RADIO'S LIVEST MAGAZINE

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Radio-Craft

SPECIAL RADIO VOCATION NUMBER

November
25 Cents
in United States and Canada

HUGO GERNSBACK Editor

SOUND SYSTEM
for the
CHEERING SECTION

See Page 266

Is Television in the U. S. Asleep? — A 1-Tube Battery-Type Interphone
New Uses of the "Electric Eye" — "Wobblers" for the Service Oscillator

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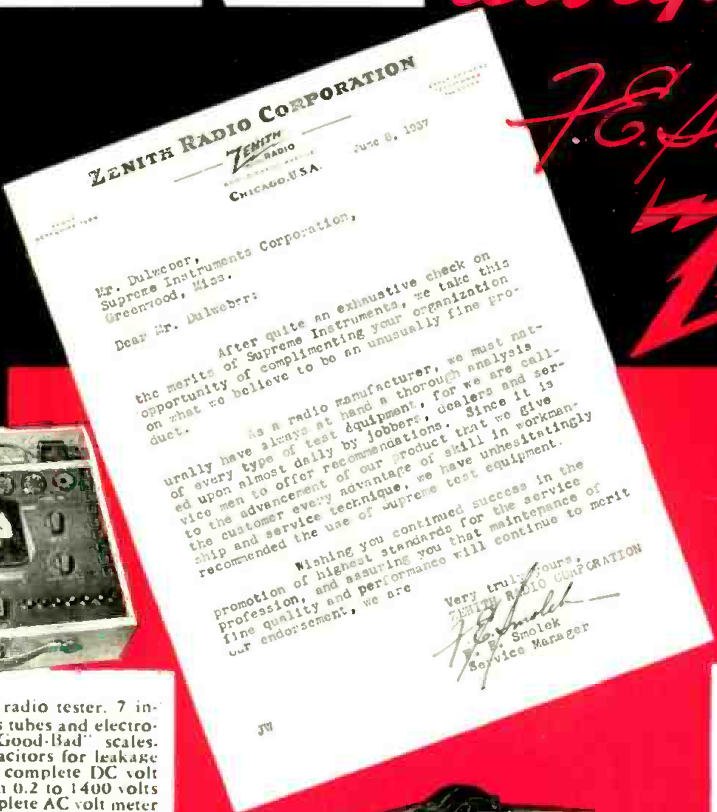
SERVICE MANAGER

F. E. Smolek

ZENITH



ZENITH RADIO CORPORATION

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CHICAGO, U.S.A.

June 8, 1937

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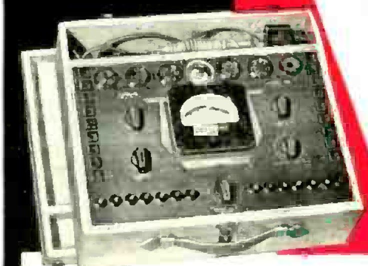
F. E. Smolek
Service Manager

JW



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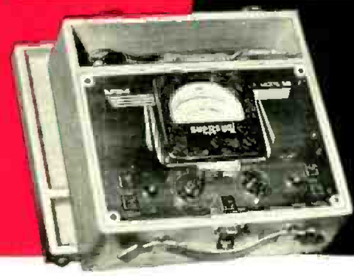

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Radio-Craft
FOR THE SERVICE MAN · DEALER · RADIOTRICIAN

SPECIAL RADIO VOCATION NUMBER

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C. P. MASON, Associate Editor
R. D. WASHBURNE, Managing Editor

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SPECIAL EXPERIMENTERS' NUMBER

We have been "saving up" for this forthcoming annual issue of RADIO-CRAFT and consequently there are so many good stories scheduled that to list only the few for which we here have room would be to present a most inadequate picture of the contents of December RADIO-CRAFT. In brief, however, there will be many new articles of special interest not only to the Service Man but also to experimenters in radio, electronics and public address.

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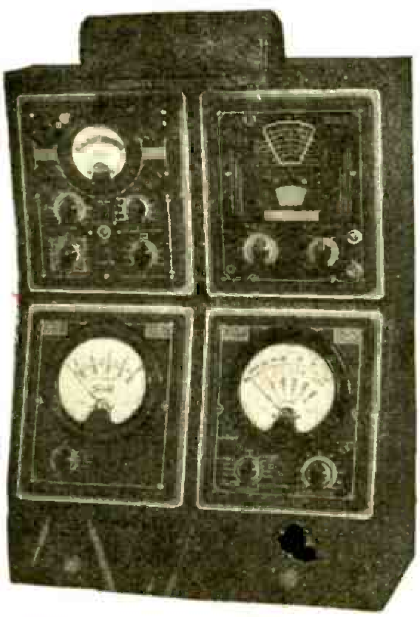

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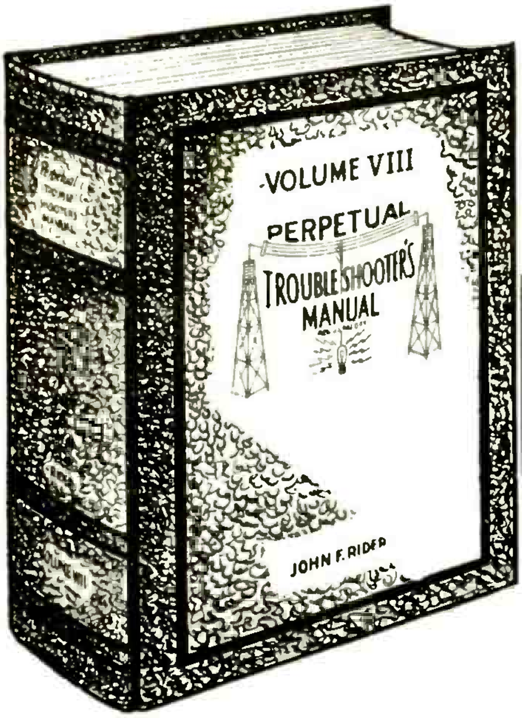

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Radio-Craft
FOR THE SERVICE MAN · DEALER · RADIOTRICIAN
"Takes the Resistance out of Radio"

Editorial Offices: 99 Hudson St., New York, N. Y. HUGO GERNSBACK, Editor Vol. IX, No. 5, November, 1937

RADIO AS A VOCATION*

An Editorial by HUGO GERNSBACK

IT IS estimated from best available sources that the radio industry as a whole today employs no less than one hundred and fifty thousand** men in all its branches. This includes everybody, from the lowest-paid radio assembler girl up to the highest-paid radio executive. In between, we run the entire gamut of all classes of radio men and *the classification of all of them would take more space than this printed page!*

The young man eager to enter the radio field today has a tremendous field before him with numerous branches of the industry from which to choose. Each succeeding year, new sub-divisions of the various branches are being added and the field constantly expands and keeps enlarging. The major branches of radio today may be roughly summarized as follows:

Radio set manufacturing, radio tube manufacturing, radio parts manufacturing, television, general electronics, radio broadcasting, radio servicing; and a great many minor branches.

I constantly receive letters from young men who write to me that they "wish to get into the radio game." As a rule, the writers do not state their qualifications or their educational background, and it is almost impossible, without closely questioning the subject, to determine just where he will fit in best. It is useless to speak in generalities to these people without having made a careful survey of their mental equipment. One man might fit in well as a Service Man and might make a success of it, while the same man as a research engineer or broadcasting engineer would be totally unfit. For this reason, it is impossible to give hard and fast rules, it being impracticable for the outsider to arrive at any definite conclusion.

We cannot all be radio executives or research engineers of high order. We may not have the right mental equipment for this. In many ways, the college graduate who has taken up electrical engineering is fitted for an entirely different capacity than the man who has only a high school education; but, of course, there are exceptions. Some of our best radio executives have had no college education. Here then, again, the mental equipment and other educational background play a big role. No two cases are ever alike for two men. No two men will react exactly alike; or will their likes be exactly the same; or will they fit into the same position equally well.

There is, however, a general rule—that may be summarized in *one word*—which the young man who wishes to enter the radio industry should be told about. In the first place, what are his personal likes in the matter? What are the goals he is striving for? Some men who wish to reach the top do not care how low they start; anything that comes along will be taken as the first rung of the ladder to be climbed. Others have fixed ideas as to what they wish to tackle. My own recommendation to would-be aspirants to a position of importance in the radio industry has always been expressed in one word—"*Specialization.*"

What the radio industry of today needs more than anything else is specialists in the various branches. There are too many half-baked, irresponsible young men who just hold down jobs and never get anywhere. These form by far the largest percentage of the total manpower of the radio industry. *It is the minority who specialize, and who, as a rule, get somewhere.*

And it makes little difference in this respect whether they are college graduates or not. Of course, if you can afford to go through college and take the various courses (always provided that you know how to take advantage of the teaching offered at college), you will emerge from college with a first-class background which will enable you to "go places" in the radio industry. By far, the greater majority of young men, however, are not so fortunate. They find it necessary to earn a living after they leave high school. A large proportion of these either take a good radio correspondence course or visit a resident school for a number of months. Others, who cannot afford this, get their entire knowledge from practical work in the field and from radio books and publications. In the end, it all amounts to the same thing. If they have the correct mental make-up, it will get them just as far with one type of education as with another,—and often the self-taught man has been able to go as far as the college graduate. Edison, for instance, never had better than a high school education, yet he had a mentality of the highest calibre; and most of his knowledge was gained from books and publications.

In the final analysis, everything depends upon yourself. The more you know about a given subject, the more you specialize in it; and the more you know about it the greater are the chances that you will succeed.

Coupled with this, you require other qualities. It is, for instance, not enough that you are another Edison or a Marconi unless others know about your qualifications. The world, as a rule, does not run after you, *you must put yourself ahead;* in other words, you must know how to sell yourself to the radio industry. This can only be accomplished by bringing yourself to its attention, either by personal contact, by letter writing, or by writing for various radio publications and thus getting a reputation in the radio industry.

The radio industry is no different than any other, when it comes to manpower. Competition is just as keen in the radio industry, as it is in any other industry, and perhaps in many respects more so. It has, however, plenty of room for the young man of the right mental calibre. Every radio organization needs good men and is willing to pay their price; every organization needs specialists in their own line, men who can think for themselves, men who can do things, men with initiative, and men who believe in the future of radio. And after everything is said and done, always remember that radio is still in the earliest stage of its infancy; and that the young men who enter radio (and its legion of subdivisions) today, will "make" the great radio industry we will have tomorrow.

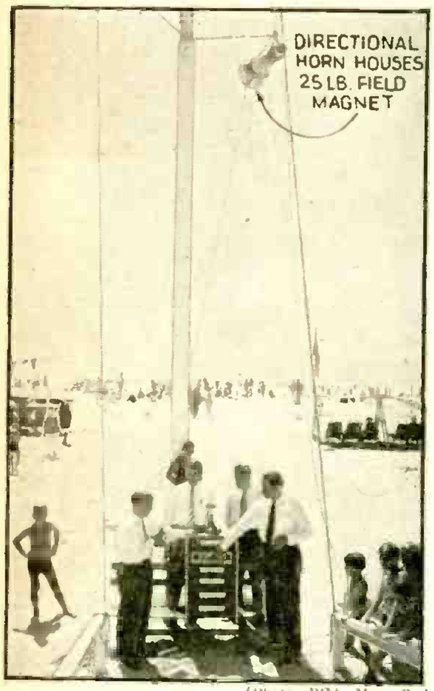
*Reprinted from November 1935 RADIO-CRAFT by popular request.

**Corrected estimate, as of 1937, 164,000.

THE RADIO

This portable ultra-S.W. transmitter is transported on a motor launch to the Cup-contending yachts.

"Cup" races at Newport last month assembled an unprecedented fleet of sail and motorized craft. A staff is here shown preparing to make a call on each competing yacht. Inquiring Reporter Dave Driscoll took his mike with extension cord, first on "Endeavor II" and then on "Ranger"; with pick-up relayed by an ultra-S.W. transmitter.



(Photo—RCA Mfg. Co.)

In place of the lifeguard's whistle, a 100-watt permanent-magnet speaker is hooked up on the beach at Atlantic City; it can even talk to a ship.

NEW SUPER-POWER HORN IS AIMABLE

7,000 CYCLES is given as the upper range of the big horn at the left, whose directional qualities give fivefold more power in its sound beam, and whose tone fidelity makes its articulation most distinct. It is intended for communication with crowds, air and water craft, etc. The permanent magnet weighs 25 lbs. and is 8 ins. in diameter; the unit is 40 ins. long and 20 ins. in diameter. As pictured, in use last month, it is mounted on a swivel to control its aim.

RADIO TUBE HELPS MAKE RADIO TUBES

"HARD" TUBES can be made only by driving off gas which burrows into metal parts; and this is done by heating them during the air-pumping. At the Bell Laboratories, as explained last month, R.F. generators are used to provide high-frequency heating, on the principle of the electric furnace. The smaller the elements, the more power must be applied to a tube; the oscillators used have more power than most broadcast stations. The R.F. coil, around the tube, must be water-cooled while it is in operation. The higher the frequency, the more efficiency; but other considerations prevent using above 1,000 kc. in this way.

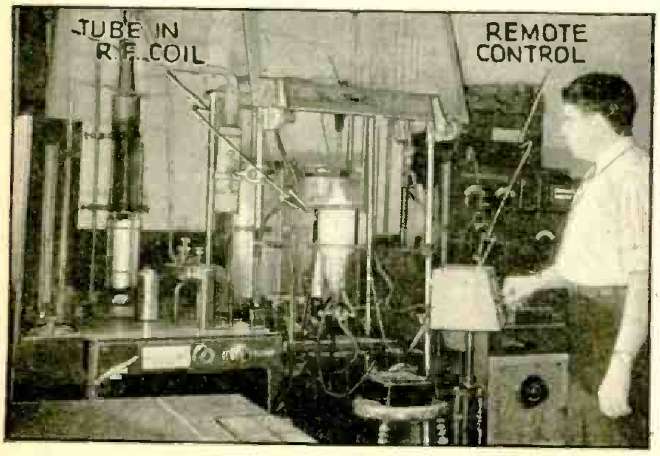
NEW APPLICATIONS OF RADIO METHODS

EARTHQUAKES might be forecast by radio, says Prof. G. G. Narki, of Bombay; he proposes that "etherical waves (similar to those used in wireless) should be utilized in the study of the internal stresses and strains in the earth's crust" somewhat as X-rays show flaws in a metal casting.

Radio has created a language, as amateurs know; but this is not understood by the public. A New York musician, Carlo Spatari, has announced the perfection of a musical language which uses the 8 notes of the scale as syllables; and is therefore adapted to broadcasting internationally. Tests are being made this month by WMCA, New York; and there are plans for an amateur network around the world.

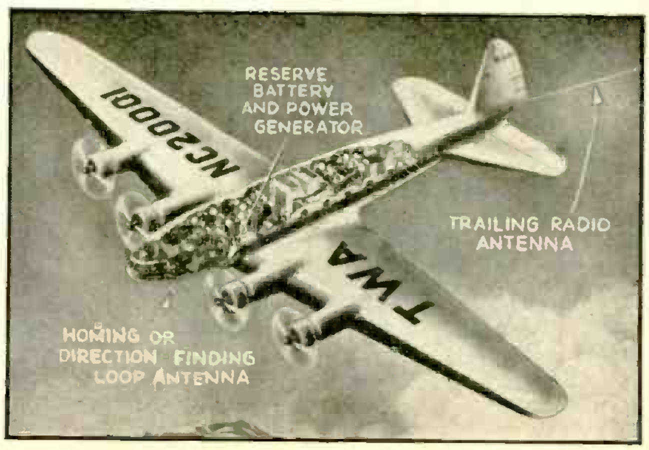
Whether or not radio waves can be felt by birds, as some are convinced, is being tested in a series of experiments begun last month at WENR, Downers Grove (Chicago) and its S.-W. station W9XF. Pigeons were released close to the antenna during a broadcast. The first experiments failed to show any effect of long waves (WENR's signals).

Abscessed teeth, say two German physicians, Drs. Gutzeit and Kuechlin, can not only be treated, but diagnosed, by the use of short waves, according to an abstract in the *Journal of the American Medical Association* last month. If teeth are centers of infection, poisoning the system, a blood test within 4 hours after treatment will show the effect.



(Photo—Bell Tel. Labs.)

An engineer operates the remote control of a 35-kw. oscillator, which feeds its output at from 250 up to 1,000 kc., into a coil surrounding vacuum tube being exhausted. This is to drive out gas from the tube elements.



1938 styles in passenger planes, to fly at high altitudes, carry newly-developed receivers for communication as well as beacon and radio-direction reception; also "marker" receivers for "cone-of-silence" and "fan" markers of fields and hazards.

MONTH 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.

To petition for improvement of Jones Inlet, Long Island, 500 boats paraded before U. S. engineers last month. Four vessels, equipped with 2-way radio sets, directed the flotilla in regular formation.

Cries of petrels (birds of stormy weather) were picked up last month on Kents Island, N. B. (Canada), with a microphone and relayed by short wave to Grand Manan Island, the nearest place where sound recording apparatus could be located, and registered on film.

ODDS AND ENDS IN NEWS OF RADIO

CHANGE of policy in the FCC is forecast by the press with the appointment by the president of Frank R. McNinch of the Federal Power Commission to be chairman of the FCC, in place of the late Anning S. Prall; and T. A. M. Craven, chief engineer of the FCC, to succeed Comm. Stewart, whose term expired. It is expressly understood that the former appointment is of a temporary nature.

The radio telegraphists' union (RTA) has changed its name to ACA (American Communications Ass'n.) as part of a campaign in connection with CIO to organize the whole electrical communications industry. The Associated Actors and Artists of America, to whom Equity (actors' union) has surrendered jurisdiction over radio performers, will operate under the A. F. of L.

To pick up a golf match, without disturbing temperamental stars, Announcer Husing has acquired a telescopic periscope which can view the situation from behind the crowd. Incidentally, columnists discuss the question of "bootlegged" broadcasts of athletic events from outside a field; and of interference with such broadcasts by rivals who have purchased "rights."

New York City will have 2-way radio on its police cars within 6 months, Superintendent Morris stated last month; since the system was adopted 5 years ago, 19,000 arrests have been made, and $5,300,000 of stolen property recovered with the aid of radio. On the other hand, the state of Ohio last month dropped from the 8-state radio police system, because the legislature failed to supply funds for station operation!

"I believe that sooner than many of us realize, television will be established in homes throughout the country," said President Roosevelt in a letter congratulating the NBC on their new television-anticipating Washington studios last month: "Indeed, it may not be long before radio will make it possible for us to visualize at the breakfast table the front pages of daily newspapers or news reports, no matter how remote we may be."

GERMAN RADIO GETS PAT ON BACK

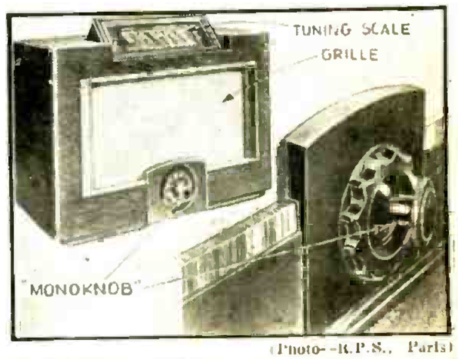
IN THE PAST year (as figures printed in our October issue show) Germany became second only to the U. S. in number of radio sets owned. Dr. Goebbels, minister of propaganda, at the opening of the Berlin Radio Show, last month, said there has been a drop of 20% to 30%, in prices, and a new "people's set" is now available at 59 marks ($24) in mass quantities. He praised the high standard of present German programs, compared with the "shoddy semi-advertisements of a few years ago."

It is reported that a German gadget

(Continued on page 311)

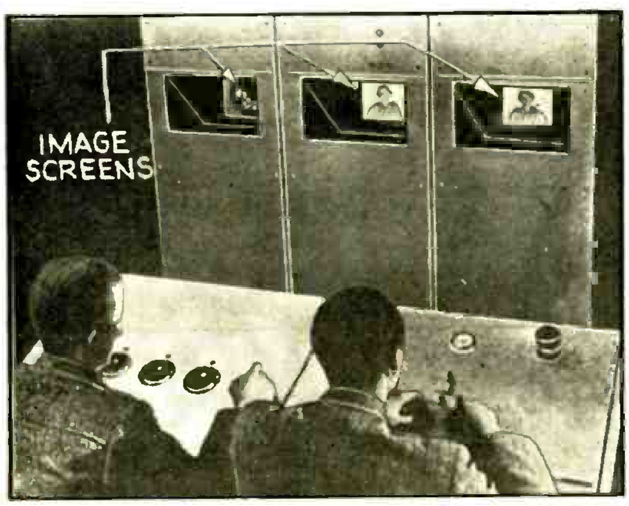
(Photo—Globe)

This radio robot, now intriguing German audiences, is assembled by "Prof. Mewu", an American entertainer, on the stage. It tells time, makes computations, sings, etc., at the command of the master, through a microphone.



(Photo—R.P.S., Paris)

The "Monoknob" of this Philips 6-tube super., exhibited in Berlin, swings up, down and sidewise, as well as turns. It controls on-off, tone, wavebands and volume, as well as tuning.



(Photo—R.P.S., Paris)

Engineers, monitoring the pick-up of 441-line television programs, and controlling the output, at Berlin Radio Show. Several programs can be transmitted at once. Thirty receivers have been installed in the exhibition rooms. A 729-line set is exhibited, but not commercialized.

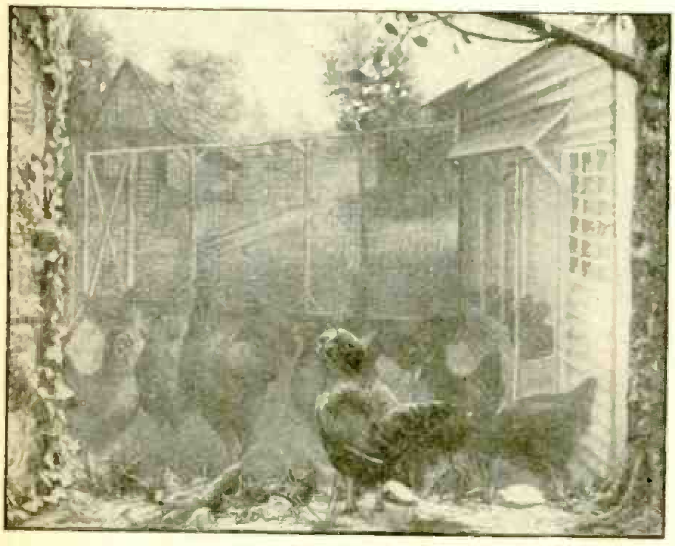
(Photo—Bell Tel. Labs.)

Magnetic steel tape (improved "telegraphone") system is in use at Hightstown, N. J., as a robot agricultural announcing system. Potato growers, 10 at once, can call the announcing number, and listen-in to price information. Announcements are recorded through the microphone on a second tape.

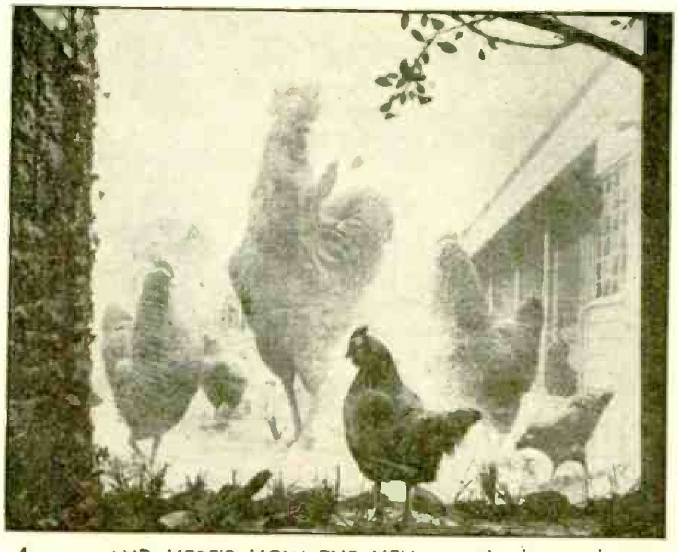
RADIO INVADES THE MUSEUM!

1 A NOVEL EXHIBIT, in the American Museum of Natural History in New York City, in which visitors view scenes in the perspective of fowl and fish. The seemingly changing scenes are actually stationary but are "transformed" by automatic manipulation of lighting effects. As the spectator approaches the exhibit he "cuts" a light beam . . . .

2 . . . . INSTANTLY, an automatic electric phonograph starts up and the announcer's voice issues from the loudspeaker. "This exhibit," he begins and rambles on into an interesting discussion illustrated by changing scenes. On the recording, at intervals, are specially-cut grooves which actuate relays controlling the lights. Then . . . .



3 . . . . "IN THIS SCENE," continues the voice, "is a typical farm barnyard as the human eye sees it." Soon the perspective of the scene changes and the museum visitors view it as the hen in the foreground would see it. Similarly the visitors' normal view of a room will suddenly change and they then see how the same room appears to a dog. Another "transformation" enables the visitor to see what the world looks like through the eyes of fish. The exhibit is extremely interesting and quite educational. We learn, for instance, that the much detested housefly sees all objects in mosaic form. These exhibits were arranged by Dr. G. Kingsley Noble, Curator of Experimental Biology.



4 . . . . AND HERE'S HOW THE HEN sees the barnyard scene illustrated in photograph 3. Each exhibit comprises 2 painted gauze screens, spaced a short distance behind each other. On the front screen is painted the "normal" (human) view; while on the back screen, a built-up view of the same scene as viewed through the eyes of the hen, dog, etc. Upon illuminating the front of screen No. 1 its "human" view can be seen. But when the space *between* the screens is illuminated the scene on screen No. 1 fades and through transparent screen No. 1 can be seen the view on screen No. 2. The animal (hen) on the first screen is superimposed on the screen of the second one, thereby showing the animal's perspective ("hen's-eye-view").

RECENT APPLICATIONS OF THE "ELECTRIC EYE"

A well-presented, highly-enlightening treatise on the application of photoelectric cells to scientific fields other than Radio—specifically, Chemistry, Biology, Physiology, etc.

K. GUENTER PART I

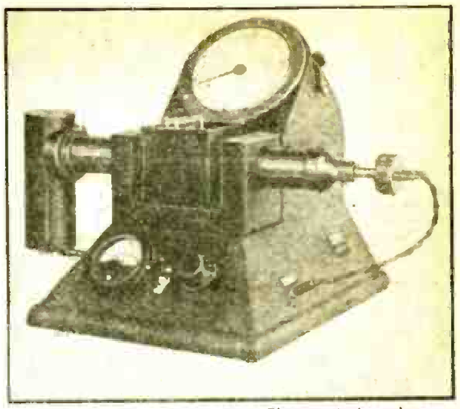


Fig. A. The Automatic Electrophotometer.

THIS ARTICLE will not dwell upon those uses of photocells which have become almost a commonplace: burglar alarms, automatic door openers, photographic exposure meters, or sound film reproduction. Instead, attention will be focused on apparatus which have been developed for the use of the chemist, particularly of the analyst, or for the solution of problems confronting biologists. This is done in the expectation that devices which are helping the men in the laboratory today may find some general application tomorrow.

PHOTOCELL FUNDAMENTALS

Barrier-Layer or Rectifier Photocell. To begin with, let me remind you of some fundamental characteristics of modern photocells. There are the *barrier-layer* or *rectifier* type cells, well-known examples of which are the Weston Photronic cell, or the Photox cell of another make.

Essentially, such cells consist of a copper disc with a coating of copper oxide on the front surface, and a thin metallic film on top of this. When light falls on this cell, an electromotive force is set up in the system (the *Becquerel effect*). The theory of these cells is quite complex and still somewhat hazy. For our purposes it is sufficient to know that such "photo-voltaic" cells constitute miniature light-operated generators which transform radiant light energy into electric current. As a matter of fact, hopes are being pinned on such cells to solve ultimately the problem of deriving power from sunlight, a problem which has attracted the best minds of all ages. Probably you have read in the newspapers a little while ago that Bruno Lange, a leading man in the field of the rectifier cell, succeeded in driving a very small and very light electromotor by exposing a large cell of this kind to bright sunlight.

These cells have some desirable and some undesirable properties: The former are, for instance, that (1) they require no driving potential; (2) they are very compact and sturdy; and, (3) their sensitivity to the visible colors of the spectrum resembles closely the color sensitivity of the human eye.

Their undesirable features are: (1) high sensitivity against radiant heat (infra-red rays) and temperature changes in general; (2) low sensitivity against light of short wavelength (violet and ultraviolet rays); (3) comparatively slow response to light; and, (4) decreasing light-sensitivity with age.

Even if we take all these drawbacks into account, there remains plenty to their credit, especially if we think of the predecessors, the almost obsolete selenium cells. The chances are that these cheap cells will find an ever widening field of operation, especially once they have been cured of their childhood diseases.

Glass-Enclosed Vacuum or Gas-Filled Photocell. This does not mean, however, that the bigger brother of the rectifier cell, the *glass-enclosed vacuum* or *gas-filled* photocell, will have to lose out in the race of competition. These cells, which show some resemblance to electron tubes in their exterior, contain a light-sensitive plate (cathode) and a suitably formed anode. High voltage (up to 100 volts) is applied to the anode. When light strikes the cathode a stream of electrons is liberated (*Hallwachs effect*). This stream is attracted by the anode.

The response of the vacuum-type cell is strictly linear to the light intensity, whereas in the cells filled with rare

(Continued on page 298)

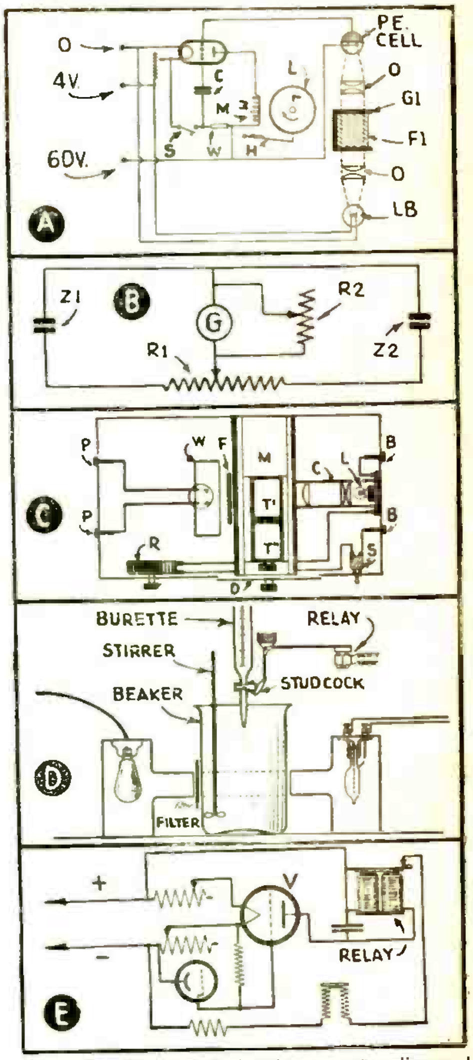


Fig. 1. Details of photoelectric apparatus discussed in the text. At A, the Automatic Electrophotometer; B, the Colorimeter; C, simple Photometer; D and E, Automatic Titration Apparatus.

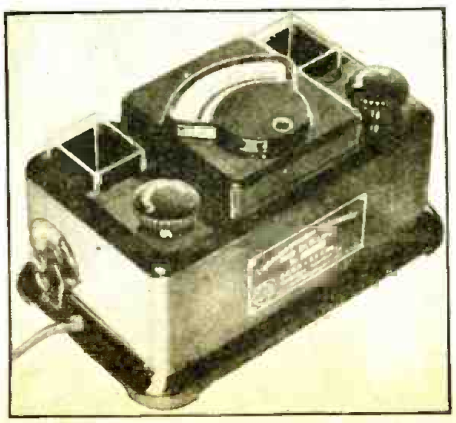


Fig. B. Appearance of photoelectric Colorimeter.

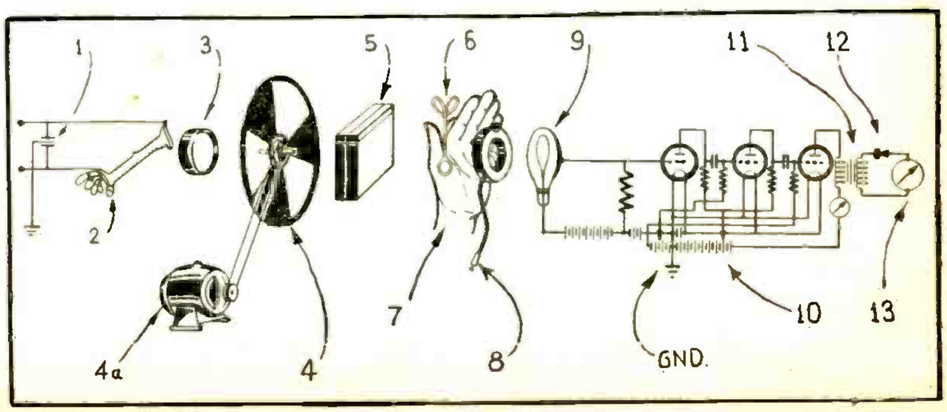


Fig. 2. Apparatus for studying physiological functions of components of living organisms.

Fig. A. Rooting-section now utilizes P.A.; perhaps the cheerleader will suffice as a 1-man "crew"!

MODERN "RADIO" AS A VOCATION

"Although the ether is a comparatively new means of communication and lends itself in many useful ways, we find ourselves continually amazed at things which have been accomplished and the development of future potentialities."

President Franklin D. Roosevelt

R. D. WASHBURNE

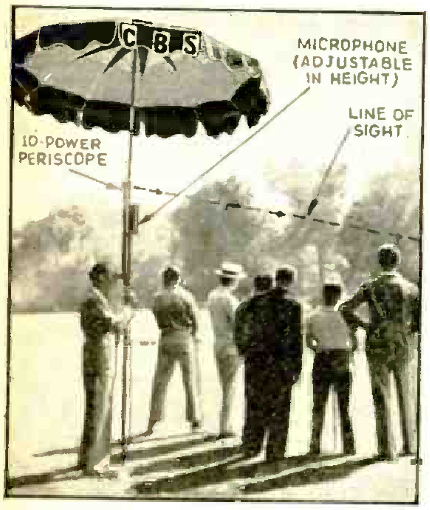


Fig. B. Ted Husing no longer need clamber up trees, to prevent disconcerting the player "away," when broadcasting putting portions of a golf match. An umbrella protects a 10-power periscope; and a movable "mike" wired to a nearby short-wave radiophone transmitter.

"RADIO" is now a term so broad in its scope as to entail explanation almost every time it is used. Whereas formerly it was generally accepted as a reference to radio program reception and transmission, today, it also may be taken as reference to either the Electronic or Public-Address field. Therefore when a person says he is going to "take up radio" it becomes logical to ask whether his interest lies in (1) Radio (program reception and transmission), (2) Electronics, or (3) Public Address.

Since both electronics and public address depend for their existence upon "radio instrumentalities"—that is, apparatus, mainly vacuum tubes and in the latter instance loudspeakers, used in radio program reception and transmission—the close relation of all 3 fields becomes evident.

Discussing the moneymaking or "vocation" possibilities of radio it then becomes necessary for us to review recent progress in *Radio, Electronics* and *Public Address*. With this in mind the writer will now touch lightly upon some of the more outstanding, recent developments in these 3 fields; the items have been selected for their value as windvanes that may show the direction which is being taken by "radio" progress.

PUBLIC ADDRESS

During the last year Public Address seems to have awakened from its lethargy, having exhibited more development in equipment design and operational technique than in any preceding 12 months. A detailed analysis of the improvements that have been effected in microphone, amplifier, and loudspeaker design and the facility in handling that these improvements made

(*Continued on page* 296)

Fig. C. 2-WAY POLICE-RADIO AUTO SPEEDTRAP!

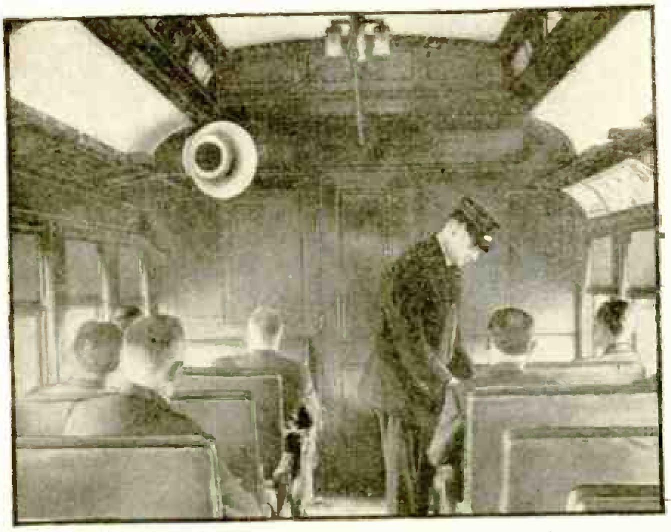
An outpost spotter . . . radiophones warning to checking crew 770 ft. ahead. A motorcycle cop . . . hands speeding motorist a ticket!

THE "IRON HORSE" WIRED FOR SOUND!

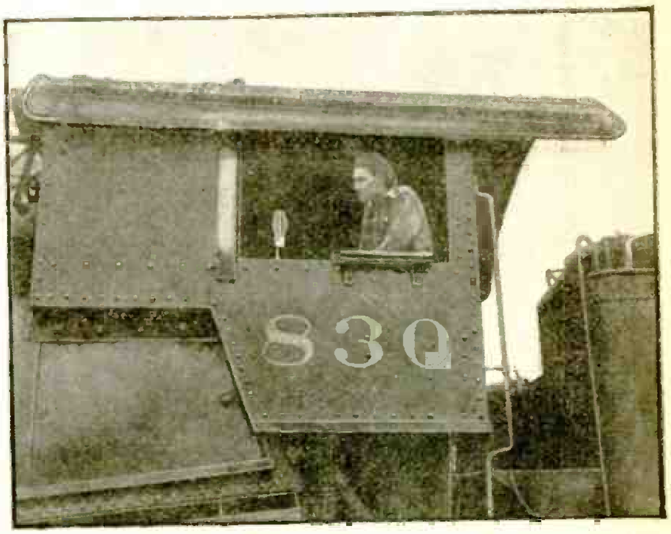
SOUP'S ON! This fortunate waiter has reason to be happy, for his musical chime, sent over the new P.A. system, instantly informs everyone that "dinner is now being served in the dining car."

ANOTHER STEP FORWARD for the railroad! Sight-seeing trains equipped with P.A. systems and guides who describe every point of interest along the "right-of-way" have been placed in operation on the lines of the Central Railroad of New Jersey. Many of these sight-seeing trips cover as many as 300 miles "at a clip" during which the passengers are entertained by a well-trained guide ordinarily stationed in the baggage car of the train. Dinner time is announced over the system through the chiming of bells and is heard simultaneously in all cars. Musical selections from time to time, interspersed with pleasantries from the microphone in the engineers' cab, help while away the time pleasantly. Another interesting feature is the announcement of conductors' names as they pass through their respective cars, introducing them to the passengers and thereby creating a pleasant atmosphere. The idea is sure "taking hold!"

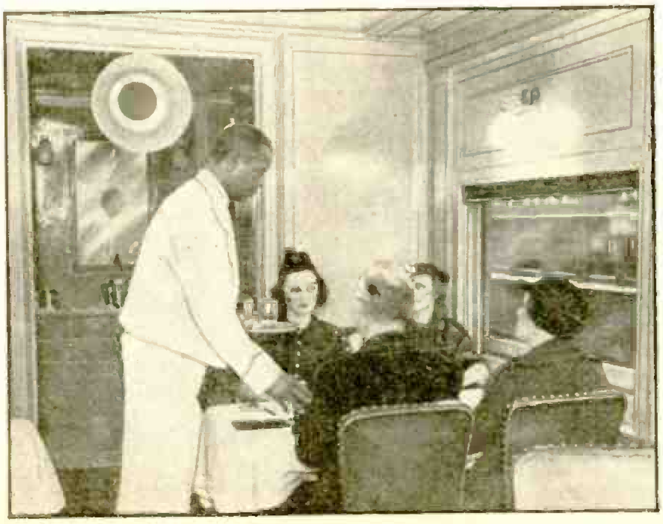
"AT THE RIGHT YOU WILL SEE . . . ," Mr. B. D. Branch, general passenger agent acting as guide on one of the trips, watches and describes, interesting landmarks in the passing scene.



MUSIC IN THE SMOKER! The smoking car, favorite with male passengers, always seemed to lack something. Now it has that "something." The loudspeaker installed in the upper-left hand corner delivers the scores of various sporting events, interspersed with news items, as well as music.

