to produce the patterns was done by sending 2, 5 or even 10 frequencies varying between 30 cycles and 2,000 megacycles into the tube. Since a constantly changing mixture of frequencies between 30 cycles and 3,000 megacycles (as used in actual television transmission) produces complicated images with a wealth of little details, one will readily understand that a cathode-ray tube must produce specific patterns when specified frequencies are sent into the terminals.

The main difficulties to be conquered did not lay in the actual production of the patterns shown on this page, but rather in the problem to design a master oscillator which was able to produce exactly all the specific frequencies desired, and a great number of them at one time.

How the master oscillator of this system looks is shown in Fig. A. In short it is a nice, but complicated, piece of test equipment, but as mentioned before, it is merely the initial nucleus of the instruments which the Service Man of the future who intends to do television work will require.

Note—This addition to the tools of the electronic specialist is a most important one. Regardless of whether a television program is "on the air," transmitting and receiving equipment may now be tested by means of the "synthetic" video program afforded by this *resolution tester*. The one here illustrated was designed several years ago; when 343-line fidelity was being employed. It is described on the basis of operation "on the air" at approximately this image-line frequency; that is, with a resolution-meter frequency of 336 lines or 10.080 c.p.s. (The frequency of 13,230 c.p.s. mentioned by the author is apparently based on 441-line operation for which the resolution meter has not as yet been redesigned. In general, however, the actual points discussed are relatively similar.)

Although, as the author states, up to 10 frequencies, constituting in the aggregate a complex "A.C. voltage mesh" which appears on the end of the cathode-ray tube as an intricate frequency pattern, may be used the practical application of the resolution meter does not require such an extensive design. The more complex mosaic is of use mostly for demonstration purposes; for ordinary, practical work it usually is sufficient to utilize only a 2 megacycle frequency, its 3rd-harmonic of about 6 megacycles and a frequency of about 700 kc. The pattern thus produced is a checkerboard.

Editor

(*Continued on page 255*)

"R.-C." STAFF CHANGE

Bert Nussbaum, formerly Assistant Advertising Manager of *Radio-Craft* magazine, has joined the staff of Reiss Advertising (agency). His former associates on "R.-C." feel sure that the ability he exhibited during his tenure of almost 8 yrs. will be a valuable contribution to his new position.

IMPORTANCE OF MODERN TEST EQUIPMENT

(Continued from page 207)

audible range. This type of equipment will allow the Service Man to check the response characteristics of the receiver from the antenna terminal to the input of the loudspeaker, giving indications of the quality which may be expected.

New opportunities are periodically being presented to the Service Man due to the fact that developments are continuously being made, and the public is becoming more aware of what it may expect in the way of radio reception. At the present time the set owner is beginning to realize that much of the radio interference which he was formerly led to believe was a necessary evil may be mitigated or entirely eliminated by filtering apparatus which causes radio noise. The Service Man who has made some study of this type of man-made static is in a good position to pick up much profitable business.

Public-address systems have long been more or less neglected by the average Service Man as an added source of income. A thorough acquaintance with the circuits commonly employed as well as the ordinary troubles encountered in this type of apparatus is well worthwhile.

THE ABC OF A RESONANCE CURVE

To return to the cathode-ray oscilloscope as a means of obtaining a visualization of the resonance curve, it might be of interest to show the manner in which a curve is actually traced on the screen. In order to obtain such a curve it is necessary to have a frequency-modulated signal generator.

Frequency modulation of a signal generator as opposed to ordinary *amplitude* modulation, where the amplitude of the radio frequency output of the signal generator varies at an audible (say 400 cycle) rate, consists of varying the frequency of the signal produced by the signal generator at a given rate, usually 60 cycles. It should be noted that in frequency modulation the amplitude of the signal does not vary with time but the frequency does. Curve B of Fig. 1 shows the manner in which the frequency produced by the signal generator varies over a complete cycle of its frequency range.

