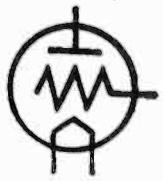
ELECTRONICS

JUNE
1939



KEITH HENNEY
Editor

Crosstalk

PUBLIC RELATIONS . . . Several readers have written us letters recently which come under the head of public relations; especially as relating to good will between technical people and their employers.

One reader notes with satisfaction that progressive factories have regular safety campaigns and safety programs. This is a sign, he thinks, that management realizes that conservation and preservation of life and limb pays from the standpoint of the community. Someone else might feel that management tries to save limbs to prevent being sued by the loser of the leg—but that is beside the point, probably.

Then our reader wonders why management does not take the same interest in maintaining and improving the happiness, contentment, and morale of the workers? Why they don't try to prevent the occurence of mental grievances?

This is a good point. The chief reason is, we believe, because management itself is well fed and well housed and wears nice clothes, with the kids well along in school. When a man gets to the point where he is a bit free of worry he forgets the earlier troubles; and so the guy in the front office may never bother to wonder about Joe Goofus in the shop who may only have $20 in his pants pocket per week, and who may be working with only a couple of footcandles of illumination over his desk or his machine; and who may have problems all out of proportion to his ability to solve them.

Undoubtedly there are many bosses who are suffering from contentment, and who really and honestly think all their employees are correspondingly happy.

▶ **VOTE PLEASE** . . . A group of store executives recently surveyed their employees to learn how these workers would rate certain job factors. We won't tell you now how 3,000 men and women voted—but we ask you as an employer, or employee, to rate them and to let us have your list. The factors are: Fair pay, interesting work, credit for all work, personal counsel, opportunity to learn, departmental planning, job security, promotion on merit, understanding and appreciation, good physical working conditions.

▶ **GOOD JOBS** . . . Have we mentioned this before? Recently we have interviewed many young engineers and writers who were looking for jobs. It is remarkable the number of times the applicant has stated that the actual salary expected was not as important as the knowledge that the job would be one in which he would be happy. As one engineer stated, "my wife and I have talked over the matter of pay, and we have agreed that if I am happy at the job, it is worth good money to us."

▶ **ART** . . . During the Toscanini concerts, NBC was dismayed by the appearance of duplicated tickets (so the story goes.) A little detective work disclosed the fact that in the printing plant where the tickets were made there was one lowly printer who coveted a seat to see and hear the Maestro at first hand. But tickets were available, through the regular channels, only to those with a good deal of influence. It was a matter of few minutes, during lunch hour, for our friend the printer to knock out a few tickets for himself, and later to present himself at the studio. How would you handle a situation like that?

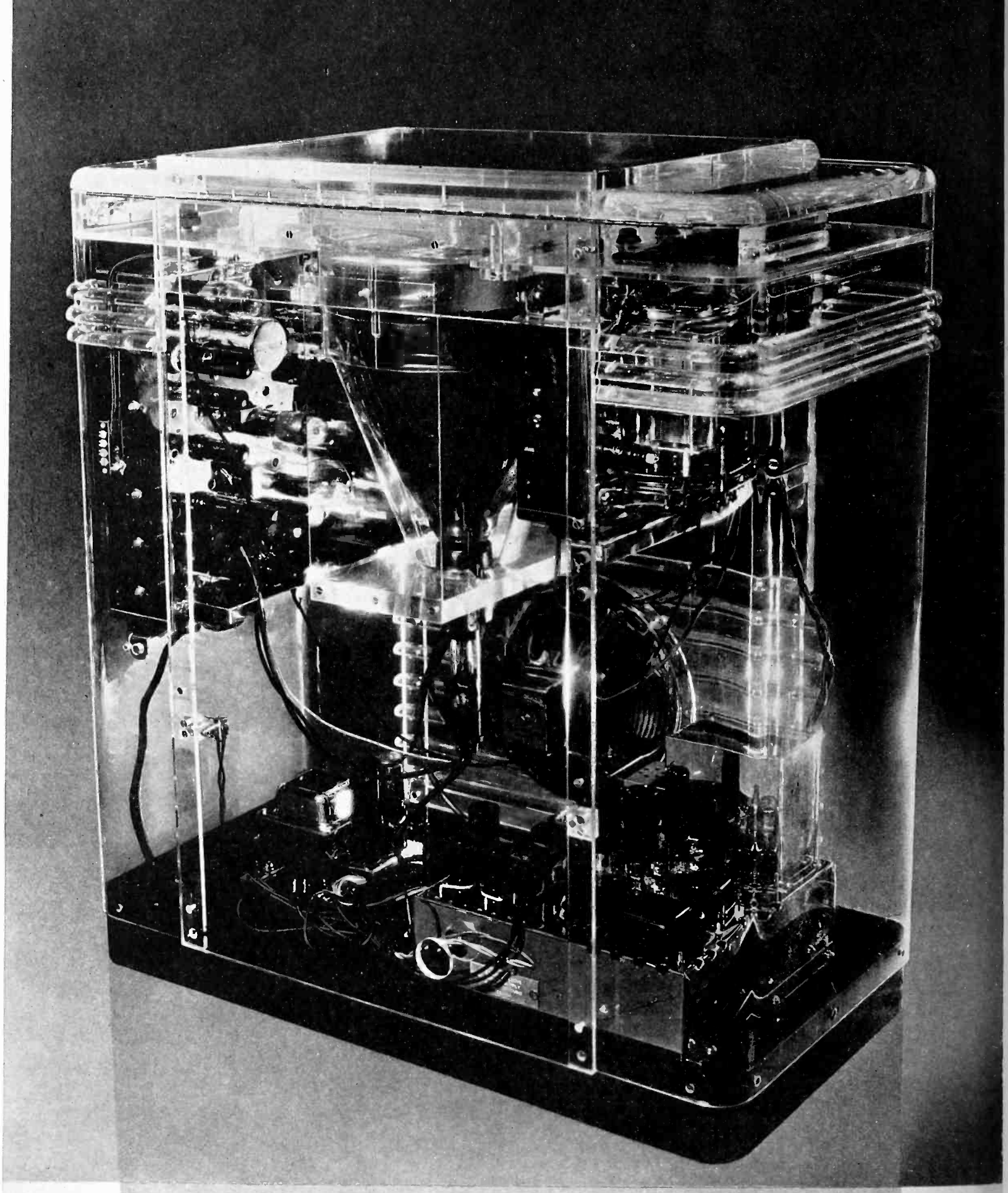
▶ **NAVY** . . . We heard a good story on a naval officer recently. It seems that, a long time ago, an amateur down in Charleston put up a Ford spark coil and made the air hideous for the Navy. Finally the Navy rigged up a loop and traced the signals to this poor ham's attic.

What do you suppose they did? Throw the fellow in jail?

They confiscated his rig and invited him to come over to the Navy yard in 10 days. When he arrived there, they presented him with a full fledged tube transmitter, ready to go. Furthermore they helped him put up a knock-em-dead antenna, and greased the ways at Washington so that he got his license with less than usual delay. How's that for public relations?

▶ **SPEAKERS** . . . World's Fairs touch the lives of thousands of manufacturers and the radio industry is having its day in court at the New York World's Fair where amplified sound is playing an important part. One leading speaker manufacturer (Cinaudagraph) has over 1800 speakers in 76 different spots at the New York World's Fair. These speakers run from 6 inch PM's to the new (world's largest) 27-inch electro dynamics used at the spectacular fountain, light and sound demonstration that goes on each night at nine o'clock at the Lagoon of Nations. There's a lot of electronics at the New York World's Fair which will be reported on soon.

▶ **REPRINT** . . . So many requests are on hand for reprints of Don Fink's series of articles on *Electronics*' laboratory receiver and for other articles on television published within the past year that they have been reprinted. In the same book will be found the series by Engstrom and Holmes, the Television Formulary and other material in much demand from men now faced with television problems. They may be obtained (50 cents each) from the Editorial Department.



INSIDE STUFF—

RCA reveals all, with the aid of a lucite cabinet, in this 36-tube television-radio receiver on exhibit at the New York World's Fair. The receiver is a standard model, chromium plated, polished, and in working order.

TELEVISION in the FIELD

Public television service in New York is just one month old. Herewith is a brief report of its problems, as well as its accomplishments, in this initial period of growth

AS this issue of *Electronics* goes to press, television is just one month old as a public service in New York City. Within that time, receivers have been placed on the market, prices established, sales made, installations completed. The field experience of the television system, with the public as judge, has begun. While it is hard to collect conclusive evidence in so short a time the editors offer this brief report.

Sets and Prices

A trip to Macy's department store on May 25th revealed as of that date four manufacturers have models priced and for sale: Andrea, DuMont, and RCA and Westinghouse. The only Andrea model thus far announced is a table model with a five inch "short" cathode-ray tube, containing 16 tubes and equipped to receive two channels. The price is $189.50. The DuMont Line has four models, all employing the same 22-tube television-sound chassis with 14-inch picture tube. A table model sells for $395, two consoles for $435 and $445, and a large console with all-wave radio for $540. The RCA line includes a sight-only 5-inch picture-tube television chassis at $199.50, a 5-inch sight-sound console model with all-wave radio at $295, a 9-inch 36-tube console with all-wave radio at $495, and a 12-inch console all-wave at $600. The only Westinghouse receiver on display was a 5-inch sight-only unit at $199.50.

The kit prices are universally lower. A Meissner kit, sold complete with tubes for $134, contains 16 tubes, and can be assembled and put in working order without test equipment. The Andrea kit, price $79.95 without tubes (tubes about 50 dollars extra), has been widely sold through other outlets. The Fulton Radio Corporation has a kit for sale, $89.50 without tubes ($55 extra for tubes). Reports are that several hundred kits were placed within three weeks after program service began.

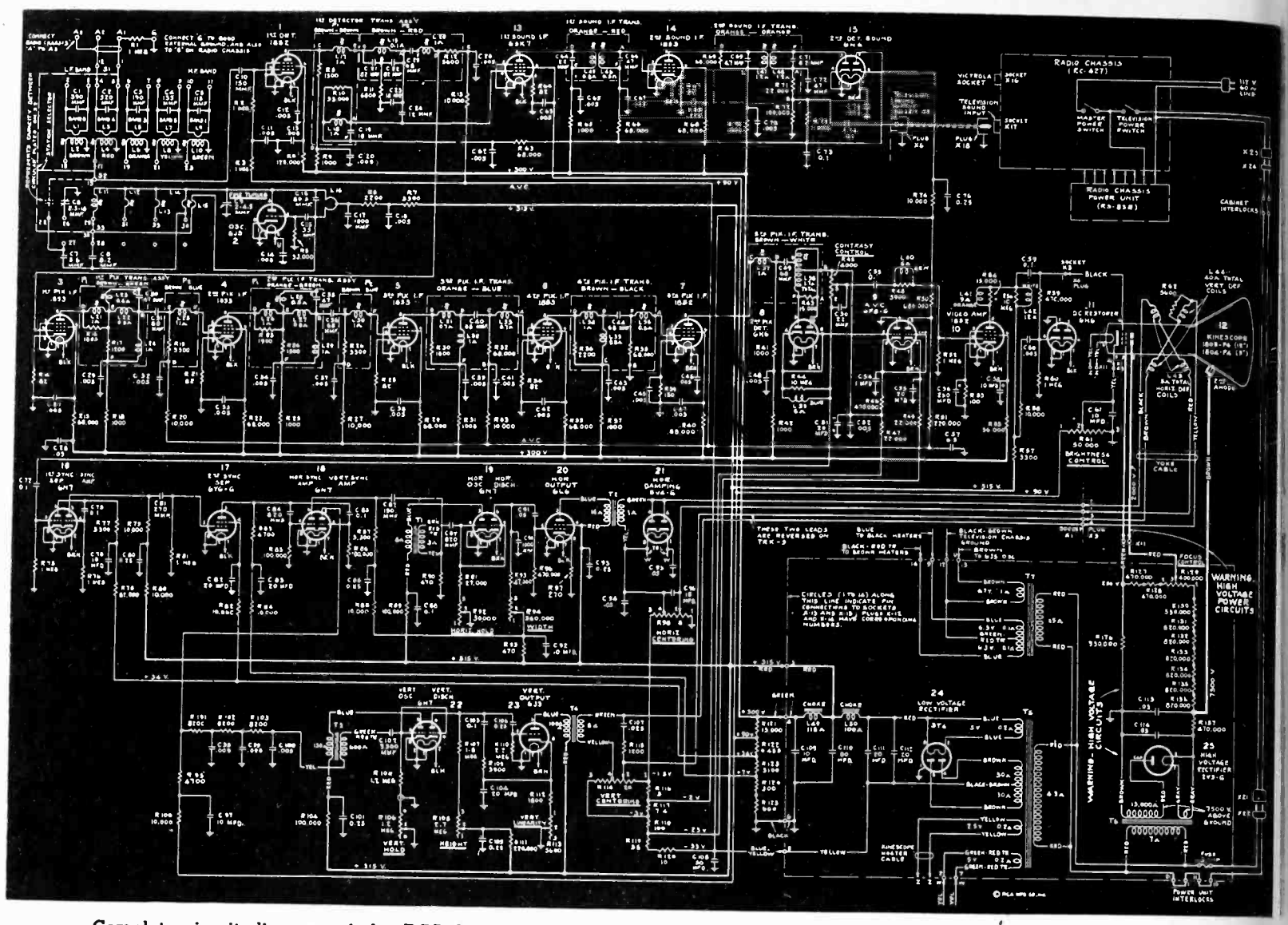
The sales of complete sets are difficult to estimate, but a rough checkup indicates that between 1000 and 2000 sets have been put in the hands of distributors and dealers by the manufacturers. Of these, only a small percentage, perhaps 300 or 400 in all, have been sold to the public. The total television audience, including field test receivers of the RCA system, is estimated at close to 500, exclusive of dealers. The dealers find as many as a thousand people a day dropping in to see the telecasts. A line of 100 people is usually on hand at Macy's before the 11:00 A.M. broadcast begins and later in the day the crowds increase.

Program Schedules and Techniques

The broadcast schedule at present maintained by NBC (the CBS transmitter is not expected on the air with programs until July) consists of a total of 25 hours per week. The "regular" programs, including variety acts, plays, etc., run from 8:30 to 9:30 Wednesday and Friday evenings. Saturday evenings have been occupied with sporting events picked up by the mobile units. Film transmissions, intended for use in demonstrating and installing receivers, are maintained from 11:00 A.M. to 4:00 P.M. Tuesdays and Fridays, and from 4:30 P.M. to 8:30 P.M. Wednesdays, Fridays and Saturdays. The film transmissions consist of approximately ten minutes of film (educational subjects for the most part) followed by a five minute intermission during which a standard test chart is displayed.

The programs are similar to those broadcast during the past year during the field tests of the system, but the advent of single-sideband transmission has considerably improved detail of the image and over-all quality. Remote pick-up broadcasts from the World's Fair have been made several times with good results. The mobile-unit trucks made a trip to Baker Field at Columbia University and were successful in radiating a broadcast of the Princeton-Columbia baseball game to the Empire State transmitter where it was rebroadcast to the public audience. The fact that only one camera was available to cover so large an area as a baseball field made it difficult to recognize the players and follow the detail of the plays but, with the aid of expert announcing by Bill Stern, the performance was projected satisfactorily, in the opinion of sports fans. Later, the trucks were run into the basement of Madison Square Garden, the camera placed on the grand-stand and a telecast of the six-day bicycle races broadcast at night, with the aid only of the standard projection lighting fixtures in the ceiling of the arena. The broadcast marked a milestone in remote pick-up practice, since ordinary telephone wires were used for the connecting video line, over a distance of more than a mile from the arena to Radio City.

The television signals were picked up by the NBC telemobile unit from the edge of the track at the Garden and were transmitted over existing telephone cables to the Circle central office on West 50th Street, and then over a similar circuit to NBC at Radio City. Special amplifier attenuation equalizers and their phase equalizers were provided at the Circle office and both the terminals. The adjustment of the over-all circuit was such that the signal was delivered at Radio City without noticeable impairment although the illumination available was far less than



Complete circuit diagram of the RCA Victor type TRK-12 television receiver, one of the most elaborate designs now available to the public. The physical arrangement of the receiver is shown in the frontispiece of this issue

was used for studio pickup, and thus made the undertaking a difficult one. The results were felt to be distinctly satisfactory.

This accomplishment has created considerable interest because of the use of pairs of ordinary telephone cable rather than the coaxial conductor which had been generally associated with the transmission of television signals. The use of ordinary telephone cables under certain conditions and properly arranged and equipped for the transmission of such a wide range of frequencies as television requires was discussed in a paper by A. B. Clark of Bell Labs before the American Institute of Electrical Engineers in January 1935. The recent experimental accomplishment is a practical demonstration of the possibilities which he then described. The energy loss of television current, however, in passage over a mile of ordinary telephone cable is about a million times greater than over a mile of coaxial cable. A series of measurements on the cable must precede its use. There must be some alterations in it, and the provision of amplifiers, and of special apparatus for equalizers of attenuation and phase. The recent experiment, therefore, does not imply that ordinary cable pairs can be economically used for television, except over comparatively short distances. What the experiment does show, however, is the possibility of using telephone cables to pick-up television news and carry it over short distances to main lines of coaxial cable or to nearby transmitting stations. At the time of the broadcast, the available amplifiers and equalizers were suitable for a maximum video signal of 3 Mc, and this range can be extended.

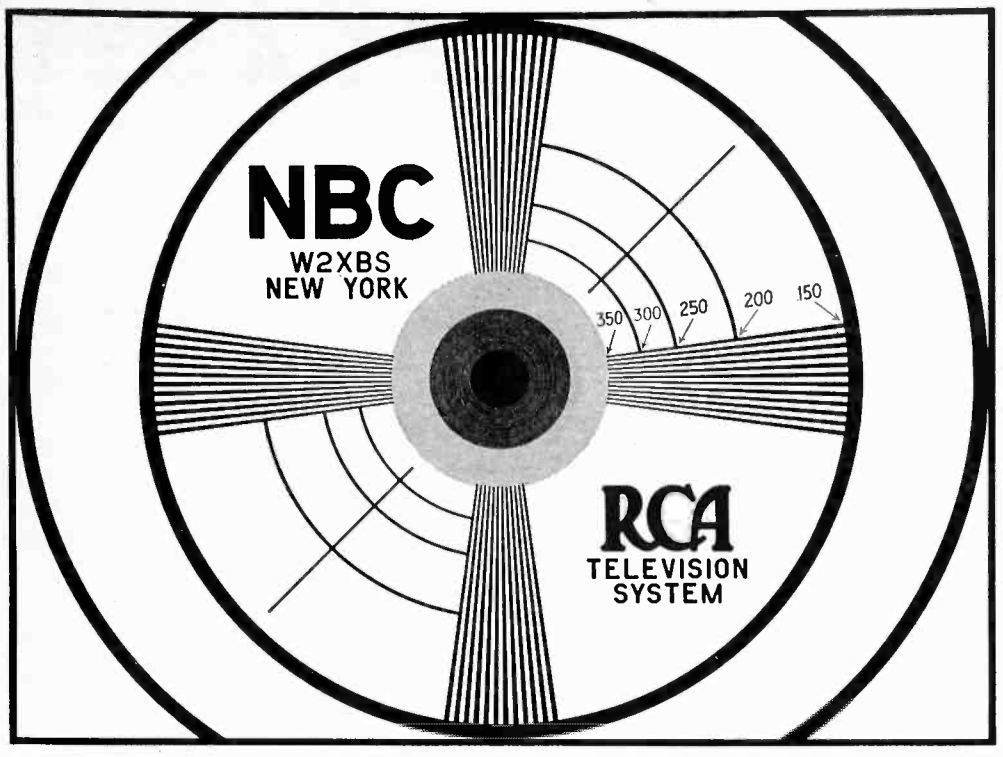
Installation Procedures and Problems

The first installations have brought out the serious nature of several forms of interference, all of which have been prominent in earlier tests but which were tolerated because the engineers understood their cause and the difficulty of avoiding them. The public cannot be expected to be so lenient. Ignition interference is apparently the most serious offender. In the writer's experience, a dipole antenna was installed on the roof of an apartment house, 60 feet above, and roughly 50 feet back from, a traveled highway about 10 miles airline from the transmitter. The signal level existing at the antenna, at the upper end of the transmission line, exceeded one millivolt. The ignition from trucks, buses, and early vintage passenger cars is the most serious. In the presence of the carrier, the ignition "rattle" can scarcely be heard in the loudspeaker, but its effect on the picture is definitely noticeable as a loss of line synchronization, which is restricted to small groups of lines (perhaps five or ten lines in a group). The frame sync is very seldom affected, however.

The troublesome nature of diathermy interference has been very well illustrated in *Electronics'* laboratory, where the television receiver described last year (July to December issues) has been used to receive the transmission from W2XVT, the DuMont station at Passaic, N. J. This station has an output power of

50 watts, and is located 9.5 miles from the McGraw-Hill Building. The antenna heights are 80 feet at the transmitter and 495 feet at the receiver. The calculated signal strength is approximately 500 microvolts, but substitution measurements indicate that the actual signal strength is in the neighborhood of 100 microvolts. The receiver is successful in reproducing a synchronized image, but the interference is, of course, very prominent. Diathermy interference destroys the image fully 25 per cent of the time. Ignition is much less prominent, due to the height of the receiving antenna above the street. Tube and circuit noise is plainly visible when the gain is maximum.

The reflection problem, which produces ghost images, may arise in a variety of guises. In the antenna system on the McGraw-Hill Building two separate dipoles are mounted on the same standard, nearly at right angles, one two feet above the other. One of the dipoles has an extremely low-loss lead-in composed of 50 feet of "twin" coaxial cable (two cables bound in a single sheath), balanced to ground. If the terminals of this cable are left open-circuited, a reflection is induced which completely obliterates the fine detail of the image when the receiver is connected to the other dipole. When the low-loss line is short-circuited, the reflection disappears. When two or more dipoles are installed near each other, as on the roofs of apartment buildings, this effect can readily occur, and it may be extremely difficult to find unless access to both lead-in terminations is available.



Standard test chart used during current NBC telecasts. The numbers indicate the degree of resolution, i.e., the number of times the width of the black lines is contained in the picture height (the numbers do not appear in the pattern as broadcast)

Sales Methods—and Mistakes

The demonstration of television receivers to the public is as yet not too thoroughly understood by many dealers. The necessity of shielding the face of the cathode-ray tube from external light has been recognized in most instances (most dealers have provided a darkened booth, or corner of the store protected by a heavy curtain in which to demonstrate the receivers). But the effect of the settings of the brightness and contrast controls on the appearance of the image is not so well appreciated. In one store visited by the writer, great care was taken to shield the receiver from stray light, but the brightness control was set at a level two or three times the maximum value for which the engineers designed the set. This made a very bright picture (there was plenty of gain to allow adequate contrast even with excessive brightness) But the excess current in the scanning beam caused the scanning spot to assume a diameter three or four times its normal value, and the detail of the reproduced image suffered in inverse proportion. When the test pattern appeared between the film transmissions, the resolution wedges for showing vertical detail showed less than 200-line resolution whereas 300- to 350-line resolution would have been normal performance. Had the demonstrator been aware of the trouble he could have corrected it by a twist of the brightness knob, and after the eye had accommodated itself to the decreased brightness (a matter of a few seconds only) the picture would have appeared nearly as bright and

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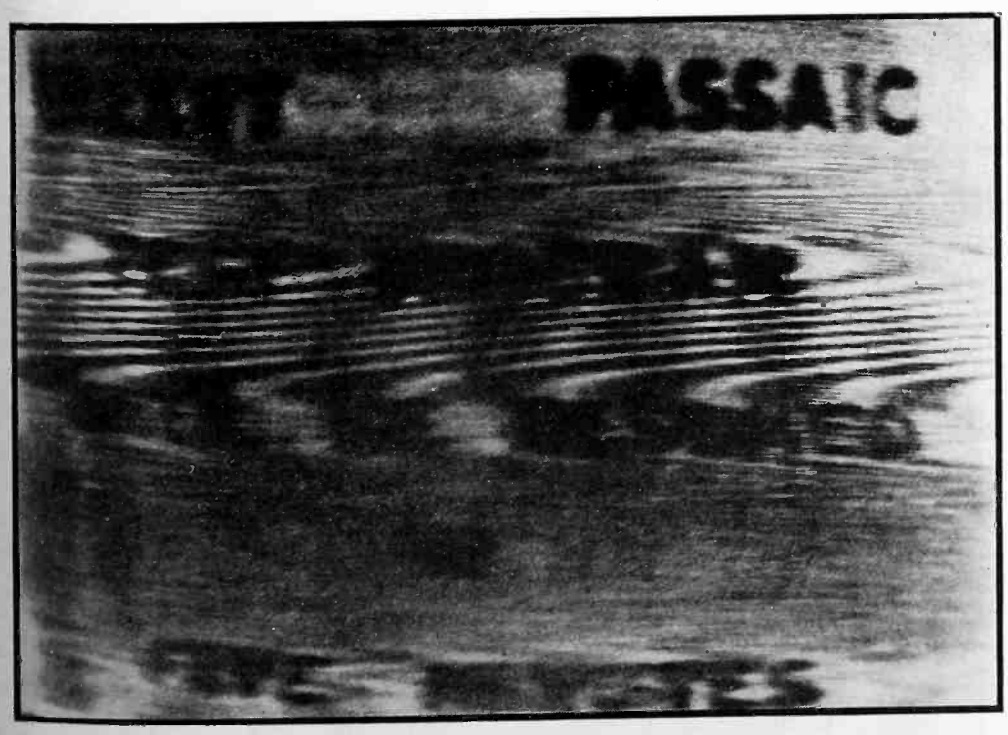
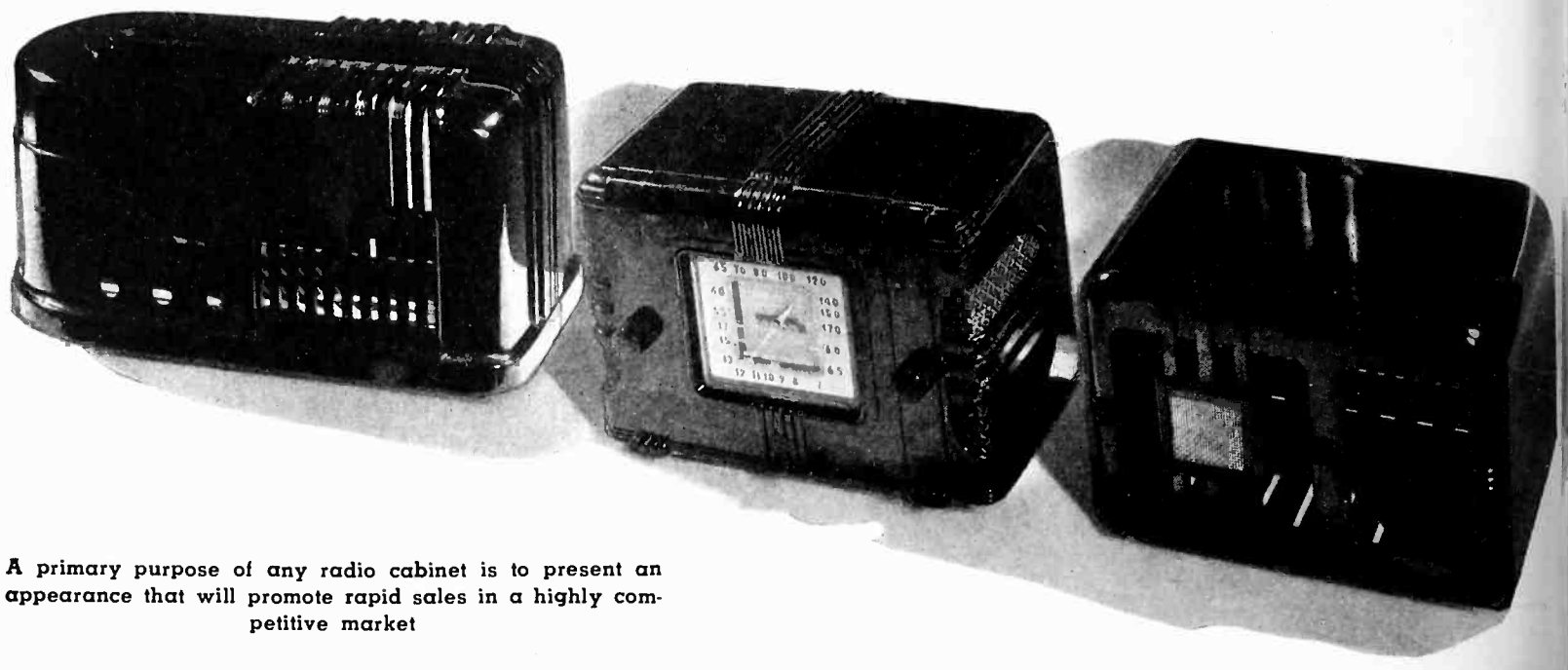


This transmission from the DuMont station, of high quality when initially broadcast, has been impaired by interference almost beyond recognition. The signal level at the receiver was about 100 microvolts. Diathermy interference (center wavy lines) and circuit noise (note "I" in Passaic) are troublesome at such low signal levels

PLASTIC CABINE



A primary purpose of any radio cabinet is to present an appearance that will promote rapid sales in a highly competitive market

CASUAL observation of molded plastic radio cabinets may lead to the conclusion that they do not involve any very special problems in design. Those with experience in such design, however, will be the first to testify to the contrary. From another point of view it may be said that although the design is not especially difficult, there are many difficulties in adapting the design to economical production unless the designer is familiar with practical plastic molding.

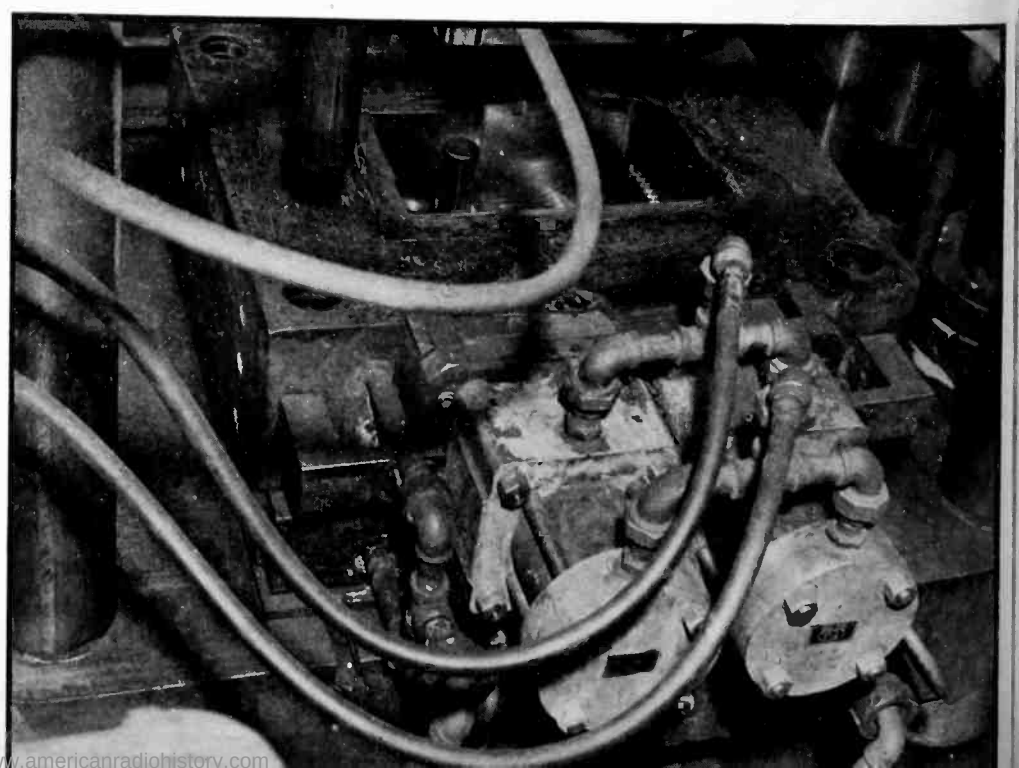
A primary objective of any cabinet is to realize an appearance so fine that it will promote rapid sale in a highly competitive market. The fact that the cabinet is to be molded does not insure fine appearance. Some designs which are excellent from an appearance standpoint cannot be molded or they may present so many molding difficulties that their cost is excessive. For this reason, even though the designer is acquainted with molding practice, some competent molder should be consulted early in the design.

In laying down a design, it must be remembered that it is to be produced in a rigid steel mold and must be made so that it can be withdrawn from the mold and also so that the male "force" which shapes the interior, must be capable of being withdrawn from the molding. It should also be remembered that the plastic is nearly always introduced into the mold in powdered form or in solid pills. Heat causes it to soften or "flux" and pressure causes it to flow, but there must be enough space between the force and the mold to permit adequate flow before the heat and resulting chemical reaction causes the plastic to harden.

