MAY, 1929

25 CENTS

RADIO

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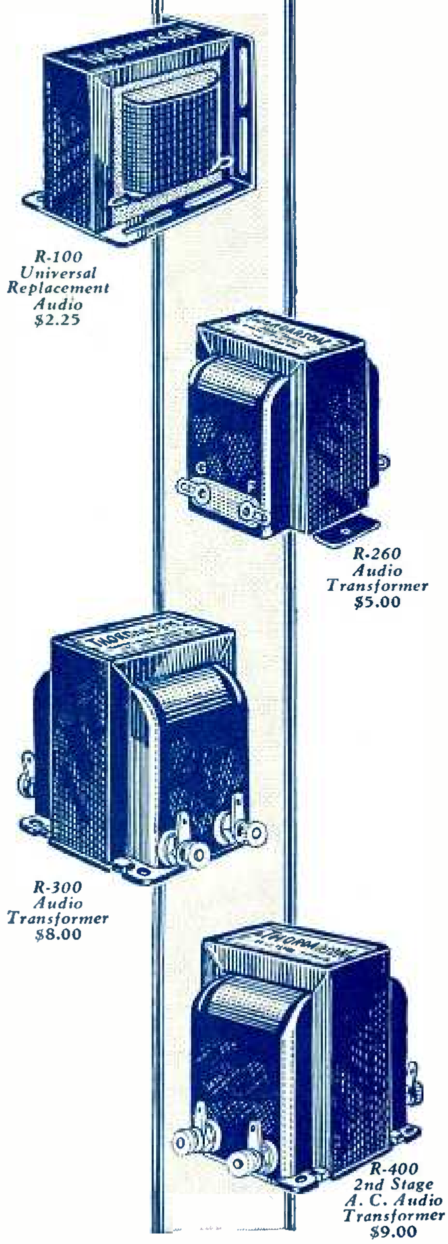
New THORDARSON AUDIO TRANSFORMERS



ONCE again Thordarson steps into the foreground, this time with three new audio transformers of unrivaled performance—fitting companions for the Famous R-300.

The R-100 is a quality replacement audio transformer for use by the service man in improving and repairing old receivers with obsolete or burned out audio transformers. The universal mounting bracket of this replacement unit permits mounting on either side or end, and is slotted in such a way as to fit the mounting holes of the old audio unit without extra drilling. List price $2.25.

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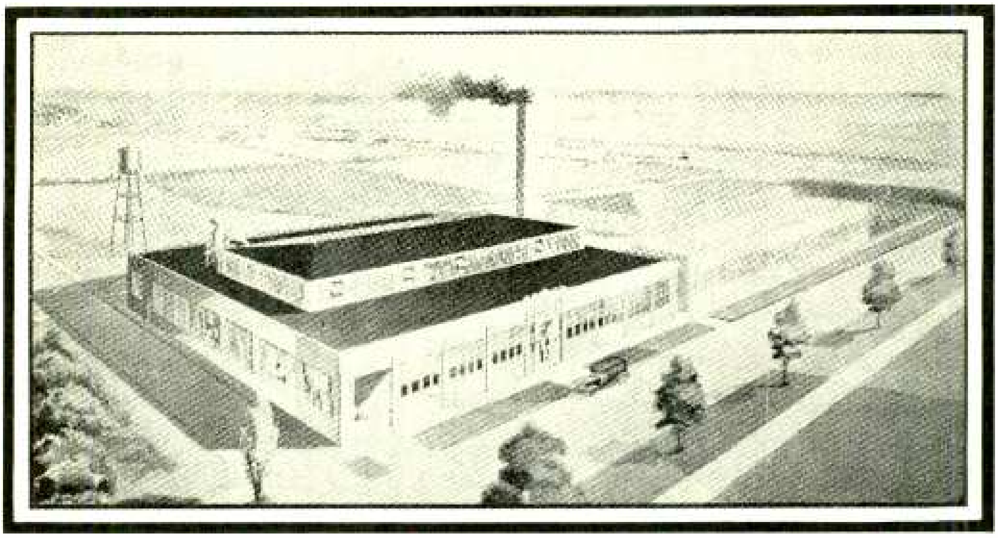

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DYNAMIC SPEAKERS

RADIO

Established 1917

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VOL. XI MAY, 1929 No. 5

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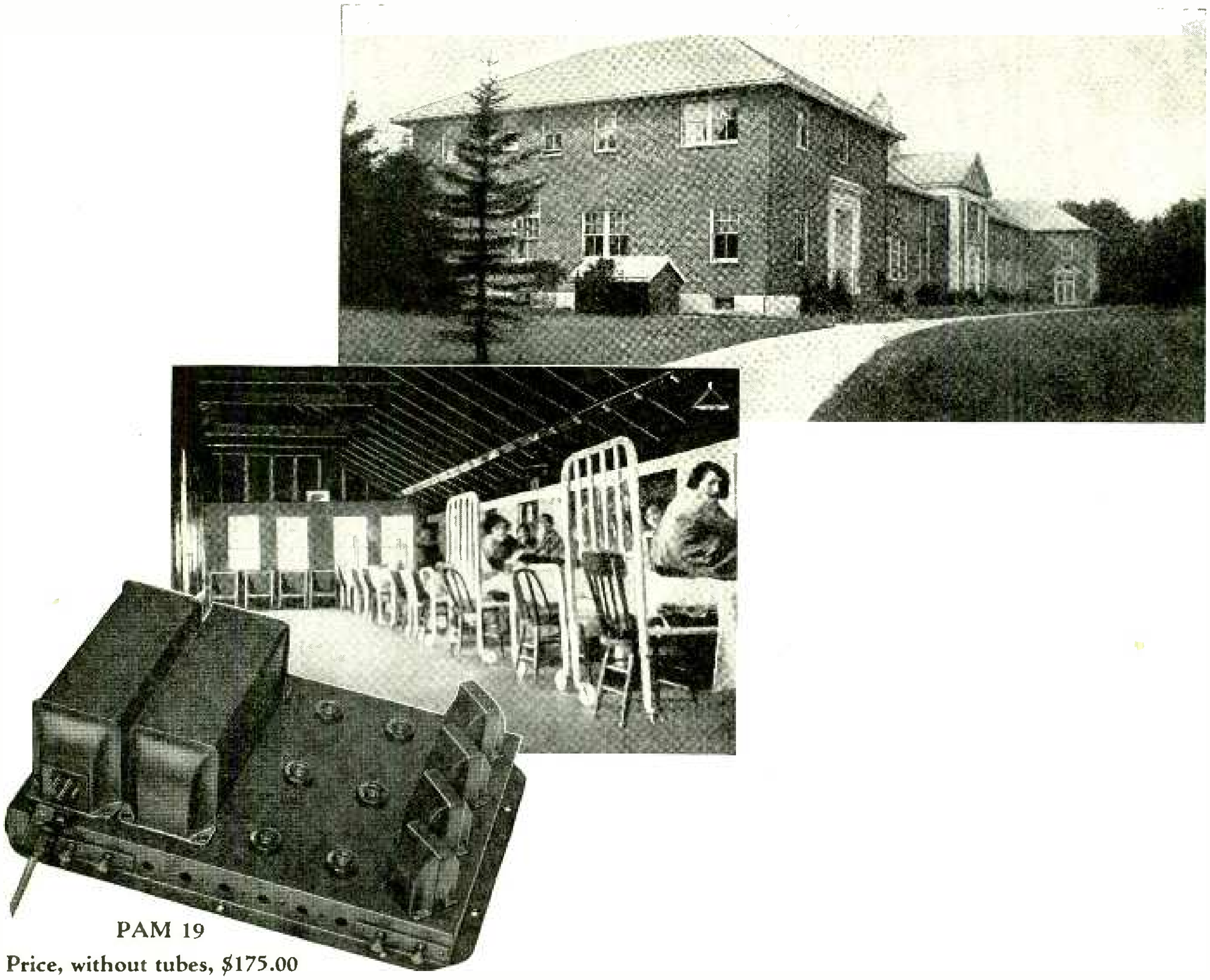
FORECAST OF JUNE ISSUE

J. G. Eisenberg gives details regarding a modern test kit whereby it is possible to measure the voltage used by all the a.c. and d.c. tubes now available. B. F. Estes tells how to align single control receivers. E. E. Power explains the use of an r.f. oscillator and dip meter in shooting trouble. Arthur Hobart presents a chart for finding the impedances of tuned circuits. P. S. Lucas gives complete directions for constructing a compact four-tube screen-grid set with power detector, for use as a portable. R. Raven-Hart has some interesting information regarding new vacuum tubes in France. C. A. Kuhlman describes the use of a chart for the graphical computation of band-pass filters for intermediate frequencies. C. Sterling Gleason takes "A Tip from the Talkies." R. Wm. Tanner gives many good suggestions on improved C.W. and phone operation. Frank C. Jones discusses audio frequency amplification. John P. Arnold presents a wealth of information on methods of transmitting and receiving pictures.



PAM 19
Price, without tubes, $175.00

PAM—the healing assistant

THROUGHOUT the North Reading State Sanitorium, pictured above, the children are helped to recovery and keep in touch with the outside world—its news, its fun, its music—by means of a radio set and a "PAM" Amplifier. In this installation both head sets and loudspeakers are used.

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Send for booklet R-7, which shows how PAM Amplifiers are a "Sound Investment."

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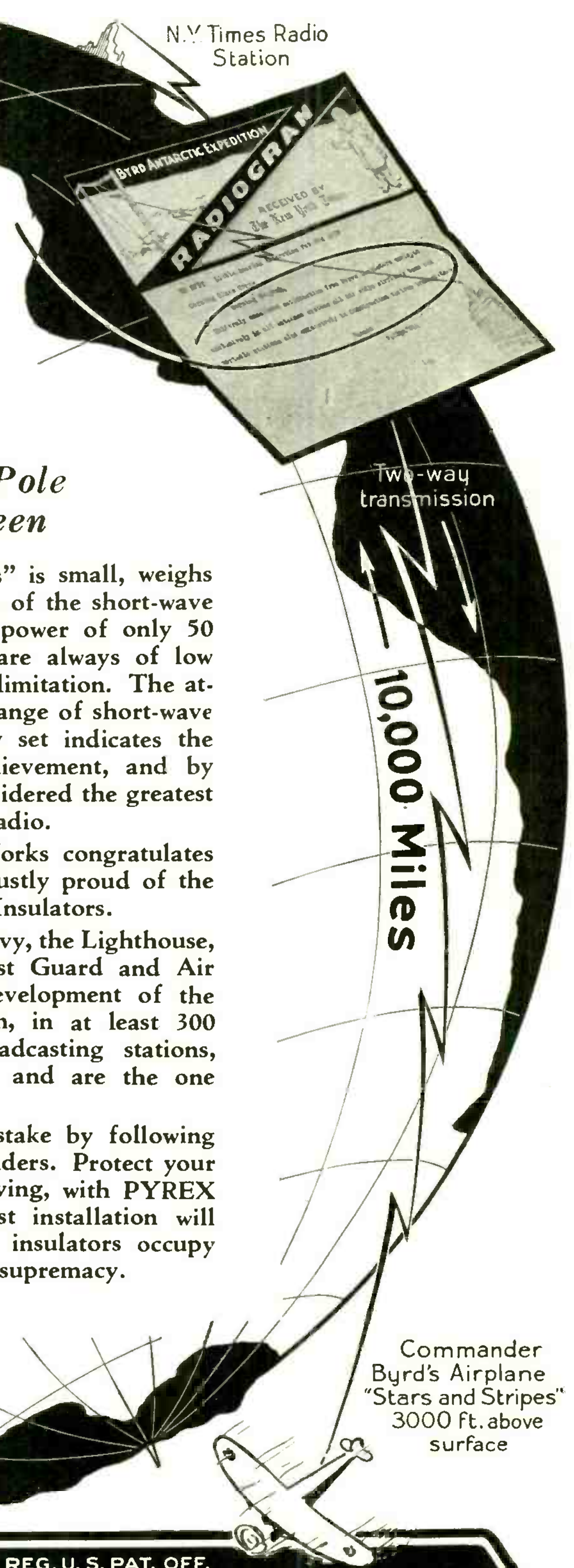

Little America, Antarctica, Feb. 3rd, 1929.

Uniformly excellent satisfaction from PYREX Insulators employed exclusively in all antenna systems all our ships, airplanes, base and portable stations, also extensively in construction various transmitters.

—HANSON, 9:55 P. M.

PYREX Insulators make records at the North Pole, at the South Pole —and everywhere between

THE stream of messages from Commander Byrd when he flew across the North Pole traveled out from an antenna equipped with PYREX Insulators.

Now for his Antarctic expedition, the Commander uses PYREX Insulators exclusively for all antennae and also employs them where possible at other locations in his equipment.

PYREX Insulators are therefore one of the most important factors in the dependability of his communication system between the various ships, base, portable and airplane stations, and in giving us our interesting daily news from the Antarctic regions.

Commander Byrd—and PYREX Insulators—recently set a new world's record in aviation radio, when his plane "Stars and Stripes," 3000 feet above Antarctic ice, established perfect two-way communication with the New York Times station in New York City 10,000 miles away, and the occupants conversed at will with F. E. Meinholtz, the local Radio Consultant of the Expedition.

The transmitting and receiving equipment in the "Stars and Stripes" is small, weighs only about 40 lbs., and is of the short-wave (34 meter) type with a power of only 50 watts. Plane radio sets are always of low power because of weight limitation. The attainment of 10,000-mile range of short-wave signals from such a tiny set indicates the height of insulation achievement, and by many radio experts is considered the greatest feat ever performed by radio.

The Corning Glass Works congratulates the Commander and is justly proud of the part played by PYREX Insulators.

In the United States Navy, the Lighthouse, Atlantic Ice Patrol, Coast Guard and Air Mail Services, in the development of the Directional Beam System, in at least 300 of America's finest broadcasting stations, PYREX Insulators were and are the one and only choice.

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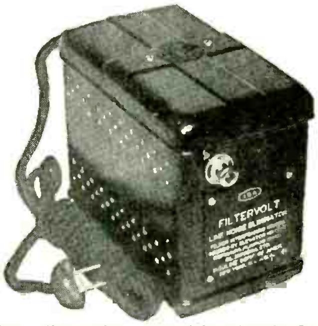

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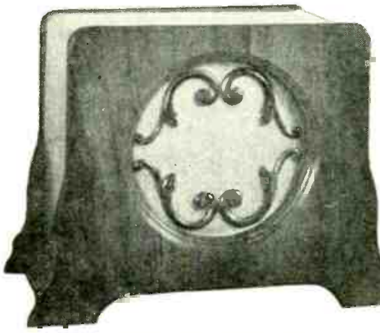

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For 110 v. A.C. Operation

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These Mammoth Sound Chambers can be equipped with rollers to make them portable.

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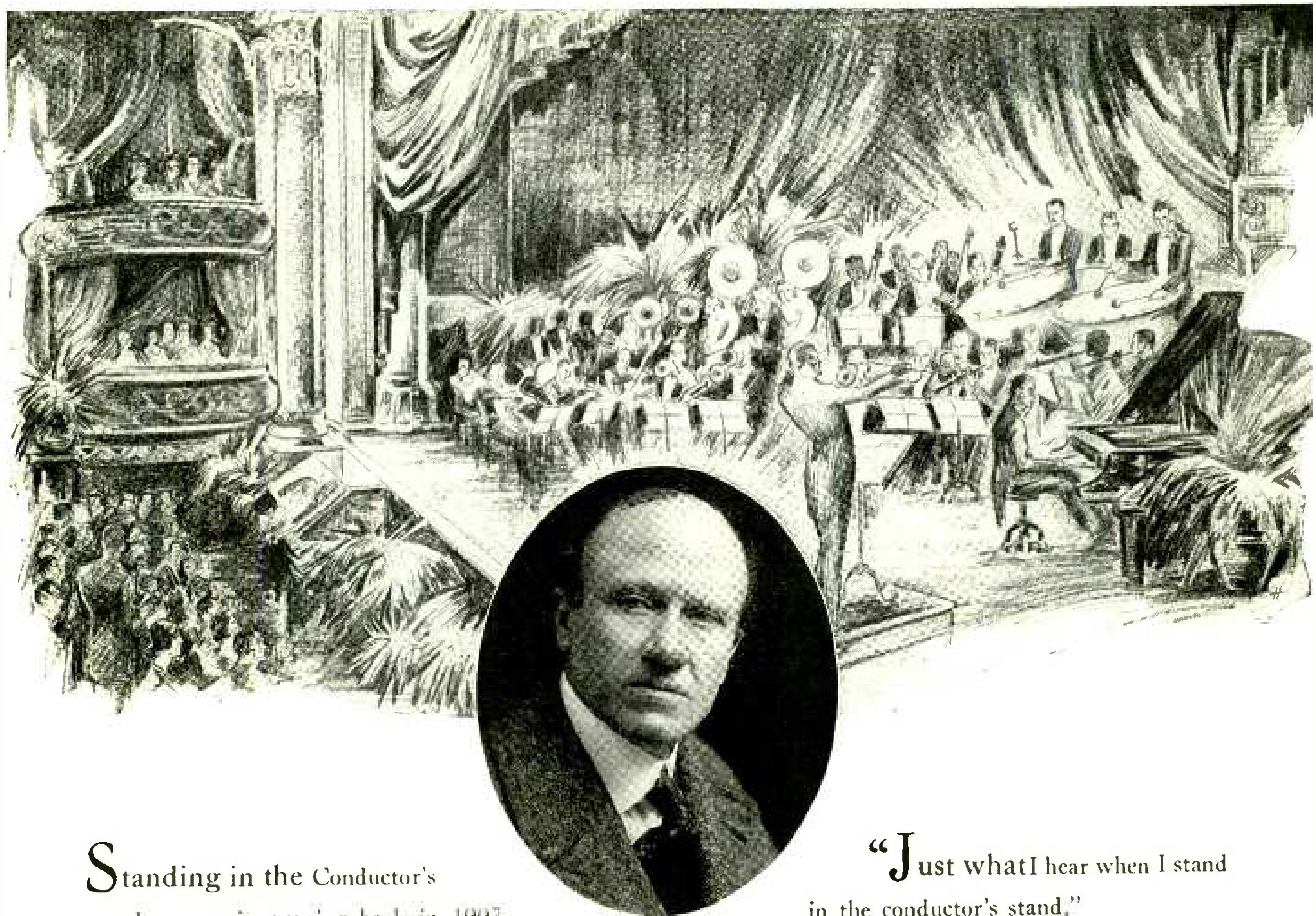

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Standing in the Conductor's stand, a certain evening back in 1907, Louis F. Gottschalk created a sensation that theatre goers and music lovers of New York City are never apt to forget. It was the introduction of the "Merry Widow" to the American public.

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The first composer selected by the Griffith Films to write original scores, Louis F. Gottschalk produced many beautiful musical compositions, such as those accompanying "Broken Blossoms," "The Four Horsemen of the Apocalypse," "The Three Musketeers," and the "Prisoner of Zenda."

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"Just what I hear when I stand in the conductor's stand."

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Just how on earth any mechanism can transport a full hundred artist orchestra through the air and reproduce it in a distant place with all the richness and clarity of the complete ensemble, with the very "personality" of each instrument perfectly reproduced,—that, to me, is a miracle.

Louis F. Gottschalk

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Write for descriptive matter and address of nearest branch office.

Wright DeCoster Inc.

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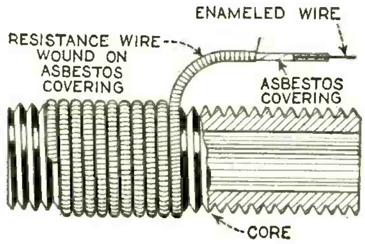
MAIN OFFICE AND FACTORIES

ST. PAUL, MINN.

THE SPEAKER OF THE YEAR

They SAVE SERVE SATISFY



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Truvolt "Electrad Control Manual" (Enclose 10c),
"What B Eliminator Shall I Build?"
(Enclose 10c).
Name ......
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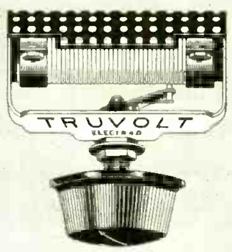

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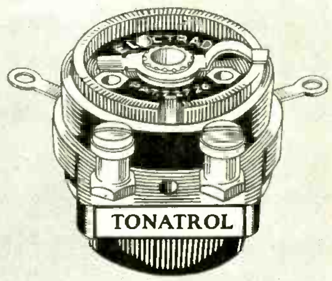

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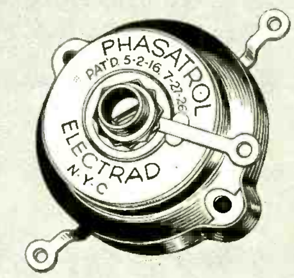

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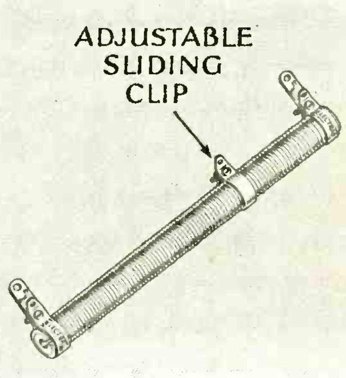

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RADIO

VOLUME XI | MAY, 1929 | No. 5

Radiotorial Comment

NOT content with exacting tribute from the broadcast stations which transmit copyrighted music, the American Society of Composers, Authors and Publishers now maintain that a license fee should be paid wherever broadcast copyrighted music is reproduced for profit. This means that a restaurant or hotel keeper who operates a radio set as a means for inducing patronage may be asked to pay for the privilege of entertaining his guests with the Society's music. The courts have not yet decided that this claim is valid. So far as we are aware no radio dealer has yet been asked for such a license fee, although his profits are usually dependent upon musical demonstrations.

* * *

PERSONALITIES are seldom discussed in these columns. But in view of the two-year campaign of newspaper vilification of Elmer T. Cunningham, the pioneer manufacturer of vacuum tubes, it is our duty as well as our pleasure to chronicle the fact that the million dollar suit against his business integrity has been decided in his favor. While his friends have always regarded the suit as a "hold-up," it now is a cause of satisfaction for them to know that his business record remains unsullied in the courts of law.

* * *

MANY warnings have been sounded with regard to saturation of the radio channels. The experience in trying to accommodate six or seven hundred broadcast stations in the ninety-six available channels between 550 and 1500 kilocycles has often been cited as indicative of future difficulties in the allocation of the short waves to various services. But all of these forebodings have ignored the fact that each channel can be used many times more effectively than it has been in the past.

The engineers have already devised ideal structures whereby all possible needs for broadcasting, point-to-point communication, and still pictures could be met by changing some of the present practices. These improvements are based merely upon today's limited knowledge of the conditions which govern radio transmission and reception and do not take future discoveries into account.

For instance they claim that a single chain broadcast, instead of requiring fifty or more channels for as many different stations, could be simultaneously transmitted by all the stations using a single channel. Exact adherence to such a single frequency could be maintained by means of a standard control frequency transmitted over the same wire as the program.

Practical tests in such synchronized broadcasting are being made by WCCO in Minnesota, and WPCH in New Jersey, which have been assigned to the same channel. Two other stations, WBZ and WBZA, are operating simultaneously on the same wavelength. With continued growth in chain broadcasting this scheme might be applied to many other small stations that are now limited to part-time operation. While satisfactory reception of such stations would be difficult in certain locations between them, the listeners would still have their choice of programs on other chains.

The Continental Broadcasting Company of New York has proposed a plan which dispenses with the necessity for wire connection and local synchronizing equipment. They propose the erection of two 50,000-watt short-wave stations at some central location. If one station should transmit on 7000 kilocycles and the other on 7900 kilocycles, both could be picked up at almost any station in the country and made to heterodyne on 900 kilocycles. This could be amplified and radiated for local reception in each locality, the local station acting merely as a relay.

These ideas are merely suggestive of the new problems that are engaging the attention of radio engineers. Other ideas with regard to the use of very narrow channels for code transmission with several messages transmitted simultaneously in each channel are also being studied.

* * *

WHO would erect a billboard in his back yard so that his family might have the pleasure of seeing a pretty picture of a girl smoking a cigarette or a bull standing behind a fence? Yet that is practically what the purchaser of a radio set is asked to do today. Is it any wonder that the people who have invested billions of dollars in radio receivers are critical of the kind of programs that are sent into their homes? The marvel is that more people have not thrown away their sets in disgust.

The blame rests squarely on the shoulders of the broadcasters who do not censor the length and character of the advertising which is interlarded in their programs. Formerly there was a great deal of justifiable talk about the debt that the radio manufacturers and dealers owed the broadcasters. Without broadcasting, no radios could be sold.

But now there should be just as much talk about the debt that the broadcasters owe the radio manufacturers and dealers. Without radios, no programs could be sold. This debt of gratitude becomes doubly great as more and more high-grade advertising of radio sets is conducted over the air.

These considerations seldom deter a broadcaster from accepting the advertising of any Tom, Dick or Harry who has something to sell. Broadcasters have frequently taken business which any reputable newspaper or magazine would refuse. And as a result, listeners are becoming so nauseated that many of them refuse to listen to stations which are persistent offenders in this respect.

It is to be hoped that the broadcasters and the offending advertisers will realize these truths before it is too late. Radio advertising, to be effective, should be palatable and non-obtrusive. Anybody will remember and commend a good program and those who made it possible, while they will condemn the attempts that are being made to ram long-winded talks into their ears. Radio is just as effective a builder of ill will as of good will. This is an evil which deserves the attention of the radio industry whose business is threatened if the evil is not stopped.

* * *

BROADCASTS of misleading, inaccurate, and even fraudulent advertising have frequently occurred from various stations throughout the country. Fake medical devices, deceptive real estate publicity, and advertising by financial houses whose officials were under indictment for past offenses are cases in point. While the station managers generally were uninformed as to the unsavory reputations of such advertisers until after the broadcasts were made, yet they cannot be absolved from their moral responsibility as agents in the misrepresentation of facts.

Consequently, in order to protect themselves and their listeners, as well as to forestall possible censorship by federal or state authorities, they are accepting the coöperation of the Better Business Bureaus in preventing further use of their facilities by unscrupulous advertisers. This has already been done in Chicago and St. Louis and will soon be done elsewhere.

Reputable advertising men recognize a grave danger of breakdown in public confidence in the truthfulness of all advertising because of the obvious untruthfulness of some advertising. This condition is not confined to radio advertising alone. For instance, what intelligent man believes the paid testimonials by well-publicized men and women, or why do the humorists point the finger of fun at the blindfold tests of indistinguishable differences in certain well-known products? Captain George Fried is better known to cigarette smokers than to radio men. But where radio advertising is at fault it now stands ready to correct the abuse.

The broadcasters, in adopting a code of ethics intended to prevent misrepresentation and deception, are also agreeing not to bring any other accepted form of advertising into disrepute, not to allow any "knocking" of competitors, and not to conceal the source or purpose of any commercial broadcast. But they have not yet taken the one final step in agreeing to accept financial responsibility for the losses suffered by listeners because of fraudulent broadcasts.