The mode in which the radio receiver responds to a frequency modulated signal must be thoroughly understood. Assume for example that an unmodulated, single-frequency signal were fed into the input of the receiver. When the receiver is tuned to this frequency the R.F. amplifier and I.F. amplifier, if the receiver has one, will amplify this un-modulated single frequency and a voltage will be built up across the diode detector circuit which is proportional to the amplitude or intensity of the input signal. However, if frequencies other than the frequency to which the set was tuned were fed into the receiver, the voltage developed in the diode detector circuit would be smaller in value because of the selectivity of the receiver. The sharper the receiver the more variation in voltage developed in the diode circuit between the resonant frequency and other frequencies higher and lower than the resonant frequency. Curve C of Fig. 1 shows the magnitude of the voltage in the diode circuit as the frequency varies about the frequency to which the set is tuned, which is indicated by point O on the curve.

It will be noted that the frequency modulation of the signal generator as indicated by curve B varies about a mid-point to 15 kc. higher and 15 kc. lower than the middle frequency. For instance, if the mid-frequency is 600 kc., the frequency produced by the frequency-modulated signal generator will vary from 585 kc. to 615 kc., a range of 15 kc. either side of the mid-frequency.

If a connection is made so that the voltage in the diode circuit is fed to the vertical deflecting plates of the oscilloscope and the beam is swept horizontally back and forth across the screen at the same rate as the frequency modulation (which in this case is 60 cycles) then a resonance curve may be depicted on the cathode-ray screen. The 60-cycle sweep voltage is shown in curve A of Fig. 1. In order that the pattern on the screen of the cathode-ray oscilloscope will be stationary, the resonance curve must be plotted by the inertialess cathode-ray beam over and over again, falling in the same position on the screen for each successive cycle. Curve D

(Continued on following page)

(Continued from preceding page)

represents the picture which actually appears on the screen under the above conditions.

HOW A CYCLE "PAINTS" ITS IMAGE

The intersection of horizontal lines drawn through points of curve C representing various points in the cycle, with vertical lines drawn through the corresponding points of curve A, determine the pattern which is traced on the screen of the 'scope during a complete cycle.

The reader can readily follow these points as they are numbered consecutively. For instance, at point O the moving spot is in the center of the screen as regards its horizontal position; at this same instant of time the frequency-modulated signal generator is producing the frequency to which the set is tuned so that the response of the set (applied to the vertical deflecting plates) is a maximum. At point 1 on curve A the spot has moved slightly to the right as regards to its horizontal position. At this instant of time the frequency produced by the signal generator is slightly higher than the frequency to which the set is tuned and the response is correspondingly lower. The remainder of the picture traced on the screen may be understood by following the consecutive points indicated on the drawing.

THE "SERVICE TECHNICIAN"

The Service Man is becoming more and more, as the years go on, a technician. In the successful pursuit of his work he must have a fundamental understanding of the various principles underlying each and every individual circuit which goes to make up the radio receiver. These circuits, when individually analyzed, are not extremely difficult. However, they do require a thorough understanding of the operation of each of the component parts entering into the circuit. Not only must the Service Man have a good physical picture of circuit operation, but he must also be thoroughly acquainted with the various types of test equipment which he uses in analyzing receiver faults. He must know the applicability and limitations of this equipment and, as a consequence, he must understand the principles on which it operates.

The standards for efficient Service Men are being constantly raised. Their professional services should demand increased remuneration. Radio service racketeers are finding that it is becoming increasingly difficult to hoodwink the public. Probably the day will arrive when no Service Man not having a diploma from a creditable school will be allowed to practice.

SERVICING QUESTIONS AND ANSWERS

(Continued from page 227)

your 4-tube set, the plate voltage is generally much higher, and this is responsible for the resistor on the primary side of the No. 255 audio transformer burning out.