Open Back vs Open Bottom

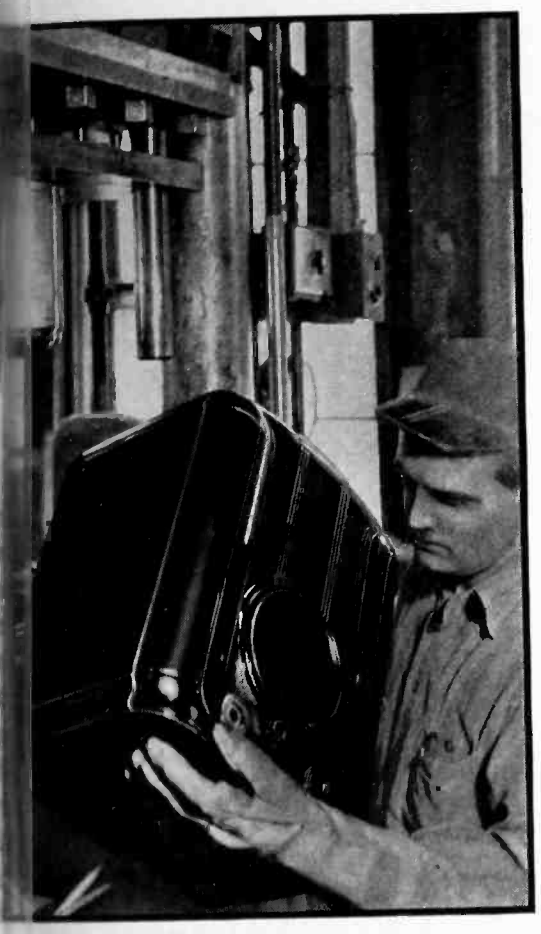
If, as is usual and almost essential for minimum cost, the cabinet is to be molded in one piece, it must be decided whether the opening for the force is to be at the back or at the bottom of the cabinet. A back opening, even though covered, is usually unsightly from the rear, whereas a cabinet with a bottom opening can be made sightly from any angle. On the other hand, it is an easy matter to form openings for dial, grille, knobs and buttons on the front when a back opening is chosen, and such front openings may be much more difficult to form and may involve greater mold cost and slower molding in an open bottom cabinet. In general, it is cheaper and better to form as many of the openings as are required by the force or by shallow projections in the bottom of the mold cavity and to have the plane of these openings at right angles to the axis of the force. It is easy, however, to form openings in the side walls, if the walls are sloped inward or are rounded and, somewhat less advantageously, if provided with suitable offsets, even though the walls are approximately parallel to the force. In the latter case, however, the off-

Openings in the side of the cabinet are formed by the use of side cores. The photograph below illustrates typical method of forming side openings

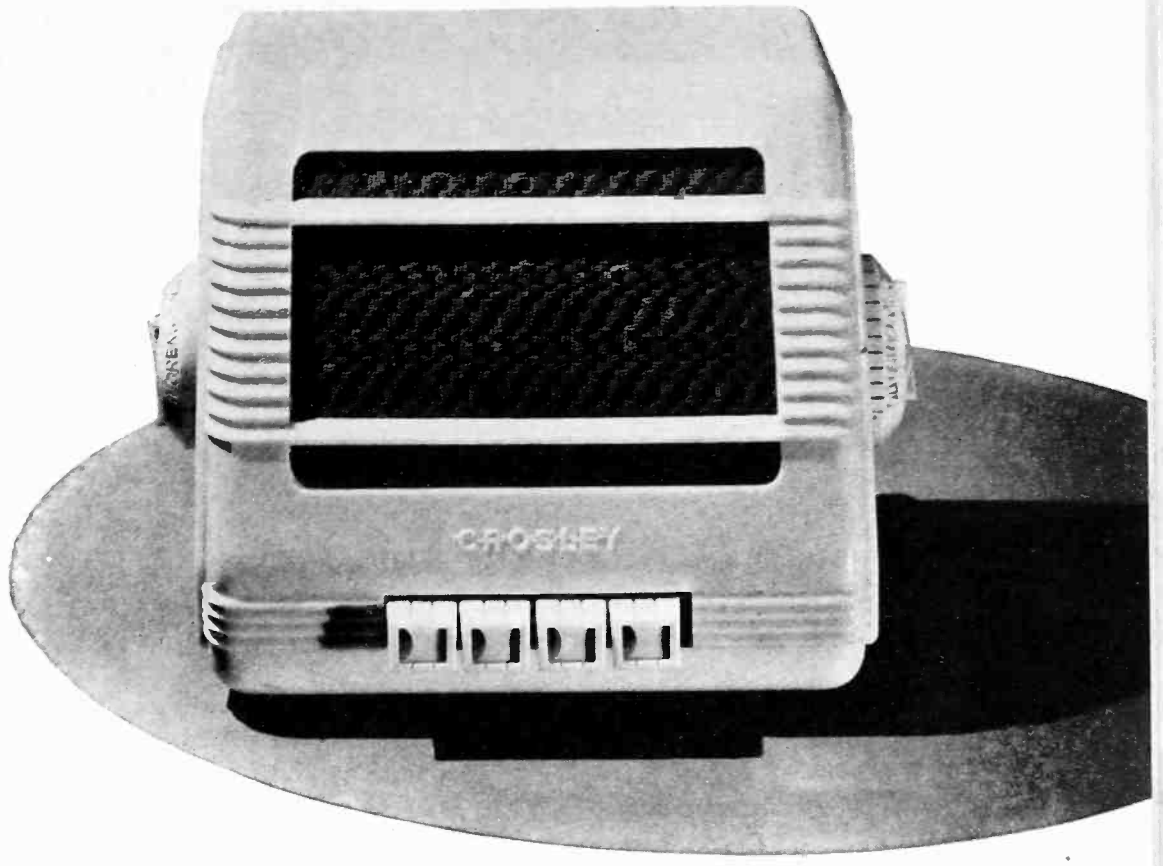


SIGN

By HERBERT CHASE



For minimum cost it is almost essential that the cabinet be molded in one piece



The location and shape of openings determines whether the cabinet is to have an open back or an open bottom

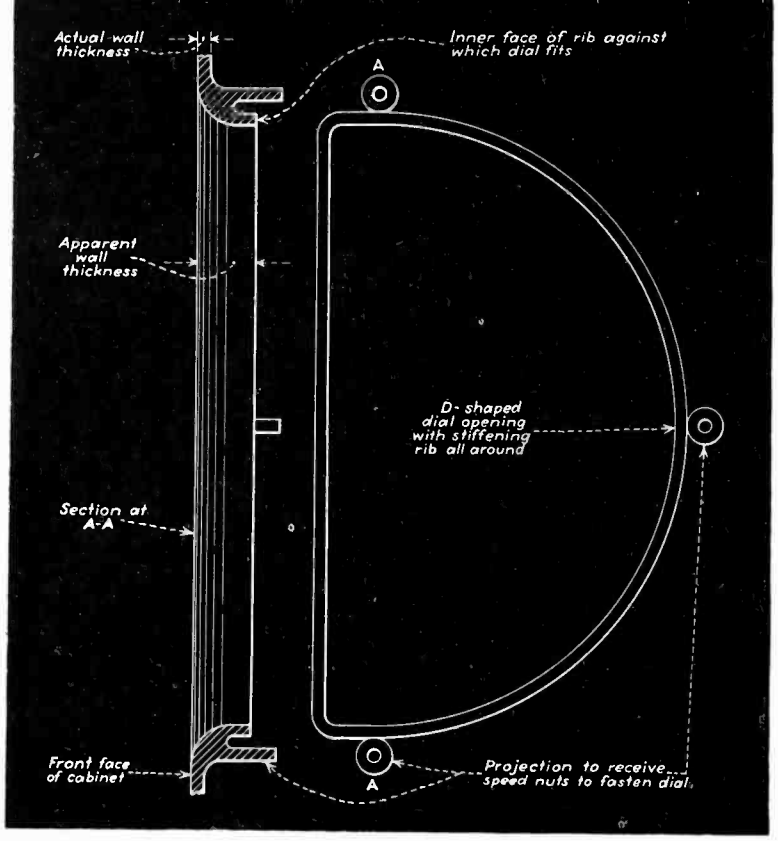
set, whether on the force or in the side wall, must clear the molding, that is, not interfere with its withdrawal from the mold or with removal of the molding from the force. The slot or opening must extend to the bottom of the cavity if it is formed by a projection on the cavity wall or to the open side of the molding if it is formed by a projection on the force.

Another way of forming side openings is to use a side core or a loose piece in the mold which is withdrawn with the molding and afterward detached from the latter, but although feasible, this increases mold cost and is likely to lengthen the molding cycle, yielding fewer pieces per day and thus increasing the cost per piece. For this reason, it is usually better to drill side holes than to core them if they are small and circular, but large side holes, unless formed as indicated in the foregoing paragraph generally have to be cored from the side.

Projections

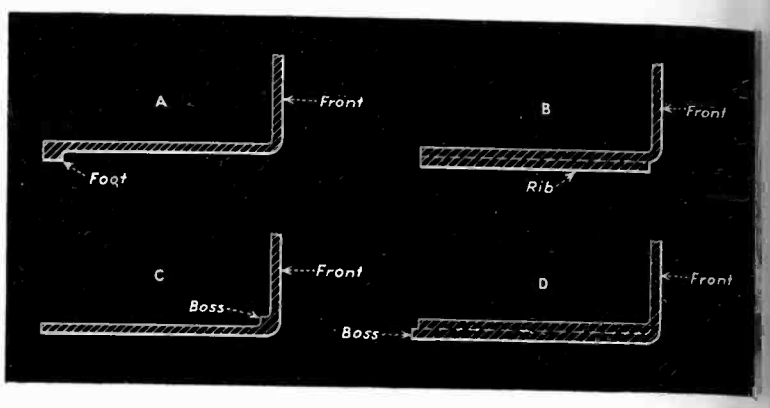
Somewhat similar considerations control the use of projections on the outside of the molding. They can be made readily on the front of a back-opening cabinet or the front can be recessed (as with bas relief designs, for example) but corresponding projections or recesses on side walls cannot be used if they involve undercuts unless side cores or loose pieces in the mold are provided. A foot can be molded on the bottom of a back-opening cabinet if placed next to the rear edge, but an integral foot placed at the front edge has to be carried back as a rib all the way to the back edge. Similarly, a boss projecting from an inner side wall can be formed at and against the front, but a boss required at the rear edge of a side wall has to be carried as a rib down to the front wall. In a translucent cabinet the rib may show to some extent from the outside. It is considered good practice to place such ribs in the corners of cabinets rather than midway on side walls, as they tend to strengthen the cabinet more if at the corners. These boss ribs, even when not required for screws to hold the back plate (which is sometimes fastened only to the chassis) may be needed to take the thrust of ejector pins. The latter must be provided, as a rule, on the force. As the molding which tends to shrink onto the force is lifted out of the mold on the force, it must be pushed off by some form of ejector or stripper. Ejector marks made against lugs do not mar the finished cabinet.

Most of the foregoing points will become apparent on a solid model of a new design and such a model should invariably be made before constructing a mold, not only to reveal such items, but to make apparent other possible defects in the design. The cost of a model is likely to be much more than offset by savings in mold alterations which, having to be made in hard steel, are always expensive. A good model will help in locating and arranging details of openings, will show just how the grille or louvres will look, where flash will come and where flash lines will show least. It will make apparent where bosses and ribs should be placed, will determine how any lettering or decoration will look and will help to make sure that the chassis can be fitted in as desired with assurance that controls and



The strength of the cabinet, as well as the apparent thickness and consequently the appearance, is increased by the use of a stiffening rib around large openings

Care must be exercised in the location of feet and bosses. A foot may be placed at the bottom rear and a boss at the inside front, but a foot at the front or a boss at the rear must be a rib extending the full depth of the cabinet



speaker will come exactly where required.

Louvres and Grilles

Recent designs have tended toward the use of louvres rather than grilles. Some designs of louvres have the openings facing downward, which, besides effectively hiding interiors, hide also any saw-tooth edges where flash is broken away. In this connection (which is also a consideration with the bars of grilles) it should be remembered that it is impossible to avoid a thin flash where, when the mold is closed completely, the force comes as close as is feasible to the mating cavity but does not quite touch it. This flash is broken away after the molding is removed from the mold, but it is very brittle and leaves a jagged edge where it breaks off. Such edges are usually filed, but even then, unless an excessive amount of filing is done, the edges may still be somewhat rough. For this reason, it is well to bring the flash where the rough edge will show least. When the design is such that the hard flash lies parallel to the draw or nearly so, it may cause rapid wear on mold parts, hence such design is best avoided.

It is good practice to form a stiffening rib around a large opening cored in a cabinet, providing this can be done without complicating the molding unduly. The rib in such positions strengthens the cabinet and makes the wall thickness appear greater without adding materially to the quantity of plastic required in the molding. Rearward projections or pins are now often molded on the back of the front face to receive speed nuts which make a quick fastening for a dial or other part. The projection is formed by a properly located hole in the force. Such projections require no thread and take the place of bosses with tapped holes. They should be as short as conditions permit and should have liberal fillets where they join the front face of the molding so as to minimize the chance of being broken off.

Some methods of forming louvres are shown in an accompanying sketch. The openings can go straight through or face downward, but should not be so narrow as to necessitate formation by mold projections which are so narrow as to be easily broken or to make it difficult to remove flash. 3/32 inch is about the minimum width of projections feasible in small cabinet molds and ⅛ to 3/16 inch the minimum desirable on larger cabinet molds, but such projections should be as shallow as conditions permit and preferably should widen toward their bases as much as conditions permit, as this makes them stronger and reduces the chance of breakage.

Grilles should not have long slender bars as they are too fragile and may be broken by shrinkage stresses, by sticking in the mold or by blows suffered in packing, transit or handling. A bar of L-shaped section or channel section can be made to look quite heavy and yet be adequately strong and stiff without involving excess material.

In certain types of molded cabine designs, where future changes i model design are contemplated, it i possible to form the grille, louvre or certain other prominent feature by a portion or portions of the mol which are made separately from th mold as a whole and are fitted int the latter in such a way that the can be removed and replaced by othe parts of changed design. To do thi may increase the initial cost of th mold, but assuming that the size o the cabinet as a whole does no change, it may greatly reduce th cost of the revised model, as an en tirely new mold will not be needed This is a feature which should b planned in close cooperation wit the molder. It is possible to work ou mold designs in which changes o this nature will permit the produc tion of two or more models and it i surprising how great a difference i general appearance can be brough about by changing only one or tw outstanding features.

Another way of accomplishing similar result is to design the cabine so that some prominent part, such as the grille, is molded separately or perhaps the whole front made in a separate piece. This makes it pos sible to change the design of th separately molded part (by using a new mold) yet retain the body of th cabinet as before. The cost of the ex tra molds, of producing separat moldings and of assembly must b considered, but the advantages o varying combinations may offset th extra cost and give a range of model not secured by other means.

Thickness and Surface of Plastic Cabinets

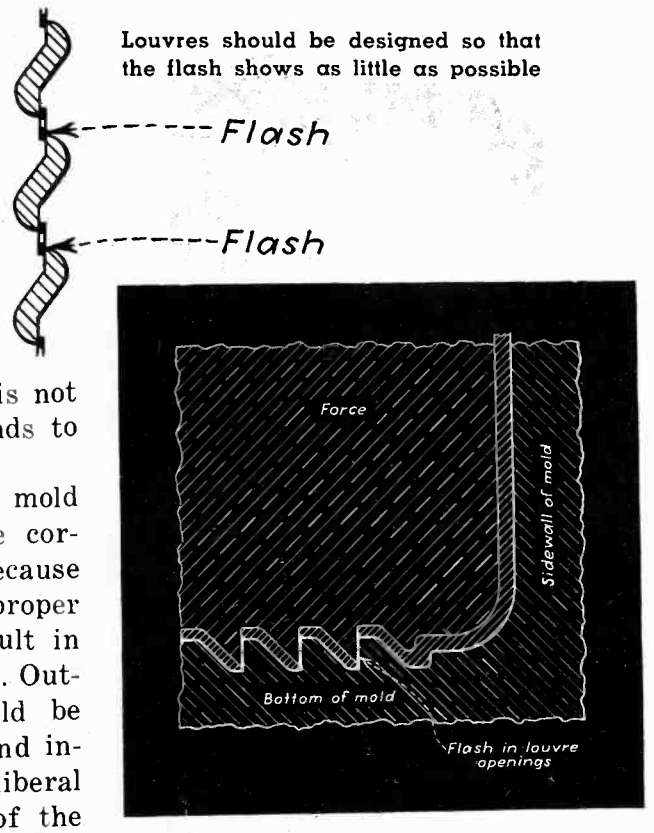
Turning again to the details of nstruction, that of section thickess is highly important. It should e as nearly uniform as conditions ermit and where differences are unvoidable they should be made as radually as possible, because abrupt anges may result in cracking since eavy sections tend to shrink more an thin ones. Another reason fapring sections as nearly uniform in ickness as possible is that there an optimum time for cure for a iven section thickness in each type nd grade of plastics. A molding hich combines thick and thin secons is likely to have the in ones overcured and ick ones undercured. Avrage section thickness is bout ⅛ inch minimum for edium size molded cabinets nd about 3/32 inch minium for very small cabinets. lthough thinner sections an be molded in some cases, hey do not afford adequate trength. Excessive thickness is not conomical in material and tends to ncrease the molding time.

Although it is possible to mold harp edges and sharp inside corers, they should be avoided because hey tend to interfere with proper low of the plastic and to result in racking or in chipping or both. Outide corners and edges should be "broken" (slightly rounded) and inide ones should have fillets as liberal s conditions permit. Many of the best looking cabinets have generously rounded corners which facilitate the flow of the plastic in the nold.

It is generally better to avoid large lat surfaces without relief even though they are sometimes used without serious detriment. Flat and unbroken surfaces are considered uninteresting from an artistic point of view and from a practical molding standpoint they have the disadvantage of showing up defects which would not usually be apparent. Even a slight crown on a surface results in highlights when polished (as most molded cabinets are) and such highlights attract attention. Artists say that highlights make the surface more interesting. Although designs which are simple are in general favor, raised convex bands or ribs and other simple means of breaking up large flat surfaces often add highlights and make for a more attractive design without adding unduly to mold cost and little if at all to the cost of the molding. Bars of grilles are often extended as ribs beyond the grille openings and are not infrequently carried from fronts well around one or both sides of the cabinet with pleasing effects upon appearance.

Colors

Plain colors are commonly favored by stylists, as compared to mottles supposedly simulating wood grains, but there is still a considerable production of mottled cabinets. Mottles have the advantage that they tend to hide minor defects in the surface of the molding. The appearance of the mottles is likely to vary considerably as between front and side walls and some mottled materials are more expensive than plain, dark colors in similar dark phenolic materials. The latter are lower in cost than the white, ivory and light tinted ureas, but the ureas have a distinct advantage in being translucent which adds to their beauty. When color contrast is desired, it is often secured by using knobs, buttons, grille backing and dials in colors other than that of the cabinet itself. A few cabinets are provided with feet molded separately in colors contrasting with the cabinet, but this necessitates separate molds and extra assembly operations.



"Flash" is formed where the surfaces of the force and the mold close together but leave a small opening between them

Lettering, trade marks or decorative panels are readily applied on the front of back-opening cabinets and to the top of bottom-opening cabinets and can be either embossed or debossed. Raised letters, are usually cheaper than depressed letters as they involve only the engraving of corresponding recesses in the mold surface, whereas depressed letters require that they be raised on the mold surface. When depressed letters are wanted on the molding, they are often made by machining them on a piece of steel separate from the mold and afterward setting this into the mold surface.

Air Circulation

An important consideration in cabinet design is the provision of vents to insure circulation of air over tubes and other parts of the chassis not only to keep the latter at proper temperatures, but also to avoid overheating the cabinet. Phenolic cabinets should not be operated at continued temperatures above 150 deg.F. and those in light colored urea plastics above 140 deg.F. as warpage and change in color may result. Neither material is softened by heating, but neither is a good conductor of heat and this may result in excessive localized temperatures unless adequate air circulation is insured.

In small cabinets, adequate air circulation may be afforded by using a perforated back plate, but large cabinets, as well as some small ones, are provided with holes in the base to permit air circulation. Air circulation often takes place also through louvres, grilles or other openings. Air vents in or near the top are desirable and can be provided for in the design without detracting from appearance. In bottom-opening cabinets it is simple to core vent holes in or near the top and in back-opening cabinets louvres or other vents can be provided near the top. It is common practice to raise the chassis base above the bottom of the cabinet and to provide space for air circulation between the two.

These recommendations should help to avoid some pitfalls as well as the increased expense which will be met if they are not given due attention in preparing the design.

THE ART ADVANCES

Report of progress during the past twelve months on all fronts of electronic endeavor—tubes, components, circuits, equipment, techniques—compiled by the *Electronics* staff from data supplied by engineers and manufacturers

"ELECTRONICS has for many years been the most active branch of electrical engineering in producing new and useful applications of electricity." These words are taken from a textbook now widely used in the technical colleges of this country—words which, to the majority of the readers of these pages, seem obvious enough. But the statement is important enough in its implications to be worthy of strong emphasis. The evidence behind the statement must, every so often, be reviewed. For the electron tube is a tool which can reach its greatest effectiveness only if its adaptability is widely appreciated. Your editors feel, therefore, that an occasional review of the extraordinary progress of the electronic arts is a necessary part of their editorial service. The recapitulation presented herewith, based on the advancement of the past twelve months, is an attempt to evaluate the engineering developments, as well as the commercial applications.

The Least Common Denominator—Tubes

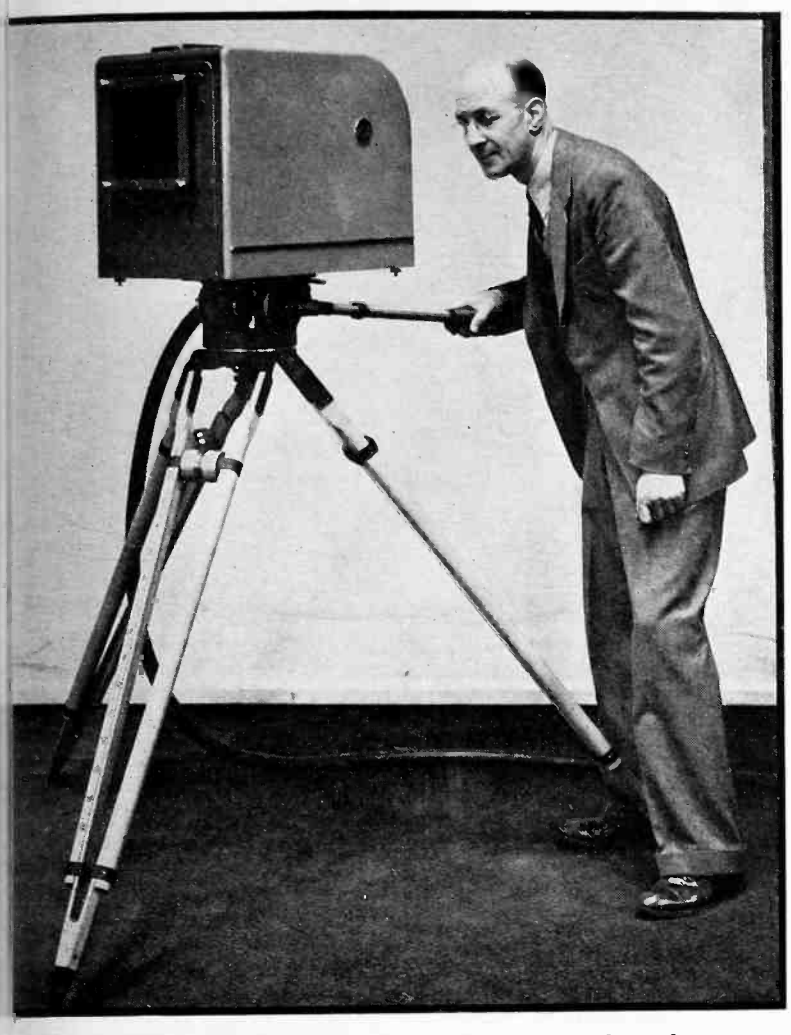
The least common denominator of all electronic work is the group of electron tubes available for use in circuits. During the past 12 months new tube types have appeared in profusion—some representing new ideas, others merely refinements of existing tubes. In the latter category is the single-ended construction, in which the grid-cap is eliminated in favor of a properly shielded prong in the tube base. These tubes, available in glass as well as metal types, have been rapidly accepted by radio design engineers, and it seems likely that the appearance of grid wires

Frequency-limit meter developed by the Browning Laboratories

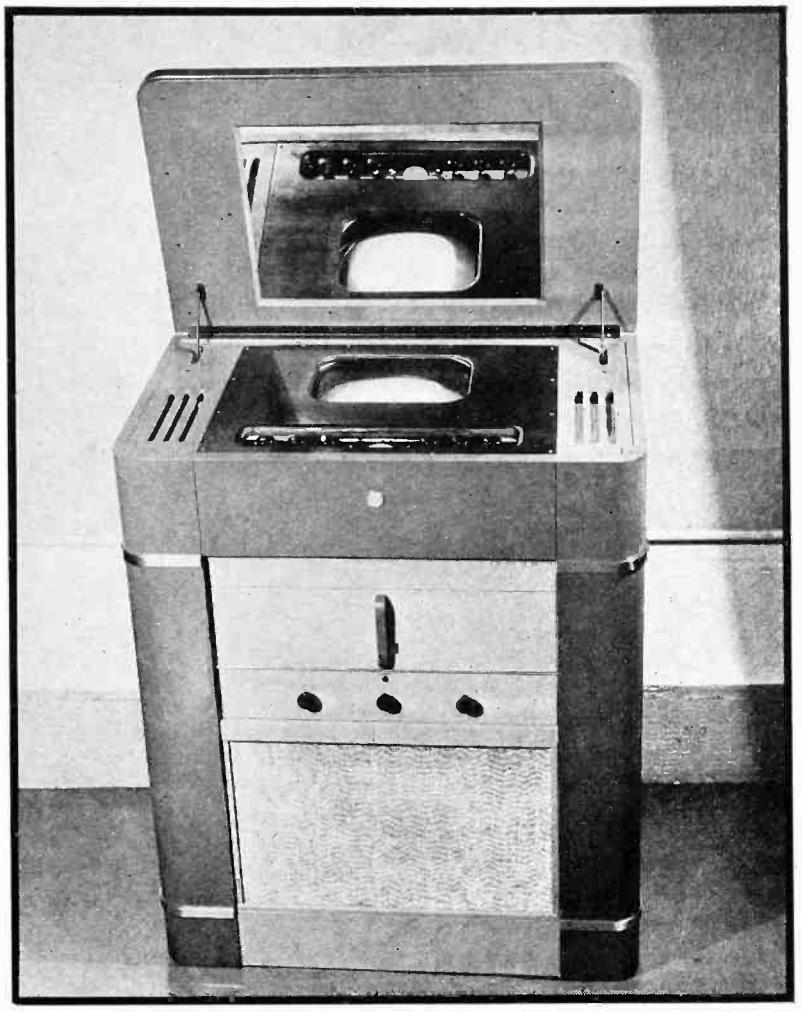
above a chassis is definitely a thing of the past. Tube construction has been improved in other ways: the loctal base which engages positively in its socket, is an example, and its importance where vibration and shock are factors can readily be appreciated. Tubes have been combined and combined: rectifiers with beam-power-output tubes, remote pentodes with sharp-cut-off pentodes, and (believe it or not), a pentode, a triode and a diode all bound up in one envelope. The use of these tubes is, at present, confined to small receivers, such as the two-tube midget sets which employ a double pentode for r-f and detector (or for converter and second detector in superhet circuits), and a rectifier-beam-output tube. The heater voltage of these combination tubes runs as high as 70 volts, to avoid the necessity of dropping the line voltage within a resistor, ballast tube or line cord.

New converter tubes, the 6K8 and 6J8 types, offer much improved service at high frequencies, and have been adapted to the single-ended form. Tubes of high mutual conductance, the 6AC7/1852 and the 6AB7/1853, have been made available for television service, have found use in wide-band r-f and i-f amplifiers for frequency modulation receivers, and show promise as sensitive control tubes for electronic control circuits. Extremely small receiving tubes, including additions to the acorn tube line, the "Bantam, Jr." series and the HY625 tubes with extremely short grid and plate leads, have contributed to portability and to utility on ultra high frequencies. Transmitting tube design has not lagged; here the major emphasis has been more power at higher frequencies. A new line of battery tubes, designed to operate on 1.5-volt dry cells with high performance characteristics relative to plate current has made its appearance and has acted as the foundation of the sizable business in "battery portable" radio receivers reviewed below.

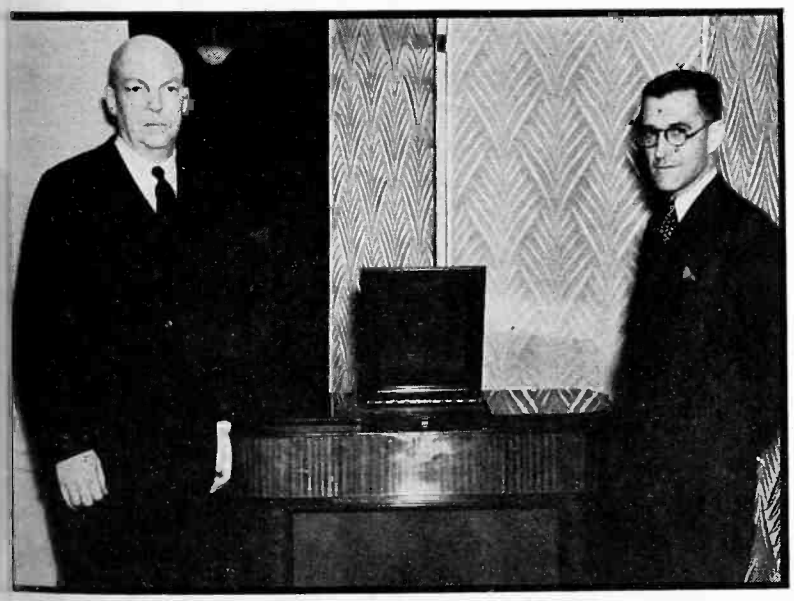
The permatron, a magnetically controlled mercury rectifier, has been announced to industry, and its applications described. Finally, and perhaps most significantly of all, there have appeared in the laboratory several forms of "beam-group" tubes which operate on a radically new principle. Electron beams, similar to those employed in cathode-ray tubes, are chopped into groups in these new tubes, and the groups are herded into compact charge concen-



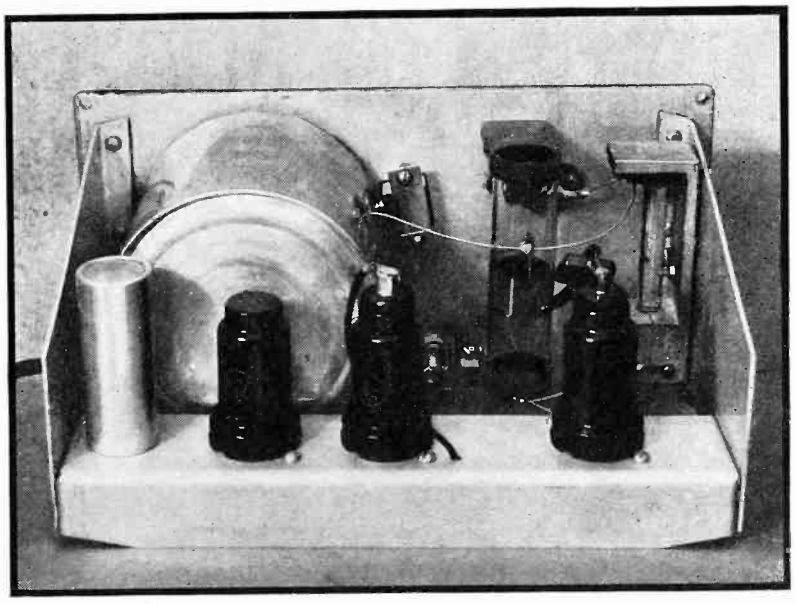
A complete television system in one cabinet is the achievement of RCA (Camden) engineers. The camera, above, feeds picture signals to the equipment at the right, which generates standard R.M.A. sync and blanking pulses



The 12-inch picture tube reproduces the picture, which is reflected in the mirror lid. The equipment is useful wherever sight must be transmitted instantaneously over a coaxial cable circuit, but includes no radio equipment



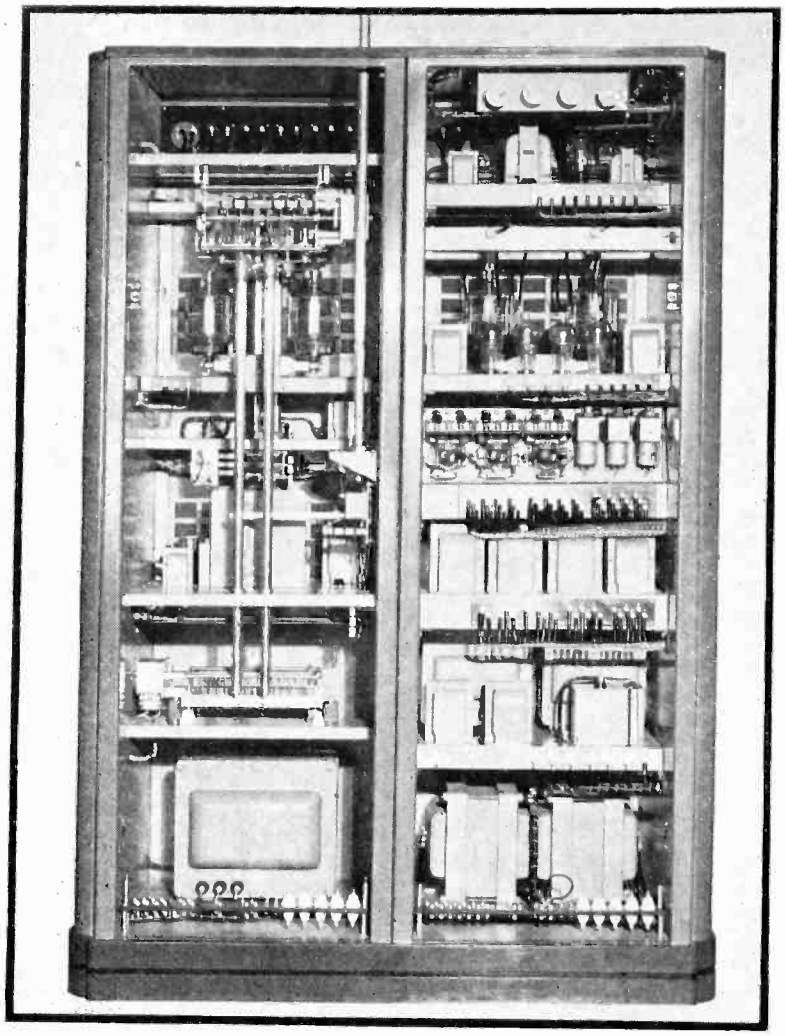
Frequency modulation system of Major Armstrong (left) was brought closer to commercialization by the researches of the G. E. Company under W. R. G. Baker (right)



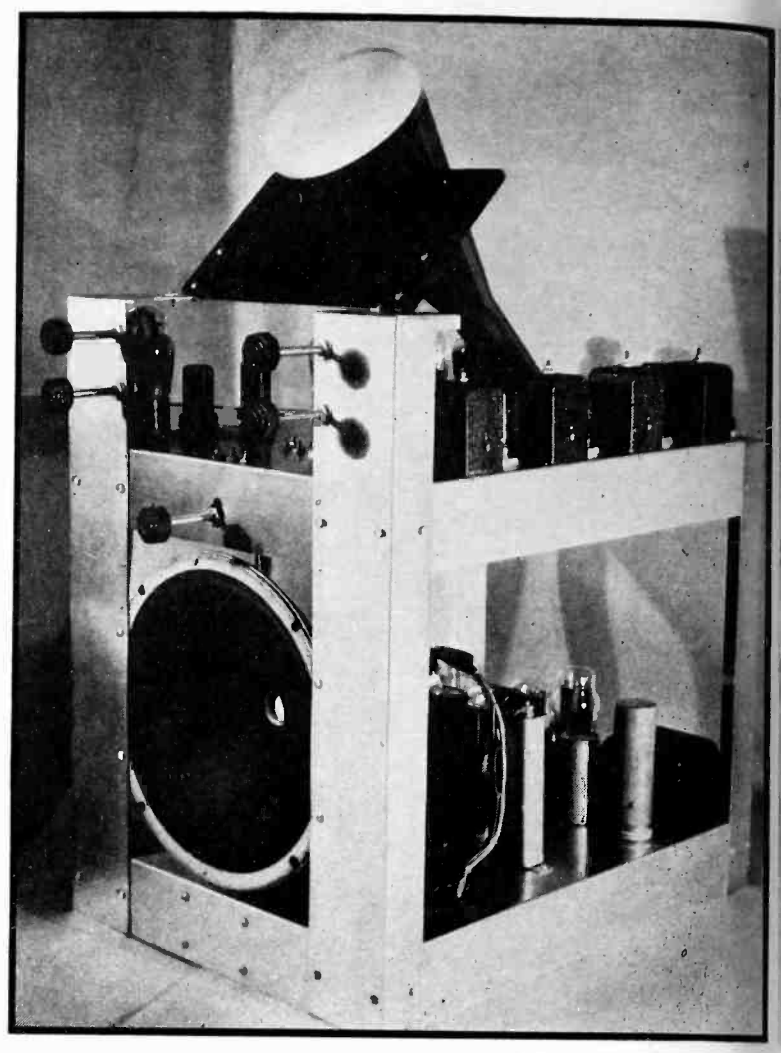
A u-h-f frequency meter, produced by the Lampkin Laboratories extends accurate readings as high as 56 Mc, makes use of a non-selective detector

trations, from which the output power of the tubes may be obtained. Hundreds of watts at wavelengths as short as 10 centimeters may be obtained. The word has gone out, "watch those new beam tubes". Much is to be expected of them in the coming years.