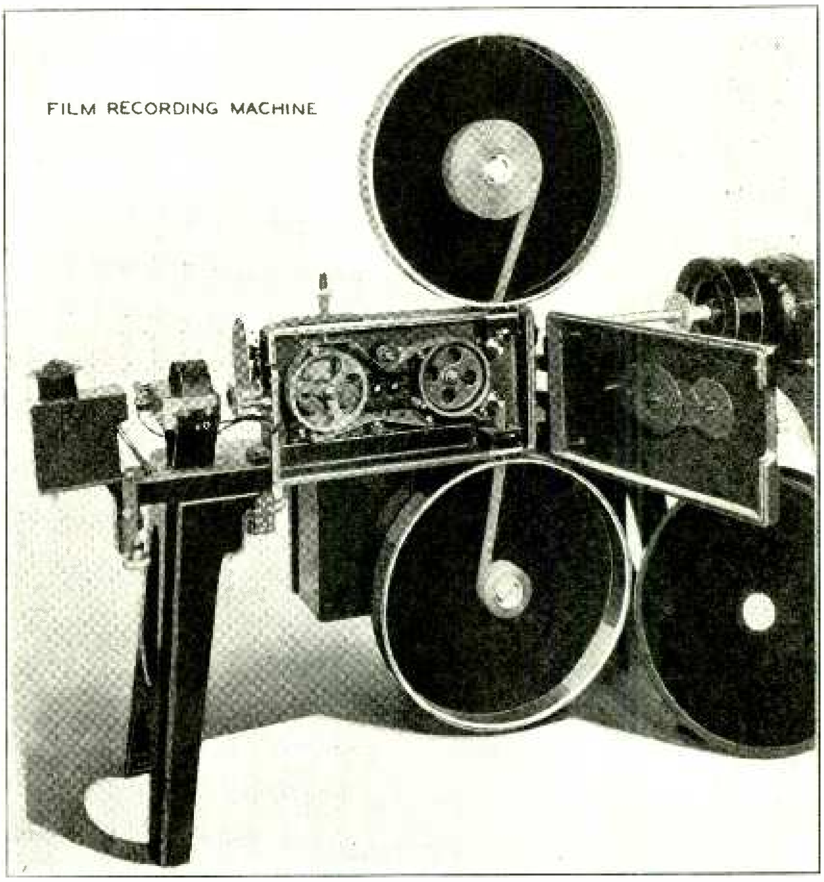
How the Movies Are Made to Talk

A Concise Description of the Movietone, Photophone and Vitaphone Methods of Recording and Reproducing

By ARTHUR HOBART

THE success of the talking moving picture is due primarily to the perfection of the electrical reproduction of sound which has been accomplished in the radio telephone transmitter and receiver. Without this recent perfection neither the desired volume and tone quality nor the delicacy of control necessary for the synchronization of sound and sight would have been possible. Knowledge of the methods employed give the radio experimenter new ideas for improving present radio-phonograph combinations and for anticipating the advent of sound-picture equipment in the home, whether using film directly or receiving it by radio.

In general, there are two practical methods of recording sound. One is by means of "wax" phonograph methods, as exemplified in the Vitaphone. The other is by film records, as used in the Movietone and Photophone, the former of which produces variations in sound from variations in light passing through a film of variable density, and the latter of which depends upon variations in the area of a uniformly dark film. The Vitaphone and Movietone methods were developed in the Bell laboratories and the Photophone by the Radio Corporation of America. All of them are being feverishly applied at Hollywood, having revolutionized the moving picture industry.



Bell Laboratory Film Recording Machine

Radio men are most interested in film recording and reproduction. For studio recording the Bell Laboratories employ the machine illustrated herewith. This is put in a room near the "set," to whose concealed microphone it is connected by wires. The recording machine is driven by a three-phase syncronous motor which is supplied with current from the same source as is the camera motor. These motors are electrically interlocked so that they are always driven at the same speed.

Close speed regulation is necessary, both in recording and reproducing, not only to keep the picture and sound machines in step, but also to prevent any change in the sound's pitch which may be caused by variation in speed. Failure in speed regulation for even a fraction of a second would cause music to sound like that from a phonograph which is running down.

The heart of the studio recording machine is the light valve. This device mechanically opens and closes in accordance with any variations in the electric current from the microphone and amplifier. It is interposed between the light and a photographic film, together with the lens system shown in Fig. 1, so that the undisturbed valve opening appears on the film as a line .001 in. wide and ⅛ in. long. The width of this line varies with the audio frequency current supplied to the valve, so that the film exposure is proportionately varied.

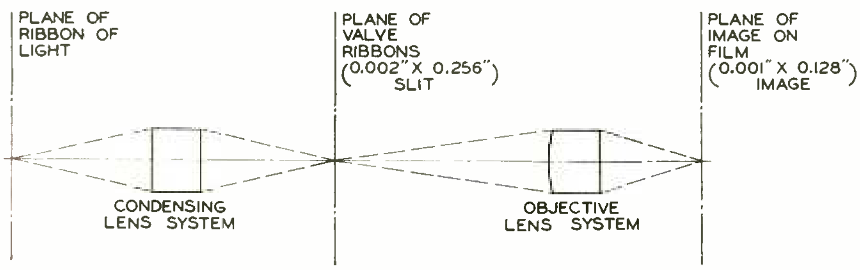
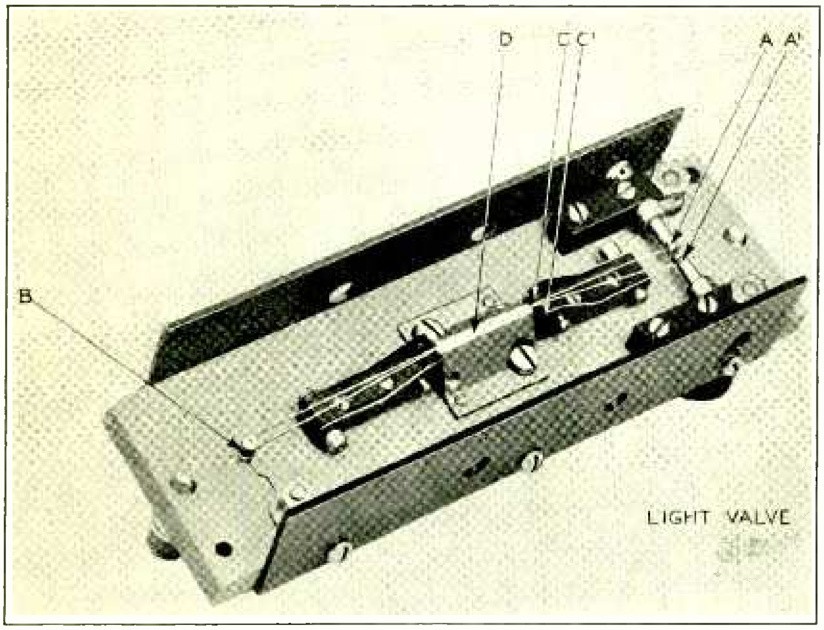


Fig. 1. Diagram of Optical System for Studio Recording

The light valve consists essentially of a loop of duralumin tape suspended in a narrow slit between the two poles of an electromagnet. When the amplifier output is superimposed upon the magnetizing current the loop opens and closes in accordance with the current alternations.

The accompanying picture shows the tape stretched from a pulley at *B* to two windlass supports *A* A^1. Insulated pincers at *C* C^1 confine the tape to a slit .002 in. wide as it passes between the poles of the electromagnet, whose armature is shown at *D*. The output terminals of the audio amplifier are connected to *A* and A^1, one being grounded.

Full modulation of the aperture is accomplished when one side of the impressed a. c. opens the valve to .004 in. and the other side closes it completely. The valve is tuned to 7000 cycles per second by adjusting the tension applied by the pulley *B*. About 10 milliwatts of a.c. power are required for full modulation at an audio frequency remote from resonance and about one-hundredth of this power at 7000 cycles.



Light Valve in Bell Laboratory Film Recorder

The recording machine is designed to draw the film from the upper feed magazine, past the valve slit, to the take-up magazine below. This is accomplished at a uniform speed of 90 ft. per minute by means of two sprocket wheels which engage the film perforations. Inside the left-hand sprocket is a photoelectric cell which is affected by the light passing through the film so that its amplified current variations may be heard from a loudspeaker used to monitor the record as it is actually being shot on the film.

The light source, shown at the left of the machine, is an 18-ampere projection lamp with ribbon filament. Great care is exercised in adjusting so that the loudest sounds give the maximum allowable exposure. The program is rehearsed until satisfactory arrangement of microphones and amplifier gain is effected, this being judged by the monitoring loudspeaker.

The talking newsreels and photoplays released by Fox are usually recorded by a different method than that employed in other studios using film recording, since the heart of the system is a flashing lamp called the Aeo Light. This light consists of a gas-filled bulb with a pair of electrodes placed at one end, and so spaced that when a direct current of about 200 volts is applied to the terminals, a bluish-white discharge passes continuously between the electrodes, and when focused on a moving film through a suitable lense system masked by a narrow slot, an image about one-thousandth of an inch is obtained. By impressing the output of the audio frequency amplifier on the terminals of this bulb, the light is made to glow brighter or dimmer, according to the voltage and polarity of the a.c. input, and hence exposes the film more or less in proportion to the above conditions. In all Fox newsreel cameras, this light is mounted on the camera, and exposes the sound track on the film at the same time that the picture is being taken. In the studios, the sound track is usually recorded on a separate piece of film, and the sound and picture are combined into a single print during the printing process, the picture being printed first, with the sound track masked out, and the sound track is printed last, with the exposed picture masked out so as not to fog it. The Aeo Light has the disadvantage of giving insufficient light to completely expose the film, and hence limits the amount of power which can be obtained in the reproducing system, without excessive surface noise, but has the advantage of being practically independent of frequency within the audio range.

The sound negatives made in the Bell Telephone Laboratories are on Eastman positive film. These are carefully developed and are then printed, marking the space needed for printing from the picture negative. The latter is then printed in combination with the sound record, which is similarly marked during the process. As the sound gate of the theater projector is located 14½ in. below the picture gate, in order that the sound record may be projected from a point which is in continuous motion

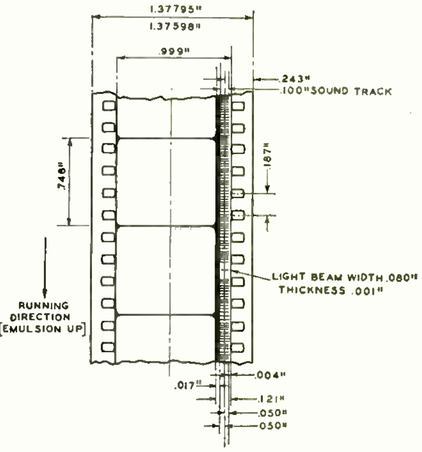


Fig. 2. Synchronized Sound Film

instead of moving in the discontinuous manner necessary for pictures, the sound is displaced 14½ in. ahead of the picture of the corresponding frame when printed. Fig. 2 shows the dimensions of the finished product.

In practice it is found that the final print does not reproduce the higher frequencies as well as the lower, since the illumination of the film is .001 in. wide instead of being infinitely narrow. Thus an illumination due to an 18,000-cycle note completely extinguishes the note. The frequency characteristics of a sound film are shown in Fig. 3, curve *A* showing the light modulation for constant sound pressure of various frequencies at the transmitter and curve *B* the overall characteristic of the reproduction.

The accompanying picture of a section of Movietone film shows the sound track at the left as a series of parallel black lines of different densities. To reproduce these lines as sound, the film is passed in front of a narrow slit through which shines a powerful light. The resulting variations in light intensity fall upon a photoelectric cell which converts them into variations in electric current. These are amplified in a five-stage audio amplifier whose output feeds the loudspeakers behind the screen.

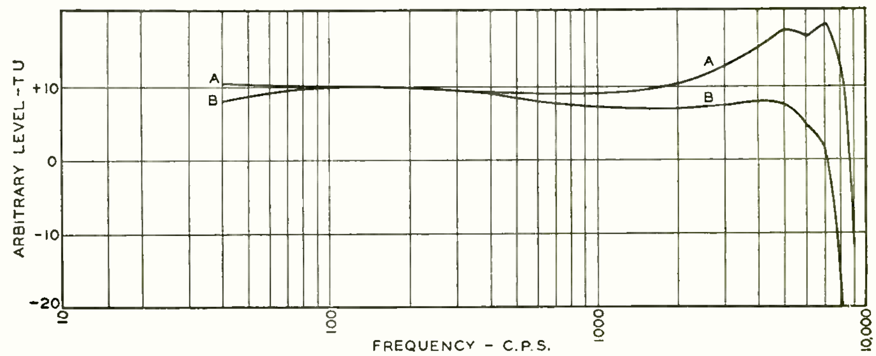


Fig. 3. Characteristic Curves of Sound Recording

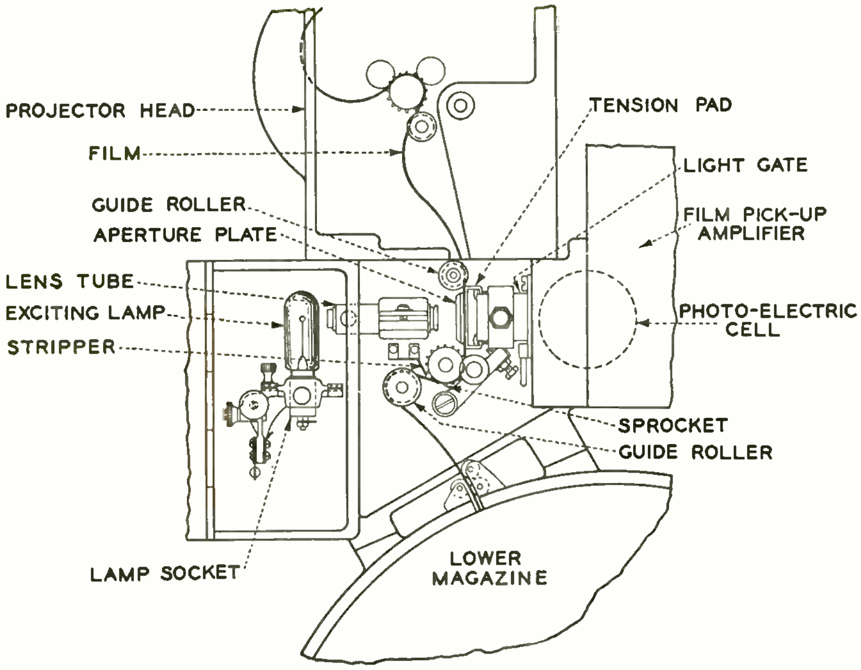


Fig. 4. Motion Picture Projector Equipped for Reproducing Sound From Film

Section of Movietone Film

Fig. 4 is a diagram of a motion picture projector equipped for reproducing sound from film. It is designed to throw a narrow beam of high intensity light onto the film. The film records any change in the intensity of the sound as a change in the density of the record. Any change in pitch is represented by the number of changes from dark to light and back again in a given length of the sound track.

This light falls upon a photoelectric cell such as shown in Fig. 5, and whose circuit diagram is shown in Fig. 6. The polarizing voltage is supplied to the cell

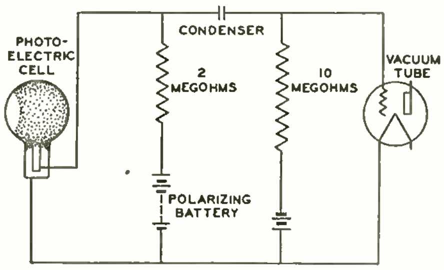


Fig. 6. Photoelectric Cell Circuit

through a very high resistance, across which is a voltage proportional to the light falling upon the cell.

The Photophone system of film recording utilizes an oscillograph whose mirror is actuated by variations in audio frequencies and intensities so as to throw a strong beam of light onto a moving film. These light variations, corresponding to sound variations, are recorded as a single jagged heavy line that looks like the distant skyline of a great city with its tall spires, high buildings, and narrow streets.

Fig. 7 shows the combined picture and sound projector. In this, as in the Movietone, the light beam passes through the film onto a photoelectric cell. In this cell the varying light gives rise to feeble electric currents which are greatly magnified so as to operate a battery of loudspeakers on the stage. The machine is provided with an attachment

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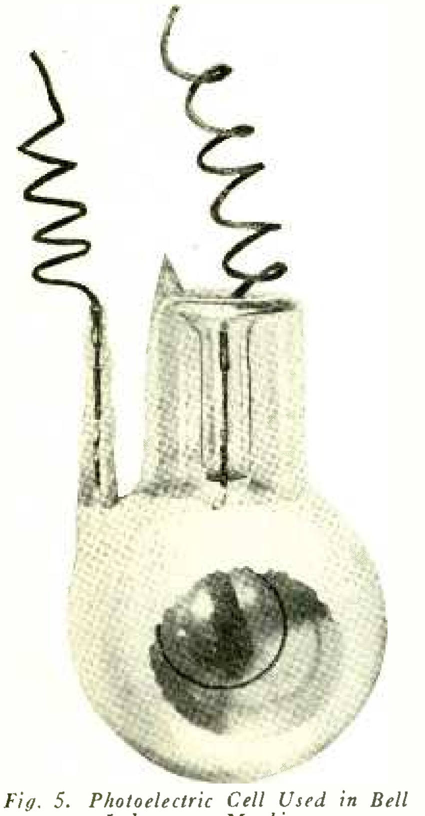

Fig. 5. Photoelectric Cell Used in Bell Laboratory Machine

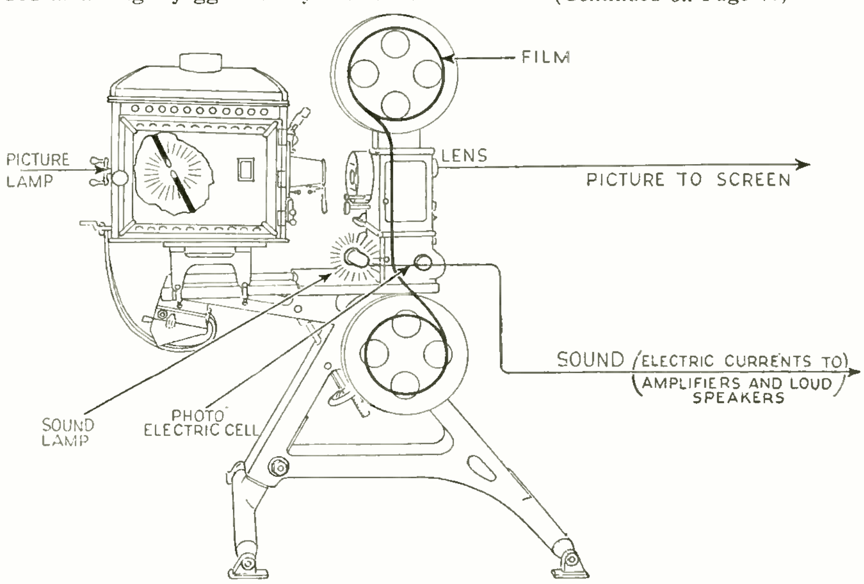

Fig. 7. Photophone Picture and Sound Reproducing Equipment

Experience With the Marshall Receiver

An Account of 13–7.5-Meter Reception and a Discussion of the Operating Principles of This Circuit

By THOS. A. MARSHALL

THE writer has had the pleasure of making certain observations within the band ranging from 13 to 7.5 meters, or more technically between 23,000 and 40,000 kilocycles. These observations were made over a period of nine months and at distances ranging from 2000 to 2500 miles.

During the first few days it was found that WIK could be heard with good signal strength on 27,800 k.c., NAA could be heard with fair signal strength on 32,120 k.c., WLL on 35,800 k.c. could be heard from 8:30 a. m. to 3 p. m. during certain days while at other times the signal was audible from 1 p. m. to 3 p. m. WDS could be heard at intervals during afternoons on 37,800 k.c. Observations were made on these stations since they operate continuously over daylight hours. A list of stations heard at intervals follows:

STATION	LOCATION	FREQUENCY
FY	Syria	26,440
LSD	Sweden	26,500
WGT	Porto Rico	27,560
HJO	Colombia	26,900
KWE	San Francisco	30,860
XDA	Mexico	37,800
KLL	San Francisco	27,440
KQJ	San Francisco	36,040

Frequencies given are the second harmonic values of the fundamental transmitting frequencies. The Naval Research Laboratory at Bellevue, D. C., could be heard during morning and afternoon tests on 27,740, 30,000, 32,300, 32,700, 36,000, 37,000, 38,500 and 40,000 k.c. The 38,500 k.c. was heard during afternoon tests while others were heard with exceptionally good signal strength on all tests. Failure in reception throughout the day of frequencies above 36,000 k.c. is due to the effect of the earth on the primary skip distance.

From observations made since last June, it appears that the band of frequencies ranging from 23,000 to 33,000 k.c. should be considered available for various governmental and commercial services for distances beyond 2000 miles. In this band there are 1000 channels, each 10 k.c. in width, available for immediate use.

Since the absorption of extremely short waves is negligible in the Kennelly-Heaviside layer, and the primary skip distance is long, these super frequencies should produce strong signals during daytime from 2000 to possibly 5000 miles. Since the use of higher frequencies is somewhat uncertain, due to geographical locations of receiving tests so far conducted, it appears that extreme distances with frequencies above 33,000 k.c. could be reached over the hemisphere which is in daylight.

The receiver used for these observations is illustrated diagrammatically in Fig. 1. (See circuit diagram on next page, for whose designation the author's text has been changed so as to correspond.—EDITOR.) By the arrangement of the circuit, the intra-electrode tube capacities are reduced by using a split condenser. The two tubes are so connected that each grid to filament capacity is across one of the series sections. Thus, the total effective tube capacity upon the tuned circuit is halved. The two-tube grid to filament circuits are across each half of the tuned circuit input voltage, which decreases the grid to filament conductance. Since the two reactances are in series, the total conductance across the tuned circuit is one quarter value of that in conventional circuits. Due to reduced intra-electrode capacity, a relatively large L/C ratio is made possible. The circuit, therefore, has an increased input impedance which produces a higher signal voltage potential across the tuning circuit.

In the conventional type of radio receiving circuit used for short-wave reception the input impedance of the tube is low due to the relatively high grid to filament capacity. The L/C ratio is also low, making it incapable of giving amplification in the upper frequency bands.

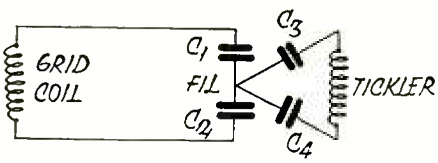

Fig. 2. The Equivalent of Internal Tube Capacities

In Fig. 2, C_1 and C_2 represent the grid to filament capacities of the vacuum tubes. These capacities are in series, thus providing a high L/C ratio which is so desirable at short-wave lengths. C_3 and C_4 represent plate to filament capacities. Since these capacities are in series, a greater tickler inductance is made possible for regeneration. For a given frequency a higher value of L may be used. In conventional circuits it is difficult to adjust the regeneration circuit so that it is not near resonance. Under this condition, the circuit is about the same as a tuned-plate and tuned-grid combination. The wave change in controlling regeneration will be as much as that caused by the tuning condenser. A change in the regeneration control of the push-pull receiver shown in Fig. 1 does not change the wavelength even when covering the entire 5-meter band. Another advantage of this circuit is that constant frequency calibration is maintained regardless of variations in filament and plate voltages. When a station is once logged, the experimenter will find the dial settings of future use.

The complete unit employs six tubes. The r.f. stage requires two four-element shielded grid tubes which are connected for push-pull operation. The push-pull detector and audio stages employ type '01-A tubes. The shielded grid tubes operate on 3.3 volts with a plate voltage of 125 to 135 volts, and a plate screen maintained at 66 volts with respect to the filament. (This differs from the 45 volts shown in the diagram.—EDITOR.) The detector tubes operate from a plate voltage of 45 volts which is made continuously variable by means of a universal range clarostat R_7. The audio tubes use 65 volts on their plates. C_{13} is a 2 mfd. by-pass condenser which eliminates noise in operating the resistor R_7.

The r.f. amplifier stage is coupled to the detector circuit through two small variable condensers C_8 and C_9. These condensers are 50 mmfd. each. The value of capacity for each unit should be kept relatively small in order to prevent reaction of the r.f. amplifier on the detector stage. The value selected must be determined by trial which may be done by comparison for balancing effect on C_6 and C_7 as well as the reaction on the detector stage.

To adjust the balancing condensers the antenna should be connected and the set made ready for operation. Set C_8 and C_9 about 35 mmfd. and tune the r.f. stage to resonance with the detector stage which has been set near the regeneration point. An unbalanced condition is evidenced if the detector stops oscillating. The r.f. stage should be detuned and the detector circuit set so that it is barely oscillating. Tuning of the r.f. stage near the point of resonance should be tried while C_6 and C_7 are varied until it is possible to obtain an adjustment where the reaction between the r.f. stage and detector stage is negligible. The balancing process should

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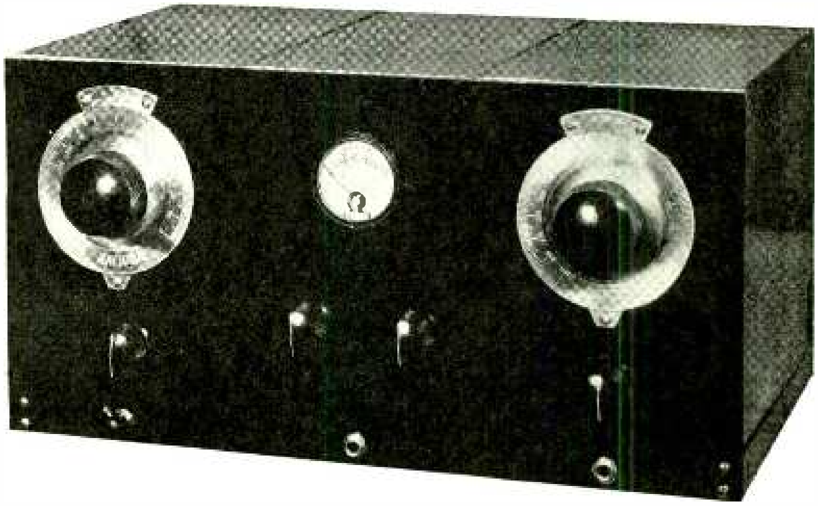
The Marshall Short-Wave Receiver

Constructional Details and Operating Suggestions for an Experimental Model

By P. S. LUCAS



Front View of Marshall Receiver

SINCE the announcement of the Marshall receiver in November, 1928, RADIO there have been many requests for information regarding the construction and operation of this set, so one was constructed from available parts. Although the results are not revolutionary they have been more than satisfactory, especially for the broadcast listener who can spend a few moments in tuning in a station, or the amateur or commercial operator who handles a lot of traffic with a comparatively few stations. But the amateur who desires speedy selection of many stations spread out over a certain band will probably not find the Marshall exactly suited to his needs.

The major circuits are dependent upon each other, and when the r.f. stage is a few degrees off resonance with the detector the latter refuses to oscillate; therefore both major controls must be tuned almost synchronously.

The two screen-grid tubes in the r.f. stage are in push pull, the rotor of the double stator condenser forming the center division. The grids are returned to filament via a pair of 1 megohm grid closure resistances and a 6-ohm resistor which supplies necessary bias. A criss-cross balancing scheme, in which two very small semi-variable condensers take part, equalizes in effect the internal capacities of the screen-grid tubes, the plates of which are fed through the choke system as shown.

The plates of the r.f. tubes are coupled to the grids of the detector tubes, which are also in push-pull, through another pair of semi-variable condensers. The detector plug-in inductance is tuned by a split

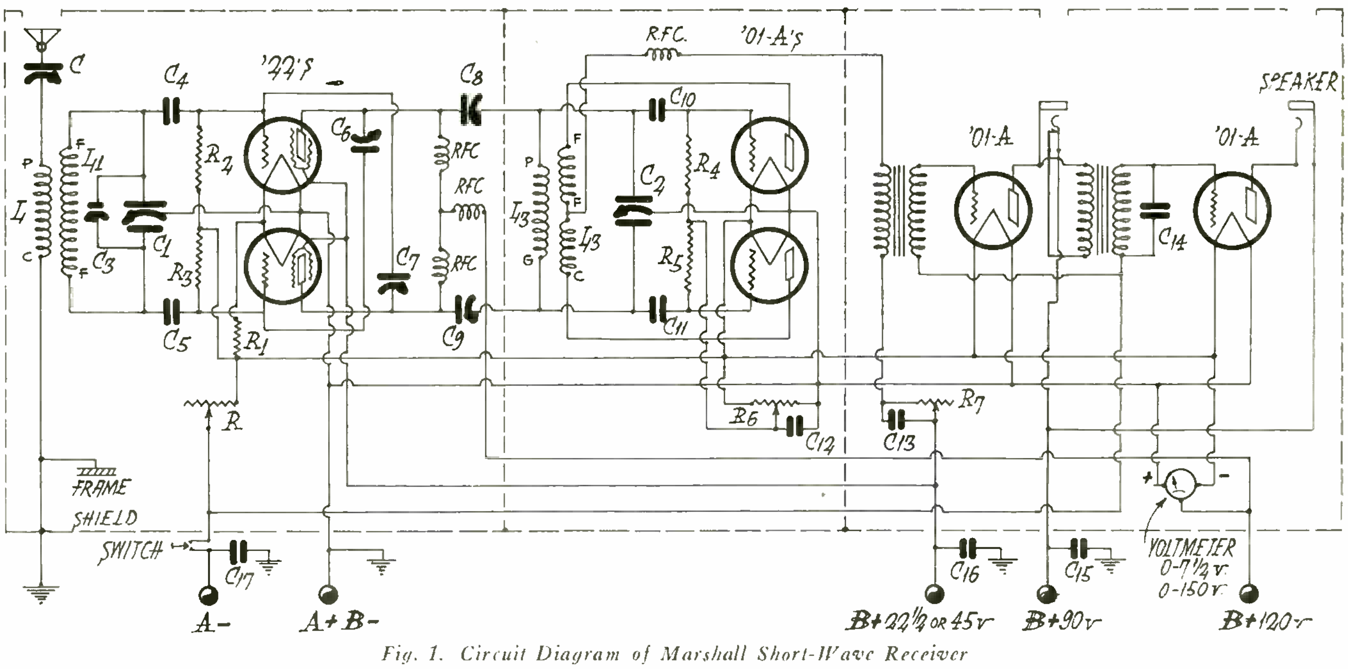


Fig. 1. Circuit Diagram of Marshall Short-Wave Receiver

C—Variodenser Type "N"
C_1, C_2—.00035 or .0005 variable condensers with stators divided.
C_3—Variodenser Type "N".
C_4, C_5, C_{10}, C_{11}—.0001 fixed condensers.
C_6, C_7—Air dielectric condensers.
C_8, C_9—Variodensers Type G-1.
C_{12}—1 mfd. by-pass condenser.
C_{13}—2 mfd. by-pass condenser.
C_{14}—.00025 fixed condenser.
C_{15}, C_{16}, C_{17}—.01 by-pass condensers.
L—Antenna inductance.