You ask what the correct voltage should be on the plate-return of the 1st audio stage. It is advisable to "juggle" the voltages from 45 to 135 in order to determine the best results.

Remove the 3-to-1 audio transformer and reconnect the Silver-Marshall No. 255 unit, for since you only burned-out the primary resistor, it is merely necessary to replace this resistor with one having a value of 0.2-meg. See Fig. Q27. It is not necessary to open the transformer, to get at the resistor; merely shunt this resistor across taps 1 and 2, and this unit will be as good as new.

LOUD HUM AND WEAK SIGNALS

(28) Floyd Coomber, Walworth, N. Y.

(Q.) I have an RCA model 4-17-M set. It has a loud hum and only faint reception of the nearby, powerful, local stations. Tubes were checked and found to be OK.

(A.) The reason for a loud hum and only faint reception of nearby local stations of your RCA model 4-17-M 4-tube receiver is due to the filter condensers capacities being below their designated rating. The only remedy is to replace these filter condensers, and in doing so, make sure that the correct polarity of the replacement condensers is maintained. Voltages will read from 60 to 100 V. on all sockets.

NEW "RESOLUTION TESTER" FOR CATHODE-RAY TUBES

(Continued from page 252)

TABLE I
HOW THE PATTERNS OF FIG. B WERE OBTAINED

No. 1—Deflection: Vertically, 30 c.p.s. saw-tooth; horizontally, 10,080 c.p.s. sawtooth. Grid: 1. 30 c.p.s. square-wave, negative portion the width of the vertical-deflection return-line time; 2. 10,080 c.p.s. square-wave, negative portion the width of the horizontal-deflection return-line time; 3. 2,222,640 c.p.s. sine-wave; 4. 740,880 c.p.s. sine-wave; 5. 246,960 c.p.s. square-wave; 6. 70,560 c.p.s. square-wave; 7. 1,260 c.p.s. square-wave; 8. 180 c.p.s. square-wave.

No. 2—Deflection: Vertically, 30 c.p.s. saw-tooth; horizontally, 10,080 c.p.s. sawtooth. Grid: 1. 30 c.p.s. square-wave, negative portion the width of vertical deflection return-line time; 2. 10,080 c.p.s. square-wave, negative portion the width of horizontal-deflection return-line time; 3. 740,880 c.p.s. sine-wave; 4. 246,960 c.p.s. square-wave; 5. 1,260 c.p.s. square-wave.

No. 3—Deflection: Vertically, 30 c.p.s. saw-tooth; horizontally, 3,780 c.p.s. sine-wave plus small component of 1,260 c.p.s. Grid: 1. 30 c.p.s. square-wave, negative portion the width of the vertical-deflection return-line time; 2. 70,560 c.p.s. square-wave.

No. 4—Deflection: Vertically, 30 c.p.s. saw-tooth; horizontally, 3,780 c.p.s. sine-wave plus small components of 1,260 c.p.s. and 180 c.p.s. Phase of horizontal deflection is changed from that in No. 3. Grid: 1. 30 c.p.s. square-wave, negative portion the width of the vertical-deflection return-line time; 2. 70,560 c.p.s. square wave.

No. 5—Deflection: Vertically, 30 c.p.s. saw-tooth; horizontally, 3,780 c.p.s. sine-wave plus small components of 1,260 c.p.s. and 180 c.p.s. Phase is shifted slightly from No. 4. Grid: 1. 30 c.p.s. square-wave, negative portion the width of the vertical-deflection return-line time; 2. 3,780 c.p.s. sine-wave; 3. 70,560 c.p.s. square-wave.

No. 6—Deflection: Vertically, 30 c.p.s. saw-tooth; horizontally, 3,780 c.p.s. sine-wave plus small components of 1,260 c.p.s. and 180 c.p.s. Phase is shifted slightly from No. 4. Grid: 1. 30 c.p.s. square-wave, negative portion and width of the vertical-deflection return-line time; 2. 3,780 c.p.s. sine-wave; 3. 70,560 c.p.s. square-wave.