The outstanding contribution in radio sets within recent months is the battery-operated portable receiver. Sales of this type of receiver, thus far this year, have run into the hundreds of thousands, and there are predictions that the total sales for the year will top a million sets. This is a major achievement in merchandising an engineering development which, while not new in itself, represents a very thorough coordination of new developments. Apparently the ball got rolling with the use of loop antennas, first in large console sets then in ac-dc midget sets, as a means of discriminating against interference. Loop antennas are as old as the art itself, but apparently engineers everywhere were surprised to find how much gain could be obtained from a tuned loop properly built to have a high Q. At the same time the new 1.4-volt series of tubes was being developed, in pentode, tri-



This u-h-f transmitter by the Collins Radio Company will operate with 500 or 1000 watts output, on any frequency between 22 and 45 Mc. with high fidelity



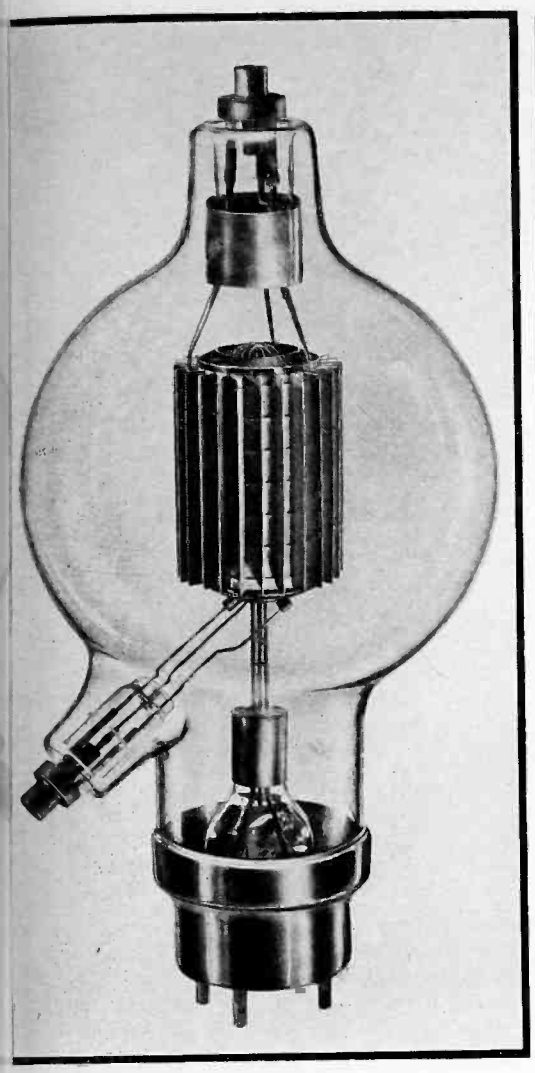
One of four television kits now available to the experimenter is this 5-inch picture tube outfit designed by the Fulton Radio Company. It uses electrostatic deflection

ode, diode, and even in diode-triode types. So the stage was set for a tuned-loop battery-powered set. Permanent dynamic speakers were called into play. Circuits were tuned sharply, iron core coils employed for maximum gain. The sensitivity of such receivers, weighing 9 pounds complete with batteries, with a loop antenna coiled inside the case, is remarkable. This is an engineer's point of view. But the public likes the idea of complete and easy portability, the fact that the battery power costs roughly but one cent per hour of operation, (the total B battery drain is in the neighborhood of 10 ma, and the usual operating life is from 200 to 300 hours), plus the fact that a complete outfit can be bought for from fifteen dollars up.

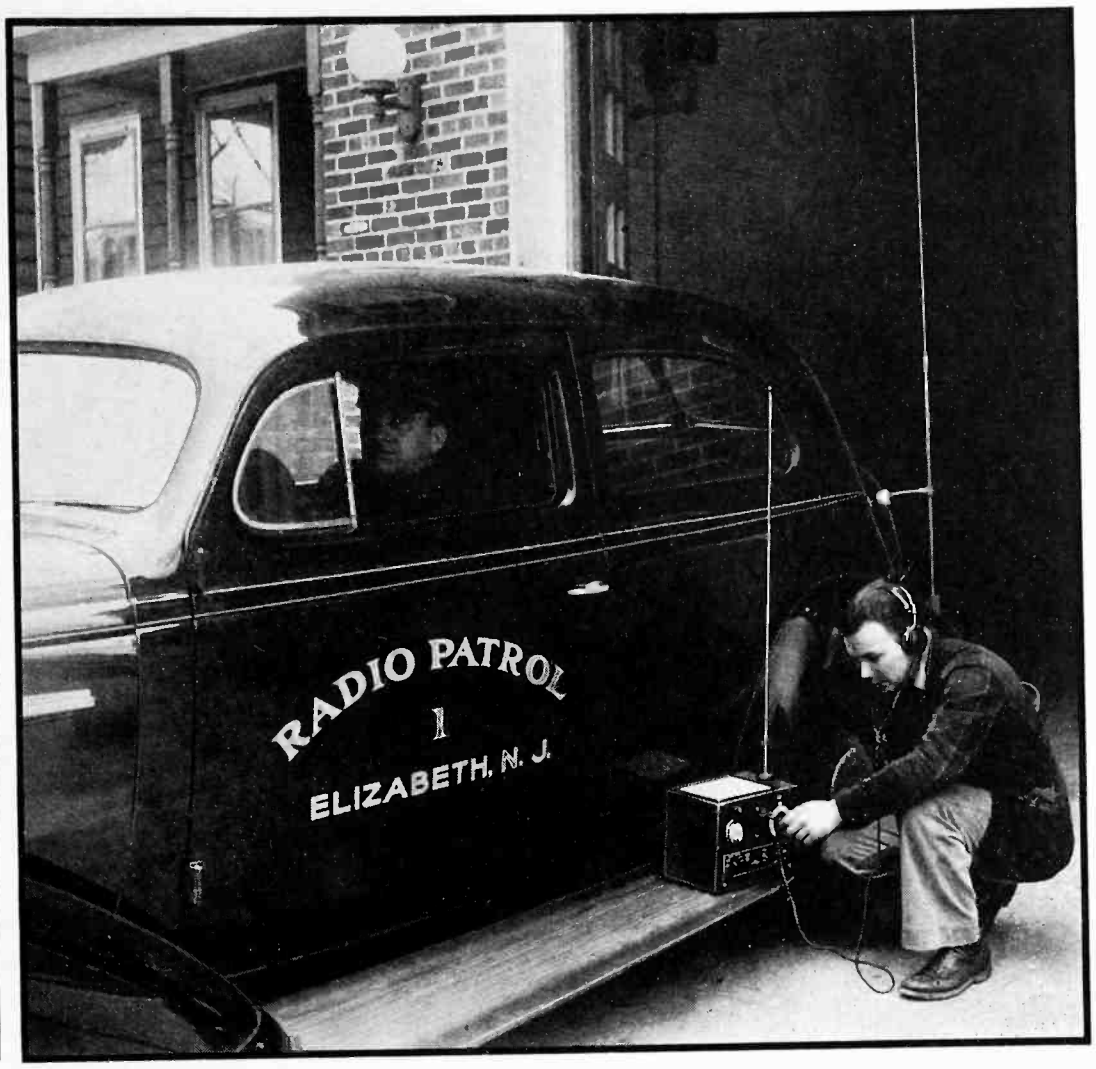
Notable improvements have appeared in components used in radio receivers. Self-compensating capacitors have contributed greatly to the stability of r-f and i-f circuits. The sizes of many components, especially electrolytic capacitors, have been markedly reduced. A permanent magnet dynamic speaker only two inches in diameter has appeared. A whole new line of components (described in detail in the May issue of *Electronics*) has arisen to meet the specialized demands of television receiver production. A volume control for use with auto radio receivers, which changes the volume according to the speed of the car has been offered commercially. This device is actuated by air pressure; it turns up the volume as the speed of the car increases, thereby overcoming the increased noise from the engine and the windage of the car body. Automatic tuning to the nth degree has appeared in a station preselector which will set up programs a week in advance, in 15 minute intervals. Simplified forms of diversity reception, in which a relatively simple receiver may be used with two antennas by high speed electronic switching, have made their appearance on the market.

One of the most significant new lines of endeavor, one which has many potentials for good and bad, is the use of r-f energy for short-distance control purposes, and for short-distance communication to radio receivers. One of the first devices of its kind on the market was the automatic dial tuner, consisting of a battery operated transmitter keyed by a dial-operated switch, mounted in a small box. The output is received by a special circuit in the receiver, and the keyed impulses actuate step switches which tune the stations, increase or decrease volume and turn the set off. Shortly before this device went to the market, the FCC ruled that the signal strength at a distance of ⅛th the operating wavelength (actually the wavelength divided by 2π) from the transmitter should be no more than 15 microvolts per meter. The full text of the rules governing these devices may be found in the *Federal Register*, issue of May 24, 1939, page 2108. There is some question as to the strict observance of this rule in all cases, but no serious cases of interference seem to have arisen, except in apartment houses.

No sooner had the remote dial-tuner transmitter appeared than the same idea was applied to a multitude of other uses: the "wireless" phonograph player has had a conspicuous commercial success. It consists



A new high-powered air-cooled tube for u-h-f use is the 1500T announced by Eitel-McCullough



The Weston u-h-f signal generator (22 to 150 Mc) is here used to check the performance of police radio equipment operating in the 40-Mc band. The generator also has uses in television research and service

simply of a small oscillator, modulated by the phonograph pickup, and tunable to any point in the broadcast band. The player is plugged in, turned on, and the radio receiver (located anywhere within say fifty feet of the player) is tuned to the oscillator output. Another application is the wireless converter used for remote tuning. The converter consists of an oscillator, against which the incoming signal is heterodyned to produce an output signal in the low-frequency end of the broadcast band. Such converters have been in use for some time, using a wire connection between converter and receiver, instead of relying on the ether as do the newer devices. The same system has been applied to "wireless" interoffice communicating systems, and to relaying devices for industrial pursuits.

Frequency Modulation

No review of the past year's accomplishments would be complete without recognition of the status of frequency modulation. During the year Major Armstrong's station at Alpine, New Jersey has been completed and demonstrated with great success to editors of the technical press and to engineers and executives of the broadcasting industry. Up to the present, the ability of the public to participate in the experiments has been restricted by the lack of information on how to construct a suitable receiver. This lack is now removed, with the publication in this issue (page 32) of the complete constructional details of a simple, seven-tube receiver using standard components.

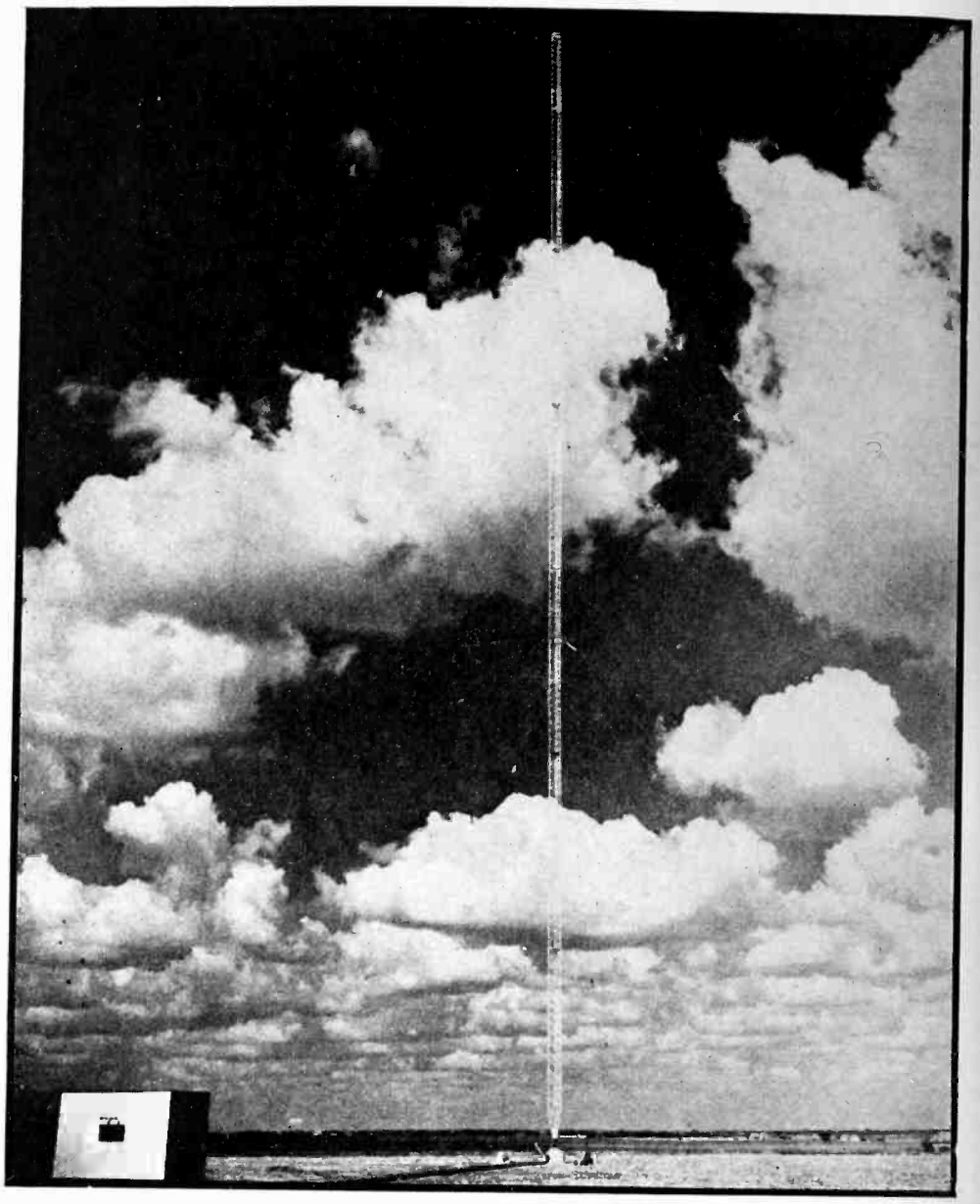
The erection of stations to employ frequency modulation by the Yankee Network, and by other broadcasters and individual experimenters is evidence of the interest and enthusiasm the new system has aroused. The Yankee network station near Worcester, Mass. is to have a power of 50 kilowats, the highest power ever generated in the ultra-high-frequency range (Major Armstrong's station is built for 40 kw, and is operated currently at 20 kw). Noteworthy experiments in comparing the relative merits of frequency- and amplitude-modulation on the same frequencies were reported to the Radio club of America by Messrs. Weir and Fyler of the General Electric Company. In general these reports substantiate Major Armstrong's conclusions and reveal an additional phenomena, one first suspected by Hans Roder, who outlined the theory of the effect in *Electronics* in May 1937. The effect is that two frequency modulation stations, operating on the same carrier frequency, are not both received by a receiver if one station has a signal strength at least twice as great as the other. The receiver responds to the stronger signal only. Thus the interfering radius of a frequency-modulation station is confined, and the allocation of frequencies for simultaneous use by several stations is much simplified.

Public Television Makes Its Debut

Of all the events of the year, the most eagerly awaited by the engineering public in the New York area was the beginning of public television service, inaugurated by the NBC Station W2XBS on April 30,

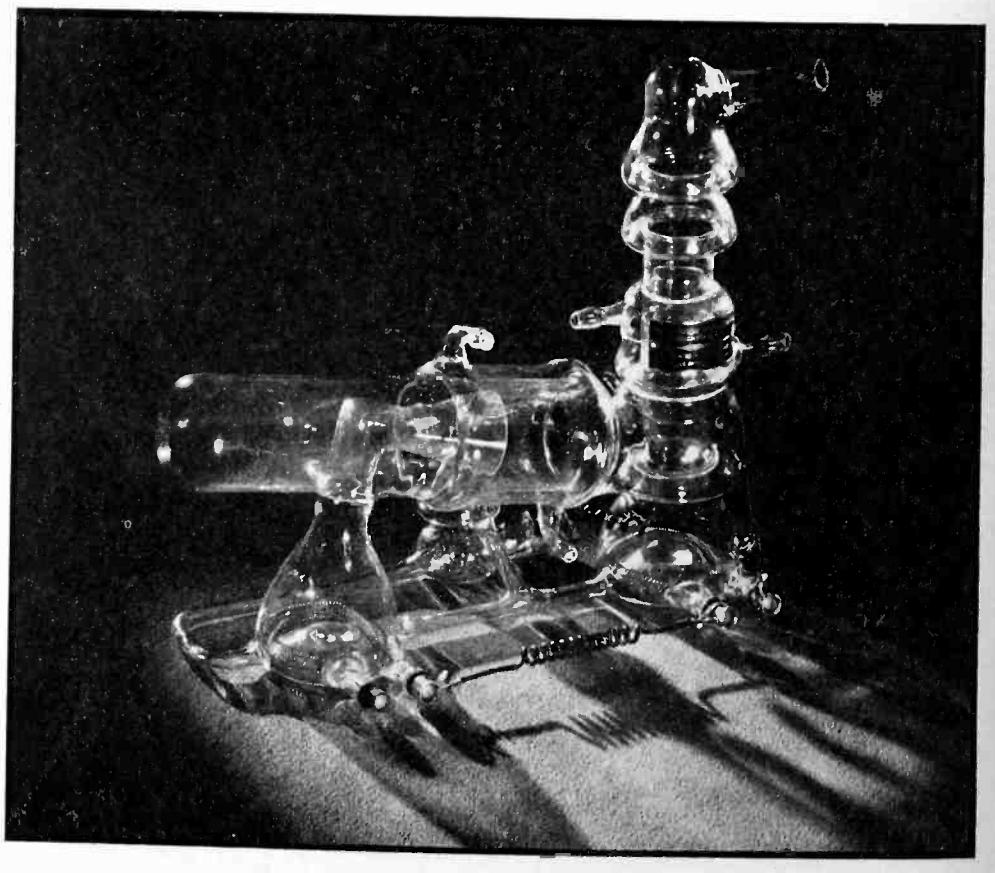
1939. Elsewhere in this issue (page 13) are reported some of the experiences of the first month of the new service. From the standpoint of progress over the past year, however, a broader outlook is indicated. Perhaps the most significant development in the television field during that time is the adoption of single-sideband transmission for the picture. The lower frequency sideband is partially attenuated in a filter structure at the transmitter. The carrier is transmitted full strength (same amplitude as the high frequency sideband components) and a portion of the attenuated sideband near the carrier are also transmitted. At the receiver, the carrier is attenuated to one half its original amplitude (by placing the carrier half-way up the slope at the edge of the pass-band) thus producing full modulation with only one sideband. The available channel space in the former double sideband case was 2.5 Mc; in the single-sideband system it is increased to more than 4 Mc, giving more than 60 per cent increase in horizontal picture detail. The engineering problems of producing the single side band at the transmitter and of providing the proper response curve at the receiver have been solved with but little difficulty, once the basic requirements had been formulated. The result is that when the new service started, some three months after the single sideband standard was voted by the R.M.A., the pictures were vastly improved, compared to what they had been the previous year. Seldom has so radical an improvement been made in so short a time.

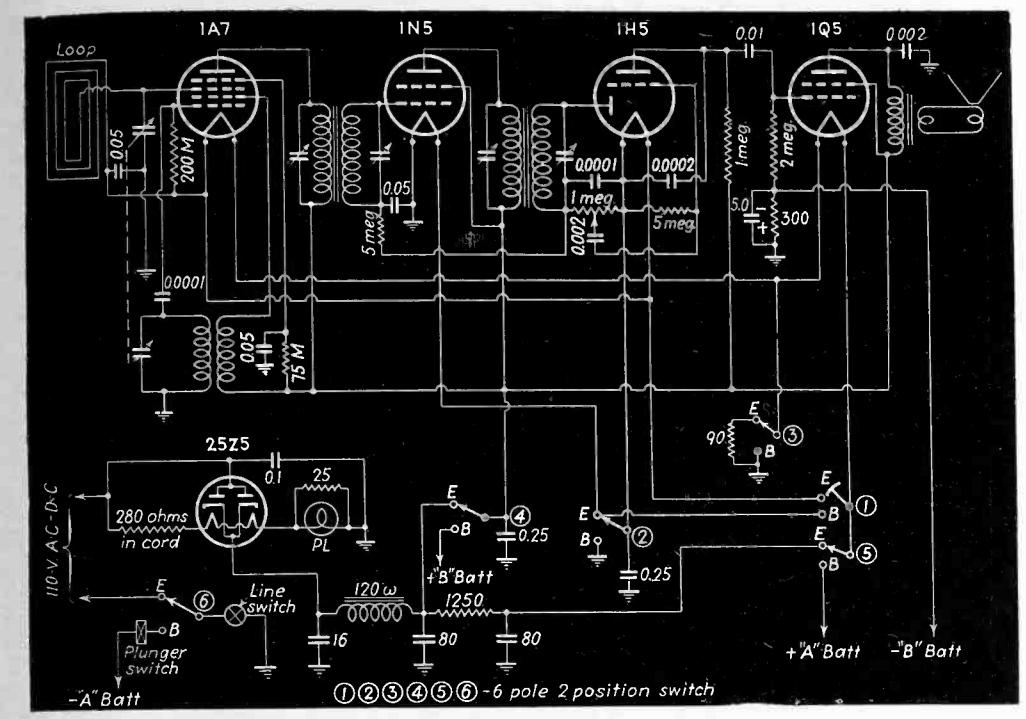
A second station for New York City, W2XAX of the Columbia Broadcasting System, is scheduled to take the air with a program schedule some time in July. The Don Lee station (W6XAO) at Los Angeles has been on the air with regular program schedules for several years, on locally-formulated standards, but has announced that the changeover to the standard R.M.A. type of transmission will be complete by the end of June. Thereafter, receivers will be made available in that area. Stations in other parts of the country are operated experimentally, or are in construction, but no program service is in view in these cities for several months or a year.



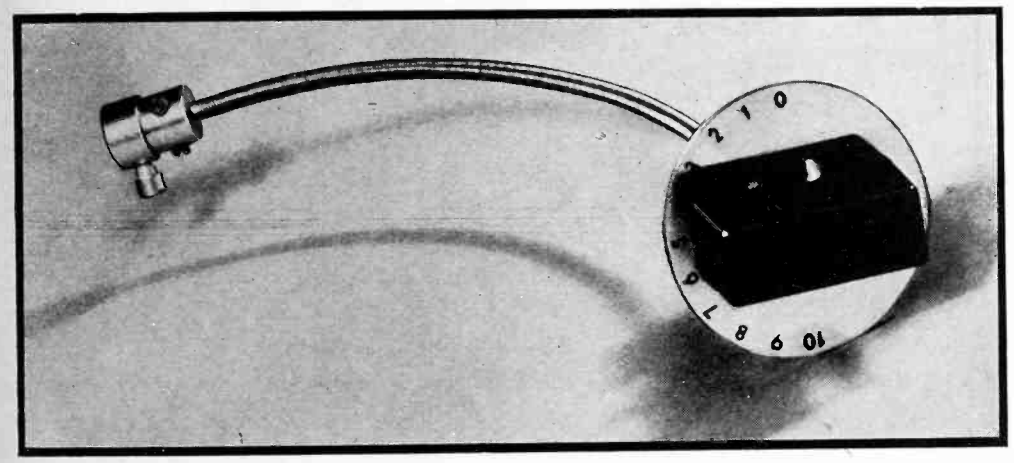
Tower at WFAA erected by Truscon, whose engineers are prepared to design u-h-f antennas for erection on top of conventional broadcast towers

A new self-cleaning diffusion pump by Distillation Products Company is capable of exhausting ten cathode-ray tubes on a single manifold

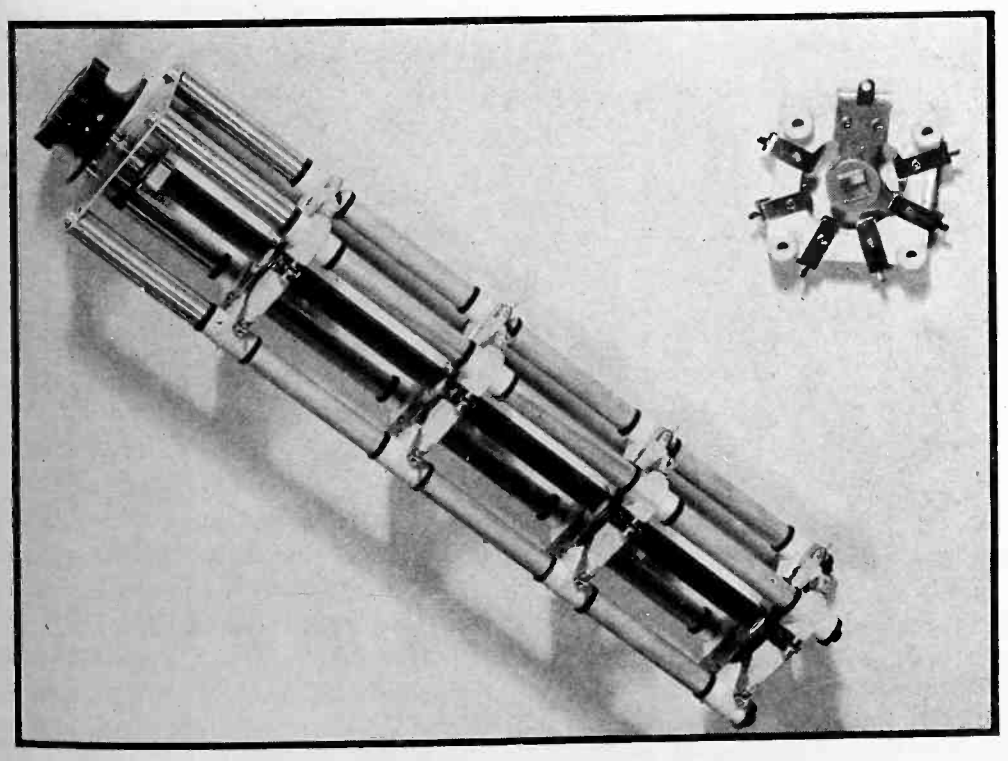




Typical battery-or-power receiver circuit from the Wholesale Radio Service. It can be switched from portable battery operation to the power lines



To permit placing tuning parts at the best electrical position and yet allow ease of adjustment, flexible shafts, such as this S. S. White unit, are finding increased use in transmitting equipment



Heintz and Kaufman have designed this power band-switch which can handle as much as a kilowatt of r-f power, with low loss and ease of rotation

In all some 18 radio receiver manufacturers have indicated their intention of producing television receivers or kits before fall, and at least six of these will have their wares on the markets by the time these pages are published. So far as can be judged at present, the engineering achievement represented by these receivers is remarkable considering that all the experience had to be gained, up to the time of production, on the basis of laboratory tests alone. The success which "kitchen mechanics" have had in assembling television kits into working receivers is another testimony to the careful planning which has gone into the design of the kits themselves. The prices of completed receivers seem to be high, perhaps 20 per cent higher than the values predicted before the models were formally announced, but in general the higher prices are accompanied by correspondingly high quality in the components, circuit arrangements, cabinets, etc. The principal limitations at present seem to be picture brightness and picture size. The picture detail seems to be all that can be expected from a 441-line image—and this appears to be adequate for nearly all subjects except those which take in so large an area that the important figures occupy but a few scanning lines (as, for example, the outfield players in a baseball game recently telecast, when the camera took in the whole playing field). When these situations are avoided, in favor of close-ups, observers are universally well impressed with the picture detail.

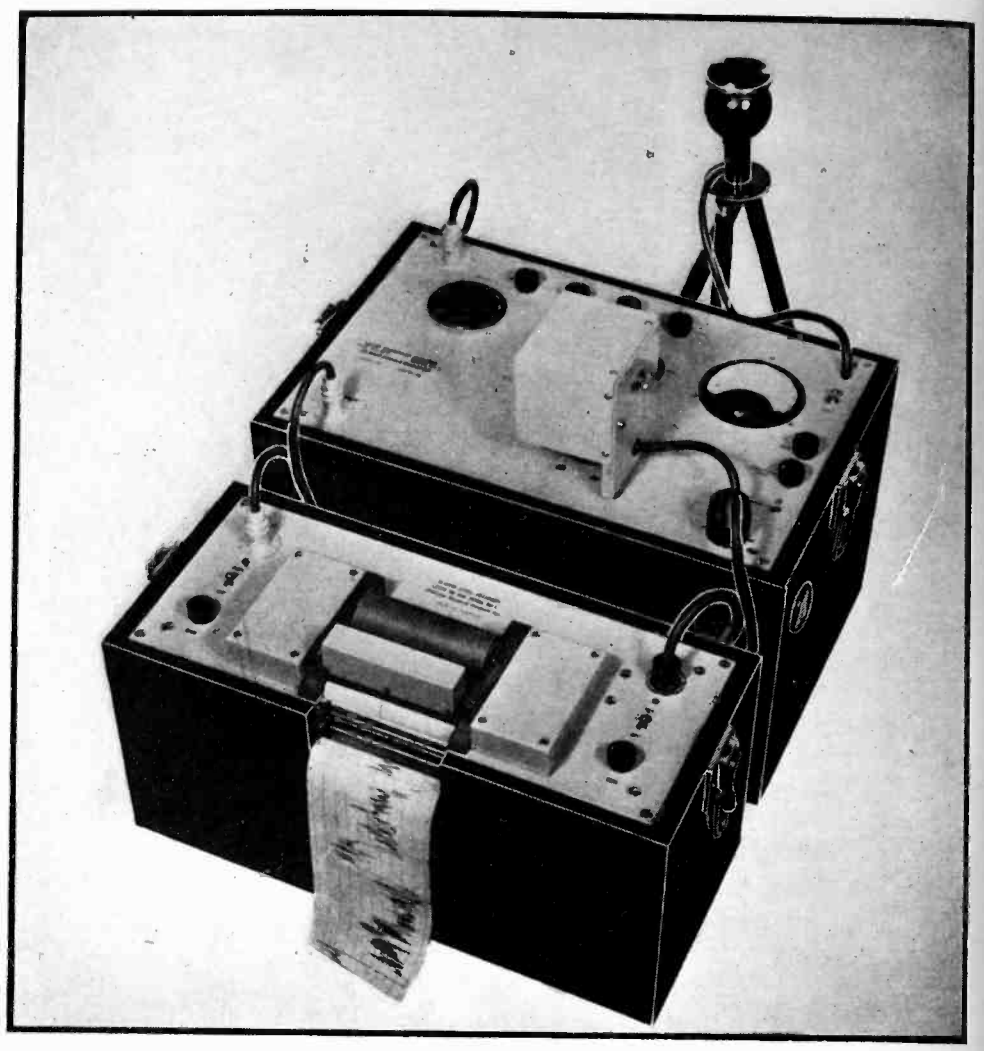
An incidental, but significant, change has been made in the transmission of the sound which accompanies the picture. The sound channel is gradually predistorted in the upper frequency range to give some 20 db emphasis at 15,000 cps. At the receiver, the inverse curve is applied to produce essentially flat over all response. Actually, the frequency characteristic employed is the same as the impedance characteristic of an R-L series circuit whose time constant is 100 microseconds, as stated in the R.M.A. standard recently adopted. An advantage in signal-to-noise ratio is gained, against the high frequency components (tube and circuit noise) and in addition it is easier to obtain good high frequency performance in receivers having less than adequate

response at the high end. The net result is that the sound reception of television receivers is universally excellent.

Laboratory Practice — Equipment and Methods

Measuring equipment has proceeded "at high speed in all directions". On the one hand, increased stability in the measurement of direct current effects has been obtained by using tube voltmeters combined with inverse feedback. On the other extreme in the frequency scale, equipment has been devised to generate and measure further and further into the ultra-high-frequency range. The variable inductance tuned circuit developed by Paul Ware has been applied to a signal generator which covers the range from 22 to 150 Mc. Also, improved forms of vacuum-tube voltmeter are now available for this range. Both of these equipments are intended primarily for television measurements. Also in this category are square-wave generators, and video sweep generators for aligning wide-band i-f picture channel circuits, which have found their way to the commercial market. The measurement of high voltage has assumed new importance, thanks to television, and in consequence electrostatic voltmeters, and multiplying resistors for extending the range of d'Arsonval meters, have been produced and offered for sale.

In the service field, simplicity has been the keynote of new instruments. Tube testers with push-button selector switches for setting up the test circuits for different tube types have become popular. The analysis of receiver faults by a channel analyser (employing several v-t voltmeters simultaneously, channel by channel and tube by tube) has also made the serviceman's job easier. In meter-

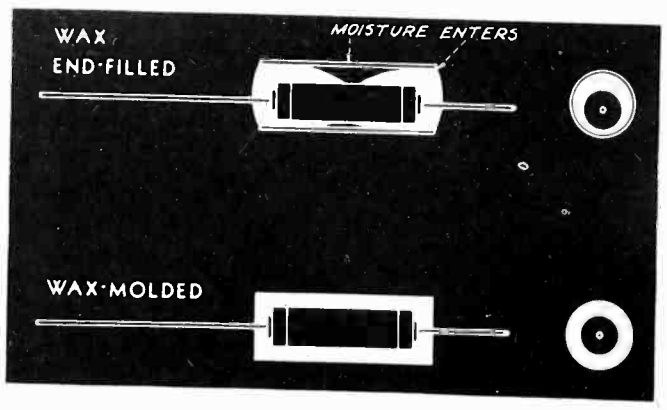


This automatic recording frequency analyzer made by the Electrical Research Products Company can follow sounds at a rate of 50 db per second

type analysers, more sensitive meter movements are being employed and consequently greatly extended ranges of current, voltage and resistance, are covered.