L_1—R. F. grid inductance.
L_2—Detector inductance.
L_3—Center-tapped tickler.
R—10-ohm rheostat.
R_1—6-ohm fixed resistor.
R_2, R_3, R_4, R_5—1 to 5 megohms.
R_6—200-ohm potentiometer.
R_7—100,000-ohm variable resistor.
RFC—250 mh. radio frequency chokes (4).
Voltmeter—0-7½, 0-150.
2 Jacks.
2 A. F. transformers.

2 Vernier dials.
1 Filament switch.
6 UX tube sockets.
2 A. C. tube sockets.
Cable cord.
4 Phone tip jacks.
2 '22 tubes.
4 '01-A tubes.
9 x 18 in. bakelite panel.
11 x 18 bakelite or wood sub-panel.
Pair of sub-panel brackets.
3 Shield cans.

stator condenser exactly like the one in the r.f. stage, and the tickler is the only coil that must be center-tapped. A 200-ohm potentiometer is shunted across the filament, with its slider arm connected to the grids through the leaks, in order to eliminate the hangover effect caused by working the detector near the point of regeneration. The audio frequency system is conventional.

In constructing the set, the first problem is the selection of two variable .00035 or .0005 mfd. condensers that will prove adaptable to the necessary operation of splitting their stators. The one requirement is, of course, that the stator plates be mounted in an insulating material rather than in a conductor, so that when the middle plates are clipped out there will be no electrical connection between the remaining two sets of stator plates.

In some condensers it will be possible to saw out a section of the side brackets without impairing the rigidity of the plates. This is a job that requires a little time, a hacksaw and a pair of tinsnips, but is not complicated enough to scare anyone having access to these three necessities. The rotor, of course, is grounded and as it is turned, tunes both halves of the circuit simultaneously. It is

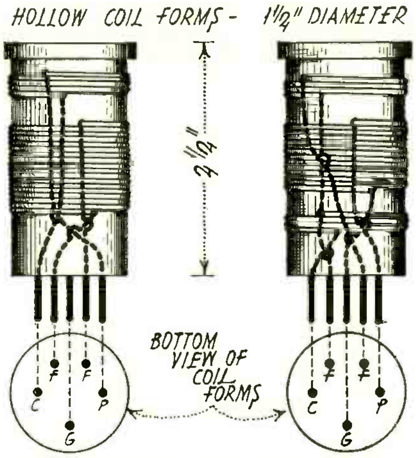


Fig. 4. Coil Winding and Connections

therefore important that the maximum and minimum capacities of both halves of the condenser be as nearly equal as possible, although a few micro-microfarads either way has not seemed to affect the efficiency greatly. A Variodenser was put in series with the antenna coil, although a .0001 or .00025 mfd. fixed condenser would do just as well. All shield cans were grounded.

The coils were wound on standard 5-prong plug-in forms 1½ in. in diameter, and according to the following data:

BAND	ANT.	GRID R.F.	GRID DET.	TCKLR.
10	3	4	3	4
20	3	8	6	6
30	4	15	12	6
40	4	17	14	6

No. 16 enameled wire was used for all grid coils and No. 22 enameled for the tickler coils. In the r.f. coil the primary and secondary were coupled at ¼ in. The tickler of the detector coil was wound half at either end of the secondary as shown in the drawing, and the center tap soldered to the cross-over inside the coil form and then to the filament prong between the other filament and cathode prongs.

It would not be difficult to estimate the approximate number of turns necessary for reception up to 150 meters, although it would be found that the tuning condensers would be rather small for those wavelengths and would not cover much territory. A type "N" Variodenser was shunted across the r.f. tuning condenser so that the latter could be tuned to the same point on the dial as the detector. If the coils are properly matched this will be unnecessary and another possible loss may be done away with.

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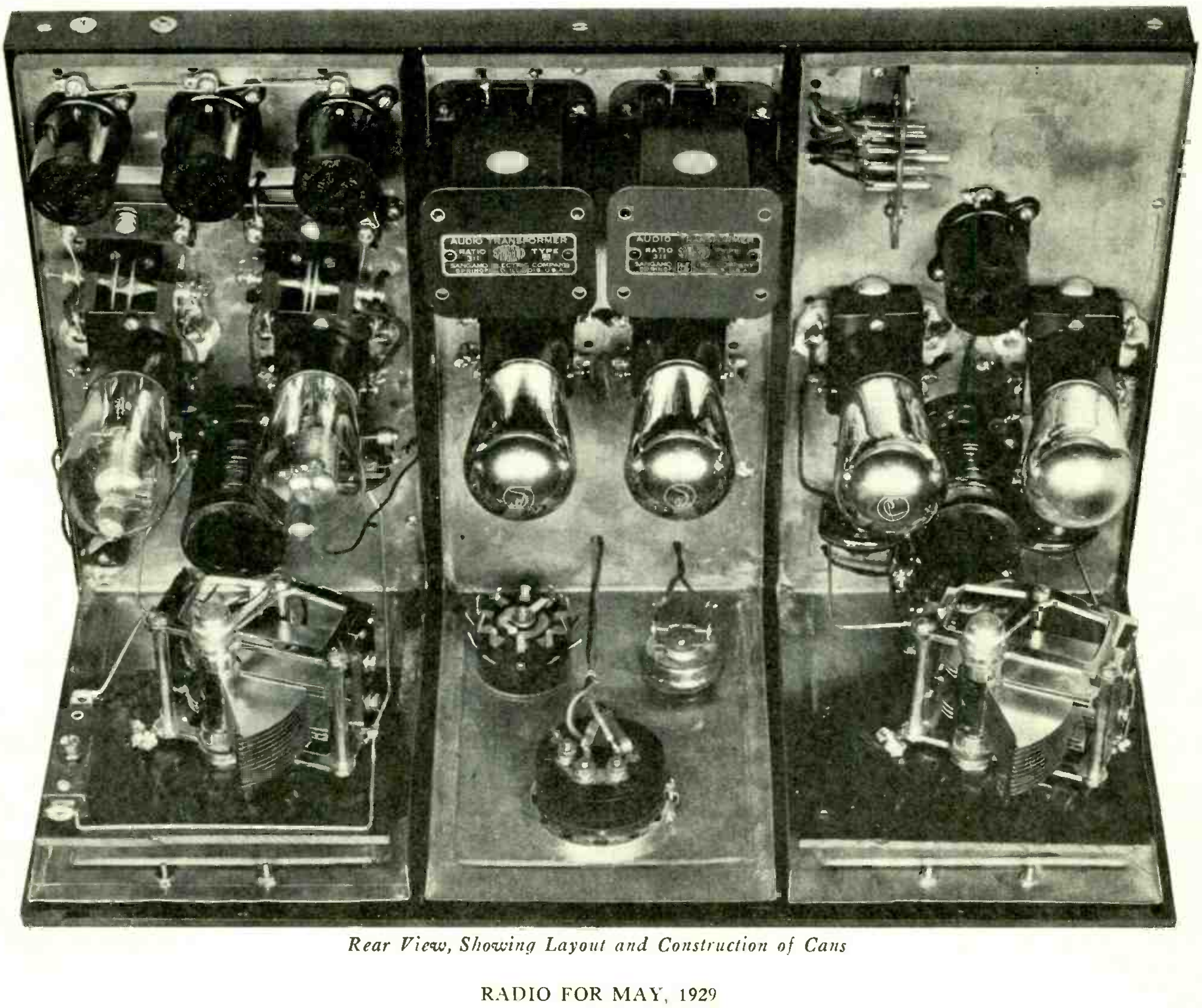

Rear View, Showing Layout and Construction of Cans

Practical Design of A. F. Filters

By E. A. TUBBS

THE practical design of filters for smoothing the pulsating output of a rectifier so that it is suitable for use as the *B* supply for the tubes in a radio receiver is based upon the use of two sections of either the T or the π type. A single section of the T type employs two inductance coils in series and one condenser in parallel. The π type employs one coil and two condensers. Fig. 1 shows various arrangements of both types, together with their attenuation characteristics and design formulas.

In the attenuation characteristic the point f_c marks the cut-off frequency at which the filter begins to attenuate or reduce the amount of current passed by the filter. The filter offers more and more attenuation as the frequency increases above f_c. This cut-off frequency may be figured from the formula $f_c = 1 \div 3.1416\sqrt{L\ C}$, where L is the inductance of the coil in henrys and C is the capacity of the condenser in farads, these values being those of a single section. Adding more similar sections gives greater attenuation without changing the cut-off frequency.

This formula shows that the frequency at which cut-off occurs may be lowered by increasing either the inductance or the capacity or both. Obviously, the lower the cut-off, the more the attenuation that is offered to some given frequency. Consequently the designer usually obtains attenuation of unwanted frequencies by using the largest available coils and condensers.

It will be noted in the various design formulas that the resistance *R* of the load which is connected to the filter is an important factor in determining the size of the condensers and coils. In the type A filters of Fig. 1, if *R* is doubled it cuts *C* in half and doubles *L*. Any decrease in the current or increase in the voltage supplied by a filter is equivalent to an increase in *R*.

Another factor to be considered in the design of a filter is the type of rectifier with which it is associated. This has considerable influence upon the amplitude of the various frequencies which make up the pulsations in the rectified current. Thus Fig. 2 shows the relative peak amplitudes of the various components in the output of a theoretically perfect full-wave and half-wave rectifier. It will be noted that whereas the 60 cycle fundamental component constitutes 50 per cent of the output of the half-wave rectifier it is entirely absent in the full-wave rectifier. Yet the full-wave has twice as much 120 cycle component (second harmonic) as the half-wave. These ideal figures do not always hold in the case of rectifiers on the market. For instance, some of the gaseous rectifiers which do not pass current until a critical voltage is reached have more of the second harmonic present than of the desired direct current. But, in general, a higher cut-off frequency can be used with the full-wave than with the half-wave type and 120 cycles is the most troublesome component in the full-wave output.

The attenuation curves of Fig. 1 show that the three-element filters, types B

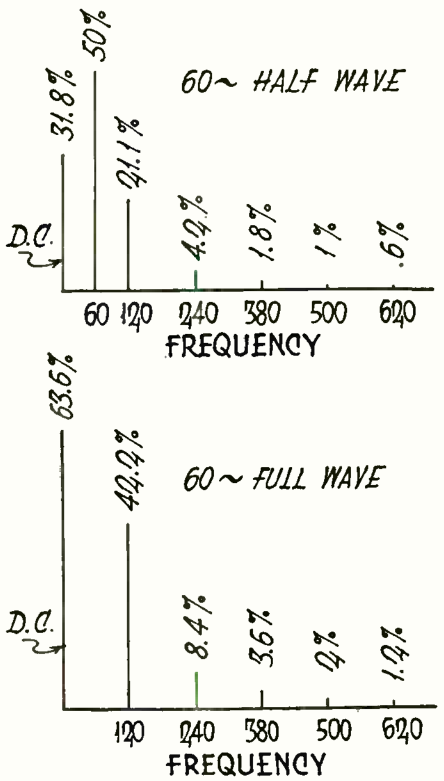

Fig. 2. Peak Amplitudes of Frequencies in Output of Perfect Rectifiers

and C, offer a very high attenuation to some given frequency f_r termed the resonant frequency. This resonant frequency or frequency of maximum attenuation, is given by the formula: $f_r = 1 \div 6.2832\sqrt{L\ C_1}$ for the type B filter and by $f_r = 1 \div 6.2832\sqrt{L_1\ C}$ for

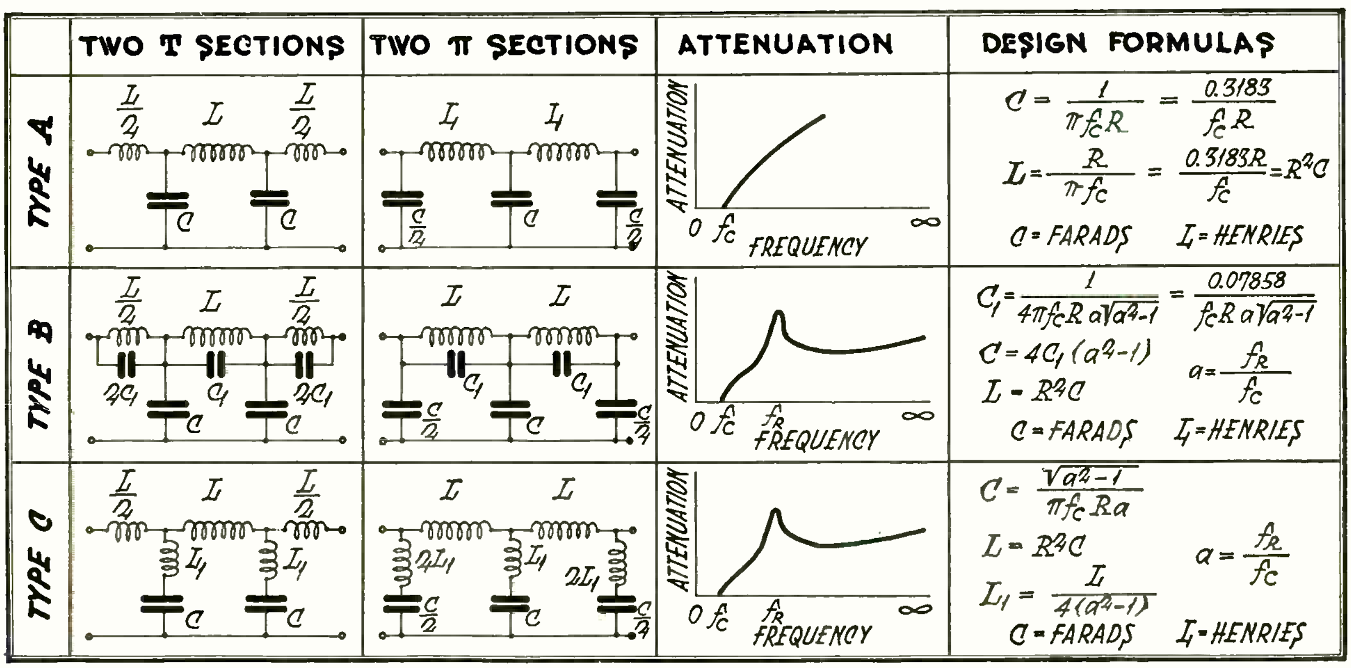

Fig. 1. Various Arrangements of Two Section T and π Filters, Together With Attenuation Characteristics and Design Formulas

the type C filter. Thus it is evident that type B or C filters are advantageous in suppressing 120 cycles. The cut-off frequency of the type B is given by $f_c=1\div3.1416\sqrt{L(C+4C_1)}$ and for the type C by $f_c=1\div3.1416\sqrt{C\ (L+4L_1)}$.

The practical use of these formulas may be illustrated in the design of a full-wave rectifier, working with 50-cycle current and supplying a receiver whose resistance is 2000 ohms, such as might be used in a series filament connection requiring 100 m.a. at 200 volts. Fig. 2 shows that the lowest frequency in the output of the rectifier will be the second harmonic (100 cycles in this case) and that this 100-cycle component is much stronger than the other a.c. components. It is easily seen that this is the component that will give the most trouble, so it would be advisable to use a section of the type B filter to eliminate it.

Twenty-five cycles is far enough removed from the 100-cycle component so that it may be chosen as the cut-off frequency f_c. From the formula for the type B filter in Fig. 1 we have:

$$a=\frac{f_r}{f_c}=\frac{100}{25}=4$$

$$C_1=\frac{1}{4\pi f_c R a\sqrt{a^2-1}}$$

$$=\frac{1}{314.159\times2000\times4\times3.873}$$

$$=0.00000010275\text{F}=0.10275 \text{ mfd.}$$

$$C=4C_1(a^2-1)$$

$$=4\times0.00000010275\times15$$

$$=0.000006165\text{F}=6.165 \text{ mfd.}$$

$$L=R^2C=4{,}000{,}000\times0.000006165$$

$$=24.66 \text{ henrys}$$

This may be conveniently checked from the fact that C_1 and L form a trap circuit tuned to 100 cycles. And inasmuch as the product of C in microfarads and H in henrys for resonance at 100 cycles is 2.533 (this figure is 1.759 for 120 cycles) we should obtain either L or C by dividing 2.533 by the other, $L=24.65$ henrys.

In a π filter section the terminating impedances always have twice the value of impedance which is figured from the formulas and the terminating impedances of a T filter section always have one-half the value given by the formulas. Consequently the resulting π and T sections of our type B filter are as shown in Fig. 3.

Now that we have the 100-cycle component *hors de combat* we may choose a section of the A type filter to suppress the other frequencies. Twenty-five cycles will again be chosen as the cut-off frequency in order that this section will

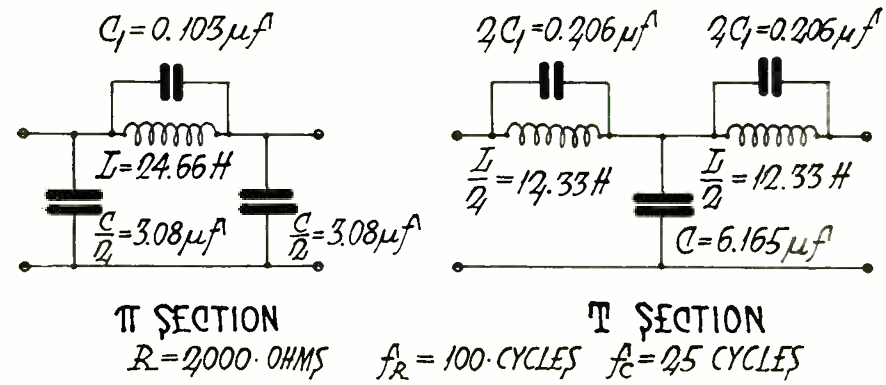

Fig. 3. Design Constants for Type B Filter

offer a high impedance to the undesired frequencies and because this value of f_c will be found to give us convenient values of L and C.

From Fig. 1, for the type A filter, we have:

$$C=\frac{1}{\pi\ f_c\ R}=\frac{1}{78.539\times2000}$$

$$=0.000006365\text{F}=6.36 \text{ mfd.}$$

$$L=R^2C$$

$$=4{,}000{,}000\times0.000006365$$

$$=25.46 \text{ henrys}$$

Fig. 4 shows the resultant π and T sections of this type A filter.

The theory of filters demands that the impedance connected to each end of the filter should be equal to R in the formulas. This means that the rectifier, which is connected to the input of the filter, should have the same impedance as the receiver which is connected to the filter's output; but in the design of rectifier filter systems for supplying radio receivers this fact is, as a rule, not taken into consideration.

It will be seen from the formulas that in order to cut the load resistance of the type B filter in half it would be neces-

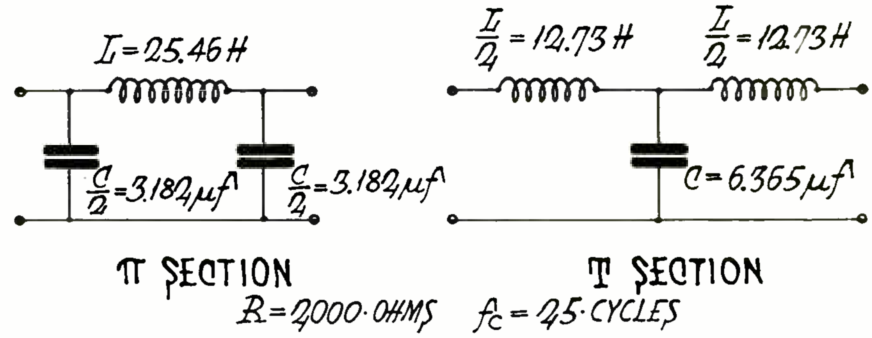

Fig. 4. Design Constants for Type A Filter

For the complete filter the π section of both types will be chosen. A T section next to the rectifier would place less of a load on the rectifier, but this would make the filter more complicated. The complete filter is shown in Fig. 5. Change of the calculated values to values more easily obtainable would make no practical difference because the changes are within the limits of ordinary manufacture. In fact much larger changes than this can be made without harm so long as the product of the capacity, in microfarads, and the inductance, in henrys, of the trap circuit, is kept in the neighborhood of 2.5.

sary to double the capacities C_1 and C. This would give us: $C_1=.2055$ mfd: $C=12.33$ mfd. and $L=12.33$ henrys. Similarly for the type A filter the capacity must be doubled for a load of 1000 ohms, thus giving: $C=13.73$ mfd. and $L=13.73$ henrys.

The difficulty in building such filters lies in obtaining satisfactory chokes on the market. For the various filters that I have constructed it has been necessary to design the chokes and have them specially made. It must be borne in mind that such chokes change their inductance when the amount of d.c. flowing

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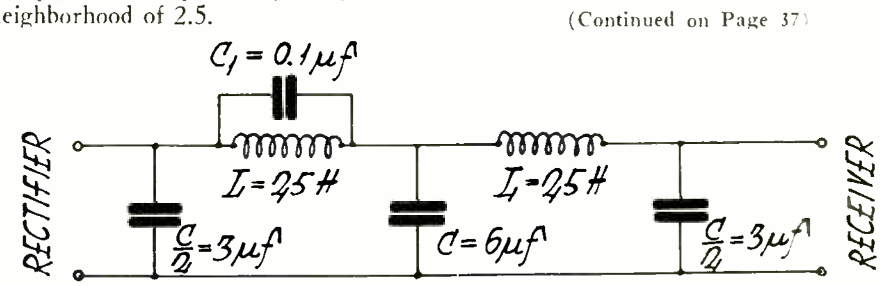

Fig. 5. Complete Filter for 50-Cycle Current

Radio Picture Transmission and Reception

Photoelectric Equipment and Methods for Visual Communication

By JOHN P. ARNOLD, *Department Editor*

SCANNING METHODS

Direct Scanning Systems

IN THE optical systems used for television there are two practical methods of scanning—the *beam* and the *direct* methods. The former, which is an important feature of the Bell system, makes use of an intense beam of light projected through the apertures of a scanning disc on the subject to be transmitted and the reflected light from the subject is collected by large area photoelectric cells. The effective illumination obtained by this means may be thousands of times greater than that available with the direct method, resulting in the production of larger electrical currents for transmission purposes.

The direct scanning method, however, can be used successfully with advantage in dealing with certain kinds of subjects. This has been clearly demonstrated in the recent "daylight television" experiments at the Bell Telephone Laboratories which were described in the October issue of this department. In the direct method, an image of the subject to be transmitted is projected by a lens on the scanning device itself, as shown in

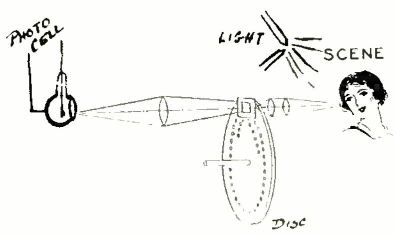

Fig. 1. Direct Scanning Method

Fig. 1. With the usual form of apparatus this method allows only a small amount of light to operate the light-sensitive cell, and for this reason heretofore it has seemed to be impractical on account of its inefficiency. Gray states (Jour. Opt. Soc. Am., vol. 16, p. 180; Mar., 1928) that "the question of efficiency in this case comes back to the familiar limit of the ratio of aperture to focal length in practical lens construction. Experiments show that, with the best F/1.9 lens available to form an image that is to be scanned in 50 lines, it would be necessary to illuminate the subject with a 16,000-candlepower arc at a distance of four feet in order to secure enough current output from a photoelectric cell for successful amplification. Television under such conditions would be extremely inconvenient to a subject."

But by increasing the physical dimensions of the whole scanning system, the Bell engineers have discovered that this method is the most practical for transmitting outdoor subjects illuminated by natural daylight. This increase in size of the apparatus means a larger scanning disc and larger lenses, which, in the case of the former, might be 10 ft. in diameter, although 3 ft. was sufficient for the purpose. It should be noted that this increase in size is only necessary at the sending station, and the receiving apparatus can still be so small that it will not take up any more space than a console model radio set.

As an example of how this method works out, consider an image formed on an ordinary disc. This image may be 1 in. square and is broken up by the scanning disc into 2500 picture elements, which would each have an area of 1/2500 sq. in. If an image 10 in. square is formed on the disc, but divided into the same number of picture elements, there will be no more loss of detail than if it were only 1 in. square, but each element at the scanning end can now receive ten times as much light.

"For," report Gray and Ives, "in forming the larger similar image, we either decrease the distance between lens and object, so that the lens collects substantially ten times the light it did before, or we use a longer focus lens, which, if of the same ratio of area to focal length as the original lens, likewise collects and delivers to the image ten times the light. In each case the *illumination* of the image is the same as with the original smaller image. Each hole in the disc now receives the same light per unit area as originally, but being ten times larger in area actually gets ten times as much light; that is, we have outstanding a gain exactly in proportion to the increased area of the holes."

Among the limitations to increasing the physical dimensions of the apparatus is that the apertures of the disc must not be so large that adequate definition is lost. As has been mentioned, a disc 10 ft. in diameter can be rotated at the necessary speed of 15 to 20 times per second, but the experiments showed that it is not necessary to go to such extremes to secure the proper efficiency. This was particularly true in the Bell Laboratories, where they had at their command photoelectric cells of greatly increased sensitivity.

For daylight work, a proper choice of lenses must be made to scan various subjects at various distances from the lens. In the demonstration mentioned a human figure was scanned when about 30 ft. distant from a lens of F/2.5 aperture, but this lens system had to be changed when close-ups of the subjects were desired. This direct system is discussed by Gray and Ives in a recent paper, "Optical Conditions for Direct Scanning in Television," Jour. Opt. Soc. Am., vol. 16, pp. 428-434; 1928.

A "Preferred" Scanning System

A UNIQUE scanning system for television has been described by Otto B. Blackwell and Joseph Herman (U. S. Pat. 1,624,918; Apr. 19, 1927) by means of which certain "preferred" portions of the received images are reproduced with great detail, while other portions—those of lesser importance, such as a background before which a person stands—appear in somewhat coarser detail. The object of this system is to make the best use of restricted transmission channels, such as the narrow band of frequencies allowable in radio broadcasting, as well as the somewhat larger band which can be transmitted over telephone lines.

The practicability of the system may be understood from the following quotation from the patent: "When a person views an object or objects having motion he ordinarily fixes his attention and directs his gaze on a small central region of his entire field of view and sees this narrow region very distinctly, and all the outlying portion of his field of view is comprehended less distinctly. Moreover, when there is motion within the field of view the observer will be likely to shift the narrow region of closest attention according as the motions cause his interest or concern to change from one place to another. If an observer is looking through a telescope or field glasses at a moving object or objects he turns the direction of his instrument from time to time to correspond to the change in location of the regions on which he desires to fix his attention. We have provided that the observer looking at the (receiving) screen can shift his attention from part to part of the image of the (original) object in a manner somewhat analogous to that just described for a person who views an object directly through a telescope."

The original patent paper must be consulted for a complete description of the mechanical and electrical details, as we are here concerned with only the analyzer or scanning mechanism itself. These are placed in the optical systems of both stations just as the conventional Nipkow disc would be used; that is, one of these analyzers is interposed between the photoelectric cell and the object to be scanned in the sending studio and between a light source and the viewing screen at the receiving station. Their function, then, is merely to break up and to reconstruct the images in the usual manner.