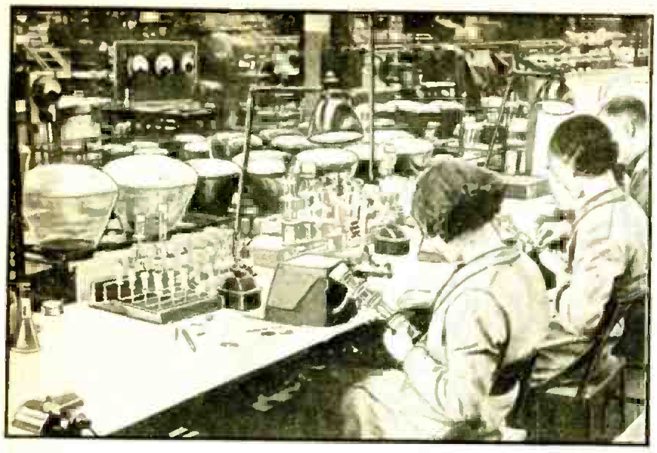


"TUNNEL AHEAD, CLOSE ALL WINDOWS!" The engineer with a microphone in his cab is now able to warn passengers of dusty and sooty tunnels; and, as well, augment the descriptions, of points of interest, of the guide. The hissing of steam and the grinding of machinery add zest to the trip.



DINE WITH MUSIC! High-class hotels and cabarets have nothing on this train diner. Dinner music is played during mealtimes. Loudspeakers are installed in the dining car as well as in all other cars. Programs are recordings and hence do not have any background noise or static.

STRANGE BAGGAGE IN THE BAGGAGE CAR! Note the phonograph and the mixing panel. By means of these controls the operator can "cut-in" the various microphones or switch-in the phonograph. The train's 32-volt lighting system operates the sound system's motor-generator set.



Photo—R.P.S.

TELEVISION-TUBE ASSEMBLY LINE. The Philips Laboratories in Eindhoven, Holland, push out cathode-ray tubes for use in television receivers almost as though they were ordinary radio receiver tubes! The cathode-ray tube becomes practically worthless unless almost superhuman accuracy in assembly is maintained; experts are here shown working on the "stem assembly."

IS TELEVISION IN AMERICA ASLEEP?

The author of this article, a well-known pioneer in the electronic field, has just returned from Europe. Read his frank opinions concerning overseas television.

ALLEN B. DuMONT

EUROPE is pioneering in commercialized television and thereby pulling ahead of us by leaps and bounds, I find, after having recently visited leading workers in England, France, Belgium and Holland (thereby securing a true insight as to Europe's television situation).

We might better imitate our English friends in commercializing our own achievements, instead of voicing so much loose talk. Instead of promising and predicting and boasting, the English have gone ahead with regular television broadcasting which, in turn, has given rise to a very sizable television industry. I venture to say that our overseas friends have learned more in 6 *months* of such practical efforts than we can learn in 6 more *years* of continued laboratory work behind more or less sealed doors.

TELEVISION AN "EVOLUTION," NOT "INVENTION"

As I see it, television is an evolution and not a single invention. It is a development that must come out of practical experience. Kept in the laboratory for another few years, if that be the unfortunate decision of our radio leaders, we may not know the right answers relative to (1) *technique*, (2) *program*, (3) *service areas*, (4) *networks* and (5) *economics* until we have made a real "try". So the sooner American television goes on a *regular program basis*, with television sets made available to the public—regardless how crude and no matter what the obstacles may be—the sooner we are going to realize practical television.

I was pleasantly surprised to see the British Broadcasting Corporation (or "BBC") operating a television station in the Alexandra Palace, overlooking London. The Palace is surmounted by a mast about 300 ft. tall, making a total height of about 600 ft. The 17-kw. television transmitter sends out its television programs on 6.9 meters.

QUASI-OPTICAL THEORY SHATTERED

With regard to the service range of television transmitters, our English friends have somewhat shattered that "quasi-optical" theory. We have been led to believe that the range is virtually the distance one can see from the television aerial. In other words, signals are not supposed to go beyond the horizon, on the short waves used. Yet the London transmitter is covering a service area of better than 100 miles' radius, and on freak occasions the signals are being picked up at a very great distance, such as in South Africa! (and in the U. S.!; and conversely, BBC has picked up 6-meter television —both audio *and* video—signals originating here in America! These, however, still must be considered only freak performances.—*Editor*) The great covering power of television signals is undoubtedly due to the high sensitivity of the receivers, plus the fact that there is very little static interference on such short waves.

TELEVISION SANS "COAXIAL"

Another fetish blown up by our practical English workers is the absolute need for special coaxial cables for the transmission of television programs from pick-up source to remote television transmitter, and thence, to associated stations of a network. The BBC sends out each day its 3 *television pick-up vans*, in search of interesting news and sporting events. Each truck is completely equipped with cathode-ray tube cameras, microphones, amplifiers, and low-power transmitters operating on about 3½ meters. Sight-and-sound programs are flashed back to the Alexandra Palace station for re-broadcasting to the audience.

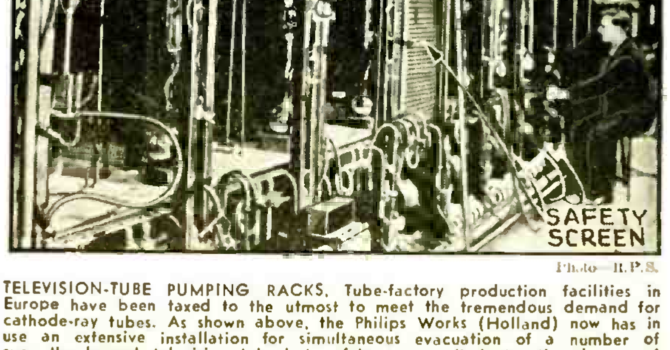
WIMBLEDON TENNIS MATCHES HAD "HOME-TALKIE" QUALITY

I had the pleasure of following the Wimbledon tennis matches via television. The pictures measured about 10 x 12 ins. The pictorial detail was excellent—fully on a par with good home movies. The synchronized sound provides virtually a radio talking movie.

(Incidentally, the Japan Broadcasting Corp. plans to make direct television views of the 1940 Olympic Games to be held in Tokyo available to homes throughout Japan—or, at least, within the limits of Greater Tokyo—according to recent reports!—*Editor*)

The British are using a 405-line screen, with 25 pictures per second, interlaced scanning. There is no flicker, nor is there apparent screen pattern when viewed at the same relative distance as a theatre screen. By holding one's hand at arm's length, with outstretched palm just masking the

(*Continued on page* 306)



Photo—R.P.S.

TELEVISION-TUBE PUMPING RACKS. Tube-factory production facilities in Europe have been taxed to the utmost to meet the tremendous demand for cathode-ray tubes. As shown above, the Philips Works (Holland) now has in use an extensive installation for simultaneous evacuation of a number of even the largest television tubes! A safety screen eliminates the danger of shock from high voltages when the pumping racks are in operation.

"SNOW STATIC" BEING BEATEN BY "FLYING LABORATORY"

If this article whets interest—by showing the extent and importance of *just one phase* of radio engineering designed to make flying safer—in aviation-radio as a vocation we will feel amply repaid in having selected this story for RADIO-CRAFT readers.

H. M. HUCKE PART I

SNOW STATIC was first recognized as such about the time radio equipment was first installed on commercial air transports in 1929. Its effects were not serious since most flying at that time was done by contact observation of the ground and not by instruments and radio, coupled with the fact that aircraft cruising speeds were relatively slow. As instrument flying came into vogue along about 1933, along with faster planes, the reliance placed upon radio beacon reception increased and the effects of all static were more generally recognized. Pilot complaints of snow static interference very steadily increased until in February, of this year, at a Safety Conference in Washington it was discussed at length. *As a result of these discussions on March 3, the Department of Commerce issued an order requiring anti-snow static antennas to be installed on all transport aircraft by November 1, 1937.*

Two types of atmospheric static interference are normally experienced in aircraft reception: (1) lightning static; and, (2) snow static. The first type consists of short, intermittent crashes which result from lightning flashes. The second type is peculiar to air transportation in that it is normally only experienced on aircraft when they attain speeds exceeding 100 miles per hour.

This second type of static is classified under the general heading of "snow static," although the identical effects are experienced in ice crystals, rain, hail, snow, and dust storms. Normally, it is only experienced while flying through clouds containing moisture or dust particles and is usually recognized as a combination of noises containing frying sounds, intermittent or regular crackling, and a characteristic musical "crying" during which the noises run up and down the audible musical scale. In thunder storms and line squall conditions, the phenomena of "snow static" has been experienced at ground stations when the wind was of sufficient velocity to blow the water or dust particles past the ground station antennas so rapidly as to simulate the effect of speed in aircraft flight.

Snow static interference was probably observed as early as before the World War at ground radio stations but was not recognized as such. Between 1925 and 1930 it was observed that *metallically-shielded loop direction finders* used on Great Lakes steamships gave reception in snow storms when reception on regular antennas was obscured by static. In 1930 a radio engineer of National Air Transport division of United Air Lines in Cleveland covered a plane antenna with friction tape in an effort to reduce snow static. In 1932 United equipped its entire fleet with special rubber-covered antennas in an effort to reduce the difficulty. These systems presumed that the noise was due to impinging charged moisture particles. This method proved unsuccessful. Early in 1935 Mr. D. S. Little of the RCA Aviation Division recalled the Great Lakes steamship experience and suggested the first practical efforts toward improvement. Following his

(Continued on page 306)

STATIC-PROOF PLANE? Equipped with several unique inventions designed to eliminate rain and snow static that occasionally interferes with 2-way short-wave aircraft radio reception, this "flying laboratory" of United Air Lines is making a series of far-reaching tests which may unlock the problem of static suppression. Four special anti-static antennas, developed in United's technical and research laboratories, are installed on this twin-engined airliner. They include the football-shaped device mounted on top of the plane's nose, the "ring-in-the-nose" type projecting from the nose, and a rotatable ring under the belly of the ship. The 4th type is installed inside the plane. The thin shafts, LR, projecting downward from the nose and from the side are "lightning rods" designed to discharge static collected by the metal skin of the transport. (Pilot Bert Ball, left, and the author, H. M. Hucke, chief of United's communications laboratories.)

TEST NEW AIRPLANE AID. The football-like object on the nose of this United Air Lines "flying laboratory" is actually a stream-lined "tear-drop" anti-static antenna developed by the airline's engineers as a possible solution to the problem of eliminating interference from rain and snow static which sometimes hampers plane-ground radio communication. Test Pilot Bert Ball and Copilot Walter Briggs (holding microphone) are now piloting United's flying laboratory while 8 radio engineers and technicians in the cabin of the plane test this and other devices intended to eliminate static interference.

3-MILE-A-MINUTE EXPERIMENTS IN "FLYING LABORATORY" SOLVE AIRCRAFT-RADIO STATIC MYSTERY. While their flying laboratory speeds along at 3 miles a minute, these United Air Lines technicians (N. E. Klein and H. W. DeWeese, left and right, respectively record their effectiveness of several new types of anti-static aircraft radio antenna developed by company engineers. Upholstered chairs of the big airliner have been replaced by a test stand with delicate recording devices with which the engineers check their success in their battle against rain and snow static which occasionally interferes with plane-ground radio communication. Stripping the mystery from static, engineers aboard the "flying lab." disproved former theories concerning air static and developed the *real* causes of this communication interference. Company engineers are hopeful that one of the new devices now being tested will solve the problem.

INTERNATIONAL RADIO REVIEW

RADIO-CRAFT receives hundreds of magazines from all parts of the world. Since the cost of subscribing to each of these would be prohibitive for most radio men, we have arranged with technical translators to prepare reviews for our readers.

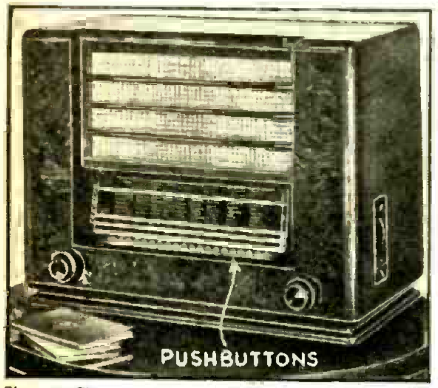


Fig. A. The new German automatic button-tuning receiver recently displayed at the 1937 Berlin Radio Salon. Any one of 20 favorite stations may be preset and henceforth tuned-in by merely pressing a button. Tuning is quite simple and more accurate than could be obtained manually.

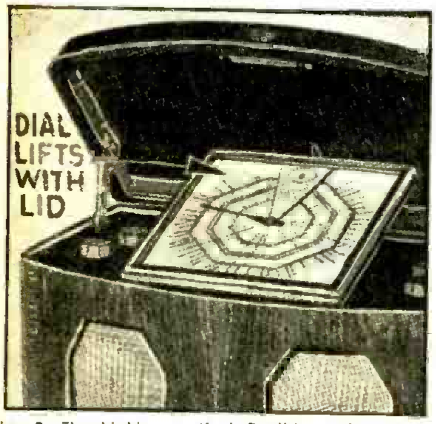


Fig. B. The highly practical English version of a "full-vision" dial. The 10-in. scale tuning dial automatically lifts into a tilted position when the lid of the cabinet is raised.

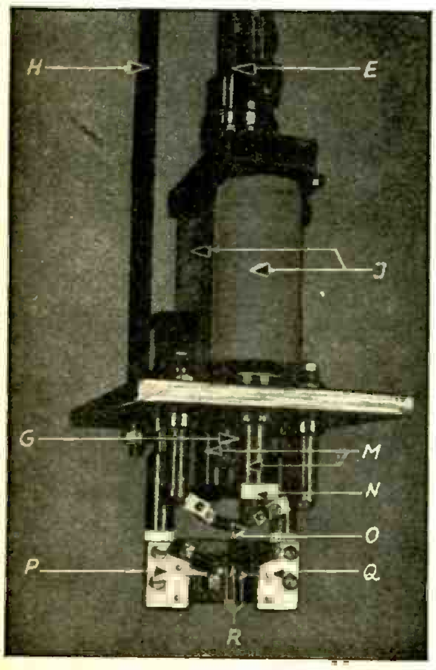


Fig. C. New German giant high-power "vibrator" has a capacity of 5 kw. A mercury stream lashes back and forth like a whip.

GERMAN PUSHBUTTON-TUNING RECEIVER

ILLUSTRATED in Fig. A is the latest-type pushbutton-tuning receiver recently displayed at the 1937 Berlin Radio Show held in the Berlin Radio Salon. It is a well-designed all-wave receiver on which any one of 20 stations may be tuned-in automatically by merely pressing one of 20 buttons. American pushbutton receivers generally have up to only 8 or 10 such buttons. Hence this German receiver offers a greater variety of automatically-tuned stations. London, Berlin, Milan, Vienna, Paris—all these may be button-tuned.

A large, rectangular dial, illuminated, makes the logging of stations quite a simple matter and eliminates crowding. Any given button is pressed until the indicator on the dial comes to rest; then as the button is released the program instantly starts.

AUTOMATIC TILTING TUNING DIAL

A VERY novel English receiver in which a large 10-in.-square tuning dial tilts forward as the lid of the cabinet is opened was described in a recent issue of *Wireless World* (London). This action, taking place automatically, provides easy readability without the necessity of uncomfortable stooping. This is one of the largest dials ever to be used on a home-type broadcast receiver. It is claimed to have met with great popularity. An additional feature is the use of twin speakers. The set is an all-wave superheterodyne. See Fig. B.

GIANT VIBRATOR RECTIFIES 1,000 VOLTS AND 1,000 AMPERES

IN THIS revolutionary vibrator, designed by Austrian engineers and described in a recent issue of *Wissenschaft und Technik*, a beam of mercury replaces the vibrating reed. This beam of mercury is projected under heavy pressure and by means of magnetic fields whips back and forth between 2 contacts. The entire apparatus is contained in an airtight housing to avoid arcing at the contacts.

The principles of operation are illustrated in Fig. 1. Here a mercury beam, J, is projected from a container, N, into an airtight chamber. During its travel it is moved rythmically back and forth between the 2 contacts E_1 and E_2 by the magnetic field, F. This back-and-forth motion is not in a straight line but rather in the form of a wave similar to that of a rope being "snaked". The sickle-shape contact, E', is used to send an alternating current from the transformer into the mercury beam. The rectified current is taken from contacts S1 and S2. V1 and V2 are load resistors. Figure C is a photograph of a 5 kw., 220 V. model rectifier unit.

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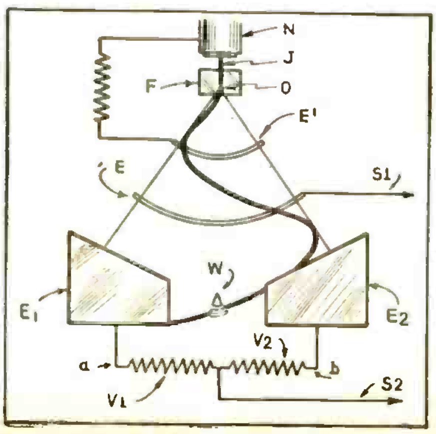

Fig. 1. Illustrating the operation of the vibrator rectifier shown in Fig. C.

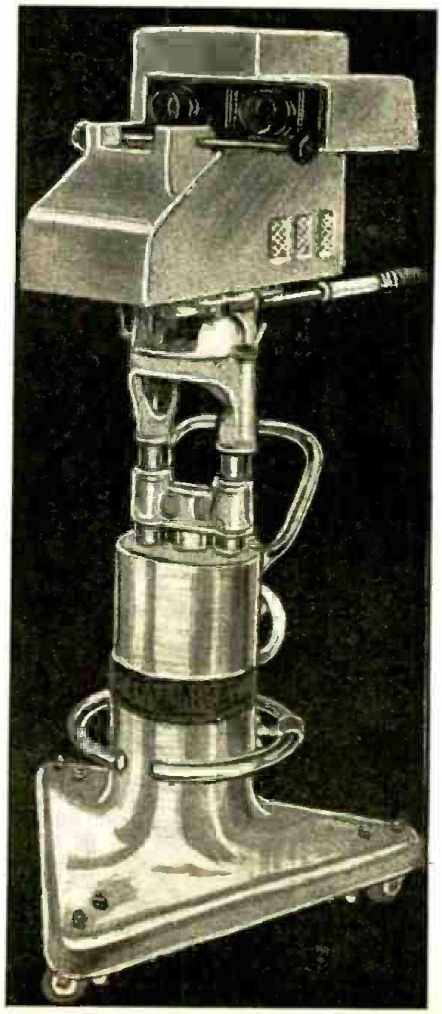

Fig. D. The new English Emitron electronic television camera. It is used in a "television truck" for televising "spot" programs.

GERMAN 8 X 10 FT. TELEVISION IMAGE

At the Berlin Radio Exhibition last month was introduced a new type of "public address" —not only the voice of the speaker was amplified but also his image! Television means made possible this new type of "P.A."

Fig. A. Photo of actual image projected on the theatre-size screen. Visitors who chanced to pass the speaker's platform at a distance found the loudspeaker reproduction enhanced by the overhead 8 x 10 ft. close-up image of the orator.

AS SHOWN in the drawing (Fig. 1) below a combination of *audio* and *video* equipment has made possible a new type of public-address set-up that is infinitely more effective than all previous public-address systems.

At the Radio Exhibition recently held in Berlin it was demonstrated that stage performance could be amplified not only as to its sound but also with respect to its visual properties. Thus for the first time it becomes possible for the "peanut gallery" to enjoy equally or to even greater extent a stage performance which heretofore could only be best appreciated by patrons of the "diamond horseshoe"; by means of television facilities persons in the balcony or low-price seats may now see the image, greatly amplified on a distant screen, of a speaker being viewed, directly and at a closer range, by persons in higher-price seats.

Figure A is an actual, unretouched view of an image as it appeared on the giant (8 x 10 ft.) screen. Better appreciation of the image fidelity will be obtained by approximating more normal viewing distance through holding the page at about arm's length.

MODUS OPERANDI

In addition to the usual sound equipment this "new" public-address set-up incorporates 3 basic elements—(1) image pick-up, (2) image illumination, and (3) screen resolution or projection and building-up (on a viewing screen) of the image.

(1) Video (image) pick-up and sound pick-up are shown in Fig. B1 combined in a "speaker's table." The 2 photocells have response characteristics that exhibit sharp cut-off to

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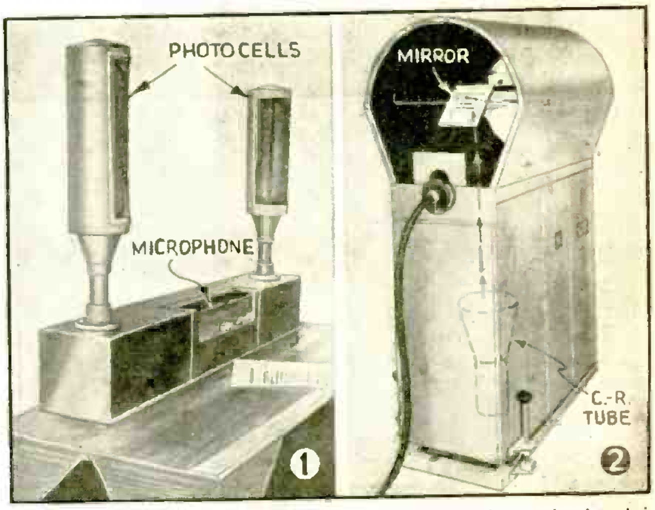


Fig. B. Something new in speakers' desks as shown at 1 was developed in order to pick up, by means of a microphone and photocells, the audio and video elements of the new P.A. system. Illumination was obtained from a cathode-ray scanner as shown above at 2.

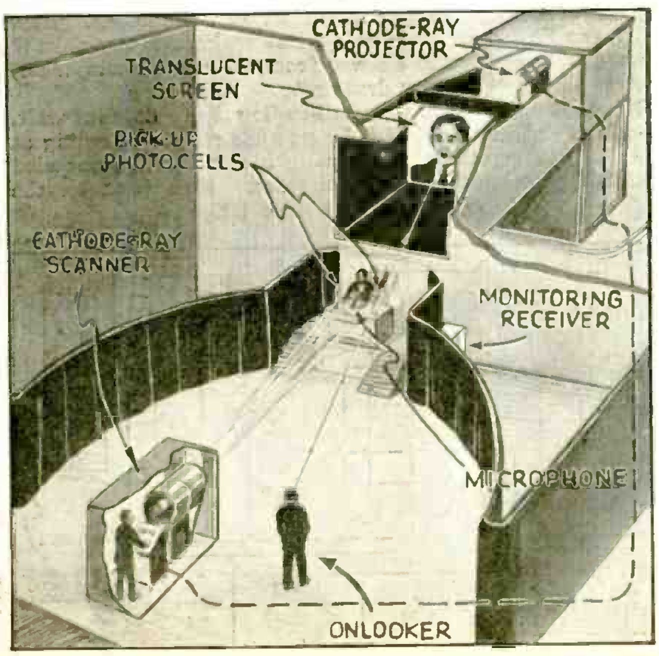


Fig. 1. Telefunken's new system of combined audio and video public address as demonstrated at the recent German Radio Exhibition. The video system incorporates image pick-up, speaker (orator) illumination, and image projection.

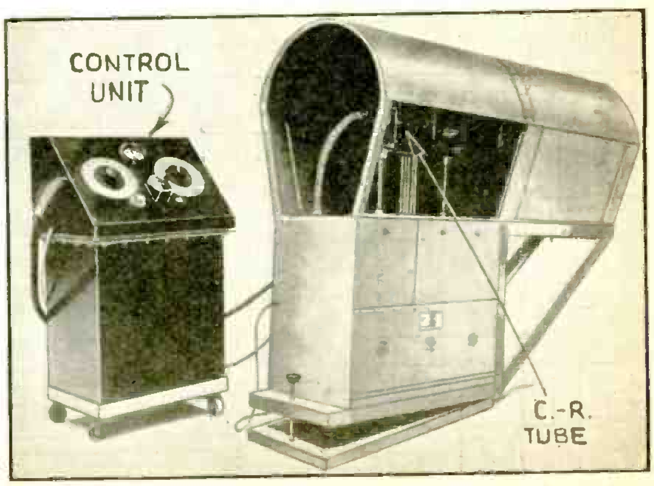
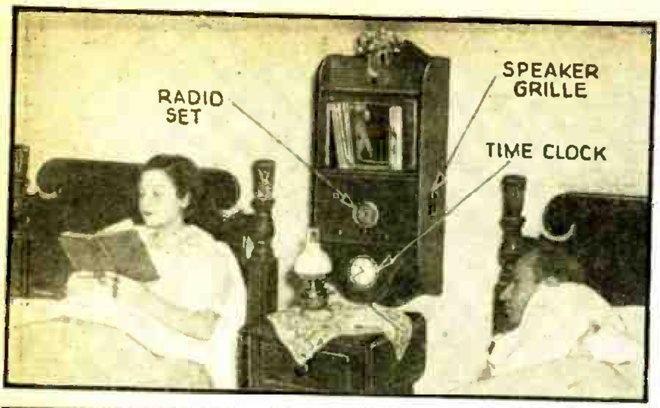
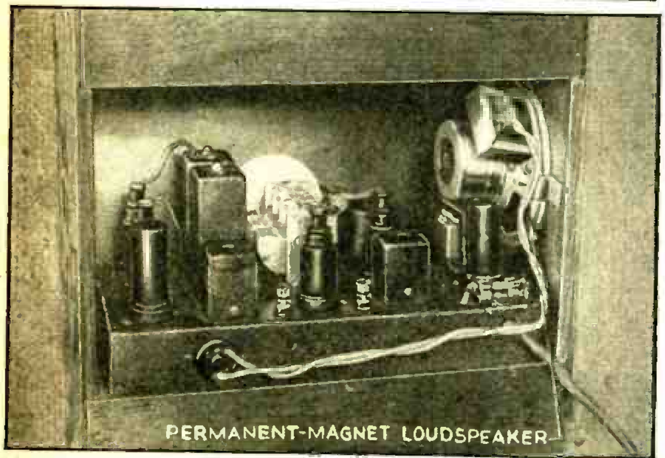
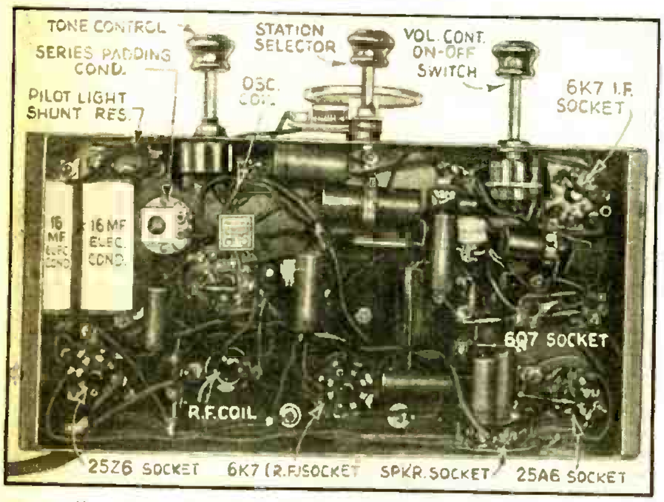


Fig. C. The output of the photocells was fed into a control unit and thence into a high-intensity cathode-ray projector, with 20,000 V. on the anode, to illuminate the 8 x 10 ft. screen; the projector incorporates a lens system.





Rear view of the set in its compartment of the cabinet. Top photo shows the completed set in actual use.



Under-chassis view of the set showing the wiring and parts.

HOW TO BUILD THE "ALARMCLOCK" WALL-RADIO SET

RADIO-CRAFT introduced the first wall-radio (Sept., 1936, issue), but, for those who "like their comfort" it's hard to beat this newer design of "ideal" home radio set.

N. H. LESSEM — PART I

A *LUXURY*, states the dictionary, is "anything that ministers to comfort or pleasure but is not necessary to life, health, sustenance, etc." . . . . so the "Alarmclock Wall-Radio" is a luxury. However, like most luxuries, after a short time we begin wondering how we were able to get along without it.

The author, having a great fondness for himself and his comfort, "concocted" the idea for this radio receiver for very obvious reasons and he will now attempt to justify its existence by taking you through a typical night's and morning's usage of it.

THE "RADIO ALARMCLOCK" A 24-HOUR SERVANT

Night and bedtime . . . . at 11 o'clock all important news of the day is received while in bed. At 11:15 the soft strains of music accompany the reading of our favorite book and slowly but surely make our eyes drowsy and heavy with sleep. At 11:45 the radio set (electrically connected with the clock switch), promptly turns itself off while we are already in heavy sleep.

Morning, and we are abruptly awakened by a bugle-call, from the loudspeaker or (if we prefer) soft morning music. A few minutes later, while we are still debating whether or not to sleep for another 10 minutes, we become conscious of a steadily-rising whistling sound coming from . . . . the electric whistling tea kettle which was automatically turned on by the time clock together with the radio receiver. So, our hot water for shaving is now ready! . . . . all done while we are still drowsing. We finish shaving and start looking around for our shirt. Not finding it, we walk over to the radio set, turn a knob and talk into the loudspeaker to our mother or wife preparing breakfast in the kitchen. "Hey, Ma," (or "Lil," your writer's wife) "where is my shirt?" Immediately comes the answer from the same loudspeaker, "It's in the lower bureau drawer."

Now you know what this wall-radio set can do! But wait, there's one other thing. If baby gets his morning feeding at 4 A.M., you set the clock to ring a small bell (concealed within the cabinet) and at the same time turn on the

(*Continued on page* 300)

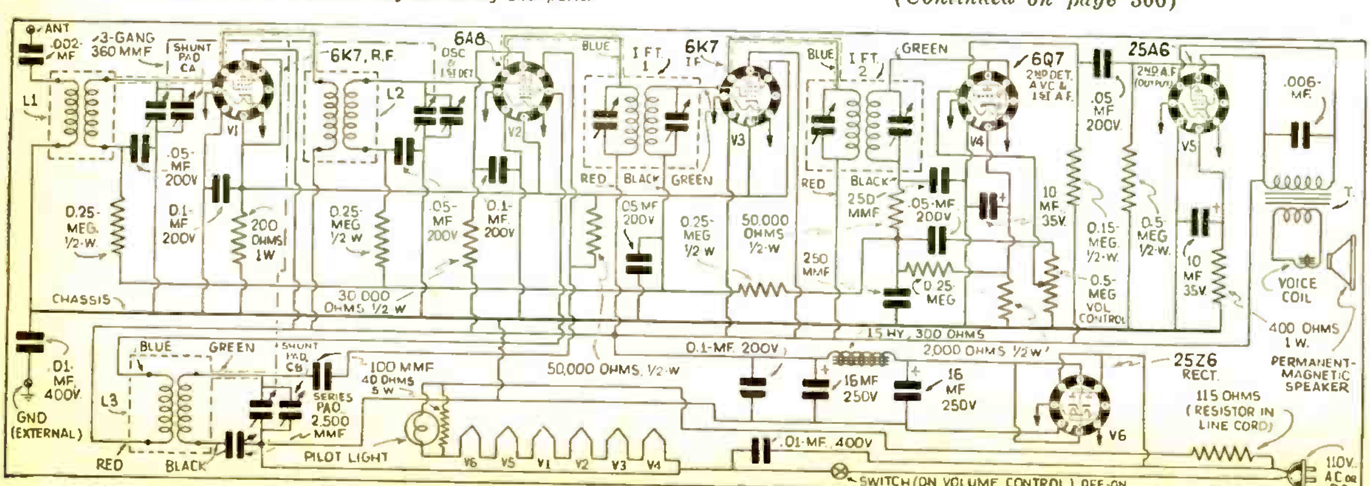


Fig. 1. Schematic diagram of the "Alarmclock" receiver. Note the shielding of some of the grid and plate leads to avoid instability.

FREQUENCY "WOBBLERS" FOR SERVICE OSCILLATORS

A discussion of basic circuits, both mechanical and electronic, for frequency "wobbulation" of signal generators when servicing with a cathode-ray oscilloscope. Every Service Man should read it.

EDWARD LOVICK, JR.

CATHODE-RAY servicing has made provision for *frequency modulation* an essential feature of the technician's laboratory signal generator ("service oscillator").

Because many Service Men build their own generators it was thought that data on frequency modulation or "wobbler" systems would be helpful.

There are 2 major classifications of wobbler systems, (1) mechanical and (2) electronic. (Many of these systems have been described in detail in past issues of *Radio-Craft.—Editor*) We shall consider the mechanical class first because it is less complex, electrically.

(1) MECHANICAL SYSTEMS

Since frequency modulation can be accomplished by any means which varies one of the constants of the tuned circuit of the generator, examples of variable capacity and inductance will be given.

Motor-Driven Variable-Condenser System. A popular system used by a reliable company is shown in Fig. 1A. A motor-driven, split-stator variable condenser and a small A.C. generator on a common shaft are used. The variable condenser is connected across the tuning condenser of the signal generator. The A.C. generator delivers the synchronizing voltage to the oscilloscope.

While synchronization is positive, hum may cause image distortion because the synchronizing voltage is other than powerline frequency. Amplitude modulation is present (output is less at one end of the band) but is not very serious and may be over-looked for ordinary aligning operations.

"Vibrating-Reed" Variable-Condenser System. Figure 1B shows another (or "vibrating reed") type of variable-capacity frequency modulation using an "A.C. magnet". The iron-core inductance alternately attracts and releases an armature made of magnetic metal (iron) which is used as one plate of a variable condenser. This condenser is connected in parallel with the tuning condenser of the generator and hence modulates the output.

Disadvantages of this system are poor synchronization and difficulty of obtaining symmetrical sweep over wide limits. Both these are the result of the magnetic plate's inertia.

Variable-Inductance System. Perhaps the most practical system of varying inductance by mechanical means is revealed in Fig. 1C. A motor-driven copper disc, mounted slant-wise on its shaft, varies the inductance of the tuned circuit. This arrangement is practical only in generators utilizing the beat principle for their lower-frequency bands. In this case the fixed oscillator is wobbled, the output from the mixing circuit being automatically wobbled. A synchronous motor is used in order to secure exact synchronization, the effective sweep is the powerline frequency.

(2) ELECTRONIC SYSTEMS

Most electronic wobblers depend upon the fact that changes in characteristics or properties of vacuum tubes may be brought about by varying their gain. These changes are utilized to affect changes in inductance or capacity, thereby varying the output frequency in accordance with the sweep frequency.

Depicted in Fig. 1D is a simple and satisfactory electronic wobbler. Condenser C is the tuning condenser of the circuit to be wobbled. It is effectively in parallel with the internal grid-to-plate capacity of the tube. The sweep voltage is applied to the control-grid of the tube and bandwidth is largely controlled by governing the amplitude of this voltage on the control-grid. Resistor R3 also controls the bandwidth to some extent, its control varying with frequency. With R3 at a constant value, bandwidth increases with frequency. Therefore, if R4, used as the bandwidth control, is to be calibrated in kilocycles bandwidth, R3 must be changed for each band that calibration is intended to be used.

The circuit of Fig. 1E was originally an automatic frequency control arrangement used to shift the oscillator to accomplish automatic tuning. It can be adapted for wobbling as shown. This system has been used in a signal generator with the values shown and gave a maximum variation of 24 kilocycles. A larger condenser in place of C1 will give somewhat greater variation. This system uses inductive reactance variation to attain frequency modulation.

Figure 1E shows another circuit which was originally an automatic frequency control. This system is very nearly the same as that of Fig. 1D and its principle of operation is the same. In this instance however, the tuning condenser is not connected directly to the wobbler tube. This circuit operates by changing the effective capacity in the tuned circuit to obtain modulation.

The circuit given in Fig. 1G is merely a more complicated arrangement of an

(Continued on page 304)

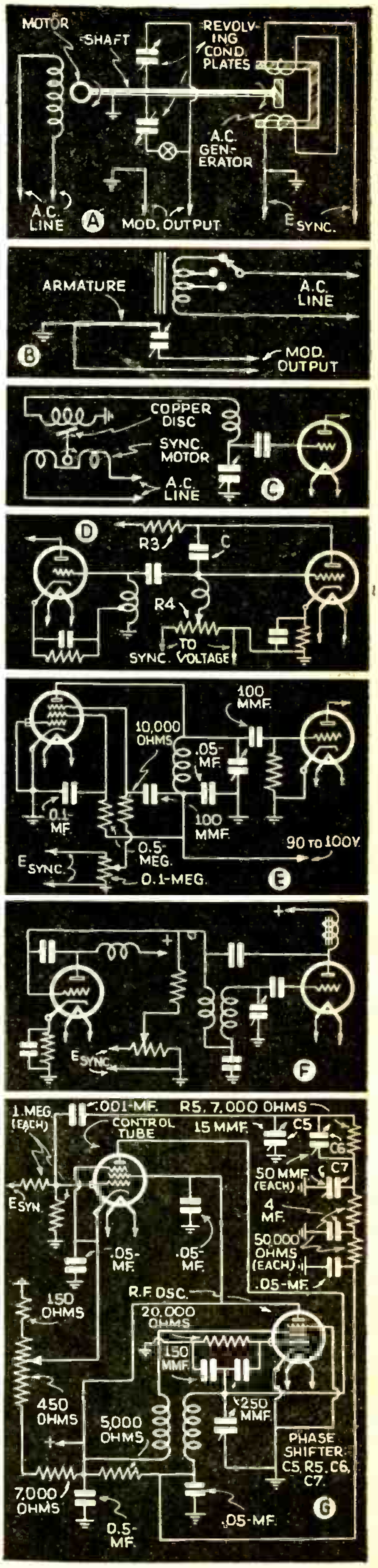


Fig. 1. Sections A, B and C are circuits of mechanical wobblers while sections D, E, F and G are those of electronic wobblers. See text.

HOW TO MAKE THE RADIO-CRAFT SUPER-DELUXE 30-TUBE SET

PART IIIA I.F. CHANNELS AND——

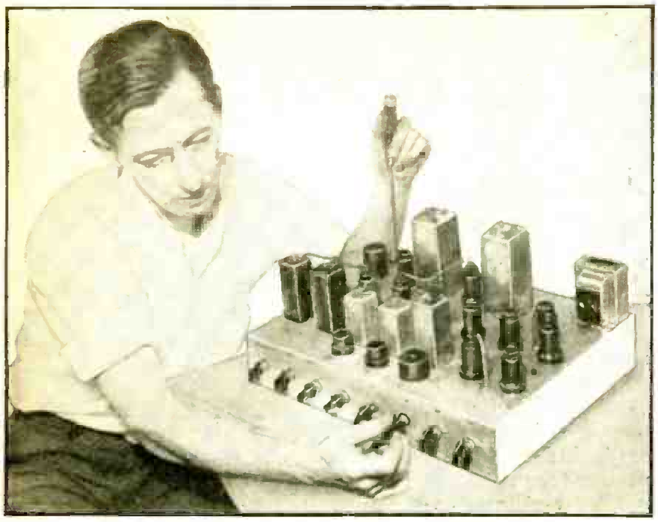


Fig. F. Mr. Charles Sicuranza adjusting Chassis No. 2.

LIST OF PARTS

Fourteen General Electric metal tubes, 3—6H6s—V9, V11, V17; 3—6K7s—V10, V12, V20; 2—6L7s—V13, V14; 1—6J7—V8; 1—6R7—V19; 4—6C5s—V15, V16, V18, V21;
Two Meissner I.F. transformers, No. 7412, I.F.T.-1, I.F.T.-2;
One Meissner I.F. transformer, No. 5977, I.F.T.-3;
One Meissner I.F. transformer, No. 6633, I.F.T.-4;
Two Meissner I.F. transformers, No. 6760, I.F.T.-5, I.F.T.-6;
One Meissner oscillator coil, No. 4243, No. 2 oscillator;
One Meissner B.F.O. coil, No. 6747;
One Meissner switch, No. 18254, Sw.1;
*One "ham" switch, No. 151-L, Sw.2;
One Meissner switch, No. 18254, Sw.3;
Two Meissner padders, No. D2500, C33, C48;
Two Meissner R.F. chokes, No. 5590, R.F.C.;
One Meissner R.F. filter choke, No. 6848, 10 kc., R.F.C. 10 MH.;
*Eight knobs, No. 366;
*Ten 3-lug terminal connectors, No. A016;
*Five 2-lug terminal connectors;
*Eight 1-lug terminal connectors;
One Centralab control, No. 72-105, 0.1-meg., R46;
One Centralab control, No. 72-120, 0.2-meg., R48;
Two Centralab controls, No. 72-110, 5,000 ohms, R6, R8;
One Centralab control, No. 70-206, 25,000 ohms, R50;
One I.R.C. resistor, 500 ohms, 1 W., R5;
One I.R.C. resistor, 1,500 ohms, 1 W., R9;
Three I.R.C. resistors, 1,000 ohms, 1 W., R19, R22, R24;
Four I.R.C. resistors, 5,000 ohms, 1 W., R17, R20, R23, R27;
Three I.R.C. resistors, 10,000 ohms, 1 W., R37, R54, R55;
Two I.R.C. resistors, 15,000 ohms, 1 W., R45, R49;
Five I.R.C. resistors, 30,000 ohms, 1 W., R7, R10, R11, R26, R30;
Nine I.R.C. resistors, 50,000 ohms, 1 W., R12, R28, R30, R32, R34, R38, R39, R52, R53;
Five I.R.C. resistors, 0.1-meg., 1 W., R13, R18, R21, R33, R44;
Seven I.R.C. resistors, 0.25-meg., 1 W., R14, R15, R29, R40, R41, R42, R51;
Two I.R.C. resistors, 0.5-meg., 1 W., R16, R43;

(Continued on page 317)

BEFORE WE GO into a detailed description of the various steps involved in the actual construction of this chassis, it is necessary for the constructor to thoroughly familiarize himself with the circuits and their functions.