Contributions by Commercial Organizations

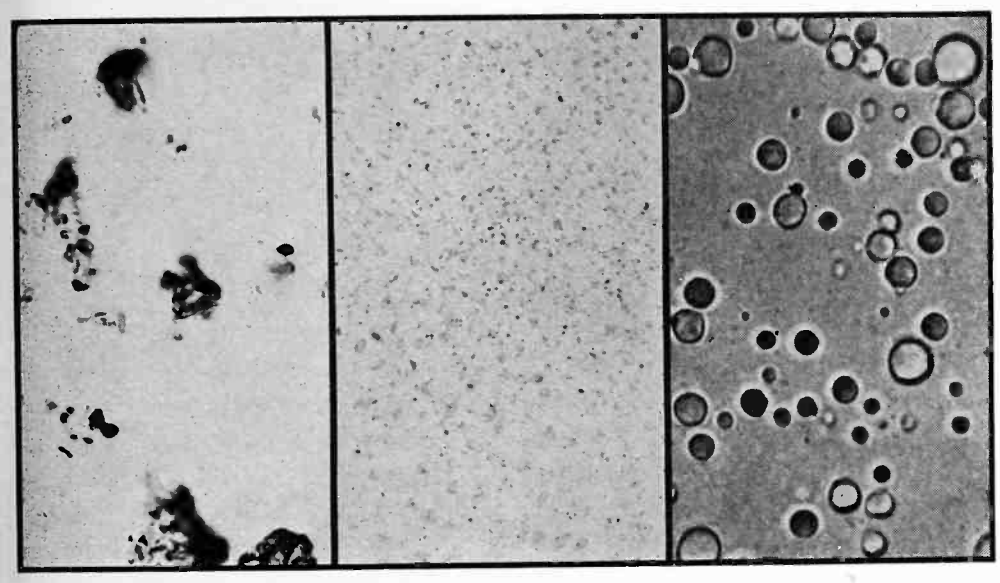
There is a tendency among radio engineers to believe that when the production blue-prints have been turned over to the factory, the job is finished. But before a product is useful it must be manufactured and distributed, at a price the customers feel willing to pay. Hence the commercial record of new product development is an important index of the activity of the electronics field. To gauge this activity, the editors sent a letter to nearly 700 individuals and companies, asking for information on the latest product offered by them. An overwhelming response was obtained. From this material the remainder of this article (and all the illustrations) has been prepared. The reader will appreciate the difficulty of covering adequately so broad a field; consequently it has been necessary to restrict attention to products of direct interest to engineers in radio and allied electronic fields.



The Solar Manufacturing Company has developed a means of wax-molding paper condensers which insures against the entrance of moisture

The Acheson Colloids Corp. has produced a collodial graphite suspension of extremely fine composition, the majority of particles less than one micron in diameter. Stable suspensions of these particles in water, carbon tetrachloride and kerosene are now available. The American Emblem Company has a new cam lever drive for radio tuning mechanisms especially suitable for automatic dialing, since its calibration cannot be destroyed by sudden strains or shocks. The Acme Steel Company has a new Steelstrapper packaging machine of particular value for shipping delicate mechanisms common in the electronic field. The American Lava Corporation has a new ceramic, Alsimag 222, which can be machined after firing, a property of special value in development and research work. A direct-coupled push-pull amplifier of 10 watts output useful for a variety of audio

This mixer and preamplifier provides individual control over two lines. It is manufactured for broadcast station use by the Operadio Company



A new fine grade of colloidal graphite by the Acheson Colloids Company (center) is compared under the microscope with fine face powder (left) and pasteurized milk (right)

equency purposes in sound work id in the laboratory is offered by ie Amplifier Corporation of Amer- a. Among the new Arcturus tubes a 12-volt-heater single-ended pen- agrid converter, (12SA7GT) a 35- olt-heater rectifier with a tap for ilot light connection (35Z5GT), and 25-volt-heater diode-triode-pentode 25D8GT). The latter tube can be sed as an i-f amplifier, detector, and -f amplifier, at one and the same ime.

A new exponential public address orn designed for proper diaphragm oading of an eight-inch speaker is vailable from the Atlas Sound Corp. A miniature 60-cps frequency meter f the reed type is offered by the ames G. Biddle Company. The in- reased necessity of employing rystal-control in portable trans- nitters, made necessary by recent FCC regulations, has been met by new Bliley crystal holders which incorporate a new electrode spring design. A compact crystal holder and oven combined is also made by this company. The Boonton Radio Corp. offers a beat oscillator of particular value in video work, range from 20 cps to 5 Mc, in two ranges with output voltage from 1 millivolt to 32 volts. The Browning Laboratories have marketed a new frequency monitor which reads frequency limits and which takes up a small space. New Hoyt (Burton-Rogers Co.) meters have the moving coil mechanism included in a small case, requiring but a small panel hole, while allowing a full size face to fall in front of the panel proper.

The latest product in the Collins Radio Co. line is the 236A u-h-f transmitter, frequency range 22 to 45 Mc, crystal controlled, 500 or 1000 watts output with high-quality, low-distortion audio modulating equipment. A new fractionating (oil self-cleaned) high vacuum diffusion pump, especially developed for pumping cathode-ray tubes (making non-getter production possible without cooling) is available from Distillation Products, Inc. The pump can handle as many as ten tubes on a single manifold. A professional recorder free from wows and hum vibration is announced by the Duplex Recording Devices Co. Two large air-cooled tubes, the 1500T and the 2000T, of particular value in generating high power at u-h-f have just been announced by Eitel-McCullough. Electrical Research Products Inc., announces a commercial model of their automatic recording frequency analyzer which permits recording audio response over the entire audible range in two minutes, and is capable of following sound level differences at a rate of 50 db per second. New metal casings and cabinets of modernistic design, suitable for housing transmitters and other large electronic equipment are available from the Falstrom Co. The Ferranti Company continues its development of light-weight high fidelity audio transformers with a unit for aircraft work. Calcined beryllium oxide of use in the preparation of fluorescent screens for cathode-ray tube has been offered recently by the Foote Mineral Co.

(Continued on page 92)

Style plus performance is the watchword for new microphones. The Shure Unidyne is a typical example

I. R. E. San Francisco

A "Report-in-Advance" of the National Convention of the Institute of Radio Engineers, to be held June 27, 28, 29, 30, at San Francisco. Twenty-seven papers, covering all phases of radio development, to be presented by outstanding engineers

THE first major convention of radio engineers to be held this year is the Pacific Coast National Convention of the Institute of Radio Engineers, which will be held June 27, 28, 29 and 30 in San Francisco. For many years past May and June have been traditional months for the presentation of outstanding papers on radio engineering in conjunction with the Annual Conventions of the I.R.E. This year, the I.R.E. Annual Convention has been moved forward to September, but the spring get-together tradition is being carried forward by the San Francisco Section, whose members have seized the opportunity of presenting a meeting at which no fewer than twenty-seven papers will be read by outstanding members of the profession. The technical program has been arranged by a sub-committee acting under the leadership of Fred Terman of Stanford University.

Realizing that many readers of *Electronics* will be unable to attend the Convention because of its distance from many radio centers, the editors have prepared a "report-in-advance" of the program, from summaries and carbon copies of papers supplied by the authors.

Geophysics and Communications

An interesting example of the impact of modern technology on an established industry is found in the application of geophysical exploration methods to prospecting for oil. These methods have succeeded in revealing new oil deposits faster than the old ones have been depleted, and have created thereby a difficult economic problem. The methods of geophysical prospecting, revealed in the paper by Herbert Hoover, Jr. of the United Geophysical Corporation, have largely been developed by communications engineers. The seismic method, most widely used today, make use of a small blast of explosive buried in the ground. Whenever the seismic wave thereby generated encounters a discontinuity in the substrata of the earth, a portion of the wave is reflected toward the surface, where it may be detected by vibration microphones, amplified, and recorded oscillographically. By determining the time interval between the blast and the reception of the reflected impulse, and by determining the direction of the reflected wave, it is possible to determine the geologic structure of the sub-strata, with amazing accuracy. By proper interpretation of this geologic information it is possible to assure a high percentage of success when oil-drilling begins. Mr. Hoover's paper treats the equipment used, and emphasizes its relation to similar equipment employed in communication engineering.

Radio in the Air

At the opposite extreme in communication techniques are those discussed in three papers which treat of aircraft radio. Mr. H. H. Willis of the Sperry Gyroscope Company tells of recent developments in the field of aerial navigation. Several of these have been covered in *Electronics* ("Aircraft Radio, 1939", page 10, January 1939 issue). These include the automatic radio compass, in which a motor-driven loop-antenna is constrained to hold the null (minimum signal) position regardless of the motion of the plane relative to the incoming wavefront. A pointer, geared to the loop through a flexible shaft, indicates the direction of the incoming signal, continuously and automatically. Another application lies in the consolidation of several airplane instrument indications on the face of a cathode-ray tube. Mr. Willis's paper also reviews the general problem of orientating a plane relative to a fixed point on the earth's surface, and enabling it to travel from one point to another, regardless of visibility conditions.

Professor E. L. Bowles presents a paper on the landing of aircraft by instruments alone, in reference to the research on this problem now being conducted at M.I.T. This work has been described in *Electronics* (January issue, see previous reference). Essentially the system consists of indicating to the pilot, on the face of a cathode-ray tube, the position of his plane relative to a fixed reference landing path in space. The landing path is established by the projection of ultra-high-frequency (500 Mc) beams from the mouths of horn structures located on the airport surface, each of the beams being modulated with an identifying signal. The M.I.T. research group is among the first to make practical use of the Klystron, the new ultra-high frequency generator developed at Stanford University, which is described in another paper later in the program.

One of the important problems in aircraft navigation is the effect of mountainous country on the accuracy of radio direction-finding indications. This difficulty has been the subject of a study made by Andre Busignies, of Le Materiel Telephonique, Paris, in conjunction with the experimental flying laboratory ship of the United Airlines. M. Busignies shows how the two types of radio-beacon range stations (those using loop antennas, and those using vertical "Adcock" radiators) should behave with respect to the fluctuation of bearings, and shows that experience agrees well with the theoretical predictions. Particular em-

PROGRAM

TUESDAY, JUNE 27 9:00 A. M.

10:00 A. M.—12:00 NOON

Opening address by R. A. Heising, President of the Institute.

1. "Communications Engineering in Geophysical Exploration," by Herbert Hoover, Jr., United Geophysical Corporation.
2. "Federal Communications Commission Engineering Regulations and Standards of Good Engineering Practice for Broadcast Stations," by S. L. Bailey, Jansky and Bailey, Washington, D. C.
3. "Columbia's West Coast Operations," by L. H. Bowman, Columbia Broadcasting System, Hollywood, Calif.

2:00 P. M.—4:30 P. M.

4. "Recent Developments in Aerial Navigation," by H. H. Willis, Sperry Gyroscope Company, Brooklyn, N. Y.
5. "Aircraft Instrument Landing Research at the Massachusetts Institute of Technology," by E. L. Bowles, Massachusetts Institute of Technology, Cambridge, Mass.
6. "Study of the Effects of Mountains in Radiogoniometry and on the Combined Use of Radio Beacons and Radio Compasses for Aerial Navigation," by Andre Busignies, Le Material Telephonique, Paris, France.
7. "Acoustic Models of Radio Antennas," by E. C. Jordan and W. L. Everitt, Ohio State University, Columbus, Ohio.
8. "Recent Advances in Receiving Equipment for Transoceanic Telephony," by F. A. Polkinghorn, Bell Telephone Laboratories, New York, N. Y.

WEDNESDAY, JUNE 28

9:00 A. M.—11:00 A. M.

9. "Electron Optics," by V. K. Zworykin, RCA Manufacturing Company, Harrison, N. J.
10. "Current Division in Plane-Electrode Triodes," by Karl Spangenberg, Stanford University, Stanford University, Calif.
11. "Functions of Electron Bombardment in Television," by I. G. Maloff, RCA Manufacturing Company, Camden, N. J.
12. "Surface-Controlled Mercury-Pool Rectifier," by T. M. Libby, Pacific Telephone and Telegraph Company, Seattle, Wash.

11:30 A. M.—2:00 P. M.

Trip to Pan American Airways Terminal and inspection of Boeing Clipper.

2:00 P. M.—4:30 P. M.

13. "Direct-Current and Audio-Frequency Amplifier," by L. J. Black and H. J. Scott, University of California.
14. "Golden Gate International Exposition Radio and Sound Distributing Systems," by C. A. Lahar and L. Hewitt, RCA Manufacturing Company, Camden, N. J.
15. "Radio-Frequency Spark-Over in Air," by P. A. Ekstrand, Heintz and Kaufman, South San Francisco, Calif.
16. "Solar Cycle and the F_2 Region of the Ionosphere," by W. M. Goodall, Bell Telephone Laboratories, Deal, N. J.
17. "Atmospherics and Radio Transmission Phenomena in Puerto Rico," by G. W. Kenrick and P. T. Sammon, University of Puerto Rico, Rio Piedras, P. R.
18. "Transmission on 41 Megacycles," by S. S. MacKeown, B. M. Oliver, and A. C. Tregidga, California Institute of Technology, Pasadena, Calif.

THURSDAY, JUNE 29

9:00 A. M.—11:30 P. M.

(Joint Session with American Institute of Electrical Engineers.)

19. "The Klystron as a Generator of Very Short Waves," by W. W. Hansen, R. H. Varian, S. F. Varian, D. L. Webster, and J. R. Woodyard, Stanford University, Stanford University, Calif.
20. "Instruments and Methods of Measuring Radio Noise," by C. V. Aggers, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Penna.; D. E. Foster, RCA License Laboratory, New York, N. Y.; and C. S. Young, Pennsylvania Power and Light Company, Allentown, Penna.
21. "Methods of Controlling Radio Interference," by C. V. Aggers, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Penna.
22. "Technical Framework of our Television," by E. W. Engstrom, RCA Manufacturing Company, Camden, N. J.
23. "A New Standard Volume Indicator and Reference Level," by H. A. Chinn, Columbia Broadcasting System; D. K. Gannett, Bell Telephone Laboratories, New York, N. Y.; and R. M. Morris, National Broadcasting Company, New York, N. Y.

12:30 P. M.

Trip to Stanford University jointly with American Institute of Electrical Engineers.

2:00 P. M.—4:30 P. M.

24. "Electronic-Wave Theory of Velocity-Modulation Tubes," by Simon Ramo, General Electric Company, Schenectady, N. Y.
25. "Recent Ultra-High-Frequency Developments," by B. J. Thompson, RCA Manufacturing Company, Harrison, N. J.
26. "Simple Television Antennas," by P. S. Carter, RCA Communications, Rocky Point, L. I., N. Y.
27. "Continuous-Wave Interference with Television Reception," by C. N. Smyth, Kolster-Brandes, Ltd., Sidcup, Kent, England.

FRIDAY, JUNE 30

10:00 A. M.—12:00 NOON

Trip to the tube manufacturing plants of Eitel and McCullough, San Bruno, and Heintz and Kaufman, South San Francisco.

2:00 P. M.—5:00 P. M.

Trip to University of California.

phasis is laid on the advantage of combining the indications of a radio compass (direction-finding antenna in the plane) with those of the radio range beacon (direction-establishing antenna on the ground).

"Acoustic Models of Radio Antennas"

When models are used as the basis of radio antenna designs, it is customary to employ wavelengths which are a fraction of the operating wavelength, in order to obtain the advantage of small size. But, as E. C. Jordan and W. L. Everitt of Ohio State University point out in their paper, it is possible to obtain the same effect by using a lower velocity of wave propagation. The low velocity which obtains in acoustic propagation makes it possible to build acoustic analogs of antenna structures. Sound waves display the effects of interference phenomena, and hence can be used to study directional arrays. The fact that sound waves are compressional, whereas radio waves are transverse, must be taken into account, but when this is done, the acoustic model permits more rapid control of all the independent variables in an array. The acoustic radiators consist of closed pipes, with holes drilled along their length. A single audio frequency is fed to the pipe, and the reflection from the closed end sets up a standing wave similar to that in a radio antenna. The radiation of acoustic power from the holes is in proportion to the pressure behind them. The pressure distribution, which can be made to correspond to current distribution, can thus be measured. The effects of finite ground conductivity, improper lengths and positions of the elements of the array, and special non-sinusoidal current distributions can all be measured at will. The measuring equipment is made sharply selective to the audio frequency used as a basis of the measurement, so that other sounds present do not affect the accuracy of measurement. The authors feel that this new technique may aid greatly in devising more effective arrays, employing unusual current distributions and element structures.

Broadcast Engineering Papers

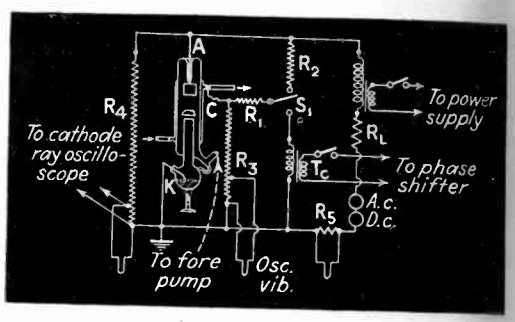
Three papers are directed to the problems and procedures of broadcasting. S. L. Bailey, of the Jansky and Bailey consulting firm in Washington, discusses the "Standards of Good Engineering Practice" which at the time of writing are pending before the Federal Communications Commission. The paper reviews briefly the historical aspect of the allocation problem and then proceeds to a point-by-point discussion of the proposed engineering rules. The types of station set up, and the channel protection afforded each, as well as the methods and equipment used to measure output and insure optimum performance, are discussed. L. W. Bowman of the Columbia Broadcasting System describes the West Coast operations set-up of CBS, as illustrated in the Columbia Square installation (see *Electronics* April, 1938, page 20). The facilities described include not only those on broadcast wavelengths, but also those for intermediate-relay and high-frequency work. Another member of the CBS staff, H. A. Chinn, combines with D. K. Gannett of the Bell Labs, and R. M. Morris of NBC in a paper on the new standard volume unit (the VU) and the reference level associated with it. This subject has been discussed by Affel, Chinn, and Morris in the February issue of *Electronics*.

News from the U-h-f Front

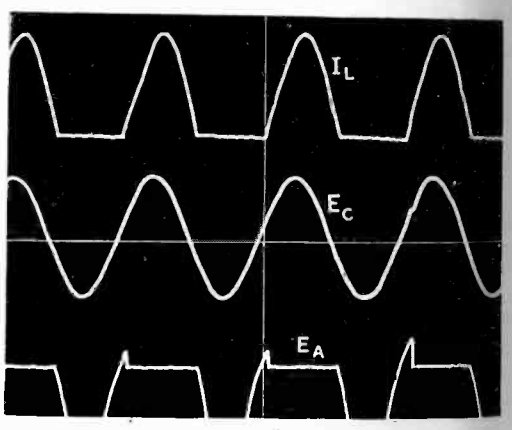
As is to be expected, many papers deal with developments in the field of generating and transmitting ultra-high-frequency waves. A general paper by B. J. Thompson of RCA (Harrison) shows that the present interest in the field has been stimulated by the practical uses to which the new regions in the spectrum have been put. Mr. Thompson classes u-h-f radiations in two divisions: "perceived radiation" in which simply a source and a detector are involved, and "communication radiation" in which amplification, modulation, demodulation, etc. play parts, and in which frequency stability is important. The most promising field for generation and reception of signals above 500 Mc seems to be in the development of new tube types. As a transmitting tube, the "inductive-output" power amplifier seems to be the most promising, whereas controlled electron multipliers and beam-deflection tubes serve well as receiving tubes. It is encouraging to note that Mr. Thompson believes that all the proposed applications of frequencies up to the region of 1,000 Mc (30 cm) can be accomplished with developments either now in the laboratory, or definitely in prospect.

At the lower end of the u-h-f region, the subject of transmission characteristics on 41 Mc is reviewed by Messrs. MacKeown, Oliver, and Tregidga of California Tech. These men have been conducting experiments on the signal strength and fading characteristics of 41 Mc signals over a 90.5-mile path from Mount Palomar to Pasadena. They find a mean signal fluctuation (fading) over a 48-hour period of only 2 decibels, despite the fact that earlier measurements showed large signal variations during the day.

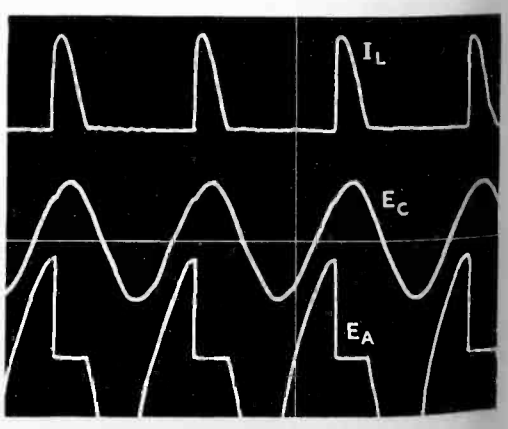
Two papers on the beam-group tubes which can generate high power



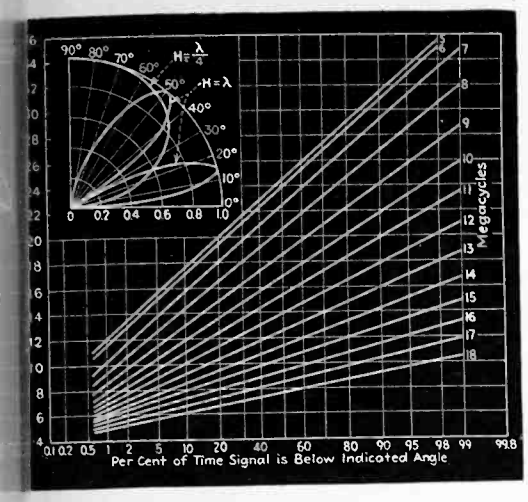
Surface-controlled mercury rectifier described by T. M. Libby

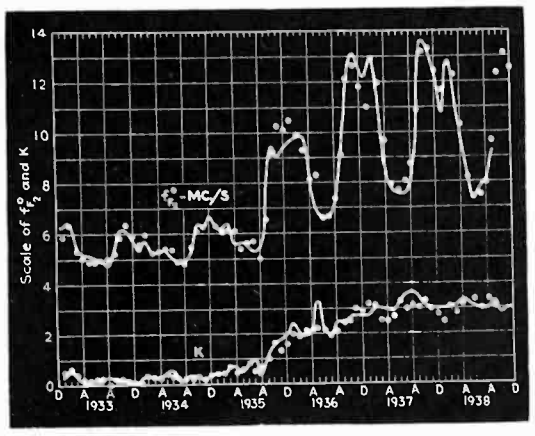


Relations between load current I_L applied voltage E_A and control voltage E_C for full conduction of new rectifier



Decreased conduction results when phase of control voltage is advanced relative to applied voltage

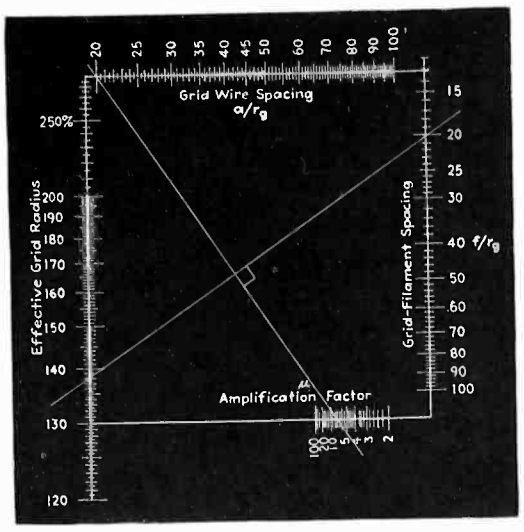




Left, statistical study of vertical angle of arrival of radio waves against frequency (F. A. Polkinghorn)

Below, correlation of sun-spot data with critical ionosphere frequencies (W. M. Goodall)

Right, nomogram for effective grid area in terms of tube dimensions (Karl Spangenberg)



wavelengths of less than 100 cm, ee *Electronics*, April, 1939, page 9) e to be presented by Simon Ramo the G. E. Research Laboratories d by Hansen, Varian, Varian, Webr and Woodyard of Stanford Uniersity. The former paper reveals new approach to the theory of elocity modulated tubes, treating he electron groups as a wave phenomena. The second paper is one of he first public presentations of the etails of the Klystron, which has een in the forefront of the scientific ews.

Four Papers on Television

E. W. Engstrom of RCA (Camden), whose influence on the growth f television and particularly on telerision standards has been outstanding, is to deliver a general paper on he framework of our present telerision system. The paper shows the ecessity of standards, establishes the ases on which the standards have een erected, and describes apparatus with which the standards are put in practice. The subject of television antennas, with special reference to simple structures suitable for use with home television receivers, is the subject of P. S. Carter's (RCA Communications) talk. The necessity of suppressing signal pick-up in the lead-in and of other precautions to avoid ghost images are stated, as is the requirement that the antenna system display a flat impedance over the band of frequencies in the television channel. In particular, Mr. Carter shows the advantage of using dipole conductors of large diameter in order to obtain a flat impedance characteristic over the frequency band. The use of folded dipoles, and of "hourglass" structures in covering the frequency range occupied by several television stations through the television band, and of the constructional changes by which impedance matching is accomplished, are also brought out.

The use of electron bombardment as a practical instrument throughout the modern television system is reviewed by I. G. Maloff of RCA (Camden). Some of the effects, as in scanning the image plate of the iconoscope and recreating the image on the luminescent screen of the picture tube, are essentials of the television process, but others are distinctly disadvantageous. In the latter category are the effect of screen saturation in picture tubes, which limits the brightness and contrast of the reproduced image, and the redistribution of secondary electrons in the iconoscope which produce uneven background shading. The means of analyzing and controlling both the beneficial and deleterious bombardment effects are discussed. The fourth paper on television, by C. N. Smyth of Kolster-Brandes, England, presents the type of information which can be assembled best only when wide experience in public service has been gained. The subject is the interference effects produced on television images by the effects of continuous waves either in the r-f channel and with the i-f pass-band. From experience in England Mr. Smyth concludes that a 40 db ratio between picture signal and interfering signal should be maintained.

Electronic Tubes and Applications

A new type of surface-controlled rectifier of the pool type is the disclosure of T. M. Libby's (Pacific Tel. and Tel. Co.) paper. The tube is a pyrex cylinder, around which a water jacket acts as a cooling agent, and at the same time acts as a shield. A vapor-pressure gradient is maintained between the cathode and the anode by means of a mercury boiler and nozzle which directs vapor at the cathode. The high pressure in this region makes for low sparking potential, while the low pressure in the vicinity of the anode, maintained by the cooling effect of water jacket, makes the sparking potential high near the anode. Reverse conduction (arc-back) is thus rendered very unlikely, even when voltages as high as 86,000 volts are applied. Control of the conduction at a given point in the applied a-c cycle is obtained by applying a control voltage between the waterjacket and the cathode. By varying the phase of this control voltage, it is possible to vary the conduction time throughout the positive-anode half cycle in the same way as in ignitron and thyratron tubes. The maximum current limitations have not been definitely established inasmuch as the maximum current was that available from the power supply.

J. L. Black and H. J. Scott of the University of California describe an interesting method of amplifying direct currents and low-frequency alternating currents by imposing them on a carrier wave which is demodulated at the output of the device. This is essentially the same system which is now used in television transmission to transmit the d-c component of the picture signal. Since the amplification occurs as a-c, after modulation and before demodulation, the amplifier is independent

(Continued on page 95)

A RECEIVER FOR FREQUENCY MODULATION

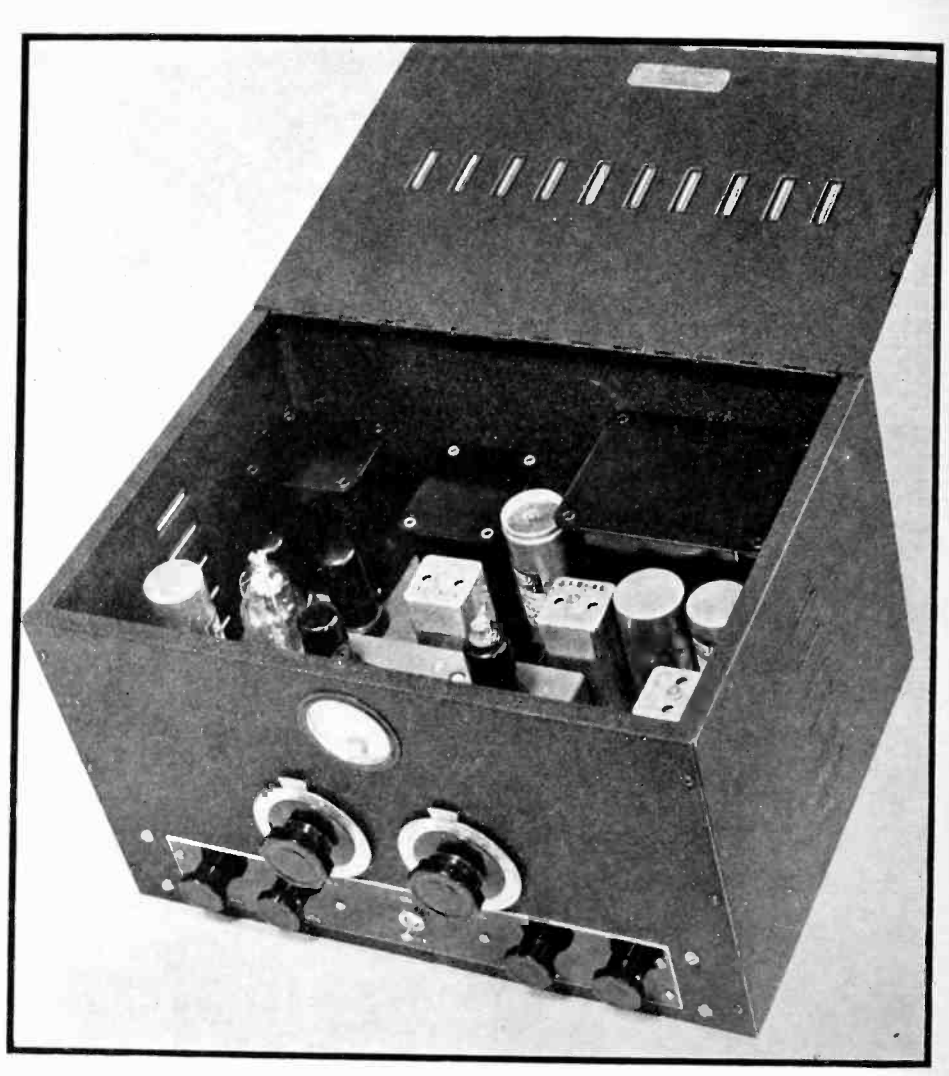
The first published data for the construction of an f-m receiver. Using but seven tubes, the circuit displays a sensitivity of the order of 5 microvolts, is flat from 30 to 15,000 cps within 2 db, and may be constructed from standard components

By J. R. DAY

Marcellus Hartley Laboratories
Columbia University

THE frequency-modulation receiver described here is representative of many others, some more elaborate, and some more simple. It was selected because its design and construction embrace all the features that distinguish frequency modulation receivers from amplitude modulation receivers. This receiver has proved capable of rendering noise-free and high quality audio from very small signals, corresponding to a field strength of from one-tenth to one one-hundredth the value that would be necessary in the case of amplitude modulation, in the absence of outside interference, and in addition possesses the advantages relating to the suppression of noise originating outside the receiver that have been demonstrated for wide-band frequency modulation.

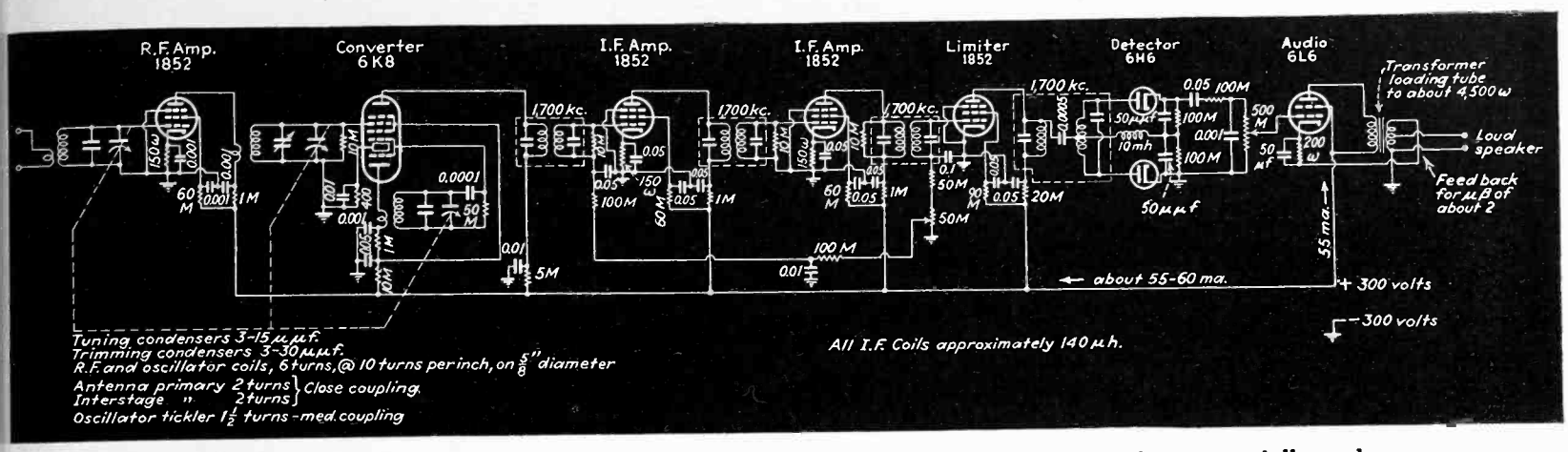
At the outset it might be well to recall a few generalities. A frequency-modulated wave is a radio-frequency carrier wave whose frequency is caused, at the transmitter, to vary linearly above and below its nominal value in accordance with the desired modulation. It is also a distinguishing and important feature of Major Armstrong's method that the maximum deviation of the transmitter frequency is several times the value in cycles of the highest frequency present in the modulation. The transmitter output, during modulation, therefore covers a considerable bandwidth, and the receiver must be designed to handle it adequately. Transmissions at present use a maximum deviation of ± 75 kc.