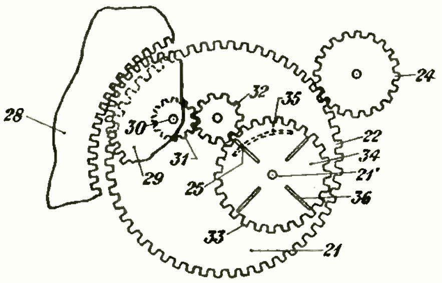

Fig. 2. "Preferred" Scanning Mechanism

Fig. 2 shows one of these instruments. They are identical for both the sending and receiving. The analyzer comprises a disc *21*, having a slot *35*, and the adjacent smaller disc *34*, having the slots *36*, so that the intersection of these slots makes the small opening *25*. The gear system is arranged so that when the mechanism is driven by a synchronous a. c. motor through the engagement of the gear *24*, the disc *34* turns comparatively slowly on its shaft, compared with the rotation of the disc *21*, about its axis. Accordingly the opening *25* describes such a spiral as is shown in Fig. 3.

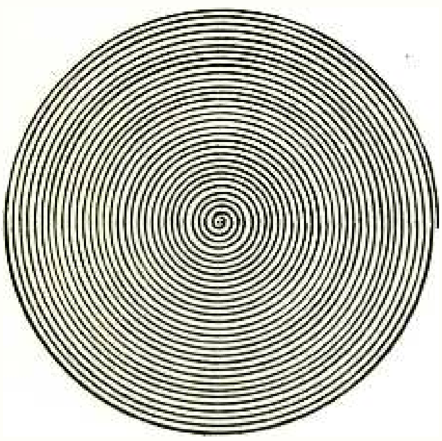

Fig. 3. "Unpreferred" Spiral

Now by making both of the slots *35* and *36* approximately wedge-shaped, so that their intersection close to the center of the disc *21* is a small compact area, and so that this area increases in both dimensions as the intersection recedes from the center of the disc, the result is secured that the elemental areas of the object which is scanned vary as the square of distance from the center. This effect is shown in Fig. 4.

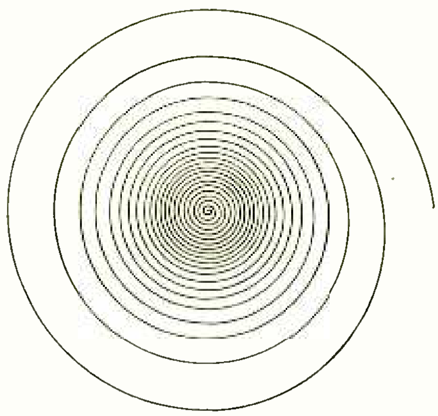

Fig. 4. "Preferred" Spiral

It can now be seen that such a method of scanning will bring out finer detail of objects which appear directly in the center of the entire area which is scanned in the sending studio and which consequently appear in the center of the viewing screen.

A further refinement of the system is a means of shifting this "preferred space" from the center of the screen to any portion of the image which the receiving operator wishes to observe more closely. This is effected by a reverse current sent back to the transmitting station. How this is done is not shown here. It is sufficient to say that it is effected by the synchronous control of lenses at the option of the receiving operator.

This patent has been assigned to the American Telephone and Telegraph Company and the system in its entirety is more suitable for wire transmissions than for radio broadcasting. The analyzer itself might, of course, be used in radio television broadcasting since it would reproduce more satisfactory images without using an extremely wide frequency band which is one of the difficult problems that must be solved before we can have satisfactory "radio pictures."

Multiple Scanning System

In television systems relying upon the persistence of visual impression, it is necessary that the subject of the transmission be scanned with sufficient rapidity to present an apparent continuous visual sensation to the eye of an observer at the receiving station. Numerous methods have been devised to accomplish this, such as rotating discs, oscillating mirrors, etc., but with such devices, especially where a single beam of light is used, an appreciable time is required which in certain cases may seriously interfere with the quality of the received images.

Among the methods proposed to overcome this disadvantage, John M. Fell (U. S. Pat. 1,649,819; Nov. 22, 1927) has suggested the use of a plurality of separate light beams for simultaneously scanning separate definite areas of the subject.

The system is shown in Fig. 5. The subject, *80*, which may be a scene in the studio of the transmitting station, is intensely illuminated by the source of light, *87*. The reflected light falls upon a rotating drum-mirror, the number of facets of which is entirely arbitrary and is determined by the speed at which the drum is rotated. The light is then collected by the lenses, *83* and *84*, and after passing through an apertured screen, falls on the cathodes of the photoelectric cells, *85* and *86*. It will be readily seen that any convenient number of lenses, apertures and cells may be employed in this optical system although only two of each are shown.

Consequently, for every revolution of the mirror frame, each of the lenses

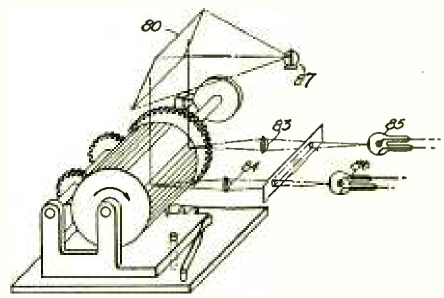

Fig. 5. Multiple Scanning System

focuses upon the corresponding photoelectric cell the light rays corresponding to a definite area of the subject as reflected in the mirror facets, each facet presenting a succession of elementary lines of the picture to the several lenses. The electrical signals generated in the output of the photoelectric cells are amplified and transmitted to the receiving station by wire or radio, where they are reconstructed by an identical mirror drum. Synchronism is maintained between the drums by employing phonic wheels controlled by electrically driven tuning forks as recently described in this department.

The optical system at the receiving station is slightly different from that of the transmitter. The picture signals generated in each of the photoelectric cells at the sending station are separated by electric filters and control the moving elements of several light valves ("RADIO," p. 25; Nov., 1928), or string galvanometers, which are interposed between fixed sources of light and the mirror drum. By means of the latter, these light beams, which vary in intensity with the reflected light from the various elemental areas of the subject, are thrown upon a screen and thus form an image of the original.

STRUCTURE OF RECEIVED PICTURES

ONE of the chief aims of commercial phototelegraphy is not merely to transmit pictures to a distant point, but to reproduce such pictures at the receiving station in a form which is readily adaptable to subsequent processes of reduplication, particularly of preparing them for the printing press.

When a customer presents a photograph to the commercial company, he does so with the expectation of highly efficient and speedy service. If he did not require this, either the mails or the airplane would be more satisfactory as carriers. To meet these demands, the companies engaged in this service are anxious to reduce the number of steps necessary in preparing the pictures for transmission and particularly to receive them in a form which is most suitable for the purpose for which they are intended.

Where it is merely desired to reproduce a single print of an original picture, the important feature is usually to obtain a faithful likeness of the original. This may be achieved with little difficulty. However, the greatest bulk of the business is to supply pictures from which photoengravings are to be made. When, for instance, a newspaper avails itself of this means of communication for the transmission of news photographs, it is, of course, desirable to record the pictures so that they are available for printing by stereotype processes without any loss of time.

We have previously described in this department ("RADIO," page 25; Sept., 1928), the receiving method used in the commercial system of the American Telephone and Telegraph Company, which maintains a picture communication service between the larger cities of the country. This explanation of how pictures of various structure may be reproduced refers to systems which make use of similar apparatus.

Here the actual recording of a picture at the receiving station is accomplished by the use of a special galvanometer known as a "light valve." This instrument consists essentially of a wire, through which the picture currents flow, placed in a magnetic field. Due to the interaction of the electric and magnetic fields, a small shutter attached to the galvanometer wire (or wires) is deflected to one side or the other of a small aperture through which passes a beam of light. This light is varied by the opening and closing of the aperture by the shutter which is, as has been said, controlled by the signals from the sending station. The beam of light is then allowed to fall on a photographic film and this is exposed according to the amount of the light which reaches it through the aperture.

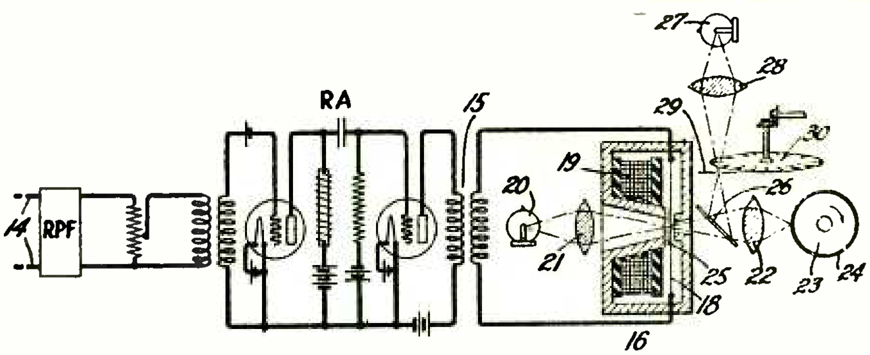

Fig. 1. Ives Receiver for "Dot" Pictures

It has also been stated that with this light valve, two types of pictures can be recorded: (1) a picture composed of substantially parallel lines of constant density but of variable width, resembling one type of "line engraving" and (2) pictures composed of lines of constant width but of variable density. Pictures of the latter type are the most faithful reproductions of an original photograph, but it is the former type, in which the structural character is more apparent, that is, most suitable for quick adaptation to ordinary printing processes.

However, this constant density, variable width picture is not as pleasing to the eye as it might be and also, in one respect, is not entirely suitable for printing processes. In these pictures the white portions of the original photograph appear as very fine lines which broaden out to represent the intermediate grays and black portions of the picture. Briefly, these very fine lines do not reproduce well in the engraved form, and therefore several modifications of the usual phototelegraphic apparatus have been made to remedy this defect and also to build up pictures with structural characteristics that are of a more pleasing character.

A means of recording the white portions of the picture in the form of dots instead of the fine lines which are so difficult to reproduce is described by H. E. Ives (U. S. Pat. 1,607,893; Nov. 23, 1926). The receiving apparatus is shown in Fig. 1, which consists of the light source *20*, lenses *21* and *22*, the light valve *16* with its current carrying ribbon *18* and the receiving cylinder *23* on which the photographic film is placed.

This is the usual apparatus for exposing the photographic paper in accordance with the signals transmitted over the communication channel, but the ribbon of the light valve is now adjusted in such a way that when signals representing the white portions of the original subject are received, the valve remains closed and no light from the source *20* falls on the film. But when this occurs the auxiliary system, consisting of the light *27*, the lense *28*, the sectored disc or light chopper *30* and the transparent mirror *26*, takes up the work of building up those portions of the picture. Such areas which would ordinarily appear as white spaces, as long as the light valve remained closed, are now filled in with rows of fine dots which are visible after the film is developed. Better contrast in the light and shade of the picture is thus attained and engravings may be prepared without the waste of valuable time.

The same inventor describes another method in which the entire picture ap-

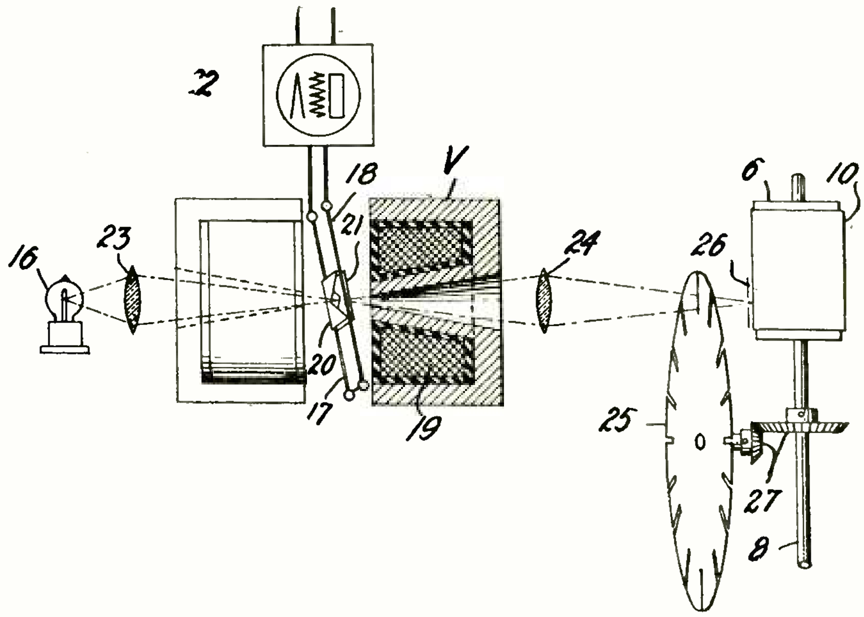

Fig. 2. Ives Square Dot Receiver

pears in square dots varying in size in accordance with the tone values of the original, (U. S. Pat. 1,631,963; June 14, 1927). This structure is obtained by several changes in the design of the light valve. Here the wires carry two opaque shields in each of which is a V-shaped notch. The square aperture between the shields is varied in size in accordance with the strength of the picture signals. This controls the light beam from the lamp, which is then in-

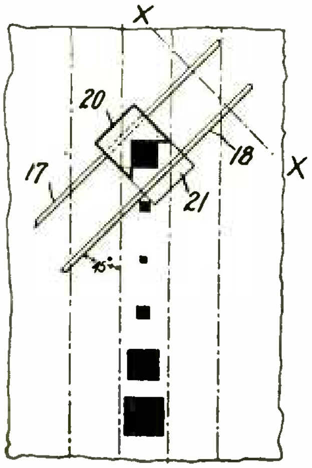

Fig. 3. Form of Dots in Ives Receiver

terrupted by the disc *25* and allowed to fall on the photographic paper placed around the cylinder 6, (Fig. 2). The

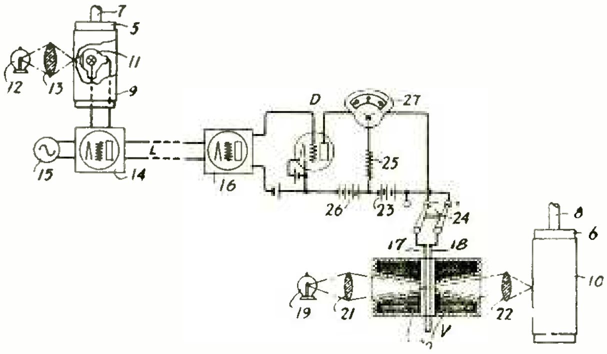

Fig. 4. Method for Reception of Either Positive or Negative Pictures

character of the marking is shown more clearly in Fig. 3. Apertures of various other shapes might also be used.

It is often desirable to reproduce either a positive or negative picture of the original. A simple method of securing either the one or the other by adjustments at the receiving station is shown in Fig. 4 as described by Maurice B. Long (U. S. Pat. 1,550,270). This is accomplished with the series circuit including the battery *23*, switch *24* and the strings of the galvanometer *17* and *18*, connected across the resistance *25*. The ammeter indicates the direction of flow and amount of current through the light valve.

The battery is of such a value that, for a given picture signal, the light valve is either opened or closed with the switch *24* in one position or the other. With such an arrangement, it is possible to

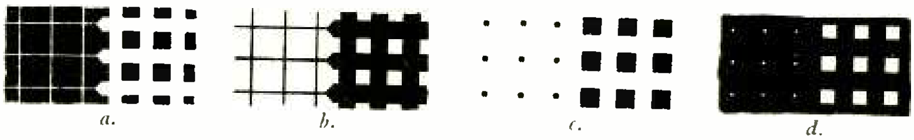

Fig. 5. "Half-Tone" Patterns

record a black portion of the original photograph as a black marking on the receiving film (positive picture) or a white portion of the original as a black marking (negative picture).

James D. Ellsworth (U. S. Pat. 1,612,005; Dec. 28, 1926), describes several means of securing pictures with various "half-tone" patterns. The picture is transmitted twice; the second time with the lines running at right angles to their direction for the first transmission. When two such positives are combined, and a common negative is made of them, the picture will have the structure shown in Fig. 5a. When this is printed on a metal plate, the prints from this plate will appear as in 5b. By judicious use of combined positives and negatives, structures such as shown in Fig. 5c and 5d may also be obtained.

Several other patents should be studied by those who are interested in obtaining pictures of various structures. These are patents of Harry Nyquist, 1,627,111; May 3, 1927, and 1,670,375; May 22, 1928.

RADIO COMMISSION ISSUES TELEVISION PERMITS

Seventeen stations have been issued six months' licenses for experimental television by the Federal Radio Commission. The stations are to be operated between 2000 to 2200 and 2750 to 2950 kc. The commission will no longer authorize visual broadcasting in the regular broadcast band when existing licenses expire, except for experimental use between 1 and 6 a. m.

Visual broadcasting licenses covering still or moving picture transmission were issued to the following stations:

W2XBW and W2XBV of the Radio Corporation of America, in New York and New Jersey, and a construction permit for a third station.

The Jenkins Laboratory, Inc., W3XK, to be located in Washington, and a construction permit for another station in Jersey City.

Westinghouse Electric and Manufacturing Company, four licenses for stations to be located in East Pittsburgh, Pa., and Springfield, Mass.

General Electric Company at Schenectady, N. Y., and Oakland, Calif., two licenses.

WAAM, Inc., at Newark.

Lexington Air Station at Lexington, Mass.

Pilot Electric Manufacturing Company, at Brooklyn.

Chicago Federation of Labor at Chicago.

William Justice Lee at Winter Park, Fla.

Aero Products, Inc., at Chicago.

AN EXPERIMENTAL PHOTO-TELEGRAPHIC PRINTER

The actual apparatus for printing the picture is a necessary and most expensive part of a "still" picture receiver. Essentially the apparatus consists of a glass or metal cylinder, a stylus that travels around the circumference of the cylinder and a clutch system which is a part of the synchronizing process. All of this requires machine work which is fairly precise, since any play in the moving parts will affect the quality of the pictures.

The experimenter who is interested in picture transmission will find the expense of having this printing apparatus made by a machinist a rather costly piece of work and, unless he has the skill of a machinist himself, he will have more than a little difficulty doing the job himself. Moreover, since the broadcasting of pictures has not been standardized, the experimenter must have some means of changing the size of cylinders, the rate of travel of the stylus, etc., in order that he will be enabled to receive pictures transmitted by various types of picture systems.

An excellent suggestion has recently been made by Thomas W. Benson, of Philadelphia; author of a book on selenium and other radio engineering subjects, which should appeal to the amateur interested in both the transmission and reception of pictures; a suggestion which will eliminate the special construction of an elaborate printing outfit.

The essence of this idea is to use a small machine lathe. With a moment's thought the reader will grasp the fact that the ordinary lathe comprises all of the essential parts for the printing ap-

(Continued on Page 41)

Detector Circuit Design Problems

By FRANK C. JONES

PROBABLY the grid-leak detector will be the most popular this year, since most manufactured receivers use two stages of audio amplification. Next season, I personally believe that the power detector and one audio stage will practically supplant all other schemes, especially with the new a.c. screen-grid tube available. Even this year, several popular receivers are using the power detector scheme, with the '27 tube.

The '27 tube is quite efficient as a detector in comparison with other tubes available and at present is the only one suitable for use in a.c. tube receivers. In using it with grid-leak detection, there are several points to consider with respect to output and to frequency distortion. Several papers have recently been published in the I. R. E. *Proceedings,* giving the necessary mathematics to show the operating characteristics and a perusal of these articles is very much worth while for any engineer.

The usual grid-leak detector circuit, as far as audio frequencies are concerned, can be represented by Fig. 1. R is the

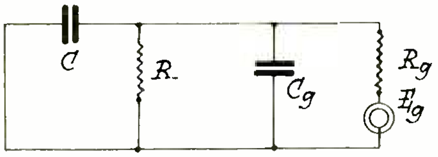

Fig. 1. Equivalent Grid-Leak Detector Circuit

value of the grid-leak, C the value of the grid condenser, C_g the value of the tube input capacity for any frequency considered, R_g the grid input resistance which is the reciprocal of the grid current—grid voltage characteristic at the operating point, and E_g the rectified grid voltage. The detection depends upon having a high audio impedance in the grid circuit and a low r.f. plate load impedance. Under this consideration, the grid condenser should be as small as possible in order to minimize the distortion due to its lowered reactance for the higher audio frequencies.

The exact loss of r.f. voltage for any given value of grid condenser, C, may be calculated if the tube input capacity C_g is known. Under normal conditions $C_g = 20$ mmfd. for a '27 tube as a detector at radio frequencies. This may vary considerably, generally to higher values. Then the effective r.f. voltage reaching the grid of the tube will be

$$E = E_S \left(\frac{Z_g}{Z_g + \frac{1}{j\omega C}} \right)$$

where $Z_g = \dfrac{R_g}{1 + j\,\omega\, C_g\, R_g}$

A close approximation can be obtained from the relation $E/E_g = C/C + C_g$ which is a rough derivation of the above formula. From this it can be seen that C should be 5 to 10 times C_g in order to not have too large an r.f. loss, or from .0001 to .0002 mfd. The .0001 mfd. will give less loss at the high audio frequencies, since its reactance at 5000 cycles is $1/\omega C = \dfrac{1}{2\pi\, 5000 \times .0001 \times 10^{-6}}$ $= 318{,}000$ ohms. This is quite high in comparison to the usual values of R_g obtained in a detector.

To obtain nearly distortionless detection, the value of R_g should be made small in comparison to the grid condenser-grid leak impedance $Z = \dfrac{R}{1 + j\omega CR}$ so that most of the rectified grid voltage will appear across the latter at any audio frequency. The total grid circuit impedance is $Z = Z_1 + R_g$ where Z_1 is

$$\frac{R}{1 + j\omega\,(C + C_g)\,R}$$

This indicates that the only variable with audio frequency is the term $j\omega(C + C_g)R$. C_g is about 80 mmfd. for audio frequencies as a maximum value for the '27 tube. This shows that making C small and R_g small, the distortion or attenuation of the higher audio frequencies may be made a negligible amount.

R_g may be made small by using a low value of grid leak R, say ¼ to ½ megohm, in order to make the grid less negative when return is made to the cathode. With a value for R_g of 50,000 ohms, the attenuation at 5000 cycles per second is negligible if the grid condenser is not over .0001 mfd. in value.

The '27 tube detector plate impedance is about 10,000 ohms under the above conditions and this value may be used in calculating the necessary audio frequency coupling impedance.

Using low values of grid condenser capacity and grid leak resistance means some loss of r.f. gain and selectivity, but this is necessary if really good audio quality is desired. The detector tube is an audio amplifier when used in this form of detection, so its circuit design is quite important.

Another detector constant that is widely used in calculations is the voltage constant v which depends on the grid resistance R_g and the rate of change of grid resistance with grid voltage at the operating point. The rectified grid voltage is inversely proportional to the value of v. The modulation frequency component of the rectified voltage $= \dfrac{mE_S^2}{v}$ where $m =$ percentage modulation and E_S is the carrier signal amplitude effective on the grid circuit of the detector. The value of v for a '27 tube is about .23 volts.

These expressions hold for small signal input voltages of not much greater than .05 volts where the detector output current is proportional to the square of the applied signal voltage.

An important consideration when using the grid leak detector is the factor of selectivity and gain. The grid leak and tube input resistance are in series with the grid condenser and across the r.f. tuning circuit. The reactance of the grid condenser at radio frequencies is normally less than 3000 ohms. So, with a 50,000 ohm effective shunt resistance, the phase angle is nearly 90 degrees different from the tuning condenser emf. which it shunts. Such a resistance in shunt to the resonant circuit tends to act as a series resistance of a low value similar to the r.f. coil resistance. The expression for this effective series resistance is $r = \dfrac{r_S}{r_S^2\, C^2\, \omega^2 + 1}$

where $C =$ eff. tuning capacity, $r_S =$ shunt resistance, $\omega = 2\pi f$. With $r_S = 50{,}000$, $C = .00035$ and $f = 550$, $r = 13.7$ ohms, at $f = 1500$ and $C = .00005$ mfd., $r = 90$ ohms.

Since the effective r.f. resistance of the detector coil and condenser generally runs from 30 ohms at 1500 k.c. down to 10 ohms or less at 550 k.c., this additional effective series resistance will lessen the selectivity greatly.

The selectivity is nearly proportional to the "Q" of the coil or $L\omega/r$, so such enormous values of r tend to greatly broaden the detector circuit. As an example, the approximate formula $X = 4\pi Ld$ gives a value $X = 4\pi \times 250 \times .05 = 157.0$ ohms for a frequency 50 k.c. off resonance. Then a 30 ohm circuit plus 90 ohms gives 120 ohms as the series impedance at resonance. At 50 k.c. off resonance, the impedance becomes $\sqrt{(120)^2 + (157)^2} = 222$ ohms, so the signal 50 k.c. off resonance would be attenuated less than 50 per cent in the vicinity of 1500 k.c.

The gain due to the tuned circuit is also decreased and since it varies approximately as $1/\sqrt{r}$, the gain at 1500 k.c. is halved in the above case and at 550 k.c., the gain is reduced about 35 per cent.

Power Detectors

Power detector circuits offer several advantages in receiver design. First is the great reduction of a.c. hum that results from the relatively small audio amplification. This means that good audio response down as low or lower than 60 cycles per second can be tolerated without audible a.c. hum if the plate supply unit is properly filtered. For this reason the filter can be cheapened, since a small amount of a.c. hum can be tolerated. But it should be lower in volume than any music, speech or microphone noise under normal conditions. With power detection the trouble due to induction from the power transformer becomes a minor factor and the complete set can be very nicely built into one chassis.

The second advantage of power detectors is the reduction in tube noise trouble from microphonic tubes or tubes with varying emission. Heater type tubes that growl and grumble or crash as detectors in a normal detector and two stage audio receiver, are very quiet when used as power detectors with only one stage of audio amplification.

The third advantage is the elimination of one stage of audio amplification with its attendant distortion. In the case of the a.c. screen-grid tube as a detector, all audio transformers may be eliminated with their sources of phase distortion and frequency distortion.

The fourth advantage is in the increased selectivity of the detector r.f. circuit. The input resistance is nearly infinite except for dielectric losses in the tube sockets, etc. The tube input resistance may be several megohms in this case, instead of the 50,000 to 250,000 ohms, as with the grid leak detectors. The tuned circuit losses are not increased above those of the r.f. stages in the biased power detector circuits.

The disadvantage is the loss in sensitivity which means more r.f. amplification in order to obtain the same loudspeaker volume. This can be calculated quite easily. Suppose a power tube of the '71A type is used with a C bias of 40 volts. Then the detector would have to put out 28.3 volts rms. to work this power tube to its full extent. From published tables, the d.c. '22 screen grid tube will develop $2.2 \times 2A^2B$ volts across a 250,000 ohm resistive load, while the '27 tube as a grid leak detector will develop $17 \times 2A^2B$ volts across the primary of an audio transformer where A is the signal peak voltage and B is the percentage modulation.

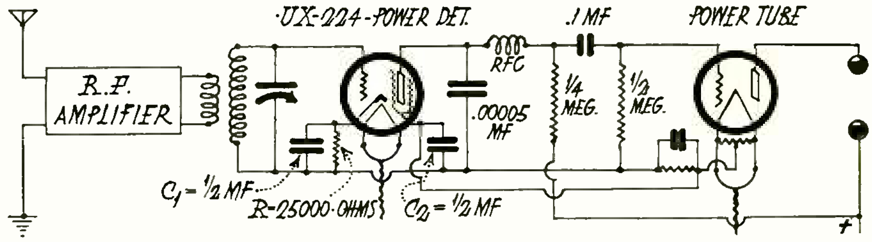

Fig. 3. Power Detector Circuit With A.C. Screen-Grid Tube

This means that the '27 tube would have 7.7 times as much output for the same input. The a.c. screen-grid tube is about three times as efficient as the d.c. model, so the '27 would only be about 2½ times as sensitive. Again, these values are for most sensitive operation and since the '27 tube would be operated for best audio quality output rather than sensitivity, the two tubes would be about equally sensitive, considering detector r.f. coil losses. The screen-grid tube circuit would be much more selective.

The usual two stage audio amplifier has a gain to the power tube of $3 \times 8 \times 3 = 72$. To obtain the same output with the a.c. screen-grid tube, the r.f. input, acting on the square law, would be $\sqrt{72} = 8½$ times as much gain. This can be accomplished very readily by means of an additional stage of r.f. amplification.