By separating each circuit and studying its relation to the other circuits we believe that the constructor will more fully realize the importance of each component, no matter how small. As can be seen, every worthwhile feature of modern receivers has been included in the design, and in addition, a most unusual flexibility of control, by means of which any operator can obtain the utmost in performance from this set.

One important feature of the design is the double-frequency 3-stage I.F. channel. The main reason for using it is simply to obtain extremely high gain *with stability*. Based on long experience, 456 kc. has been found to be an ideal I.F. to use with all-wave receivers, *but* it has also been found impractical, in almost every case, to use 3 stages of I.F. at this comparatively high frequency. On the other hand, it is well known that 3 stages are practical when the I.F. is 175 kc. or lower. But 175 kc. is not so good when used as the heterodyne frequency with all-wave sets.

These objectionable features are removed by using an input stage of 456 kc. feeding into a mixer stage with its 2nd-oscillator, which in turn drives the output stage as 175 kc. The result is high gain all the way through.

Variable band-expanding I.F. transformers are used in the input stage and a "DX-LOCAL" switch broadens the band width of the output stage, when necessary.

Another important feature is the Automatic Bass Amplifier, the purpose of which is to automatically compensate for the falling off of the low-frequency response at low volume level. Audio A.V.C. is used in the circuit and the proportions of low and high frequencies are manually adjustable. A third important feature is the Noise Silencer Circuit, by means of which, surges of noise or static *above a predetermined level*

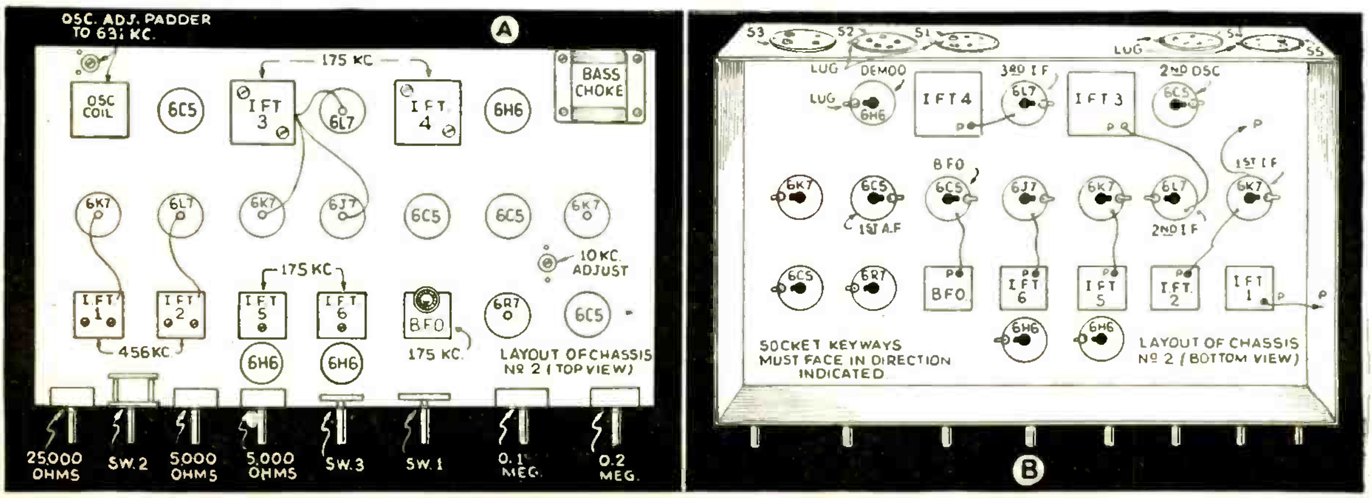


Fig. 6. Showing, in A, layout of main components on the top of the chassis; and, in B, position of the tube and cable sockets.

Every technician with an average amount of set-building experience can successfully construct this superlative radio receiver. Cost?—at mail-order-house prices, under $250! Build any of the 4, separately-usable chassis and RADIO-CRAFT—in co-operation with Mr. Charles Sicuranza—will if necessary repair your set gratis (under the conditions named in Part I)!

——AUTOMATIC CONTROL CIRCUITS

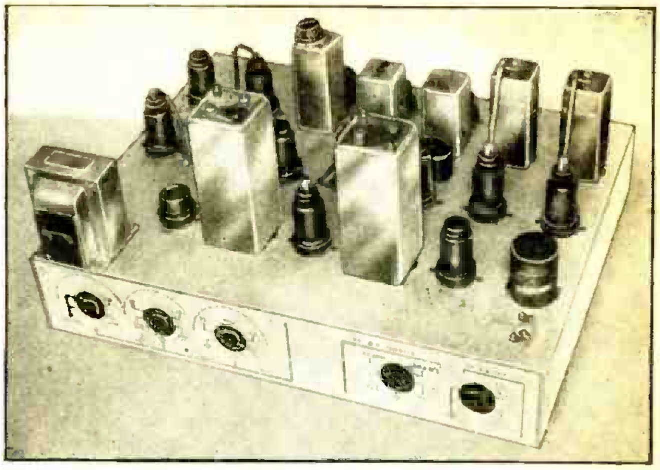


Fig. G. View of Chassis No. 2 showing the sockets of the connecting cables.

are instantly suppressed down to the average level at which the receiver is working. This makes it possible, for instance, to operate the set during a thunderstorm, where lightning crashes are usually heard *far above* the working level of the set.

The Amplified A.V.C. Circuit is almost a twin of the Noise Silencer, except for a few changes in wiring. Its purpose, however, is entirely different, inasmuch as it supplies a constant level input to the demodulator, with the added convenience of a manual control to select the optimum A.V.C. level.

The Beat-Frequency Oscillator (abbreviated B.F.O.) is useful as a "station finder" and for C.W. reception, and is tied up with a switch whereby A.V.C. may be cut out for distant short-wave reception and the B.F.O. may be cut in or out at will.

One of the 2 padder trimmers on the chassis is used to adjust the 2nd-oscillator to 631 kc. while the other trimmer is used to adjust the cut-off frequency at 10 kc. to "squelch" the whistles which sometimes occur between stations when using the high-fidelity band width.

The actual and detailed construction data and diagrams will appear in the following installment. A detailed set of alignment instructions will also be included, together with tables showing the D.C. resistance of each coil and the proper voltage applied to each tube.

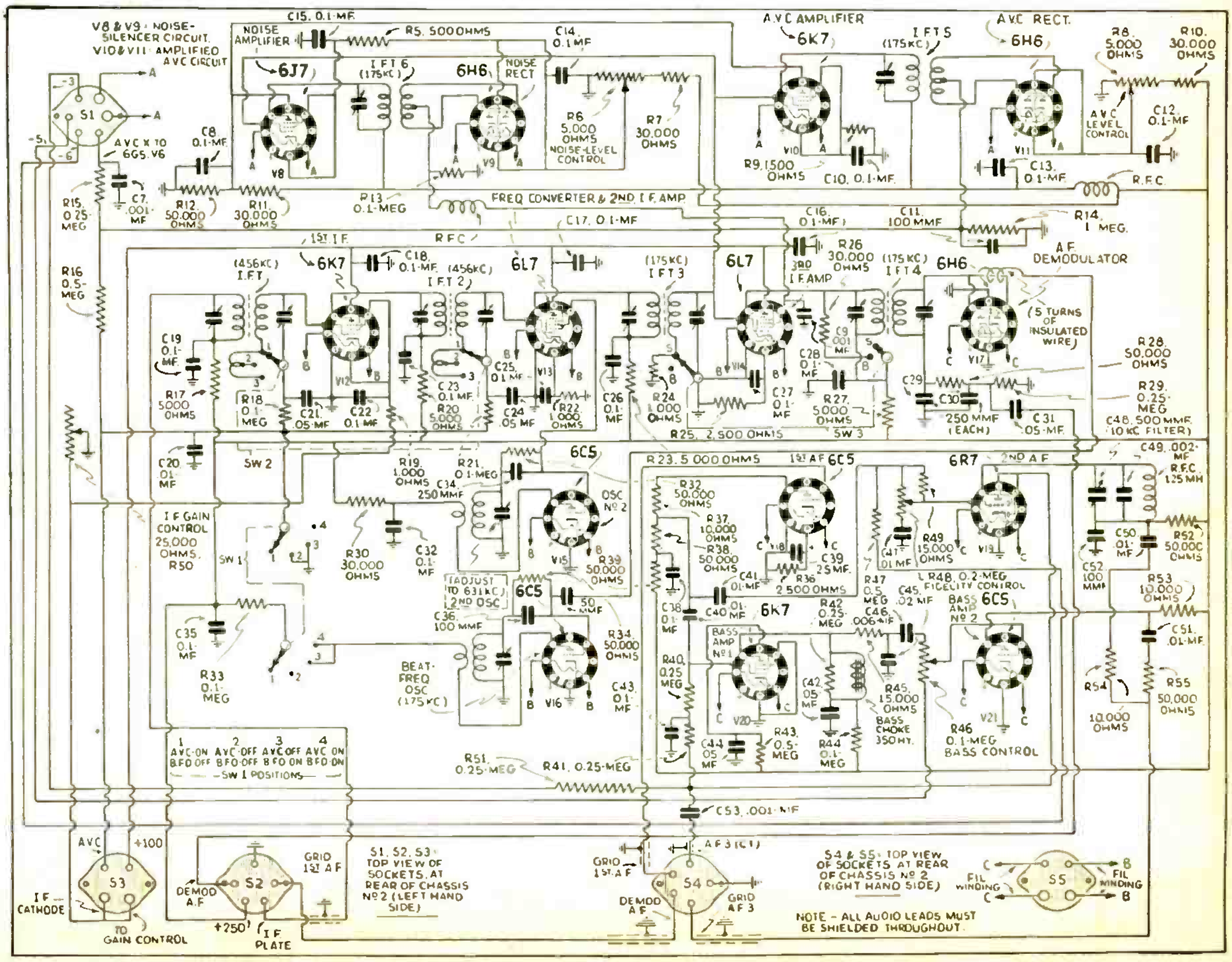


Fig. 5. Schematic diagram of Chassis No. 2 incorporating the 3-stage I.F. channel and all automatic control circuits.

Optional 110 V. A.C. or 6 V. D.C. (arrow should point to genemotor).

26-W. AMPLIFIER WITH DUAL POWER SUPPLY FOR ELECTIONEERING

Here's an amplifier—you can build it from a kit—which need not gather dust on the shelf after the election "season" closes.

LEONARD WERNER

EVERY P.A. MAN gets his share of election business. With the coming primaries and elections, he is again faced with the problem of procuring satisfactory amplifiers for use in a truck or car where the only voltage source is 6 volts D.C. from a storage battery, and for use indoors from a 110-volt A.C. line. At the same time he must have a unit which has sufficient power output.

For most all purposes, 26 watts of output is ample. The incorporation of both the 110-V. A.C. and the 6-V. D.C. power supplies on *one chassis* with this amount of output makes a most ideal amplifier for most any type of installation. The size of the chassis is 17 x 10 x 9 ins., including the cage cover. On one end of the chassis the D.C. and A.C. power supplies are mounted. Along the front side above the volume controls and switches, the tubes are placed, and opposite the power supplies are the electrolytic condensers and input transformer. The chokes, output transformer, etc., are arranged underneath. The cage cover is used for the sake of appearance as well as for tube protection. The schematic circuit of this amplifier (illustrated above) is shown in Fig. 1.

DESCRIPTION OF CIRCUIT

On the front flange are 3 volume controls, 3 switches and 2 pilot lights. The 1st control is for microphone, the 2nd for phonograph, and the 3rd is the tone control. The dual input is electronically mixed.

The overall gain of the amplifier is 115 db., and either a crystal, velocity or dynamic microphone may be used. The pickup may be either a crystal or magnetic type. The 3 switches serve as follows:

One switch throws the filaments from D.C. to A.C. and vice versa. The 2nd changes the D.C. and A.C. power supplies back and forth, also turns the amplifier off and onto the A.C. power source. The 3rd switch is the "genemotor" standby, which cuts this unit on and off independently of the rest of the circuit, saving unnecessary drain from the battery when the amplifier is not in actual use. Thus the filaments remain lit and the amplifier is always ready for immediate operation. The 2 pilot lights are red and green. The red when lit, indicates that the genemotor is on. The green when lit, indicates that the filaments are lit. This

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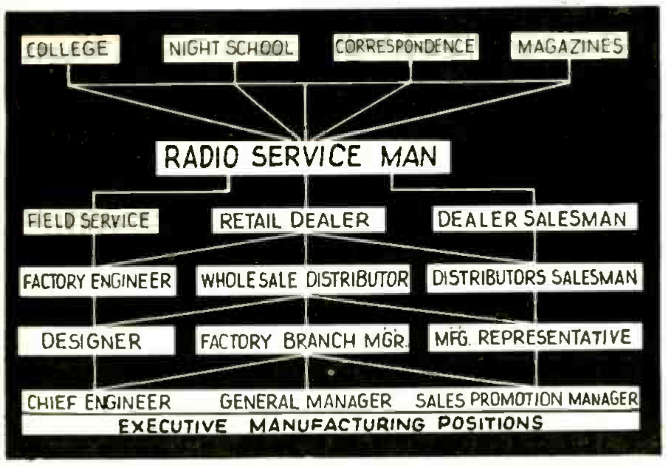

Fig. 1. The radio vocational "tree" in which Radio Servicing appears as merely a transitional occupation to higher positions.

IS RADIO YOUR VOCATION?

What future is there in Radio Service? Is it worth while studying? Can a man make a good living at it? How can one break into the already overcrowded field?

J. P. KENNEDY

RADIO servicing is not a goal but a stepping stone to engineering or merchandising. As a permanent occupation, it is probably the most difficult way you could choose to make a living.

CIRCUMSPECTION

Look at the radio Service Men you know in your own town; not the merchants, but the men who work for them or operate their own independant service business. Perhaps they have a car, a shop in their home or a neighboring garage. Their struggle to eke out a living is almost pitiable. Is that the future you want?

Look at the radio merchants, the men for whom Service Men work. Look at the engineers and the manufacturers of sets, parts, or accessories. Most of them were Service Men when they started. In some way they outgrew their service ability. Some extra ability, some extra training led them into the more profitable divisions of radio distribution, design or production. Service served as their stepping stone. It can provide your opportunity also.

INTROSPECTION

First you must *like* radio work, you must be able to find

(Continued on page 305)

MR. SERVICE MAN!—DO YOU AGREE?

Mr. Kennedy, in this article, expresses his personal views, not those of *Radio-Craft*. However, the opinions of Mr. Kennedy are of such basic importance to every Service Man who plans making radio his lifetime vocation that they merit special consideration.

Do you, as an active Service Man, agree with Mr. Kennedy? Do you feel that the conditions he describes constitute the true status of the radio service profession? Do you feel that your profession, radio servicing, is merely transitional toward higher positions?

The 5 best letters (received not later that October 15, 1937) from Service Men expressing their views on this subject will be rewarded with a FREE 2-year subscription to *Radio-Craft*.

HOW DEPENDABLE ARE YOUR METER READINGS?

A nationally-known writer on technical radio subjects presents to RADIO-CRAFT readers many heretofore unpublished facts, of importance to all radio men, concerning test meters.

ALFRED A. GHIRARDI PART II

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 now be pointed out.

(L) Unbalancing. In the construction of most movable-coil type meters, an effort is usually made to balance the assembly of movable parts (consisting mainly of the movable coil and the pointer) so that their position is not affected by gravity—i.e., so the meter will read the same no matter what position it is tilted to, or placed in. To accomplish this, small counterbalancing weights (see Fig. 2H) are placed at the two ends of a cross-piece (which is at right-angles to the pointer) and one is placed on the rear end of the pointer (as illustrated).

Since exact balancing necessitates rather precise and tedious adjustments in the positions of these weights, many meters leave the factories in a slightly unbalanced condition. Others become unbalanced by jars and knocks which they receive during shipment and subsequent use.

Errors (generally very small) are most likely to make their appearance when the instrument is tilted and used in a position other than that in which it was originally calibrated (portable instruments are generally factory-calibrated with the scale and pointer in a *horizontal* position).

An instrument intended for use with its pointer and shaft in a *horizontal* position should not be used in a *tilted*, or *vertical* position until you have assured yourself that any errors so introduced will be negligible. This applies especially to meters which are to be used in portable test instruments, and also to those which are mounted vertically on shop test panels.

The author has checked a representative group of servicing meters, and finds that the errors in some of them are increased by as much as 5 per cent (making their total errors around 7 per cent) if they are read while in a *tilted* or *vertical* position. This is a fact which most

The U. S. Army Announces World's First "Radio-Robot" Airplane Landing System!

Photographs, diagrams and a technical description of this new automatic landing system, which *without human aid* guides an airplane to a perfect 3-point landing, will appear in December *Radio-Craft!*

Service Men fail to appreciate, since they always place the meter in whatever position they find it most convenient to read, without regard to possible "unbalance" errors.

Any instrument may quickly be checked for possible "unbalance" by disconnecting it from all circuits and tipping it to a position say 30 or 45 degrees from the horizontal (or to several extreme positions). Notice if this causes considerable variations in the "zero" position of the pointer. If it does, the instrument is "unbalanced" and had best be used only in the "normal" position (with both scale and pointer *horizontal*). (See Fig. 3, sections K, L and M.) A perfectly-balanced instrument should show the same "zero", no matter in what position it is placed; and of course may be used in any position.

(M) Stray magnetic fields. The effect of a stray magnetic field upon the indications of a permanent-magnet moving-coil type instrument depends upon the nature of the field and its strength.

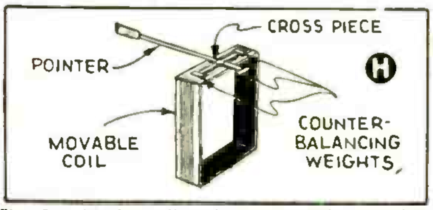

Fig. 2H. Moving-coil and counterweight assembly.

A stray field due to an *alternating* current (see Fig. 3 I) will have no perceptible effect on the reading of the instrument, unless it is so strong that it is able to demagnetize the permanent magnet to some extent, and thus cause the instrument to read *low*. Since alternating fields of such strength are rarely encountered, the Service Man need have no concern about them.

A *direct-current* magnetic field (such as that produced by an open dynamic speaker, see Fig. 3J), will affect the indication of a permanent-magnet moving-coil type instrument if it is sufficiently powerful. Such fields change merely the *strength* of the magnetic field in the air gap of the instrument, but not its *distribution*. The resulting error will therefore be a *constant* percentage of the indication of the instrument, so long as the disturbing field is constant in amount and direction. *The Service Man should therefore be most careful about the use of his instruments in locations where stray powerful magnetic fields exist.*

If a portable instrument *must* be used in a place subject to a strong stray field, the *average* value of two readings should be taken, the instrument being turned 180 degrees about the axis of rotation of the moving element for the second reading. Or, the instrument may be placed with its magnetic field at right-angles to the direction of the stray field, the latter being determined by means of a small magnetic compass. It is better, of course, to avoid, insofar as possible, exposing instruments to stray fields.

(N) External temperature errors. Change of *external* temperature produces various effects on the parts of an instrument—and these effects differ widely in magnitude.

For example, increase of temperature will cause linear expansion of the metal parts, increase of resistance of the current-conducting parts, change in elastic force of the springs, change in operating characteristics of meter rectifiers, etc. However, the design of modern high-grade instruments has been so well perfected that the errors due to these effects have been minimized—often by deliberately balancing one

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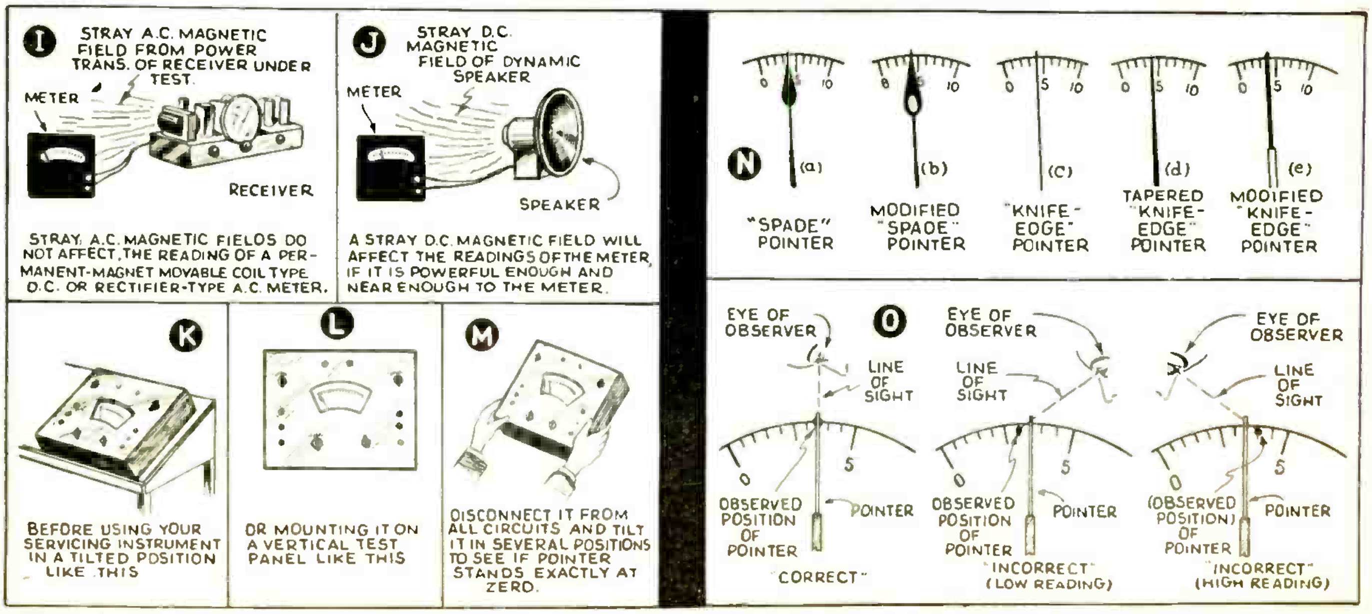


Fig. 3. Meter errors introduced by (I, J) stray magnetic fields, (K, L, M) tilting the instrument, (N) pointer, shapes and (O) *parallax*.

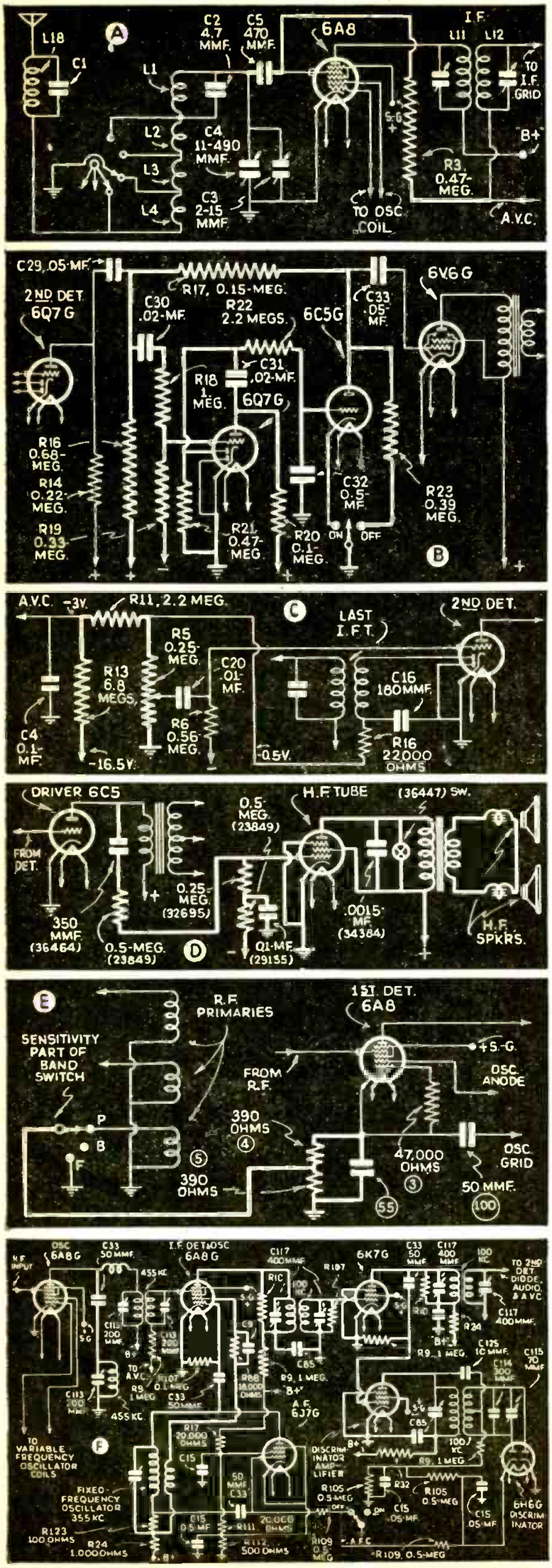


Fig. 1. The heavy lines in the circuits are the points discussed in the text.

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. 2

(1) Shunt A.V.C. Feed

RCA Models 86E, 86K, 86K7, 86T, 86T1, 87K and 87T. To avoid the grid-return or "series A.V.C. feed" with its attendant circuit problems, where R.F. band switching is involved, the shunt-feed method is employed in this new RCA line. In this way grid-returns may be directly grounded and no grid-return isolating condenser is used in the tuning circuit. The A.V.C. is fed directly to the control-grid of the tube through a resistor of high value. The circuit Q lost by this grid connection is regained by simplification of the R.F. tuned circuit and low-capacity coupling to the control-grid from the tuned circuit. There being no advantage in this method for I.F. connections, the I.F. grid-returns are series fed for A.V.C. See Fig. 1A.

(2) Dual Tube-Bridge Volume Expander

Sparton Model 968. In the audio signal circuit interposed between the 2nd-detector and power amplifier is a bridge system for distributing the signal to the output amplifier in relation to its intensity; thus, volume expansion is acquired. In Fig. 1B, in the "off" position the signal from C29 is divided across R17 and R23 in proportion to their values. The available signal is the drop across R23. In the "on" position, the available signal is the drop across the plate circuit of the 6C5G tube. The ratio of its plate resistance to R17 determines the signal strength.

The signal from C29 is also conducted to C30 through R18, and hence to the 6Q7G control-grid. After amplification, its output is fed to a diode through C31 and rectified, the unfiltered pulses being impressed across R19 with the diode plate negative with respect to ground. This rectified signal is filtered into D.C. by means of R22 and C32 and is fed to the control-grid of the 6C5G tube as a negative bias in proportion to the signal strength. The more negative this grid the higher the tube's plate resistance and the greater the signal drop across it.

Thus, the greater the signal at C29, the more of its value is transferred to the output tube; while the lower the signal at C29, the less will be the output.

(3) Simplified A.V.C. Delay for Small Sets

RCA Model 85T1. This new A.V.C. delay application as shown in Fig. 1C permits all cathodes to be grounded; in using only one diode plate, loads the output I.F. a minimum; and provides a 3-volt delay of A.V.C. action at the 2nd-detector. With no-signal, the flow of D.C. in the high-resistance circuit R13, R11, R5, provides a –3 volt drop at the A.V.C. line as indicated. A relatively high negative source (–16.5 V.) is chosen for the negative end of this divider so that the A.V.C. line will be only slightly loaded, permitting it to acquire quite high negative voltages.

Since the negative drop at the junctions of R11, R5 and R16 is scarcely –0.5-volt with respect to ground an A.V.C. voltage is developed and a signal is receivable after the 2nd-detector diode peak has exceeded this value. Up to –3 volts

(Continued on page 311)

BUILD THIS CRYSTAL-SPEAKER 1-TUBE BATTERY INTERPHONE

Fig. A. The remote unit being used in a rural district office.

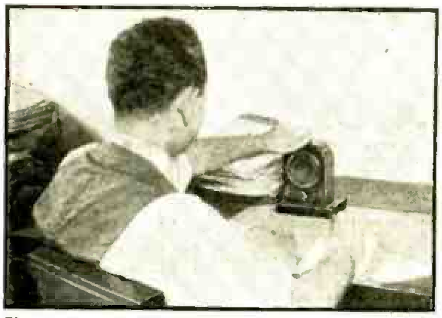


Fig. B. An executive talking to his secretary through the control unit.

This new interphone, developed under the direction of R. D. Washburne, requires no powerline current. In operation only during talking periods, it's more economical than any previous type! (Crystal transducers afford exceptional fidelity.)

W. H. MALFORD

A BATTERY-OPERATED communicating system, as illustrated and described herewith, brings the benefits of loudspeaker communication to rural or remote homes not supplied with electricity.

The recent enormous growth in the use of communicating systems of all kinds constitutes one more example of the well-known tendency of new devices to become necessities, indispensable, in spite of the fact that they were only recently unobtainable. Thus, where there is an invalid in the home, a communicating system is invaluable; and even in cases of temporary illness pays for itself many times over merely in the steps it saves. In any home it reduces the stair-climbing and shouting incident to domestic life, and those who never heard of such a thing find themselves wondering, a few weeks after they install one, how they ever got along without it!

BATTERIES FOR ECONOMY

Previous systems, however, for office and city use, and invariably operated by line power, are usually designed without much thought to current consumption. The simple 1-tube system here described is intended for unusually economical operation with drycells. Cells employed with it should have a useful life not very much shorter than their shelf-life. The system is not self-contained as to batteries, for the reason that in many rural homes it will be driven more advantageously by the drycells that operate the radio set. Hence, terminal strips are provided, by means of which connection to any available battery supply can readily be made.

All batteries are wired to the control unit. The remote unit needs no batteries. The 2 battery terminals which are part of the latter unit merely provide for parallel connection to the control unit on-off switch. Hence the system can be turned on from either location, and a person at the remote unit can call the control unit merely by operating his switch and talking into the loudspeaker, which serves also as a microphone.

At distances up to 50 ft. shielded cable is not needed for the voice connections; ordinary twisted lampcord may be used, reducing the cost of the installation.

Conversation is controlled at the master unit (illustrated in Figs. B and D) by means of the 4-pole, double-throw "talk-listen" switch on the top of the panel. This switch connects 1 of the 2 loudspeakers to the amplifier output, where it serves its normal function as a speaker, and at the same time connects the other speaker to the amplifier

(Continued on page 316)

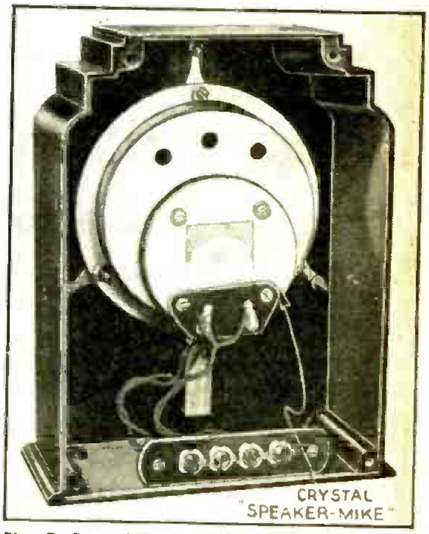


Fig. C. Rear view of remote unit. Note compactness of crystal speaker.

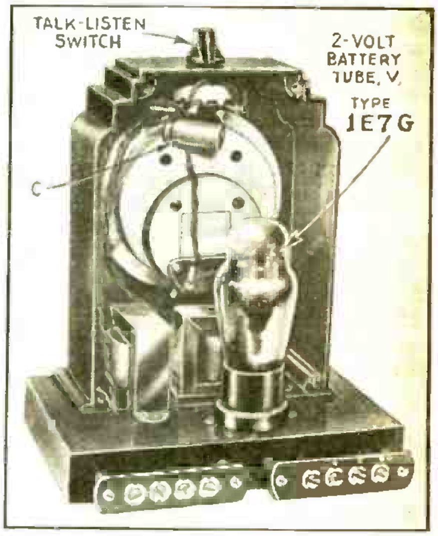


Fig. D. Rear view of control unit. On top is the "talk-listen" switch.

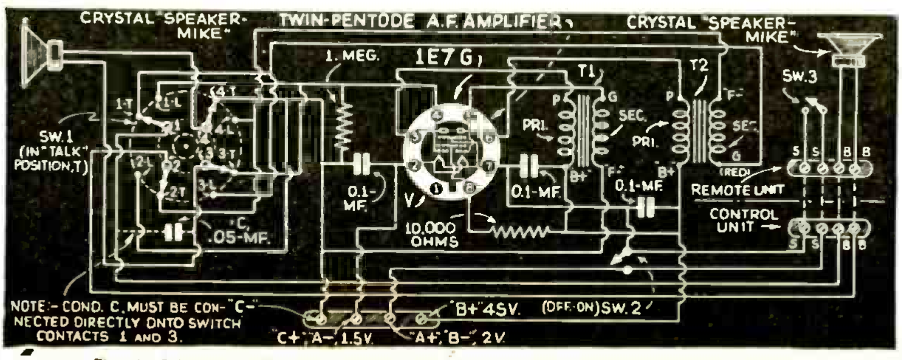


Fig. 1. Schematic diagram of the 1-tube battery-type intercommunication system.

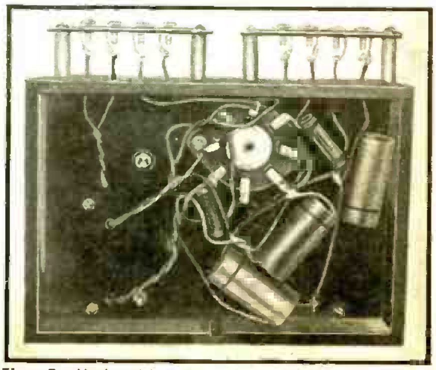


Fig. E. Under-side view of control unit showing simplicity of wiring.

"LEARN-BY-EXPERIMENTING"

BEGINNERS' PRACTICAL RADIO COURSE

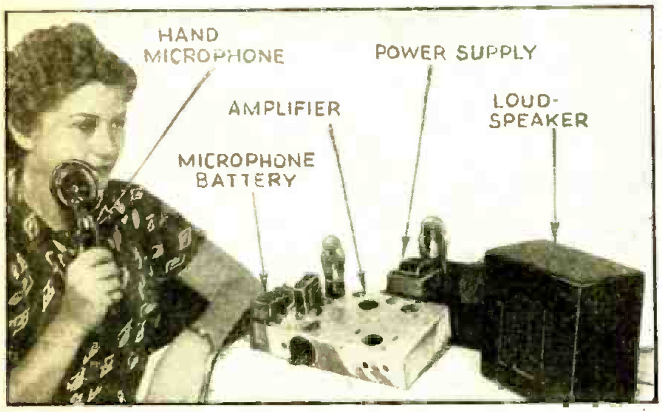


Fig. A. The microphone and amplifier shown in use with a loudspeaker.

EXPERIMENT No. 2

OPERATION OF MICROPHONE AND AMPLIFIER

New way of learning radio!—You learn basic principles while building useful radio units. The lessons are conducted by a man well fitted for the task . . . a radio instructor.

CONDUCTED BY

SOL D. PRENSKY

THIS EXPERIMENT on "Operation of Microphone and Amplifier" is the second of the series started in the last (*October*) issue. The experiment is a unit in itself, and continues the general plan of *learning by doing* with inexpensive material. It will be found very helpful for the reader to get the full explanations of the principles, which are here pointed out only briefly, from one of the text books previously mentioned in Experiment No. 1. The picture of vocational possibilities in Radio shows a wide and varied field; yet the seemingly widely different phases of Radio are all closely tied together by a fundamental principle, that of ***electrons in motion***. The key to the study of radio, therefore, lies in understanding the flow of electricity in its various aspects. The Experiment given here is a good illustration of this principle, since it involves the 3 important ways in which electricity flows.

GENERAL PRINCIPLES

The operation of a *microphone* is exactly similar to that of the familiar telephone *transmitter*. Likewise, the headphones or loudspeakers through which the sound is heard are almost exactly similar to the telephone receiver. We will therefore trod on more familiar ground if we think of the telephone mouthpiece *(transmitter)* every time the word microphone is used, and of the telephone *receiver* whenever a headphone or loudspeaker is mentioned. In order to operate the microphone so that the person wearing the headphones may hear what is said, we need only one other piece of apparatus, namely a battery, connected between the two. So simple is this arrangement, that inexpensive telephone outfits are made for children, and serve very successfully as toys. However, in going beyond the toy stage and seeking a thoughtful explanation of how the apparatus operates, we will find that the explanation is not quite as simple as the arrangement seems to be.

The microphone and, by the same token also the telephone transmitter, are devices for sending sound by means of a varying electric current through wires so that a copy of this sound is heard in the headphone or telephone receiver at the other end. The microphone differs slightly from the telephone, in that it has a greater ability to reproduce musical, as well as speech sounds faithfully.

In order to visualize the situation, we will assume that a violin string is held near a microphone as is shown pictorially in Fig. 2B and that the string is plucked to emit a "pinging" sound. Let us trace the transmission of this sound in the following order:

(1) Sound is caused by the vibration of any material thing. Fig. 1 shows a simple experiment with a *tuning fork* that demonstrates this fact. In our case, plucking the string starts it vibrating.

(2) These vibrations travel through the air and impinge upon the microphone disk (or ***diaphragm***), and exert a changing pressure on the sensitive *button* (filled with ***granulated carbon***) behind it. This changing pressure causes corresponding changes in the electric current that is continually flowing through these carbon granules in this sensitive button of the microphone, as shown in Fig. 2B. This is due to the fact that, as the pressure on the disk of the button changes, it affects the resistance of the carbon granules so that a greater pressure, for instance, lowers the resistance of these ***carbon particles*** and thus allows a greater surge of current to flow through the button. In like manner, a decreased pressure will allow less current to pass

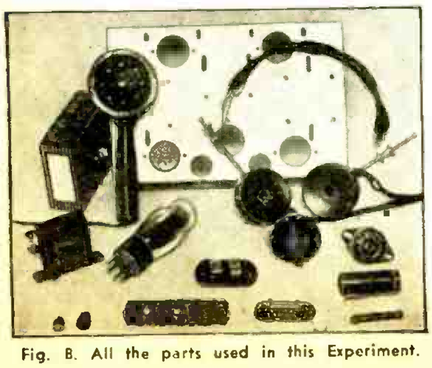


Fig. B. All the parts used in this Experiment.

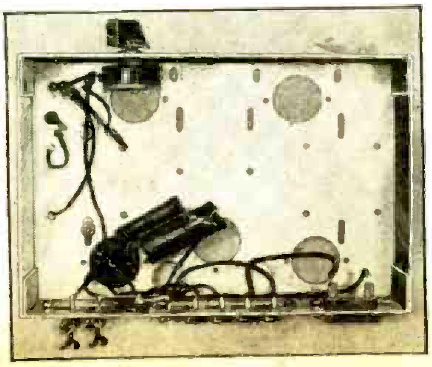


Fig. C. Under-chassis view of the amplifier.

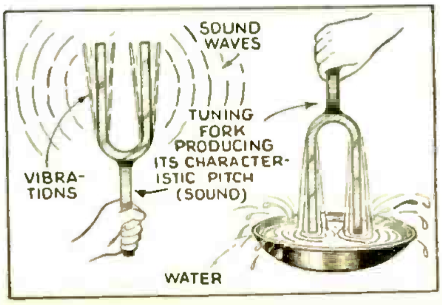


Fig. I. Illustrating the production of sound. When the tuning fork is struck its ensuing vibrations produce sound waves. The water Experiment proves existence of vibrations.

through the button of the microphone. In this way, we have caused the sound vibrations to produce surges of current, or current variations, as indicated in Fig. 2E. This type of current, since it is changing in strength, but still continues to flow in only one direction, is called *pulsating direct current*. This is the current which flows through the two wires (called the *line*) connecting the transmitting end with the receiving end.

(3) This current at the receiving end flows through the coils in the headphones shown in Fig. 2C. Since the flow of current through the many turns of wire in these coils makes them act as *magnets*, they are known as *electromagnets*, and as such are capable of attracting the thin iron disk or diaphragm. This action, however, differs in one essential point from the action of the ordinary magnet, in that the electromagnet becomes stronger and weaker as the current through it varies. The diaphragm, which is under tension, will therefore be caused to vibrate rapidly, as, at one instant, it is more strongly attracted toward the electromagnet, and at another instant, because of the weaker attraction, it is allowed to spring back to its natural position.

(4) This vibration of the diaphragm follows the current variations, which in turn follow the original sound vibrations, and so the sound produced by the vibrating diaphragm will be a faithful reproduction of the original sound.

To summarize the basic idea, then, we have, at the transmitting end, the microphone in which the original sound produces variations of current; and at the receiving end, the headphones, in which the corresponding variations of current produce corresponding vibrations of the diaphragm, which we hear in turn, as the reproduction of the original sound.