A commercial type of f-m receiver constructed by the Radio Engineering Laboratories using the same tube complement as that described by Mr. Day, but with a somewhat more elaborate audio system

The receiver described here when properly aligned will handle such a transmission with negligible amplitude and frequency distortion.

The block schematic diagram shows that the antenna current is received at a high frequency, is amplified, converted to a lower intermediate frequency, amplified further, passed through a current limiter, converted to amplitude modulation, and finally demodulated. Since the magnitude of the recovered audio is a function of the time rate of change of the frequency of the carrier current it follows that, unless the phase shift of the various circuits up to the detector is linear, there will be amplitude distortion. It is not hard to keep the distortion due to this to less than 1 per cent of the peak amplitude of the recovered audio, with thoroughly practical values of the circuit parameters. Observing this precaution the amplification from antenna to current limiter grid may be increased or decreased as necessary or convenient, only providing that there is sufficient gain at all times to provide adequate limiting action in the limiter stage. The receiver of the circuit diagram



Complete circuit diagram of the receiver. I-f transformers for 1700 kc are now available commercially and may be modified readily for wide-band reception

represents a middle ground in the way of sensitivity, and the values given are merely for the purpose of guidance, at the frequencies indicated.

The two tuned circuits at 7 meters do not provide a very high image ratio with an intermediate frequency of 1700 kc. However, consideration of the results shown by Weir will disclose that the requirements here are less stringent than would be the case were this receiver for amplitude modulation. The two r-f circuits and the oscillator in this case are operated from a single control, but for the purposes of an experimental receiver a separate control for the beating oscillator, enabling tuning both above and below the carrier frequency, would naturally give greater flexibility. Also the use of a higher intermediate frequency would better serve circumstances requiring a higher image ratio. The measured image response ratio of the receiver is about 18-to-1. Naturally the Q of the r-f coils is low enough to insure linear transmission and phase shift over the range of ± 100 kc. The resistor loading the grid of the 6K8 type tube was put there only because a wide variation in the input resistance at 40 megacycles among tubes was experienced. It appears that the new 6SA7 type is somewhat better in this respect. Some regeneration in the r-f section can be tolerated provided it does not unduly sharpen the transmission characteristic. The step-up in the antenna coil is about 5, and the gain of the 1852 stage to the converter grid is 12. At the time it appeared the 6K8 type offered advantages in stability at high frequencies that governed the choice. The 6SA7 now appears to be superior in this respect also.

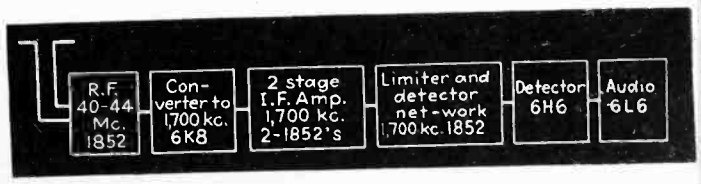
Frequency modulation of the oscillator voltage is particularly to be avoided. This may occur in a variety of ways including plate supply ripple, tube, coil, and condenser microphonic response, and heater-cathode leakage in the case where the cathode is above ground. Ripple frequency filtering in the plate supply, rigidity of coil and condenser, microphonic isolation of the tube, and large d-c bias from heater to cathode will ordinarily remedy these ills. In bad cases it may be found desirable to by-pass, and perhaps filter, the heater leads for r-f at the socket. Chokes (very small) of about 5 microhenries and 0.001 microfarad condensers will fill the bill nicely. It should be pointed out that these effects are generally very small and would not be appreciable if the overall reproduction were not so uncommonly quiet. The conversion gain of the stage is about 4.

The intermediate frequency amplifier is perfectly orthodox, and can probably be considerably improved. The 1852's give a gain of approximately 70 per stage. A gain of 50 per stage would materially lessen the hazards of unwanted feedback. Ready-made double-tuned i-f transformers are available to the trade for quite a variety of high intermediate frequencies. Several of these can be modified very simply to conform to the needs of this receiver. The coils used here were of 140 microhenries inductance and the necessary bandwidth obtained by manual adjustment of the coil spacing on the dowel, in conjunction with the indicated loading. In this case the coils were small universal-wound units of about 3/32 inch width, and the optimum coil spacing is about 3/8 inch between centers.

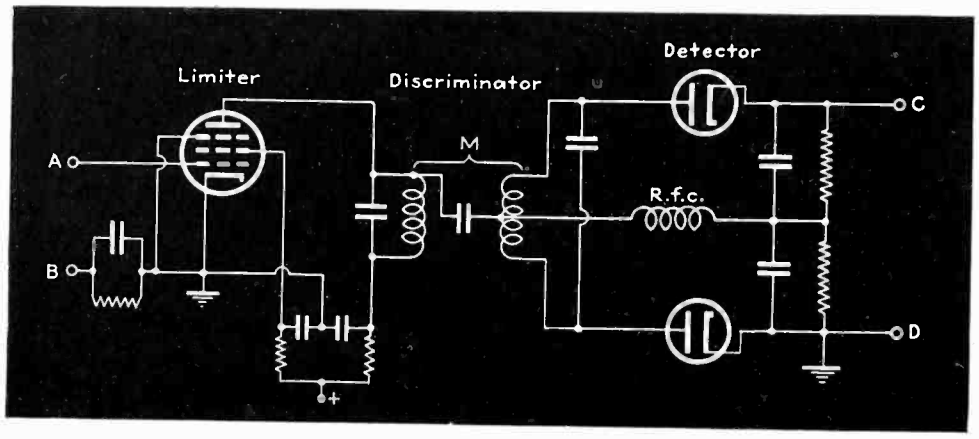
The sensitivity of the receiver cannot be compared directly with the sensitivity of an amplitude-modulation receiver, for obvious reasons, but it is possible to state a minimum signal level, required at the input of the frequency modulation receiver, to produce adequate limiting action. A voltage level of about 6 volts is required at the grid of the limiter tube to insure proper limiter action. The gains per stage prior to this grid are, from the antenna coil inward, as follows: 5, 12, 4, 70, and 70, or a total of 1,100,000 times. Accordingly, a six-volt signal can be developed from a minimum input of between 5 and 6 microvolts. It should be noted that this is the minimum signal required for limiting action against the effects of external noise. If there is no external noise to contend with, the discrimination against tube noise is active even with signals as weak as a fraction of a microvolt.

The resistance loading on the i-f coils performs a number of related functions. As mentioned before, the variation of phase angle with frequency of each coupling circuit should be linear for an interval above and below the carrier equal to the maximum frequency deviation in the transmission. A conservative figure is ± 100 kc for transmissions swinging ± 75 kc, and would represent a limit of "over-designing" beyond which there would be no benefits. In the absence of elaborate equipment for measuring the phase angle, and in the absence of the stamina required to compute it, a cheap way to

Block diagram of the receiver shown above. Except power supply, but seven tubes are used



insure success is to put one's faith in the old adage that for symmetrical circuits the phase shift is linear over the range where the transmission is constant. As a guide the individual i-f stages should be adjusted to be symmetrically tuned and to be down 1 db at the edges of the band. Symmetry is important, as stagger tuning brings in some rather unpredictable factors and can easily make a graph of the phase angle look like a bed-spring—to say nothing of what the recovered audio can sound like. The resistance loading shown is of course instrumental in obtaining the desired "steady-state" transmission characteristic. It does something else of equal importance. Since the coupling circuits contain



Limiter, discriminator and detector circuit, in which the essential demodulation functions of the receiver are performed

L, C, and R, and the currents carried are varying rapidly through the resonant frequency of the combination, transient or free-oscillation currents result. The character of these currents and their harmfulness as spurious responses is controlled by the ratio L/C and by R. The higher the damping produced by R the less pronounced will be this response. In amplifiers handling frequency modulated currents it is important that this transient current be kept to a certain low level and that it be rapidly damped out, for the highest modulation frequencies of importance (this phenomenon is clearly of greater significance the higher the modulating frequency). Using sine-wave modulation, distortion in a frequency modulation receiver due to non-linear phase angle and related defects will be characterized by the usual types of wave malformation. But this second type of distortion will appear very plainly as a damped transient of a short initial period superimposed on each half-cycle of the recovered sine-wave. The transient does not change greatly as the audio frequency is raised, being mainly dependent on the circuit rather than the precise nature of the exitation, and hence is a comparatively greater disturbance to a high frequency modulation wave than to a low. This and related phenomena are described and analyzed by Roder and by Carson and Fry. The equivalent damping shown for the circuits of this receiver is ample to insure freedom from these effects. Reasonable departure from the limits and values given here will not cause aurally detectable distortion, and experience will show the experimenter that the specifications given in this description are safe by quite a margin.

The current limiter amplifier is a coupling stage intended to remove from the carrier variations in amplitude, and to excite the conversion network with a current varying only in frequency and phase. There are a number of ways of doing this, none of them perfect. The circuit will begin to "limit" with an r-f input of three volts peak, will have leveled off at five volts, and will "drive down" slightly as the input is increased to 100 volts. This "driving down" is due to plate and screen voltage regulation as rectification occurs. As operated, this limiter is a grid-cathode rectifier and hence develops a voltage negative to ground on the resistor from coil to ground in the grid circuit. This voltage may be used for avc or manual r-f gain control by applying a part of it to one or more amplifier grids. It is important, though, not to use such a gain control voltage to an extent that might endanger the efficacy of limiting, as exemplified by a limiter grid driving voltage of say 7 volts minimum. The voltage across this resistor or the current in it may be used as a very broad tuning indicator, and, if the stages preceding the limiter are linear, as a measure of the signal strength. It is convenient to note here that up through the limiter circuit there are no requirements whatever on the linearity with amplitude of any of the amplifier circuits. Although this property in the receiver does not permit the economies that it allows in the transmitter it is none the less attractive, and neatly removes one headache for the designer of a high-quality receiver.

The network effecting the change from frequency to amplitude modulation, for the purpose of recovering the audio by ordinary means, is in the plate circuit of the limiter and consists of the familiar discriminator device as used in some types of automatic frequency control. The analysis of this circuit is ably given by Roder. Here again the coupling must be relatively "tight", in order that the peak separation should comfortably exceed the maximum frequency deviation. The circuit as shown for 1700 kc uses coils of 140 microhenries inductance, coupled a bit more tightly than the amplifier coils, that is, for a peak separation of about 250 kc. The diode load shown is sufficient to preserve linearity over the operating range. It will be found that, when the coupling is adjusted, the primary trimmer affects mainly the symmetry above and below mid-frequency of the peaks, while the secondary trimmer mainly affects the cross-over, which should be accurately nailed to the center of the i-f channel. The recovered audio when the tube ahead is limiting will be found to be between 20 and 80 volts peak for a transmitter swing of $\pm$ 75 kc. The operating conditions of the limiter tube for the most part determine the maximum audio output of the detector as shown. It should be noted that the detector output voltage consists of the sum of two voltages, one from each diode. This is a true push-pull effect, and is of aid in balancing out any unwanted modulation that appears on the diodes in the push-push sense. A 6B8 type tube can be

ed as a combined limiter detector, it it necessitates a grounded cathode and shunt diode loads, id hence a two-grid audio input. lso, being a remote cut-off tube, it is a somewhat higher limiter reshold. Since the average value the voltage across the two diode ads in series is zero when the rrier is exactly in tune, and goes sitive and negative for deviations om "in-tune", it makes a convenit and accurate tuning indication. center set voltmeter of sufficient sistance to avoid loading the diodes nduly makes a suitable indicator.

The resistance capacity combinaon intervening between the diode ad and the audio volume control a so-called "restorer", and is for ne purpose of equalizing the present ansmission characteristic. At the ransmitter the highs are accentuted in the manner familiar as preistortion. This results in a high ignal to noise ratio in the high udio frequencies, and for the case f frequency modulation does so vithout sensibly increasing the langer of side-channel interference. Further, in a frequency modulated ystem, the random noise voltage per ixed frequency interval increases as he mean frequency. Therefore the net advantage accruing is greater for the frequency modulated than for the amplitude modulated system, where the noise energy per interval s sensibly constant as the mean frequency is varied.

The recovered audio in this receiver is large enough to drive one 6L6 to full output even with the indicated feedback (mu-beta of 2.14 at 400 cycles), and the loss in the restorer. The single 6L6 will turn out 6 watts of single frequency with very low distortion. The high quality afforded by the system and the receiver permits the use of a high listening level without aural distress. However, the full use of even this single tube output will endanger the average apartment dweller's relations with his neighbors.

The writer earnestly hopes that experimenters will do their listening with this type of receiver using good loud-speaker equipment. The electrical fidelity from modulator input at the transmitter to voice coil at the receiver, in the case of this receiver and many others like it, is good to within 2 db from 30 to 15000 cps, with single frequency distortion not exceeding 2 per cent rms for full modulation. Obviously, it would be unfair and wasteful to use poor loudspeaker equipment with such a device.

The most precise method of aligning and testing a receiver like this is a point by point procedure. With a signal from some suitable generator on the grid of the limiter tube, and a high resistance d-c voltmeter across the diode output, the discriminator transformer is tuned so that for constant voltage on the limiter grid the voltage across the diodes varies linearly through zero at mid i-f range from 75 kc above to 75 kc below. It is desirable to keep the peaks as close together as is consistent with linearity in the ± 75 kc range.

The next step is to put a milliammeter in series with the limiter grid resistor and, working back stage by stage with a signal generator, to adjust the coil couplings, loads and tuning until the transmission characteristic of each stage and of all in cascade is symmetrical and flat across the operating range. It will be found that a symmetrical amplifier that is flat for the operating range to within ± 1 db, and that is sufficiently damped, will transmit a frequency modulated current of total deviation equal to the range with virtually perfect freedom from distortion. It is possible to compensate double-peaked circuits by single-peaked circuits, in the usual way, provided symmetry and freedom from feedback are maintained, in such a manner that no appreciable distortion will occur. However, since the action then occurring can be quite complex and is not easily subject to analysis, this method is not generally to be recommended. It is important to bear in mind the nature and origin of the two types of amplitude distortion mentioned above during the lining-up process.

A wide-swing frequency modulated oscillator with provision for a low-frequency saw-tooth sweep will provide a quick visual method of alignment of all circuits. For experimental purposes there are, however, some drawbacks. In the first place, relatively careful calibration of frequency deviation is necessary. The visual accuracy of cathode-ray tube indications is limited. And, finally, there is a strong temptation when using this sort of equipment to align the receiver "over-all" and perhaps unwittingly to indulge in interstage compensation for the sake of a smooth looking transmission characteristic. If this method is used the voltage on the limiter grid resistor (with by-pass reduced so as to shunt out only r-f) is convenient for vertical deflection when aligning the i-f stages and converter.

The alignment of the r-f section consists of simple peaking, as the coil and tube damping are more than enough for the purpose. Although the sensitivity of the receiver is high, and the natural noise-reduction inherently good, a good dipole with associated transmission line will repay the effort. There is nothing out of the run of ordinary short-wave practice in the collection of the signal. Only under very unfavorable circumstances and at considerable distances from the transmitter are special devices such as reflectors, indicated.

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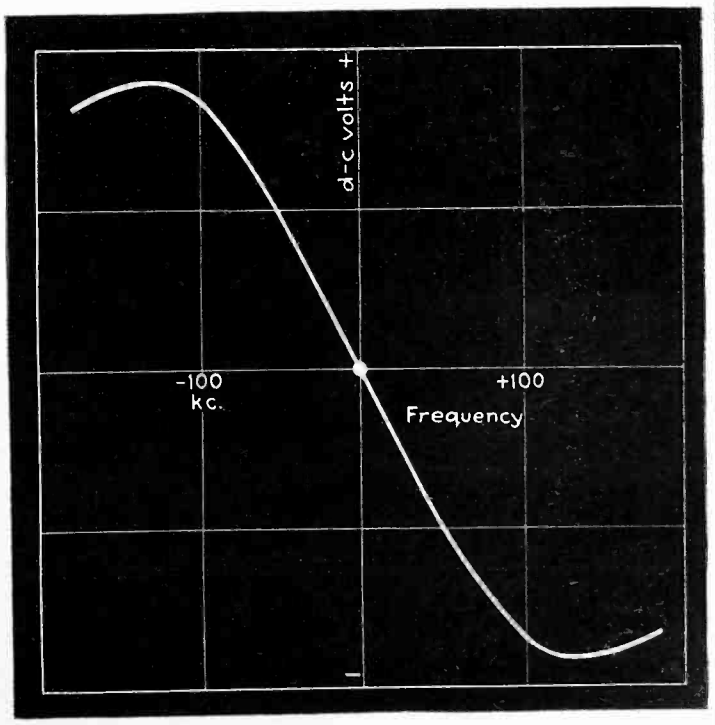
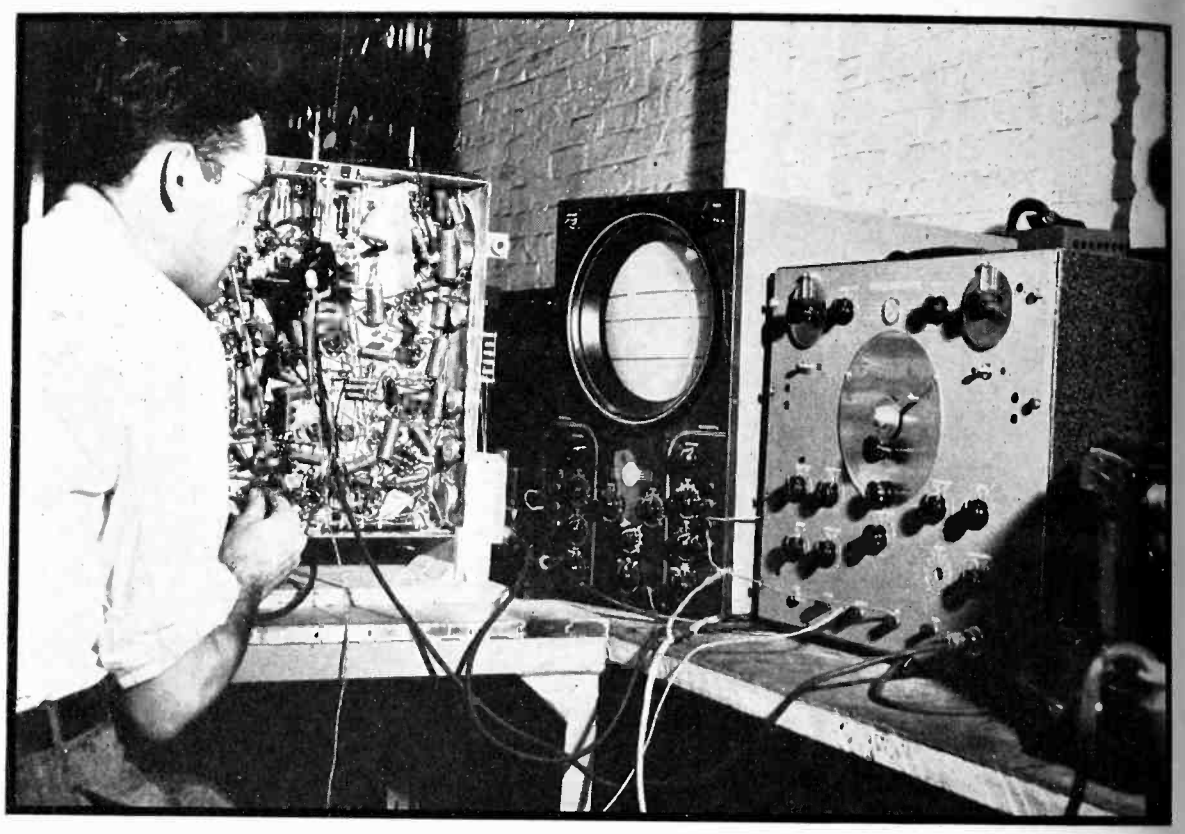


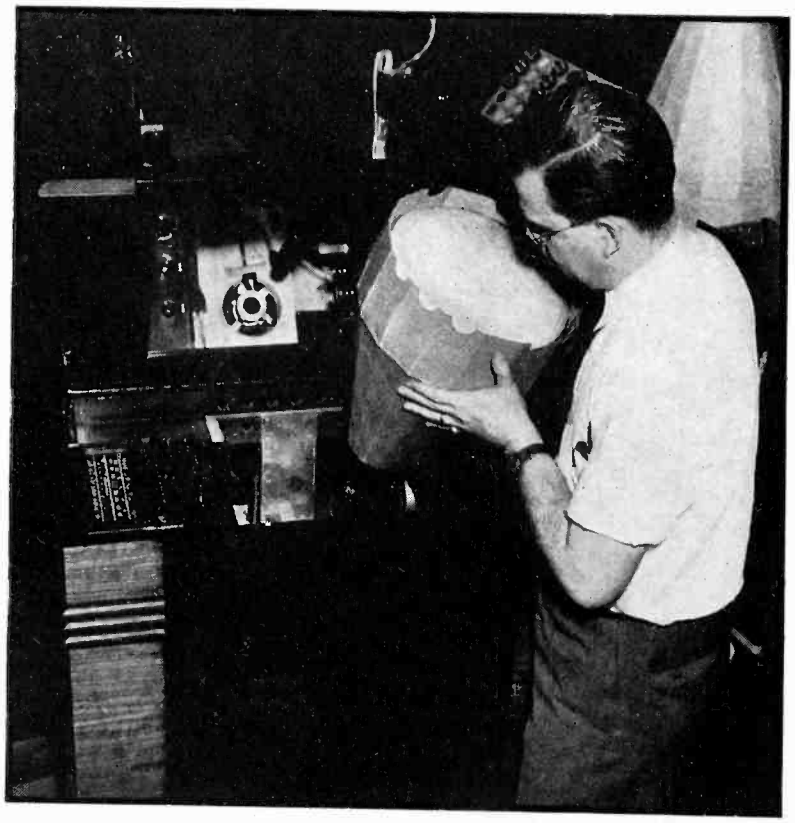
Operating characteristic of the discriminator circuit shown opposite, showing audio output amplitude against frequency deviation

ON THE PRODUCTION LINE

First published views of television receiver production at the RCA Victor plant, where methods similar to those of high-speed sound receiver production have been adapted to new assembly and testing routines



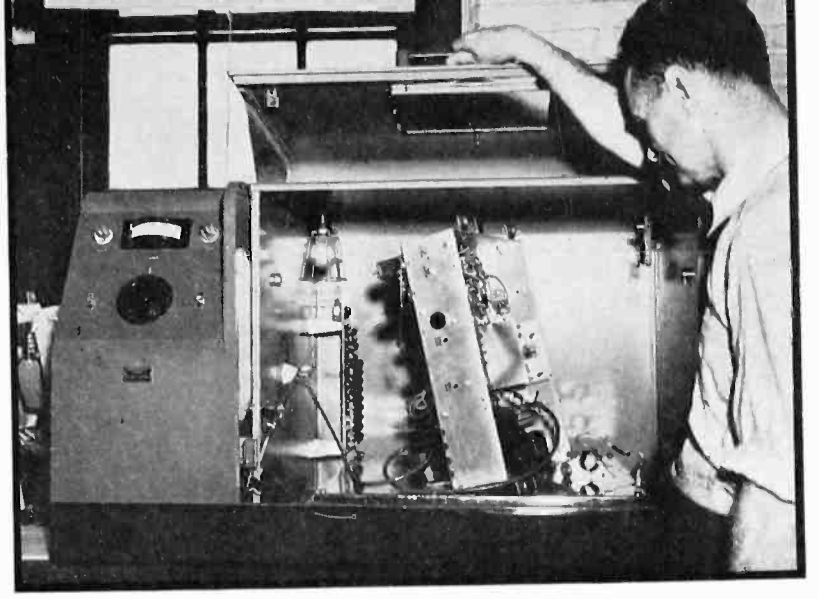
The alignment of the picture i-f system demands specialized equipment. A sweep-oscillator type of signal generator (right) covers the television channel, while the oscilloscope indicates the receiver response. Five 4-Mc i-f stages may be aligned in as many minutes with this equipment



Inserting a 12-inch picture tube into a completed receiver. The corrugated cardboard which protects the handler in the event the tube "implodes", is permanently affixed to the tube. The scanning yoke may be seen in the mirror under the cabinet lid

A direct-viewing console employing a nine-inch picture tube is here shown in completed form. The slightly bulbous shape of the picture tube adds mechanical strength against outside air pressure. The three chasses, reading downward, are all-wave radio, television, and power supply

Installing the lower chassis (power supply) in a group of direct viewing consoles. The receiver at the extreme right is of the mirror-viewing type, with chassis mounted vertically



The "hi-pot" (high potential) test of the cathode-ray tube second anode power supply, which provides 2000 volts in the smaller sets, 7000 in the larger. A heavy overload test is given each unit

Sockets are numerous in a television chassis. Here the mechanical work of assembling the parts is completed before wiring

Sub-assemblies are mounted and wired individually. Here the high voltage control circuits are mounted on an individual panel board

Wiring the chassis proper, one of the most complicated jobs in the radio field, is handled by the most experienced and capable operators

A final check-up of a nearly completed chassis is made by an operator who wears gloves to protect the parts from dirt and moisture. The wave-change switch and associated circuits are at the left

The completed chasses are inspected and placed on storage racks, ready for mounting in the cabinets. The chasses visible represent only a small part of daily production capabilities of the plant

A LOW DISTORTIO

By E. G. COOK

New York Power and Light Corp.

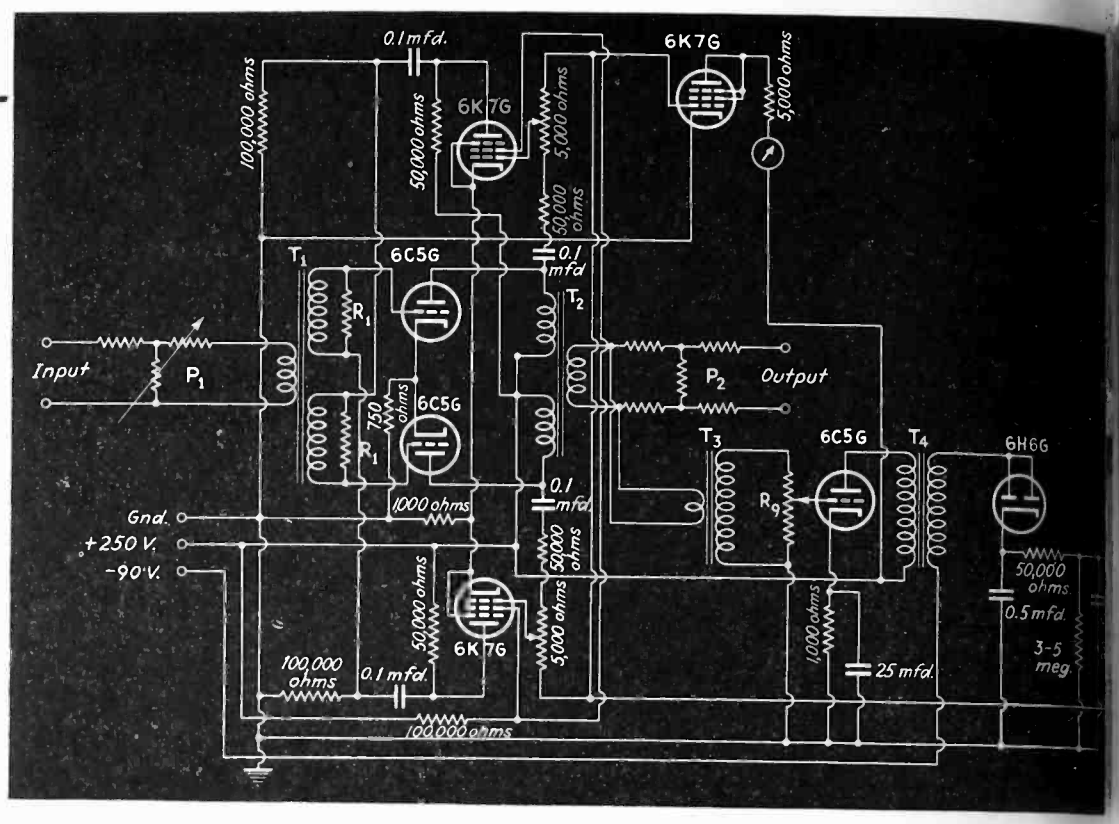
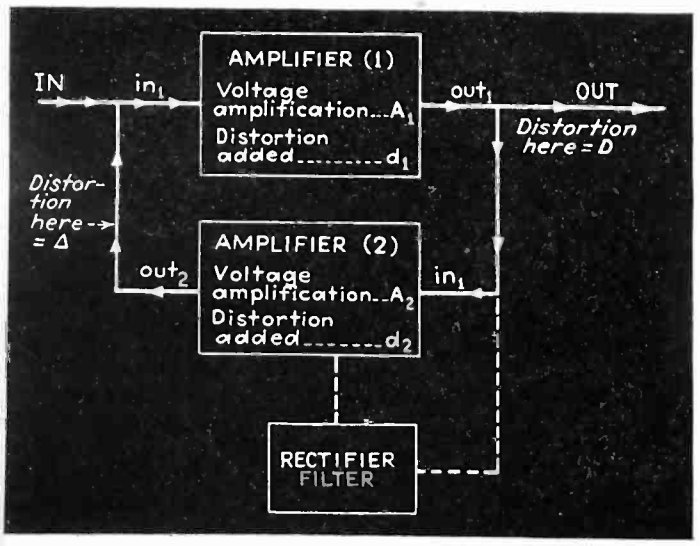


Fig. 1—The limiting effect of this amplifier is obtained by the use of a remote cutoff pentode amplifier to provide varying amounts of feedback. The significant consideration is the increase in the lowest modulation level and not the average modulation level increase

In present limiting amplifier design there is usually incorporated a type of circuit element which cannot be described as passive or linear. Characteristically, such elements tend to introduce non-linear distortion which is incapable of correction through degenerative feedback, since an inherent tendency of feedback is to maintain constant gain. The unusual feature of the design described herein lies in the use of a feedback amplifier with the limiting effect produced by the application of variable amounts of feedback through a remote cutoff pentode.

The purpose of a limiting amplifier is to extend the primary coverage area of a station, and to increase secondary coverage where noise level competition is serious. The significant quantity to be considered in achieving this purpose is not average modulation level increase, but lowest modulation level increase since it is the latter which competes with the listener's noise level. In applying this concept to practice it is first necessary to consider the available characteristic curves of limiting amplifiers (Fig. 4). In order to obtain the highest possible modulation percentage from any of these curves, the audio chain should be so adjusted as to give about 100 per cent modulation at the output corresponding to the flat top of the curve. If this is done, then curve (1) is obviously not ideal, in that it affords a minimum of increase of the low-level portion of a program, and will merely operate as a delayed "peak chopper" for excessively high signals and as a normal amplifier for average modulation. Curve (2) has its application in remote pick up work where the level fluctuations may be violent and unexpected. Its advantage lies in the impossibility of overmodulation and an overload point far removed from the operating range. Curve (3) affords some compression before 100 per cent modulation is reached and when operated in conjunction with fast compression and relaxation times is less objectionable to the listener.

Fig. 2—The value β of the feedback amplifier is made greater than unity by inserting in series with the bias battery a rectified voltage proportional to the output voltage



Compression Ratio

Compression ratio may be defined as the ratio of maximum to minimum voltage gain of a limiting amplifier during some interval of time. In decibels it is the difference of the above two quantities expressed in db. Brief tests conducted by the writer at WESG (1 kw, Ithaca, N. Y.) have indicated that a compression ratio of 3 db can cause a modulation average power increase of two to one on poorly monitored programs and that ratios of 6 db or more are usually necessary on well monitored network material.

In considering the operation of this circuit (Fig. 1), it is first desirable to investigate the special case of a feedback amplifier with an absolute value of β greater than unity (Fig. 2). The fundamental relation for overall gain of a feedback amplifier is

$$\text{Overall Gain} = A/(1-A\beta)$$

Where A is the normal voltage amplification without feedback, and

MITING AMPLIFIER

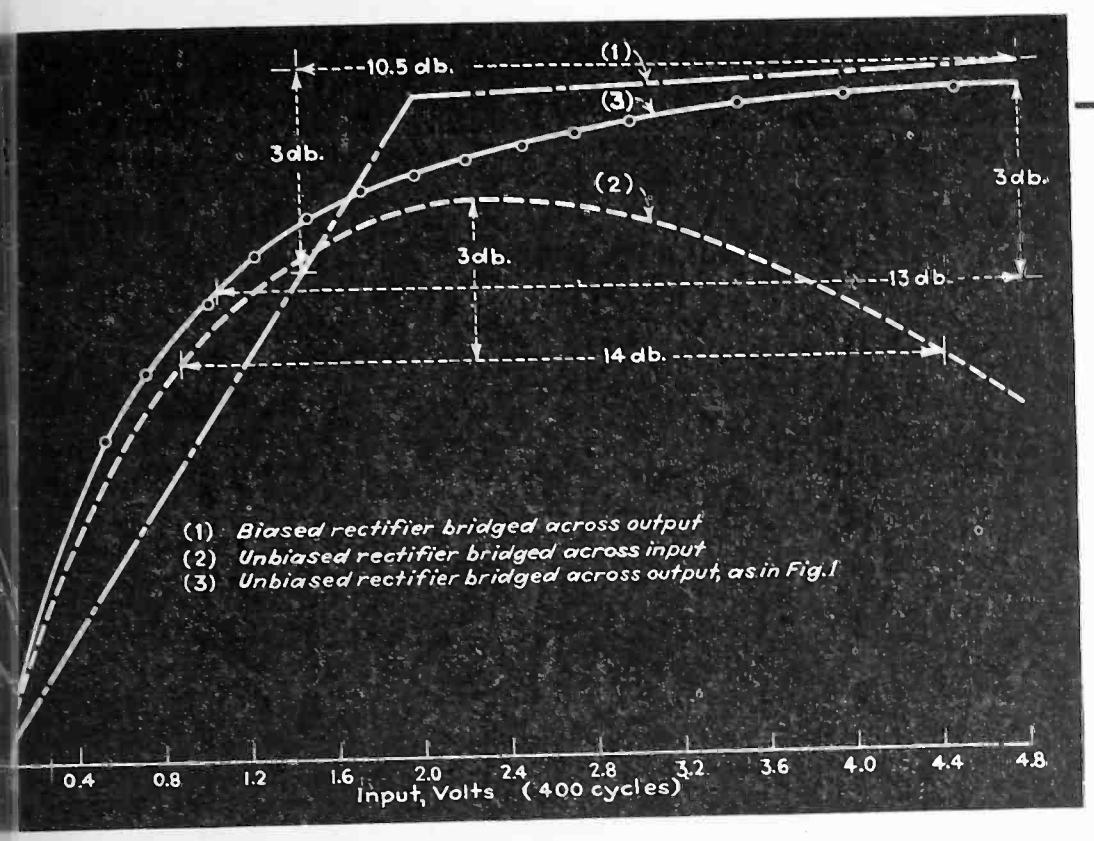


Fig. 4—Characteristic curves of limiting amplifiers. Curve (3) provides some compression before 100 per cent modulation is reached and when it is operated with the proper time constants, is the least objectionable to the listener

β is the voltage gain of the feedback circuit. Since there is nothing in the derivation of this relation to prevent β from being greater than unity, we may substitute an amplifier for the passive linear network usually found in feedback circuit. In the case of the limiting amplifier, where feedback during compression is large, gain is roughly $-1/\beta$. Thus, if the β circuit consists of an amplifier, or active network, the overall gain of the system is $1/A_2$, where A_2 is the gain of the β circuit amplifier. Then to decrease the overall gain, β must increase, or in other words, A_2 must increase. This is accomplished by means of inserting in series with a bias battery, an opposing voltage rectified from the signal output (or input), and proportional thereto. The battery performs the function of placing a large bias on the remote cut-off tube at times of zero-signal input, while the rectifier removes this bias as signal amplitude increases.