No. 7—Deflection: Vertically, 30 c.p.s. saw-tooth; horizontally, 3,780 c.p.s. sine-wave plus small components of 1,260 c.p.s. and 180 c.p.s. Phase is shifted some from No. 4, is almost same as that for No. 5. Grid: 1. 30 c.p.s. square-wave, negative portion the width of the vertical-deflection return-line time; 2. 70,560 c.p.s. square-wave; 3. 246, 960 c.p.s. square-wave.

No. 8—Deflection: Vertically 30 c.p.s. saw-tooth; horizontally 3,780 c.p.s. sine-wave plus small components of 1,260 c.p.s. and 180 c.p.s. Phase is shifted considerably from No. 4. Grid: 1. 30 c.p.s. square-wave, negative portion the width of the vertical-deflection return-line time; 2. 70,560 c.p.s. square-wave; 3. 246,960 c.p.s. square-wave.

Note—All patterns were made on a 9-in. cathode-ray tube using full magnetic deflection and a second-anode potential of 6,000 volts. All frequencies are synchronized.

ABC OF MODERN VIBRATOR SERVICING

(Continued from page 247)

A vibrator tester's primary purpose is to detect defective vibrators which will no longer function or operate properly with their associated circuits. The Triplett Laboratory in working out the design of their Vibrator Tester Model 1670, secured a number of vibrators in various stages of deterioration and worked closely with the manufacturers of vibrators so a tester could be designed which would enable Service Men to make every needed test.

In the analysis of vibrator trouble, it was found that defective vibrators had two distinct characteristics.

(1) The vibrators would fail to start properly on very low voltage such as 5.5 V. on a 6-V. battery.

(2) The vibrators would operate unevenly, thus causing a variation in the output voltage.

REQUISITE TEST FACILITIES

In the design of the Triplett tester, these facts were carefully taken into consideration and the unit was designed to:

(1) Accurately measure the input voltage.

(2) Control the input voltage to the vibrator.

(3) Accurately measure the output of the vibrator on a GOOD-BAD scale.

(4) Accurately check the regularity of the vibrator on the meter.

(5) Check the output voltage in per cent with an increase, of the input voltage, of 0.5-V.

(6) Place a 5,000-ohm load across the filtering system so the vibrator would work into the approximate load it works into in normal operation. This was found to give a vibrator test approximating the actual condition under which the vibrator would operate.

The tester has been designed for extreme simplicity using a minimum number of sockets and a rota., switch to select the proper circuits for the vibrators under test. A D.P.D.T. toggle switch is used to switch the measuring instrument in either the input or output circuits. A potentiometer is used to control the input voltage, and a second switch is used to place buffer condensers in the circuit of the vibrator when they are not a definite part of the vibrator.

Most Service Men seem not to realize the tremendous progress that has been made in vibrator-type power supply systems. It is hoped that this article, therefore, will be useful to these men.

"AIR-TRACK" SYSTEM OF BLIND LANDING

(Continued from page 248)

their development. They have not released much on their development, but we understand that it is still fixed in position, although it retains the fundamental principles of the Bureau system.

The 4 major Airlines, AA, TWA, UAL and EAL, meeting with Bureau of Commerce and Federal Communications Commission representatives recently set forth recommended specifications for instrument landing to be adopted on a national scale.

It is interesting to note that Air-Track exceeds the operating requirements of these specifications, meets all the requirements described as "practicable," and most of those which are called "projected developments." For example, the specifications suggest that glide path and localizer indications should be separate. The Bureau started with separate transmitters and we regard them as essential to safety and proper operation.

We believe this instrument landing situation has implications which make it the biggest story in radio or aviation at this time. Entirely aside from the safety angle, its economic angle is sure to have a tremendous effect on the history of air transportation.