HOW THE PARTS FUNCTION

We next consider the role played by the other parts used in this Experiment. See Fig. 2A for their radio symbols.

T-Transformer (Fig. 4F) consists of a primary winding suitable for the connection of a microphone; and a secondary winding to be connected to the grid circuit of the tube. This is called a *microphone transformer*. Note that this is different from an audio transformer which has too great a number of turns in the primary to be connected to a microphone. However, when a general-purpose transformer, as suggested here is used, there are two primary windings to choose from, either the winding (marked P, "B+") for audio use, as we did in the last experiment, or the winding (marked M.M) for microphone use, which we use in this Experiment. The purpose of the microphone transformer here is to transfer to the *line* only the variations of the current and, at the same time, to "step-up" these variations as was explained in the preceding Experiment.

Rp-Resistor (in this form called *potentiometer*, see Fig. 2F) acts as a volume control, due to the fact that the moving arm includes as much of the resistance between it and the lower end as desired. Since the signal is impressed on the full resistance (bottom to top), the moving arm, if set at the middle, for example, will only include in the circuit that portion of the resistance from the bottom to the middle and

(*Continued on page* 302)

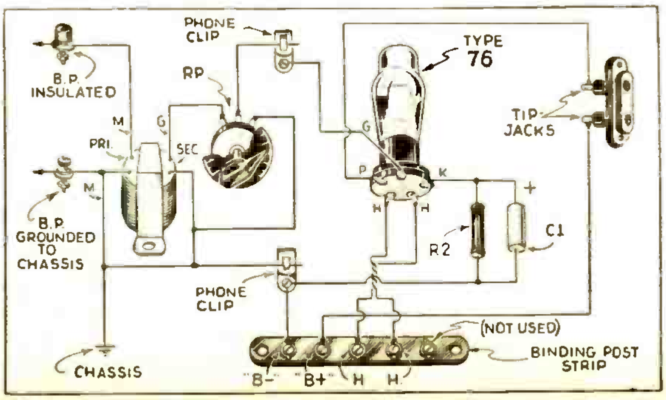


Fig. 3. Pictorial diagram showing how the parts used in this experiment are wired up. Those who prefer to work from a schematic diagram will find one in Fig. 2G.

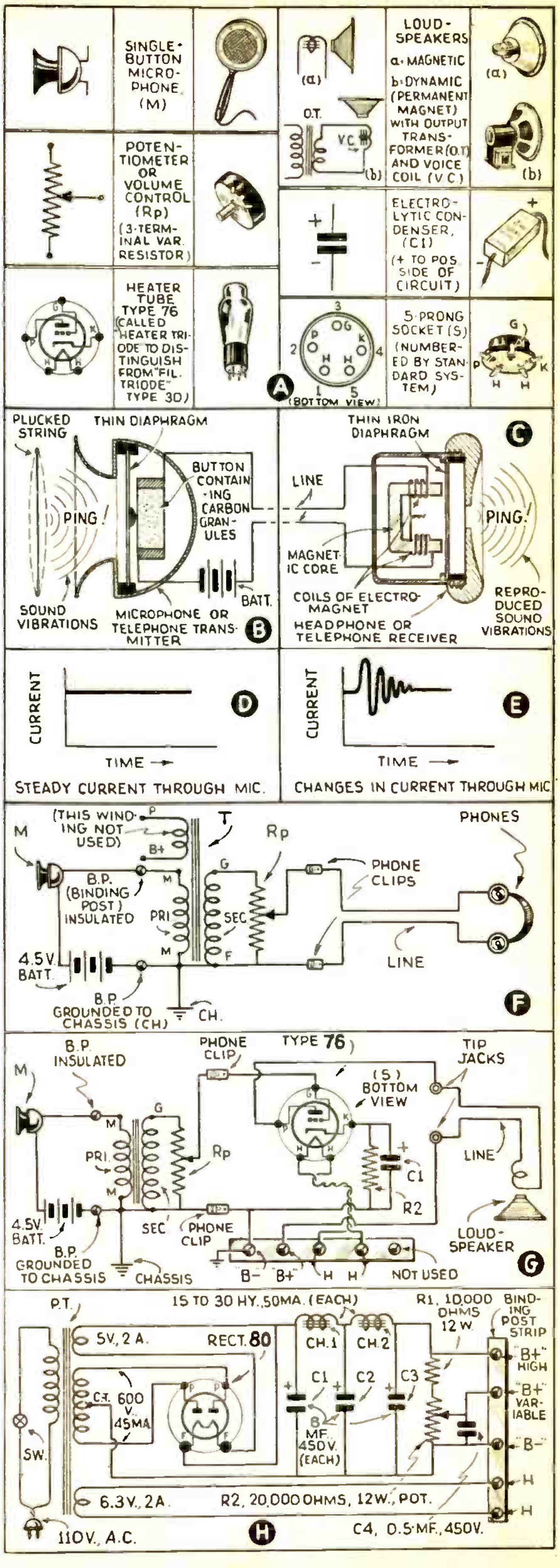


Fig. 2. See text for reference to these diagrams. Section A should be studied before reading the schematic diagram. Section H is the schematic diagram of the A.C. power supply, the use of which is optional. It will be the subject of Experiment No. 3

This typical suburban general housefurnishing store is an excellent prospect for a radio repair service tie-up of mutual benefit.

BUSINESS PROBLEMS OF THE SERVICE MAN

The third in a series of articles on the problems of Service Men who anticipate branching out "on their own". The practical solutions offered in these articles are actual experiences of men whom "Jack" has advised. Do *you* have a problem?

Conducted by JACK GRAND

THIS BUSINESS of a radio Service Man "stepping out" on his own, is a problem which any number have tried to solve. Some succeed and others fall by the wayside.

Handicaps are many but the greatest handicap of all is *funds*—or rather the lack of it. It has been proven by statisticians and confirmed by manufacturers and distributors that 80 per cent of the failures in business careers are due to lack of sufficient funds at the start of the enterprise.

One must ALWAYS remember that it is seldom that any business establishes itself on a paying basis in less than 6 months—more often it takes a year.

There is no question about the ambitions, willingness, or ingenuity of the Service Men, nor is there any question as to the lack of funds in most cases.

The lack of sufficient funds has been instrumental in keeping many men awake all hours of the night developing means of going into the radio service business. Some of these methods conceived are ingenious and the funny part of it is, that very often modest success is attained.

There is no definite locality as to where ideas and methods may be developed, but we shall at this time confine ourselves to small towns.

"SMALL TOWN" SERVICING

For those of limited funds—those who can think and transfer their thoughts into something concrete—small towns in particular are fertile fields.

In these smaller towns the atmosphere is neighborly, everyone is acquainted with each other and an excellent spirit of cooperation is maintained. If one has a pleasant personality and has the good will of the community, he will have the support of the entire local population. Added to all this, the overhead is low.

So far we have enumerated the good qualities, now let us sum up some of the disadvantages.

The population is small, the number of business organizations that can be supported is limited. The service calls extend over large areas. The people in rural districts do not readily follow the rapid changes in the industry. For these reasons sales are limited to actual requirements.

This month's problem deals with a young man in a town similar to that described in previous paragraphs. The population at the last census was slightly more than 6,000. Figuring 4 people as an average family, the indications would be that there were 1,500 families in the town.

Assuming that every family had a radio set, we have 1,500 radio receivers in this small town. These figures, while not impressive, create a problem that is faced by many in thousands of towns of this size throughout the United States.

"FRED'S" PROBLEM

Fred is the young man in this month's problem. He is capable and is a likeable sort of fellow. He had extensive training in radio theory and practical experience in servicing radio sets. However, he was no exception to the 80 per cent rule, he was lacking in that commodity commonly called "cash," and still worse—out of a job.

He *had* to make a living—and preferred to make it in the radio field—in spite of his lack of funds.

No town is complete without a hardware store, and this locality was no exception to the general rule. This store was quite large, with plenty of space, and well stocked to meet the needs of the community. Mr. Edberl, owner of this hardware store was looking for a man and upon hearing that Fred was not employed, offered him the position.

When one is out of work, it's a case of "any port in the storm." Fred was not figuring on this type of work, but, being out of a job, he decided to get all the details from Mr. Edberl and see how things would shape up.

Fred learned that while the salary was rather low, there would not be much work for him to do. He would have a reasonable amount of spare time and—a steady income.

Here was something to worry about. Fred had previously spent a lot of time and whatever spare money he had to acquire an education in Radio. His hopes and future were planned for a career in radio servicing—but he had no money to carry on with.

A pretty tough spot for anyone to be in! He did not know what to do. What would *you* do to create an opportunity to satisfy an ambition under these circumstances?

SUMMATION

In previous issues, I suggested writing down the solution on paper and comparing your answer with mine. I again suggest that you do this.

In summation, the highlights of this month's problem are as follows:—

(1) Fred was young, capable and had a pleasing personality.

(2) He studied radio with the thought of someday going into business in this particular field. To satisfy his ambitions, he had to go into radio servicing.

(3) He did not have sufficient funds to start a business.

(4) He was offered a position in a hardware store at a salary so small that he could not hope to have enough in a reasonable length of time to permit him to start a business of his own.

It was a very discouraged Fred that presented his problem. During the course of discussions the following situations presented themselves:

(1) Mr. Edberl had a list of the names of all his customers. He circularized a definite percentage of these people every month.

(2) He did not sell radio receivers, radio tubes nor accessories as he was not familiar with the radio business.

(3) He had spare space that could be used for some purpose other than hardware.

The suggestion offered Fred was that he speak to Mr. Edberl and see if he could make the following arrangements:

He would offer to work for Mr. Edberl and in lieu of a salary, receive permission to establish a radio department in the available space. In consideration, Mr. Edberl was to include in his monthly mailings, a notice to the effect that Fred would call and service their receivers as well as supply radio equipment and tubes.

(Continued on page 301)

HOW TO CONDUCT
A SOUND-ON-FILM
RECORDING STUDIO

Service Men—read this first-half of Part I *thoroughly*. If there still remain any questions, concerning the particular phase of "home-made" talkies discussed in this Part by Mr. Queen, write to ***RADIO-CRAFT at once*** and we will try to furnish answers in the next earliest issue. The point is—we want you to be able to set up your own sound-film studio, after reading the complete article.

PRINCIPLES OF RECORDING

I. QUEEN .... PART IA

A FULL knowledge of the theory and practice of sound recording is becoming increasingly essential to the radio technician. Use of sound-on-film apparatus is rapidly increasing and the alert service engineer would do well to keep in close contact with this branch of radio. This article describes the theory of the various methods of film recording used at the present time in both the commercial and theatrical fields. The writer, formerly a licensed first-class commercial radio operator and a radio Service Man, is recording engineer for a New England motion picture studio.

Practically all recording for theatrical and industrial purposes is made on photographic film. This has proven superior to disc recording for most purposes. A means of exact synchronism with the accompanying pictures is provided, since both sound and picture can be placed on the same film, and duplicate copies from the original negative can readily be made. With film recording it is not necessary to handle extra discs which are easily broken and soon wear out. There is also the great advantage that it is now conveniently possible to record a much more "natural" sound on film than disc.

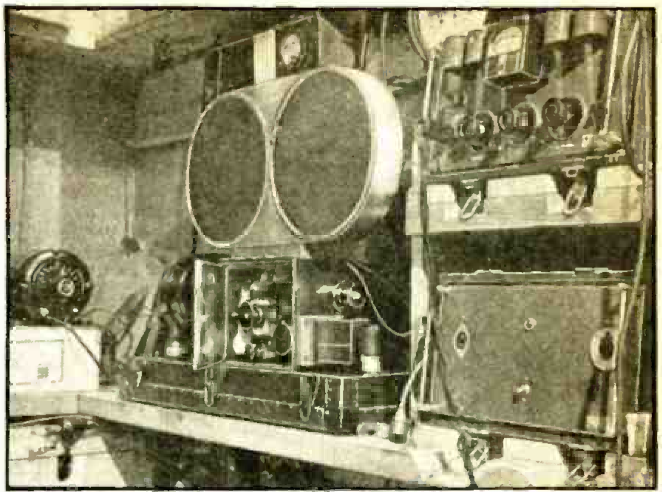
With the advent of television, most sight and sound broadcasts will probably take place from a recorded talking picture film. Recording theory and practice should therefore be studied by the radio man.

SOUND-ON-FILM

Motion picture film consists essentially of a strip of celluloid on one side of which is coated an "emulsion", a silver compound which is sensitive to light. On both sides of the celluloid film, "sprocket" holes are cut. Sprocket wheels engage these perforations and the film can thus be carried along in the machine. Photography is based on the fact that when light strikes a film coating or "emulsion", a chemical change takes place in it. When the film is developed and dried, it is found that the exposed parts have become darkened, while the remainder of the film is transparent. The density will vary with the degree of exposure to the light. This phenomenon is made use of in sound recording.

All theatrical and most industrial recording is done on 35 mm. or "standard" film, that is, the full width of the film is 35 millimeters. The sound occupies a narrow "track" next to the left-hand sprocket holes, while the remainder of the film (from the track to the right-hand sprocket holes) is for the accompanying pictures. In projection, of course, only the picture part will be shown on the screen, the track being masked off in the picture aperture. When the film passes through the sound aperture of the projector, the picture part will be masked off, and only the light passing

(*Continued on page* 308)



The recording control room. Film recorder is in the center.

Apparatus needed in making synchronized and non-synchronized talking picture films:

- SOUND-PROOFED STUDIO RECORDER including Galvanometer, Synchronous Motor, Exciter Bulb.
- AMPLIFIER including Decibel Meter, Exciter Current Meter, Attenuator Units, Mixer Units, Headphones.
- POWER SUPPLY for amplifier.
- MICROPHONE including Microphone Stand, Microphone Boom.
- NON-SYNCHRONOUS PICKUP for recording from disc.
- MOTION PICTURE CAMERA with Synchronous Camera.

For recording in a D.C. district the following are also needed:

Motor-Generator Unit, Frequency Meter, Motor Speed Control (Frequency), Generator Field Control (Voltage), Hand Starter for motor.

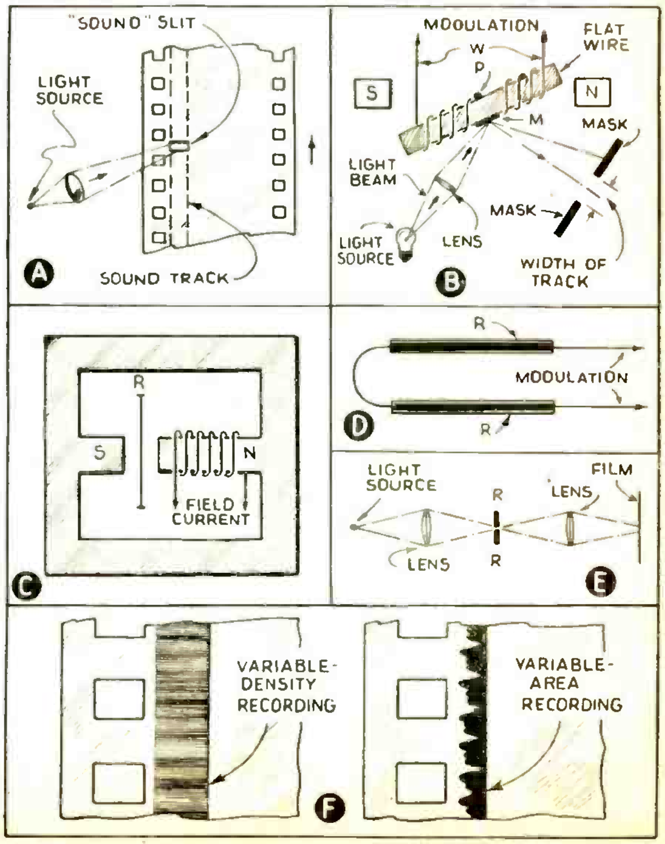


Fig. 1. Mechanics of *variable-area* and *variable-density* recording.

TELEVISION STUDENTS
LEARN BY MAKING
CATHODE-RAY TUBES

Mr. Sanabria—the man who, in 1931, demonstrated 10-ft.-square television images in Loew's State Theatre, New York City!—tells you how the problem of "school-built" television C.-R. tubes is being solved. PART I

U. A. SANABRIA

Fig. A. Completed 7-in. television C.-R. tube.

A SPECIAL-GLASS "blank," hydrofluoric acid, callux fluorescent powder, ammonium borate binder, high-pressure washer set-up, aspirator, and a drying oven: with these on hand we are "all set" to take the first step in making a laboratory model of television tube!

It is important that a man studying television learn the behavior of a tube from his actual experiments. *Commercial types intended as oscilloscopes do not permit the proper study of characteristics of television tubes;* for instance, in video service, ordinary oscilloscope tubes exhibit bad defocusing of the spot with modulation.

"SCHOOL-BUILT" 'VISION TUBE

As a result of having recently engaged in development work on cathode-ray tubes I came to the conclusion that we here at "A.T.I." could manufacture a big television-receiver tube having desirable characteristics for the money we pay for a commercial tube having undesirable characterics; these "school-built" tubes then would be more suitable for inclusion in the regular home equipment supplied to students taking the television course. Results were so promising that we plan shortly to inaugurate development of the iconoscope or television pick-up type of cathode-ray tube; also with a view to including this in the home equipment.

Some sizes of C.-R. tubes used for television reception in addition to other faults do not permit very satisfactory study of the nature of cathode rays. However by the application of a little ingenuity we found that it is possible to produce a C.-R. tube at very low cost that rivals in efficiency commercial types that sell for about $100. (See Fig. A.) The manner in which a satisfactory 7-in. cathode-ray television receiving tube was developed after numerous experiments, makes a multi-part story that I feel will interest every television enthusiast and dyed-in-the-wool experimenter.

The first problem was to obtain a suitable glass *envelope* or bulb. This problem was quickly solved when it was found that envelopes of suitable size were available in small quantities from a Corning, N. Y., glass works; *pyrex* glass was found to be the best grade for our purpose.

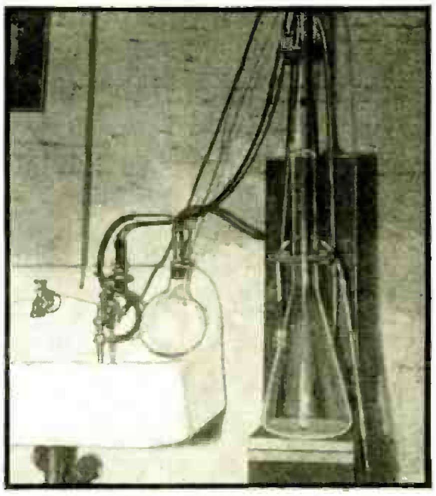


Fig. B. Aspirator sucks water off screen.

(*Continued on page* 309)

CORRECT PLAYBACK
OF SPOT RECORDINGS

Proper playback of spot recordings is equally if not more important than the actual recording. Here are additional facts which will interest the practical recordist.

RALPH L. POWER PART II

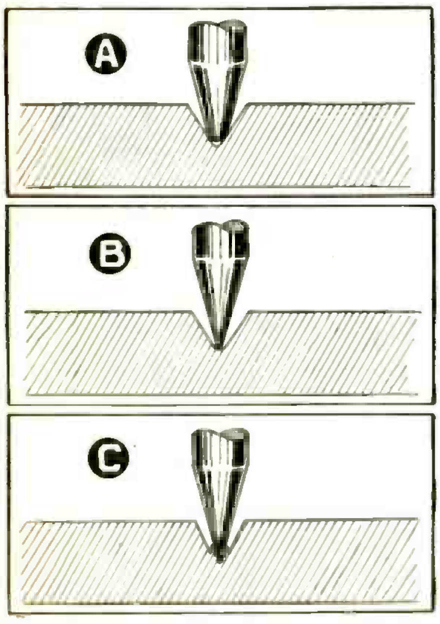


Fig. 2. A, correct needle and groove combination; B, Incorrect combination; and C, Deterioration of the groove when the arrangement shown in B is employed.

LAST MONTH we discussed the playback requirements of wax, acetate and aluminum recordings, and the difference between acetate records and commercial pressings. Also the following factors in pickup construction were commented upon: (1) freedom of armature movement, (2) needle pressure on disc, (3) needle angularity, and (4) length of pickup arm. We now continue in this Part with the considerations of a "perfect" pickup.

An "Ideal" Pickup

An "ideal" pickup for playing of acetate discs therefore to give maximum frequency response, playing both the higher and lower frequencies faithfully and without the falling-off of volume, would be one that incorporated the above features in its construction. Such a pickup is shown in Fig. 1A, Part I; the armature is only 25/64-in. long. The dampers are light in contact—just enough to keep the armature from adhering to either pole piece. The arm is adjustable for length, after mounting, to obtain best results. The pivot at the mounting end is supported on an annular ball bearing. A screw adjustment is provided in order to obtain minimum pressure (or weight) on the needle (point A in Fig. 1A).

This adjustment, as shown at A in Fig. 1A, permits the head to be lifted entirely free of the record being played; it may be allowed to impress its full weight upon the needle; or it may be adjusted anywhere between these 2 extremes, even when playing a record. In fact, the entire assembly is so delicately balanced that when mounted level it can be blown by the breath in side movement!

By use of a delicate scale (B, in Fig. 1A) an up-and-down movement of ½-in. has been found to cause only ¼-oz. change in needle pressure. This allows a record to be played that may not be perfectly flat, without noticeable change in the pressure applied at the needle point.

IMPORTANCE OF USING CORRECT NEEDLE

It might be well at this time to illustrate by the accompanying sketches, the types of grooves now in general use in instantaneous recording and call to the attention of the user that the selection of the proper needle has a very definite bearing upon hiss level and general performance in playback, likewise the life of the record.

Figure 2A shows a groove with a sharp or V bottom, and a playback needle with a round point having a radius at the point of approximately 0.002-in. Note that the point of the needle bears above the bottom of the groove and actually rides on the side walls only. Figure 2B shows a groove having a bottom curvature, cut by a stylus having a radius at the exact point of 0.002-in., being played-back by a sharp-pointed needle.

A study of these illustrations reveals that use of the combination shown in Fig. 2A should mean reproduction without groove hiss; and a material extension of the life of the acetate record. On the other hand, it will appear to even the casual observer that the sharp-pointed needle shown in Fig. 2B will pick-up all of the hiss

(*Continued on page* 315)

THE LATEST RADIO EQUIPMENT

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.

SUEDE-FINISH INTERPHONES (1486)

(Wright-DeCoster, Inc.)

NEWEST in interphones is a "Talk-Bak" unit, in taupe-finish soft suede, that makes a particularly pleasing appearance on desk or wall. Has red "busy" indicator button and 10-station selector switch. Available with built-in or separate amplifier.

SCHOOL SOUND SYSTEM INCORPORATES TALK-BACK (1487)

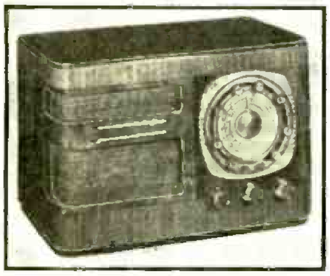
(Wholesale Radio Service Co., Inc.)

AS MANY as 30 classrooms can be provided for, each under individual control at the central board, in the design of a new sound system that incorporates talk-back facilities for individual classrooms.

All component parts—superheterodyne radio tuner, automatic phonograph, amplifier, switching panels and speakers—are custom-assembled in accordance with individual requirements.

Output power is 60 W. at harmonic distortion of only 3 per cent. Reverse feedback is included for exceptional tone quality; automatic volume control is available for microphone operation, and automatic volume expansion for radio or phonograph sound.

Suede-finish interphone. (1486)



Button-tuned table set. (1491)

CRYSTAL HAND MIKE (1488)

(Universal Microphone Co.)

SOUND technicians (both P.A. and recording) and radio amateurs, particularly, will be interested in a new "Handi-mike," with built-on switch, which features the use of a crystal-type microphone.

NEW LABORATORY TEST BENCH PANELS (1489)

(The Triplett Electrical Instrument Co.)

NEW MATCHED units simplify shop and laboratory test panel requirements. A continuous panel set-up may be obtained by bolting together any 2 or more cabinets. Here illustrated is the model 1402 cabinet which is shown as housing a model 1690 "2-in." oscilloscope and 1630 100-kc. to 30-mc. signal generator of the same manufacture.

CONTACT-TYPE MUSIC MIKE HAS PEDAL VOLUME CONTROL (1490)

(Amperite Corp.)

AN IMPORTANT addition to the electronic music field is this new magnetic-type "Kontak" microphone (with foot-operated volume control). It is merely inserted under the tailpiece (of a violin, for instance). Special adhesive tape underneath its flaps holds it in position, on other types of instruments, without tools or drilling. Can be used on all vibration instruments such as guitar, violin, double bass, etc.

A 30-W., 130-db. amplifier. (1492)

The manufacturer states that the Kontak microphone has a flat response from 40 to 9,000 cycles, and for that reason gives natural reinforcement without peaks or other undesirable effects. It has an unusually high output of −40 db. and will operate on any amplifier having 2 stages of amplification or more. The foot-operated volume control increases the range and effects of the instrument tremendously. It permits pipe organ crescendos and volume—permitting a more flexible, less mechanical interpretation of music.

8-BUTTON SKIP-RANGE RADIO SET (1491)

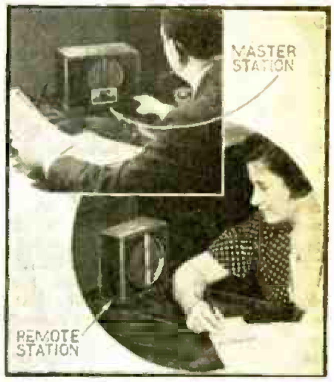
(General Household Utilities Co.)

INCORPORATED in the broadcast and short-wave A.C.-D.C. model 622 receiver illustrated is one type of Teledial automatic tuning system. Press desired-station button (set then goes "quiet"), and swing finger until stop is reached; upon release of button, A.F.C. completes the tuning. Cabinet measures only 8⅜ x 7¼ x 12⅜ ins. wide. Incorporates "6 tubes, metal and glass, ballast tube"; type 25L6 beam tube delivering 2 W.

VERSATILE 30-W. AMPLIFIER (1492)

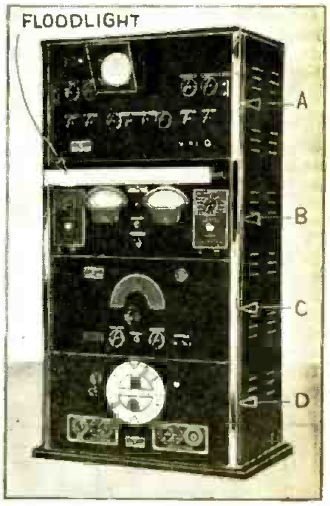
(Radolek Company)

A VERSATILE addition to the Service Man's sound needs is the 30-W. unit illustrated. It is a 4-stage amplifier, employing one 6F5G input amplifier, one 79 electronic mixer, one 76 driver, two *(Continued on page 313)*

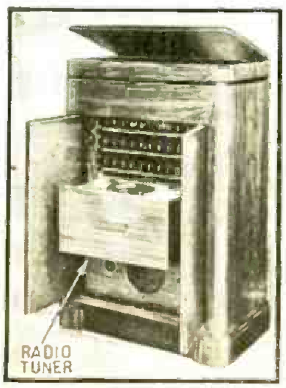


Supersensitive interphone. (1493)

Chairside radio set. (1494)



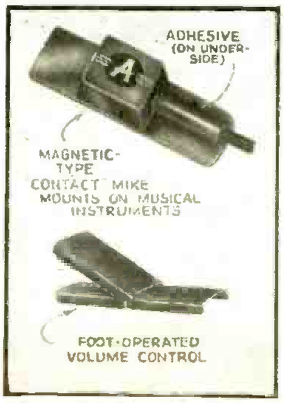
Service "lab." (1495)



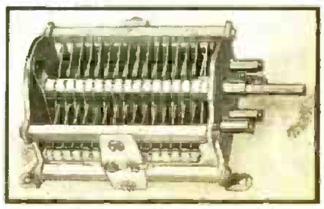
School sound system enables talk-back between 30 classrooms. (1487)

Crystal mike. (1488)

You bolt together cabinets, such as this one, to make a "lab." (1489)



An important contribution to the electronic-music field. (1490)



New line of 20 to 530 mmf., low-cost transmitting condensers. (1496)

OPERATING NOTES
ANALYSES of RADIO RECEIVER SYMPTOMS

Service Men: Please illustrate your operating notes.

Stromberg-Carlson Model 140-P. If distortion, coupling or hum is complained of, or phonograph music distorts at low volume, make certain that the phonograph motorboard floats entirely clear of the cabinet.

Be sure all 4 mounting screws are loosened, and, in excessive cases, remove the motorboard and cushion it on "live" rubber (sponge rubber is best) at center of all 4 sides. This further "damps" the motorboard against vibration.

If distortion persists, check for: (a) dull or defective phonograph needle; (b) old-style records which are not electrical recordings; (c) iron particles on pickup, near needle; (d) damaged pickup head; (e) proper mounting of counter-weight; (f) tone control fully operated, limiting volume.

Tri-Focal Eye in Stromberg-Carlson Closes or Over-Laps. Almost without exception, this is due to variations in characteristics of the 6E5 tube, and is corrected by selection of a suitable tube.

First of all, make sure that the 6E5 tube is not "soft" or "gassy," causing a blue glow in the lens of the tube, which can be seen by looking across the tube in a dim light.

Some "hard" (high-vacuum) tubes are also unsuitable. Any tube drawing in excess of 5 ma. plate current *in the receiver circuit* (as measured by a set analyzer, not a tube analyzer) should not be used.

Occasionally the 6E5 tube may be suitable and the difficulty caused by excessive plate current on the 6K7 tube used in the I.F. stage.

Tri-Focal Eye in Stromberg-Carlson Does Not Close Enough. If the shadow on the target of the 6E5 tube does not reduce on nearby signals, then: (a) check the aerial and ground connections for open lead-in, insufficient pick-up, high-resistance joints, etc.; (b) check sensitivity control knob on rear of chassis (models 130 and 140). Clockwise rotation increases sensitivity; (c) check for a faulty tube in the R.F. system, causing low A.V.C. voltage; (d) check for a grounded cathode bias resistor at 6K7 R.F. or 6K7 I.F. socket.

STROMBERG-CARLSON SOLDER NUGGETS

Victor Microsynchronous 1931 Model. Intermittent reception. This model would stop playing suddenly. The signal could be brought back by giving the cabinet a sharp jolt or by stamping on the floor. Any heavy vibration near the set, such as a heavy tread, would cause the familiar "static" effect suggesting loose contacts or wiring break. Socket test showed all OK. Mechanical examination showed no breaks. The trouble was located under the shield covering the tuning condenser at the front of the set immediately below the dial scale. A small condenser, attached by a lug to the coil here was touching the shield. It should be bent back to a position where it can give no further trouble.

Victor R-15 Model. Intermittent Reception. This is the upright chassis in which the condenser gang is mounted vertically at the front of the chassis. The behavior of this set was peculiar. Volume would suddenly drop to practically zero. Sometimes jarring the set would bring the signal back, but mostly, the set refused to respond to this treatment. A touch on the "tuning knob" brought the signal back with a bang, invariably. Again, the owner would turn off the switch—say, to answer a call on the telephone—and would find that when the switch was turned on again the station would not "come back" no matter how long he waited. Here again the slightest attempt at turning the dial would bring back the music with a bang.

Passing over all the things we did (and said), with the chassis removed from the cabinet, we tuned-in a strong station and awaited its disappearance. A touch on the top end of the shaft and back came the music. But the shaft adjustment and rotor contacts, etc., were correct and clean. Again we tuned-in and waited. This time when the music disappeared we slowly and gently pulled off the shield. At about the halfway point the signal crashed in. We could see no cause for it but pressure from the top end of the shield cover on the disc carrying the dial. We took out a slight—very slight—bulge on the top face of the shield by hammering with the end of a screwdriver handle. Shield replaced and all OK. We still have doubts but the set continues to play. So there!

D. & W. HOYLE

A "Universal" Volume Control. A suitable replacement volume control is almost impossible to find for many of the older model "radios." One which can be adapted easily to many of these sets is made by shunting a 0.5-mf. condenser in series with a 0.25-meg. potentiometer from the control-grid of the 1st audio tube to the chassis. The old, defective control may be wired around (and, in some cases, may be left out of the circuit entirely).

Car-Radio Receiver Dials. A lot of trouble will occur in car-radio sets, due to the dial being warped. When this takes place the teeth do not mesh properly to drive the control. A simple method for repairing this is as follows: wrap the dial in a *damp* cloth and place it in a hot oven or sandwich toaster and let it steam flat.

Pilot 68. Servicing aboard ships at sea is especially difficult, owing to lack of essential apparatus. "Customer" (chief engineer) complained: no reception on low band. Upon checking-up I found that the reaction (feedback) coil of the oscillator circuit had blown out, and spare parts were not on hand. Tried to rewind the 6-turn, fine-wire coil with wire of larger size, but no result.

Built a separate, self-contained oscillator around a 30 tube, which replaced the out-of-duty circuit (*Continued on page* 318)

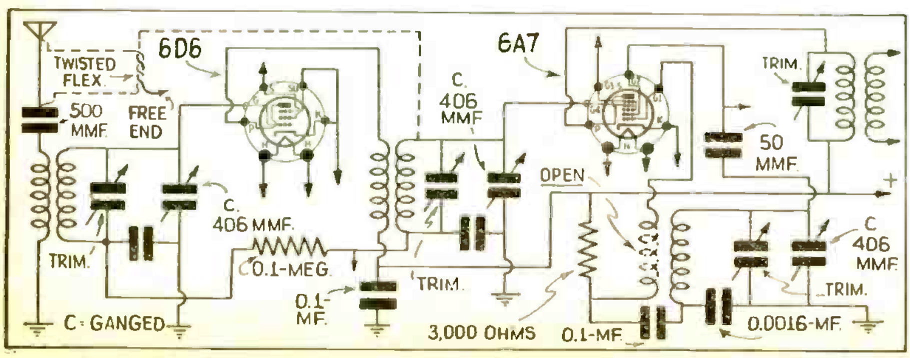


Fig. 1. A Dutch radio operator makes an emergency repair to a Pilot 68.

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.

DRIFTING

(29) Jacob Unruh, McClusky, N. Dak.

(Q.) I have a Sparton radio set, an 11-tube, model 700, which has some peculiar thing the matter with it. I have this radio set in our service shop, but cannot find the trouble. If I have a station tuned-in on about 550 kc. or thereabouts and then wiggle the dial back and forth or tune away and back again, the volume will go down quite considerably. But if I tune the set to the higher wavelengths and then come back to the lower wavelengths it will be OK again. If we leave the set tuned to 550 kc. and do not detune, it will work perfectly all day without fading away, and it works perfectly on the higher wavelengths. I can also make it snap back by just tapping the variable condensers. Do you suppose the variable condenser shaft is worn and that moving it back and forth at this place will throw it out of line? It has a 4-gang condenser.

(A.) Your inquiry is self-explanatory, and no doubt your trouble is due to the condenser gang shaft which has been bent. This can be overcome by removing the back plate which is mounted with 2 screws on the rear of the gang and reshaping so that the shaft rotates truer. At the same time, add pigtails on each individual condenser in order to make a good ground contact to remedy change in volume which you state takes place when you wiggle the tuning gang back and forth.

STATIONS OFF-CALIBRATION

(30) John R. Burgess, Greenville, Ky.

(Q.) I have a Grunow 580 receiver in my shop which is a headache to me. A 650 kc. station comes in at 800 kc. It seems to be about 150 kc. off, all over the dial. At 550 kc., or around there, it will receive ship signals. This is the first time I have ever experienced this trouble, and so far have failed to find the cause of it. Please try and help me solve this problem.

(A.) A remedy can easily be effected simply by realigning the broadcast padding condenser (designated by the factory number 33065) at 600 kc., at the same time rocking the tuning gang back and forth. It is then necessary to set the dial at 1,400 kc. and adjust the trimmer on the oscillator tuning condenser to maximum signal with the aid of a local test oscillator. It is advisable to adjust the antenna secondary coil trimmer for maximum signal output after the above has been done, in order to obtain full efficiency of your receiver.

HUM IN LANG RADIO SET

(31) Joseph Sylvester, Saratoga Springs, N. Y.

(Q.) My 5-tube A.C.-D.C. Lang set has only 20 V. on the plates of all tubes. Shorting filter choke brings voltage up to normal but introduces excessive hum.

(A.) This condition is due to either badly leaking or "open" filter condensers. Replace with new ones using 12 mf. on rectifier side and 8 mf. on load side of filter choke. This will clear up your trouble. (See Fig. Q.31.)

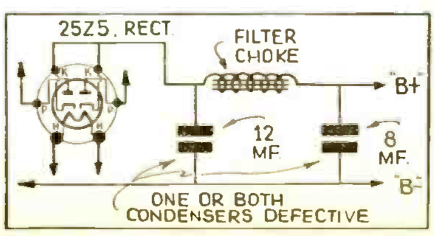
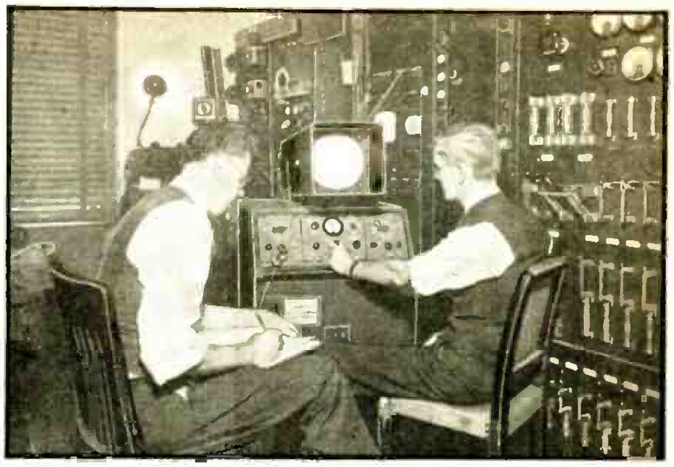


Fig. Q.31. Hum in a Lang set.

"WHAT IS THE FUTURE OF RADIO?"

A question frequently asked the author is answered by inductive reasoning based upon the record of multitudinous achievements—in radio, electronics and public address—that now constitute inspiring history.

H. K. BRADFORD



(Photo—NBC, Television Div.)

PATRICK HENRY, speaking in the Virginia Assembly just before the Revolutionary War, said, "I have but one lamp by which my feet are guided, and that is the lamp of experience."

I always like to quote these words when asked, "What do you think is the Future of Radio?"

It is only 40 years since Guglielmo Marconi demonstrated before the Italian Government an apparatus which transmitted sound—without use of wires—12 miles between ships.

At that time probably no one but Marconi, himself, could see any use for the "wireless" except as a ship-to-ship and ship-to-shore communication system. But Marconi was gifted with rare foresight as well as inventive genius. He dreamed of a day when the voice, itself, would be transmitted over the "air."

I suppose there are not more than 500 persons at best who heard that pioneer effort of station KDKA on November 2, 1920, as returns of the Harding-Cox election were broadcast. It is safe to hazard the opinion that of these listeners not one could have predicted the rapid rise of "the toy"—Radio—into the center of a huge industry.

Not quite 17 years ago that was. Not a single Radio factory, not a commercial broadcast station; little thought of *television, electronics, facsimile picture transmission, public address*. The idea of *talking movies* was held to be a vision which would probably never materialize.

Today there are over 20 million receivers in use; over 4 billions of dollars have been spent on Radio; and, need I mention the status of *talking movies, public address, electronics*, etc.?

Facsimile picture transmission which has already revolutionized the newspaper business may well extend to all businesses. Imagine the value to the business man of being able to write a letter to a customer in, let us say, Australia, and having a written answer within a half-hour in this country. Think of the simplicity of executing contracts in this way.

Mind you, this is scarcely practical now, but judging by

(Continued on page 307)

A.F. DEGENERATION NOW USED IN MODERN RADIO SETS

AT LAST! A circuit arrangement that results in good low-note response IN SPITE OF THE HANDICAP OF SMALL CABINET DIMENSIONS! It now is possible, as Mr. Pallin discloses, to reproduce audio frequencies considerably below the resonant frequency of a loudspeaker.

R. O. PALLIN

A NEW "audio degeneration circuit" has been developed for use in the 1938 G.E. radio sets. This feature, known as the "Tone Monitor," is carried throughout the G.E. line of receivers and provides several distinct advantages over ordinary methods of tone compensation. The benefits derived from the new circuit are as follows:

(1) Automatic tone compensation which is directly dependent upon volume control setting.

(2) Extended and more uniform low- and high-frequency response ranges on strong signals not obtainable with the customary compensation circuits.

(3) Automatic reduction of high- and low-frequency audio response on weak signals to improve intelligibility.

(4) (a) Reduction of harmonic distortion originating within the audio amplifier and (b) increased undistorted power output.