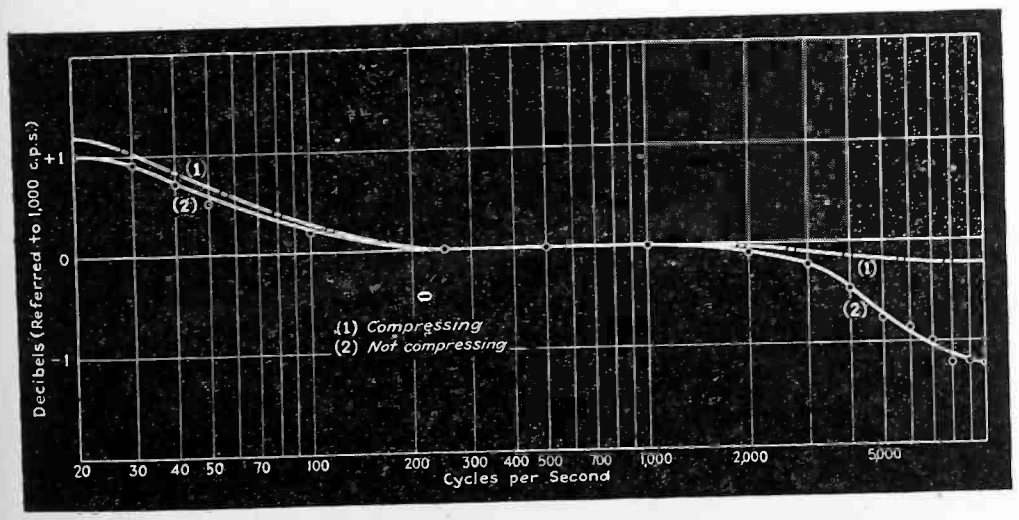


Fig. 3—The high frequency response is slightly increased by compression. Tests have indicated that on poorly monitored programs a compression ratio of 3 db and on well monitored programs a ratio of 6 db is required for an average power increase of two to one

Distortion

It remains to show that distortion arising from non-linearity of the remote cut-off tube characteristic is not present at the output of the limiting amplifier to any great extent. Consider two amplifiers (1) and (2) (Fig. 2) with voltage gains A_1 and A_2 which include all attenuating networks associated with the amplifiers, so arranged that amplifier (2) is the feedback path for (1), and assume a distortion component of output signal, D. To produce this output distortion, a distortion Δ must be present at the input to amplifier (1) such that

$$\Delta A_1 + d_1 = D \text{ or}$$
$$\Delta = (D - d_1)/A_1$$

where d_1 is the distortion arising in the output due to amplifier (1) alone. However, since D is also the input distortion voltage to amplifier (2), the distortion output of amplifier (2) will be

$$\Delta = DA_2 + d_2$$

where d_2 is the distortion arising in amplifier (2) alone. Observe here that the output of (2) is the same as the input of (1) and that distortion output of (2) is the same as distortion input to (1). Equating,

$$DA_2 + d_2 = (D\text{-}d_1)/A_1 \text{ or}$$
$$D = (d_2A_1 + d_1)/(1 - A_2A_1) =$$
$$\textit{Total distortion}$$

Here, for the purpose of approximation, we may make two assumptions: that d_1 is very small compared with d_2A_1, and that A_2A_1 is large with respect to unity. Therefore the output distortion voltage is closely approximated by

$$D = d_2/A_2$$

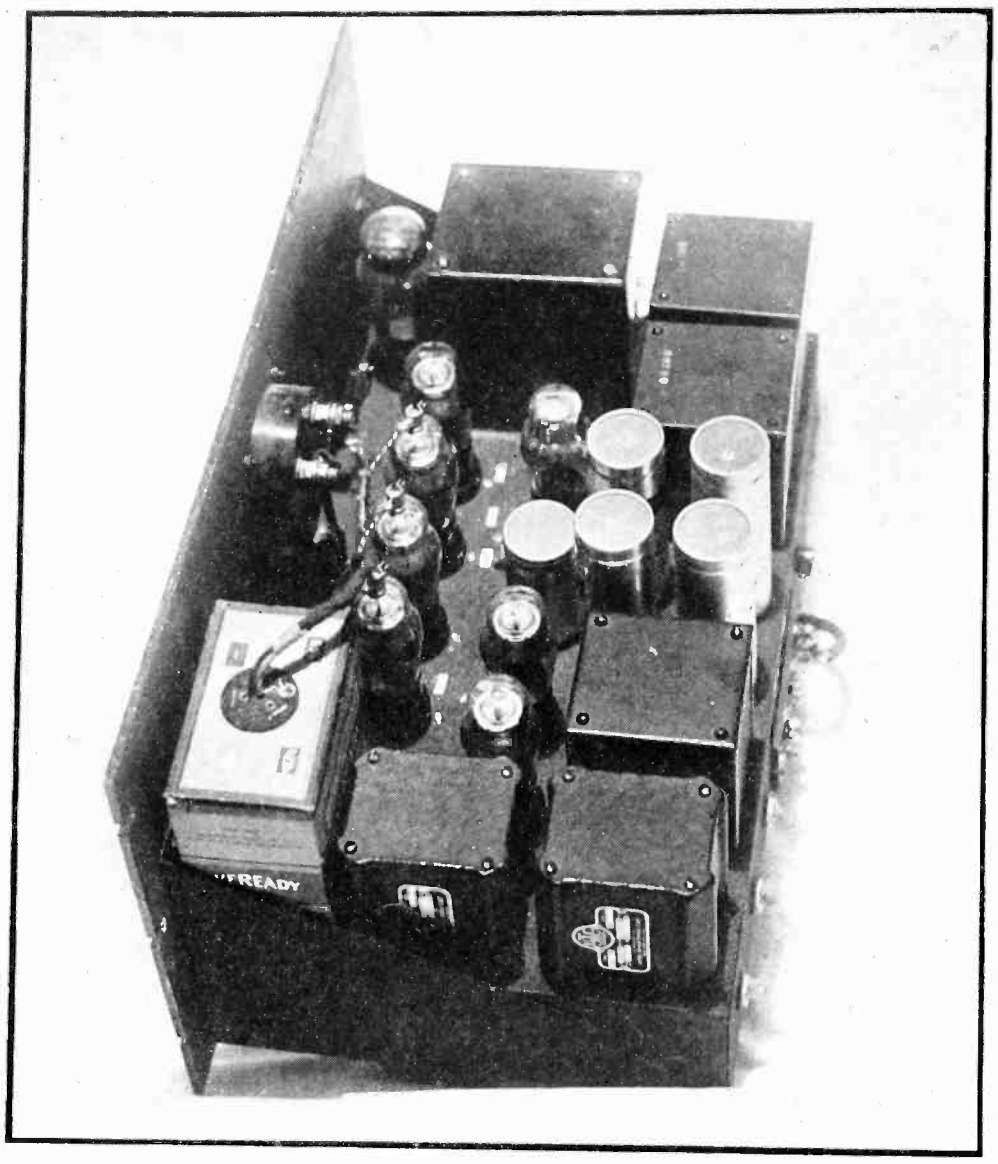


Fig. 5—The complete unit may be accommodated on a chassis 10½ by 17 inches. The question of time constants is open to much dispute. The charge time for this amplifier was chosen to be one-quarter to one-half second to reach 90 per cent of the ultimate value

In interpreting this relation it must be remembered that d_2 is not an independent variable, but a function of A_2. The character of this function is not mathematical, but follows from the i_p–e_c characteristic curve of a 6K7. By referring to this curve it will be found that there are two relatively straight sections, one near the ordinate E_c=O, and one near cut-off, joined by a curved portion. Distortion will be low in the straight line sections, and will reach a maximum in the curved portion. There is still another factor involved in the determination of distortion at low frequencies. The filter for the audio frequency rectifier must be so proportioned that at the lowest frequency desired for transmission, the alternating component of rectifier output voltage is negligible compared with the feedback signal voltage appearing at the remote cut-off grid. In one test model, economy of design dictated that the amplifier be single ended rather than push-pull; the consequent use of an air gap transfer with d-c unbalance resulted in a residual second harmonic content of 0.5 per cent regardless of compression. Measurement of harmonic components in the output at typical conditions disclosed no other harmonic present in quantities greater than 0.05 per cent, thus confirming the theory. The cathode resistor and screen resistor of the 6K7 variable gain feedback tubes are left unbypassed to afford an additional path of degeneration for distortion correction in that stage. This has no effect during periods of zero compression and tends to make a gradual transition between the range where output is proportional to input and where output is independent of input.

Frequency Response Measurements

In taking frequency response measurements on any limiting amplifier employing an audio frequency rectifier, significant data cannot be obtained by taking readings of input and output voltage. Since output signal voltage depends directly upon the magnitude of rectified voltage as well as the input voltage, the rectifier will force its own characteristic upon the amplifier by failing to give a linear ratio of a-c applied voltage to d-c output bias voltage over the entire frequency range. The proper method is to disconnect the rectifier and arbitrarily place the desired d-c bias voltage on the grid return.

In Fig. 4 are shown some of the curves obtainable from this type of circuit. For a very sharp transition between linear and constant output conditions (curve 1) the audio frequency rectifier must be biased. Curve (2) is obtained by bridging the rectifier driver amplifier across the input rather than the output of the limiting amplifier. The vacuum tube voltmeter employs a triode connected 6K7 to measure the net d-c bias and the meter may be calibrated directly in db compression. In using this meter it should be remembered that compression ratio is not the absolute reading of the meter, but the difference between maximum and minimum readings for any specified interval of time.

Time Constants

Perhaps the most disputed point in connection with limiting amplifiers is that of time constants, or time required for compression and relaxation. A fast compression time will tend to place rapid changes of amplification on the program and involves an inadequate filter for the audio frequency rectifier. Slow compression time may cause overmodulation with high compression ratios on the first few peaks of a high level burst and may also permit the loudest volume to occur at the wrong moment. Charge time for rectifier voltage to reach 90 per cent of ultimate value was chosen at one-fourth to one-half second. If relaxation time is too long, it may arouse resentment in the audience due to a perceptible fluctuation of the background noise level. A slow recovery of gain appears to elude even trained listeners who have proven themselves incapable of detecting compression ratios of 10 decibels.

ELECTRONIC CONTROL FOR SHIP STEERING

By BRITTON CHANCE

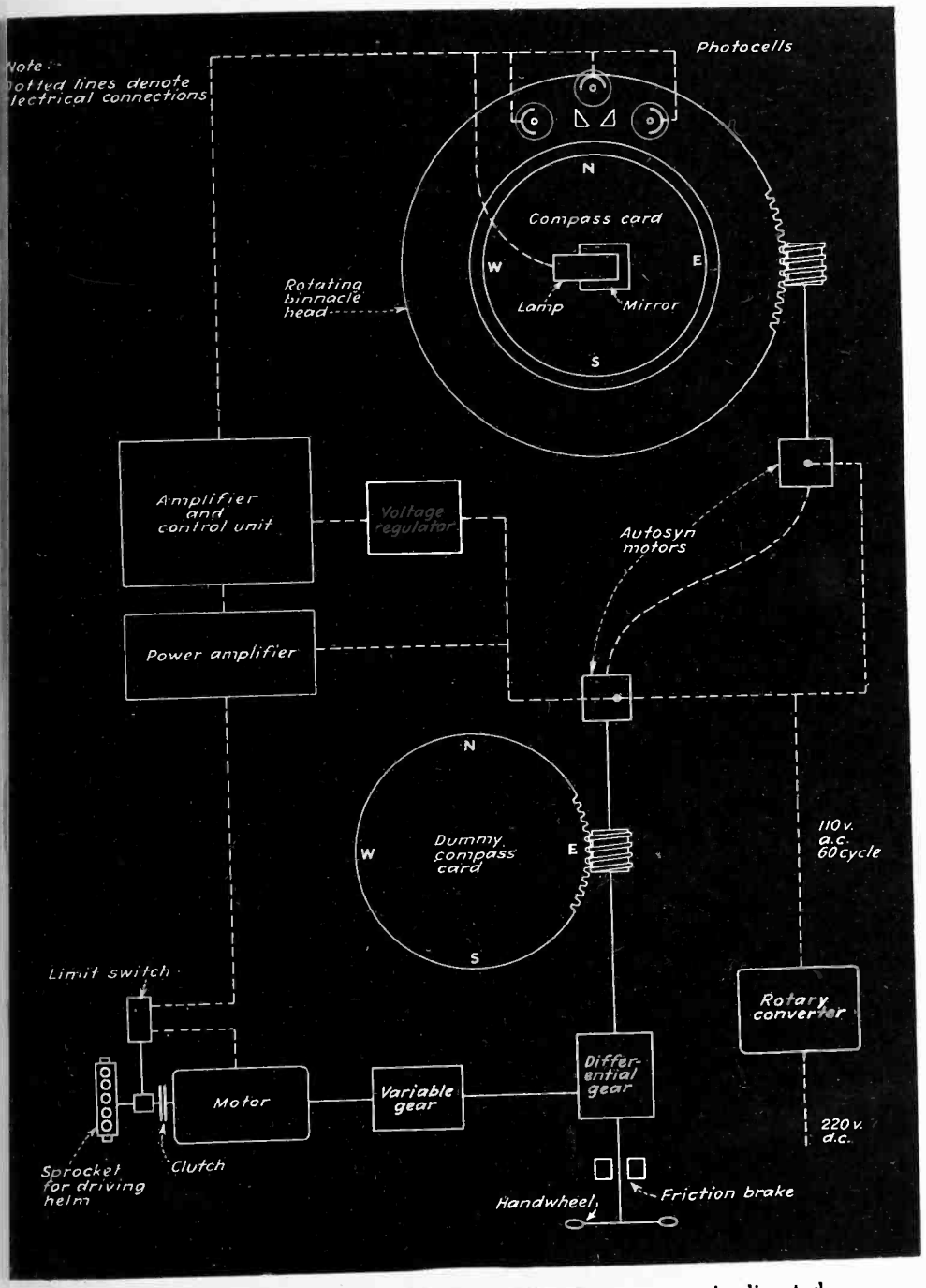


Fig. 1—A beam of light which turns with the compass is directed toward a system of phototubes. As the ship yaws the light beam illuminates one of the side phototubes causing the steering motor to operate the rudder

FOR several years extensive tests have been carried out in developing an automatic steering apparatus for ships which is operated from a magnetic compass by means of phototubes. The present apparatus has evolved from a number of past forms and has resulted in the attainment of a highly sensitive and accurate type of automatic steering device. Experience has shown that mechanical circuit-closing devices are not suitable for use on large vessels where continuous operation is required under adverse temperature and humidity conditions. Therefore, complete electronic control of the apparatus has been developed for commercial vessels with the result that the sensitivity, flexibility, and reliability of the apparatus has been greatly increased.

The apparatus is essentially a servo mechanism in which the output torque is proportional to the input-output deviation. This type has been fully analyzed by Hazen.[1] In this particular case the torque producing element is the ship's rudder which in most cases produces a torque substantially proportional to the angle through which it is turned. There is, however, non linearity in the case of certain twin screw vessels. The rudder is usually operated by a Ward Leonard system, a hydraulic system, or a steam engine in such a way that the position of the rudder corresponds to the position of the steering wheel. Automatic steering requires two things from the rudder and two from the steering engine.

1. Small rudder angles from the mid-position must produce sizable torques.

2. Large rudder angles must produce no abrupt deviations from linearity.

3. The steering engine must be able to turn the rudder through angles as small as $\frac{1}{4}$ degree.

4. The steering engine must respond to a small movement of the steering wheel.

Method of Operation

The method of operation of an automatic steering device follows. The automatic steering gear turns the steering wheel through a motorized reduction gear and a clutch to disengage the automatic steering. The steering motor serves these purposes: it turns the ship's steering wheel when on automatic steering, operates a follow up system for the compass and drives any remote indicators or recorders of the ship's path. Due to this follow-up connection, the position of the steering wheel depends upon the input-output deviation and that of the remote indicators upon the deviation from the north point.

The most important technical problems of automatic steering lie in the relations between the steering motor and the compass. There would be no problems at all if a ship would stay on a straight course with a

[1] *Journal of The Franklin Institute*, Sept. 1934, p. 279.

given rudder setting for any length of time. A ship will not do this and experience has shown that high sensitivity is necessary to stop incipient yaws before they become too large to be satisfactorily controlled. This means that a large number of minute adjustments must be continually applied to the rudder, as frequently as once every five seconds. In the past, relays were used for ship steering, but the following faults have been encountered in their use:

1. They are noisy in operation and disturb officers in foggy weather.
2. They seriously interfere with short wave radio.
3. Their life is short as the operations are frequent.
4. Dynamic and/or solenoid braking must be used.
5. There is a lack of correlation between input-output deviation and steering motor speed.

Their advantages are low first cost and simplicity.

The method in which the indications of the compass are utilized to bring the motor control system into operation can be criticized also. The indications must be obtained without the slightest disturbance to the compass. If a mechanical device is to control the steering motor relays, then a sensitive servo mechanism must be used to obtain the compass indications. This method is used in conjunction with gyroscopes and suffers from a multitude of minute mechanical lost motions. If the steering motor is to be controlled by the compass directly, a non-reactive pick-off must be used and high sensitivity must be attained.

Electronic Control

Now that the general nature of the problem has been set forth an explanation and description of the operation of a device designed to overcome the difficulties mentioned previously will be described.

A diagram of the equipment is shown in Fig. 1. The compass card of an ordinary magnetic compass carries a mirror which reflects a beam of light, from a source just above it, to a system of prisms and phototubes. When the ship is on her course the middle phototube is illuminated, but any deviation throws the light on to one of the side phototubes, and this starts a motor which moves the steering wheel as re-

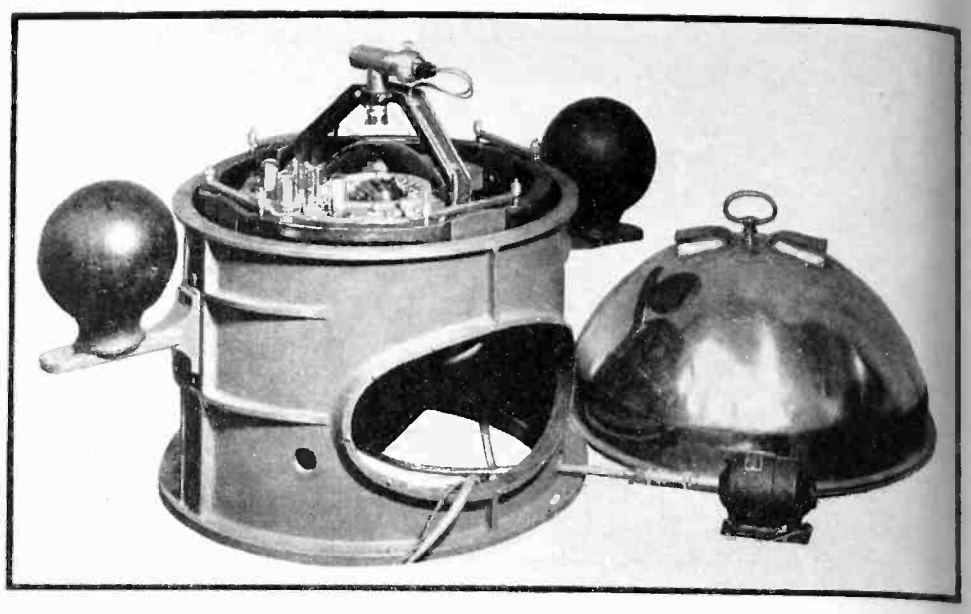


Fig. 2—A mirror is mounted on the spindle of the spherical compass and a lamp is placed directly above it

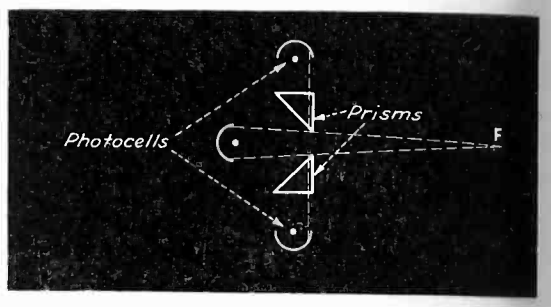


Fig. 3—The prisms are adjustable so that an initial sensitivity setting may be made

Fig. 4—If the light beam goes beyond the side phototube, the steering motor continues to operate because a negative bias is put on g₃ of the appropriate 6L7

aired. This motor is coupled rough a gearing, a differential ear, and two autosyn motors, back the frame carrying the photo- bes, thus moving them back to the ght beam as the steering wheel is oved. When the light beam shines the middle phototube again the otor stops and the effect is to make e movement of the steering wheel roportional to the input-output de- ation.

The function of the variable gear- g is to alter this proportionality suit the particular ship and the nction of the differential gear is to ange the course by changing the gular displacement between the dder and the binnacle head carry- g the phototubes. The autosyn otors and connections take the ace of a long flexible shaft between e compass and the rest of the ap- aratus. The dummy compass card cts as a repeater of the automatic eering compass and gives the urse of the ship. Normally the eering motor is located on the ridge of the ship while the binnacle usually placed amidships and not ar from the waterline to avoid ranslation effects on the compass imballing.

The details of the apparatus will ow be described and the methods of vercoming the difficulties previous- y mentioned will be explained. The innacle containing the compass and hototubes is shown in Fig. 2. While ny type of magnetic compass can e utilized, the spherical compass

Fig. 6—The control unit is directly connected to the steering wheel on the bridge of the ship

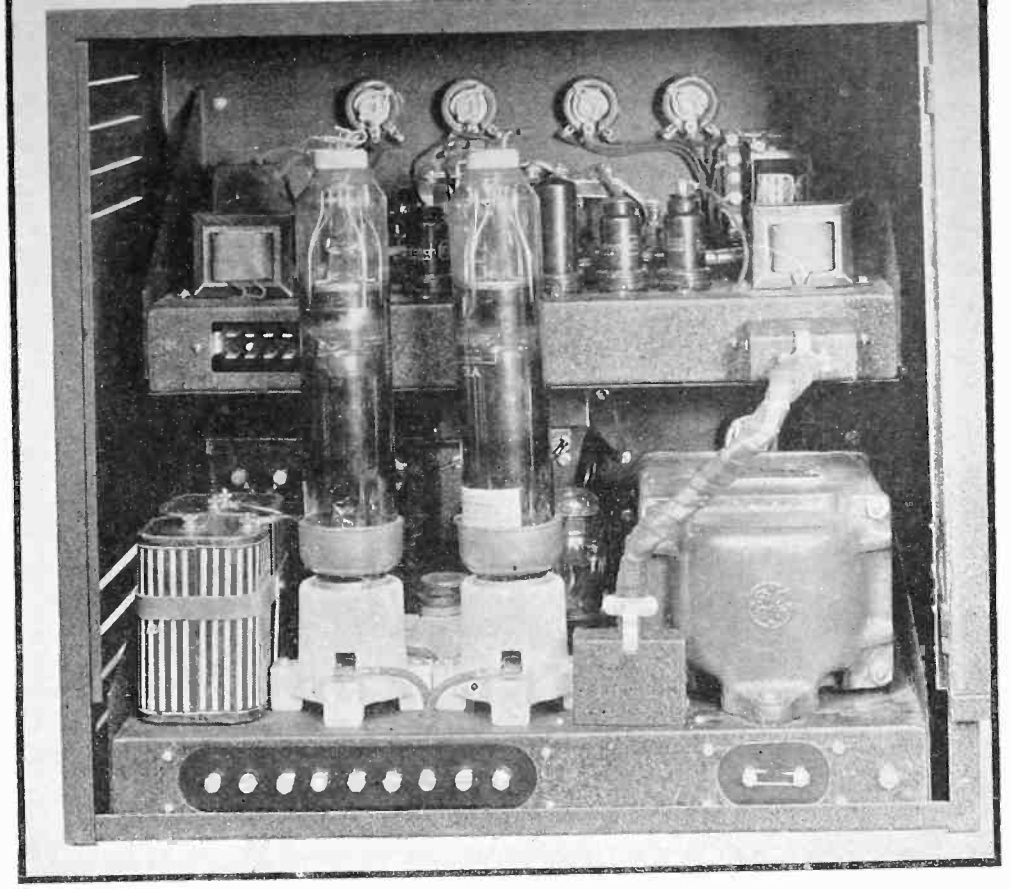


Fig. 5—The grid voltage of the C6As lags the anode voltage by about 90° to give smooth control of the motor current by means of the d-c bias supplied by the 6L7s.

lends itself best to conditions of low horizontal intensity usually encountered on ships and is easily adapted for use in automatic steering. All that is necessary is to mount a mirror on the spindle already provided on this type of compass. The lamp and lens project a beam of light vertically on to the mirror which reflects the light horizontally towards the junction of the two prisms. A rectangular image of the filament is formed which is normally framed by the prisms. See Fig. 3. The prisms, however, are adjustable to make an initial sensitivity setting of the apparatus. The light beam gives about 0.078 lumens per degree operated at ¾ rated voltage to ensure long life. The phototubes have a sensitivity of 100 microamperes per lumen. As the phototubes, prisms, light source, and compass bowl are rotatable to secure follow-up, the phototube and lamp currents are carried through slip rings. The whole assembly is carried in gimbal rings to render the apparatus unaffected by the motion of the ship. Follow-up is secured through the autosyn which rotates the phototube assembly by a worm driven through a flexible shaft.

The phototube currents are fed through cables up to 40 feet long to the amplifier, Fig. 5, which is the heart of the apparatus for therein lies the means for obtaining the desirable motor control characteristics mentioned above. The circuit is shown in Fig. 4. The cycle of operation is that an increase of light on one phototube decreases the plate current of one 6L7, hence the negative bias on the gas triode C6A is decreased and current is passed to the steering motor armature through one of its series fields. The motor turns in the appropriate direction to produce rudder torque to send the ship back toward the desired course and also turns the antosyn follow-up system to restore the normal relation between the light beam and phototubes which will operate to stop the steering motor.

Circuit Operation

In detail the operation of the amplifier circuit is this. Assuming that the light beam falls on the left phototube, this will apply negative bias to g_1 of the 6L7. If the beam continues to move rapidly past this phototube, g_3 of the 6L7 ensures that the motor continues to run because g_3 is negative as long as there is no light on the middle phototube. A special relay is used for this so that both rectifiers do not go on simultaneously. This relay has two coils (marked 1 and 2) in the anode circuit of the C6As, and two pairs of contacts, one pair of which is shown on Fig. 5. This relay is held mechanically either in position 1 by a spring or in position 2 by a latch. When coil 2 is energised it pulls the

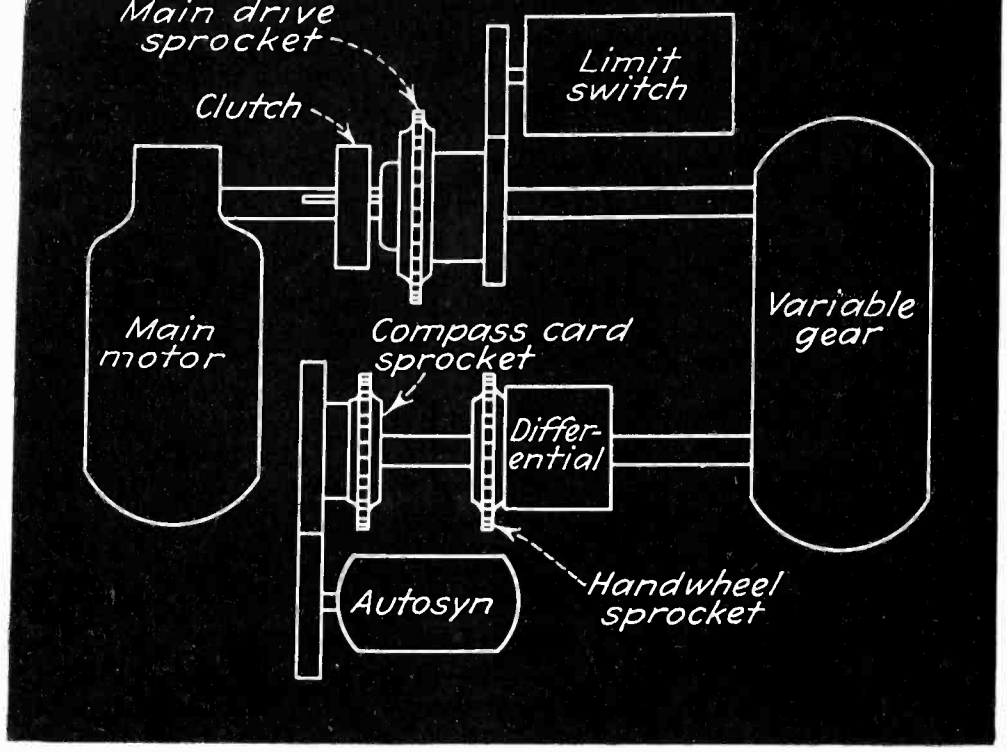


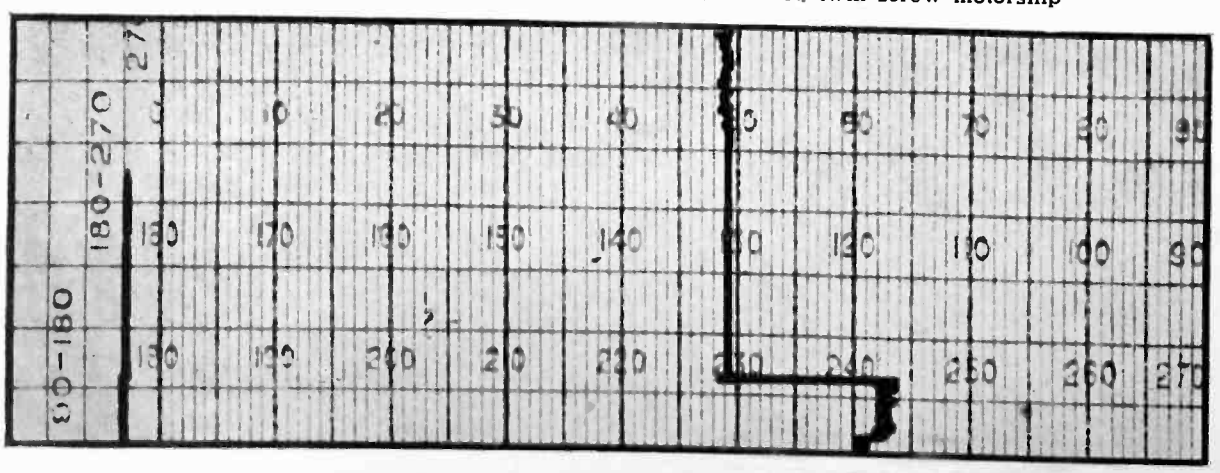
Fig. 7—The control unit on the bridge and the compass binnacle amidship near the waterline are synchronized by means of autosyn motors

arm over to position 2, where it is latched, and coil 1 releases the latch so that the arm returns to position 1. As long as the middle phototube is dark, the 6C5 on the right of Fig. 4, puts a negative bias on g_3 of the appropriate 6L7 so that the latching function is applied to the proper C6A and the motor continues to run in the appropriate direction to return the light to the middle phototube.

This middle phototube also operates an alarm circuit to warn the navigating officer of an unusual deviation of the ship from the course which he has set. This alarm in effect continually watches the course of the ship and takes this responsibility from the ship's officers. If, in the event of an unusual deviation of the ship or any failure of the electro - optical - mechanical system, the light beam does not illuminate the middle phototube, the anode current of the left hand 6C5 (Fig. 4) is cut off and the condenser shunting the alarm relay coil, discharges and rings the alarm in seven seconds if the unusual condition is not corrected. The extreme reliability of the magnetic compass gives this alarm fundamental importance among the ship's safety devices.

In usual practice it is continually necessary to increase the sensitivity of the automatic steering to improve the course steered or to decrease the sensitivity to avoid excessive wear on the steering engine. This adjustment can be made manually by altering the phototube anode voltage, but this equipment also affords an automatic weather control which automatically maintains the steering motor activity at a predetermined level of highest efficiency irrespective of the state of the seas in which the ship is travelling. The operation is as follows: If the left C6A is operating, the a-c component of its anode current passes through a step-up transformer to the terminals marked bb in Fig. 4, and charges up a condenser through a diode. This makes the anode of the right phototube more positive, reducing its effectiveness in controlling its 6L7 until this condenser has discharged. The time constant of the circuit can be varied to suit different vessels, and the peak value of the applied ac can be varied to predetermine the desirable level of motor activity. This has been so effective in practice that one ship travelled 8,000 miles without altering any adjustment.

Fig. 8—Performance is shown by this chart recorded by an independent gyroscope on a 23,000 ton, 17 knot, twin screw motorship



As mentioned previously, the fourth fault of rudder control can be corrected. This is done by giving the rudder a larger throw whenever the direction of the ship's yaw changes. Under certain conditions this results in a severe loss of stability and efficiency. It is embodied in this apparatus by a variable resistance connected to either phototube by means of the second pair of contacts of the relay referred to above.

The C6As are supplied with an a-c grid voltage lagging the anode voltage by 90° in order to give smooth control of the motor current by means of the d-c bias supplied by the 6L7s. This phase is adjustable to vary the top speed of the motor and the initial starting current. A thermionic time delay in the application of the C6A anode voltage is supplied by a 2A5 operated as a diode. This gives 40 second time delay. The capacitors across the various load resistors are to avoid any a-c pick-up which would give irregular firing of the C6As. Capacitors are shunted across the motor to give increased torque and to improve the C6A control characteristics under heavy loads. A limit switch is provided to prevent the steering motor turning the rudder control past its normal limits.