CREDITS

When a curtailment of funds necessitated a discontinuance of Department of Commerce activities on radio aids to flying in 1933, scientists who had been employed at the Bureau were set up in a new laboratory at College Park where they continued their research and experiments.

Among these men were Gomer L. Davies, Dr. Frank G. Kear, Gerald H. Wintermute, and the late William H. Orton, who are largely responsible for the improvement of the Air-Track and its adaptation to commercial needs.

The first job of instrument landing is to save lives. Its second job is to make possible the completion of every trip interrupted or cancelled because the terminal airport is "closed in", and thus to guarantee flying on an announced schedule. The story of its contributions will be the first chapter in an entirely new epoch of human flight.

Airlines of the country took a big step toward 100% in safety and regularity of scheduled operation when they recently agreed upon specifications for an acceptable instrument landing system.

As a result, it appears that a workable system will have been tested and accepted before the arrival of bad flying weather this winter.

BOOK REVIEWS

MARCONI—THE MAN AND HIS WIRELESS, by Orrin E. Dunlap, Jr. Published by The Macmillan Company. Size, 6 x 9 ins., 360 pages, 16 illustrations. Price, $3.50.

This is the life story of Marconi; the emphasis is on the man's work and on his personality.

Starting with the birth of Marconi, Mr. Dunlap, Jr., portrays in a technically-accurate and most vivid narrative manner the entire history-making sequence of Marconi's life to within several short months of his death.

The author very ably interprets, with historic accuracy and scientific acumen, the role that Marconi played and the significant steps in the epic of "wireless" (radio).

The book touches on many historic events—the heroic and dramatic role of Marconi wireless in the *Republic* disaster and the *Titanic's* mid-ocean tragedy. The period of the World War which started the hectic rush to develop new radio devices and led to the development of short waves (on which Marconi was working when death claimed him) is fully and most interestingly covered.

Incidentally, Marconi himself thoroughly checked the final proofs so that the book would be accurate in facts about radio and historically correct in personal details.

AUTOMATIC FREQUENCY CONTROL SYSTEMS, by John F. Rider. Published by John F. Rider, Publisher. Size, 5¼ x 7½ ins., hard cloth cover, 144 pages, profusely illustrated. Price, $1.

Automatic Frequency Control is radio's biggest development—and, the Service Man's latest headache, unless he knows what it's all about.

The author evidently had this thought well in mind for A.F.C. is explained from its fundamentals, through its various developments up to the final forms which the circuits assume in various commercial receivers. A review chapter covers that part of the theory of inductance and phase relations upon which A.F.C. depends.

Automatic Frequency Control Systems is another Rider book that should be on every Service Man's bookshelf.

JONES ANTENNA HANDBOOK, by Frank C. Jones. Published by Frank C. Jones. Size, 6 x 9 ins., 64 pages. Price, 50c.

If it serves no other purpose than to clarify in the mind of the reader conflicting opinions as to relative merits of various arrangements of antennas the *Jones Antenna Handbook* will have effected a worthwhile achievement. Merely to list the chapter headings—which is all that space permits in this column—is hardly to do justice to this valuable reference work. Contents: Antenna Theory; Antennas for Transmitting; Directional Antennas; Antennas for Receiving; Antennas for Ultra-High Frequencies; Special Purpose Antennas; 160-Meter Antennas; Antenna Coupling Systems; Antenna Charts; Measuring Equipment.

AIR CONDITIONING IN THE HOME, by Elmer Torok, M. E. Published by The Industrial Press. Size, 6 x 9 ins., 296 pages, 50 illustrations, 39 tables. Price, $3.

We find upon reviewing this book that no better cross-section concerning its makeup can be prepared than is contained in the author's preface, from which we quote:

"The first 2 chapters deal with the benefits, effects and functions of air conditioning. Chapters III and IV describe in detail various types of air-conditioning equipment and systems. Chapter V is devoted exclusively to the subject of installation and operating costs. If the reader wished to go into the matter more in detail, Chapter VI, written in question and answer form, will enlighten him on the principles of air conditioning. If one finds simple calculations more fascinating than solving crossword puzzles, Chapters VII to XII will give him a generous amount of material in the form of tables, examples, and solutions."