(Continued on page 307)

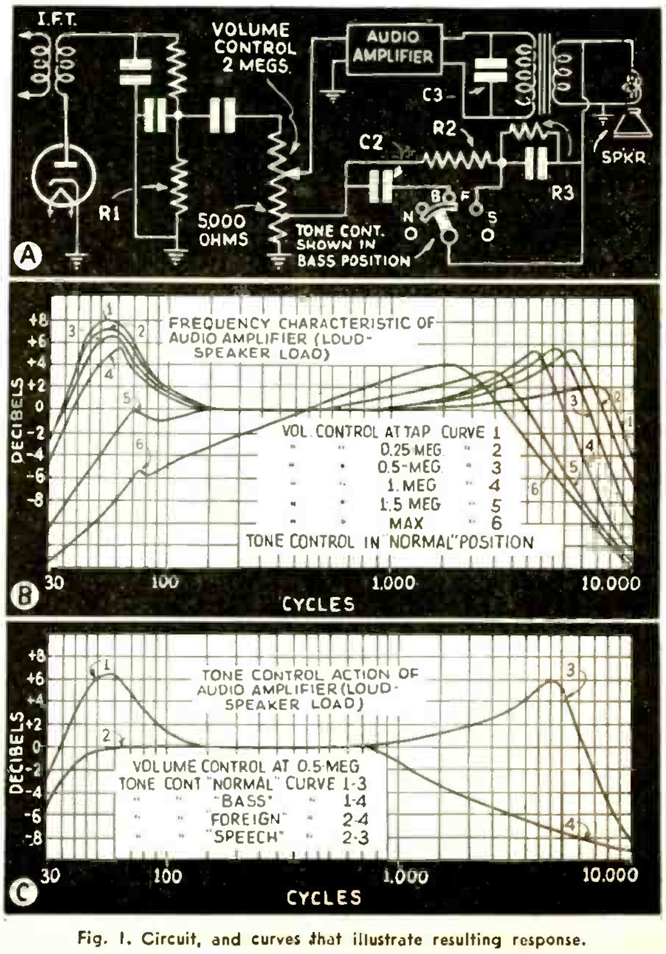


Fig. 1. Circuit, and curves that illustrate resulting response.

AWARDS IN THE CONTEST
FIRST PRIZE $10.00
SECOND PRIZE .. 5.00
THIRD PRIZE 5.00
Honorable Mention

USEFUL CIRCUIT IDEAS

Experimenters: Here is your Opportunity to win a prize for your pet circuit idea, if it is new, novel, and useful.

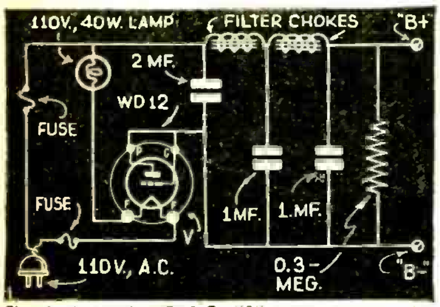


Fig. 1. A novel A.C.-D.C. "B" power supply using a filament-type tube as rectifier.

FIRST PRIZE—$10.00

An A.C.-D.C. "B" Supply Using Filament-Type Tube As Rectifier. "Necessity is the mother of invention." A small amount of 90 V. "B" was needed. An inventory of the available junk box showed no transformers, not even for filaments. The accompanying diagram shows the exact "B" eliminator that was rigged up. An 01A, 71A, or similar tube that draws ¼-A. filament current would give more output. The less said about the efficiency of this circuit the better, but it is simple and served the purpose. See Fig. 1.

I have never seen a similar hook-up using a filament-type tube.

OLIVER H. SMITH

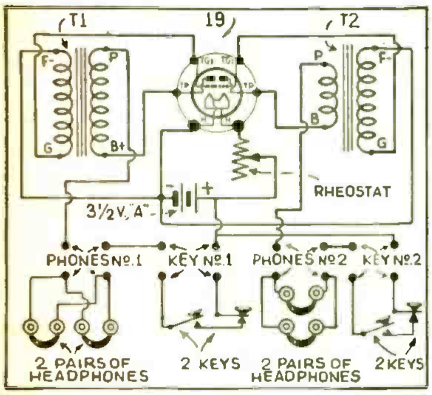


Fig. 2. Circuit of the multiple code-practice set using a type 19 2-V. twin-triode tube.

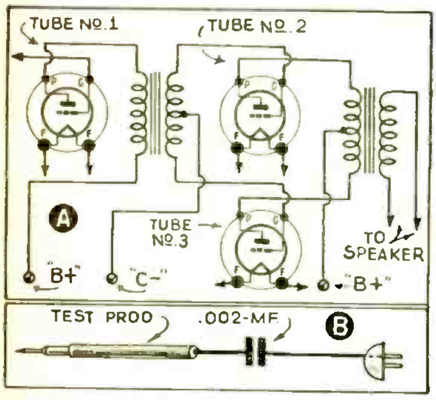


Fig. 3. A practical method for testing audio amplifier stages with A.C. hum as test signal.

SECOND PRIZE—$5.00

Operating a Tube Tester From A.C. or Batteries. In spite of the rapid advancement in the design of equipment for testing, a Service Man is still lost when he comes to working on the many types of battery sets that have flooded the farm homes in the last 3 years. It used to be the old 01A tubes, but now it may be a "6XYZ" or a "2PDQ" that he has to face. Our present tube testers are wonderful as long as there is a source of electricity, but out on the farm that is not true. Having about two-thirds of my work on the farm, I decided to do something about this problem. I found the solution simple after I started. (See Fig. 7.) Here it is:

Step No. 1: Cut the wire from filament to voltage selector switch of the tube tester and run it from the filament to one of the center connections of a D.P.-D.T. switch and the wire from the selector switch to one of the ends on the same side of the D.P.-D.T. switch. The other end of the D.P.-D.T. switch goes to a phone tip-jack on the instrument panel. A second phone tip-jack goes to the other side of the filament. Now by throwing this switch you can change from the A.C. supply of the tester to an outside D.C. (or battery) source of filament supply.

Step No. 2: In most testers the plate supply is obtained from a secondary winding of the transformer. One of these wires goes to the cathodes and filaments and the other to the various plates and grids. Cut the wire to the plates and run it to the center of the other half of the D.P.-D.T. switch. The wire to the transformer goes to the end of the same half of the switch. This wire must be connected to the same end of the switch as the wire that went to the filament selector switch. The other end of the switch goes to a "B" battery (positive) plate source. The negative side of the "B" battery connects to the other side of the secondary winding of the transformer. Now by throwing the switch you change from an A.C. filament source to one of the D.C. and at the same time change your plate source from A.C. to D.C.

As to the plate supply, I found that 3 small "C" batteries give me plenty of voltage. By using the taps I was able to adjust the plate supply so that the quality test was the same on A.C. or D.C. After all, the plate supply is less than half that of the A.C. source and that is generally about 31 V.; so you see that 12 or 13 V. is not so far off.

In using this hookup, get 2 wires with clips and phone tips. Use these to connect to the outside filament source through the phone jacks. (Be *sure* to observe polarity and voltage requirements for each tube.) Connect the "C" batteries permanently and place them inside the tester. Place a good tube in the tester and test it by using A.C. Then throw the D.P.-D.T. switch and see how the 2 tests compare. Increase the plate voltage if the second test is too low and do the opposite if the test is too high. Of course you may calibrate all the tubes over again if you care to do so.

ESCAL S. BENNETT

THIRD PRIZE—$5.00

Locating Grid-Current Distortion. Many are the times when the busy Service Man finds himself confronted with regeneration and distortion in a receiver, that is caused by grid-current flow. The method to be described makes it easy to locate the offending stages, and to correct the trouble visually.

(*Continued on page 312*)

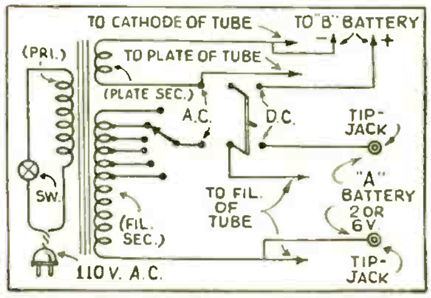


Fig. 7. Making any tube tester work from either an A.C. source or an external battery source.

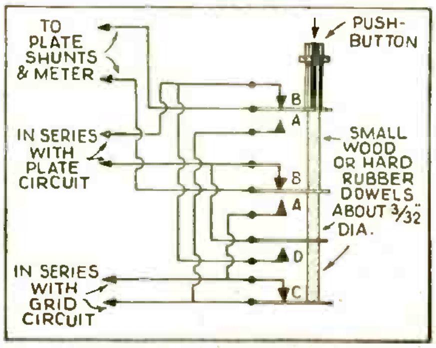


Fig. 8. Here's how any analyzer can be made to locate grid-current distortion.

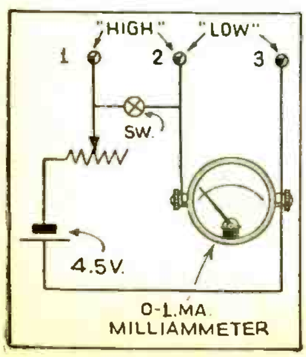


Fig. 4. Low-resistance ohmmeter.

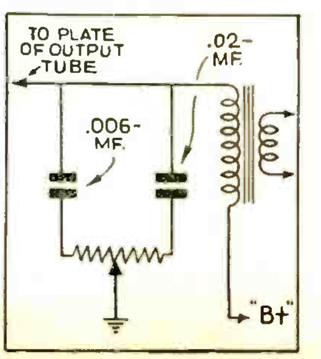


Fig. 5. Novel tone-control circuit.

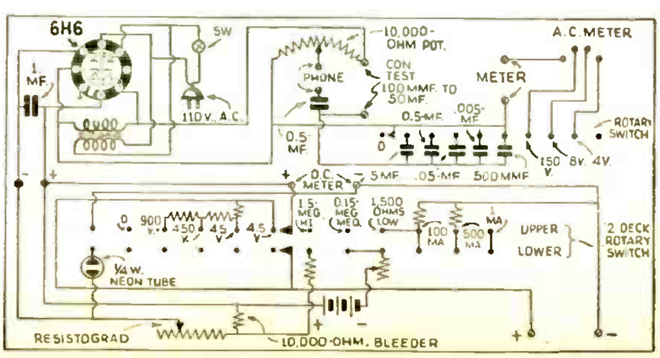


Fig. 6. Circuit of a homemade multitester which includes condenser testing.

Fig. A. A typical neon output indicator.

CALIBRATION OF A NEON OUTPUT INDICATOR TO READ DB. AND WATTS

A practical radio man explains how to extend the useful scope of a neon output indicator for use in practical service and public address work. The expense involved is almost nil. Don't fail to read the article.

W. B. WILSON

THE DEVICE shown schematically by Fig. 1A, and illustrated in Fig. A, a neon output indicator which appeared in the April 1936 issue of *Radio-Craft*, is easily constructed—but would be more useful in many cases if the *relative power levels* at which the neon light just begins to glow were known.

OBTAINING TEST VOLTAGES

Such a calibration is relatively simple. The average experimenter or Service Man has power transformers which make available the following filament (or heater) voltages: 1.5, 2.5 with center-tap, 5, and 7.5 with center-tap. Combinations of these windings—in series and in series-reversed—make it possible to obtain the voltages in the column headed V in Table I.

For example, the 1.5 V. winding connected in series with one-half of the 7.5 V. winding will result in 3.75 plus 1.5 or in 3.75 minus 1.5 V.; that is, in either 2.25 V. or in 5.25 V. Testing with a suitable pilot light or a Christmas-tree bulb will indicate which is which.

Calibration of the output indicator consists merely in connecting the various voltages to the INPUT terminals and noting the point on the dial of the potentiometer arm at which the neon bulb just begins to glow. The scale can then be marked either in relative power level or (relative) decibels (or "db.").

Selection of a potentiometer with proper taper will make it possible to obtain a uniform scale.

When used, the neon output indicator is connected in parallel with the voice coil of the speaker. The speaker remains as the load for the output of the power stage and the neon output indicator acts merely to show the relative audio voltage which, *squared*, is an indication of relative power.

TABLE I

V.	Power Ratio	Decibels (Relative)
1.00	1.00	0.00
1.25	1.56	1.94
1.5	2.25	3.52
2.25	5.06	7.0
2.5	6.25	7.96
3.5	12.25	10.88
3.75	14.06	11.48
4.0	16.0	12.04
5.0	25.0	13.98
5.25	27.56	14.40
6.0	36.00	15.56
6.5	42.25	16.26
7.5	56.25	17.50

CALIBRATION IN RELATIVE DB.

The calibration points of Table I will not result in whole numbers for the relative power or decibel scales. For many purposes, it will be sufficient to locate the whole numbers by estimating their position between a higher and a lower value of Table I.

To calibrate the neon output indicator at predetermined decibel levels, it will be necessary to use a 10 or 15 V. alternating-current voltmeter.

The voltmeter is connected as shown in Fig. 1B. The rheostat, R, a 4- to 10-ohm unit (look in the junk box), is used to secure the desired voltages at the input terminals of the neon output indicator.

Table II gives the voltages necessary to apply in order to obtain points for the various decibel levels.

The method of calibration is to set the proper voltage by means of rheostat R—use the filament winding or combination having a slightly higher voltage—move the dial of the output indicator until the neon light just begins to glow. Check the voltmeter reading and mark the position of the dial.

TABLE II

Decibels (Relative)	Volts	Decibels (Relative)	Volts
20	10	9	2.82
19	8.91	8	2.51
18	7.94	7	2.24
17	7.08	6	2.00
16	6.31	5	1.78
15	5.62	4	1.58
14	5.01	3	1.41
13	4.47	2	1.23
12	3.98	1	1.12
11	3.55	0	1.00
10	3.16		

For those mathematically inclined, Table II is obtained as follows: The 1-V. point was chosen for convenience as an arbitrary zero-db. level.

For any other relative level, say 15 db., reason as follows: 15 *deci.* means that 1.5 *bels* is the logarithm of the power ratio. The power ratio is the *square* of the voltage ratio. Therefore the logarithm of the voltage ratio is one-half of 1.5 or 0.75. Reference to a table of logarithms shows 0.75 to be the logarithm of 5.62.

The correct voltage to use in obtaining a 15 db. point is therefore 5.62, where 1 V. was used for zero db.

(Continued on page 305)

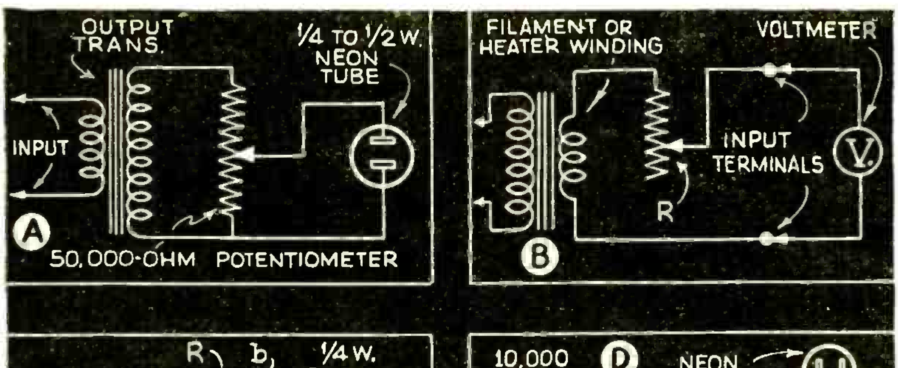


Fig. 1: A, Schematic diagram of neon output indicator; B, Obtaining readings of voltages supplied to output indicator; C, Calibrating the instrument for use as a wattmeter; D, Determining the "striking" point of the neon tube.

FAIRBANKS-MORSE CHASSIS MODEL 12A (SALES MODEL 12-AC-6)

12-tube A.C. superhet.; wide-arc tone diffuser, automatic-tuning dial, automatic volume and frequency controls, 4-bands, including ultra-short waves (down to 4.1 meters!), "Signa-Lite" band indication.

(See Data Sheet No. 215 for additional description.)

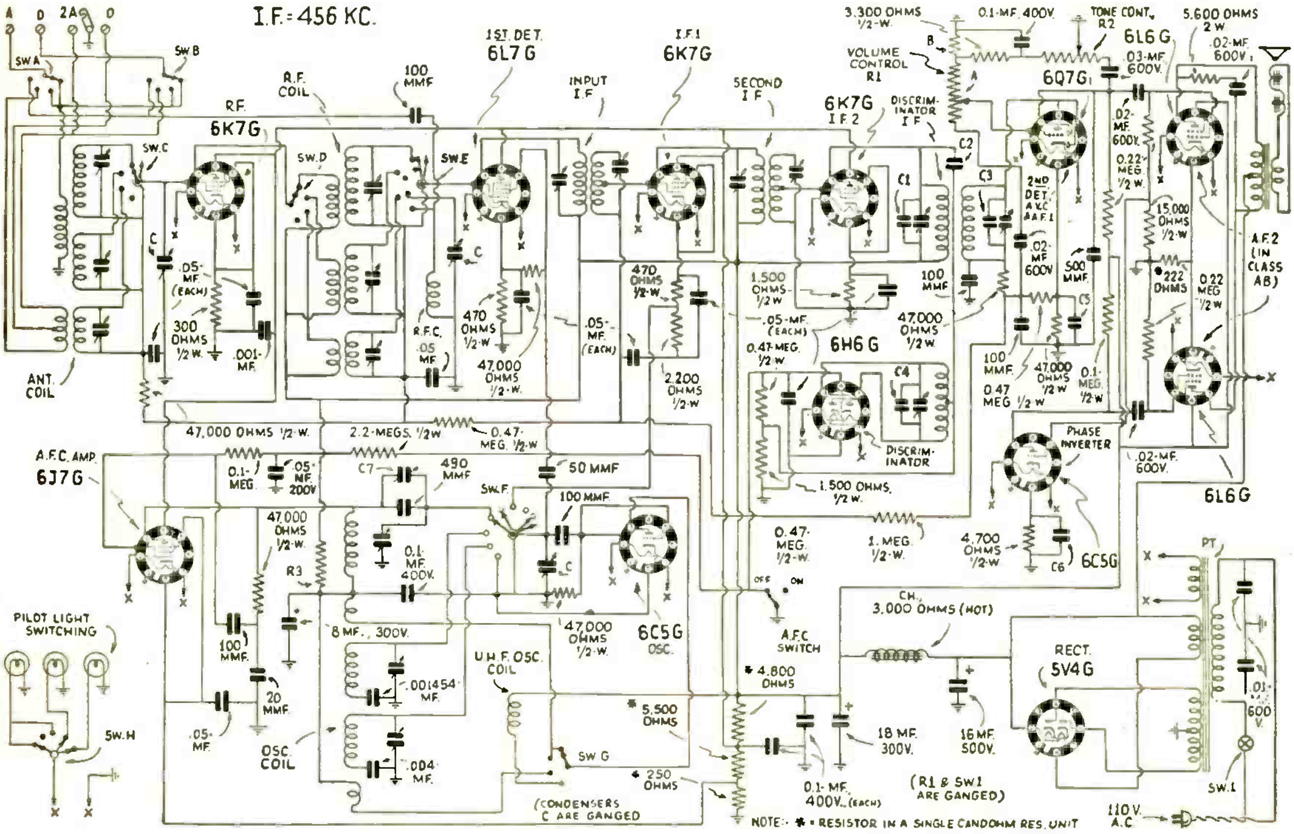


Fig. 1. Schematic diagram of the Fairbanks-Morse Chassis No. 12A (Sales Model 12-AC-6) receiver.

6K7G — RF

OHMS	VOLTS	VOLTS	OHMS
5,700	100	3.7*	320
10,500	235	0	INF.
0	6.3	0	0
0	0	3.7*	320

6L7G

OHMS	VOLTS	VOLTS	OHMS
5,700	100	.35**	42,500
10,000	232	0	INF.
0	0	6.3	0
0	0	5.2*	500

6J7G

OHMS	VOLTS	VOLTS	OHMS
5,700	100	4.8*	250
13,500	192	0	INF.
0	6.3	0	0
0	0	4.8*	250

6C5G — OSC

OHMS	VOLTS	VOLTS	OHMS
		-.05**	41,500
13,500	200		
0	6.3	0	0
0	0	0	0

6K7G — 1ST IF

OHMS	VOLTS	VOLTS	OHMS
5,700	100	8.3*	2,900
10,500	232	0	INF.
0	6.3	0	0
0	0	8.3*	2,900

6K7G — 2ND IF

OHMS	VOLTS	VOLTS	OHMS
5,700	100	3.2*	1,500
10,500	232	0	7.50
0	0	6.3	0
0	0	3.2*	1,500

6H6G

OHMS	VOLTS	VOLTS	OHMS
0	0	-.13**	230M
230M	-.13**		
0	6.3	0	0
0	0	0	0

6C5G — PHASE INVERTER

OHMS	VOLTS	VOLTS	OHMS
		0	190M
13,000	108		
0	6.3	0	0
		4.8*	225

6Q7G

OHMS	VOLTS	VOLTS	OHMS
500M	0	0	500M
190M	110	0	500M
0	6.3	0	0
0	0	1.15**	4,500

6L6G

OHMS	VOLTS	VOLTS	OHMS
10,500	215	0	190M
13,000	395		
0	6.3	0	0
0	0	18.7*	205

6L6G

OHMS	VOLTS	VOLTS	OHMS
10,500	215	0	190M
13,000	395		
0	0	6.3	0
0	0	18.7*	225

5V4G

OHMS	VOLTS	VOLTS	OHMS
55	AC		
		AC	58
13,500	405		
		405	13,000

**30 VOLT SCALE *3 VOLT SCALE

Table I. Chart showing all normal operating voltages as well as resistance data for fast point-to-point resistance analysis.

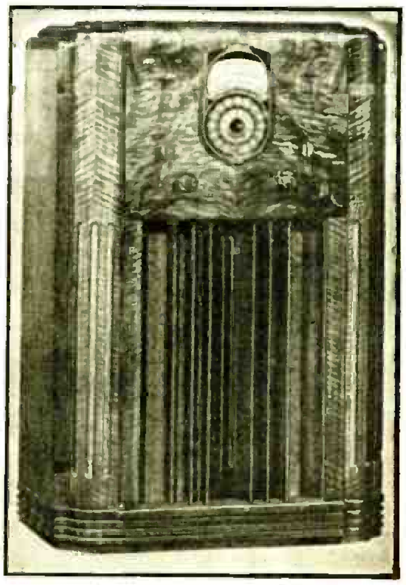


Fig. A. Fairbanks-Morse model 12-AC-6, a 12-tube 4-band superheterodyne. Automatic tuning dial; interstation silent tuning; built-in automatic antenna selector; automatic volume control; automatic frequency control with cut-out switch. Dial has light-change ("Signa-lite") wave-band identification with edge-lighted dial glass indicator. Cabinet of stump walnut in modernistic design with vertical fluted grilles. Frequency range: 530-1,700 kc.; 1.62-5.5 mc.; 5.4-18.2 mc.; 17.65-73 mc. (4.1 m.).

Radio Service Data Sheet

FAIRBANKS-MORSE CHASSIS MODEL 12A (SALES MODEL 12-AC-6)

12-tube A.C. superhet.; wide-arc tone diffuser, automatic-tuning dial, automatic volume and frequency controls, 4-bands, including ultra-short waves (down to 4.1 meters!), "Signa-Lite" band indication.

(See Data Sheet No. 214 for circuit and additional description.)

The Model 12A is an A.C.-operated superheterodyne with automatic volume control, "Signa-Lite" band indication, automatic dial, and automatic frequency control. It receives signals on 4 bands—broadcast, police-amateur, short-wave, and ultra-short wave.

Alignment procedure is given below in chart form. Make adjustments in the order given. The output meter may be any low-range A.C. voltmeter, preferably about 0-15 V. It should be connected across the plates of the 6L6G tubes with a 0.1-mf. condenser in series with one of the leads. The volume control should be set at maximum during the alignment, and as the meter pointer tends to go off-scale, the output from the signal generator should be decreased. If too strong a signal is fed to the receiver and the volume control is used to keep the hand on-scale, the A.V.C. will operate and inaccurate alignment will result.

When aligning the police and short-wave bands, care must be taken to see that the trimmers are set on the proper frequency and *not* on the *image*. The signal from the oscillator heating with the incoming signal in the mixer tube produces *two* 456 kc. heterodynes, one equal to the oscillator frequency minus the frequency of the incoming signal and the other equal to the incoming signal minus the oscillator frequency. The former is the one to which the R.F. and antenna trimmers *must* be tuned if the receiver is to work correctly over the entire band. The image falls 912 kc. below the fundamental signal, so at 18 megacycles the signal should be heard at 18 minus .912 or 17.1 megacycles approximately.

After setting the oscillator trimmer, increase the input from the signal generator and make sure that the image comes in at the proper point. When one signal can be heard at the frequency to which the generator is set and one at about 1 megacycle below it the alignment is ready to be finished. Go back to the fundamental frequency and start peaking the R.F. trimmer, rocking the tuning condenser slightly at the same time. When a peak has been reached, compare the strength of the fundamental signal and the image. If the image is the stronger, the R.F. trimmer is at the wrong peak. Find the other peak and again compare the 2 signals. It will probably be necessary to increase the generator input greatly in order even to hear the image when the right peak has been found.

Referring to the schematic circuit, Fig. 1, additional component values are now available as follows: resistor R1 is an 0.5-meg. unit (R1A, 0.45-meg.; R13, 50,000 ohms); R2, tone control, 0.5-meg.; R3, 3,000 ohms (part of the 5-section *candohm resistor; condensers C1, C2 and C3 are 100 mmf., each; C4, 50 mmf.; C5, C6, 5 mf., 25 V., each (part of a dual electrolytic); C7, small trimmer, variable from 3 to 40 mmf.

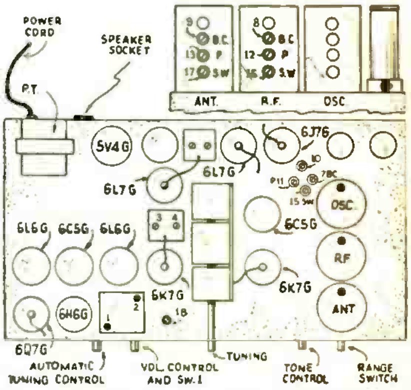


Fig. 2. Chassis layout and trimmer locations.

No.	Connect Generator To	Signal Generator Frequency	Dummy Antenna	Range Switch	Dial Setting	Stage	Trimmer No.	AFC Switch	Peak For	Special Instructions
1	6L7G Grid	456 KC	.1 Mfd. Condenser	Broadcast	550 KC	Disc.	1	Out	Max.	***See foot note below.
2	6L7G Grid	456 KC	.1 Mfd. Condenser	Broadcast	550 KC	Disc.	2	Out	Max.	***See foot note below.
3	6L7G Grid	456 KC	.1 Mfd. Condenser	Broadcast	550 KC	Disc.	18	Out	Min.	***See foot note below.
4	6L7G Grid	456 KC	.1 Mfd. Condenser	Broadcast	550 KC	2nd IF	3	Out	Max.	
5	6L7GGrid	456 KC	.1 Mfd. Condenser	Broadcast	550 KC	2nd IF	4	Out	Max.	
6	6L7G Grid	456 KC	.1 Mfd. Condenser	Broadcast	550 KC	1st IF	5	Out	Max.	
7	6L7G Grid	456 KC	.1 Mfd. Condenser	Broadcast	550 KC	1st IF	6	Out	Max.	
8	Antenna	1500 KC	200 Mmf. Condenser	Broadcast	1500 KC	B.C. Osc.	7	Out	Max.	
9	Antenna	1500 KC	200 Mmf. Condenser	Broadcast	1500 KC	B.C. R.F.	8	Out	Max.	
10	Antenna	1500 KC	200 Mmf. Condenser	Broadcast	1500 KC	B.C. Ant.	9	Out	Max.	
11	Antenna	600 KC	200 Mmf. Condenser	Broadcast	600 KC	B.C. Pad.	10	Out	*Max.	*While rocking. Repeat 8, 9, 10, and 11 until no change is noted.
12	Antenna	5.4 MC	400 Ohm Resistor	Police Amateur	5.4 MC	Police Osc.	11	Out	Max.	
13	Antenna	5.4 MC	400 Ohm Resistor	Police Amateur	5.4 MC	Police R.F.	12	Out	Max.	
14	Antenna	5.4 MC	400 Ohm Resistor	Police Amateur	5.4 MC	Police Ant.	13	Out	Max.	
15	Antenna	1.8 MC	400 Ohm Resistor	Police Amateur	1.8 MC	Police Pad.	*	Out		*Check calibration at 1.8 MC. Padder is fixed.
16	Antenna	18 MC	400 Ohm Resistor	Short Wave	18 MC	S.W. Osc.	15	Out	Max.	
17	Antenna	18 MC	400 Ohm Resistor	Short Wave	18 MC	S.W. R.F.	16	Out	Max.	
18	Antenna	18 MC	400 Ohm Resistor	Short Wave	18 MC	S.W. Ant.	17	Out	Max.	
19	Antenna	6 MC	400 Ohm Resistor	Short Wave	6 MC	S.W. Pad.	*	Out		*Check calibration at 6.0 MC. Padder is fixed.
20	Antenna	60 MC	400 Ohm Resistor	Ultra S.W.	60 MC		**	Out		**See foot note below.
21	Antenna	30 MC	400 Ohm Resistor	Ultra S.W.	30 MC		**	Out		**See foot note below.

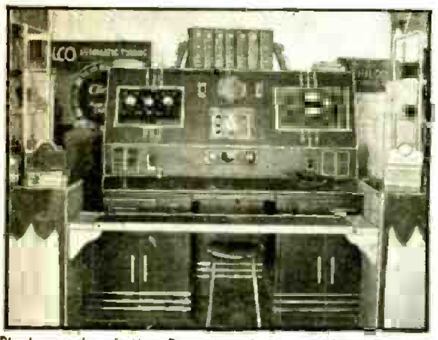
**No adjustment is required on this band. If signal is not received on or near dial setting, check the oscillator tube, switch contacts, the fixed padding condenser and the coils.

***To check the setting of the discriminator, tune in a fairly weak station near 1000 kilocycles with the automatic tuning switch in the "OUT" position. Peak the station carefully and then throw the switch to the "IN" position. If throwing the switch detunes the station, repeak it carefully using trimmer number 18. A further check may be made by tuning to either side of the station with the switch out until only the side bands are audible and then throwing the switch in. The station should come into resonance as the switch is thrown in. Failure to do so indicates that the adjustment just described has not been careful enough and that it should be made over again.

Table II. Chart showing the proper procedure and frequencies for accurate alignment of this Fairbanks-Morse Model 12A chassis.

OFFICIAL RADIO SERVICE MEN'S ASSOCIATION, INC. — MEMBERS' FORUM

A department devoted to members and those interested in the Official Radio Service Men's Association. For mutual benefit, contribute *your* kinks, gossip and notes of interest to Service Men, or others interested in servicing.



Photograph of the Pompton Lakes Radio Shop at Pompton Lakes, New Jersey, owned and operated by Mr. Donald Abrams. Supreme instruments are well represented in this efficient, business-like layout.

CANADIAN P.A. TALE OF WOE

RADIO-CRAFT, ORSMA, *Dept.*:

Public Address work, as it is applied in the U.S.A. means almost nothing here. In fact, the P.A. business is flat, and how! The cost of a 12-W. job—no speaker, no mike, no tubes—is $110. A 3-W. portable, complete, is $165!

The high prices are due to a combine, and homemade equipment is not allowed, as one gets into trouble over patent rights. Besides, same may be seized. Only 2 makes of sound systems are allowed to operate, and their prices are approximately the same. So—my fellow U.S.A. Service Man, how would *you* like to sink $1,000 in a small sound system, consisting of a 12-W. job, complete, and an old car? Some fun, eh kid?

In the auto-radio field, there are very few installation jobs. Most of the auto-radio sets are installed by the auto factories in their respective makes of cars. In regard to servicing, there is an argument as to whether the auto service department or the local Service Man should service these factory auto-radio jobs after the guarantee period.

This sort of thing—a very forceful effort on the part of the radio manufacturer to force their dealers to return all the servicing to them, the idea being to boost the paying return of the factory service department—has been going on for some time in the radio service trade. Another viewpoint is that they claim that the average (8 out of 10) Service Men cannot repair from a schematic the 1934 to 1938 radio receivers. In this I agree that they are right, as you should see some of the radio circuits!

I know of one case where a radio firm sold the franchise to a radio Service Man who was doing repair business for 3 dealers, then went around and solicited repair business from the dealers for the radio company service department.

So, my fellow Service Men in the U.S.A., if you think the going is tough and the fields far away in Canada are green, you are due for a big surprise—for the green fields have a red danger sign!

ROBERT ROGERS,
Lachute, Quebec.

Thanks for the low-down, "Bob"! Did you note Mr. Perong's article in July *R.-C.*?

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 at end of dept.)

(19) A *transformer* is—

(a) An apparatus for converting telegraph into wireless. (b) An ex-cross-country runner. (c) A device for coupling electrical circuits. (d) A device for altering the form of electrical energy between circuits. (e) A toupée or wig.

W. WARD

(20) Any person who is "up" in his radio knows that *Radio-Craft* is—

(a) Any sailing vessel which is especially equipped so that it can be controlled by radio. (b) Newly developed acoustic paper used for cones in the better loudspeakers. (c) A police cruiser having both radio transmitting and receiving facilities. (d) Radio's livest magazine. (e) The radio servicing profession.

E. J. SAMPSON

(21) A *mixer tube* is usually one in which—

(a) Alternating current is changed to pulsating current. (b) Concrete for building purposes is produced. (c) The desired beat frequency is obtained by combining the carrier signal frequency with the locally-generated frequency. (d) One in which the bass and treble notes are harmoniously mixed in order to produce a hi-fidelity tonal output.

L. A. WEBSTER

(22) A *Wheatstone bridge* is—

(a) A traffic bridge designed by Mr. Wheatstone. (b) A device used to measure resistance. (c) A stone used to grind wheat.

VICTOR RICHARD

(23) A *photoelectric cell* is—

(a) One of those new-fangled, escape-proof contraptions in Alcatraz prison. (b) A device for rushing photos back and forth in busy newspaper offices. (c) A vacuum tube in which electron emission is produced by the illumination of an electrode.

CARL GRAHAM

(24) It is generally known that an *indoor antenna* is a type of antenna—

(a) Built in a door. (b) Used to decrease the sensitivity and to increase the effects of static. (c) One that needs no insulation. (d) Strung up in a room or attic.

LYLE C. RAGAN

(25) All good amateurs know that an *ohm* is—

(a) A domesticated animal of South America. (b) Equal to 40 W. (c) A unit of electrical resistance. (d) A new type of fixed condenser.

CLARENCE E. MAW

(26) A *grid cap* is used—

(a) To keep the grid warm. (b) As a shield. (c) To prevent removal of the grid. (d) To provide electrical connection to the grid.

GEORGE GELLATLY

(27) Those of us who dabbled in radio prior to the World War would refer to a *loose coupler*, meaning—

(a) A defective connection between earth and ground. (b) An amateur who would not stay on his assigned frequency. (c) A Justice of the Peace who

(*Continued on page* 307)

Radio Service Data Sheet

STROMBERG-CARLSON NOS. 230 AND 231 SERIES

7-Tube Superheterodyne; Metal Tubes; 3 Bands (530-1,700 kc.; 1,700-5,600 kc.; 5,600-18,000 kc.); A.V.C.; Trifocal Tuning Indicator; Carpinchoe Dynamic Speaker; Power Consumption, 65 W.

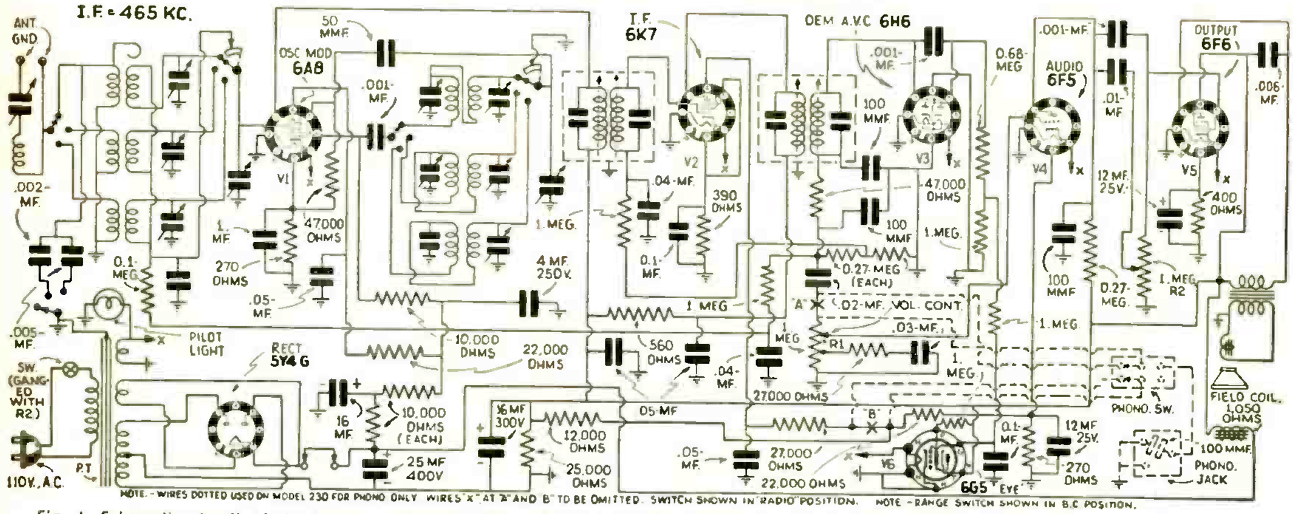


Fig. 1. Schematic circuit of the Stromberg-Carlson Nos. 230 and 231 Series receivers. (See text for model numbers covered by this chassis.)

Intermediate-Frequency Adjustments. The intermediate frequency used in these receivers is 465 kc. In making these circuit adjustments always align the circuits in the order given in these instructions.

(1) Operate the "Range" switch of the receiver to the "A"-range position. Set the receiver's tuning dial at its extreme low-frequency position, and operate the tone control knob to the "normal" position. Rotate the volume control knob to its maximum clockwise position; (2) Apply between the chassis and the control-grid of the 6A8 tube, a modulated signal of 465 kc. from a good test oscillator, using a 0.1-mf. condenser in series with the signal lead. Do not remove the control-grid lead connecting to this tube; (3) Now align the I.F. circuits in the following manner: Secondary of 2nd I.F.; primary of 2nd I.F.; secondary of 1st I.F.; primary of 1st I.F.; adjusting the circuits to obtain maximum reading on the output meter, reducing the output of the test oscillator as required.

Alignment of "C" Band. In aligning the R.F. circuits for this range, replace the 0.1-mf. condenser which was placed in series with the test oscillator's output lead for the I.F. alignments, with a 400-ohm carbon resistor. This lead should then be connected to the antenna binding post. (1) Operate the range switch on the receiver chassis to the "C" position, and set the test oscillator's frequency and the receiver's tuning dial to 17 megacycles; (2) Adjust the oscillator's "C"-band trimmer for maximum output; (3) Adjust the antenna's "C"-band trimmer for maximum output, at the same time rock the gang tuning condenser back and forth, through resonance, until maximum output is obtained.

Alignment of "B" Band. In aligning the R.F. circuits for this range, use the same artificial antenna (400-ohm carbon-type resistor) as was used for aligning Band "C". (1) Operate the range switch on the receiver chassis to the "B" range position, and set the test oscillator's frequency and the receiver's tuning dial to 5 megacycles; (2) Adjust the oscillator's "B"-band S.-W. trimmer for maximum output; (3) Adjust the antenna's "B"-band S.-W. trimmer for maximum output, and at the same time rotate the gang tuning condenser back and forth through resonance until maximum output is obtained; (4) Set the test oscillator's frequency and the receiver's tuning dial to 1.8 mc.; (5) Adjust the oscillator's "B"-band low-frequency trimmer (series trimmer), and at the same time rotate the gang tuning condenser back and forth, through resonance, until maximum output is obtained; (6) Reset both the test oscillator's frequency and the receiver's tuning dial to 5 mc. and repeat operations Nos. 2 and 3.

Alignment of "A" Band. In aligning the R.F. circuits for this range, replace the 400-ohm carbon resistor with a 200 mmf. condenser and align these circuits as follows: (1) Operate the range switch to the "A"-range position and set the test oscillator's frequency and the receiver's tuning dial to 1.4 mc.; (2) Adjust the oscillator's "A"-band high-frequency trimmer for maximum output; (3) Adjust the antenna's "A"-band high-frequency aligner for maximum output; (4) Set the test oscillator's frequency and the receiver's tuning dial to 0.6 mc.; (5) Adjust the oscillator's "A"-band low-frequency aligner (series aligner) for maximum output, and at the same time rock the gang tuning condenser slightly back and forth, through resonance, until maximum output is obtained; (6) Reset both the test oscillator's frequency and receiver's tuning dial to 1.4 mc. and repeat operations Nos. 2 and 3.