The unit which is placed on the bridge of the ship and is directly connected to the steering wheel is called the control unit and is shown in Fig. 6. The various components on the base may be identified from the sketch plan in Fig. 7. The steering motor drives through a worm to one shaft of a variable gear; the main drive sprocket with the limit switch is connected to this shaft only through the clutch. The other shaft from the variable gear drives differentially on two chain sprockets which are coupled to the hand wheel and to the repeater card seen at the top of Fig. 6. The latter drive goes to the autosyn transmitter also. The front of the control unit contains the clutch lever, remote sensitivity and motor speed controls.

The use of complete electronic control has eliminated all of the previous difficulties of relay control, the automatic speed control has enabled an increase in accuracy of steering, and long life of the parts has been obtained.

Amplification Factor Chart

A method of determining the amplification factor of a receiving tube from its geometrical construction by means of a graphical solution of the Vodges and Elder formula

By E. R. JERVIS
National Union Radio Corp.

ONE of the most important parameters in the design of radio receiving tubes is the amplification factor and there are almost as many methods of calculating it as there are tube engineers. The reason for this multiplicity of solutions is that no formula has yet been found which is completely satisfactory.

The most widely used formula is probably that of Van der Bijl. It is very useful for quick computations and its accuracy is quite sufficient for practical purposes after its constant for the particular structure in question has been determined. The formulas of Miller and King are certainly more accurate, but the increase in accuracy is not sufficient to compensate for the large increase in complexity of computation. A more accurate version of the formulas, given by Vodges and Elder, is rather involved.

To enable the engineer to compute the amplification factor as accurately as possible with computations kept to a minimum, this formula was put in nomogram form. The chart presented gives the value of the amplification factor for both cylindrical and plane structures.

The Vodges and Elder formula for cylindrical triode electrodes is

$$\mu = \frac{2\pi N R_c \log. R_p/R_c - \log. \cosh \pi N W}{\log. \coth \pi N W}$$

and for plane electrodes it is

$$\mu = \frac{2\pi N D - \log. \cosh \pi N W}{\log. \coth \pi N W}$$

in which μ = amplification factor
N = pitch of grid winding
W = diameter of grid wire
R_p = radius of plate (cylindrical structure)
R_g = radius of grid (cylindrical structure)
D = distance between grid and plate (plane structure)

In order that the chart will consist of straight line scales, two new variables have been introduced. The screening factor of the grid, given by the product NW, is used instead of the grid wire diameter W and the ratio of plate radius to grid radius, R_p/R_g, is used instead of the plate radius.

The amplification factor is determined in the following manner. On scale I a point is located which represents the actual grid pitch and on scale II a point is located which represents the screening factor of the grid or the product NW. A straight line connecting these two points is extended to intersect scale III at a reference point. At this point a discrimination must be made between plane and cylindrical structures. For a plane structure, a point corresponding to D is located on scale V and a straight line drawn connecting it and the reference point on scale III. This line intersects scale IV at the value of amplification factor for the structure in question.

For a cylindrical structure, points are located on scales VI and VII corresponding to R_p/R_g and R_g respectively and connected by a straight line extended to intersect scale V at a reference point. A line connecting the reference points on scales III and V intersect scale IV at the value of amplification factor for the structure in question.

The most serious discrepancies from theory result from the presence of grid supports and the fact that tube structures are generally a combination of shapes rather than plane or cylindrical. The general procedure is to determine the value of μ considering the structure to be both plane and cylindrical and to take an intermediate value. A fairly close evaluation of the effect of electrode shape can be made by the use of the following formula:

$$K = \frac{\mu_p - \mu}{\mu_p - \mu_c}$$

Where K = form factor
μ_p = amplification factor for plane structure
μ_c = amplification factor for cylindrical structure
μ = amplification factor for actual structure

The insert shows an attempt to evaluate the form factor for various practical constructions. The diameter of the grid supports is kept constant. A few typical results are tabulated below.

COMPARISON BETWEEN CALCULATED AND MEASURED VALUES OF AMPLIFICATION FACTOR.

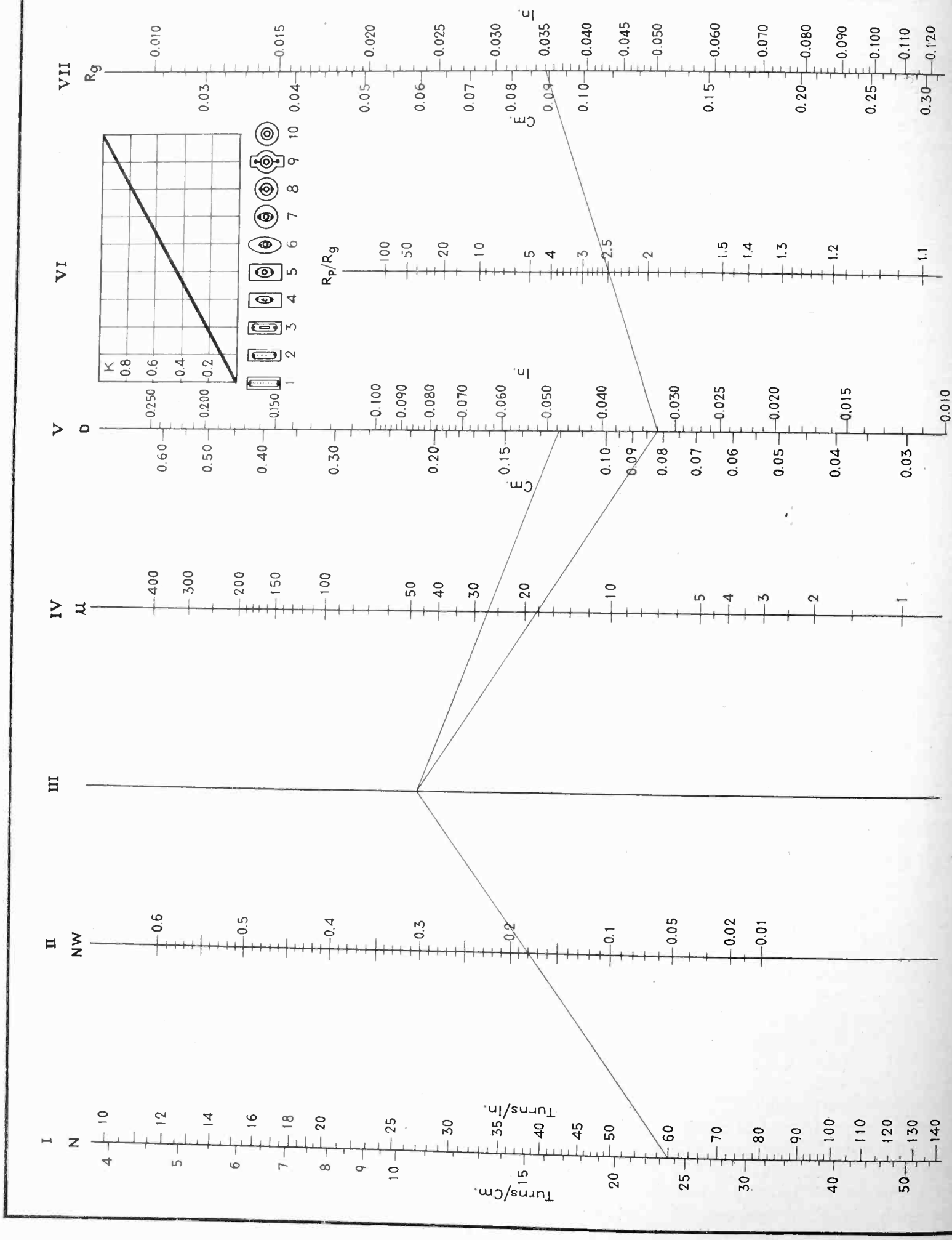
Tube type	Structure number	Form factor	Calculated values of μ_p	Calculated values of μ_c	Calculated values of μ	Measured μ
2A3	1	00	4.2	...	4.2	4.2
31	2	.11	4.0	2.2	3.9	3.8
45	2	.11	4.0	3.2	3.8	3.5
26	5	.44	8.5	5.8	7.3	8.3
76	6	.55	16	11	13.1	13.8
75	7	.66	148	69	95.8	100
6K5	8	.77	92	47	66.5	70
6B5	9	.88	5.6	4.1	4.24	4.20

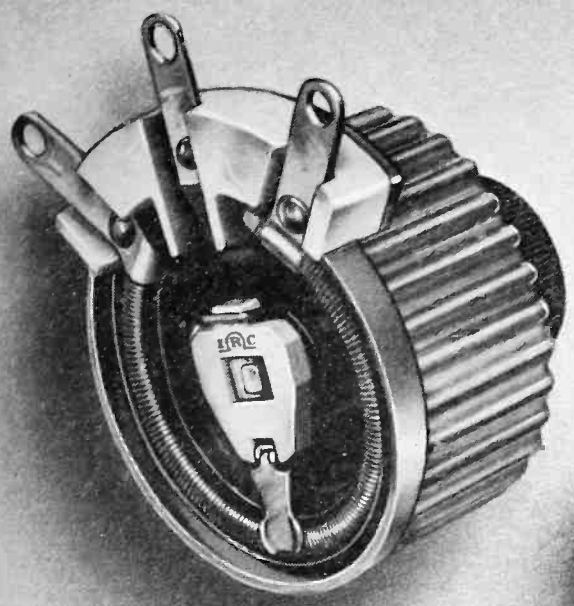
An exhaustive discussion of the discrepancies would be too long due to the complexity of the problem. However, a few cases might well be pointed out. For instance, the twelve per cent error shown for type 45 is due to the abnormal structure of this tube. The plate is very close to the grid and the grid has a relatively large diameter and a course pitch. Therefore, the values of μ_p and μ_c are close together and their approximation is poor because of the nonuniformity of the field at the surface of the plate.

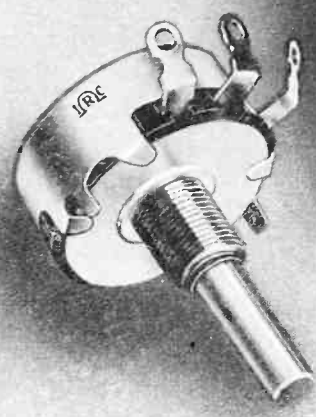
In cylindrical structures the most common cause of error is that due to the variation in size and position of the grid supports. A change in diameter or in the center-to-center distance will change the form factor. The relative position and size of the supports has been omitted in the diagram so as not to complicate the problem any further. An average value which has proved to be quite accurate in practical cases has been taken.

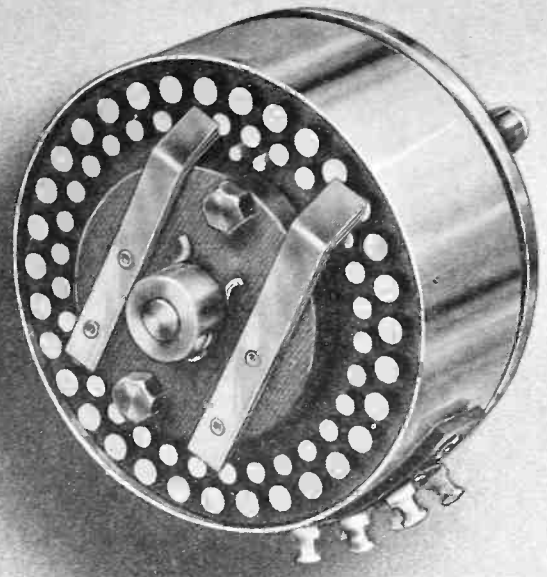
AMPLIFICATION FACTOR CHART

By
E. R. JERVIS
National Union Radio Corp.









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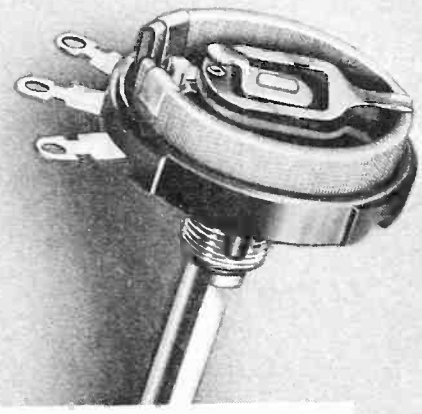

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TUBES AT WORK

Multi-purpose midget receiving tubes, a sync impulse generator for television signals, a single-tube intercommunicator, and a self-checking vacuum-tube voltmeter are under discussion this month

Multi-purpose Midget Tubes

ULTRA-SMALL broadcast receivers have been the subject of considerable interest during the past few months. The extremely small size is made possible by the use of small component parts and multi-purpose midget tubes. Three midget tubes, the 12B8GT, 25D8GT, and 32L7GT, announced by the Arcturus Radio Tube Co., Newark, N. J., are used in this class of receiver. They have considerably better characteristics than previous tubes of this general type.

The 12B8GT has a super-control amplifier pentode section similar to the 6K7 and a high mu triode section similar to the 6F5. The two sections are well shielded from each other so that the capacitance of the pentode grid to the triode elements is low enough to avoid trouble from feedback in this class of receiver. The entire tube is shielded from external electrostatic fields and no external shielding is necessary. The two sections have separate cathodes to provide flexibility in circuit design. The 25D8GT combines the functions of a pentode section such as the 6K7, a high mu triode section such as the 6F5 and a single diode section. Its shielding is the same as that of the 12B8GT. The 32L7GT is a combination of a beam power amplifier and a half wave rectifier. The heaters of each section of these tubes are connected in series.

Using tubes such as these, it is possible to build a tuned-radio-frequency receiver of very small dimensions with only two tubes. A superheterodyne receiver may be built using three or four tubes. The circuit of a typical TRF receiver of this type is shown in Fig. 2. The pentode section of the 12B8GT performs the function of the r-f amplifier and the triode section is the grid-leak detector. The 32L7GT is the power output tube and rectifier. The heaters are connected in series with a dropping resistor with one side of the 12B8GT heater grounded. A receiver of this type will deliver close to one watt of audio power.

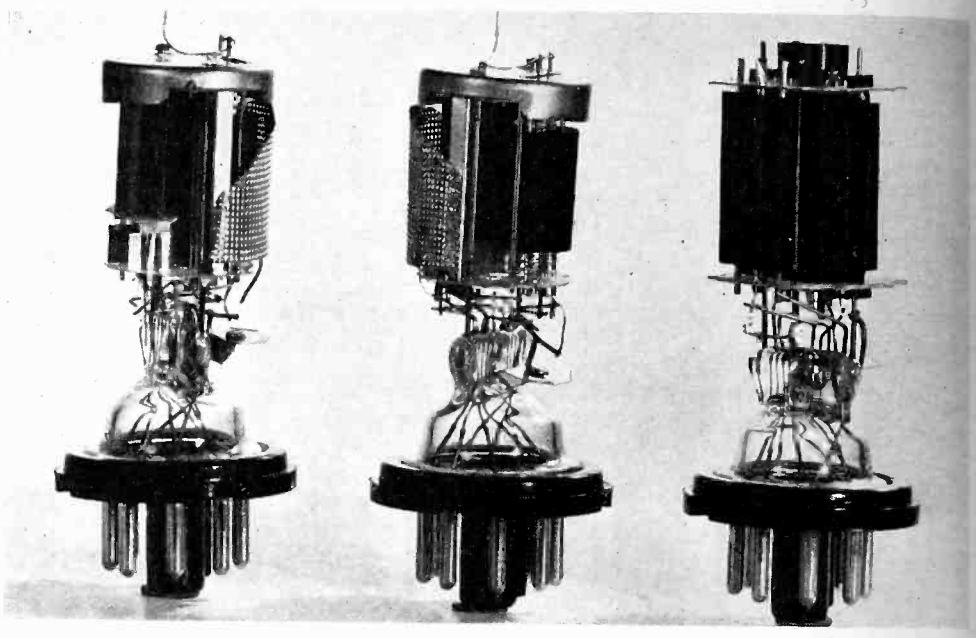

Fig. 1—Internal construction of the multi-purpose midget tubes; (Left to right) 25D8GT, 12B8GT and 32L7GT

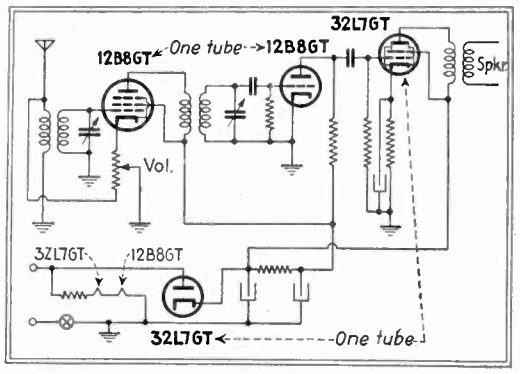

Fig. 2—Circuit of typical ultra-small receiver

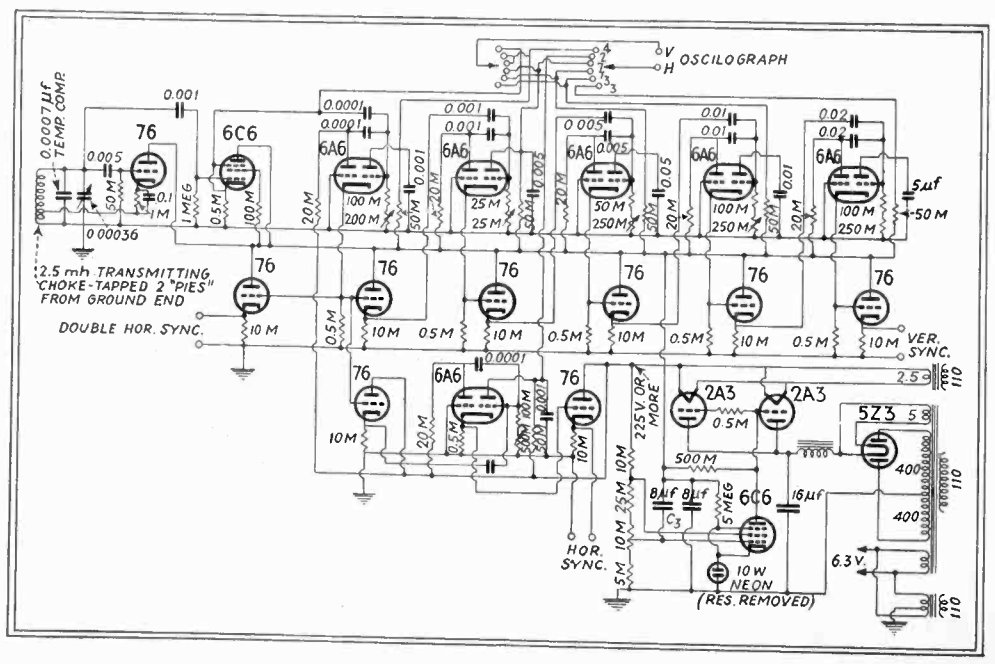

Fig. 1—Circuit diagram of sync impulse generator for television deflection circuits. The master frequency of 105.84 kc is subdivided by a series of multivibrators

• • •

Sync Impulse Generator for Television Deflection Circuits

GUSTAV ZAHARIS
Engineer WCHS

A SUITABLE PULSE generator for synchronizing television deflection circuits according to accepted standards of 441 lines, 60 fields and 30 frames should be of interest to one working with experimental television. The correct frequency relationship between horizontal and vertical synchronizing signals is accomplished by subdividing a higher correct frequency. Circuits for frequency division are old and many. The one described was selected after much consideration was given to adjusting facilities and locking qualities.

The basic circuits for each multivibrator stage is shown in Fig. 1. It will be noticed that it is essentially a relaxation oscillator in which the feedback element is the common cathode resistor R_2.[1] The synchronizing impulses are injected into grid of triode No. 2

(Continued on page 54)

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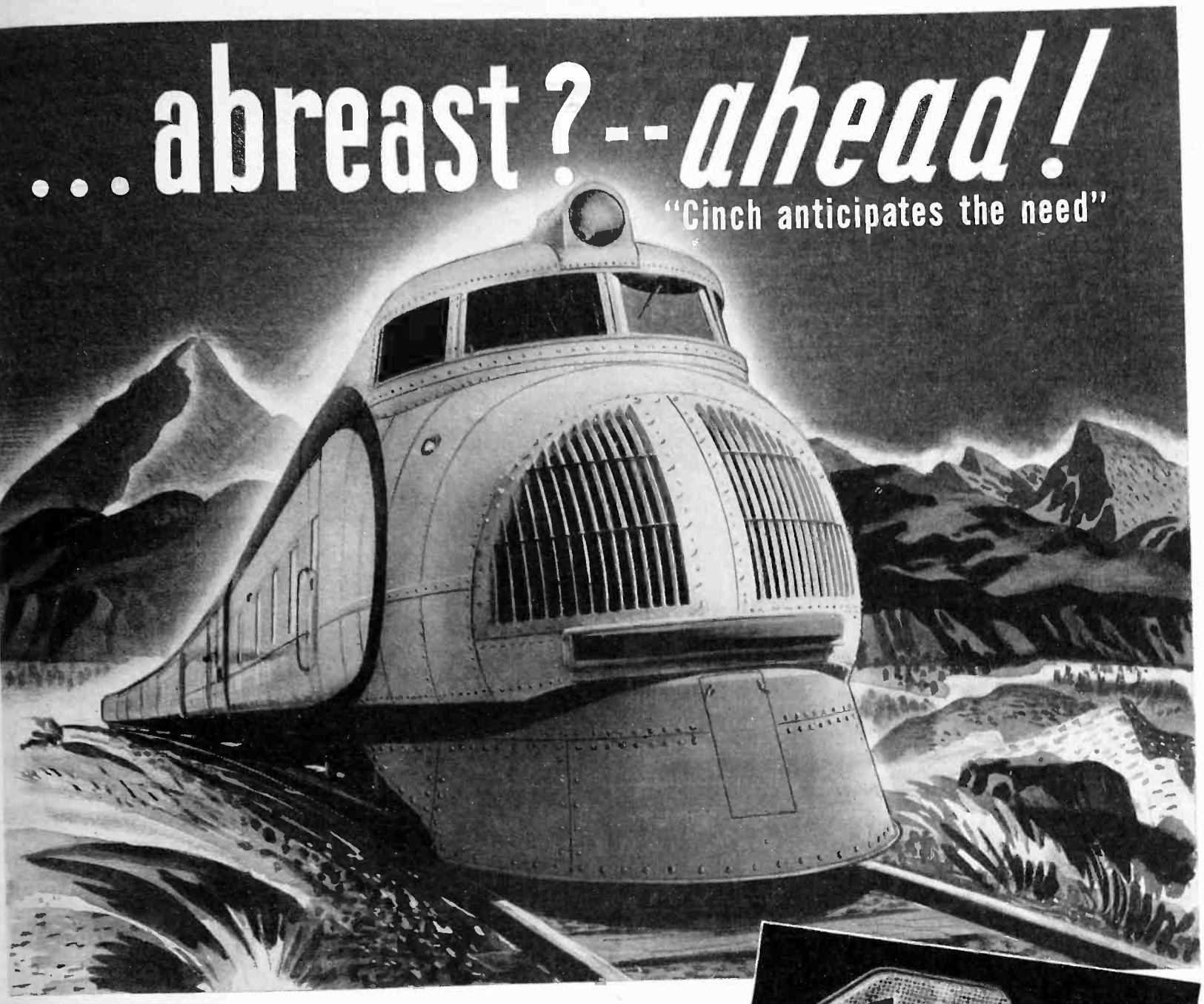

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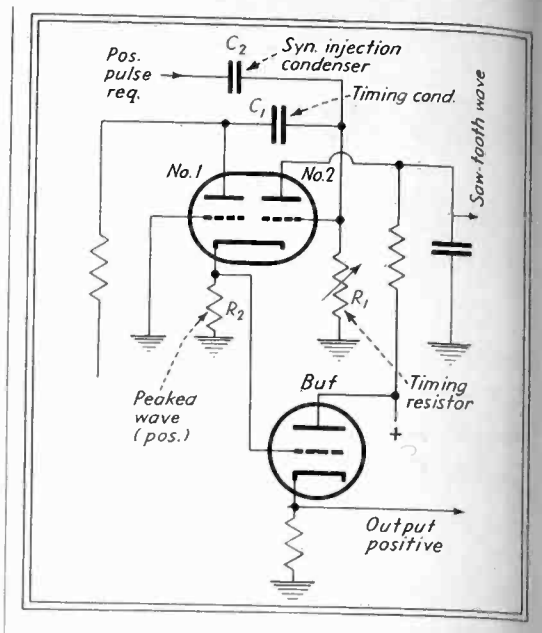

Fig. 2—The feedback element is the common cathode resistor R_2

by condenser C_2. The following type 76 tube is merely a buffer stage in which no phase reversal takes place, since the pulse supplied by the previous stage and one needed on grid of triode No. 2 are both positive. The signal across the cathode resistor being positive and sharply peaked is used in synchronizing following stage. A sawtooth wave appears on plate of triode No. 2. The natural period of oscillation of the stage is not excessively affected by connecting an oscillograph at this point, and consequently this voltage can be used in adjusting the operation of the stage.

The master frequency of 105.84 kc, used to control subsequent multivibrators, is generated by a type 76 tube as a self excited oscillator. A crystal oscillator may be substituted but the temperature compensated circuit used showed adequate stability. The sine wave thus produced is applied to a

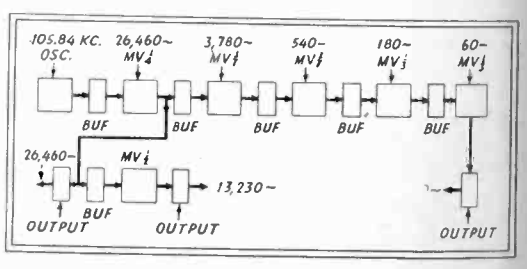

Fig. 3—Each multivibrator is separated from its neighbors by a buffer stage

pentode buffer which sharpens the wave due to the small operating angle of the stage (high automatic bias on pentode grid). This peaked wave synchronizes the following 26,460 cycle multivibrator. The subsequent stages are arranged as shown in block diagram Fig. 3. The interlace characteristics are due to the division of the 26,460 cycle signal by an even number (2) for the horizontal and an odd number (7x7x3x3) for the vertical. The 60 and 13,230 cycle pulses thus arrived at are applied to buffer output tubes with

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Smaller SIZE
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Maximum Temp. Coef. (20° to 80°C.)	+.000036

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Average Power Factor	.031%
Maximum Power Factor	.048%
Average Capacity Change	±.113%
Greatest Capacity Change	+.135%

AFTER 100 HOURS IN 100% RELATIVE HUMIDITY AT 104°F.

Average Power Factor	.032%
Maximum Power Factor	.048%
Maximum Capacity Change	.05%
Lowest Leakage Resistance (at 1000 Volts D. C.)	over 10,000 Megohms

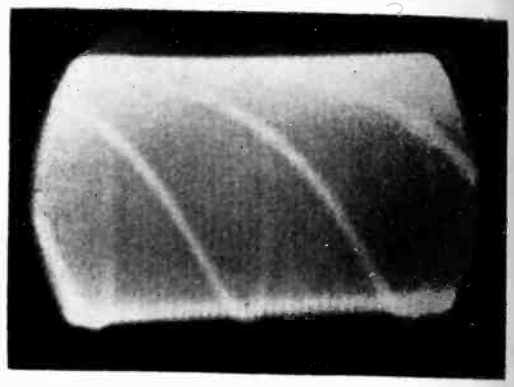
The above figures will vary slightly for different nominal capacities.

ERIE RESISTOR CORPORATION, Erie, Pa.

TORONTO, CANADA • LONDON, ENGLAND • PARIS, FRANCE-J.E.CANETTI CO.

MANUFACTURERS OF RESISTORS • CONDENSERS • MOLDED PLASTICS

load in cathode circuit. The lowered output impedance afforded by this type of output, lessens the affect on pulse wave shape by long connecting leads to generator. The double horizontal frequency used in equalizing successive vertical sync signals, is brought out in a similar manner. The sawtooth wave available at each multivibrator and the peaked master oscillator frequency are connected to an oscillograph through a rotary two gang switch. This arrangement permits rapid adjusting and checking of each stage. The speed con-



Section of television scanning pattern produced by sawtooth output of 60 and 13,230-cycle multivibrators. The 60-cycle deflection is expanded in order that individual lines are visible. Interlace is indicated by the two overlapping return traces. Stability of pattern permitted 3 minute time exposure.

trols may be made broader in adjustment by reducing value of variable controls and increasing the fixed component. Constants of entire unit are so proportioned that each state falls into synchronism from one sub-multiple to another with very little or no range on speed control during transition.

The regulated power supply for the generator is of prime importance. Even though the multivibrators showed correct divisions throughout, it was found

Construction should permit short leads to timing and sync injecting condensers and speed controls

impossible to secure stationary placement of the horizontal 441 lines regardless of amount of brute force filtering used in power supply. This apparently was due to the change of tripping points of the multivibrators by voltage variations and stray frequencies across common impedance of power supply. It might be mentioned that individual filtering for each stage was

No Two Alike—
but all "Superior"

One of the chief reasons for the recent marked improvement in tube performance is due to the creative thinking of their designers. Not content with "things as they are," experiment has followed experiment in the search for longer tube life and higher fidelity of reception. Cathode sleeves have had an important role in this development, and we pride ourselves on the fact that a majority of the designers have depended upon "Superior" to provide them with the specialized sizes, shapes, etc., needed for their individual designs. Many of these unusual cathodes are now being turned out here on a production basis. Perhaps we can assist you along these lines.

SUPERIOR TUBE COMPANY

NORRISTOWN PENNSYLVANIA

SUPERIOR PRODUCTS IN TUBING

SEAMLESS TYPE	*OTHER TYPES*
CARBON STEELS	*Welded or Brazed and then Cold Drawn*
ALLOY STEELS AND TOOL STEELS	
STAINLESS STEELS	BUTTWELDED STEEL
COPPER	BRAZED STEEL
ALUMINUM	* BRAWN "MONEL"
"INCONEL"	* BRAWN "INCONEL"
NICKEL	WELDRAWN STAINLESS
"MONEL"	

Largest American Producers of Pure Nickel Cathode Sleeves in Seamless and Lockseam"

* U. S. Reg. Trademark
** Under U. S. Patents

SUPERIOR TUBING

not tried since a regulated supply completely eliminated this trouble. The voltage regulator is conventional except for the introduction of C_8 which lowers further the supply impedance at all but the very low frequencies. This is due to the application of the entire power supply irregularities to the grid of the 6C6 d-c amplifier instead of only a portion as permitted by the usual resistive divider.

Mechanical arrangement of completed unit should be such that it permits short leads to timing condensers, sync injecting condensers and speed controls. The generator may be used to synchronize directly monoscope-kinescope set-ups or used to control circuits that produce the complete television synchronizing signal.

[1] Potter: "Sweep Circuit." *Proc. I.R.E.*, June, 1938, p. 713.

A Single-Tube Intercommunicator

THE EDITORS are indebted to Mr. George P. Deitz for information concerning a novel a-f intercommunicator employing but one tube. The tube is the type 32L7, a combined beam-power-output tube and half-wave rectifier, designed primarily for use in the "two-tube" midget radio receivers. Mr. Deitz's design, shown schematically in Fig. 1, is self-explanatory. The components shown are all

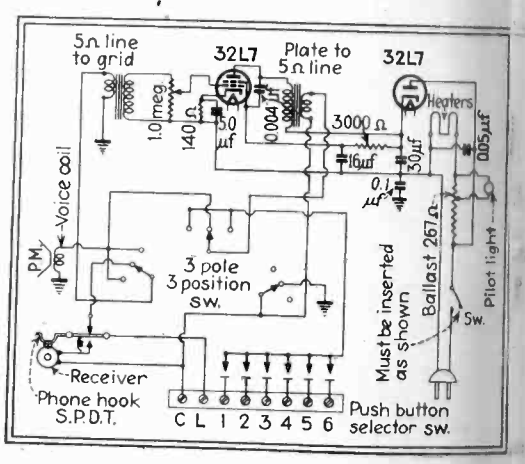


Fig. 1—Circuit of the single-tube intercommunicator

conventional, with the exception of the three-pole three-position switch which may be obtained from any rotary switch manufacturer.

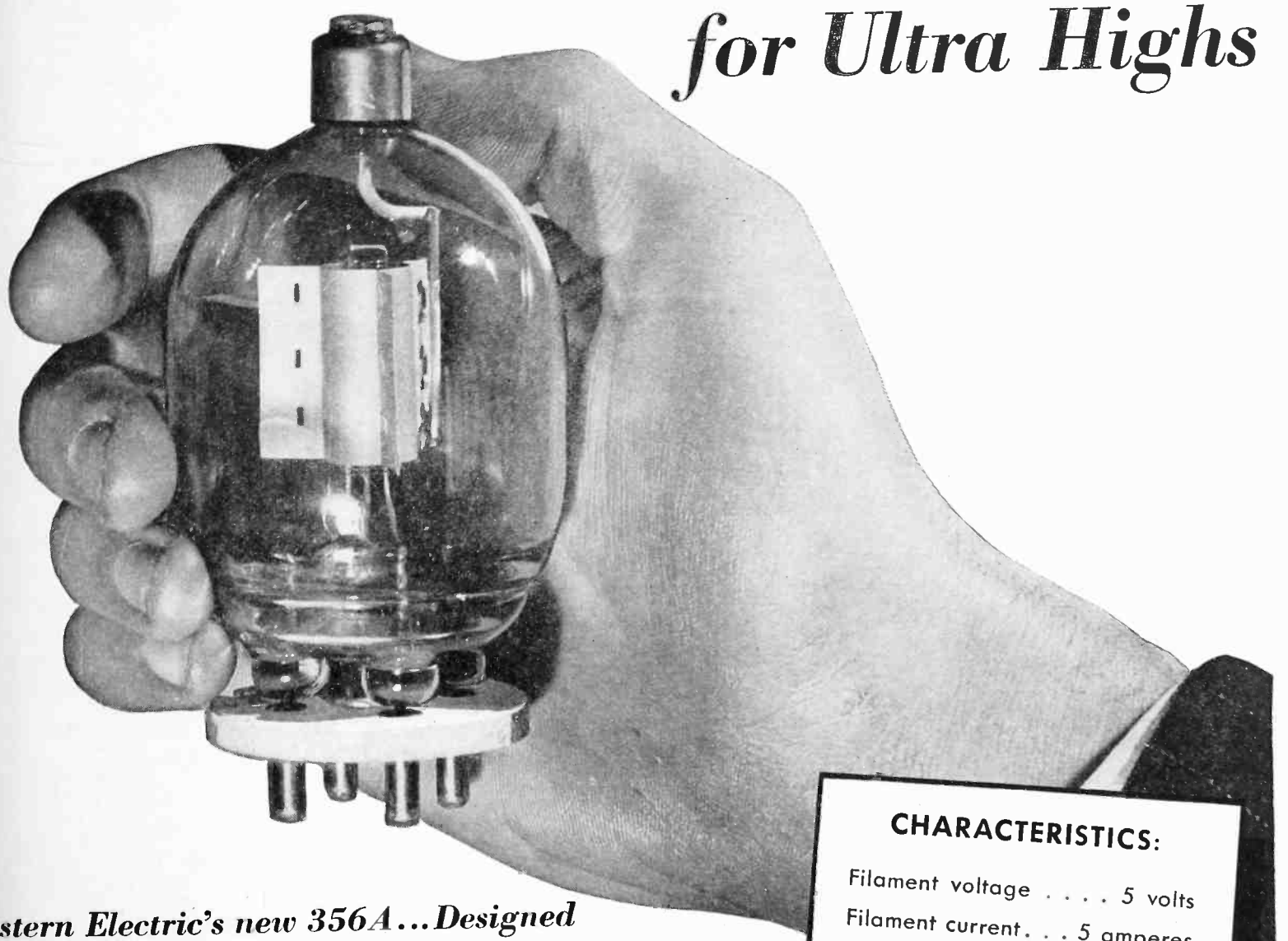
The switching arrangement makes possible the connection of four independent and separate stations through a five-wire cable as shown in Fig. 2. The selection of the stations is accomplished through push-button switches. When this arrangement is employed, any number of stations can be accommodated with a cable having one more wire than the number of stations. The number of push-buttons required is one less than the number of stations.