The '27 tube may be used as a power detector with quite satisfactory results if a special transformer is used to couple this tube to the power tube. The plate impedance is rather high and so it is necessary to use a special coupling unit such as described in the next month's discussion on audio amplifiers. The output level for a given signal strength is about the same for an a.c. screen-grid detector with resistance coupling as with a '27 tube power detector with a 2½ to 1 ratio audio transformer.

The second harmonic distortion of the power detectors is very little greater than the grid leak detector and, since less than 20 per cent is very difficult to discern, this type of distortion is relatively unimportant. This is especially the case because the second harmonic distortion due to second audio stage is eliminated. The higher audio frequencies are not attenuated in the power detector scheme, except in the r.f. tuning circuits, so generally the music and speech is quite brilliant and pleasing.

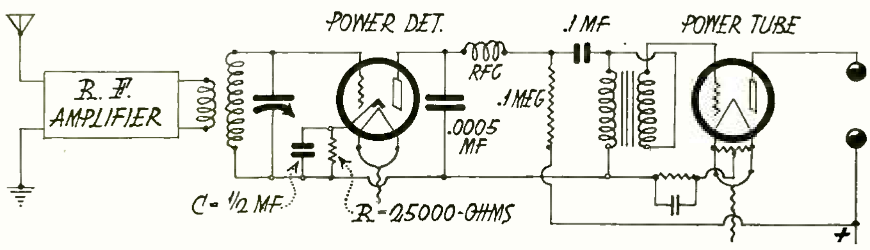

Fig. 2. Power Detector Circuit With '27 Tube

Fig. 2 shows a '27 power detector circuit with some circuit constants as used in one commercial receiver designed by the writer. Fig. 3 shows the a.c. screen-grid tube as a power detector with circuit constants which gave very satisfactory results in an experimental receiver.

HOT CATHODE MERCURY VAPOR TUBES

By Milton A. Ausman

The operation of the hot cathode mercury vapor tube as a rectifier may be explained by the electron theory on the assumption that some of the electrons which are emitted by the filament ionize the surrounding mercury vapor so that the positive mercury molecules tend to neutralize the negative space charge around the filament. Consequently the emitted electrons are free to be attracted to the positive plate of the tube and thus enable it to function as a rectifier at remarkable efficiency.

In operating these tubes, the filaments should be allowed to come up to full temperature before the plate voltage is applied. Otherwise the active material will be knocked off the filament.

Every effort should be made to keep the mercury tube out of intense r.f. fields. This should be accomplished by isolating the power supply from the transmitter and shunting it with a fairly high capacity mica condenser (about .002 for 40-meter operation) preceded by adequate r.f. chokes. The radio frequency tends to keep the mercury in a permanent state of ionization and results in "back current," which in turn, causes difficulty in filtering the output of the rectifier. The reason for this is quite complicated, in its true sense, and hinges on Bohr's theory of quanta and other laws of mathematical physics.

The output of these tubes is usually limited by the capacity of the leads through the stem. There is enough energy, which has ability to pass through the tube, to kill the unfortunate person who gets across the output of the device. Further this output will destroy the rectifier system or the transformer if it is not amply protected by fuses.

An Inexpensive High-Range Voltmeter

By HARRY R. LUBCKE

An inexpensive high-range voltmeter suitable for both a.c. and d.c. measurements is shown in Fig. 1. It consumes less than .005 the current taken by the popular high-resistance meters, and can be made for perhaps fifty cents. It is an electrostatic voltmeter of simplified design. Since it

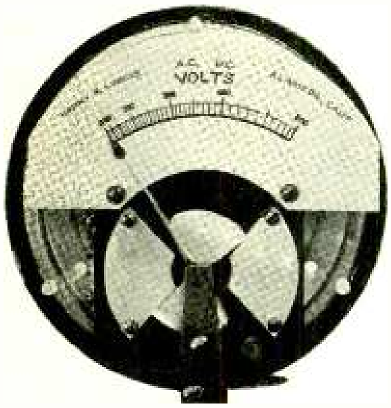

Fig. 1. Meter with Front of Case Removed

employs the electrostatic principle, it can be used with equal accuracy for measuring alternating or direct voltages, making it possible to measure the a.c. output of a *B* socket-power step-up transformer as well as the d.c. output of the unit. The construction has been simplified to the point where the meter can be easily made by anyone familiar with radio apparatus and with the use of the hand tools found in such a person's equipment.

The instrument shown has a range of 0-500 volts. Meters of this simplified design can be constructed for ranges of from 0-350 volts to about 0-2000 volts. The lower limit is set by the small magnitude of the electrostatic forces and the upper limit by the difficulty of providing adequate insulation. Through the use of a more elaborate lead-in bushing and further separation of high potential leads the upper limit could be increased to 3000 or 4000 volts. The overall accuracy of the meter as constructed is better than 3 per cent.

The fact that the meter draws a current measured in a few microamperes is most significant. The electrostatic principle depends upon the attraction of unlike electric charges for its operation. It is thus merely necessary to charge the sets of opposite plates to line potential to secure the deflecting force. The charging current required is equal to that taken by a condenser of capacity equal to that of the interleaving plates, a condenser of perhaps .000025 mfd. capacity, and is thus very small. With direct current the charging current flows but once; with alternating current it flows with each alternation and equals the current passed by the condenser if connected across the a.c. line. With the meter illustrated the current drain is less than *five microamperes* at full scale deflection on a.c. and an initial instantaneous value of five microamperes for d.c.

The construction is simple. The movement consists essentially of a lightly made variable condenser with the movable plates supplied with a pointer and counterweight. With a counterweight the force of gravity provides the restoring torque. Zero adjustment is accomplished by rotating the meter as a whole by very slight amounts from its normal position. The fixed plates of the movement are mounted on a formica slab, which also holds the pivot mounting and scale, and which itself is supported from the rear portion of the case by threaded-rod standards. The pictures make the arrangement apparent. A few bits of aluminum, copper, steel, brass, formica, bristol-board, and glass; a coffee can, and some paint comprise the entire list of materials.

The necessary aluminum parts are detailed in Fig. 3. For the 500 voltmeter, eight stationary and three rotary plates are required. The stationary plates should be made of fairly stiff aluminum, about No. 30 gauge, but all other parts require the thinnest aluminum obtainable, .010 in. material being used in the meter shown, which is about half the thickness of No. 36 gauge. After being cut to shape and drilled as shown, the stationary plates are stacked on 1-in. 4-36 brass bolts. Suitable brass washers are used between plates to give a separation of 3/32 in. (0.23 cm.). The assembly is made rigid by tightening on a 4-36 nut after the last plate has been put in place. It is held 3/16 in. from the formica slab by two more nuts, one on each side of the slab.

The rotor plates are spaced 3/32 in. apart by small square aluminum washers on a hardened steel shaft. The washers are 3/32 in. square and need be only 3/64 in. thick if desired, two being used for each space. The shaft is 5/8 in. long by about 1/64 in. diameter and is made of a section of a sewing needle. The pointed end is used and the rough end, caused by breaking it, is sharpened to a tapered point on an oil stone. The washers are made a force fit on the shaft, being drilled with a "drill" made by breaking off the eye end of a sewing

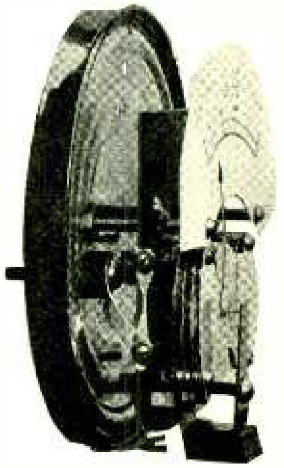

Fig. 2. Side View of Meter Movement

machine needle and sharpening it to a drill point, if ordinary drills are not available in the size required. The movable assembly is made rigid by soldering two very small brass washers to the shaft, top and bottom. The pointer and counterweight arm are clamped under the top brass washer.

The pointer is bent from the flat pattern dimensioned in the figure to a 90 degree angle member by careful manipulation of tweezers and a dull knife. It should be made as light as the skill of the constructor permits, since its long lever arm has a potent effect on the balance of the system. It can be "shaved down" with a sharp knife, after bending, to reduce its weight. A *very* thin coat of black paint is applied to the tip to improve readability.

Three threaded-rod standards and one

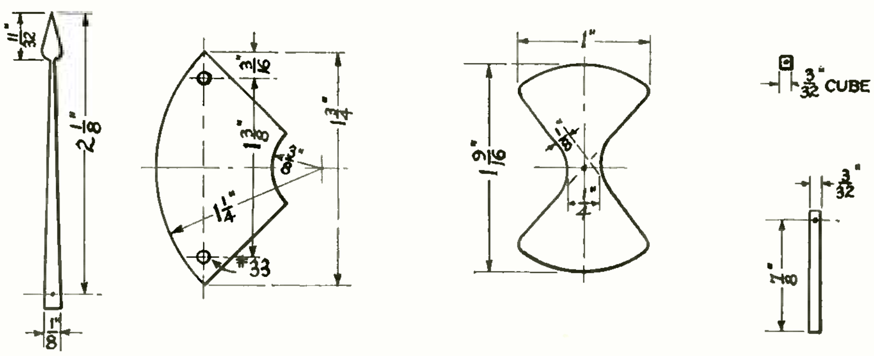

Fig. 3. Aluminum Parts

pivot holder are made of brass as shown in Fig. 4. Two long standards support the bristol-board scale ½ in. above the formica slab in addition to holding the slab 5/8 in. from the back of the case, which is the function of all three. The tops of the long standards need not be drilled and tapped for 4-36 screws, if this is difficult, but can be extended 1/8 in. farther and two 8-32 nuts used to hold the scale. The pivot holder is made of 1/32 in. brass having some spring temper. The bearings are dents in the material made with a sharply and carefully pointed center punch. One ¾ in. 8-32 bolt passes through the upper hole and threads into the lower one near the back of the holder to adjust the distance between the bearings to suit the length of the needle spindle. The holder is fastened to the formica slab by one 6-32 screw, 3/8 in. long.

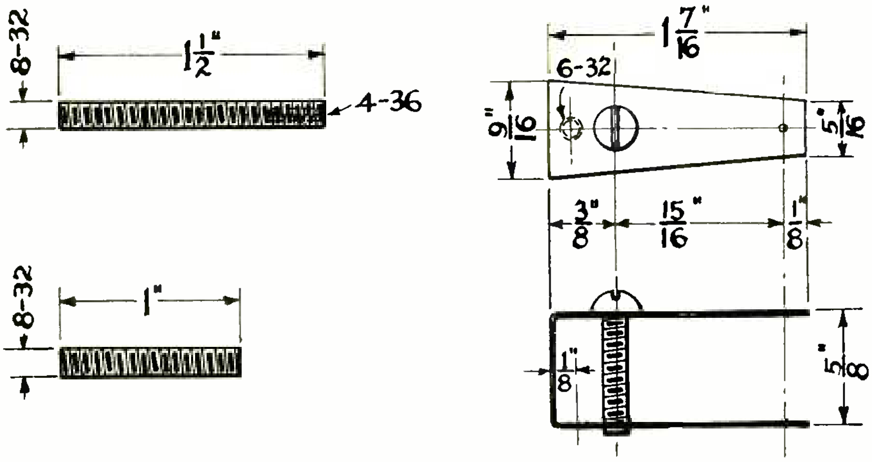

Fig. 4. Brass Parts

The formica slab shown in Fig. 5 is the main supporting and insulating member. It is made of 3/16-in. material. The two upper holes, threaded 8-32, pass the long standards, while the isolated lower right-hand hole labeled 8-32 is for the short one. The four No. 33 holes, symmetrically located, pass the 4-36 bolts of the stator and the one No. 28 hole at the bottom, the mounting screw for the pivot holder. Two 4-36 tapped holes in the left-hand edge hold screws securing a tinfoil fuse placed in series with the stator and protecting the meter in case of overloads or accidents.

The back of the case, shown in Figs. 1 and 2, supports the formica slab and the external terminals. Holes for the three standards are provided in it, of course, coincident with those in the slab. They are so placed that the pivot holder comes 1/4 in. from the bottom of the case, a 5-in. diameter can as used in the instrument shown. Two other holes are located near the center of the case 1½ in. or more apart for the external terminals. These are 10-32 brass bolts 1¼ in. long.

The terminal connecting to the moving plates is grounded to the case and joined electrically to the pivot holder by a short aluminum strip running between the lower standard and the holder fastening screw, but the stator terminal is insulated from the case by passing through an oversize hole 5/16 in. in diameter. Two 1/2-in. diameter formica washers 1/8 in. or 3/16 in. thick insulate the nuts from the case. An aluminum strip connects this terminal to one side of the fuse, the other side of which makes connection with an adjacent stator bolt by way of a short aluminum strip. Five other holes are drilled, three equally spaced around the circumference 1/8 in. in from the outer bead of the cover for the screws that hold on the front of the case and two more spaced 3½ in. apart on a vertical diameter for mounting the instrument to its support.

It will be noted in Fig. 2 that what was the top of the can cover is next to the formica slab and that consequently the can proper fits inside the bead on the top of the cover, rather than fitting into the longer portion as would be done were the can put together normally. This procedure sets the insulating bushing away from any external support against which the meter is placed, and provides an ornamental rear rim which effectively disguises the fact that the case was once a tin can. It is given one or two coats of black automobile enamel when completed.

The coffee-can used for the meter shown was a one-pound vacuum pack container requiring a turn-key for opening. The top portion of the can proper was cut off, decreasing its depth from about 3 in. to 1¾ in., *but leaving material* for three 3/8 x 3/8 in. tabs extending which are bent inward, drilled, and provided with 6-32 nuts soldered to their inner sides for the three 6-32 by 1/4 in. screws that hold the two parts of the case together. The front slot for viewing the scale has a maximum width of 3⅝ in. with an inner radius of 1¾ in. and an outer radius of 2¾ in. A piece of appropriately shaped glass is held against a backing of cardboard by two angle clamps. The cardboard is shellacked to the case and forms a semi-soft backing against which the glass can be clamped with safety.

The scale is made of heavy white bristol-board and is entirely supported by the two long standards between washers and either screws or nuts. Short pieces of No. 30 B. & S. gauge wire are held under the top washers and provide stops for the pointer. The scale arcs and random guide divisions are drawn in with pencil before calibration.

The weight of the counterweight is an important factor in determining the scale range of the meter. With a given

(Continued on Page 42)

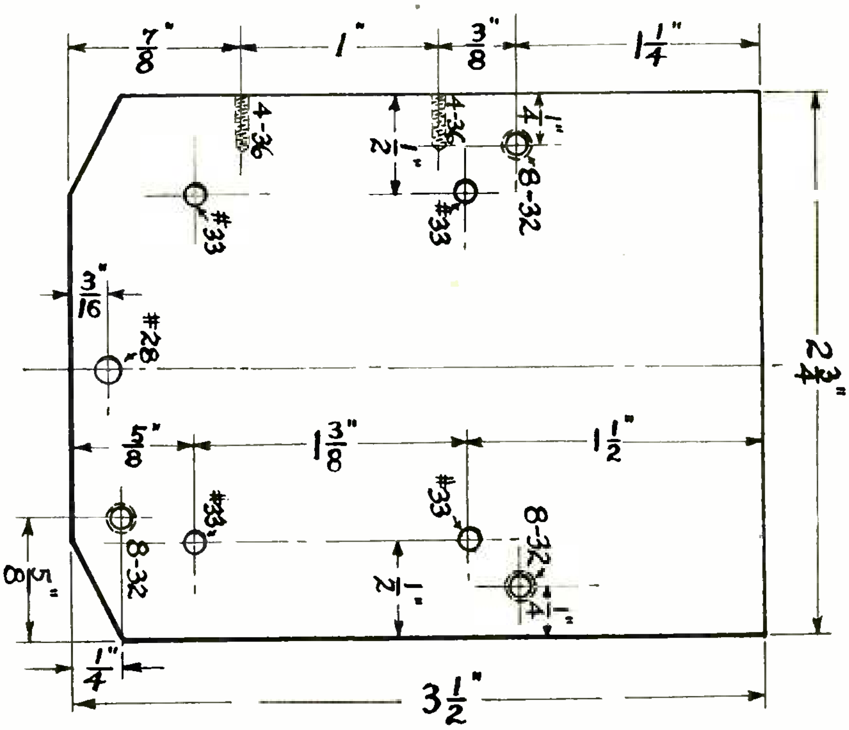

Fig. 5. Formica Slab

TECHNICAL BRIEFS

MEASUREMENT of an airplane's distance above the ground when landing in a dense fog is accomplished by an altimeter devised by Ross Gunn of the U. S. Naval Research Laboratory. The plane fuselage is equipped with two metal plates whose capacity is part of the tuning circuit of an r.f. oscillator. This capacity changes with any slight change in height below 150 ft. and thus changes the oscillator current, as measured by a micro-ammeter. By calibrating the meter in feet it is possible to get accurate indications of changes in elevation from an arbitrarily established 150-foot level.

THE frequency characteristic of a typical 1-k.w. broadcast transmitter and amplifier is shown in Fig. 1. These measurements were made from the microphone plug outlets in the studios through all of the audio amplifiers and transmitter. The transmitted energy was measured by means of a special field strength measuring set designed for that purpose. This curve indicates that many of the broadcast stations are still ahead of the broadcast receivers as far as quality of transmission and reproduction is concerned.

The usual high class broadcast receiver drops off from 10 to 20 DB. at both ends considerably inside of the cut-off portions of the transmitter curve. Possibly in another year or so a few of the broadcast receivers will have frequency characteristics as good as the transmitter shown. To accomplish that, special audio circuits or power detector circuits and r.f. band-pass tuning circuits will have to be used in the manufactured receivers. Better loudspeakers and acoustically designed set cabinets will also be necessary.

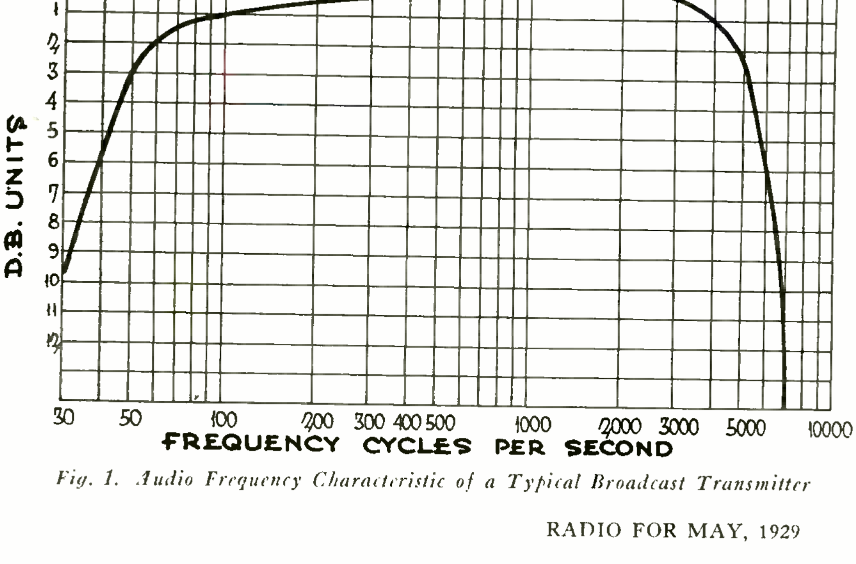

Fig. 1. Audio Frequency Characteristic of a Typical Broadcast Transmitter

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WARNING is necessary against the use of too small a size of wire in the secondary winding of a transformer which is to supply filament current to a.c. tubes. The safe current-carrying capacity of wire to be used in coils subject to continuous service is 1500 circular mils per ampere. This is about the size of No. 18 wire, which consequently should not be expected to carry more than 1 ampere. As each heater element ('27) and each a.c. screen-grid ('24) tube draws 1.75 amperes at 2.5 volts and as a '45 tube draws 1.5 amperes at 2.5 volts it is evident that very large wire is necessary in a transformer secondary supplying several of these tubes in parallel. Thus a five-tube set using three '24s, one '27 and one '45 would draw 8½ amperes, requiring No. 9 wire.

MEASUREMENTS of low voltages in a.c. circuits can be made with a 110-volt a.c. voltmeter and a toy step-down transformer provided that the transformer has sufficient current-carrying capacity to prevent any undue drop in voltage under the current drain experienced. Thus if the 15-volt transformer tap is used, the meter reading should be multiplied by 15/110 to indicate the unknown voltage, or with the 6-volt tap the reading should be multiplied by 6/110. The results obtained are only approximate unless the combination is calibrated with a voltmeter which actually covers the desired range.

Likewise a low-reading a.c. voltmeter may be used to measure high voltage current by means of a condenser multiplier, which does not consume as much power as would a resistance multiplier. The necessary size of condenser for 60-cycle current may be found from the formula $C = 2653 \div \sqrt{Z^2 - R^2}$, when C is the capacity in microfarads, R the resistance of the meter in ohms and $Z = mR$, m being the multiplying factor. Thus if it were desired to measure 0-500 volts with a 0-15 voltmeter having a resistance of 150 ohms, m would be $500 \div 15 = 33.3$ and Z would be $33.3 \times 150 = 5000$ ohms. $\sqrt{Z^2 - R^2} = \sqrt{5000^2 - 150^2} = 4997$ and $C = 2653 \div 4997 = .53$ mfd. Using a .5 mfd. standard condenser would slightly increase m and thus increase the voltmeter range to 520.5 volts, as can be verified by substitution in the formula. The meter and condenser are connected in series across the line. This arrangement must also be calibrated with a standard voltmeter.

AN available higher voltage filament transformer may be used to supply current to a low voltage power tube, such as the '45, by inserting a resistor in each of the filament leads to the tube. The value for each unit may be figured from the formula $R = (E_1 - E_2) \div 2I$, where R is the resistance in ohms, E_1 is the output voltage of the transformer, E_2 is the rated filament voltage of the tube and I is the tube's rated filament current in amperes. Thus a 7½-volt filament transformer may be used to supply 1.5 amperes at 2.5 volts to a '45 tube by using two 1.66-ohm resistors $[(7.5–2.5) \div 2 \times 1.5 = 5 \div 3 = 1.66$ ohms]. A similar transformer could be used to supply two '71A tubes, each drawing .25 amperes at 5 volts, by using a 2½-ohm resistor in each of the main filament leads $[(7.5–5) \div 4 \times .25 = 2.5$ ohms]. The resistors should have sufficient current carrying capacity to prevent overheating or burn-out, as should also the transformer secondary.

CONSTANT volume may be obtained from a loudspeaker, irrespective of the incoming signal strength, by using the automatic volume control circuit connections shown in Fig. 2. One of the speaker terminals is connected to the

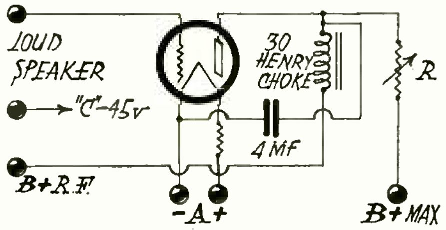


Fig. 2. Automatic Volume Control

grid of the control tube and the other to —45 volt *C*. The plate voltage for the r.f. tubes is supplied from the +*B max* tap of the eliminator through a variable resistance unit *R*, which is adjusted to show 90 volts across the plate and filament terminals of the first r.f. tube. This should be measured by means of a high resistance voltmeter when the receiver is fully turned on but not tuned to any station. The value of *R* may be anywhere from 10,000 to 50,000 ohms, depending upon the plate and grid voltages and the number of tubes.

The connections are shown for a loudspeaker having an output transformer. If it uses a choke-condenser output circuit the condenser and choke in the volume control are unnecessary, the +*B max* being connected to the end of the regular choke. This sort of a device has been found to work satisfactorily with any type of r.f. amplifier except one using '26 tubes, which give a bad hum if the plate voltage is changed.

CONVERSION of power gain in watts to transmission units (or decibells) may readily be accomplished by means of the scale published herewith. The method is also reversible for the conversion of TU. (or DB.) to watts. Furthermore the chart also shows the maximum undistorted output of the standard amplifying tubes, giving the tube performance either in watts or DB. This facilitates a ready comparison of the various tubes at different plate voltages.

The arbitrary unit for zero DB. is .006 watts, as adopted by the American Tel. & Tel. Co. For any given power gain, the number of DB. is equal to ten times the logarithm of the ratio of the given power output to .006 watts. This arbitrary unit was chosen because it represents the minimum difference between two sounds that can be detected by the human ear.

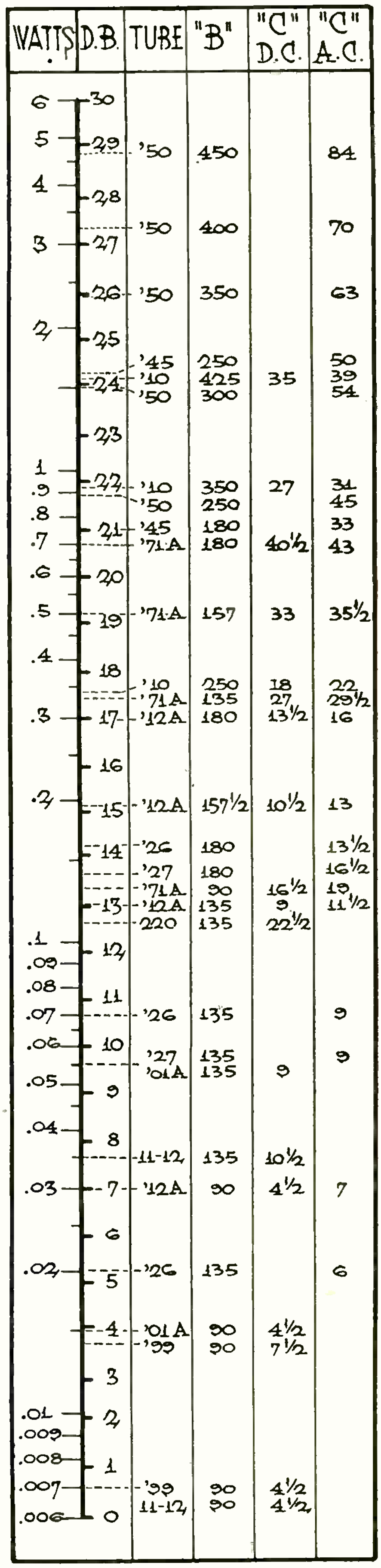
This chart is particularly useful in graphically portraying the fact that doubling or tripling the power output of an amplifier does not double or triple the sound output. Thus while a '50 tube with 300 volts on the plate has more than twice the wattage output of a '71A tube with 180 volts, it adds only about 3 DB. to the 21 DB. obtainable from the '71A tube. Or while a '50 tube with 450 volts on the plate gives three times the power output of a '10 tube with 425 volts, it adds less than 5 DB. to the 24 DB. obtainable from the '10 tube. In general, doubling the power adds 3 DB.

The conversion scale may also be adopted for current or voltage ratios, assuming equal impedances by doubling the DB. values shown for corresponding power ratios. Thus a DB. gain of 10, corresponding to a power ratio of 10 to 1, becomes a DB. gain of 20 for a 10 to 1 voltage ratio.

The chart is also interesting in that it shows the relation of the new '45 power tube to the '71A and the '10 tubes. With 180 volts on the plate it gives a very slightly greater output than the '71A with 180 volts. But with 250 volts it gives a larger output than a '10 with 425 volts or a '50 with 300 volts. In this connection it should be noted that the '45 tube is not interchangeable with other power tubes, especially as it takes only 2.5 volts on the filament.

TO DISTINGUISH between "radio tubes" which are used as r.f. amplifiers, detectors, and a.f. amplifiers, and special service tubes which are used for rectifiers, automatic volume control, and voltage control, the RMA has recommended that the numbers used to designate the two classes of tubes be separated by a dash when specifying the number of tubes in a radio set. Thus "6—3" would be used to designate the number of tubes in a set having three r.f. stages, a detector, and two a.f. stages, together with a voltage control, automatic volume control and rectifier tube.

THE selectivity of a radio receiver is apparently better at low volume than at high. Even a non-selective receiver can be made more selective by turning down the volume control. Likewise a really selective receiver tunes broadly when the volume is too great. A short aerial is recommended as a means for minimizing interference because it reduces the input voltage and thus reduces the volume.



Outputs of Standard Amplifying Tubes in Watts and in DB.