Wavetrap Adjustment. In adjusting the wavetrap circuit, the "signal admission control" should be set for the most sensitive position (shaft rotated in the most counter-clockwise direction). Set the range switch of the receiver to "A" range and the tuning dial to 1,000 kc. Connect a 200 mmf. condenser in series with the output of the test oscillator and the antenna binding post on the receiver, and the ground terminal of the test oscillator to the ground binding post on the receiver. Then, with the test oscillator set to 465 kc., supply a fairly strong signal to the receiver and adjust the wavetrap trimmer for *minimum* output-meter indication.

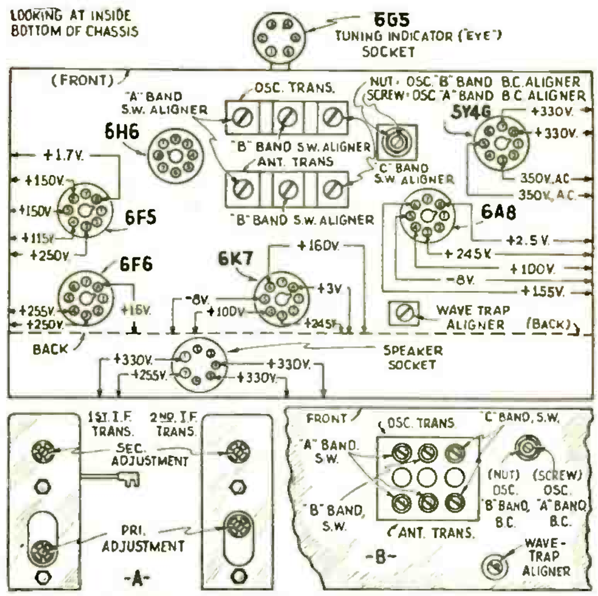
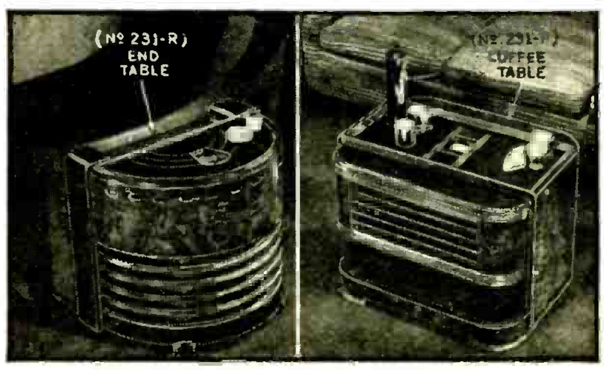
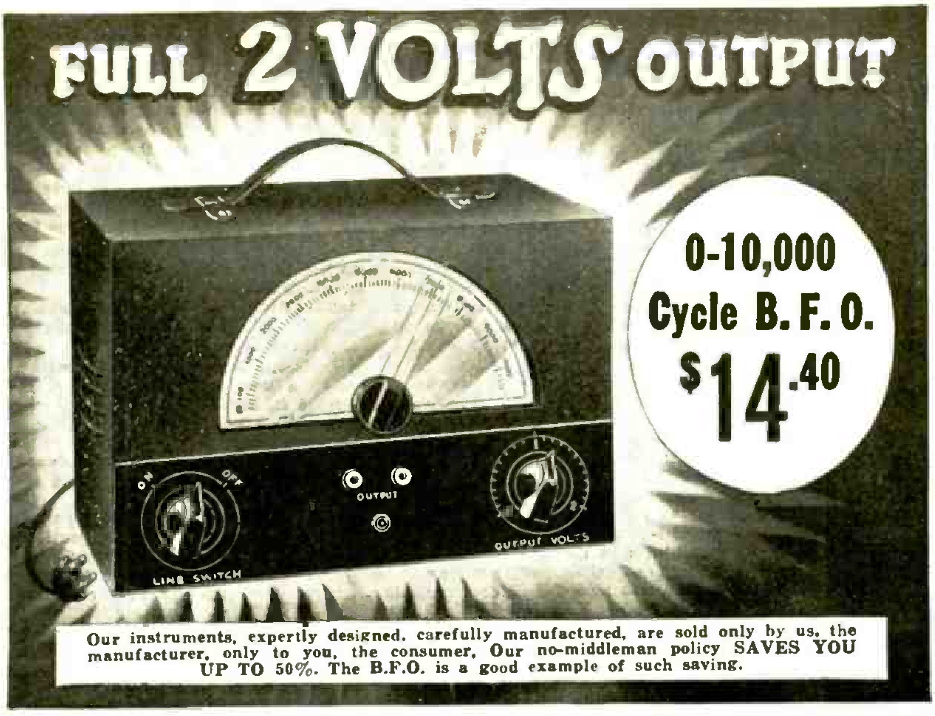


Fig. 2. A, location of osc. and ant. trimmers and socket voltages; B, location of R.F. trimmers.



Models 231-R (left) and 231-F (right) receivers.

Number 230 series includes models 230-H, 230-HB, 230-L, 230-LB. Number 231 series includes models 231-F, 231-FB, 231-R, 231-RB, 231-P and 231-PB (the last 2 models being phonograph combinations). The 230 and 231 series of chassis differ only in the type of electrolytic condensers used.



PURE SINE WAVE AUDIO BEAT OSCILLATOR With Flat Output and High Stability

INCORPORATING the original developments of H. J. BERNARD, 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 or more. Absolutely flat 1,000-10,000 cycles, substantially flat 50-1,000 cycles. Sine wave, 100-10,000 cycles. Harmonic content less than 3%.

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.

The instrument is equipped with a volts-calibrated attenuator. 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

METER WITH UNEARTHLY SENSITIVITY

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 voltmeters permit a-c measurements of tuned circuits or any other a-c networks. Here is a remarkable answer to the serviceman's crying need for an instrument of almost unearthly sensitivity. Not only does the INFINOMETER draw make 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 on a par with that of instruments that measure only d.c. and draw much current, at that.

JUST to show what an astonishing instrument this is, we use our 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, 5/15/50/150 volts, a.c. or d.c.

The INFINOMETER is direct reading—no slideback—just "look and see." It has two input connections, 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

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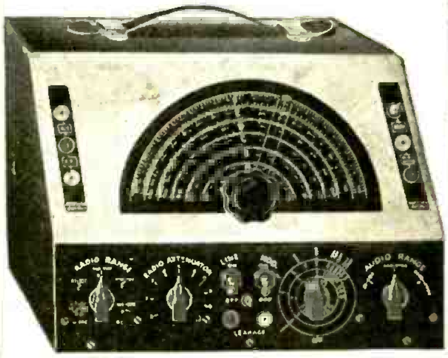
Our superlative signal generator, direct reading fundamental frequencies, 100 kc. to 22 mc., and direct reading also to 100 mc., has modulation on-off service, with bandspread audio frequencies 25-10,000 cycles. Audio, in three bands, is saw-tooth wave and useful also for oscilloscope sweep. Complete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



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MODERN "RADIO" AS A VOCATION

(Continued from page 266)

possible, would require much more space than is here available; those who are interested in practically all the important technical developments in this field will do well to review the past issues of *Radio-Craft* in which they were illustrated and described. Observe, instead, some of the actual accomplishments in various fields that P.A. improvements have facilitated.

Loudspeaker System for Rooting Teams. First on the list is a purely imaginative set-up which by the time this magazine appears on the newsstand may have become an actuality! We refer, as you may have guessed, to the cover illustration (reproduced photographically, on page 266, as Fig. A) of a sound system for use at football games, etc.

The idea as *Radio-Craft* proposes it is to use an individual sound system of moderate power arranged specifically to boost the sound of the cheering crew in action. The directive loudspeakers here shown pointing toward the grandstand may be directed at the team in the field. It is no trick at all to arrange the microphone (at left, in photo) to prevent feedback howl.

Thus the volume of a few men in the cheering crew may be amplified and directed at teammates to produce an effect equivalent to or greater than that obtained by a larger cheering section in the opponent camp.

SHORT-WAVE RADIO

Short-wave radio has had a mushroom growth that is even more apparent in the ultra-short wave field—but the future holds in store far greater promise. As an interesting example of recent equipment developments in short-wave radio broadcasting we illustrate in Fig. B a new device to aid in spot broadcasts.

Golf-Tournament Microphone Assembly for S.-W. Spot Broadcasts. The bane of Ted Husing's life—the necessity for mumbling into a microphone lest he disconcert a golfer dropping a putt—has been overcome by a new invention constructed under the direction of Paul White, Columbia's Director of Public Affairs. Husing put Mr. White's invention to its first test at the National Amateur Golf championships at the Alderwood Country Club, Portland, Ore., the week of August 23-28.

The same principle involved in the periscopes that are on submarines applies to the new device. It is a tall, umbrella-topped stick with a sharp point which enables the stick to be plunged into and held solidly in the ground. Attached to this stick is a periscope. When the players reach the green, Husing jabs the stick into the ground behind the crowd at the green and looks into the periscope which he focuses on the player "away," or the first to putt. *The "tele-periscope" magnifies the ball, cup, and player 10 times!*

Attached to the pole is a weatherproof microphone, which slides up and down to accommodate any talker Husing may call upon. This microphone, which is easily detached, is connected to nearby short-wave equipment.

The periscope is constructed so that the bottom is on a level with Husing's eyes, and the top about 3 ft. higher. A few feet above the top of the periscope is a huge umbrella which protects the equipment from rain. With this equipment Husing can stay quite some distance from the actual play and give an accurate story of what is going on.

Previously Ted has had to clamber up ladders or trees to broadcast the putting portions of a golf match!

New 2-Way Police-Radio Auto Speedtrap. In Fig. C is shown another new application of short-wave facilities that illustrates in dramatic fashion some of the application possibilities in the short-wave radio field.

This unusually fine set of staff action-photographs, Fig. C, by *Kansas City Star* (newspaper)—made available to *Radio-Craft* by courtesy of Lieut. Roy DeShaffon, Supervisor of Radio KGPE, Dept. of Police, Kansas City, Mo.—illustrates the newest thing in law enforcement.

At 1, Sergt. Cecil Hastings is shown warning a checking crew of the approach of an automobilist traveling at high speed. Two RCA Victor type ATR-219 portable 2-way radio sets, with vertical antenna mounted to the side wall of the transmitter unit, are utilized to signal by short waves between the two crews. (The ATR-219 utilizes the conventional type 19 tube in a modulated oscillator circuit that affords an output of approximately 2 W.)

At 2, we see Sergt. D. W. Tays clocking by means of a stop-watch the speed of a passing autoist whose approach has been announced. A motorcycle cop, concealed with the checking crew

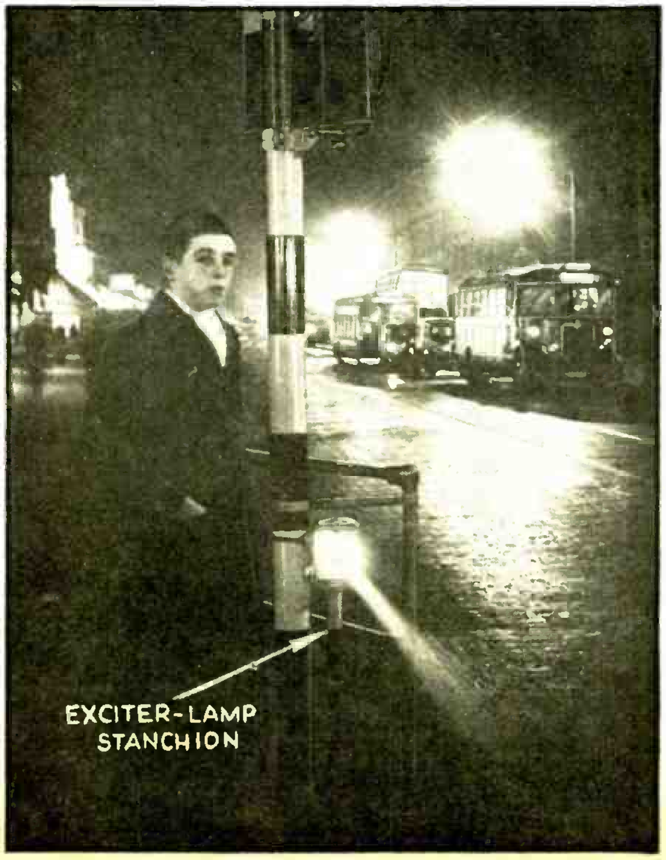

Fig. D.

Londoners recently were introduced to an electronic innovation that soon may be accepted as an essential element in making traffic conditions in every city more safe. As shown at right, a pedestrian has only to interrupt the "safety-first ray" (focused onto a photocell), at one of London's most dangerous cross-roads, to operate 8 sets of traffic lights. The beam and photocell are placed so close to the ground that even small children may operate the system.

(Photo—Fox)

in a deep driveway, awaits the word to dart after the speeder.

At 3, is the well-known "you can't get away with it" scene—patrolman George Downie hands a victim of science's latest machinery for circumventing lawbreakers a "ticket" for passing the speedtrap at 40 miles an hour!

ELECTRONICS

Without going deeper at the moment into Public Address and Radio we will turn now to an ultra-modern application of Electronics.

Electric Eye Controls 8 Sets of Traffic Lights. An excellent example of the practicality of the use of electronics and one that should enliven interest in electronics as a vocation is that illustrated in Fig. D.

Manor Park Council, London, England, has installed a "safety first" photoelectric traffic control system. A strong beam of light from an exciter lamp mounted on a post is focused across the gap between safety railings onto a photocell mounted on a second post. Anyone stepping to the pavement edge interrupts the beam and thus automatically sets 8 groups of traffic lights, at one of London's most dangerous crossroads, to STOP position to afford pedestrian right-of-way; time-delay relays control the stop lights to prevent too-frequent operation.

The *exciter* or "light-beam" post and its photocell counter-part across the path are mounted sufficiently close to the ground to permit even the smallest child to set the system into operation. (In passing, it is interesting to note the photographic evidence that London traffic always "keeps to the *left*" of the road.)

So much for a few of the new, practical applications of radio principles that tend even if only slightly to show the diversity and scope of radio development.

CONCLUSION

Stripped of its unessentials, the basic questions confronting the radio-minded young man (or woman) are: (1) "Can I get a job in radio?"; (2) "How much money can I earn?"; and, (3) "Is radio only a mushroom industry, soon to collapse, or is it one that is founded on bed-rock and therefore capable of affording me a reasonable degree of surety that I may be able to get ahead?"

Answering the first question, offhand the answer, positively, is "yes!"; but immediately we must qualify it with the additional statement, "provided you have something on the ball." Merely to look in desultory fashion for an opening is not enough; instead the job-hunter must first make a searching analysis of his own capabilities (see the article, based on Bell Laboratories researches, entitled "'Finding Yourself' in the Technical World," in the November, 1935, issue of *Radio-Craft*). Only then is he ready to ferret out the occupational possibilities, either latent or active, in his own territory which his self-analysis has indicated are within his reach. To make the point more clear we quote, from the opening paragraph of the article mentioned above, as follows: "All too-often the . . . . radio man becomes calloused to the phase, 'We'll get in touch with you if we have an opening,' without realizing that *perhaps an opening already exists for a* QUALIFIED *technician*."

Answering the second question, the pay is as good as, or slightly better than, comparable industries; albeit in radio the hours are sometimes longer and the work, in its very nature, a greater tax of stamina. The top-flight figures of course are paid only to men of exceptional capability and holding positions of considerable responsibility. A *major requisite* for advancement (and consequent increased remuneration), *today*, is TRAINING.

Now we come to the third question. Is radio a "sound proposition"? Well, let us see. During 1937, according to recent estimates, the more than 600 broadcast stations will have received something like $100,000,000 in advertising revenue; about 27,000,000 radio receivers, here in America, will have tuned-in to their programs; and, about 164,000 persons will have comprised the personnel of the radio industry. (Note—only slight account has been taken of the extensive and rapidly increasing activities in the fields of *electronics* and *public address.*)

The ultra-short wave field—facsimile, television, etc.—and other radio fields have yet to be explored and developed.

Once the radio neophyte has gained a toehold in radio by obtaining even the most menial of jobs he is "on his own" to exercise sufficient initiative and industry to take the next step, and the next, and so on up the ladder.

RECENT APPLICATIONS OF THE "ELECTRIC EYE"

(Continued from page 265)

gases under low pressure the electrons are likely to collide with gas molecules on their way to the anode. The result of such collisions is ionization of the gas particles and production of still more electrons. Since the intensity of the photoelectric current depends on the number of electrons hitting the anode, it can readily be seen that the introduction of gas into the tubes results in an "amplification" of the original light-effect.

Their correct filling requires much skill. For best results the voltage must be high, but if it is too high a glow discharge sets in which will rapidly destroy the cathode. Almost every large electric company (e.g., General Electric, Osram, Philips) manufactures such photocells. Some firms, e.g., Pressler, actually specialize in it.

Cells based on this "external" photoelectric effect (Hallwachs effect) are indispensable where immediate response to light stimuli is essential. It is generally believed that they are entirely free from inertia, i.e., that their response is instantaneous. A scientist in Glasgow has just shown that with highly refined apparatus involving metal mirrors revolving at extreme speeds, a lag period of the order of billionths of a second may possibly exist in such cells, which, of course, can be neglected for all practical purposes.

APPLICATIONS

The most important field of application of these cells at present is sound film reproduction. Rectifier cells would be much too slow here.

The photoelectric current generated by vacuum or gas-filled cells has to be amplified with electron tubes before indicator instruments like galvanometers are able to register it. This makes apparatus comprising such cells more complex than rectifier cells would necessitate.

But the reward is not only an increased sensitivity but also a more constant performance. Furthermore, by varying the nature of the light-sensitive coating of the cathode, the range of sensitivity to radiation of widely differing wave-length may be selected.

For example, a film of sodium metal spread on silver renders the cell highly sensitive to light of short wavelength (near ultraviolet, violet). Caesium, another alkali metal, on the other hand makes the cell red-sensitive. It is rather a disadvantage that in order to cover the whole range of the spectrum with sufficient sensitivity a series of cells with different photo-sensitive layers is necessary. But only rarely is this a point of practical import.

After these introductory remarks let us turn to some photoelectric apparatus, showing features of particular interest.

AUTOMATIC ELECTROPHOTOMETER

This ingenious apparatus (invented by Geffcken and Richter, manufactured by Freye, Braunschweig) consists of an optical arrangement and an electrical circuit. The light of the low-voltage lamp LB (Fig. 1A) is made parallel by the lens combination O. The beam of light passes the solution F1 to be measured, contained in the trough G1. The second lens system O concentrates the light on the photocell. A highly-insulated vacuum-type photocell is employed. The electron tube is contained in a special electrometer circuit. At the beginning of the measurement the grid receives a high negative bias and at the same time the counter, L, is started. The bias makes the anode current of the electron tube almost negligible. The light-sensitive layer (cathode) of the photocell (P.E. cell) is connected with the grid of the electron tube V. Upon illumination a *photocurrent* is produced which effects a discharge of electrons from the grid to the plate. This will take the less time the stronger the photoelectric current is. When the negative charge of the grid sinks below a certain value the plate current sets in again. This puts the relay, M, in operation which in turn stops counting mechanism L. It is evident that the counter will run for a length of time depending upon the intensity of light falling on the photocell. The light intensity, in turn, depends on the depth of color of the fluid in the trough G1. The time, as indicated by the counter, then, is a measure of the light transmission of the fluid. Figure A shows the exterior of this interesting instrument. It may be used not only for color but also for *turbidity* measurements.

PHOTOELECTRIC COLORIMETER

Let us have a look at B. Lange's colorimeter which contains 2 of the copper, copper-oxide rectifier cells, Z, Z, of his own design (Fig. B). The circuit is shown in Fig. 1B.

The 2 photocells are connected in series. Resistor R1 is a variable precision unit and G is a sensitive pointer galvanometer. The sensitivity may be adjusted by the variable shunt, R2. We are dealing here, therefore, with a bridge circuit with a measuring instrument in the diagonal branch. The light source is in a central position.

For purposes where *monochromatic* light is desired an electrical sodium burner emitting strong yellow light, or else thallium-vapor lamps may be used. Otherwise, a tungsten filament lamp in combination with permanent color filters made of glass is employed.

Before entering the photocells, which are arranged in a symmetrical position with respect to the light source, the light passes 2 plane-parallel glass cells. If both contain the same solution, the galvanometer will show zero deflection. Ordinarily, one of the cells will contain the *unknown* sample and the other the *solvent.* The deflection of the galvanometer may either be directly read off the scale and the content in the colored substance taken from a calibration curve; or, the unknown solution may be matched with the aid of standard solutions of known concentration until the galvanometer pointer is brought back to the zero position.

The instrument covers a broad field. It may be used by the chemist, the biologist, the bacteriologist, the colloid chemist; in short, wherever accurate and rapid analyses must be conducted. One of its chief advantages is its insensitivity against fluctuations, due to voltage variations, in the intensity of light. The compensatory arrangement of the photocells permits the use of light sources which are fed from the mains.

A SIMPLE PHOTOMETER

Here is a home-made instrument which has rendered valuable services to the writer. It is contained in an inexpensive radio amplifier metal box. The layout is shown in Fig. 1C. The light source, L, is a miniature flashlight bulb (6 V.) which is fed from a storage battery. The 6-ohm variable resistor, R, permits regulation of the filament current and, thereby, of the photoelectric current generated by the rectifier cell, W (Weston). The lens system, C, made up from small, odd lenses, concentrates the beam on a circular opening in carriage M containing 2 glass cells T' and T''. By a sliding mechanism and by stops either cell may be interposed in the beam of light. The light filter, F, is selected as to be nearly complementary to the color of the solutions to be measured. This makes for selective measurements. One cell contains the solvent and the other the unknown sample.

The current generated by W is measured either directly by a microammeter or by a potentiometer arrangement which prevents drawing of appreciable current from the photocell. The instrument is calibrated by a series of standard solutions. The use of flashlight lamps using only 0.5-A. keeps the heat evolution in the instrument down; important for photocells of this type.

AUTOMATIC TITRATION APPARATUS

A dream of the chemist has come to life—all he has to do is to put the solution to be analyzed, e.g., an acid of unknown strength, and a suitable indicator dye in the beaker shown in Fig. 1D! The standard solution, an alkali in this case, is filled in the burette and the apparatus of Muller and Partridge will do the rest. Let's assume that the indicator is *yellow* as long as the solution is acid and that it will change over to *red* when the solution becomes alkaline, i.e., when the end-point of the titration is reached. The diagram shown in Fig. 1D shows how the trick is done.

The stopcock of the burette is controlled by a magnetic device which is operated by a relay. As long as the solution is yellow the stop-cock will remain open and fluid from the burette will drop into the beaker where it is mixed with the acid by the stirrer shown in Fig. 1D. When the color change to red takes place the photoelectric current changes abruptly. The relay operates and closes the stopcock of the burette. All the analyst has to do is to read the amount of alkali used off the graduation of the burette. You will note that an electron tube, V, is em-

(Continued on page 311)

OCT. 31st

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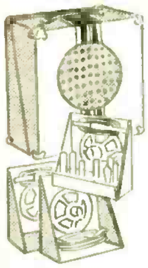

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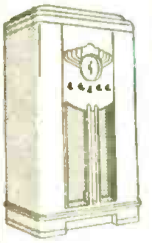

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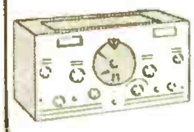

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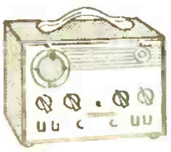

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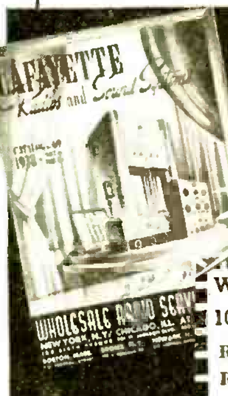

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HOW TO BUILD THE "ALARMCLOCK" WALL-RADIO SET

(Continued from page 272)

night-light, and promptly at 4 o'clock you wake up in a lighted room, ready for the task.

THE CIRCUIT

There is nothing radically new in the circuit (see Fig. 1) used in this superheterodyne receiver although the tubes employed are all-metal and of the very latest variety. The set has excellent sensitivity and selectivity.

A type 6K7 stage of R.F. ahead of the type 6A8 combined oscillator and 1st-detector tube contributes greatly to the satisfactory over-all performance of the set. Another 6K7 is employed as a high-gain I.F. stage peaked at 456 kc. This is followed by a type 6Q7 performing the triple function of automatic volume control, 2nd-detector, and first A.F. tube. The output of the 6Q7 is resistance-capacity coupled to the 25A6 output tube. The 25Z6 tube is used as a half-way rectifier furnishing more than ample current for the receiver inasmuch as no field supply current is required (a permanent-magnet type of dynamic speaker being used).

LAYOUT PRECAUTIONS

In laying out the parts for this set, it is suggested that the author's layout (see Fig. 3) be used, since considerable time and effort was expended in obtaining the best placement of parts from the standpoints of short leads and over-all efficiency. If this layout is followed and the circuit adhered to, there will be no difficulty later in aligning the set. See Fig. 2 for complete specifications on the drilling and punching of the chassis, which is made of 1/16-in. iron (aluminum may be used) finished in black crystalline.

WIRING PRECAUTIONS

The schematic circuit of the complete receiver is shown in Fig. 1. Make certain in wiring the filament circuit that the tubes are connected in proper sequence.

All tubes, including the pilot light and its shunt resistor are wired in series in the following order: pilot light (and shunt resistor), 25Z6, 25A6, 6Q7, 6K7 (I.F. stage), 6A8, and finally the 6K7 (R.F. stage).

Also make certain that all grid and plate leads indicated in the diagram as shielded are shielded. Otherwise difficulty will be had later on in lining up the set.

The filament voltage-reducing resistor is located in the line cord and has a value of 115 ohms (the author used a 175-ohm line cord and cut it down until 115 ohms were obtained). The pilot light should be none other than a Mazda 6-8 volt type with brown bead (0.3-A); and should be shunted with a 40-ohm, 5-W. resistor.

In mounting the parts to the chassis, (especially those which are to be grounded to chassis) make certain the paint is thoroughly scraped from the chassis at point of contact to assure good electrical connection. After the set has been wired according to the diagram, proceed to align the receiver.

ALIGNMENT PROCEDURE

Use a calibrated signal generator and an output meter to make all adjustments for maximum output, (maximum swing of the needle on the output meter). Allow the chassis and signal generator to warm up for about 5 minutes before aligning. Connect the ground lead of the signal generator to the chassis. Then insert a .05-mf. condenser in series with the signal lead of the generator which is then attached to the grid cap of the 6A8 tube. Set the signal generator at 456 kc. and turn the receiver volume full-on.

Adjust the I.F. trimmers for maximum signal output in the following order: secondary trimmer of 2nd I.F. unit, primary trimmer of 2nd I.F. unit, secondary trimmer of 1st I.F. unit and, finally, primary trimmer of 1st I.F. unit. To insure accurate setting of these trimmers, repeat the adjustments using always the lowest signal generator output that will give a readable deflection on the output meter, and keeping the volume control full-on.

Since the dial which was used on this set was not calibrated but was stamped arbitrarily from 0 to 100, aligning the R.F. section of the set becomes a very simple matter. The author proceeded as follows:

Using another superheterodyne receiver as a "standard," he noted that the "rotor" of the variable condenser when a 1,400 kc. station was tuned-in was about 1 in. from being fully "out." Therefore, bringing the variable condenser of the "Alarmclock" Radio into the same approximate position, a 1,400 kc signal was supplied to the antenna of the "Alarmclock" Radio Set through a 200-mmf. condenser. The *shunt* padding condenser of the oscillator section of the tuning condenser was then adjusted until the signal from the generator came in strongest. Further adjustments were made by varying the R.F. trimmers on the 2 other sections of the variable condenser for maximum signal strength.

Then the "standard" receiver was tuned to a 570 kc. frequency station (which in New York happened to be WMCA, "at the top of the dial"—nearly). In this position the variable condenser rotor was about 1¼ ins. from being in full-mesh with the stator plates. Simulating this condition with the variable condenser of the set under construction a 570 kc. signal was fed from the signal generator into the antenna of the receiver and the *series* padding trimmer of the oscillator section aligned for maximum signal strength. This completed the alignment of the receiver.

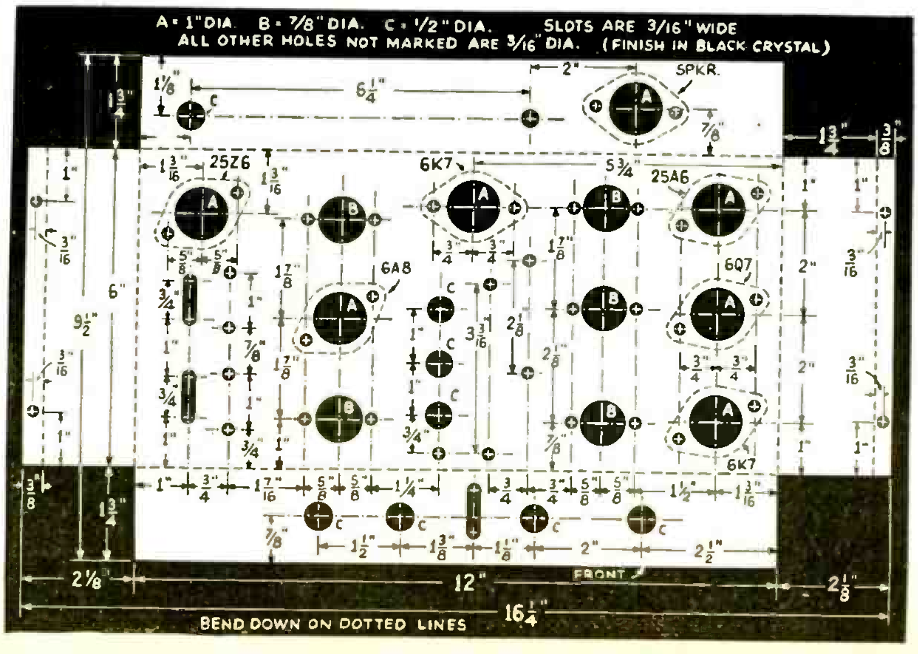

Fig. 2. Complete specifications for shaping, drilling and punching the chassis.

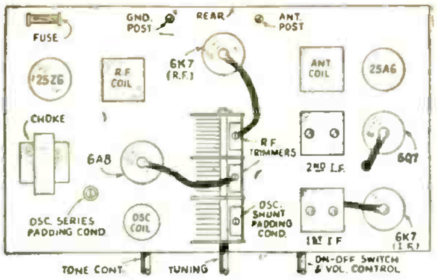

Fig. 3. Layout of main components on the chassis.

LIST OF PARTS

One Meissner midget high-impedance antenna coil, No. 2436;
One Meissner midget high-impedance R.F. coil, No. 2436;
One Meissner oscillator coil, 456 kc., No. 4243;
One Meissner I.F. transformer, No. 5740;
One Meissner I.F. transformer, No. 5742;
One Meissner adjustable padder No. 2500;
One Meissner 3-gang compact variable condenser, 360 mmf., No. 15115;
One Meissner 3-in. vernier tuning dial, No. 18248;
*Six octal metal tube sockets;
Two National Union or Tung-Sol type 6K7 metal tubes;
One National Union or Tung-Sol type 6A8 metal tube;
One National Union or Tung-Sol type 6Q7 metal tube;
One National Union or Tung-Sol type 25A6 metal tube;
One National Union or Tung-Sol type 25Z6 tube;
One Centralab vol. control with Sw., 0.5-meg.;
One I.R.C. resistor, 200 ohms, 1 W.;
One I.R.C. resistor, 400 ohms, 1 W.;
One I.R.C. resistor, 2,000 ohms, ½-W.;
One I.R.C. resistor, 30,000 ohms, ½-W.;
Two I.R.C. resistors, 50,000 ohms, ½-W.;
One I.R.C. resistor, 0.15-meg., ½-W.;
Four I.R.C. resistors, 0.25-meg., ½-W.;
One I.R.C. resistor, 0.5-meg., ½-W.;
One Muter 40-ohm, 40-W. resistor;
Five Cornell-Dubilier paper condensers, 0.05-mf., 200 V.;
Three Cornell-Dubilier paper condensers, 0.1-mf., 200 V.;
Two Cornell-Dubilier paper condensers, 0.01-mf., 400 V.;
One Cornell-Dubilier condenser, 0.006-mf.;
One Solar mica condenser, 100 mmf.;
Two Solar mica condensers, 250 mmf.;
One Solar mica condenser, 0.002-mf.;
Two Solar electrolytic condensers, 10 mf., 35 V.;
One metal chassis, 7 x 9 x 2 ins.;
One Cinaudagraph 5-in. permag dynamic speaker with output transformer to match 25A6;
*One resistance line cord and plug, 135 ohms.;
One Cornell-Dubilier dual cardboard electrolytic filter condenser, 8 mf., 250 V.;
One Cornell-Dubilier cardboard electrolytic filter condenser, 16 mf., 250 V.;
One International Transformer Co. filter choke, 15 hy., 300 ohms;
One Mazda *brown-bead* 6-8 V. pilot light;

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

Part II of this "yarn" will describe how the intercommunication feature may be added to the receiver, specifications for constructing the wall-type cabinet, and data for connecting the time clock for automatic operation of the radio set and other electric appliances.

BUSINESS PROBLEMS OF THE SERVICE MAN

(Continued from page 282)

The suggestions were made to Mr. Edberl and accepted by him slightly over 2 years ago. The results have been pleasing and beneficial to both. Strange to say, this small town is only about a 1-hour ride from New York City.

The advice in this article regarding free space in lieu of labor is in contrast with that offered in last month's "Business Problems". It is suggested that a comparative study be made.

If you want to get a FREE copy of the 1937 RADIO REFERENCE ANNUAL turn to page 312 of this issue and get all the details.

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

(Continued from page 281)

so only half of the signal will be delivered to the tube. In this way, we can control the volume from zero volume, when the moving arm is set at the bottom, up to full volume when the moving arm is at the top. Note that when a variable resistor (such as a potentiometer) is used in this way, it requires 3 connections, namely, (1) top, (2) bottom, and (3) movable arm. This distinguishes it from the variable resistor when used as a *rheostat*, which needs only 2 connections, namely (1) the moving arm and (2) only one end (either one) of the wire.

Type 76 tube—The tube used in this Experiment has 5 prongs and is called a *heater-type* tube to distinguish it from the 4-prong (type 30) tube, used in Experiment No. 1, which is called a *filament-type* tube. The extra element is a "sleeve" called the *cathode* (marked K in Fig. 2G) surrounding and heated by the filament. It is this *heater cathode* which emits the electrons in this case, and the filament, which is enclosed within it, serves only to heat the cathode to the proper operating temperature. Such a heater-type tube has the great advantage of being able to be heated by alternating current as well as by a battery (direct current), as the hum which would be caused by the use of alternating current on a filament-type tube is avoided in a heater tube, since the cathode is not electrically connected to the filament, but is simply being heated by its physical closeness to it.

The operation of the vacuum tube as an amplifier was covered in the preceding Experiment. It was pointed out at that time that the grid of the tube, by means of its "trigger action" could cause any small electrical variations on it, to control large changes in the plate circuit of the tube, thus magnifying or amplifying the original effect.

Units R2 and C1—These units help keep the grid at its proper operating point. See Fig. 2G. Their connection in this manner makes the grid negative by an amount proper for its operation and so is said to furnish the proper "grid bias," instead of using a battery for the purpose. Condenser C1 used with this grid bias resistor R2 is an *electrolytic* condenser which must be connected in a special way. In this condenser, the insulator between the two metal plates is in the form of a chemical film, which has been formed by electro-chemical action as the name "electrolytic" implies. Therefore, in connecting this type of condenser, we must make certain that the terminal on it marked + is connected to the positive side of the circuit, as shown in the diagram of Fig. 2G.

Chassis—The one used here is of the metal type used commercially, which has the advantage that all connections which go to one common terminal, usually the chassis itself, can be conveniently and efficiently made. (In this case the common point is the "B–".) Care must be taken that no other exposed parts of the circuit are allowed to touch (or "short" to) the metal chassis. While the cigar-box chassis, used in Experiment No. 1, can still be used, a metal chassis with a universal arrangement of holes and openings already punched, such as used here, will be found to be a distinct advantage.

Power Supply ("A" and "B" supply)—The operation of the system is explained here, for the sake of simplicity, on the assumption that an *"A" battery for the heaters* and a *"B" battery for the plate* having the indicated voltages, are used. The operation of the system is exactly the same if a power supply which works from an A.C. outlet is available. The latter method will be found to be much more practical since it eliminates the need for replacing batteries. However, the small 4½ V. battery for the microphone, which uses very little current, is used in either case, as it is by far the best working arrangement.

For those who wish to build such a power supply, operating from the A.C. socket, brief construction details are given at the end of this Experiment (see Fig. 2H). A full Experiment on this topic of power supplies using the same parts, and with an explanation of the principles involved, will be the basis of the next Experiment in the series.

Types of Current—In summary it is well to note that three important types of current are used in this set-up:

1. Direct current (D.C.) such as the current from the battery connected to the microphone. Shown in diagram form in Fig. 2D, it will be seen to be a constant current.

2. Pulsating direct current, such as flows through the microphone when one talks into it (see Fig. 2E). In this type, the amount of current is rapidly changing many times per second, but in no case does it fall below the zero line to flow in the opposite direction. It is therefore a varying but *unidirectional* (one-direction) current.

3. The third type is the *alternating current (A.C.)*, such as is usually obtained from the home socket. This will be discussed in later Experiments.

With these principles in mind, we are ready to proceed to the Experiment proper.

THE EXPERIMENT-**OPERATION OF MICROPHONE AND AMPLIFIER**

OBJECT—To show:

(A) Operation of a microphone in transmitting sound to a distant headphone at the receiving end.

(B) Making the sound louder by means of an amplifier to operate a loudspeaker at the receiving end.

PROCEDURE AND RESULTS

Part A—Without Amplifier

(1) *Wiring Procedure*—In mounting the parts, illustrated in Fig. B, we follow the layout in Fig. A where the assembled unit is shown. The wiring for this part is shown in schematic form using symbols in Fig. 2G and pictorially in Fig. 3.

The following points are to be noted. Leave the wire from the microphone to the battery unconnected (to conserve the battery) until ready to operate. In order to connect Rp so that the volume increases when the arm is turned to the right, connect it so that its outside terminal, which is touched when the moving arm is all the way to the right, goes to the (g) terminal of the transformer T. The connection for the two wires leading to the distant phones (the line), for this part of the experiment, is provided by the two *fahnestock* spring slips. This line, if convenient, should be long enough to reach to the phones on the other side of the room. If desired, 2 or 3 pairs of phones may be connected in series at the receiving end.

This keeps this part of the Experiment separate from Part B (using the amplifier), in which case the wires to the distant phones or loudspeaker will be connected to the tip-jacks at the other end of the chassis.

NOTE—If it is desired, in certain cases, to finish all the wiring for both parts, before starting the operation of Part A, this can be done by skipping from here to the wiring procedure of Part B, and then coming back to Part A for the operating procedure.

(2) *Operating Procedure*—Connect the wire from the microphone to the battery with the volume control (Rp) advanced half-way to the right. Determine whether a click is heard in the phones at the receiving end when making this connection. Then proceed to talk as in the case of a telephone, turning the volume control full to the right. A check on satisfactory operation can be secured when the person at the transmitting end whispers a question into the microphone held closely, so that the sound cannot be heard by the one receiving through the air. The one transmitting can determine whether the question was heard in the phones by the answer given by the one receiving. Also note that objectionable noises will be produced when the microphone is jarred or breathed into because of its sensitivity to these disturbances. Such incorrect procedure can be avoided by holding the microphone steadily and talking into it at a slight side angle. Disconnect the wire from the microphone to the battery when finished talking.

Part B—Microphone With Amplifier

(1) *Wiring Procedure*—In wiring the vacuum tube circuit, as seen in pictorial form in Fig. 3, and in symbol form in Fig. 2G, we will again use the plan of taking the 3 circuits of the vacuum tube in their proper order.

Filament Circuit—includes the socket terminals marked H, H (for heaters). Note that the socket prongs in addition to being labeled by letters are also numbered (see Fig. 2A). This is the standard numbering system used for all sockets. As we look at the *bottom* of the socket, keeping the two large holes at the bottom we number the prongs in order, starting with the large hole at the left as No. 1, and go around to the right (or clockwise), in numerical order. The H, H prongs (numbered therefore 1 and 5) are connected to the H, H terminals of the binding post strip by a twisted pair of wires, for the "A" supply. This will be either 6.3 V. of the power supply, or 6 V. of dry cells. No + or − polarity need be observed since the heater works on either alternating or direct current.

NOTE: If a power supply is available having 2.5 V. for the "A" supply, a type 56 tube may be used instead of the 76.

Note that the common point to which the grid and plate circuits will be returned (which is always the electron emitter), is now the cathode. Resistor R2 and condenser C1, connected together, are wired into the circuit with the positive terminal of C1 going to cathode terminal of the socket (marked K) and the other side of C1 going to terminal labeled ("B−").