Service Men can well use this book as a guide to work in the new, profitable field.

ADVERTISERS' INDEX

(While every precaution is taken to insure accuracy, we cannot guarantee against the possibility of an occasional change or omission in the preparation of this index.)

NO GREATER OPPORTUNITY THAN THIS

The GROUND FLOOR of TELEVISION

Every student receives this giant television cathode ray tube as part of his equipment.

TRAINED TELEVISION MEN WILL BE NEEDED *SOON!*

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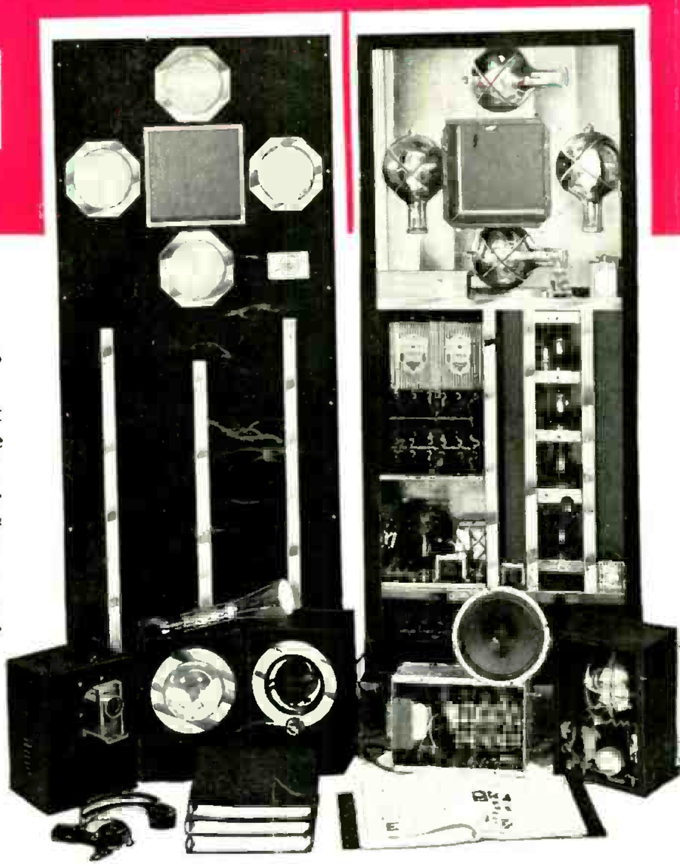

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was established in 1935, to provide skilled men for television development in the United States. A. T. I. was founded by U. A. Sanabria, internationally famous inventor of the interlaced scanning system, now universally used. The Institute possesses one of the best equipped television experimental laboratories in the world, and it is here that students complete their courses under the personal supervision of Mr. Sanabria.

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★ **Bulletin!** ★

7/17/37. The National Resources Committee reported to President Roosevelt that the most important development work in television was completed, and that only the commercial arrangements remain to be made to provide national television service.

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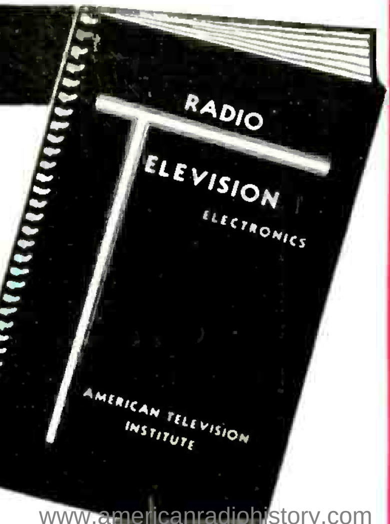

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