With the Amateur Operators

TRANSMISSION MONITORING

G. F. Lampkin

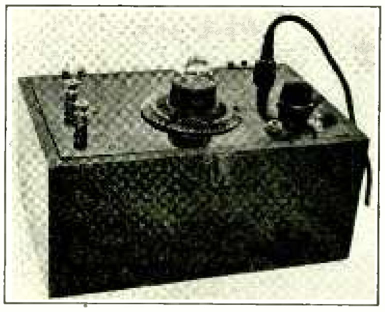
The international amateur regulations for 1929 make mandatory, if not compulsory, practice that should have been common years ago. The time-honored custom of taking the other fellow's word for the performance of one's own transmitter, of asking for and accepting in good faith reports that were tinged with flattery, imagination, or the vagaries of a poor receiver, should have long since ceased. One would think that building and using a monitor box, or even checking up by listening with the receiver to transmitter harmonics, would be the obvious course followed in order to really discover the facts about the performance of the local transmitter. Perhaps the truth, when known, would be too horrible, and it is natural to want to believe "ur sigs pure dc R8 sure fb—QRK?"

Tuned and peaked audio amplifiers, acoustic filters, and kindred devices, are to a great extent superfluous until stability of frequency and purity of tone are attained in amateur transmissions. Before measures can be taken to impart such qualities to a transmitter those in which it is deficient must be determined. After such qualities are had, a continual check on the transmission must be made to insure that they be retained. To this end a method of monitoring is necessary.

Monitoring boxes have been described in which all the apparatus is totally enclosed in, say, a biscuit tin. There are disadvantages in the use of this sort of monitoring. The shielding must be so complete that when tuned to the fundamental there is no tendency for the monitor to be "pulled" into synchronism by the transmitter. The batteries must be self-contained, which not only makes the monitor box rather lubberly, but the *A* battery particularly is subject to inconvenient renewals. To monitor under operating conditions the headphones must be plugged back and forth from receiver to monitor box, or else some sort of switching arrangement used—in either case break-in operation is not possible.

The method at W8CAU has none of these disadvantages. It uses the harmonic from a heterodyne frequency meter to beat with the transmitter, so that there is no tendency for pulling. The heterodyne meter is fed with plate voltage through the primary of the first audio transformer of the receiver. Thus, with no switching whatever, when the key is down and the meter tuned to the transmitter, the monitoring tone is present in the receiver headphones. The frequency-meter *A* battery supply is derived from the source for the receiver, so that as long as the receiver has operating voltages the meter is also supplied. Both the receiver and the heterodyne meter are turned off by one control.

If the station is equipped to use break-in, then operation becomes a pleasure indeed. When transmitting, besides accomplishing the primary object of a continual check on the character of the emitted signals, the monitoring scheme is conducive to cleaner-cut keying, since the operator can hear his outgoing dots and dashes. With the key up, the incoming signals from the other end may be heard. And last, but by no means least, the heterodyne meter is an ever-present source of known frequencies. It is but the work of a moment to accurately determine the frequency of any station which may request the information.



Heterodyne Frequency Meter

The scheme of a regenerative detector and one step in which the monitoring scheme is incorporated is shown in Fig. 1. There is nothing unique about the receiver. To any one of the various short-wave sets the monitoring idea is applicable. Concerning the heterodyne frequency meter dimensional and constructional details will be given more as a suggestion than as a hard and fast pattern.

The meter is assembled on a 7 in. by 9 in. panel which is the top for a box 5 in. deep. Both box and panel are fitted with shields of 1/64 in. sheet copper so that with the panel in place all the apparatus is completely shielded. The tube, an '01A, is inserted through a hole in the panel and shield and is so mounted that just enough for a finger-hold projects. It is not put entirely inside because that would require opening up the meter merely to change tubes. The main tuning control, the filament rheostat, the phone jack, and an off-on toggle switch appear on the panel. The battery supply, for convenience, is introduced through a battery cable and plug.

The only r.f. filtering of the battery leads which was found necessary was a 0.002 mfd. mica bypass condenser from the plate lead to ground. The heterodyne note between the third harmonic of the frequency meter and the 7500 k.c., 400-watt crystal-controlled transmitter at W8CAU was then about R7 after passing through the receiver one step. The shielding was such as to give an R8 beat between the second harmonic of the meter and the fundamental of the 3770 k.c. set.

Apropos of break-in with crystal control, since the crystal oscillator and one or more amplifiers usually run continually, it is not possible to receive as long as the transmitter is turned on. However, by arranging the keying system so as to control all the amplifiers which operate at the output frequency of the set, it is possible to work break-in. For instance, at W8CAU the 7500 k.c. transmitter uses a 210, 1875 k.c. crystal oscillator from which 3750 k.c. excitation is taken direct for a 210 frequency doubler. This 7500 k.c. resultant then passes through a single 852 amplifier stage and a final power stage with four 852 tubes. The plate supply for all tubes is derived from the same motor-generator set. Originally, only the 852 tubes were keyed, in the center tap of their filament transformer. This, however, left the frequency doubler to run continuously, and the ever-present energy produced by it on 7500 k.c. prevented reception in that band as long as the transmitter was turned on. To key the 210 frequency doubler its filament is supplied through appropriate resistances from the 10-volt source for the 852 tubes. Thus keying the center tap of this supply keys all the amplifiers which operate on 7500 k.c., and when the key is up it is easy to receive R4 signals that are removed only 10 to 20 k.c. from the output frequency of the transmitter.

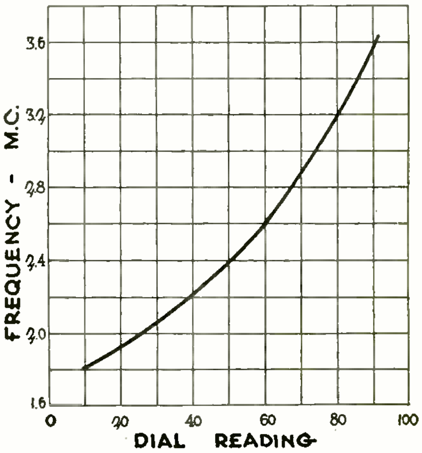


Fig. 2. Calibration of Heterodyne Frequency Meter

The tuned circuit dimensions for the heterodyne frequency meter are 16 turns of No. 18 DCC wire on a 3-inch form, and a Bremer-Tully 13-plate S. L. W. condenser. The tickler coil consists of 19 turns of No. 24 DCC wire wound on the same form ⅛ inch from the grid coil. The dimensions were such as to give the frequency calibration in Fig. 2.

It may be preferred to restrict the range of the frequency meter to the 1929 bands, in the interest of greater accuracy. If so, it is necessary to buy a special condenser, such as one having a fixed capacity across which a single-plate variable is used. The older semi-circular plate condensers may be very easily renovated to give full scale coverage for a small band, and to do so with a close approach to a straight-line-frequency characteristic. The gist of the idea is given in the picture of a renovated condenser rotor, and the manner in which it works in the calibration of Fig. 3.

By reversing a portion of the rotor plates some of them are meshed with the stator at all times. The minimum capacity of the condenser becomes that due to the reversed

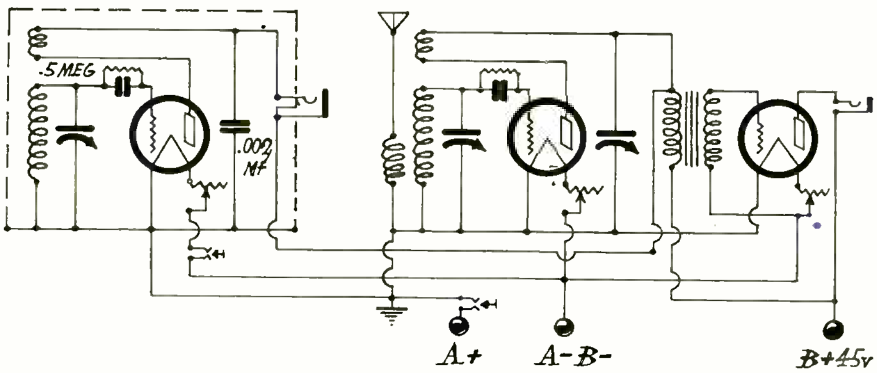


Fig. 1. Monitoring Scheme With Regenerative Detector and One-Step

plates, and the maximum capacity that due to the remainder. Since the change in capacity on rotation is equal to the difference of these two values, by reversing nearly half the plate, the 180-degree dial rotation

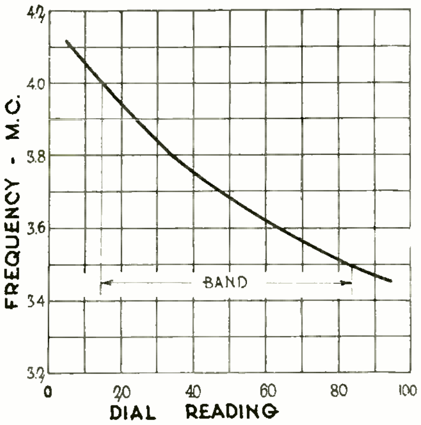
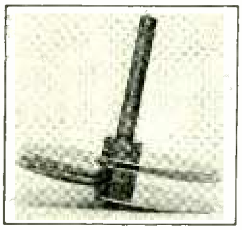


Fig. 3. Frequency Calibration with Reversed-Plate Condenser

can be made to represent only a very small change in capacity. Rather than count the number of plates on either side of the shaft to get an idea as to the change in capacity, it is necessary to count the number of active dielectric spaces, since one side of each end plate has nothing with which to mesh.



Semi-circular Plate Rotor with Reversed Plates

Thus, in obtaining the curve of Fig. 3, a Cardwell 11-plate semicircular condenser was used, having 5 stationary and 6 rotary plates. The manner of reversing shown in the picture gave 6 active dielectrics on one side of the shaft and 4 on the other. The condenser was used across a grid coil of 9 turns of No. 18 DCC wire on a 2¾-inch diameter, with a tickler of 7 turns on the same form. All tuned circuit dimensions that have been given cannot be expected to give exact duplicate calibrations in other cases—the final adjustment for a given band coverage in any case must be done empirically. In Fig. 3 the band of 3500 to 4000 k.c. extends from 84 to 15 in the meter dial, and frequencies to within 1 k.c. can be estimated.

With a heterodyne frequency meter the setting can be made even closer than 1 k.c. The accuracy of readings, then, is primarily dependent on, first, the precision of the frequency source which is used for calibration, and, second, on the constancy of the parameters which determine the meter frequency. The standard frequencies from WWV are transmitted to within 0.1 per cent of the announced value. Four k.c. in 4000 k.c. represent the same degree of error, so that with a reversed-plate rotor the dial can be set closer, and the frequency read to as great a degree of accuracy as the ordinarily available standards of calibration.

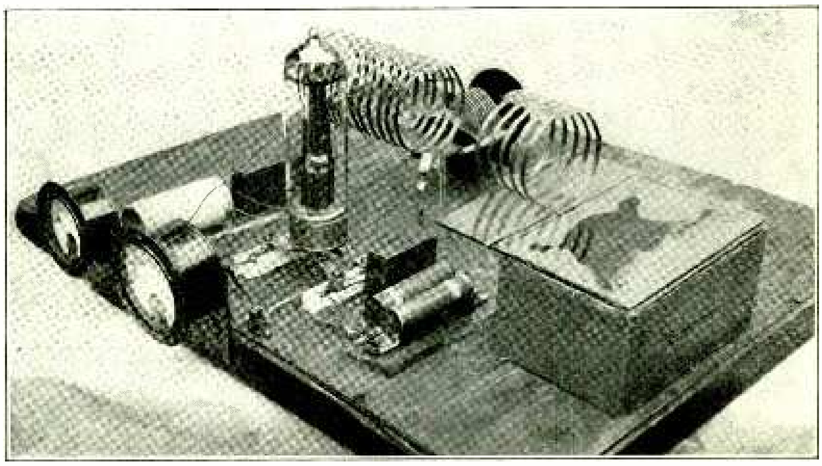
The parameter which has a major effect on the frequency of the heterodyne meter is filament temperature. The variation due to this cause may be as high as 20 k.c. A cure is to choose the value of grid leak such that the tube howls shortly after going into oscillation, as the filament rheostat is turned up.

A FIFTY-WATT SHORT-WAVE TRANSMITTER

By A. Binneweg, Jr.

With comparatively little expense, it is possible to construct a 50-watt transmitter from odds and ends easily secured or already available. The tube, meters and transformers are the real essentials; the rest of the set is the result of a combination of inventive ability, influential friends and luck; and every amateur has all three. With the aid of the illustration and Fig. 1, construction is quite simple.

The ribbon used for the inductances is from two Ford magneto coils. It is wound around a wooden cylinder upon two strips of celluloid. The turns are cemented in place with collodion, or any suitable household cement, and, when dry, the coils are removed from the cylinder.



Inexpensive 50-Watt Transmitter

The variable condenser may be the choice of those which happen to be available. Large capacity and small inductance will give a steadier wave, although there are limits. The voltage across the oscillating circuit is lower for a high-capacity circuit, and for voltages up to about 1000 on the plate the condenser plates will not spark over for ordinary spacings if sufficient capacity is used. Large capacities give rise to heavy oscillating currents, however, so that all leads in the oscillating circuit should be short and heavy.

Clips are convenient for the experimenter and can be used if they are good ones made of brass. "Iron" clips will often heat badly. In the Hartley circuit used, only that part of the inductance across which the condenser is shunted will carry the heavy currents, and as the copper strip provides sufficient surface for these current values, heating here is negligible.

When using a 50-watt tube, and the usual voltages for operating it, it will be necessary to double space the condenser plates. Only the better types of condensers will serve for the oscillating circuit, as bad spots soon heat, lower the insulation resistance, cause more heat, etc., until there is a breakdown. A 41-plate condenser should be used for double spacing.

The following coil values are suggested for short-wave use:

WAVE-BAND	COIL DIAMETER	NO. OF TURNS
80 meter	2¾ in.	10
40 meter	2½ in.	5
20 meter	2¼ in.	3
10 meter	2 in.	2
5 meter	1½ in.	2

For the 5 and 10-meter bands, the necessary coil values will be influenced to some extent by the tubes used, as well as other particular circuit conditions. All of the above values are for coils of copper tubing.

For the transmitter shown in the illustration, the usual methods for adjusting the

(Continued on Page 43)

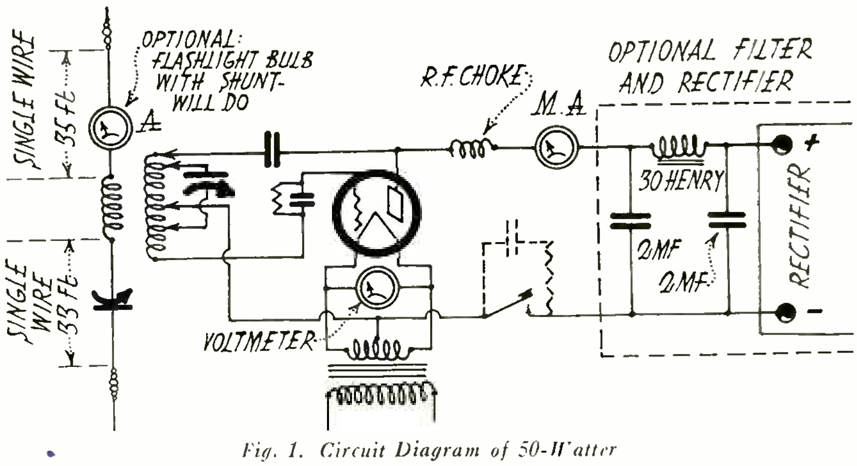
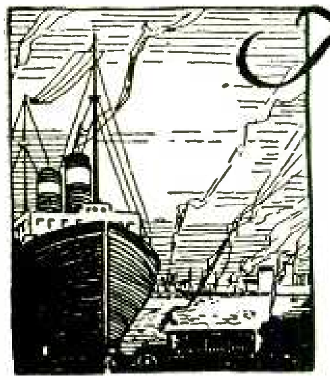


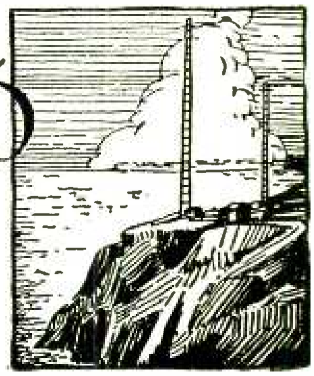
Fig. 1. Circuit Diagram of 50-Watter

1 0 to 200 d.c. milliammeter
1 0 to 15 a.c. voltmeter
1 Plate transformer, 1100 volt
1 30 henry choke (optional for filter)
4 1 mfd. 1750-volt condensers (optional for filter)
1 41-plate condenser for double-spacing
2 .002 mfd. 3000-volt condensers
2 5000-ohm grid-leak resistors
1 50-watt tube
1 Socket for same
1 Filament transformer
2 Ford magneto coils
40 ft. No. 26 D. C. C. wire (for choke)
4 Clips
Binding posts, screws, scrap bakelite, some pieces of glass, baseboard, etc.



The COMMERCIAL BRASSPOUNDER

A Department for the Operator at Sea and Ashore



Edited by P. S. Lucas
R. O. Cook, *Assistant*

Six and seven hundred-meter stuff surprised us the other night when we heard not one in a half dozen operators consistently using the new Q signals. Why? we wonder. One operator says you can't expect ship ops to start until the coast station operators do. That's passing the buck. The shoreside op says he'd use them but the ship op wouldn't understand him. That's an alibi.

The truth is that 99 44/100% of the whole gang are too QLZ (that one, you may remember, was invented by Bob Cook to inquire if an operator was enjoying his slumber, and could be emphasized by the addition of a few extra Zs, thus: QLZ-Z-Z? It is a pity the convention failed to include it in the new list.) ?? too QLZ to learn the new Q sigs. It's up to every conscientious operator to put this over whether he approves of the new list or not. And the sooner a given few shoreside and ship ops start the ball rolling by refusing to recognize the old sigs and demanding the new; or even by consistently using the new sigs in their own transmissions, the sooner this somewhat chaotic condition is going to be cleared up. If the other man doesn't know them that's his worry. After a few fast ones have been pulled on him he'll wake up.

Come on, gang, let's get rolling.

GMT

From time to time we have received letters indicating the existence of some confusion regarding the use of GMT and GCT as published in schedules that have appeared here. Until 1925 Greenwich Mean Time was reckoned from noon, 0000 corresponding to 1200 Greenwich Civil Time. In 1925, however, GMT was altered to conform to Civil Time, which has been abandoned. GMT and GCT are therefore identical, GMT being the correct term to use.

Due to the fact that readers of the Commercial Brasspounder range the seven seas, and because it is so simple a matter to convert GMT to Mean Time of Place, (M. T. P.) we shall hereafter simplify our procedure by publishing all skeds in G. M. T.

UNITED STATES NAVAL RADIO STATIONS

By Wm. A. Breniman

Broadcast Schedules of the Naval Radio Stations Transmitting Time, WX, Hydro, Ice and Px.

G.M.T.	Call	Wave	Sys.	Material Broadcast
0000	NAY	2265	A2	Wx, Hydro.
0045	NAU	6230	A1	Wx (July 1 to Nov. 15)
0100	NAM	2464	A2	Weather
	NPC	2540	A1	Weather
0115	NAA	72	A2	Aviation Wx & Upper air reports
0130	NPW	2875	A2	Weather, Hydro.
	NAM	2464	A2	Weather
0200	NPO	5220	A1	Press (For naval vessels only)
	NPO	2673	A2	Press (For naval vessels only)
	NAW	2540	A1	Weather (June 1 to Nov. 15)
	NAU	2827	A2	Weather (June 1 to Nov. 15)
0255	NAA	2678	A2	Time Signals
	NAA	435	A3	Time Signals
	NAA	72	A2	Time Signals
	NAA	36	A2	Time Signals
	NAA	22	A2	Time Signals
	NSS	17600	A1	Time Signals
	NPO	5220	A1	Time Signals
	NPO	2673	A2	Time Signals
0300	NAA	2673	A2	Marine Wx, Hydro, Ice reports in season
	NPO	5220	A1	Wx. Hydro.
	NPO	2673	A2	Wx. Hydro.
	NAR	2940	A2	Wx. Hydro.
	NPC	2540	A1	Hydro.
0305	NAA	435	A3	Weather, Navy Yard, Washington, D. C.
0330	NPG	7005	A1	Weather, Hydro.
	NPG	2773	A2	Weather, Hydro.
	NPU	4548	A1	Hydro.
0355	NBA	6520	A1	Time Signals
	NAX	2772	A2	Time Signals
0400	NAA	72	A2	Weather broadcast to Europe
	NAJ	2272	A2	Weather, Hydro.
	NPC	2540	A1	Weather
	NAU	6230	A1	Weather
0430	NPE	2673	A2	Hydro.
	NPL	2940	A2	Weather
0500	NAY	2265	A2	Weather, Hydro.
0555	NPG	4835	A1	Time Signals
	NPG	2773	A2	Time Signals
0600	NPG	2773	A2	Weather, Hydro.
0630	NPM	5555	A2	Weather, Hydro.
0700	NSS	17600	A1	Press (For naval vessels only)
	NAA	2673	A2	Press (For naval vessels only)
	NAA	37	A2	Press (For naval vessels only)
0730	NPU	4548	A1	Hydro.
1000	NBA	6520	A1	Hydro. Press (For naval vessels only)
	NBA	2540	A1	Press (For naval vessels only)
	NAX	2272	A2	Hydro.
	NPL	9808	A1	Press (For naval vessels only)
1300	NPC	2540	A1	Weather
1315	NAA	72	A2	Aviation Wx & Upper air reports
	NAA	36	A2	Aviation Wx & Upper air reports
	NAA	22	A2	Aviation Wx & Upper air reports
1330	NAM	2458	A2	Weather
1355	NPO	5220	A1	Time Signals
	NPO	2673	A2	Time Signals
1400	NPO	8320	A1	Weather Hydro.
	NPO	2673	A2	Weather Hydro.
1500	NAA	2673	A2	Marine Weather, Ice reports in season
	NAA	17	A2	Marine Weather, Ice reports in season
	NAT	2828	A1	Weather
1505	NAA	435	A3	Weather
1530	NAH	2778	A2	Wx, Hydro. Ice reports in season
	NPG	7000	A1	Weather, Hydro.
	NAO	2458	A2	Weather, Hydro.
1545	NAI	2882	A2	Weather, Hydro.
	NAJ	2273	A2	Weather, Hydro.
	NAM	2458	A2	Weather, Hydro. Ice reports in season
1600	NAD	2940	A2	Wx. Hydro. Ice reports in season
	NAF	2540	A2	Wx. Hydro. Ice reports in season
	NAA	22	A2	Wx. brdcast. to Europe
	NAT	2825	A1	Wx. Hydro.
	NAU	6230	A1	Weather
	NEV	2270	A2	Weather
1630	NAQ	2270	A2	Weather. Jupiter, Fla.
	NPL	2940	A2	Weather. San Diego
	NAP	2340	B	Weather. St. Augustine, Fla.
1645	NAS	2678	A2	Weather. Pensacola
1655	NAA	2678	A2	Time Signals
	NAA	435	A3	Time Signals
	NAA	72	A2	Time Signals
	NAA	36	A2	Time Signals
	NAA	22	A2	Time Signals
	NSS	17600	A1	Time Signals
	NAJ	2273	A2	Time Signals
	NAR	2940	A2	Time Signals
	NAT	2823	A1	Time Signals. New Orleans
	NPL	9808	A1	Time Signals. San Diego
	NPL	2940	A2	Time Signals
1700	NAA	2678	A2	Hydro.
	NAY	2272	A2	Weather, Hydro. Brownville, Texas
	NPW	2884	A2	Weather, Hydro. Eureka, Calif.
	NAR	2940	A2	Weather, Hydro. Key West, Fla.
	NPC	2540	A1	Weather, Hydro. Puget Sound
1755	NBA	6520	A1	Time Signals
	NAX	2270	A2	Time Signals
1800	NBA	6520	A1	Hydro. Balboa
1830	NIM	5555	A2	Weather, Hydro.
1930	NPU	4545	A1	Hydro.
1955	NPE	2678	A2	Time Signals. Astoria, Oregon
	NPW	2883	A2	Time Signals, Eureka, Calif.
	NPG	7000	A1	Time Signals. San Francisco
	NPG	4825	A1	Time Signals
	NPG	2773	A1	Time Signals
2045	NAA	435	A3	Weather. Arlington
2100	NAM	2458	A2	Weather, Hydro.
	NPC	2540	A1	Weather, Hydro.
2130	NPE	2678	A2	Hydro.
2200	NAD	2940	A2	Wx. Hydro, Ice reports in season
	NAF	2540	A2	Wx. Hydro. Ice reports in season
	NAH	2773	A2	Wx. Hydro, Ice reports in season
	NAI	2882	A2	Weather, Hydro.
	NPW	2882	A2	Weather, Hydro. Eureka, Calif.
	NAJ	2272	A2	Hydro.
	NAT	2825	A1	Weather. Hydro. New Orleans
	NPL	2940	A2	Weather
2230	NPM	5555	A2	Weather, Hydro.
2300	NAO	2458	A2	Weather, Hydro.
	NAQ	2773	A2	Weather. Jupiter, Fla.
	NAS	2678	A2	Weather
	NEV	2273	A2	Weather
2330	NRU	4545	A1	Hydro.
2355	NPM	2825	A2	Time Signal. Honolulu.
	NPM	11490	A1	Time Signals

In addition to the above NPG, NPM and NPO handle press reports (Paid) on both long-wave and short-wave circuits. No certain schedules.

WANTED

Circuit diagram of the CM 294A ship receiver. If anyone having this circuit diagram will shoot it in, it will surely be appreciated.

Inside Stories of Factory Built Receivers

THE NEW FADA MODELS

The chassis of the Fada 16, 17 and 32 are essentially the same, while those of the 16Z and 32Z differ only in the operating frequency of the power pack, the latter pair being designed for 25 cycle operation and the former three for 60 cycle supply.

The ten posts of the power pack terminal strip are coded in colors as shown in the chart and in the wiring diagram itself. Nos. 1 and 2 go to the on-off panel switch which controls the input to the dynamic speaker field as well as the power transformer when an a.c. speaker is used. Nos. 3 and 4 connect the filaments of the two power tubes to the 5-volt secondary. The center tap of this secondary is grounded to the chassis (*B* negative) through a 750-ohm resistor which supplies the necessary voltage drop for grid bias.