Plate Circuit includes the plate terminal (P) of socket, the tip-jacks for the loudspeaker, "B+" and "B−" terminals which connect to the "B" supply at the binding post strip. This "B" supply may be either battery or power supply, as explained before, preferably about 180 V. although 90 to 250 V. may be used.

(2) *Operating Procedure*—(a) *Using Headphones:* First check to see that the line from the phones is disconnected from the phone clips and is reconnected to the tip-jacks; that the "A" and "B" power supply is turned on; and that the volume control (Rp) is set about half-way. Now connect the wire from the microphone to the battery. When this is done a loud click should be heard in the phones. Talk into the microphone and, by asking the person at the receiving end to note the effect on the loudness (volume) as the volume control is advanced to "full", *obtain a rough comparison* by ear between the volume of sound in the phones both with and without the amplifier. Always disconnect the microphone when not in use.

(b) *Using Loudspeaker—Caution!* Be sure that the power is turned off to prevent the possibility of a shock, and then substitute the loudspeaker for the phones in the tip-jacks. Again set the volume control to the half-way mark. Turn on the power supply and connect microphone to produce a click in the loudspeaker. Before making any attempt to operate the loudspeaker with any great volume, a suitable place for it must be found in order to avoid producing a loud "howl." This howl develops when the loudspeaker is so near the microphone that the sound from the loudspeaker can "feed" back into the microphone. If this happens, the sound fed back into the microphone appears in the loudspeaker again in amplified form and again feeds back into the microphone, thus building up into the howl we hear, known as the "feed-back howl."

This tendency can be entirely avoided wherever it is possible to place the loudspeaker in another room, with a door closing it off from the microphone. Where this is not convenient, the loudspeaker must be placed far enough away from the microphone and so faced that it is least likely to feed back into the microphone. Facing the loudspeaker out of a window or toward any open space will usually be effective.

As the volume is turned up, the operator will find that a certain position of the loudspeaker which may be effective for low volumes, will not be suitable for high volume, as a "howl" develops. Since this is due to the reflection of the sounds from the walls and ceiling, the volume will have to be kept down below the feed-back point under these conditions. Experiment with the position of the loudspeaker so that satisfactory volume is produced without howling.

Sound effects may be tried at this point by making some sounds very close to the microphone such as crumpling a paper for a noise effect; gently tapping the microphone for a dance tap effect; or, picking up a whispered conversation for a dictaphone effect.

Other possibilities will no doubt present themselves, such as an entertaining imitation of an "amateur hour".

CONCLUSION

(A) *Microphone Operation*—The microphone converts sound impulses into variations of current. These current variations are sent through wires to cause the receiver to reproduce the original sound.

(B) *Amplifier Operation*—When the small variations produced in the microphone are applied to the grid of a vacuum tube, the tube acts as an amplifier by converting these small electrical changes in its grid circuit into large current changes in its plate circuit. Now for the questions.

(Continued on following page)

Have you found out about all the new features which have been incorporated in the 1937 OFFICIAL RADIO SERVICE MANUAL? Complete details on page 314 of this issue.

(Continued from preceding page)

QUESTIONS*

(1) What is the fundamental cause of all types of sound?

(2) When a telephone is being used, the form of energy which actually travels over the wires between the transmitter and receiver is: (sound, varying electric current).

(3) How is the microphone held in order to avoid objectionable breathing noises?

(4) The vacuum tube acts as an amplifier because small changes in the .... circuit control large changes in the plate circuit.

(5) A "feed-back howl" occurs only when the position of the loudspeaker is such that it faces the opening of the microphone; (state whether true or false and justify your answer).

**Answers to these questions appear on page 311. School Radio Clubs are invited to write to the editors concerning the use of these questions for club groups.*

LIST OF PARTS

Parts Mounted On Chassis

†One T—Transformer, general purpose, audio and microphone (used here as a carbon microphone transformer); United Transformer Co. —type VTG;
*One Rp—Potentiometer, 500,000 ohms (volume-control type);
*One R2—Resistor, preferably 2,500 ohms, 1 watt; or 2,000 ohms may be used;
One C1—Condenser, electrolytic, 10 mf., 25 V., Solar DT 879;
*One S—Socket, 5 prong, sub-panel type;
*One chassis, metal 6 x 9 x 2 ins. high, universal punched;
Hardware—one binding post insulated, one binding post metal, and connectors mounted on bakelite strips as follows: double phone-clip strip; double tip-jack strip; and strip of 5 binding posts.

Other Parts

*One M—Microphone, single-button carbon, hand-type; type SB hand (a more expensive microphone will give better quality, but even a telephone mouthpiece, if available, may be used);
*†One battery, 4½ V. ("C"-battery type, preferably or 3 dry cells may be used);
One type 76 tube (or type 56, as explained in text);
*†One Headphone, standard 2000 ohms;
*†One Loudspeaker, 5 in., preferably permanent magnet dynamic, or magnetic type may be used; Permag Cabinet Model 5BMC-T;
One "A" and "B" Supply—either batteries giving 6 V. for A and 90 V. for B supply; or A.C. Power Supply giving 6.3 or 2.5 volts for A and 90 to 250 V. for B supply. *NOTE*—The A.C. Power Supply will be constructed in the next Experiment.

†Parts were used previously in Experiment 1.
*Names of manufacturers will be supplied upon receipt of a stamped and self-addressed envelope.

FREQUENCY "WOBBLERS" FOR SERVICE OSCILLATORS

(Continued from page 273)

inductive reactance type of modulator. The plate of the R.F. oscillator, a pentode, picks up an out-of-phase voltage (at R.F.) and delivers it to the control-grid of the wobbler tube, also a pentode.

The output of the wobbler tube then is applied to the control-grid. This voltage appears as shunt inductance to the tuning inductance. In this circuit the bandwidth control calibration is independent of frequency. Resistor R5 and condensers C5, C6, and C7 form a phase-shifting network governing the phase of the R.F. voltage applied to the control-grid of the wobbler tube. The amplitude of the sweep voltage applied to the control-grid of the wobbler determines the bandwidth.

To adjust any of these circuits an oscilloscope and an intermediate frequency transformer which has adjustable coupling should be used. As an example, in order to correctly adjust the phasing circuit in Fig. 1G, the variable condensers should be adjusted so that the 2 response images coincide and are symmetrical. For this adjustment the transformer should be over-coupled to secure double-peak tuning. The bias on the wobbler tube is somewhat critical and is adjusted so that the 2 traces coincide at their peaks.

CALIBRATION OF A NEON OUTPUT INDICATOR TO READ DB. AND WATTS

(*Continued from page 289*)

CALIBRATION IN ACTUAL WATTS AND DB.

The experimenter or Service Man may calibrate the neon output indicator for use as a wattmeter or power-measuring device, to show the actual watts output of an audio amplifier or radio receiver.

The only equipment needed to calibrate it in this manner is an ohmmeter.

The neon output indicator is now connected as shown in Fig. 1C, in which R (6.000 ohms) has been connected in parallel with the 50,000-ohm potentiometer a-b.

The INPUT terminals of Fig. 1C are to be substituted for the voice coil of the speaker. The output of the amplifier or receiver under test will then appear as heat in the output indicator instead of as sound from the speaker.

The resistors connected as shown in Fig. 1D are used merely to determine the voltage at which the neon light just begins to glow. This point was found to occur at about 50 V. for the ¼-W. neon light used. There will be variations due to the spacing of the electrodes, etc.

Tables III and IV are calculated with this value as a basis. To use these tables, connect your neon light as shown in Fig. 1D, and note the degree of brightness. When using the indicator always duplicate this degree of brightness.

The calibration consists in disconnecting the 50,000-ohm potentiometer a-b-c (Fig. 1C), and using the ohmmeter to locate the various dial settings which will give resistance values between terminals a and c as shown in columns Rac of Tables III and IV.

TABLE III

Watts	Volts	Rac
7.0	193.6	12920
6.5	186.6	13400
6.0	179.2	13940
5.5	171.6	14570
5.0	163.6	15270
4.5	155.3	16100
4.0	146.4	17200
3.5	137.0	18240
3.0	126.8	19720
2.5	115.7	21560
2.0	103.5	24160
1.5	89.7	27880
1.0	73.2	34150
.5	51.8	48300

TABLE IV

Decibels	Watts	Volts	Rac
20	.6	56.7	44100
21	.756	63.6	39340
22	.950	71.3	35050
23	1.197	80.0	31250
24	1.507	89.8	27860
25	1.90	101.0	24750
26	2.39	113.2	22060
27	3.00	126.8	19710
28	3.786	142.4	17530
29	4.88	161.6	15470
30	6.00	179.2	13940
31	7.56	201.3	12420

Unlike Tables I and II, Tables III and IV give *actual watts* and *decibel* values. The decibel scale is based on 6 milliwatts (0.006-W.), as zero level, which has been commonly adopted.

If the reader is to use these tables, it is necessary for R and a-b of Fig. 1C to be 6,000 ohms and 50.000 ohms, respectively. If R is a few hundred ohms less than 6,000, connect the proper 1-W. resistor in series. If R is more than 6.000 ohms, connect a high resistance (1 W.) in parallel, choosing one which makes the combination 6,000 ohms.

If the potentiometer-rheostat a-b is a little less than 50,000 ohms, connect the necessary value of resistance in series. A potentiometer of more than 50,000 ohms can not be used without recalculating Tables III and IV.

Tables III and IV are obtained as follows: 6,000 and 50,000 in parallel give

$$\frac{6.000 \times 50.000}{6.000 + 50.000} = 5.360$$

$$\frac{V. \times V.}{R} = W. \quad V. = \sqrt{5,360}\ \sqrt{W.} = 73.2\ \sqrt{W.}$$

For 5 watts, V. = 73.2 × 2.302 = 163.6 volts.

The neon light is used to show that the voltage from a to c (Fig. 1D) is 50. Therefore the resistance from a to c, when the device is using 5 watts and the neon light just glows, should be

$$\frac{50}{163.6} \times 50.000\text{; or } 15,270 \text{ ohms.}$$

The current taken by a ¼-W. neon bulb at 50 V. is too small to affect the results.

For Table IV, W. is 0.006 multiplied by the number of which 1/10th of db. is the logarithm. For 23 db.; 2.3 is the logarithm of 199.53. This, times 0.006 is 1.197 W. Values V. and Rac are obtained as shown above.

IS RADIO YOUR VOCATION?

(*Continued from page 276*)

in its complicated technicalities the keen pleasure of a physician seeking, finding and curing an ailment. But the physician has spent 8 to 10 years learning his profession; how much time can *you* devote to learning radio?

The men in radio today who are profiting are the students of yesterday. They studied radio in the old *Electrical Experimenter*, and in *Science and Invention* magazine which years ago preceded *Radio-Craft* and many similar publications. Some went to college, others studied in night schools or at home through correspondence courses, but study they did. Service offered, and still does, a means of making enough money to carry on with study, and to supplement theory with practical experience. It brought them into contact with the public. To many it opened the more enjoyable field of *merchandising*.

Amelia Earhart, writing in *The American Magazine* a few years ago said, "Experiment! Meet the people. Find out about them. Adapt yourself to them, please them, anger them, study them! That's better than any college education. You will find the unexpected everywhere as you go through life. By adventuring about, you become accustomed to the unexpected. The unexpected then becomes what it really is—the inevitable. But you are ready for it—flexible, realistic, tolerant, hard-boiled, sympathetic."

Radio service work brings you close to many people. You learn to please them. You learn what angers them; you learn to adapt yourself to them and you become trained to meet any situation and handle it adroitly. Thus you become a merchant selling not only your services but the products which you have learned to present to people in the most favorable light. If your study has properly prepared you, you design and engineer what you know will please the most people or you branch into manufacturing and fabricate that which others want.

SERVICING IS PATHWAY

Radio service is not the end but the means by which you can acquire the experience with which to go farther. With modern instruments, solving the mystery of complicated circuit troubles becomes but a routine task, monotonously similar day after day. The real thrill is in selling, designing or building.

Let service lead you to this goal. If you've got what it takes in perseverance, ability to learn from study and observation, sufficient funds with which to weather the first few tough months, you can break into the game, glean the experience it offers and go beyond it within a few years, making room for new men to follow.

If you are considering radio service as a lifetime trade, get a job in some factory and forget radio because you'll be only overcrowding an occupation in which the man who stands still without advancing himself sooner or later becomes a burden to society; a virtual pauper with respect to acquiring the world's goods. *Radio service can serve a better end; let it introduce you to a higher business plane and you'll bless the day you chose it as your new vocation.*

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

"SNOW STATIC" BEING BEATEN BY "FLYING LABORATORY"

(Continued from page 269)

suggestion TWA and United Air Lines constructed and tested experimental metallically-shielded loop antennas in May and June of that year.

METALLICALLY-SHIELDED LOOP ANTENNAS

The TWA antenna was mounted on top of the wings of a Ford plane and was test flown on the "T L type" Kansas City range. It gave good "courses" but poor "cone of silence." The cone of silence indication was subsequently corrected by mounting the loop on the belly of the plane.

The United Air Lines antenna was mounted as a ring on the nose of the plane and was test flown on the loop-type Chicago radio range. It gave no cone of silence and very bad course distortion when within 5 miles of the station. During the months that followed United Air Lines worked on the correction of the course troubles and succeeded in developing two types of loops which had a *circular* pattern instead of the usual *figure-8*. Either type has commercial limitations and further development work would be required before it could be used.

It was almost a year later before it was discovered that the loop operated successfully on a T L type range but gave no cone of silence and poor courses on a loop-type range, thus accounting for the difference in the TWA and United Air Lines results.

WIND-TUNNEL TESTS OF RADIO INTERFERENCE

In October, 1935, the Snow Static Committee of the Radio Technical Committee for Aeronautics met in Chicago for a lengthy discussion of the snow static problem. The committee recommended that the Department of Commerce provide funds for a *wind tunnel* investigation of the snow static phenomena.

In December, 1935, Professor Homer Dana of Washington State College succeeded in producing a mild form of *dust static* in a small wind tunnel. In March, 1936, Dr. Marcus O'Day of Reed College, Portland, Oregon, working with Pilot A. C. Ball on a United Air Lines plane between Portland and Salt Lake City, succeeded in recording on an oscillograph the charges gathered on the plane windshield. In October, 1936, TWA began installing metallically-shielded *anti-static loops* on their entire fleet of planes.

In November, 1936, United Air Lines began assembling equipment and personnel to make a thorough study of the subject. This culminated in an expedition for snow static investigation which got under way last February and has been actively pursuing the problem to date.

Work was carried on in a standard 10 passenger, 2 motored, all-metal Boeing transport equipped with work benches, electrometers, oscillograph, recording meters, and special radio sets and antennas.

Comprising the plane personnel were UAL, Bell Labs. and Bendix engineers, and 4 college professors.

The material which follows represents a resume of our notes to date. While many phases of the investigation are incomplete we feel that the information which has been gathered will be of material assistance to transport operators in their work toward improved radio reception.

The problem was attacked simultaneously on 3 general fronts to determine, 1st, the meteorological aspects of static formation and its avoidance; 2nd, the static generating effect of the plane and its reduction; 3rd, the value of special antennas in reducing the interference.

The ideal solution would consist of stopping or reducing the generation of the static at its source. The second best solution would be the development of special antennas which could reduce the interference in the radio receivers. The less desirable solution would be a mapping of the static areas as is done for air mass movements and instructing pilots in flying around these areas.

Our work to date indicates that we will probably use part of all 3 solutions insofar as the coming winter's flying is concerned. The reasons for this will become apparent as the 3 classifications of the problem are covered in the sections which follow.

Part II will continue with this interesting discussion of "snow static."

IS TELEVISION IN AMERICA ASLEEP?

(Continued from page 268)

screen, we obtain the proper viewing distance for television.

At Kensington Science Museum there are the various makes of British television sets on display. A row of booths provides individual demonstrations. Television programs are received from the Alexandra Palace transmitter or, in the absence of programs, from a local pick-up and transmitter.

WHAT PRICE TELEVISION?

There are some 15 television set manufacturers now operating in Great Britain, of which 8 are large and prominent. *Something like 10,000 sets have already been sold in England.* The average price for an excellent sight-and-sound receiver is about $350. There are cheaper sets, of course, especially those without the dual-receiver arrangement for sound as well as sight reception. I fully anticipate British television sets at under $200, just as soon as manufacturers tool up and swing into mass production, which they will.

Throughout England one sees television sets on display in radio shops, music stores and department stores. The public is keenly interested—something more than passing curiosity which has attended the premature television demonstrations in this country. The British public is interested because they are seeing television programs, and not mere experiments.

One idea which might well be passed on to our American radio merchandisers, in anticipation of their handling television sets some day, is the matter of home demonstrations. One British manufacturer charges the equivalent of $20 for a set installed in any home on a demonstration or trial basis. If the set is purchased, that sum is applied on the payment. If the set is returned, the $20 becomes a rental fee. Thus families wishing to entertain or startle their friends with television entertainment have to pay one way or the other.

Television manufacturers are installing and servicing their sets for the present, to ensure satisfactory results.

Going over to France, I found our French friends lagging behind the British, although keyed up to television possibilities. I visited the laboratory of the pioneer worker Barthelmy, outside Paris. There I found a well-equipped laboratory and studio. They will soon have a television transmitter on the lofty Eiffel Tower, for regular television programs. *France will "go commercial" this Fall!*

In Belgium and Holland, television is likewise moving ahead. Those smaller countries follow the lead of Britain and nearby Germany. I saw German television demonstrated at the Paris Exposition. The results are splendid, even though the Germans are using 375 lines as compared with the British 405. The Germans plan to go to the American 441-line standard shortly.

CONCLUSIONS

Back in the States again, I cannot help but feel that while we have transmission and reception technique fully equal to anything abroad, we sadly lack in commercial experience. Indeed, we haven't even started. Of course I fully admit the many complications facing television workers here. Our country is vast as compared with compact European countries. We have no tax on radio sets, but prefer to raise the cost of the programs by the commercial sponsorship method. There is much uncertainty as to where the money is to come from in putting on television programs.

Nevertheless, I still feel that a start should be made very soon. Far too long have we been marking time. The many problems of commercialized television will never be solved in advance of the actuality. Television must be a development—out in the field—in everyday use.

No matter how crude the start, no matter how the economics may look at first, no matter how limited the programs and service areas covered, commercialized television will rapidly work out its own salvation, repeating the history of sound broadcasting.

A.F. DEGENERATION NOW USED IN MODERN RADIO SETS

(Continued from page 287)

(5) Improved loudspeaker damping, simulating the constant voltage drive of a triode and reduction of "boom."

(6) There is little loss in maximum gain with the type of degenerative feedback circuit shown, *thereby permitting application of the circuit to small receivers.*

In general, the circuit of Fig. 1A is sufficient for describing the manner in which these results are obtained. This circuit is used in the 6- and 7-tube models and, with some modifications of the tone control circuit, in the smaller and larger sets.

THEORY OF "TONE MONITOR"

The conventional diode and volume-control circuits are shown followed by the audio amplifier which may contain a single-ended or push-pull output stage with the conventional drivers or phase inverter as required. The feedback voltage is returned to a 5,000-ohm tap on the 2-meg. volume control. Since the volume control resistance is approximately 9 times the diode load resistance there will appear only 1/10 of the feedback voltage on the slider at maximum volume setting; therefore, if 5 to 1 degeneration is introduced when the slider is at the tap there will be a loss in gain at maximum setting of only 30%. It follows that since the extent of degeneration is variable with the volume control setting, the compensating effect of C1, C2 and C3 will also vary in accordance with the volume control setting.

For simplicity, let us assume that the audio amplifier consists of a 6F5 driver and a single 42 output tube. Then at high frequencies the phase of the output voltage will be lagging the input voltage due to shunt capacities in the amplifier and due to the leakage reactance of the output transformer. The value of C3 is so chosen that the fidelity curve falls off at 10 kc. and peaks around 3,000 to 6,000 cycles for "ordinary" volume control settings. Since C3 reduces the amplifier gain at high frequencies as well as shifting phase, the result is that the amplifier becomes less and less degenerative with increasing frequency until we reach the peak. At this point regeneration starts, but since the amplifier gain is very low at these frequencies the output goes down for any further increase in frequency.

In the BASS and FOREIGN positions of the tone control, C2 is shunted across the feedback resistor. This introduces a leading current around R2 making the feedback voltage lead the output voltage, or in other words correcting for the phase shift in the amplifier at high frequencies. At the same time the feedback voltage is increased at high frequencies, thereby reducing the high-frequency output simply by further degeneration.

The output voltage leads the input at low frequencies due to the shunt inductance of the output transformer and the fact that a coupling condenser is used between the 6F5 and 42. Capacity C1 is added to the circuit to increase the phase shift of the feedback voltage and reduce its amplitude. What results, of course, is a sharp rise in the low-frequency end of the fidelity curve, since degeneration is reduced with lowering frequency. The function of R3 is simply to prevent regeneration, or possible oscillation, from occurring at extremely low frequencies.

Fidelity curves for the "normal" position of the *tone control*, with variation of the volume control, are shown in Fig. 1B (model F-75 receiver). It can readily be seen that for strong signals an extended frequency range is used, while for weak signals which require a high volume control setting, both "highs" and "lows" are reduced leaving only the important voice frequencies. This characteristic is better suited to cope with noisy conditions of reception.

The tone-control switch short-circuits C1 in the FOREIGN and SPEECH positions, providing a flat response down to 60 cycles. Fidelity curves for the "normal" or No. 3 (0.5-meg.) position of the *volume control*, with variation of the tone control, are shown in Fig. 1C.

Loudspeaker resonance is practically non-existent except in curve No. 6 where there is very little degeneration present. This fact, together with the fact that compensation does not start until after the cabinet has become a very inefficient baffle, account for the marked reduction of cabinet "boom." With ordinary compensation methods an 8 db. rise at 55 cycles would be accompanied by considerable rise at 150 or 200 cycles and very likely a tremendous rise at loudspeaker resonance. The first of these puts a peak in the acoustic output of the set since the cabinet is still a fairly good baffle, or possible resonator, at these frequencies, giving rise to "boominess" of reproduction.

Loudspeakers have the annoying tendency to reproduce bass notes at their own resonant frequency so that with a constant-current drive it would be practically impossible to reproduce 55 cycles with a loudspeaker resonance of 75 cycles. *However, with the degenerative amplifier described, bass frequencies no longer sound all the same and very low frequencies are reproduced IN SPITE OF THE SMALL CABINET SIZE and any desire on the part of the loudspeaker to have its own way!* This follows from the fact that spurious frequencies are reduced in direct proportion to the amount of degeneration; hence, the term "Tone Monitor."

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.

RADIO WITTIQUIZ

(Continued from page 292)

performed marriage ceremonies. (d) An R.F. receiving transformer.

P. A. FLANAGAN

Answers

(19c)	(22b)	(25c)
(20d)	(23c)	(26d)
(21c)	(24d)	(27d)

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 should preferably 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 January, 1938, *Radio-Craft*, on the newsstands about Dec. 1, must be received at *Radio-Craft* editorial offices not later than Oct. 15th, 1937.)

"WHAT IS THE FUTURE OF RADIO?"

(Continued from page 287)

past progress, I see no reason to believe that *facsimile picture transmission* won't be a fairly common thing within a decade.

Electronics applications seem to have no end. We're all familiar with the *automatic drinking fountain*, the *electronic counting and sorting machines*, the *automatic door*, etc. The *lie-detector* is based on electronics principles. Now the field extends to music, medicine, and metallurgy. (All these are based on *radio*.)

Similarly, *television*, which was originally planned to synchronize with *sound*-radio. Because the sound angle was solved first the country's outstanding engineers concentrated on this field to the exclusion of *sight* broadcasting (*television*).

But during the last 10 years television experiments have never ceased and reports, which can be relied upon, indicate that the *television receiver* will soon take its place as part of every living-room.

Therefore, is it not reasonable to assume that *another* 4 billion dollars will be spent in the next 10 years in radio?

The Future of Radio, then, in my opinion, can best be gauged by its past performance, the only fair basis for judging any industry.

This article has been prepared from data supplied by courtesy of Sprayberry Academy of Radio.

HOW TO CONDUCT A SOUND-ON-FILM RECORDING STUDIO

(Continued from page 283)

through the track will affect the photoelectric cell.

Two general recording systems are in wide use, the *variable density* or *Movietone* and the *variable area* or *Photophone*. The difference between these 2 methods of recording lies only in the manner of recording and either type can be reproduced in a sound movie projector. The object is to change a varying audio-frequency current into a corresponding density change at the same audio rate. These density variations can then be transformed into electrical variations at the same frequency by passing a beam of light through them onto a photoelectric cell, the steady light being modulated when the film is passed in front of it.

VARIABLE-AREA RECORDING

The film on which a recording is to be made is drawn up by means of sprocket wheels continuously and rapidly (90 ft. per min.) in the recorder. It is essential that the motion be very steady, since even slight variations are immediately noticeable. The film passes up in such a way that the sound track is always just in front of a *sound "slit"* or horizontal opening through which the exposing light is passing. (Fig. 1A.) The slit itself is 0.280-in. wide and 0.002-in. high. The light passing through this opening is now focused down by means of an *optical system* so that the light actually striking the film track is only 0.070-in. by 0.0005-in. Until the film is developed, no light must be allowed to strike the film except, of course, that passing through the sound (light) slit.

The variable-area or Photophone recording method is controlled by RCA. Among its advantages is the case of laboratory processing. Also, this system provides a great range of volume (from maximum to minimum).

The recording unit is called a *galvanometer*. It consists essentially of a flat wire to which is cemented a tiny mirror in a magnetic field. Sufficient tension is applied to the wire to give the assembly a resonant frequency of approximately 8,000 cycles. The result is that the galvanometer unit shows practically a straight-line-frequency response characteristic from zero to approximately 10,000 cycles per second.

Modulated. When audio-frequency (or A.F.) current is passed through the galvanometer windings, the fluctuating magnetic field around the wire causes it to vibrate at that same A.F. rate.

The mirror is so adjusted that it reflects light from a 6-V. bulb through the light slit onto the moving film. The bulb must, of course, be fed from a pure D.C. source. A storage battery may be used, or a tube rectifier and well-designed filter circuit may be provided for this purpose. When the galvanometer is modulated, therefore, a vibrating (from side to side) light beam will be projected onto the sound track. The galvanometer windings are usually of very low impedance and must be matched to the transformer feeding it.

Unmodulated. When unmodulated, the mirror is adjusted to illuminate exactly one-half of the track. Full modulation causes a movement of the beam from one side of the track to the other. If still more audio power should be supplied, the peaks would be cut off at the edges of the track and distortion would set in. Approximately 100 milliwatts is required for complete modulation. The action is somewhat similar to that of the cathode-ray oscilloscope with the important exception that the galvanometer, as a mechanical device, has inertia. A density of 1.3 or over (as measured on a *densitometer*) is usually obtained in variable-area recordings on the dark part of the track. It is desirable to have as dark a black section as possible without causing the light section to become "fogged" or filled-in when developed.

The principle of the *recording galvanometer* may be understood from the diagram (Fig. 1B). The field-magnets are supplied with steady D.C. power from the amplifier. The flat wire is free to vibrate about its pivot P. When the modulation is supplied, A.C. flows through the winding W. During one alternation an end of the wire becomes a *North magnetic pole* and the other a *South pole*; and during the other half of the cycle the reverse is true. Attraction and repulsion by the field-magnets then cause the mirror M to vibrate carrying the light beam with it. This beam is guided by a mask so that it will at no time expose outside the track limits.

The diagram in Fig. 1B shows the unmodulated *position. Here only* half *of the track is exposed. Modulation will alternately increase and decrease this value.*

VARIABLE-DENSITY RECORDING

There are 2 methods of recording by variable density. The more commonly used has a *light valve* to modulate the constant light source. The valve consists of 2 horizontal ribbons of duralumin, each 0.006-in. wide by 0.0003-in. thick, one placed above the other in the same plane, forming a light slit 0.002-in. high. This is the *unmodulated height.* When modulation is applied, the height of the opening varies. When the valve ribbons are varying from 0.004-in. to zero, maximum power is being delivered without distortion. As with variable-area recordings, the light through the slit is focused down so that with no modulation the beam falling on the track is only 0.0005-in. high. *The width of the beam falling on the track does not vary at any time.*

Figure 1C illustrates the principle involved. The field-current for the electromagnets is a D.C. supply. The edge of the ribbons is shown at R. They are connected as in Fig. 1D, that is the current travels through them in opposite directions. From elementary magnetic theory it can be shown that when the current is passed in a certain direction through the valve assembly *the ribbons separate.* With a reversal of current, *the ribbons approach each other.* The direction of the beam is in a plane perpendicular to the plane of the ribbons. (Fig. 1E.)

Using variable-density recording, horizontal lines of different density result on the track, because the exposure of the film to light is not constant as the film moves continuously. Darker streaks will result where the opening in the light valve increased and lighter ones where it decreased, the density varying with the valve opening.

"Variable Light Source" Recording System. Another manner of securing a variable-density recording is by means of a *variable light source but using a constant slit.* A *glow lamp* containing mercury vapor is supplied with the A.F. modulation. Normally, the lamp is kept at a certain brilliancy by passing D.C. through it. The modulating power is combined with this D.C. power and the glow lamp varies from maximum to minimum. Care must be taken that this variation is kept within the range of a linear response.

One form of lamp used is called an *AEO* (or *Aeo*) *Lamp* and is a quartz bulb about 1 in. in dia., requiring 350 V. at 10 ma. for proper operation. A constant light slit must always be used with a glow lamp. One advantage over other systems is that with a glow lamp there is no inertia in the unit to contend with. All other recording devices are of a mechanical nature.

The density of the film *must* be kept within certain limits. At both extremes of density, the curve showing film density versus the logarithm of the exposure is no longer a straight line and so these values cannot be used. *At no-modulation the density should be such that a proportional variation takes place up to full-modulation. As with the variable-area system, the number of variations of light per unit length of track determines the frequency; and the amount of the variation determines the volume.*

Part IB will discuss Noiseless Recording, Ultra-Violet Recording, "Mirrophonic" Recording, Double-System Recording and other important essentials to a full understanding of modern sound-film technique. Don't miss it.

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TELEVISION STUDENTS LEARN BY MAKING CATHODE-RAY TUBES

(Continued from page 284)

HOW—AND *WHY*—THE FLUORESCENT SCREEN LUMINESCES

Our next problem was to obtain on the comparatively flat end of the bulb a suitable *fluorescent screen* which would serve as an "image resolution" material or "transducer," that is, converter of electrical energy into some other form of energy—in this instance, light. (In the iconoscope the reverse action takes place.) In the 100 per cent cathode-ray system of television the complete process involves (1) the conversion of light impulses into electrical impulses, (2) the amplification and transmission of these electrical impulses to a distance, and, (3) the amplification and re-conversion of these electrical impulses at the receiver back into light again. In operations 1 and 3 a fluorescent screen is the medium through which the energy is "transduced" or changed from its form as light into electricity and back into light again.

Fluorescent materials depend upon a certain amount of impurity content within the molecules of the substance. When the substances are highly pure they will not appear to fluoresce (or "glow" with a "cold light") when bombarded by electrons. *Fluorescence appears to be a resonance property of the atoms of materials which resonate at the frequency of the light emitted when bombarded by the little electronic particles similar to the manner in which a bell rings when struck by a bullet.*

A fluorescent material called *callux*, readily obtained from a firm in New Jersey, exhibited greater efficiency than any other fluorescent material we were able to obtain.

Since only the crystals that are struck by the electrons *luminesce* ("give off light") a screen thicker than 1 crystal will only obstruct the light. The matter of obtaining on the end of the bulb a smooth, very thin and even layer involved many experiments; and 3 major steps prior to *fusing the screen.*

WASHING THE C.-R. ENVELOPE "CHEMICALLY CLEAN"

(1) A long-necked water faucet with a nozzle turned upside down was arranged over a sink like any bottle washer. Thus a high-pressure water stream was available for washing the inside of the glass flask.

We found that we had to clean the flask with *hydrofluoric acid* in order to wash away any foreign materials inside of the glass bulb. Then we placed the bulb on the high-pressure washer for several minutes to wash out the acid. After that we washed the bulb with a small quantity of distilled water until the water would run out of the flask so perfectly smooth and evenly as to leave no marks whatsoever when it dried out, that is, the water did not run down the glass in streaks, but altogether.

(2) The glass envelope or *blank* then was ready for the next step—that of placing on the inside-end of the blank or flask, the fluorescent powder mixed with a *binder* which would hold the fluorescent material in place until the subsequent fusing process was completed, and which would at the same time readily give up its gas and vapor content so that, like an X-ray tube, the cathode-ray tube could be completely evacuated and made free of any trace of gas.

Ammonium borate proved best, as a binder, providing the proper proportions were used. We finally found that 5 parts of fluorescent material to 3 parts ammonium borate in 750 parts of water made the best combination. We also found that we could make nearly any temporary binder work reasonably well if we handled it with care.

(3) Four radiant heaters were placed around the top of the bulb and on the sides, while the bottom was allowed to sit on a piece of asbestos. Then the entire device was surrounded with a sheet of metal and the temperature within this *drying oven* was maintained slightly below the boiling point of water. Since glass conducts heat very poorly, the moisture would pass out of the tube leaving it completely dry without the bottom of the glass becoming very warm. Thereafter when the bottom of the glass became very warm, the tube was already dry and free of water vapor.

After settling a very even deposit on the bottom of the tube and, by using an *aspirator* (Fig. B),

(Continued on page 319)

HOW DEPENDABLE ARE YOUR METER READINGS?

(Continued from page 277)

error against another of the opposite sense, resulting in cancellation of the original error.

The result is that the errors caused by those ordinary room temperature variations which are encountered in practice in temperate climates are negligible and need cause no concern. Of course, if electrical measuring instruments are used under unusual conditions of extreme heat or cold outdoors, their readings will be in error and suitable corrections should be made if accuracy is essential. However, the radio Service Man rarely has occasion to make measurements under such abnormal conditions.

It should also be understood that *contact resistance* in switches, pin jacks and test prods sometimes results in errors, although these are only large enough to cause trouble in very low range ohmmeter circuits. In hot, humid climates, certain metals corrode very fast and if erratic readings are observed under these conditions, suspect "contact resistance." The remedy? Wiping of all open contacts with a piece of heavy canvas, and cleaning all tips with very fine sandpaper or an ordinary eraser. Most rotary switches have "self-wiping" contacts and these may be cleaned by rotating the control knob through 8 or 10 revolutions.

(O) Instrument alters circuit conditions. *Since the function of an ordinary meter is merely to measure the current, voltage, or resistance of a circuit, it should not alter or influence the circuit into which it is conected in any way which would cause an inaccurate or fictitious reading to be obtained.*

So many excellent discussions of this source of error have appeared in radio magazines and books, that little need be said about it here, except to caution Service Men to be sure to make all voltage measurements on receiver circuits with sensitive voltmeters having sufficiently high resistance values so that very little change in the voltage being measured will be caused by the "shunting" effect of the voltmeter. This is especially important when checking voltages in high-resistance A.V.C. circuits.

A good working rule to remember when using a voltmeter is that: ***the resistance of the voltmeter (for the particular range employed) should be at least 10 times the resistance of the circuit across which it is connected when making the voltage measurement.*** Practical portable instruments having a D.C. sensitivity as high as 20,000 ohms/volt are now available in commercial test instruments.

(P) Quantity under measurement fluctuating. If the quantity under observation varies in value while the meter is being read, it is likely that the reading will be in error due to the difficulty of accurately determining the exact correct position of the pointer.

For example, this condition is likely to occur when checking currents or voltages in a receiver which is connected to a power line whose voltage fluctuates. Of course, measurements made under these adverse conditions may be very inaccurate—due to no fault of the electrical measuring instrument! They should be made as carefully as possible—due allowance for the possible inaccuracy being made when interpreting the receiver circuit conditions from them.

(4) Inaccuracies due to Observational Errors

(Q) Pointer position read inaccurately. The accuracy of a measurement made with electrical indicating instruments always involves the *personal* element, over which the instrument maker has no control. No matter how good the inherent accuracy of the instrument is, there is always a certain amount of error introduced by the observer who does not read the *exact* position or indication of the pointer correctly. Of course, the error of reading is influenced by the size and shape of the pointer, the lighting conditions, the angle at which the pointer is read, the position of the pointer with respect to the extremities of the scale division, the care and skill of the observer, and the steadiness of the quantity under measurement (for the present, we will assume that the quantity under measurement, and the pointer, are perfectly steady). Let us analyze these separately.

(Pointer design.) Test instrument manufacturers have given considerable thought to the design of the pointers used on their instruments, in an effort to reduce observational errors. The evolution of pointer design is shown by the illustrations in Fig. 3N.

The rugged, but more or less heavy *spade* pointer shown at (*a*) was used in the earlier type instruments because its rugged body is not easily bent when the meter is overloaded and the needle is "slammed" or "pegged". Also, because of its large, black surface area, it is more easily followed under the poor lighting conditions which are encountered in some locations. However, because of its "bluntness", its position on the scale cannot be read as accurately as can the position of the thinner types of pointers which have now become more popular. The spade pointer is still used, however, on electrical measuring instruments whose inherent accuracy is not very high anyway, on instruments which must be read under poor lighting conditions, on switchboard type meters which must be watched or read (not accurately) from a distance, etc. By cutting out the center of the "spade" pointer, as shown at (*b*), its weight is decreased without materially decreasing its ruggedness. However, the objection regarding difficulty in reading its position accurately still holds.

At (*c*) we have the true *knife edge* pointer, which is used to some extent on test instruments. Its advantage lies in the fact that since it is very thin, it enables closer readings to be taken. However, "knife edge" pointers are more difficult to follow in bad light than "spade" pointers are; and, since they are less rugged, they are much more easily bent when "slammed" or "pegged".

The *tapered "knife edge"* or *"sword"* pointer shown at (*d*) represents one attempt to maintain the observational accuracy of the true knife edge pointer while adding more ruggedness to it by reason of its tapered shape. This type is now being used on some radio test instruments.

Another variation of the knife edge pointer which has been adopted by several of the leading test instrument manufacturers is shown at (*e*). Since this has a rugged body like the old spade pointer, it has good visibility even in poor light; and it is not easily bent when "slammed" against the stop during overload. The part of the pointer which rests over the scales is a flat, thin, "knife-edge" to make accurate reading possible. Knife-edge pointers such as these help a great deal in reducing observational error in reading the pointer position.

(R) Parallax error in reading pointer position. Even though the instrument manufacturer has been careful to provide the instrument with a pointer designed for accurate reading, the observer may introduce an error in reading its position if he is not careful. The illustrations in section O of Fig. 3 show how this may happen.

When reading the position of the pointer of any indicating instrument, the person usually closes one eye and "squints" through the other. He should place his head in position, so that his open eye is *directly over* the pointer. Then his line of sight will be through it, and exactly at *right-angles* to the plane of the scale, as shown at the left. The reading taken will then give the correct position of the pointer.

If the eye position is to the *right* of the pointer, as shown, the line of sight will be *oblique*, and the pointer position will be read inaccurately ("low" reading). On the other hand, if the eye position is to the *left* of the pointer, as shown, the pointer position will be read "high". (This type of observational error is commonly known as *parallax.*) Therefore, a good rule to follow when reading meter indications is always to place yourself directly *over* the meter and look directly *down* on the pointer (if the meter is flying flat). If the meter is in a vertical position, place yourself directly *in front* of it, and look directly at the pointer. If the pointer happens to lie between 2 divisions on the scale, estimate its correct position as nearly as possible.

In some types of more precise instruments, possible observational errors due to "parallax" are reduced by the use of a thin mirror which is usually cemented to the scale card and located alongside the scale under the pointer. The image of the pointer reflects in this mirror. Whenever a reading is to be taken, the observer shifts his head position until the pointer is seen *directly over* its image in the mirror (so the pointer hides its image from view). He then knows that he is looking straight down onto the pointer and thus will avoid parallax errors.

If a reasonable amount of care is taken, it is possible for a skilled observer to read the scale position of a knife-edge-type pointer to within 0.005-*inch* of its true value, when a mirror is present to avoid parallax. Of course, the accuracy of reading obtained in practice depends upon the lighting conditions, the eyesight condition of the person, *and the care exercised.*

(S) Pointer deflection fluctuating. If the quantity under observation varies in value while the meter is being read, it is difficult to accurately determine the exact correct position of the pointer. Under these adverse conditions, a fairly large observational error is likely to be made. (This was discussed in part [P] of Section [3].)

Read Part III 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" books—all valuable contributions to the field of literature for the practicing radio Service Man.

NEW CIRCUITS IN MODERN RADIO RECEIVERS

(Continued from page 278)

no bias is applied to the R.F. or I.F. tubes and the receiver remains at maximum sensitivity. Above –3 volts in the A.V.C. line, up to maximum voltage that the signal can produce, the A.V.C. voltage may advance without hinderance.

(4) High-Fidelity Set uses Separate Amplifiers for High Frequencies

Grunow Model 1541 Chassis 15W. As in Fig. 1D, the 6C5 driver tube supplies a transformer-coupled output to the 6F6 power tubes and an additional output to the control-grid of another 6F6 (high-frequency) output tube. The additional gain of the high-frequency tube makes up for possible loss of high frequencies due to the transformer load of the first audio tube.