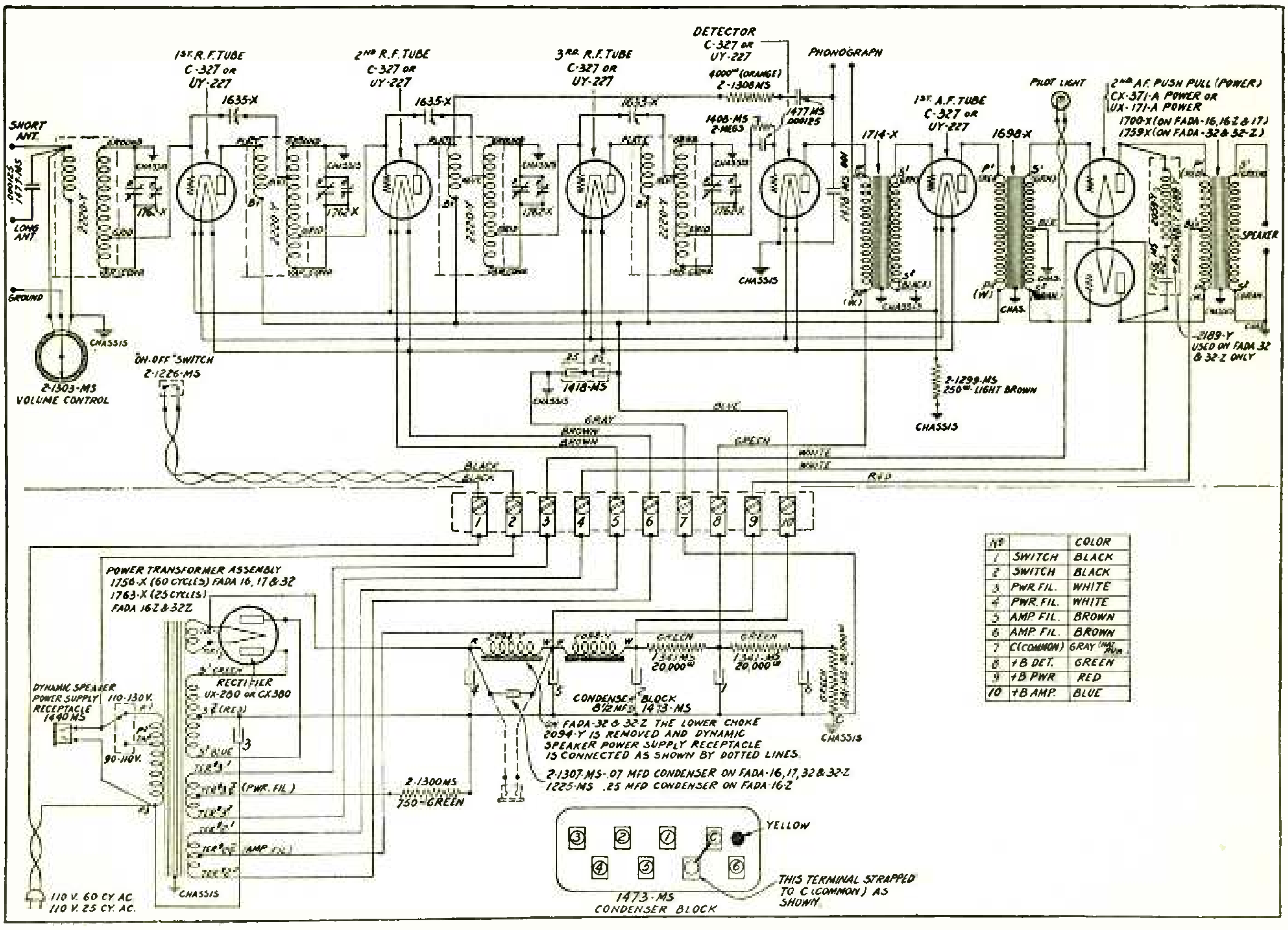
Terminals No. 5 and No. 6 lead the output of another low voltage secondary to the heaters of the r.f., detector and first audio tubes. The center tap of this secondary goes to a point in the voltage divider midway between the detector plate tap and *B*—. Judging by certain indications in the factory drawing this point is assumed to be *B*—, while the ground is referred to as the *C*— lead. This is not correct, however, as the grid bias is figured with respect to the cathode and not the electrical center between the heater leads. Terminal No. 7, the so-called common *C*— lead, connects the *B*— and power pack chassis to the chassis of the set proper. Terminal *8* supplies the detector plate voltage, obtaining it from the 40,000-ohm tap in the voltage divider. No. 9 connects the positive output from the first audio frequency choke to the plates of the power tubes. This choke is replaced in models 32 and 32Z by the field coil of a high voltage d.c. dynamic speaker. As noted in the diagram, a .07 mfd. condenser shunts this field coil in the 32 and 32Z or the choke in the 16 and 17, while a .25 mfd. condenser is used on the model 16Z.

The last terminal, No. 10, connects the output of the second choke to the plates of the r.f. and first a.f. tubes.

A rather unusual volume control arrangement is incorporated in the antenna circuit, a potentiometer being connected directly across the primary of the antenna coupling transformer. In other words, the ends of the potentiometer are connected from antenna to chassis and the movable tap goes to ground. The latter is the only ground connection, all other "grounded" terminals being connected to the chassis and separated from the ground by the amount of resistance in the volume control potentiometer between the movable tap and the chassis terminal. The secondary of the antenna coupling transformer is grounded (to chassis, of course) at one end, tapped for the grid connection and tuned by one of the ganged condensers and its trimmer which are connected to the ends of the winding. The same type of inductance system is used between each of the following r.f. stages as well as between the third stage and detector, except for the fact that each of the subsequent secondaries is tapped near the grounded end by the lead from a neutralizing condenser. The other side of the latter, in each case, goes to the grid of the preceding tube.

With the exception of the two '71-A's in the last stage and the type '80 rectifier tube, all tubes are '27s or heater type tubes. All r.f. cathodes and that of the first a.f. tube go to ground via a 250-ohm resistor which supplies the voltage drop necessary to give these cathodes the proper positive potential with respect to their grids. The detector operates on the principle of grid rectification, employing the customary leak and condenser. As mentioned, the grids of the two push-pull '71-A tubes, being grounded, get their negative bias from the 750-ohm resistor between *B*— and the center tap of the filament secondary. This is located in the power pack. The pilot light is connected across the 5-volt filaments.

The cathodes of the three r.f. and first a.f. tubes are bypassed to ground via a .25 mfd. condenser and the plates of the same tubes are bypassed to the cathode lead by a condenser of like capacity. All four tuning condensers are balanced with trimmers which are carefully set at the factory. The detector plate is bypassed to ground by a .001 mfd. condenser and the primary of the first audio transformer is tapped at each end for the output of a phonograph pickup.



Circuit Diagram for Fada 16, 17, 32, 16Z and 32Z

An Outdoor Audio Amplifier

By W. P. Brush

The amplifier equipment for a theater or large hall requires less power than is ordinarily assumed. A factory-built 2-stage amplifier with a pair of '10 tubes in the output and an efficient dynamic unit with a paper horn baffle has proven sufficient, in practice, to serve a 1500-seat house. Not more than one-fourth of the possible undistorted volume from this little amplifier was required for the satisfactory reproduction of music with 1000 people in the seats.

On the other hand, an installation in an open-air park or race track requires much greater power. Apparatus which is satisfactory for a store front with the reproducer near ground level where surrounding buildings restrict and reflect the sound waves has often proved inadequate in the open air. Nor does any normal increase in power suffice to give sufficient volume, as is evident from a consideration of the great increase in power necessary to give a slight increase in volume.

Thus a '50 tube with three times the power output of a '10 tube gives an increase of only 5 DB. To double the 24 DB. output of a '10 tube at 1.54 watts would require 390 watts! An amplifier using four '50 tubes in push-pull parallel in the output stage will deliver only 3 DB. more undistorted sound than one using two of these tubes in push-pull. But even this small gain is helpful when great volume is necessary.

For outdoor installations, in addition to being weather-proof, the reproducer should give rather over-full reproduction to the bass notes, as the carrying power of this portion of the music is less than the higher notes, and if the reproduction is nearly "straight line," the music begins to sound tinny at a slight distance. This is not a characteristic of "canned music" alone, but holds true of an actual band or orchestra. Another vital necessity in a reproducer for use where there is no building or reflector of any kind immediately behind it, is that some solid background be furnished, from which the sound waves can be projected.

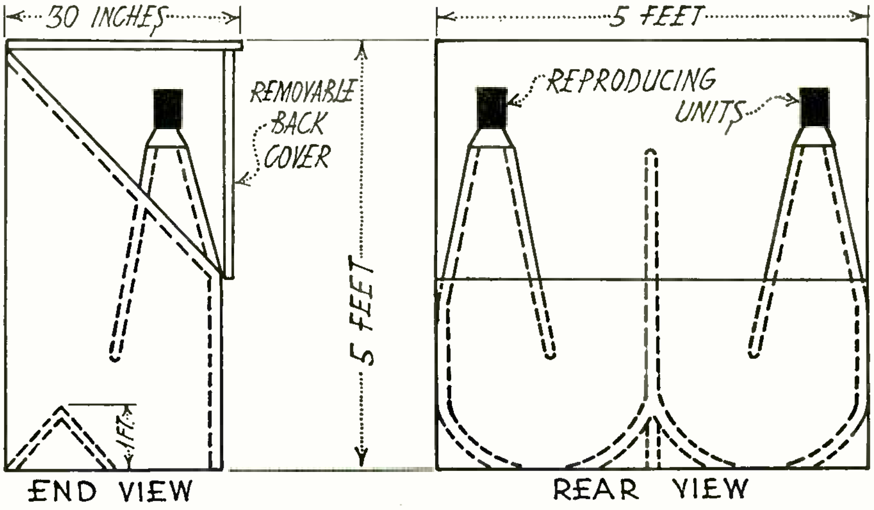
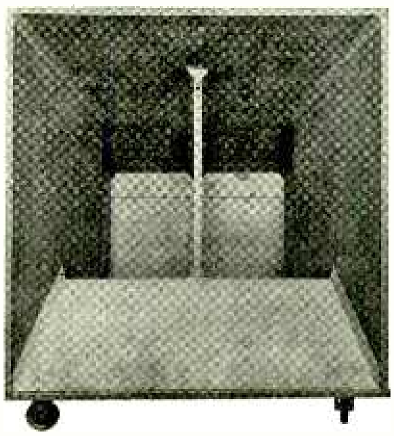


Fig. 2. Reproducer Detail



Reproducer

We have found that, with either flat baffles, or horns of thin material, a very large per cent of the energy is dissipated upward and in directions where it is not needed. An illustration of this is the deflector, which is almost invariably built at the back edge of a bandstand which faces a group of seats.

The picture shows a reproducer we designed to meet such requirements. Fig. 2 indicates the two throats on which the dynamic units are mounted. The material which forms the back and deflecting chambers is white cedar, 1¼ in. thick, lapped and glued. The opening is 5 feet square and the overall depth is 30 in. The total weight, including the 2-lb. drive units, is about 350 pounds. This reproducer delivers very heavy bass note reproduction, but does not muffle the higher register, nor sound "tubby."

While neither circuit nor design of the amplifier is new, when three stages of

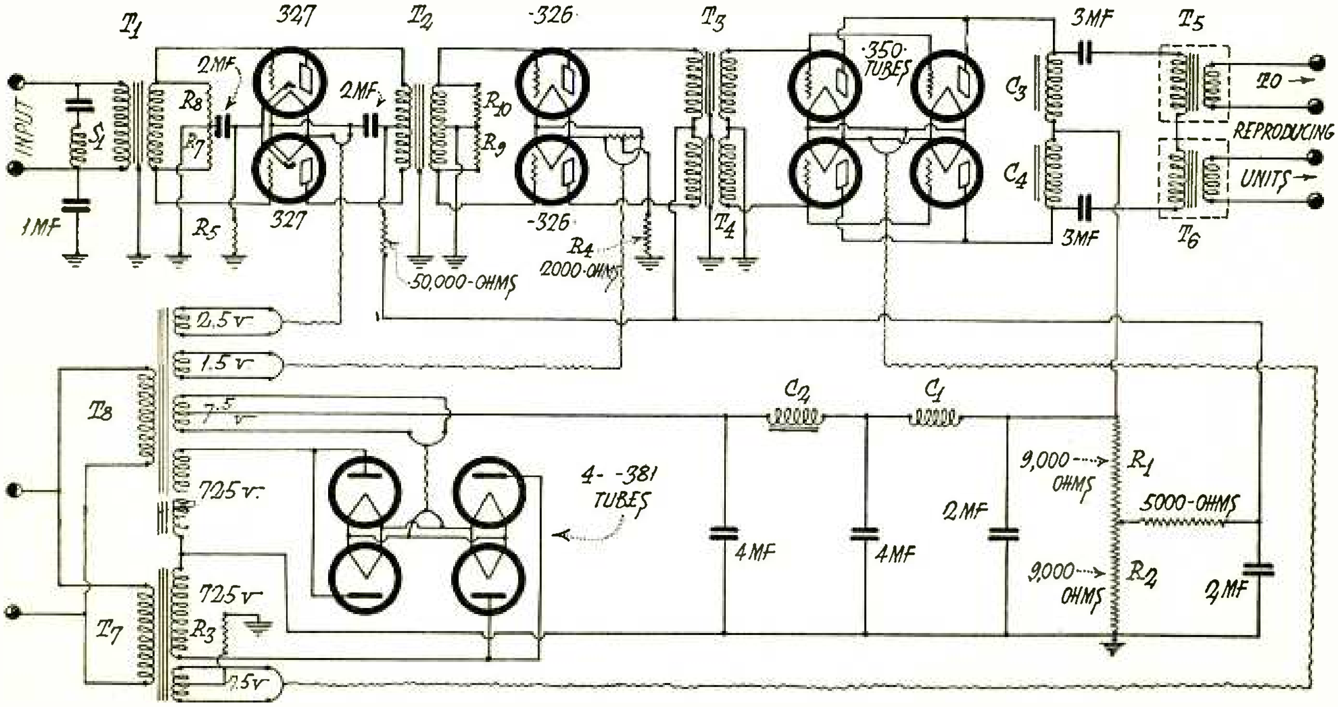
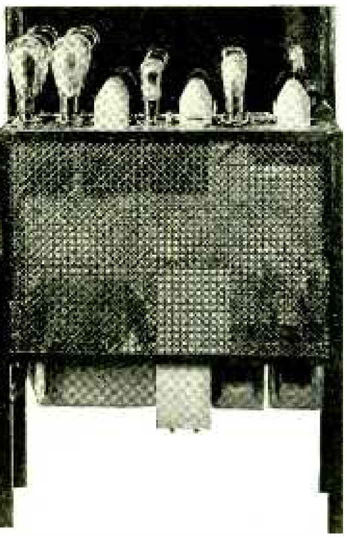


Fig. 1. Circuit Diagram of Outdoor Audio Amplifier

straight transformer coupling (with units of good efficiency and frequency characteristic) are used, and the a.c. grid voltage for the final stage built up to the value permissible with '50 tubes, viz., 59.4 volts, some trouble is apt to be encountered from regeneration, due to feed-back by way of the common *B* and *C* circuits, unless means are taken to isolate the a.c. circuits of the various stages, by means of resistors, or chokes, and condensers in these leads, or by the use of resistors across the secondaries of the coupling transformers. The latter method was used for the following reasons:

To bring the fractional volt available from an ordinary detector tube to approximately 60 volts, necessary for full use of the 350 tube, either extra high ratio transformers, or high-mu tubes, or both, would be necessary, if only two stages were used. However, with three stages, more voltage gain is available than is needed to overload the output tubes.



Completed Amplifier

By the use of grid-leak clips, connected directly to the secondaries, resistors of various values can be clipped in, controlling the gain, suppressing the tendency towards oscillation, flattening the effective frequency characteristic of the coupling unit, and materially lessening the hum, due to pick-up of stray a.c. fields, by the lowering of the sensitivity of these grid circuits.

The reason for the use of push-pull in all three stages is that the cancellation of a.c. hum and harmonic distortion make it very much worth while. In this amplifier, two half-wave power transformers were used, so "poled" as to give full-wave rectification, and as the total load on the high tension supply source was in excess of 250 mils., two '81 tubes, connected in parallel, were used on each side.

The output circuit of the power stage, with two '50 tubes in parallel on each half of the push-pull, presented the worst problem. Output transformers of various makes were tried, but with the large chokes, having an inductance of 30 henrys, with 120 mils. d.c. in the windings, and the primaries of the step-down transformers in the speakers connected in series, as shown on the schematic diagram (Fig. 3), considerably more volume was obtainable, before the overload point was reached, than with any other combination tried.

As previously stated, there is nothing out of the ordinary in the amplifier, but as all of the parts are standard apparatus, the builder can assemble a duplicate with the assurance that it will give very good results.

WHAT RADIO SET SHOULD I BUY?

Radio men are constantly being asked by their acquaintances: "What radio set should I buy?" just as automobile men are similarly interrogated as to the best make of car. In both cases the answer is usually given in the form of a question: "How much do you want to pay and what do you want to hear, locals or distant stations?"

Assuming that the price is to be less than two hundred dollars and that the main interest is in good reception of local programs, most of the nationally advertised sets are very much on a par. Any one of them will give satisfaction.

Of course in this day and age the set should be equipped with tubes designed for a.c. filament supply. This criterion applies equally to those who are buying a set to replace an older type and to those who are buying a set for the first time. The only reason for buying a battery-operated local broadcast receiver is the non-availability of alternating current.

A second consideration is that the set should be equipped with a dynamic speaker, which is largely responsible for the widespread interest in radio reception today. Relatively few persons want a table model set with separate speaker when a combination of the two is available in a single console.

This fact was demonstrated last year by the phenomenal sales of Majestic sets. To Majestic is due most of the credit for killing the old bugaboo of a summer slump in radio. Majestic is also responsible for the decreased sales of custom-built sets, for this was the first factory-built set to incorporate the advanced ideas that were formerly obtainable only from the professional set builder.

Most of the professional set builders are now devoting their efforts to the installation of special amplifier equipment in theaters and other places of public assembly where great volume of sound is desired. They realize that they cannot compete with the standard factory-built a.c. receivers.

Close on the heels of the Majestic success other manufacturers commenced to meet the demand for lower-priced sets with better tonal quality. First among these was the Sparton, with special tubes and a power detector requiring only one audio stage to operate a dynamic speaker. They were quickly followed by the Fada, Kolster, Freed-Eisemann, Eveready, Bosch, Victor and other well-known lines in the medium-priced field.

The low-priced sets, such as the Crosley and the Atwater-Kent, give the biggest value for the money. Their prices are such as to appeal to the greatest number of prospective buyers.

The high-priced sets contain better workmanship and materials and, like the high-priced automobiles, will appeal to the discriminating buyer to whom cost is not the governing factor.

The sales feature of most of the new sets to be shown at the R. M. A. show in Chicago will be in the use of the a.c. screen-grid tube and the new '45 type of amplifier tube. A number of radical ideas are in process of development and may be given their first showing at Chicago. These include the complete elimination of a.c. hum, the use of heavier dynamic speakers, and larger cabinets to give more space for the baffle-board. The band-pass filter will be largely used in r.f. stages, though not to the extent of giving the five-kilocycle separation that is being talked about.

The introduction of the a.c. set has greatly increased the consumption of vacuum tubes, fully 70 per cent of them now being sold for replacement purposes. This is not due to any shorter useful life of the tubes but because the a.c. set is used more hours per day than was the d.c. set with its drain on the battery. New program features have also increased the hours of use.

While this season has not witnessed nearly as much "dumping" as characterized former seasons, a number of manufacturers are trying to reduce their inventories by cutting prices on their old sets. Sometimes this is being skillfully done by unusual allowances on turned-in equipment, as in the case of Kolster sets and Peerless speakers, which are priced too high to meet competition. In other cases there is no attempt to camouflage. Some exceptional bargains are available in d.c. sets with battery eliminators.

Succeeding discussion of this question of what receiver to buy will appear in future issues wherein detailed analysis will be made of the various factory-built sets.

TRADE NOTES

Power Amplifiers made by the General Amplifier Company, comprise a complete line of two and three-stage models for use with a.c. filament tubes. The rating of standard models in undistorted energy to the speaker is 4 watts for the GA10, 12 watts for the GA30, 14 watts for the GA20 and 25 watts for the GA40. All use one or more '50 and '81 tubes and require no output device to the speaker. All components are housed in steel cases; each individual stage is filtered in both the plate and grid circuits; a.c. hum is reduced to a minimum.

Potter Dynamic Speaker Filter is a dry condenser of high capacity, designed to be connected across the field coil of a dynamic speaker so as to minimize a.c. hum. It is intended for use with a speaker which uses a low-voltage rectifier to magnetize the field from an a.c. source. Its leakage current is less than 1 m.a. at 10 volts.

Raytheon Ray S Tubes are high-voltage, half-wave rectifiers intended to supply plate voltage to transmitter tubes. Type SX-866 supplies up to 250 m.a. at 1500 to 2000 volts. Type S supplies up to 300 m.a. at 2000 to 3000 volts. Both combine the high efficiency and reliability of the mercury arc, with the simplicity and sturdiness of a thermionic tube. They use an individually heated cathode to secure long life and stable performance. The former has a d.c. drop across the rectifier of 12 volts and the latter of 17 volts.

The Clarostat Hum-dinger is an extremely compact center-tap resistance which can be adjusted with a screwdriver. It may be used as a center-tap grid return for a.c. filament tubes, for which it is available in a 30-ohm unit in the usual a.c. tube circuit. Other values from 6 to 500 ohms are also available.

The Thordarson R-245 Compact is a combined current supply and one stage audio amplifier for use with the new '45 type of power tube, used either singly or in push-pull. It includes a power transformer with high voltage tap for rectified plate and grid voltages and low voltage taps for the rectifier and amplifier tube filaments, inductance coils and condensers in the filter circuit, and a push-pull audio transformer.

Silver-Marshall have been licensed by the RCA to manufacture radio receivers. A model using a.c. screen-grid tubes will be marketed. A new factory has been secured to supply the anticipated demand.

Raytheon Mfg. Co. has been licensed to make and sell vacuum tubes under the RCA patents.

The Jewel 210 A.C. Tube Tester comprises an a.c. voltmeter, d.c. milliammeter and a transformer that supplies filament current at 1.1, 1.5, 2.5, 3.5 and 7.5 volts through a selector switch. It is equipped with 4 and 5-prong sockets. It gives direct readings of plate current for various grid voltages. It also indicates the rectified current delivered by half-wave and full-wave rectifiers.

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what your set will do
'til you try ARCTURUS TUBES

NEVER before has there been such radio reception . . . such clear-tone reproduction . . . such all around efficiency . . . in *any* radio set.

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Brings in programs in 7 seconds —no waiting

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Your dealer sells Arcturus *Blue* Tubes . . . come in for a demonstration today.

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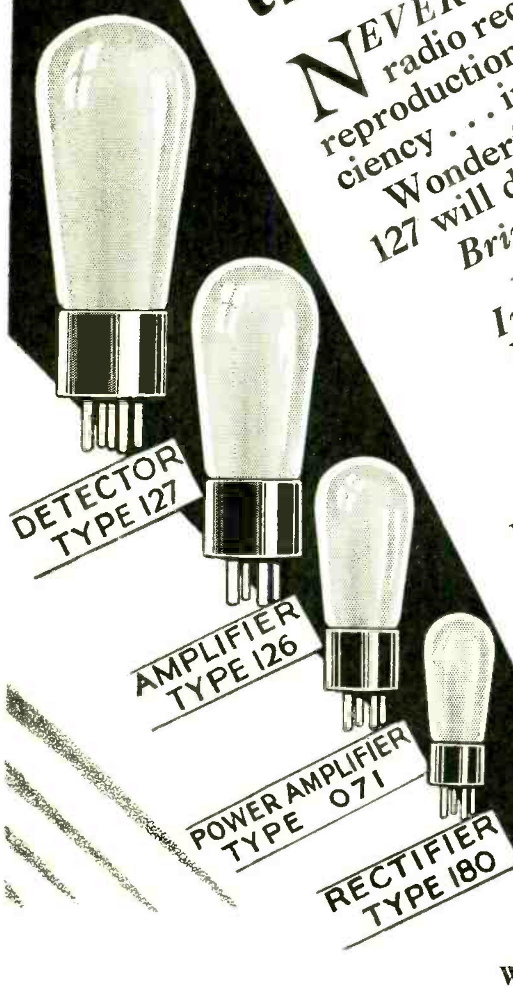

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ARCTURUS
BLUE A-C LONG-LIFE TUBES

EXPERIENCE WITH THE MARSHALL RECEIVER

(Continued from Page 14)

be done in the 40-meter band and need not be changed for other bands.

The condensers C_6 and C_7 are made up from two pieces of brass ¾ in. in diameter and are permanently secured to a bakelite strip. These condensers should be so arranged as to vary the distance between each pair of plates. This may be done by securing one plate to a brass screw which can be adjusted by a wooden screwdriver. The two condensers should be located between the tubes and about the same height as the grid connections.

The chokes $R\ F\ C$ are located approximately 3 in. from the top of the '22 tubes. These chokes are Sampson No. 125 type and are secured to the inside shielding of the r.f. stage. There is a slight feed-back taking place from these coils to the grid circuit. This feed-back is advantageous in that it overcomes the resistance of the circuit.

The two condensers C_1 and C_2 may be Cardwell .00023 mfd. condensers, having heavy rotor plates. These condensers are split by cutting the bus bar spacers at the center point. The rotor member is connected to the positive filament and to the shield. It is therefore at ground potential which eliminates all hand effect in tuning.

The antenna coil L is coupled to the amplifier tuning inductance L_1. The spacing between the coils should be approximately ½ in. Both inductances are wound on plug-in coil forms and have fixed relationship to one another.

C_{12} is a 1 mfd. condenser. C_4, C_5, C_{10} and C_{11} are .0001 mfd. fixed condensers. R_2 and R_3 are 1 megohm grid leaks. Through these resistors the r.f. amplifier grids obtain their d.c. bias, which is approximately 1.6 volts.

The tuned detector circuit uses plug-in coils L_3. The tickler inductance is tapped at the center, which is connected to the plus B through an r.f. choke and the primary of the first audio stage. Regeneration or oscillation control is accomplished by variation of the plate voltages by means of the resistor R_7. The grid and tickler inductances are wound with about ½-in. separation. Below 15 meters these coils are wound very closely together in order to obtain increased feed-back. R_4 and R_5 are ½ megohm grid leaks, which are connected through a common junction to the potentiometer R_6 which is 400 ohms. The correct grid bias for proper detector action may be determined by varying the slider of R_6 to a position where the detector circuit will go in and out of oscillation without a "hangover" effect taking place. This should be done before the r.f. stage has been balanced.

For best operation three shielded compartments should be used. The first compartment should be used for the r.f. stage, the second compartment used for the detector stage and the third compartment containing the two audio stages. After the receiver has been properly built and adjusted, the experimenter will find the following advantages: Retains constant frequency calibration; no reaction between r.f. stage and detector stage; covers any desired frequency; easy to tune regardless of sensitivity and signal intensity.

COIL DATA

Band in Meters	Coil No.	Turns Antenna	Turns Grid	Turns Detector	Turns Tickler	Diameter In Inches
80	1	6	21	21	6	2
40	2	4	13	13	6	2
30	3	4	7¾	7¾	4	2
20	4	3	5	5	4	2
15	5	2	3¾	3	3¾	2
12	6	3	4	4	4	1
10	7	3	3	3	4	1
8	8	2	2	2	4	1
6	9*	2	2	2	4	¾

* Space tickler until desired frequency is obtained. Grid and antenna coils are wound 18 turns to the inch with No. 22 enameled wire. Tickler coils for coils 1 to 5, inclusive, wound 4 turns to ⅛ inch with No. 28 enameled wire. Tickler and grid coils No. 6 to 9, inclusive, are wound with No. 22 silk covered wire. Both grid and tickler coils are wound with turns as close together as possible.

DESIGN OF A.F. FILTERS

(Continued from Page 18)

through them is changed. Therefore it is necessary to have a choke which has the correct inductance at the value of d.c. it is desired to use. It is to be hoped that manufacturers will furnish curves of their chokes so as to show the approximate inductance that can be expected with different d.c. values.

The question of voltage regulation is usually an important one when working from the alternating current mains. Obviously it would be best to regulate the input to the primary of the rectifier transformer because by this means the load on the filter will remain constant. However, I have always obtained excellent results by placing a high resistance rheostat and a milliammeter in series with the positive lead from the filter to the receiver. This rheostat and meter can conveniently be mounted on the panel of the receiver.

The '27 type of vacuum tube with a.c. heater element is rapidly taking its place as an all-purpose tube in sets using a.c. filament supply. It is less sensitive to slight changes in voltage supply than is the '26 type and is freer from hum.

The R. M. A. has defined television as "vision by radio." The unit picture is a "frame." Their recommended standard for frames is 48 lines per in. and 15 frames per second, the latter figure being necessary when standard 60-cycle motors and gears are used.

MARSHALL SHORT-WAVE RECEIVER

(Continued from Page 16)

The grid coupling condensers should have a .0001 mfd. capacity and be of a good grade. They are connected by a flexible wire and a clip to the control grids on top of the tubes. The two grid closure resistances, R_2 and R_3, may be from 1 to 5 megohms. They are brought together and led back to the negative side of the filament through a 6-ohm fixed resistor R_1, which is employed to drop the filament voltage from 5 to 3.3, thereby supplying the grids with this drop of 1.7 volts. The screen grids are fed by a common lead from the 45-volt source, which voltage will not be found critical. A .01 mfd. fixed condenser by-passes this lead to ground.

The plates are supplied with 120 volts through a T arrangement of r.f. chokes which serves the triple purpose of keeping the r.f. currents out of the battery leads, coupling the two r.f. tubes to each other and supplying the impedance necessary to efficient operation of screen grid tubes.

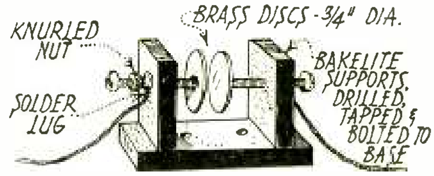


Fig. 3. Details of Criss-cross Condensers

The construction of the criss-cross balancing condensers, C_6 and C_7, was found to be very important, after failing in an attempt to take a short cut by using ordinary mica trimming condensers. The plates of these should be variable, a la screwdriver, and should not be more than ¾ in. in diameter. Dimes might be used, although such usage of our transient medium of exchange is held illegal. Telephone slugs at 1 cent apiece were found to be just the thing, which gives us our choice of the illegitimate use of legitimate money or the legitimate use of illegitimate money. The construction of these condensers is clear in the drawing and in the photograph.

Type G-1 Variodensers have been found satisfactory as coupling condensers and were located in the r.f. section, although there might have been some advantage in having them in the detector can and near the coil mount, which is, of course, an ordinary 5-prong tube socket. Two .0001 mfd. condensers were used as grid condensers and the leaks may be of any value from 1 to 5 megohms.

The secondary circuit is tuned in the same manner as the r.f. grid circuit, with the rotor of the condenser going to A plus and ground. The 200-ohm potentiometer connected across the filaments

(Continued on Page 40)

MARSHALL RECEIVER

(Continued from Page 38)

was located in this can, its variable tap going to the two gridleaks. This lead is by-passed to ground by a 1 mfd. condenser.

As was shown in the coil data, the tickler coil is divided into two halves with the center tap passing through a 250 mh. radio frequency choke, the primary of the first audio transformer and a 100,000-ohm variable resistor for regeneration control to the 22½-volt tap. A 2 mfd. condenser shunted across the resistor smoothes the operation of the latter. The detector grid coil is shown in the diagram as L_3 instead of L_2, due to our failure to catch the error in the drawing.

The voltmeter was originally intended to check all circuits, and a bi-polar switch was installed for that purpose, but due to lack of time and the suspicion that the extra leads involved might be detrimental to efficiency, the operation of hooking it up was put on the shelf until the set had graduated from the experimental stage. As it is, when the detector and audio frequency filaments are supplied with 5 volts, the voltage on the r.f. filaments is known to be 3.3. This was determined in the selection of the 6-ohm resistor in that circuit. The plate voltage reading merely indicated the condition of the batteries, therefore the overall voltage is enough. Perhaps a reading of the detector voltage would have been more interesting, although nonessential.

Nothing need be said about the audio frequency, as it does not differ from standard practice. If music is desired it would be wise to have good transformers and a power tube in the last stage. If quality is not important any old transformers will do.

The sub-panel was made of bakelite and mounted on a pair of standard base brackets. Strips of bakelite were screwed along the sides and back for the sake of appearance. A front panel 9 in. x 18 in. was used, and the sub-panel was 11 in. x 18 in. The latter should have been one inch deeper so that the coils would have more room than in the present laboratory model. Plenty of room should be left so that all semi-variable condensers might be accessible to a screwdriver, and it would be an improvement if the criss-cross condensers were made vertical so that they could be adjusted from the top.

In order that the panel might be laid out symmetrically the audio frequency amplifier was put in the center can with the detector to the right. This necessitated an extra six inches in the coupling leads which might and might not cause a loss worth worrying about. All battery connections were brought to the outlet socket, which was located in the rear of the detector compartment, and for the sake of neatness, were tied together into a cable underneath the sub-panel. The jacks, filament switch and by-pass condensers were also mounted under the base.

The three cans were made up out of No. 20 copper. The top was cut in rectangular form 6⅜ in. wide and 19 in. long. A quarter of an inch on both sides and one end was turned to a perpendicular as shown in the rear view of the receiver, and slits were made in these ¼ in. walls 8 in. from the unturned end. Then the forward section of the copper sheet was bent upward to a right angle with the bottom section, and some solder was spread over the jagged corners of the base. The upper section, consisting of the top and other three sides, was made in a similar manner. The back end, the sides and the lip on front were bent over and soldered together at the corners allowing a ¼ in. overlap for this purpose. A little soap was rubbed on the inside front edges and the shields were slid down over the stationary section.

It is advisable to start operation in the 40-meter band and get the circuit satisfactorily adjusted while listening to a weak signal before going to the lower bands. This is a task that must not be rushed, for it will be found that the adjustment of the criss-cross condensers and the detector coupling Variodensers is somewhat critical and that much depends upon a perfect balance.

The outstanding advantages of the Marshall receiver are its low noise level, selectivity, increased signal strength, adaptability to any wavelength from 3 meters up, ease of control, and, above all, the fact that it will retain its calibration regardless of regeneration, values of filament or plate voltage or any other variation in the circuit. If the r.f. and detector circuits are thrown more than 10 or 20 k.c. (on the 40-meter band) out of resonance, the detector refuses to oscillate until this degree of resonance is restored, yet signals may be tuned in with these circuits off resonance as long as the detector is oscillating. That is to say that a signal may be received if the r.f. circuit is tuned to its frequency regardless of the detector circuit frequency as long as the two circuits are near enough to allow oscillation. When discovered in the r.f. circuit, the incoming signal is intensified by bringing the detector into resonance with it and with the r.f. coil.

PHOTO-TELEGRAPHIC PRINTER

(Continued from Page 22)

paratus of a picture receiver. The experimenter can turn out and true up cylinders of any size for the reception of various systems. The cylinders, driven by the power supplying the lathe, may be turned over while the traveling tool guide will serve as the stylus holder. Gears may also be introduced in the system to step up or down the speed of rotation of the cylinder in relation to the motion of the stylus and a friction clutch may also be readily provided in order to quickly apply the motive power to the cylinder in synchronizing it with the transmitter.

To illustrate this idea more closely, we will consider an electrochemical printing outfit and observe how the lathe may be adapted for this work. In this case, we require a metal cylinder (this usually being of exactly the same size as the transmitting cylinder) which must be accurately centered so that it turns true when held in the chuck of the lathe. The tool guide is adjusted to a speed in relation to the revolving cylinder that a needle, for instance, held by the guide will travel over the surface of the cylinder in a long spiral. When a piece of chemically treated paper is placed on the cylinder a mark is made on the chemical paper corresponding to a similar line or mark of the transmitted picture.

HIGH RANGE VOLTMETER

(Continued from Page 26)

set of rotor and stator plates it can be varied from about 350 to 750 volts full scale reading by appropriate change of counterweights. The counterweight is a short length of No. 22 B. & S. gauge copper wire, 5/16 in. long for the meter shown, and is held 3/4 in. from the center of rotation by the counterweight arm (as far away as possible without hitting any obstructions). The two are fastened by wrapping the strip arm around the piece of wire, and the weight varied by cutting off pieces of wire.

The proper position of the pointer with respect to the moving plates is shown in Fig. 1; approximately at the left edge of the assembly. The counterweight should be located at the lower right edge of the plates for the most legible scale.

The range of the meter should not be varied to extreme limits by the use of a very light or a very heavy counterweight. The range can be changed by changing the number, size, and spacing of the plates, and good design dictates that this should be done. A counterweight one-half as heavy as the other parts of the moving system will give clean-cut definite deflections, which weight ratio should not be departed from too radically.

As is almost universally true in instrument construction the moving system should be as light as possible. Sufficient counterweight effect must be supplied to give adequate restoring torque and definite readings, but the useless or gross weight of the moving element should be decreased by shaving down all possible corners and parts to a minimum. Excess solder, which is comparatively heavy, should be carefully removed. A fewer number of plates or a decrease in size lightens the moving system. This means of increasing the range should be employed rather than excessive separation of the plates so long as actual flash-over does not occur. For 0-1000 v. work two moving plates are sufficient, and for 0-2000 v. ranges one may be used.

For calibration the meter is connected in parallel with a dependable high range, but not necessarily high resistance, voltmeter to be used as the standard. It may be either an a.c. or a d.c. instrument. These are connected across the output of a step-up transformer, *B* socket-power unit, or any a.c. or d.c. source of sufficient voltage and convenient variability. With the case off and the grounded side of the supply connected to the case terminal the rough adjustments to the desired range are made, the supply voltage being shut off before each adjustment for sake of safety. This being accomplished the case is put on, sans glass, and a pencil used to mark the indications of the meter for every 50-volt increment as set on the standard.

50-WATT SHORT-WAVE TRANSMITTER

(Continued from Page 30)

Hartley circuit apply. Shunt the condenser across part of the inductance and set the filament clip between. Set the condenser at a high value and vary the clips until the approximate wave is obtained, then finish with the condenser. The greater the number of turns between filament clip and grid-end clip of the condenser, the greater the grid excitation, and this should not be too great. The filament clip has considerable effect on the note and should be carefully adjusted. When properly tuned, it may be necessary to slightly reset the other clips. The value of coupling, which should be loose, has a slight effect upon the primary adjustments.

An r.f. choke having its natural period at the working wave has some loss due to circulating currents, but this is negligible. A few taps in it will make it possible to select the proper value of inductance. The cushioned socket consists of 4 pieces of spring brass and 2 porcelain fuse-holders. About 10,000 ohms should be used for the grid leak with the usual tubes, although the 852 requires a little more. The support for the secondary consists simply of a cardboard box and a piece of glass. The antenna is connected by means of clips which make contact with the copper strip, bent around the edges of the glass.

The whole is mounted experimenter-fashion and is efficient. Any kind of adjustment may be easily made and no trick arrangement to vary the coupling is necessary. The set shown will oscillate at 20 meters with voltages as small as 10 volts on the plate, and that is better than most sets can do. One of the main advantages of this set is its low cost; and the average amateur, with the average bank-roll, usually appreciates this advantage.

BOOK REVIEWS

"Radio Receiving Tubes," by James A. Moyer and John F. Wostrel, 297 pp., 5 x 7½ in., published by McGraw-Hill Book Co., New York City. Price, $2.50.

This new text presents all the essential facts about the theory, construction, testing, and use of two, three, and four-electrode tubes in a readily understandable form. After tracing the early development of vacuum tubes, telling how they are made, and explaining the fundamental facts of electricity, the authors give a complete exposition of the theory of vacuum tube action. They then present practical data on reactivation and testing all of a tube's constants.

Succeeding chapters discuss detection, r.f. amplification, a.f. amplification, oscillation, and rectification. One chapter on specifications for vacuum tubes describes the characteristics of each of the standard tubes as used for these various purposes. The concluding chapter describes special industrial applications of vacuum tubes, including remote control.

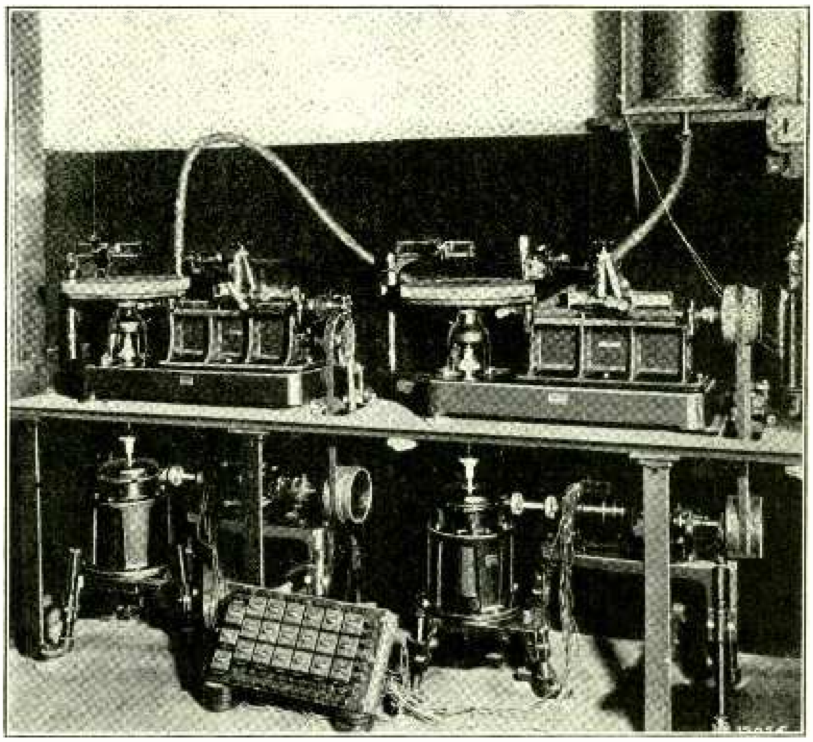
The treatment covers all of the various types of tubes which were available for use in receiving sets until the close of 1928, including the '26 and '27 type of a.c. tubes and the '50 type of power tube. The manner of presentation is as non-technical as is consistent with accuracy, and should offer little difficulty to a student who has the equivalent of a high school education. The one notable omission, which should be corrected in the future editions to which this book is destined, is discussion of the theory and use of the vacuum tube voltmeter. Radio service men and experimenters will find this book very useful in their work, as it brings many widely scattered facts into compact and usable form.

HOW THE MOVIES ARE MADE TO TALK

(Continued from Page 13)

whereby either the variable density film or the disc records may also be reproduced as sound.

The "wax" records used in the Vitaphone method are "laterally" cut, i. e., the groove is of constant depth and oscillates or undulates laterally about a smooth spiral. The recorder is an electromechanical device whose diagrammatic view is shown herewith. This is designed to operate over a range of frequencies from 30 to 5000 cycles, a typical characteristic being shown in Fig. 8.



Electromechanical Receiver for Vitaphone

The original discs are composed of a metallic soap and are from 13 to 17 in. in diameter. This is placed in the recording machine, which is essentially a high-grade lathe whose stylus cuts from the center toward the outer edge of the disc. The "wax" shaving is removed by air suction. The cutting speed is from 70 to 140 ft. a minute, the space between grooves being about .004 in.

The original "wax" record is brushed with an extremely fine conducting powder and is then electroplated, the first electrotype being called a "master." This negative is in turn electroplated to produce a positive from which is plated a metal mold or "stamper." A thousand or more pressings may be made from a single "stamper." The sound is then reproduced by means of an electric pickup similar to that used in the electric phonograph.

Great success has been attained in re-recording parts of these disc records so that the material may be entirely rearranged, portions being deleted or added. In this connection a story is told of deleting an accidental "Oh, Jesus" into an innocent "Oh, gee," without which an entire picture and sound record would have been spoiled.

Most of the information here given is taken from papers presented before the Society of Motion Picture Engineers and printed in the *Bell System Technical Journal* for January, 1929, to which credit is due for many of the illustrations used, and to which the reader is referred for details.

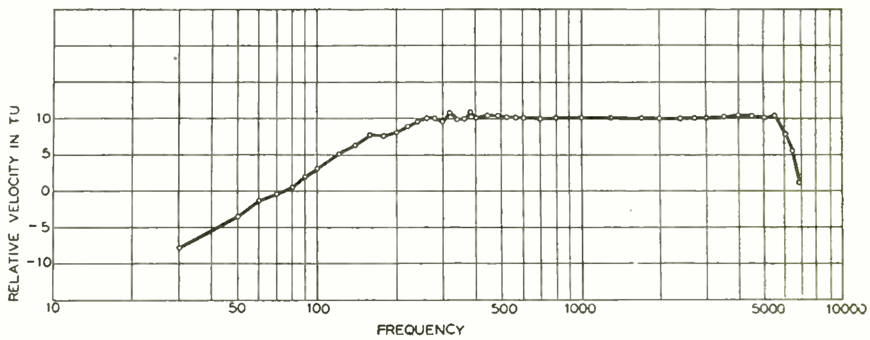
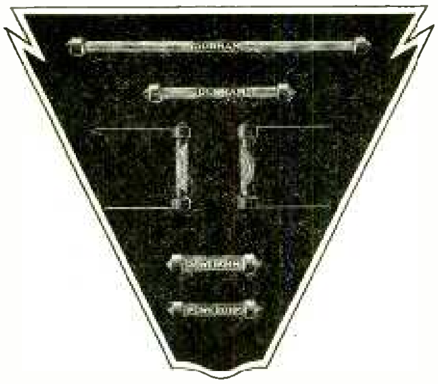


Fig. 8. Typical Frequency Characteristics of Vitaphone Recorder



The New
Improved
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EACH succeeding year, more and more important manufacturers of radio, television and talking movies are standardizing on DURHAMS — the resistances which are dependable, accurate in rating, and can be relied upon for long continued and uninterrupted service.

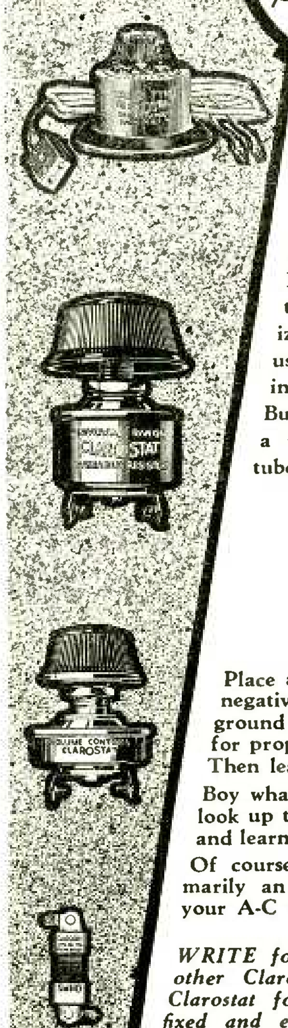
Supplied in 1 and 2 watt types in standard, pigtail or special tips; temperature rise at 1 watt is 45° C. and at 2 watts 74° C.; all types are flash tested at double the rated power load as an extra precaution against electrical or mechanical weaknesses; extremely rugged construction; supplied in all ranges from 500 to 200,000 ohms in power types and from 1 to 100 megohms in resistor types.

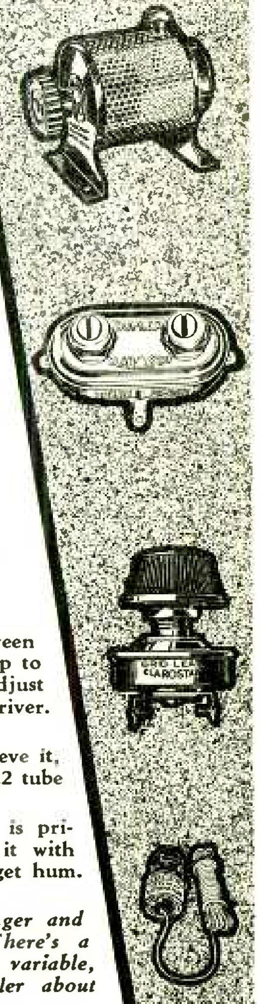
Samples for testing gladly sent upon request, together with engineering data sheets. Please state ratings in which you are interested.

International Resistance Co.
2006 Chestnut Street, Philadelphia, Pa.

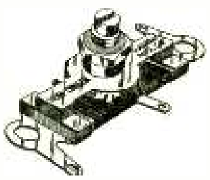
DURHAM METALLIZED RESISTORS & POWEROHMS

here's a TONIC for screen grid tubes!





Unless you are the one man out of every hundred radio men, you are working your screen-grid tubes at low efficiency. The main cause is failure to bias the control grid at 1½ volts. Most fellows don't bother with that grid bias. They don't realize its importance. Besides, the usual methods, such as dry cell in ground lead, are troublesome. But here's a new and better way—a real tonic for your screen-grid tubes:



Place a Clarostat HUM-DINGER between negative A and filament, with center tap to ground side of antenna tuning unit. Adjust for proper grid bias by means of screwdriver. Then leave it set.

Boy what a difference! If you don't believe it, look up the characteristic curves of the 222 tube and learn the reason why.

Of course the Clarostat HUM-DINGER is primarily an improved hum-balancer. Use it with your A-C filament tubes, and you can forget hum.

WRITE for data regarding the Hum-Dinger and other Clarostat products. Remember, "There's a Clarostat for Every Purpose"—adjustable, variable, fixed and even automatic. Ask your dealer about Clarostats, he knows!

CLAROSTAT MFG. CO., Inc.
Specialists in Radio Aids
287 NORTH SIXTH STREET BROOKLYN, N. Y.
SAN FRANCISCO LOS ANGELES PORTLAND

Remember—there's a CLAROSTAT for every purpose

SILVER THE KING

Gosilco Super Aerial Wire
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Greatly Increased DX Range. 50% More Volume—Clearer Tone—35% Sharper Tuning—Non-Corrosive. Endorsed by Naval Research Laboratory. Gerald M. Best, Van Buren, World's DX Champion. A permanent investment. No. 14, 100 ft., $4.00; 75, $3.25; 50, $2.50. Pat. App. 12728. If dealer cannot supply you, write us. Over 50,000 GOSILCO Aerials in use—There's a Reason.
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Radio Dealers Supply Service 1452 Market Street
Wholesale Division of OFFENBACH ELECTRIC COMPANY San Francisco, California

AN OPEN LETTER

TO OUR FRIENDS AMONG THE READERS,
MANUFACTURERS AND ADVERTISERS:

We believe that you will be interested in knowing what has happened to all of the periodicals published by the Experimenter Publishing Company and the Consrad Company since these companies were forced into involuntary bankruptcy on February 20th. We also believe that you are interested in what we contemplate doing in an editorial and advertising way; and though space does not permit us to give you an outline of our plans in detail, we hope you will read between the lines of this summary:

The record of the various publications turned out by the Experimenter Group indicates that there has been a very substantial drop in advertising and circulation during summer months. As a rule, the functioning of the business here has been carried on during those months at quite a loss. With the interest in RADIO NEWS continuing to go downward and the business going down with the interest, and with this summer season coming on, several of the principal creditors threw the Experimenter Company and the Consrad Company into involuntary bankruptcy in order to prevent the necessity of extending additional credit, in order to protect the investment they already had in these publications.

The Court appointed the Irving Trust Company as Receiver in Bankruptcy. The Irving Trust Company called upon Mr. B. A. Mackinnon, who was for twenty years Circulation Director of Pictorial Review and is at present a successful publisher of several magazines, to take care of the circulation and production end of this business. The Trust Company called upon me to run the advertising and editorial end.

According to a statement made by the Auditors for the Trust Company, the period from February 20th to the 28th showed a net profit on the entire Experimenter business of more than $25,000, whereas up to that time the business had been running at a very heavy loss. The magazines carried more advertising for May than they did in May a year ago. They are carrying more advertising in the June numbers than they did in May. This is the first time that such a condition has existed since 1922, which was the banner year in the radio business.

Beginning with the June numbers, all of the publications in the Experimenter Group and the Consrad Company were put under the hammer, and a new corporation headed by Mr. Mackinnon has purchased them; and all of the creditors are assured of their money. Mr. Mackinnon paid more than a half million dollars for these publications. Incidentally, Radio Broadcasting Station WRNY and W2XAL, which was owned by the Experimenter Group and was offered for sale along with these magazines, was considered to be a heavy liability when these properties were taken over by the Receiver. The best bid for the broadcasting station at that time was $7500. The station was sold during the Receivership Sale for $100,000 cash to a group of aviation interests.

AND NOW FOR OUR PLANS:

Without, in any way, reducing the amount of radio text material, we are going to incorporate in both RADIO NEWS and SCIENCE AND INVENTION, sections devoted to all kinds of flying, including the construction of man-carrying gliders, sport planes and the like. To our mechanically-minded readers, here is an entirely new field of endeavor which will enable them to use the knowledge they have gained in radio in another extremely interesting field. Here is an opportunity for the radio parts manufacturers to go into the manufacture of parts for gliders.

Aviation is, today, in exactly the same state of development as the radio business was in 1919. With the combined circulation of RADIO NEWS, SCIENCE AND INVENTION and AMAZING STORIES of over 375,000, here is an advertising opportunity for manufacturers of anything that can be used in this field.

Beginning with the June issues, our readers will be pleased to see that in RADIO NEWS there will be sixteen additional pages which will carry the aviation part of the magazine without, in any way, reducing the amount of radio material.

We feel sure that our readers and advertisers will be glad to know that the paper stock used in our magazines beginning with these issues is also of a superior quality.

A number of people have told us that it is impossible to publish a radio magazine successfully when there is a dying interest in Radio. We do not agree. We feel sure that you will be interested in watching what happens during the next few months.

Cordially yours,

Arthur H. Lynch

Editorial and Advertising Director
EXPERIMENTER AND CONSRAD COMPANIES

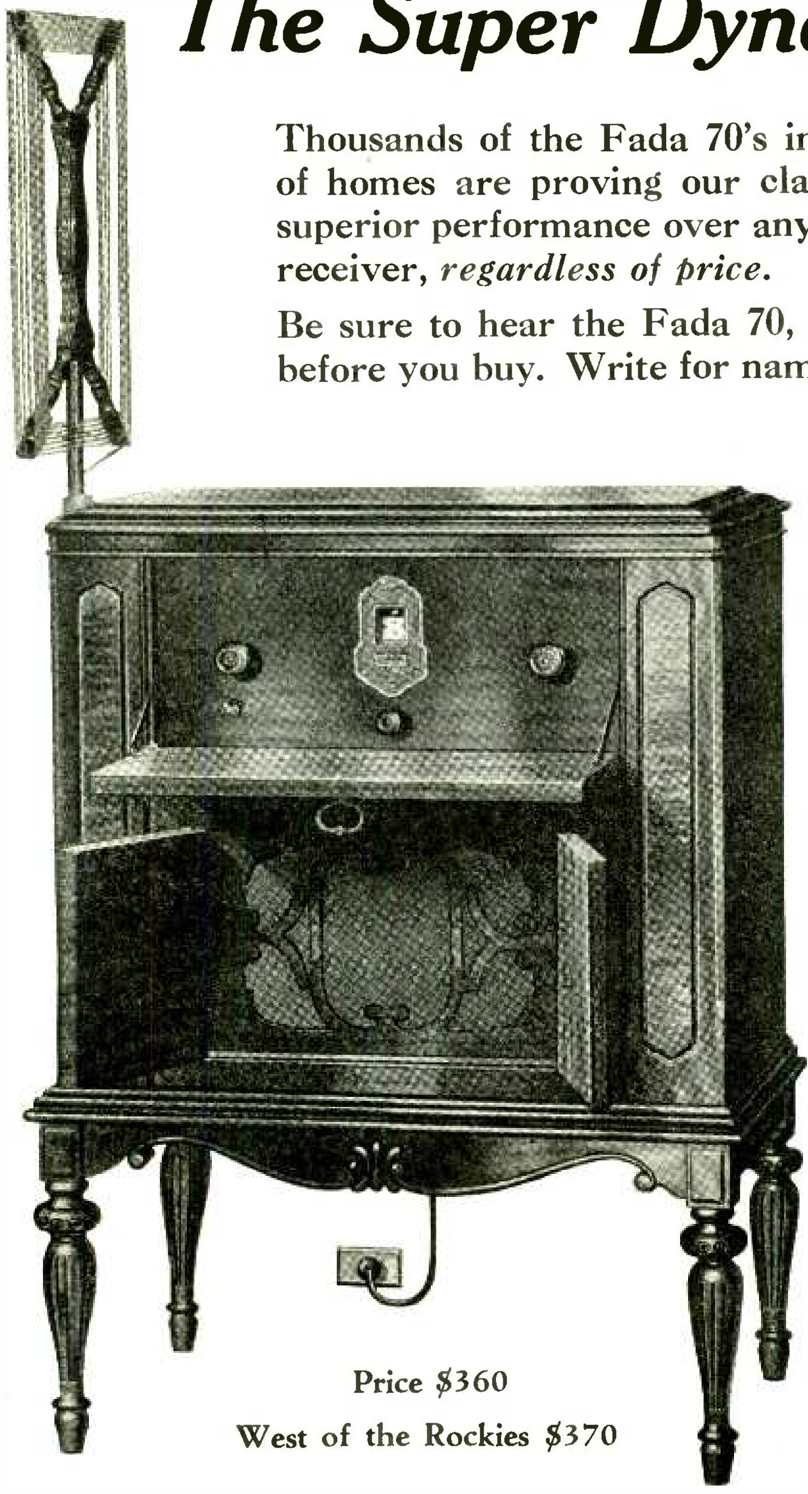
FADA Radio

FADA 70

The Super Dynamic Radio

Thousands of the Fada 70's in daily use in thousands of homes are proving our claim that each will show superior performance over any other standard make of receiver, *regardless of price.*

Be sure to hear the Fada 70, the Super Set of Radio, before you buy. Write for name of nearest dealer.



Price $360

West of the Rockies $370

FADA 70

A. C. Electric Console Model.
Built-in Fada super dynamic speaker.
Burl walnut cabinet.
Single illuminated dial.
Push-pull amplification.
Completely shielded.
Disappearing loop antenna.
Indirect heater A. C. tubes.
Phonograph attachment jacks.
Volume control on R. F. side independent of tube operation.
Extreme faithfulness of reproduction from 20 to 6000 cycles.
Uses six 227 indirect heater type tubes, two 210 power amplifiers (push-pull) and one 281 rectifier. For operation on 50 to 60 cycle, 90 to 130 volt A. C. Lines.

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F. A. D. Andrea, Inc.

Long Island City, N. Y.

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