If the high-frequency reproduction is not desired, the output of the high-frequency tube may be shorted to screen-grid with a switch provided for the purpose.

(5) Improvement in 1st-Detector Circuit

Grunow Model 1067 Chassis 10D. Where signal strength is quite low the sensitivity of the receiver can be improved by lowering the bias on the 1st-detector. This is done by tapping the 1st-detector cathode resistor 4-5, Fig. 1E, in the center (390 ohms on each side) and grounding this tap at the band switch on bands where it is desired to have greater sensitivity.

Note that the switch grounds this tap for both the foreign and police bands while for the police band it also shorts the R.F. primary.

(6) Triple-Detection, 2 Oscillators and 2 I.F.'s.

Arvin Models 1237 and 1247. The basic circuit of this "double I.F." superheterodyne is shown in Fig. 1F. The signal beats with the usual variable-frequency oscillator forming a beat of 455 kc. This is sharply peaked and beats with a fixed oscillator of 355 kc. in a following 6A8G oscillator-detector tube forming a new, and lower, I.F. of 100 kc.

A discriminator amplifier is used and the A.F.C. tube operates on an oscillator of constant frequency, whence its characteristics can be definitely set and predetermined. The 100 kc. 2nd-I.F. amplifier is broadened in sideband coverage by shunt resistors in plate and control-grid tuned circuits.

The circuit has striking advantages in the applications of A.F.C. to *all bands* because of the double-oscillator—double-I.F. system.

ANSWERS TO QUESTIONS ON PAGE 301—EXPERIMENT NO. 2

(1) The fundamental cause of all types of sound is *the physical vibration of some form of matter.*

(2) When a telephone is being used, the form of energy which actually travels over the wires between the transmitter and receiver is: *varying electric current.*

(3) In order to avoid objectionable breathing noises the microphone is held *at a slight side angle.*

(4) The vacuum tube acts as an amplifier because small changes in the *grid* circuit control large changes in the plate circuit.

(5) A "feed-back howl" occurs only when the loudspeaker faces the opening of the microphone; *this is false, because, with loud volume, the sound is reflected from walls and other surfaces, and in this way will feed-back into the microphone to cause a "howl", unless the volume is reduced.*

RECENT APPLICATIONS OF THE "ELECTRIC EYE"

(Continued from page 298)

ployed in the circuit (Fig. 1E). If a rectifier cell were used instead of the vacuum-type photocell, the apparatus would be still simpler.

PE CELL WATCHES LIFE PROCESS

Let me take you for a moment into the quiet study of the physiologist. What could be more fascinating to him and to everybody else interested in the study of living matter than to follow changes occurring inside a living organism without opening or in any way damaging the delicate structure? L. Nicolai wanted to find out more about the speed with which our blood pigment which is saturated with oxygen in our lungs hands this vital element on to the tissues which use it up in burning the food stuffs. Figure 2 is a semi-schematic presentation of his apparatus which he built for this purpose.

The light of the quartz mercury vapor lamp (2) is steadied by the condenser (1). It is then focused by the lens (3) on the object under study (7). A rotating sector (4) and a light filter combination (5) are interposed. The photographic shutter (8) is mounted in front of the photocell (9) (gas-filled type, cathode coated with caesium metal). The cathode of the photocell is connected with the grid of the input tube of the 3-stage low-frequency amplifier (10). The end transformer (11) leads into the registering circuit made up of the dry-disc rectifier (12) and the galvanometer (13).

Ordinarily, D.C. amplifiers are used in connection with photocells. In order to avoid their drawbacks, the light is chopped up by the rotating sector disc (4) thereby transforming the photo-electric current into a pulsating form suitable for A.C. amplification. The relatively translucent region between the thumb and the forefinger of our hand is chosen for the experiment.

If you look at this spot with a strong light source in back of it you will notice the red color due to the blood pigment in its loose combination with oxygen. The circular clamp (6) is placed on this part. By pressure the influx of fresh blood and the outflow of the used blood is interrupted. The tissue cells deprive the pigment of its oxygen at a rate depending on the intensity of their metabolism. When the bright red pigment is reduced, i.e., loses its oxygen, it will turn purple. The photocell is sensitive to this change which is rendered even more marked by use of the mercury lamp and light filter.

By noting the deflections of the galvanometer with time after the clamp is put on we can follow the time course of the reduction of the blood pigment in a strictly quantitative manner.

THE RADIO MONTH IN REVIEW

(Continued from page 263)

has been developed, so that a set will give a shrill whistle, even though turned off, when the authorities wish to call attention to an important announcement! This is not sufficiently definite to explain the device (though several surmises can easily be made) or how it operates.

RADIO SCIENCE REVOLUTION?

WITH THE NEW outlook on basic science that has developed in the past 40 years, and especially since the World War, there come great improvement in electrical applications and, especially, radio. This new science is almost completely mathematical. Now it is challenged. In the *Physical Review* last month, Dr. Sambursky, of Jerusalem, met the astronomers' assertion, that the universe is exploding, by the counter-proposition that the electron and all effects associated with it are shrinking. It is admitted 350 years must pass before measurement could show this; in the meantime, who will advertise a set with "pre-shrunk electrons; no fading!"?

At the same time a Russian scientist presented calculations from an experiment with "electrons moving with velocities exceeding that of light"—presumably impossible; and a Czech scientist, Dr. Basta, affirms that the ether is composed of sub-atoms, in which gravitational waves move more sometimes twice as fast as magnetic waves—light and radio. Years ago, Tesla declared the atomic nature of the ether; and a somewhat similar idea was intimated later by J. J. Thomson, discoverer of the electron.

USEFUL CIRCUIT IDEAS

(Continued from page 288)

The equipment necessary to accomplish these results consists of your own analyzer, regardless of its make or circuit connections, and an especially constructed switch. This switch when assembled measures but 2 ins. long ¼-in. wide and ¾-in. high; and costs about $1 to build. This is the only cost of the entire circuit. Two D.P.-S.T. and 2 S.P.-S.T. Jewell Analyzer switches are bolted together and to the panel and connected in the analyzer as shown in Fig. 8.

By pressing the switch button, the milliammeter is switched from the plate to the grid circuit of the tube, thus utilizing the original meter shunts. The 2 S.P.-S.T. sections of the switch close through the continuity of either circuit when the meter is switched to the other. A 1 ma. meter range is of special utility in this circuit. Screen-grid and full-wave rectifier second-plate current, are indicated when testing these types of tubes.

P. F. FARSON

HONORABLE MENTION

Novel Tone-Control Circuit. Figure 5 shows a circuit of a variable tone control. The value of the potentiometer is 0.5-meg. while the condenser values can be arrived at by experiment, to suit the builder.

I find that shifting from "highs" to bass is gradual instead of suddenly as with a single condenser and variable resistor in series.

LANSING L. POST

HONORABLE MENTION

Low-Resistance Ohmmeter. I am sending you a diagram of a low-resistance tester, for testing small values, 0-to-100 ohms. By looking at the diagram in Fig. 4, you will see the usual high-resistance tester. By adding 1 switch and 1 phone jack or binding post to this circuit we have the high- and low-resistance tester.

To use the tester for low values, close switch and with the test prods in No. 2 and 3 jacks, we are ready for tests. The resistance under test acts as a shunt for the meter. The meter resistance for this 0-to-100 ohms tester should be 50 ohms. Meters with other internal resistances will read differently. The limit of the tester will be twice the meter resistance.

PAUL E. CLAYTOR

HONORABLE MENTION

Multiple Code-Practice Set Using a Single Tube. The submission of this kink, I am sure will be of great help to radio amateur clubs or amateurs.

The audio transformer T1 is 1-to-1 ratio and T2 is 1-to-3 ratio. Unit T1 will give a high-pitch signal, if a 3-to-1 ratio is used. However both transformers may be used 1-to-1 or 3-to-1 ratio. The rheostat may be 3 to 10 ohms. Two or more pairs of headphones may be connected in parallel or 2 or more keys may be used, connected in series. All keys but the one sending must be closed. See Fig. 2.

LEE WHITE, JR.

HONORABLE MENTION

Homemade Multitester. Enclosed is a diagram (Fig. 6) of my multitester built in a Radiola III-A box, 12 x 6 x 4 ins. deep. I can make D.C. tests of 4.5 V., 45 V., 450 V., 900 V.; 1 ma.; 45 ohms (center-scale), 150,000 ohms, 1.5 megs.; 100 ma., and 500 ma.

I can make a pretty accurate test of condensers of 100 mmf. to 50 mf., and test leakage with a ¼-W. neon light up to 130 V. This could also be arranged to be used for an output indicator. The A.C. meter is a Weston 476 and the D.C. meter a Triplett 321 with 1,500 ohms internal resistance. I am using a 6H6 tube to have a plate resistance between the line to a possible ground in testing a set. The filament voltage is hardly high enough for the condenser test on small capacities but I can use it down to the lowest end of the scale.

M. S. DILL

(Continued on page 317)

THE LATEST RADIO EQUIPMENT

(Continued from page 285)

6L6Gs in push-pull output and a type 83 rectifier.

A gain of 130 db. is provided to allow operation with full output from any standard high impedance microphone such as crystal, dynamic, velocity, or velotron. Phono and radio inputs may be mixed with the microphone input channel.

SUPERSENSITIVE INTERPHONE (1493)

A NEW addition to an extensive line of equipment is the Handy-Phone recently announced by a well-known manufacturer. The *master* or model FM-41 station contains the usual common A.C.-D.C. amplifier; and controls, including a 4-station selector switch. The *remote* (up to 2,000 ft.) or model FS-5 stations are energized and controlled by the master station.

An important feature of this new addition to the interphone field is its exceptional sensitivity of pick-up at 50 ft. if desired! Maximum power output, 1 W.; 5-in. dia. reproducers are used. States the manufacturer, "The approximate operating cost is ¼c per hr."

UTILITY CHAIRSIDE ALL-WAVE RADIO SET (1494)

CHAIRSIDE radio sets have carved for themselves a niche in home decoration; and latest models incorporate unusual radio and domestic utility. For instance, the model 38-7CS receiver, illustrated, incorporates Cone-Centric Automatic Tuning for both American and foreign reception; and a tuck-a-way resting place for books of the moment.

SERVICE "LABORATORIES" (1495)

SERVICE MEN who wish to attract customer interest may now work up prestige-building service "laboratories" along the lines of the set-up here illustrated. All instrument panels are slotted for standard 19-in. relay rack mounting; finished in baked crystalac with silver-etched panels and inlaid green trim. Instruments housed in standard 19-in. rack, finished in green with chromium plated trim. Chromium floodlight adjustable to any height (operational). All line-operated rack-type instruments fitted with pilot lights. Among the available instrument panels are the following: A, oscilloscope; B, set analyzer; C, audio oscillator; and, D, signal generator.

POPULAR-PRICE COMPACT TRANSMITTING CONDENSERS (1496)

(Hammarlund Mfg. Co., Inc.)

A NEW popular series of transmitting condensers for high-frequency and ultra-high frequency, medium- and low-powered units, has just been developed by a well-known manufacturer. Though low in price, these condensers include all the constructional features required in quality transmitters of all types.

Known as the MTC series, they are available in both single and split stator styles in 19 different sizes with capacities ranging from 20 to 530 mmf. and breakdown voltages from 1,000 to 6,000 V. The end frames are of heavy aluminum sheet, while the rotor and stator plates are of heavy aluminum, firmly anchored in place by wedging into deep slots and then by further staking. An accurately-ground, stainless-steel shaft is carefully fitted to a long, bronze front-bearing mounted on a beryllium cushion-disc. The free-floating action thus afforded, provides for a perfect bearing and consequently smooth operation. The rear-bearing is of the steel ball-and-cup type. Thorough isolantite insulation and a silver-plated beryllium contact wiper assure lowest losses, lowest series resistance and noiseless operation.

The condensers are designed for either panel or base mounting and range in size from 4 to 6¼ ins. long (including a 1-in.-long shaft). Plates are either round-edged or standard type, varying in thickness from 0.025- to 0.04-in., and from 0.031-in. plate spacing to 0.171-in. plate spacing, dependent upon voltage breakdown required.

CORRECT PLAYBACK OF SPOT RECORDINGS

(Continued from page 284)

inevitably lying at the bottom of the groove. Further, accumulation of dust and foreign particles at the bottom of groove contribute to the groove hiss so objectionable in most recordings.

A worthwhile suggestion would be that every user of acetate discs equip himself with a microscope for examination of all record grooves and needle points, to make sure of proper needles in the playing of acetate discs.

If a record were played back as shown in Fig. 2B, eventually the groove would be deformed or roughened as illustrated in Fig. 2C, resulting in a decided increase in hiss level after the first playing, the roughened or fringed edges setting up a hiss that would be very evident in the speaker when the record was being played; and which would gradually increase with repeated playbacks.

Of very great importance is the fact that only needles having the very finest polish should ever be used on acetate. A rough point or points that have become rusty will tear and roughen the groove and side walls of an acetate record.

Needles that have once been played on a standard (or "commercial") *shellac pressing* should never be used on an *acetate record* because of the very simple fact that there is a slight abrasive in ordinary commercial records that grinds the point of the needle to conform to the groove. The abrasive actually tears the surface of the needle which if used to play an acetate will in turn tear and roughen the acetate groove. A needle in this condition actually becomes a cutting tool as will be readily perceived by examining its point under the microscope.

SUMMARY

Microscopic examinations of hundreds of acetate records have shown very conclusively that when not played on proper equipment having the features and details previously mentioned, the results are an ironing-out or straightening of the high frequencies—possibly "rubbed out" would be the proper term to use—as a result of being played back just once with a pickup having a stiff or highly-damped armature; or excessive weight or pressure on the playback needle; etc.

While it is fully appreciated that there are various shapes of grooves in general use they all, however, follow the same general order in that they are V grooves. Some have rounded bottoms and some have sharp bottoms. Regardless of the radius of the bottom of the groove or whether sharp or rounded, a playback needle such as shown in Fig. 1 having a bullet or ball-bearing point, gives by far the most satisfactory results in playback and long life to both the needle and record.

If acetate records are to become popular and commercially advantageous, they *must* be given more consideration in the matter of playback.

Simplicity and sturdiness of construction being vital in a part as constantly used and handled as a phono pickup, in the commercial design used as the basis of this article the well-understood magnetic principle was retained; the construction was highly refined; and, the parts, especially the armature, were made dwarf-like by comparison with the older types. As an example, the armature is only 25/64-in. in length from pivot to end; and, complete, weighs only 0.825-gram. Adjustment is easily understood by every technician and Service Man, and no delicate tools are required; which simply means that any irregularity may be easily and quickly corrected without sending the part to some distant point for service.

The pickup here illustrated (Fig. 1A) and described is not intended to be used as a technical device, but rather to fill the urgent need for a practical pickup capable of everyday use in the playing of cellulose and all other types of records. It will give faithful reproduction at full volume; and its negligible wear extends the usable life of records many times over. An instrument such as described, with a reasonable amount of care should give satisfactory service over a long period of time.

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

26-W. AMPLIFIER WITH DUAL POWER SUPPLY FOR ELECTIONEERING

(Continued from page 276)

feature is a great aid when the amplifier is used in dark interiors. The tubes used are 2—6J7s, 1—6C5, 2—6N7s, 1—83. The total drain from the battery is only 12 A. and the A.C. section consumes 100 W. See Fig. 1 for schematic.

OPERATION

Although the overall gain of the amplifier is 115 db., full volume may be utilized without fear of crackling genemotor noises. This has been the most difficult trouble to eliminate but if the circuit is carefully followed, noiseless and humless operation may be obtained. From the diagram, it will be noted that the circuit has been so designed that both power supplies may be connected simultaneously without causing damage.

For ease of operation, the use of 2 heavy-duty "P.M." speakers is suggested so that whether the amplifier is used on battery or from the A.C. line, there need be no worry about field supply. Its comparatively light weight and compactness make it an easy matter to set up this sound system either in a motor car or indoors. The battery drain of 12 A., allows at least 6 hrs. of continuous service from a good, fully-charged battery. The genemotor delivers 300 V. at 115 ma. and the A.C. supply through the filter delivers 300 V. at 150 ma.

Usually, most convertible amplifiers are made up in 2 parts. Either they are made up as A.C. units with provision for plugging-in an external genemotor, or they are made up for 6-V use with external plug-in for A.C. power pack.

Another noteworthy feature is the fact that after elections, this Fall, this amplifier does not have to be placed "on the shelf." Although there may not be much call for it in a truck or car, it will nobly fill the bill for most all indoor work, *WITH THE SAME SPEAKERS AND MICROPHONE PROBABLY PURCHASED EXPRESSLY FOR THE ELECTIONS.*

The author will be pleased to answer all questions if address to him care of *Radio-Craft*.

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

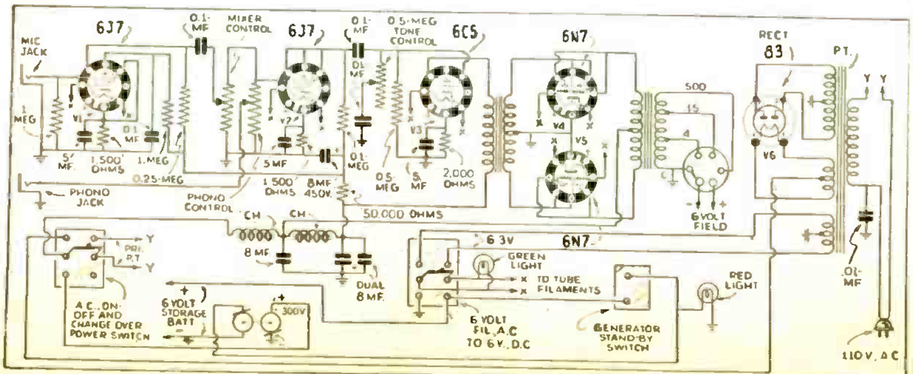

Fig. 1. Schematic diagram of 26-W. amplifier using 6V. D.C. OR 110 V. A.C. power source.

BUILD THIS CRYSTAL-SPEAKER 1-TUBE BATTERY INTERPHONE

(Continued from page 279)

input to act as a microphone. When the switch is thrown over, the roles of the 2 speaker units are reversed. See schematic diagram, Fig. 1.

TWIN-PENTODE AMPLIFIER

A twin-pentode tube and transformer coupling are used to increase gain in a circuit that uses only a 45-V. plate or "B" battery. The output transformer (which is identical with the coupling transformer) has a step-up ratio of 1-to-4. This ratio results in increased amplification. The loudspeakers are crystal units, not magnetic or dynamic, and hence work on voltage. Therefore the voltage step-up of the output transformer acts to increase volume.

NEW CRYSTAL TRANSDUCERS

The use of a crystal speaker as microphone (thus operating as a "transducer"), however, makes necessary special precautions against line-noise pick-up and amplifier feedback, since the input circuit is of very high impedance. The 0.05-mf. condenser (unit C in Fig. D) connected across the switch blades should in every case be wired EXACTLY as shown (across the switch blades); it should *not* be connected to equivalent wires in a different location. Volume can be increased by increasing the electrical size of this condenser to 0.1-mf., retaining the same physical dimensions. If the condenser is removed entirely the system will oscillate when the remote speaker is used. The crystal transducers shown here were specially designed for interphone service. Their use in this article is believed to constitute the first published description of these "crystal transducers."

In operation, it will be found entirely practical to speak in an ordinary tone of voice, talking directly into the speaker at a distance of from 1 to 2 feet. Output volume under those conditions will be approximately equivalent to a human voice in ordinary room conversation. Volume can be increased, to attract the attention of a person at the other location, either by raising the voice or by speaking closer to the microphone. Shouting very close to the microphone will overload the system and result in a rasping output. A volume control is not built into the amplifier—modulation of the voice of the person speaking provides all the variation in volume that will ever be necessary.

Normal quality is extremely clear and understandable, and exceptionally rich in high frequencies, by virtue of the use of the crystal type of loudspeaker. Intelligibility of speech is correspondingly excellent.

OPERATION

The amplifier, if turned off, can be switched on at either location, but if turned on can only be switched off when both on-off switches are turned off. Therefore each user should be careful, in the interest of long battery life, to turn off his switch at the end of each conversation. (This is the most simple and least expensive arrangement. However, the use of an S.P.D.T. switch will permit off-on control at *either* end. A pilot light could be wired-in, as an "in use" indicator. *—Editor*) The user at the control unit also, at the end of each conversation, should set his "listen—talk" control switch (at the top of the cabinet) to "listening" position. He can then be called at any time, but if he has left his control switch at the "talk" position the remote station will not be able to reach him.

One or even 2 remote stations can be added in parallel without excessive loss of volume. Each of these will be able to call the control station, but they will not be able to call each other, since when one is acting as a microphone they are all acting as microphones. When one acts as a loudspeaker all will act as loudspeakers; therefore each will be able to hear what the person at the control unit says, but they will not be able to hear what other remote stations answer. If the remote stations wish to talk to each other they will have to relay their information through the person operating the master unit.

The point we wish to stress is that here for the first time is a complete construction article on a battery-operated interphone, having exceptional speech intelligibility, capable of operating in rural districts or wherever electric light lines are not available.

LIST OF PARTS

*Two moulded bakelite cabinets;
Two U-41 audio transformers, United Transformer Corp.;
One National Union Radio Corp. 1E7G tube;
Two Brush Development Co. 3-in. interphone-type crystal loudspeakers;
*One 4 p. 4 t. rotary switch;
*Two 1 p. 1 t. toggle switches;
Three Solar 0.1-mf. paper condensers;
One Solar 0.05 mf. paper condenser;
One International Resistor Co. 1 megohm resistor;
One International Resistor Co. 10,000 ohm resistor;
*One 8C socket;
One National Carbon Co. 1.5 volt "C" battery;
One National Carbon Co. 2 volt "A" battery;
One National Carbon Co. 45 volt "B" battery;
*Three 4-point terminal strips;
One cigar box (painted with black cellulose paint) for base of master unit.

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

HOW TO MAKE THE RADIO-CRAFT SUPER-DELUXE 30-TUBE SET

(Continued from page 274)

Two Aerovox wire-wound resistors, No. 931, 5 W., 2,500 ohms, R25, R36;
Two Aerovox mica condensers, No. 1467, 50 mmf., C34, C37;
Two Aerovox mica condensers, No. 1467, 100 mmf., C11, C52;
Two Aerovox mica condensers, No. 1467, 250 mmf., C29, C30;
One Aerovox mica condenser, No. 1467, 500 mmf., C36;
One Aerovox tubular electrolytic condenser, type PR-25, 25 mf., 25 V., C39;
Twenty Aerovox tubular bypass condensers, type 484, 400 V. D.C., 0.1-mf., C8, C10, C12, C13, C14, C15, C16, C17, C18, C19, C22, C23, C25, C26, C27, C28, C32, C35, C38, C43;
Five Cornell-Dubilier condensers, 0.05-mf., C21, C24, C31, C42, C44;
Six Cornell-Dubilier condensers, 0.01-mf., C20, C40, C41, C47, C50, C51;
One Solar condenser, 0.002-mf., C49;
One Solar condenser, 0.006-mf., C46;
One Solar condenser, 0.02-mf., C45;
Two Solar condensers, 0.001-mf., C7, C53;
*One chassis, No. 1524, 17 x 13 x 3 ins.,
One Stancor audio reactor, No. A4400 Bass choke 350 hy.;
Fourteen wafer octal sockets;
Five wafer sockets: 1—6-prong, 2—5-prong, and 2—4-prong.

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

NOTICE:

As stated in Part I *Radio-Craft* has made arrangements to have tested and repaired WITHOUT CHARGE any *Radio-Craft* Super-Deluxe 30-Tube Radio Receiver, built in accordance with these instructions AND USING ONLY THE SPECIFIED COMPONENTS, which fails to function correctly (the constructor however must pay shipping charges both ways).

In other words—YOU CAN'T LOSE!

USEFUL CIRCUIT IDEAS

(Continued from page 312)

HONORABLE MENTION

Testing Audio Amplifier Stages With A.C. Line Hum. The A.C. line hum may be used as a quick and convenient method of determining whether the audio amplifier stages of a receiver are operating. Such hum is applied to the various points in the audio circuit through a condenser and test lead as shown in Fig. 3. The prong of the A.C. plug to which the lead is connected must be placed in the "hot" or ungrounded side of the service outlet.

With the receiver turned on, the terminal of the test lead is touched to the plate of tube No. 1, "B plus" of tube No. 1, the grids of tubes No. 2 and 3, or "C minus"; if all parts of circuits included are operating correctly a hum or buzzing sound will be heard in the speaker. This hum should be louder, due to amplification, at the plate of tube No. 1 than at points on other tubes.

HOWARD J. SURBEY

GERMAN 8 x 10 FT. TELEVISION IMAGE

(Continued from page 271)

the ordinary light that illuminates the speaker, but, peaked sensitivity to a fluorescent beam which, when it reflects from the speaker, appears to the eye to be of greenish hue and very weak in intensity!

(2) This fluorescent beam is projected from a "cathode-ray beam scanner" shown in Fig. B2. Referring to Fig. 1 we find that this cathode-ray scanner is located at a considerable distance in front of the speaker. In operation a high-intensity cathode-ray beam is projected onto the end of the tube thus producing an intensely brilliant spot that moves over the surface of the tube's end so rapidly that the entire end of the tube appears to be fluorescent. The cathode-ray tube that produces this fluorescent beam is mounted vertically in the scanner cabinet. The light thus projected vertically is reflected from a mirror, mounted diagonally, and thence through a lens system onto the speaker. An electronic sweep circuit, common in modern cathode-ray-tube operation, causes the beam to sweep across the speaker, from left to right and from head to waistline, at lightning speed.

(3) The reflected light picked up by the photocells is then amplified and fed into a device called the "television image projector." This projector and its control unit are shown in Fig. C. This unit like the scanner utilizes a cathode-ray tube; but unlike the scanner the projector tube is mounted horizontally. By raising the anode potential of this C.-R. tube to 20,000 V. an intense beam is developed, and thus, producing brilliant illumination of the fluorescent tube-screen. The amplified output of the photocells modifies this beam; a lens system focuses this beam onto the theatre-size screen; and a sweep circuit causes the bust-size image to fill an area measuring 8 x 10 ft. The resulting image is so bright it may be viewed in a moderately-illuminated room.

Radio-Craft feels that, by adding amplified image to amplified sound, public-address has been given an impetus which will be felt right down the line; expert P.A. Service Men will "come into their own," and will be recognized for their full worth, when they are called upon to service not only audio but also video equipment.

OPERATING NOTES

(Continued from page 286)

successfully, but owner was not content with additional tuning. So omitted this "helpful hand"; and thereupon found that oscillation appeared, when antenna lead was wound 2 or 3 turns around the input (see Fig. 1) lead of the 1st-detector—oscillator tube (between tuning condenser and control-grid of 6A7), *besides both performing their old duties*, but coil still was "out." For convenience, I made an extra connection to "control-grid", which was coupled to "antenna", instead of bringing the antenna to the control-grid. This served well for 5 weeks or so, when, in some port, replacement parts were to be had.

A. DEKRAAUW,
Radio Operator,
Dutch m/v "Miralda" (ship).

A RETURN TO THE FOLD

Bert Nussbaum whom we mentioned last month had left *Radio-Craft* to join the staff of an advertising agency, has returned to the fold; now he will have to live up to all the nice things that we said about him when he left!

"60-WATT AMPLIFIER"
(A correction)

Due to an oversight in interpreting the author's article, *Radio-Craft*, last month, erroneously titled the article, on pg. 214 of the October issue, "How to Make A Class A[1] Push-Pull Negative-Feedback 60-W. Amplifier." The correct power rating at less than 2% distortion is *32 watts*. We are sorry for this error.

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(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.)

BOOK REVIEWS

RADIO STARS OF TODAY, by Robert Eichberg. Published by L. C. Page & Company. Size, 8 x 11 ins., cloth covers, 218 pages, over 275 illustrations. Price, $3.50.

Thumb-nail description: Sparkling personality sketches of radio broadcast stars.

"Bob" Eichberg has given to the owners of the 27,000,000 radio sets in America a superlative link between our favorite broadcasters as we hear them "over the air", and the more intimate appreciation of their programs that would exist only for a person who knew and saw them all personally. Additional topics of passing interest to the average listener-in are beguilingly discussed —vide the contents listing below.

Contents: Chapter I—Behind the Scenes; Chapter II—Radio Stars and Programs (The Aces, Fred Astaire, Fred Allen: *Town Hall Tonight*, Amos 'n' Andy, Phil Baker, Jack Benny, Ben Bernie, Major Bowes, Frank Black, Bob Burns, Burns and Allen, Eddie Cantor, Boake Carter, Bing Crosby, Crumit and Sanderson, Walter Damrosch, Jessica Dragonette, Nelson Eddy, Floyd Gibbons, Edgar Guest, Helen Hayes, Edwin C. Hill, Ted Husing, H. V. Kaltenborn, Andre Kostelanetz, Warden Lewis E. Lawes, Guy Lombardo, Phillips Lord, Herbert Wayne King, *Lux Radio Theatre*, Lily Pons, *The March of Time*, *One Man's Family*, David Ross, Frank Parker, Dick Powell, Believe-It-Or-Not Ripley, Dave Rubinoff, *Showboat*: Lanny Ross, *Sidewalk Interviews*, Kate Smith, Lowell Thomas, Virginia Verrill, Lawrence Tibbett, Rudy Vallee, Fred Waring, *Voice of Experience*, Jimmy Wallington, Paul Whiteman, Ireene Wicker, Walter Winchell); Chapter III—Amateur Broadcasters; Chapter IV—Radio Police; Chapter V—Radio at Sea; Chapter VI—Aviation and Radio; Chapter VII—Large Broadcasting Stations; Chapter VIII —How to Choose a Radio Set; Chapter IX—A Sample Radio Script.

The make-up of the volume is particularly commendable, with large illustrations on heavy matt-finish paper. Your living room is incomplete without this choice viand for the literary appetites of you and your guests.

INTERNATIONAL RADIO REVIEW

(Continued from page 270)

LATEST-TYPE EMITRON ELECTRONIC TELEVISION CAMERA FOR "SPOT" BROADCASTS

AT A RECENT radio exhibition at the London Science Museum, as described in a recent issue of *Wireless World* (London), the latest-type Emitron television camera was displayed. The camera (Fig. D, pg. 270) is entirely electronic and is equipped with 2 lenses, one for the camera proper and the other purely for focusing.

The secondary lense is mounted alongside the main one and moves in unison with it as the focusing control is operated. It throws an image on a ground-glass screen which enables the operator to focus readily and quickly.

TELEVISION STUDENTS LEARN BY MAKING CATHODE-RAY TUBES

(Continued from page 309)

drying it out successfully, our next task was to make it adhere permanently to the glass. This operation of *fusing* the screen material to the glass is taken up in Part II.

Well, that's about enough for one "lesson," isn't it? It's taken quite a bit of time to tell just this portion—obtaining the envelope, and preparing the fluorescent screen—of the story about "homespun" C.-R. television tubes; however, it's been lots more fun, and it's taken lots longer to acquire the "hard way"—by trial and, too often, failure—the information given here. Are you interested in this story? Or would you rather have an article on how to make an X-tube bloop-a-dyne receiver? Letters, pro and con, may be addressed to the writer in care of *Radio-Craft*.

This article has been prepared from data supplied by courtesy of American Television Institute.

★ ACCURACY-

AN OUTSTANDING FEATURE OF THESE LOW PRICED READRITE-RANGER TESTERS

MODEL 440-740

PRECISION BUILT *Only* **$36.90**

● COMBINATION TUBE TESTER AND VOLT-OHM-MILLIAMMETER

The Tube Tester and the Volt-Ohm-Milliammeter are indispensable in Radio Servicing. Frequently these two instruments are all that the radio service man need take for a quick checkup in the home.

Model 440 Tube Tester checks all tubes speedily and accurately on Direct-Reading GOOD-BAD Triplett Model 221 instrument. Proper load values are applied to tubes under test. Indicates all inter-element shorts and leakages. Has illuminated X dial. A.C. meter for line volts adjustment.

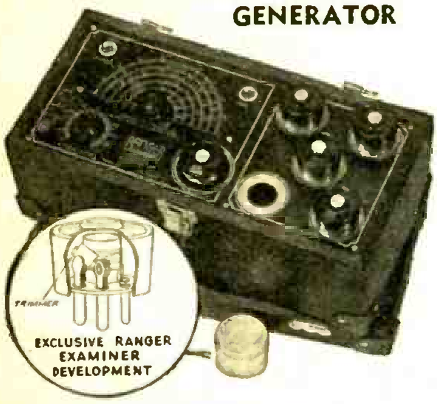
Model 440 Only, Complete in Carrying Case, Dealer Price . **$18.90**

Model 740 Volt-Ohm-Milliammeter has Triplett precision instrument. Scale readings: 10-50-250-500-1000 A.C. and D.C. Volts at 1000 Ohms per volt (D.C. Accuracy 2%; A.C. 5%); 1-10-50-250 D.C. M.A.; 0-300 Low Ohms; High Ohms to 250,000 at 1.5 Volts. Rheostat adjustment for 13-½ volts for Ohm readings to 2-½ Megohms. Batteries may be added permitting such readings in 250,000 ohms steps. Low Ohms to ½ Ohm with 25 Ohms in center of scale. Backup circuit used. Current draw is only 1 M.A.

Model 740 Only, Complete With Batteries, Instructions and in Accessories Metal Carrying Case, Dealer Price **$19.50**

AVAILABLE IN SINGLE UNITS . . . NO EXTRA CASES TO BUY!

DIRECT READING SIGNAL GENERATOR

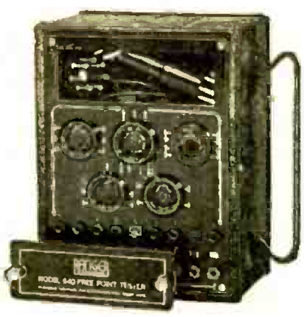


Model 557 Direct Reading Signal Generator uses plug-in type coils. Five frequency bands are covered from 110 to 20,000 K.C., all fundamentals. Completely shielded for static and magnetic fields. Attenuation and stability are outstanding features. Strong signals both modulated and unmodulated are furnished.

MODEL 557

$18.90

FREE POINT TESTER



The Readrite-Ranger Model 640 Free Point Tester has eight automatic switch type and ten single action jacks. Five sockets will handle any type radio tube.

MODEL 640

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A practical foundation unit for amateurs, engineers, sound and radio servicemen. With proper external additions, it offers facilities for the study and adjustment of countless circuit problems. May be adapted for R-F and I-F alignment, resistor, condenser, vibrator and many other tests.

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Television engineering will be the next high salaried profession. Will you be ready to cash in with this new industry? Leaders of radio recognized their opportunity some fifteen years ago, and they as engineers have since earned millions! Now the future of television is assured. Are you going to make it *your* opportunity for success? Trained men will make from $2,500 to $20,000 per year.

THE AMERICAN TELEVISION INSTITUTE

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.

A. T. I. TELEVISION TRAINING

qualifies you during the first few months to take your RADIO TELEPHONE FIRST CLASS GOVERNMENT LICENSE EXAMINATION and get into a good paying job in the radio field while completing your television instruction. Many of our graduates are successful in radio and sound motion pictures.

M. B. Foster of Prairie Du Chien, Wis., writes: "As a graduate of the class of 1936, I can highly recommend A. T. I. training with practical equipment. Since graduating, I am a technician with the Ampro Motion Picture Corp., making a good salary. I feel secure in knowing that I am able to do nearly anything in sound motion pictures or radio now, and that I am ready for television."

E. D. Carter of Bethany, Ohio, writes: "I spent two years in college and have investigated other training in radio and the allied arts, and I have yet to find anything nearly so comprehensive as the A. T. I. training in television, which includes all any practical man needs to know about radio. I have earned an average of $2,500 per year since studying with Mr. Sanabria doing television and telephone work."

★ 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.

This means trained men must be ready.

AN UNPARALLELED VALUE AMAZING QUALITY

Equipment You Receive From American Television Institute

Is not small, ordinary instruction equipment, but a full sized professional television laboratory used for public exhibitions with a steel rack and panels nearly six feet high, two feet wide and eight inches deep mounted on rubber tired casters; R.C.A. amplifier and modulator tubes throughout with A.T.I.'s giant photo-electric cells and 7" x 21" cathode ray receiving tube, together with all other parts to make a complete television transmitter and receiver worth a thousand dollars to one taking this training. All of this is included with the A.T.I. course and is yours to keep. It is all amazingly low in price and on terms arranged to suit you. It costs you nothing to thoroughly investigate this opportunity. You cannot afford to pass it up if you want to get in to television. *Send Coupon Now.*

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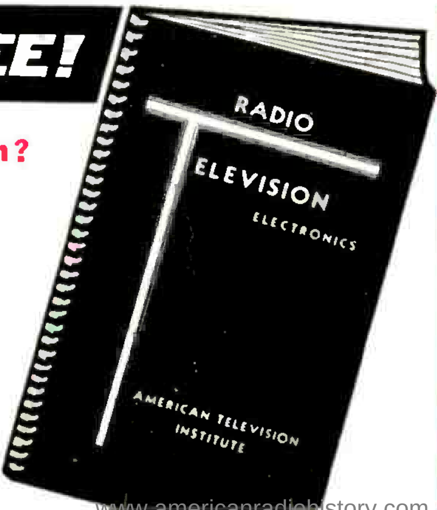
We accept only applicants who can be interviewed by our District representatives or pass the examination we send from our Chicago office. We will send this book and examination without cost or obligation so you may determine how to qualify for entrance into the American Television Institute and how A.T.I. training will benefit you and equip you for a future in radio and television. Clip coupon at right now and mail it to us without delay.



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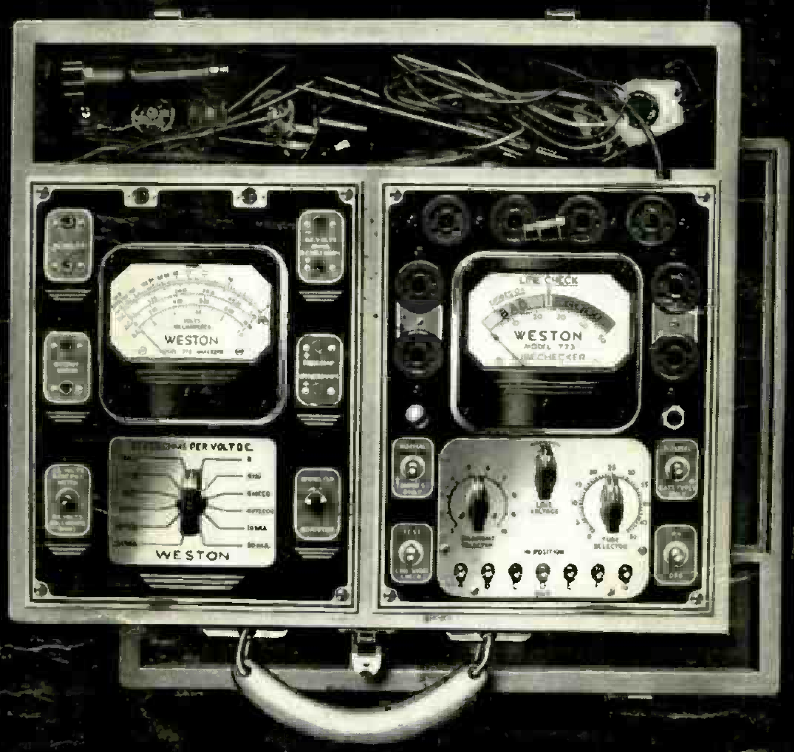
WESTON SERVISET

"The most complete, most versatile servicing tool ever offered servicemen."

"This WESTON 20,000 ohms-per-volt analyzer is the 'tops', and the new 773 Tube Checker leads them all."



"WESTON quality, dependability and long life, at prices we can afford. Big WESTON Meters, too."

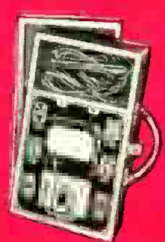
"We need high sensitivity, and we trust WESTON to provide it . . . just as they do for all industry."

"These instruments are quickly removed from the combination case, and can be used individually for portable, counter or panel use."

"With 772 I can service *all* receivers . . . measure photo-cell currents and service television as well."

Your profits this fall and winter will depend, to a large extent, on your equipment. See the WESTON Model 775 Serviset today. Examine it carefully. Compare it, feature by feature, with any other equipment the market affords. Then consider that it is WESTON built . . . that it provides the sound engineering, the quality materials, the dependable accuracy and the long, useful life that the name WESTON assures. See the Model 775, as well as all other WESTON instruments for radio use. Visit your jobber today, or send the coupon for complete information.

All WESTON Radio Instruments can be purchased under the WESTON Investment Plan



Model 772 Analyzer also is available in this light-weight, solid-wood carrying case with real luggage handle.

Model 773 Tube Checker in individual carrying case. Also available in attractive, polished, solid-wood counter case.

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