The rotary switch selects three positions: one for talking, one for receiving via the loudspeaker and one for receiving via headphones. Each unit is in

Here's a handful of

GOOD NEWS

for Ultra Highs



Western Electric's new 356A...Designed especially for ultra high frequency amplifier use

A pygmy in size, but a giant in performance and a glutton for punishment! That's the 356A filamentary, air cooled, high mu triode.

By utilizing the Western Electric stemless type construction the grid, plate and filament leads are cut to a minimum—giving efficient operation and effective neutralization at the higher frequencies.

The electrodes are supported directly by heavy leads eliminating any solid dielectric inside the envelope. The plate terminal is welded...can't come loose. The base is a standard 50 watt ceramic wafer which fits standard 50 watt sockets without shells.

A pair of 356A's in a properly designed push-pull circuit will give you 150 watts at 100 megacycles or 100 watts at 150 megacycles *and neutralize perfectly.*

For full details: Graybar Electric Co., Graybar Building, New York City. *In Canada and Newfoundland:* Northern Electric Co., Ltd. *In other countries:* International Standard Electric Corp.

CHARACTERISTICS:

Filament voltage	5 volts
Filament current	5 amperes
Maximum d-c. plate voltage	1500 volts
Maximum d-c. plate current	120 milliamperes
Maximum plate dissipation	50 watts
Amplification factor	50
Overall height	4½ inches
Maximum ratings apply up to	100 megacycles

Western Electric
ELECTRONIC EQUIPMENT

Distributed by GraybaR

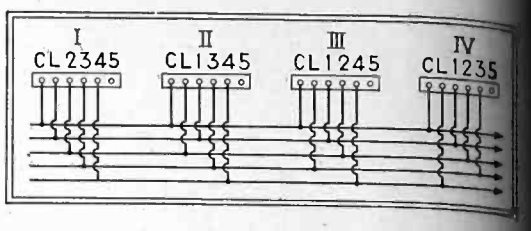


Fig. 2—Push-button switch connections for four stations

effect a master station, that is, each station may talk, privately, with any other station. When two units are in communication, the circuits are so arranged that the tubes in each act in cascade, thus giving sufficient amplification for long cable lengths (for example, up to 500 feet with number 18 wire).

To avoid hum problems, adequate filtering, as indicated in Fig. 1 should be used. Furthermore it is essential to

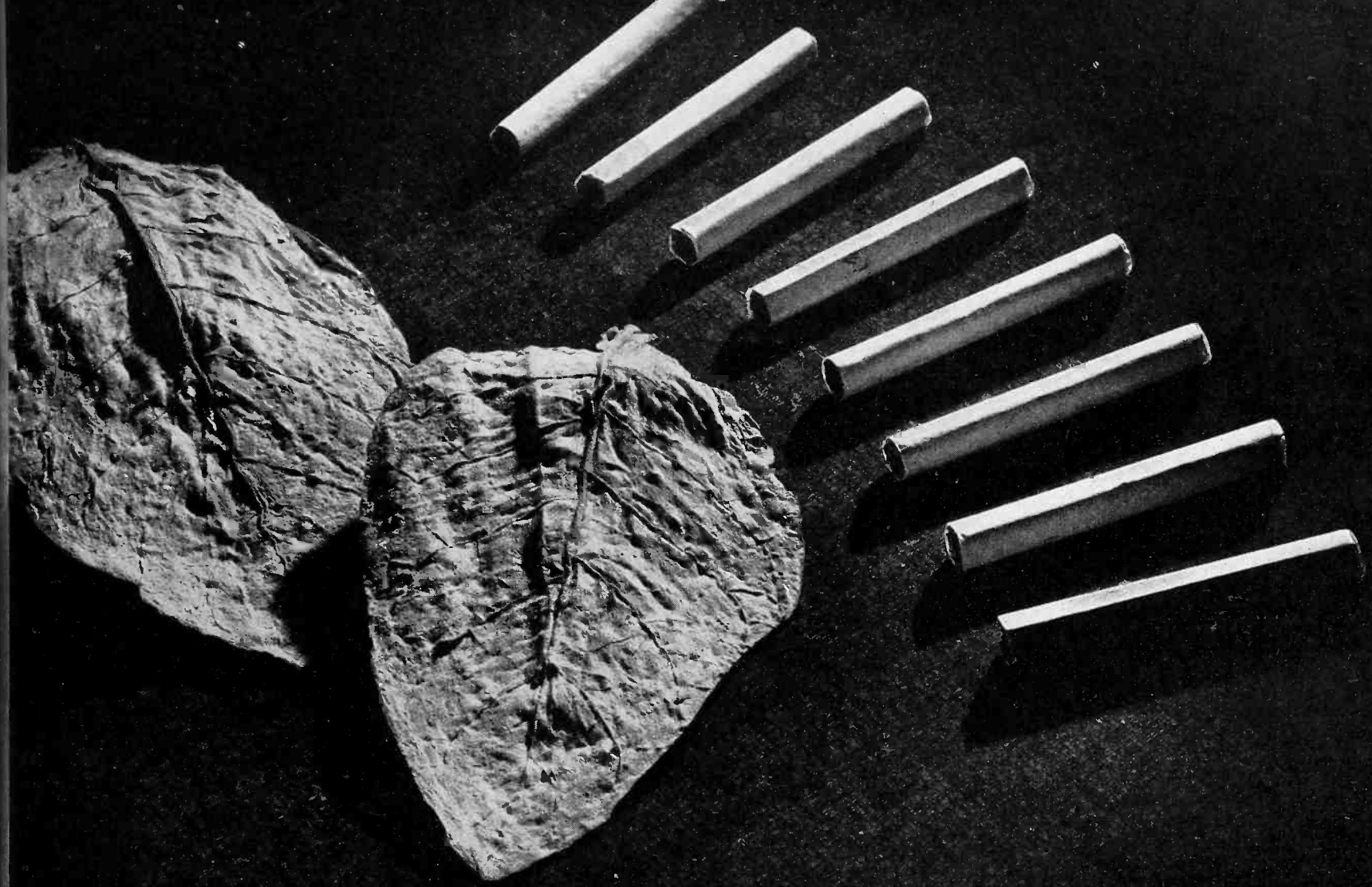
The single-tube unit in cabinet measuring 6½ by 7 by 4⅜ inches

locate the power switch on the high side of the power line (as shown in the diagram)—not in the grounded side; otherwise hum will be introduced in all other stations when one station is turned off. The polarity of the power supply plug is important also. The ground side should always be connected to the grounded conductor of the power line (or in an ungrounded system, to the same conductor at each unit). Hum from this source may be eliminated readily by trial and error, by reversing the plug at each station until the hum disappears at the other stations. When these precautions are taken hum-free performance is obtained.

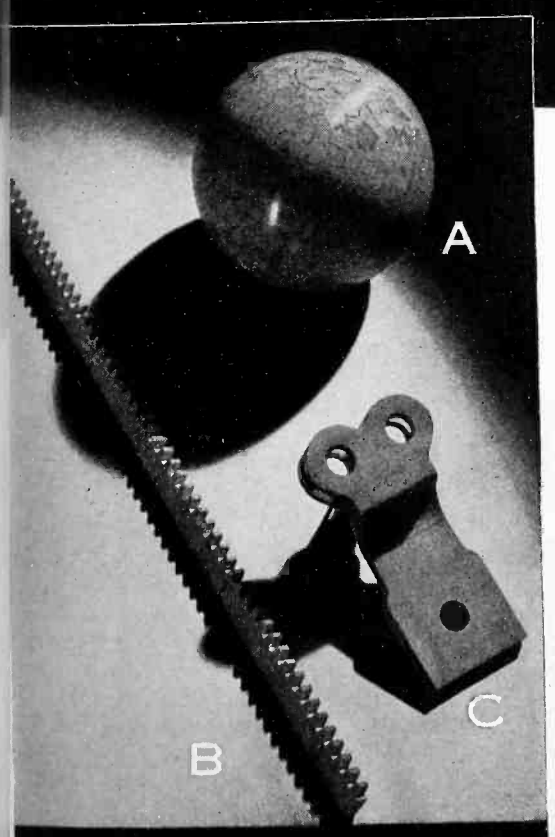
A Self-Checking Vacuum Tube Voltmeter

By R. C. PAINE

A VACUUM TUBE voltmeter suitable for laboratory testing should fulfill the following requirements: it should have a sensitivity of one-tenth volt, be simple and accurate, be readily checked and



You can buy either way—in the rough or ready to use—but . . .



A—Molded-laminated valve seat ball.
B—Sawed and milled rack.
C—Sawed, drilled and milled joint.

. . . in buying parts, as in cigarettes, ready to use is usually more satisfactory

You could buy tobacco leaf and cigarette machinery. And, in time, you might turn out a creditable smoke. But it wouldn't be worth the trouble and expense. Yet today you may be wasting time and money making parts which may be more profitable to buy from us—for two important reasons.

First, we may be able to help you as we have helped others by using Synthane Bakelite-laminated—a material with many desirable properties in *combination*. Second, by machining your parts from Synthane for you.

You, of course, benefit from our specialized experience in machining and our special tools and methods. For example, we can probably save you money on jigs and fixtures because we make them ourselves. Certainly you eliminate capital expense, interest charges, and depreciation for equipment you may not be able to use profitably later. And you eliminate mistakes, rejects and production worries.

In short, you get what you want, when you want it—at a known, predetermined cost and, most important, usually at an attractive saving in conversion costs.

Sound interesting? We believe you'll find it is. Three widely different manufacturers for whom we produced the parts at the left found Synthane unit responsibility well worth looking into. We invite you to send us your application.

If you are already set up to machine parts economically, let us supply you with Synthane Sheets, Rods and Tubes and suggest ways to help you cut costs.

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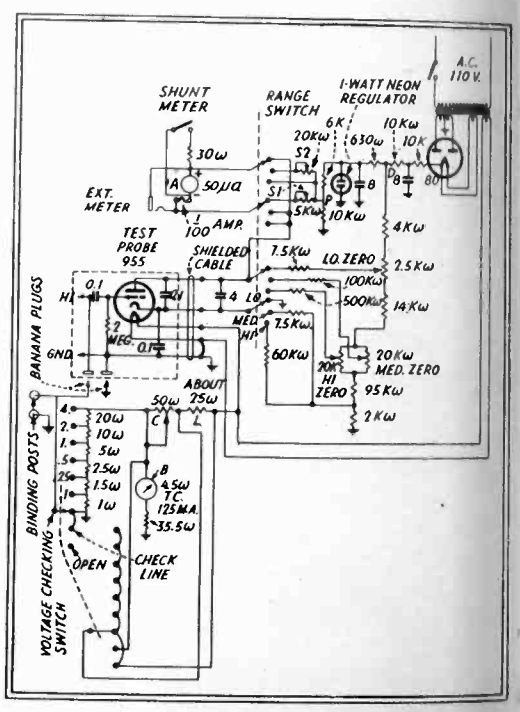
Bakelite— laminated

conveniently used. To meet these conditions a voltmeter has been built which operates from the a-c power line and the scales have been calibrated so as to be direct reading. To maintain accuracy, means of checking the calibrated scales and of setting them to the correct values have been incorporated in the instrument.

The self-checking feature of this instrument is provided by a thermocouple meter, B in the diagram, and a resistance voltage divider connected to the voltage-checking switch. The voltage is obtained from the heater winding of the transformer. By maintaining a current of 100 ma thru the meter and its series resistance, a voltage of four volts is provided at the top of the voltage divider. Appropriate resistors in the voltage divider give the proper voltages at the switch for checking the main points of the meter A. Intermediate points on the scale can be checked by setting the meter B to the proper current by means of rheostat C. The sensitivity of the meter A is varied on the low scale by means of rheostat S_1 and on the medium scale by means of rheostat S_2. Because the instrument is quite stable on the high range, no adjustment is provided here.

Three scale ranges are provided, viz:



Circuit diagram of self-checking vacuum tube voltmeter

low, 0 to 0.15 volts; medium, 0 to 1.1 volts and high, 0 to 4 volts. Each range has its own bias ajustment for zero setting. This is convenient when it is necessary to shift ranges frequently. For the purposes for which this instrument is used it is desirable to get a good reading at 0.1 volts even at the sacrifice of lowering the input impedance. This sensitivity is obtained by the use of grid-leak detection in the low range. In the low range trouble was experienced with drift in the zero setting with changes in line voltage. This has been corrected by using voltage from point P, regulated by the small neon lamp for the plate supply of the voltmeter tube and voltage from

NOW ULTRA HIGH FREQUENCY SIGNALS

WHERE YOU WANT THEM... *24 hours a day!*

WITH THE NEW

WESTON Television ULTRA HIGH FREQUENCY OSCILLATOR

- Frequency—continuous range 22 to 150 megacycles—no band switching.
- All frequencies fundamental.
- High order of stability and resetability over entire range.
- Equipped for television modulation.
- Employs continuously variable inductive tuning.*
- Equipped for use with crystals.
- Battery operated (self contained).
- Equipped with 400 cycle modulator.
- Used with portable antenna (included) or with standard output leads.
- Jack provided for external power to increase radiation.
- Over 5700 degrees of continuous dial rotation.
- Meter equipped, for six control measurements.
- Small size, light weight, extreme portability.

*Patents Pending

22 TO 150 MEGACYCLES

Essential for all branches of television, for police radio, aircraft, maintenance trucks, etc.

5000 VOLT TELEVISION AND RADIO ANALYZER (Model 772)

Sensitivity 20,000 ohms-per-volt. • *Input impedance 100 megohms on top range.* • Specially designed low-leakage jacks. • *Breakdown voltage in accordance with AIEE safety standards* . . . 11,000 volts. Current readings down to ½ microampere.

NOTE—present owners of 20,000 ohms-per-volt analyzers can bring them up-to-date with the compact WESTON 5,000 volt Televerter . . . an inexpensive multiplying unit which fits in the carrying case.

VACUUM TUBE VOLTMETER

Model 669 measures gain in video and sound amplifying channels—peak voltages in thyratron (saw-tooth) generators in oscillator circuits—grid potentials on cathode ray tubes—as well as other essential measurements in all sound receivers.

WESTON *Radio Instruments*

WESTON ELECTRICAL INSTRUMENT CORP., 618 FRELINGHUYSEN AVENUE, NEWARK, N. J.

point D for biasing the meter A to zero.

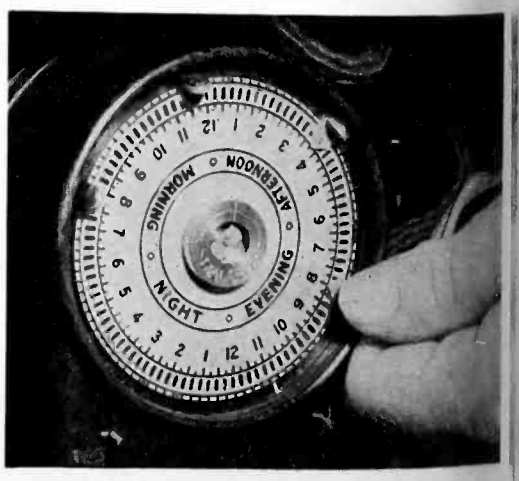
The measuring element consists of a probe containing a 955 tube fed by four wires in a grounded sheath connected to the main part of the instrument. This probe can be applied directly to the point of measurement when dealing with frequencies where length of test leads is a factor. At lower frequencies, such as audio voltages, it can be left resting on the banana plugs and test leads run to the binding posts for greater convenience. In this case the checking voltage switch will rest on the point "open." These binding posts are also useful for supplying checking voltages for other tube voltmeters which do not have a self checking feature.

A shunt meter switch has been provided to protect the meter A from batting off scale when the test leads are open while shifting test leads and also while the type 955 tube is warming up. This last condition is due to the type 80 rectifier tube warming up and supplying the biasing voltage to the meter before plate current starts to flow in the 955. It probably could be avoided by using a cathode type tube as rectifier. The external meter jack has been provided for flexibility in case it is desired to extend the range of the instrument by the use of a meter of different sensitivity.

An incidental feature of the instrument is the use of the meter B for checking power line voltage. With the checking voltage switch in the position, "check line," resistor L has been adjusted so that the scale reading of the meter indicates line voltage directly with a fair degree of accuracy.

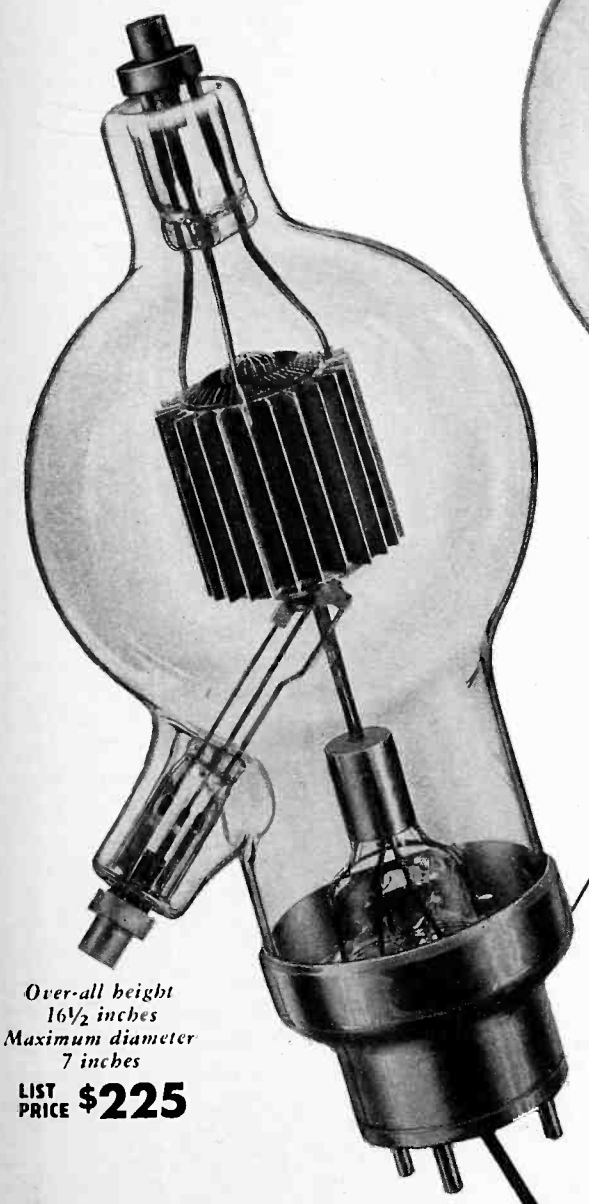
It is to be noted that a tube voltmeter of this type does not read true r-m-s voltage and when this instrument is used with a voltage regulator of poor wave form the self checking feature, which depends on using a sine wave, is not accurate.

TIMER FOR FACSIMILE RECEIVER



Dial of home facsimile receiver which may be set to turn on the receiver when pictures are transmitted. The timing dial can be set to operate the receiver for any interval during the 24-hour day

NEW HEAVY DUTY RADIATION-AIR COOLED TUBES



Over-all height
16½ inches
Maximum diameter
7 inches

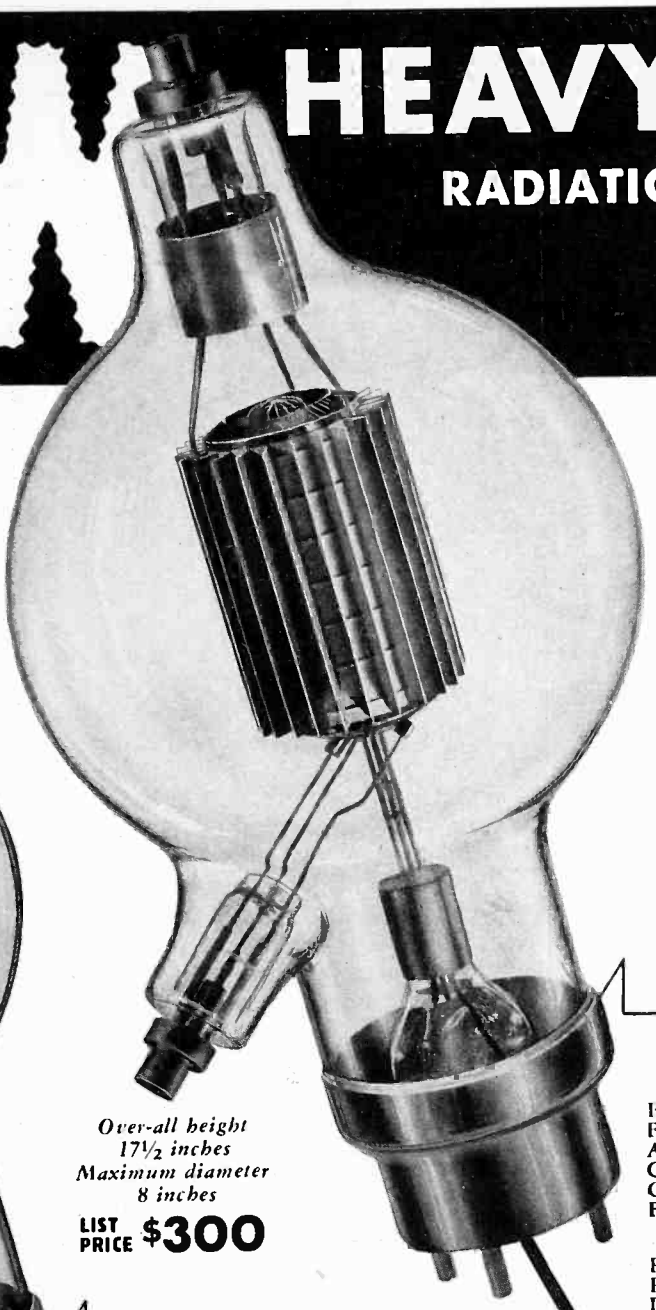
LIST PRICE $225

1500T

Filament voltage	7.5 volts
Filament current	26 amps
Amplification factor	18.5
Grid-plate capacity	7 mmfds
Grid-filament capacity	10 mmfds
Filament-plate capacity	.9 mmfds

MAXIMUM RATINGS

Plate voltage	6000 volts
Plate current	1.25 amps
D. C. Grid current	.175 amps
Plate dissipation	1500 watts



Over-all height
17½ inches
Maximum diameter
8 inches

LIST PRICE $300

2000T

Filament voltage	10 volts
Filament current	26 amps
Amplification factor	18.5
Grid-plate capacity	9 mmfds
Grid-filament capacity	13 mmfds
Filament-plate capacity	1 mmfds

MAXIMUM RATINGS

Plate voltage	6000 volts
Plate current	1.75 amps
D. C. Grid current	.2 amps
Plate dissipation	2000 watts

10 TO 15 KW ANTENNA POWER WITH PUSH-PULL RADIATION-AIR COOLED TRIODES.

Eimac TUBES

EITEL-McCULLOUGH, INC., San Bruno, California

Here's new economy and greater efficiency for communications companies and broadcasters. Eimac 1500T and 2000T open new fields for the design of commercial transmitters. These new tubes were designed especially for medium high power radio and television transmitters. The unconditional guarantee against failures resulting from gas released internally—the "Eimac-processed" tantalum elements — the extra rugged grid and filament and downright ability to outperform most other vacuum tubes makes them the most outstanding vacuum tube on the market today. Low interelectrode capacities and high electrical efficiency place them "head-and-shoulder" above the old, expensive to operate, water-cooled tube of medium power which is fast disappearing. Immediate recognition by the world's leading radio engineers places the stamp of approval on the new Eimac 1500T and 2000T. Technicians, station owners, manufacturers are invited to write for complete data—*you should have this information.*

Stripping Cotton and Silk From Wire Ends

By HERBERT CHASE

A NEAT and original way of stripping silk and cotton insulation from the ends of wires used in radio and similar applications is in use at the Stromberg-Carlson Telephone Manufacturing Company's plant. It consists of a relatively simple machine in which incandescent resistance metal electrodes take the place of the ordinary stripping knives. The insulation is burned off rather than stripped mechanically. This method has the advantage that no fine strands of the insulation are left to interfere with making good soldered joints and there is no chance that the wire will be nicked with possible resultant failure through bending at the nick in subsequent service.

Portions of the wire to be stripped are brought between the incandescent electrodes only momentarily, but long enough for the insulation to be removed where the contact is made. As only this area is raised to the ignition temperature, the remaining insulation on the wire is not affected. To avoid having the products of combustion or any burning particles of the insulation enter the room, these are drawn off through an exhaust pipe connected to a suction fan and having a closed compartment in which solid particles collect. Use of this machines solves problems which heretofore have given trouble in the plant named as well as in other plants where stripping of similarly insulated wires has to be done.

Wire stripper which burns off silk and cotton insulation from wire ends, in use at Stromberg-Carlson plant

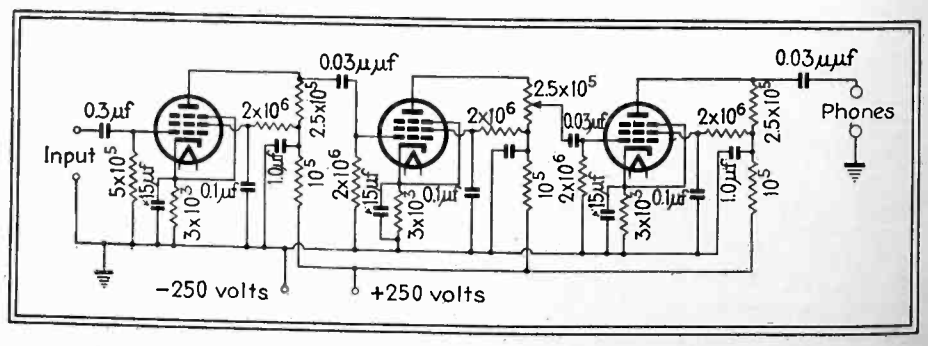
A Stethophone Amplifier

By CHARLES SINGER

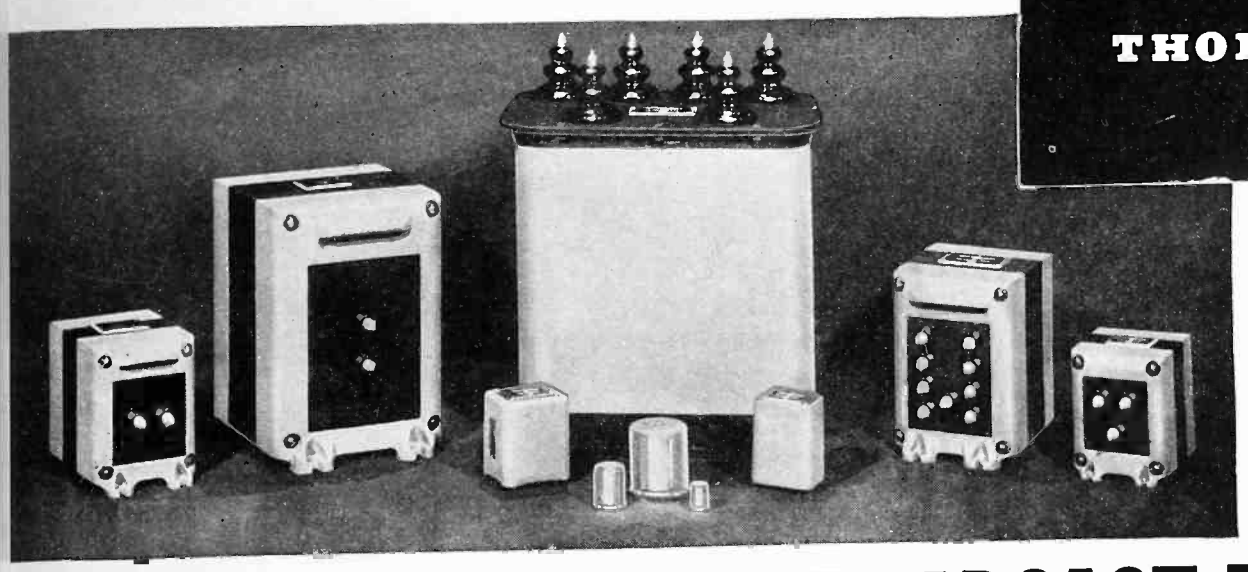
A CARDIAC AMPLIFIER is one that converts (with the proper acoustical pick-up device) the vibrations of the heart, murmurs and chest sounds through the flesh, into electrical impulses for amplified reproduction or recordings. One of the first pre-requisites for proper reproduction is the design of an adequate amplifier. It should be highly sensitive to vibrations produced by the body, but extremely insensitive to air-borne sounds.

A stable high-gain amplifier whose frequency response is determined by its input pickup is shown. It will be noticed that degeneration is employed through the use of series resistors shunted by the tube impedance and bypassed to ground. At low frequencies (at which the amplifier is primarily intended to operate) the impedance of these condensers are high, the loss of gain therefore large. There is also a loss of gain at low frequencies in the coupling of interstage resistor-condenser combination. However, by the use of a three stage pentode circuit and the proper use of values there can result a satisfactory high-gain low frequency response amplifier free from the troublesome motorboating effect of other high-gain amplifiers. With this arrangement, variations of tube characteristics effecting performance is kept at a minimum. Response curves show that good stethophone action can be had at 25 cycles.

However, aside from the existence of heart beats, chest sounds, etc.; there are murmurs, rales, and other extremely faint sounds in the human anatomy that are of interest to the medical doctor. Although these vibrations occur at a higher frequency and a more minute amplitude than the otherwise normal heart beats, sensitivity to these sounds will be governed by the ability of the crystal pickup. The piezoelectric crystal is articulate to frequencies of 1500 cycles and below. The response to frequencies above 1500 cycles is low; thus lessening pickup of undesirable noises. The response is down 10 db at 2000 cycles and down 25 db at 8000 cycles. Normal db output at a 1000 cycles is 68 db above 0.006 watts.



Circuit diagram of stethophone amplifier. Frequency range is from 25 cps to 1500 cps



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Thordarson components for broadcast applications are now available through Thordarson distributors located throughout the United States and practically all foreign countries. This means service at your finger tips.

For years Thordarson has supplied special transformers to discriminating engineers and laboratory technicians in broadcast stations, universities, industrial fields and the general radio industry. Standardization of broadcasting equipment and uniform power ratings now make it more practical to catalog representative designs. Others can be supplied to order from standard or special specifications. From microphone to loud speaker, Tru-Fidelity transformers are now available.

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A brand new development from Thordarson research laboratories. Insures a steady 115 volt output supply although line voltage supply or input varies from 90 to 130 volts and the load from 1/3 to full capacity.

CURRENT LIMITING FILAMENT TRANSFORMERS

Especially designed to limit starting current of transmitting tubes to a safe value.

AUTO TRANSFORMERS

500 V.A. to 4,000 V.A. capacity for line voltage correction.

PLATE TRANSFORMERS

Never before such universal power supplies. Twelve types cover 67 voltages and currents ranging from 300 to 11,000 volts for use in equipment up to 10,000 watts capacity.

THREE SERIES OF AUDIO TRANSFORMERS
"MAJOR"—"BANTAM"—"INCHER"

The result of months of painstaking research, careful engineering and designing, plus rigorous laboratory testing. All units have magnetic shielding provided by self-shielding or humbucking construction and cast or high permeability drawn, chrome cases. The various case styles and sizes are illustrated in the center foreground of the picture above. The smallest unit shown is 15/16″ in diameter and 1⅛″ high. These are especially desirable for portable units and to meet conditions where space and weight are at a premium.

Many new features are incorporated in modulation transformers, reactors, etc. The entire series presents a uniform appearance.

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THE ELECTRON ART

TONE reproduction in television, comparison of frequency- and amplitude-modulated systems, and use of phototube for gauging in the news this month

Gamma and Range in Television

TO THE ELECTRONIC or communication engineer, the title of I. G. Maloff's article in the April issue of the *RCA Review*, "Gamma and Range in Television" may not convey an accurate picture of the scope of the article, which is essentially concerned with the tone reproduction of television images. At the I.R.E. Convention in New York last June, Dr. R. R. Law presented a paper dealing with the contrast, halation and similar visual aspects of image reproduction, which occur in cathode ray tubes. Mr. Maloff's paper, which was delivered at the Rochester meeting last November is, therefore, at least the second paper to be specifically concerned with the tone reproduction of television images. As such, it is significant that the designers of television and cathode-ray-tube equipment have devoted their attention and time to the matter of tone reproduction in addition to such items as definition.

The problems involved in the reproduction of a television image are similar in many respects to those of reproduction in a photographic image, although the number of steps involved is considerably greater. As a matter of fact, much of the material contained in "Gamma and Range in Television" is freely translated and transported from the photographic field into the television field. As a result, engineers who may not be familiar with the technical side of photography, may have some difficulty in grasping the full significance of this paper. However, for those who are already fairly well versed in photographic sensitomity, the article is concise and to the point.

The similarity between television and other methods of pictorial reproduction is outlined and the general principles of monochromatic pictorial reproduction are presented. This pictorial representation is very largely based upon the work of L. A. Jones of the Eastman Kodak Company and recently more thoroughly dealt with by that author in the March 1939 issue of the *Journal of the Franklin Institute.*

A basis for the objective aspects of the problem is given and the works of Nutting and Abribat are reviewed. The concept of gamma and range (very roughly equivalent to contrast as this term is ordinarily used in photography) as well as perspective and density are defined and rules for handling these variables for obtaining the desired pictorial impression are given.

The peculiarity of the television system, so far as the rendition of tonal values is concerned, is then presented and the methods of measurements and data on the characteristics of a television system so far as its tone reproduction aspects are concerned are given. In order that the television image, as seen on the screen of a cathode ray tube, may have the correct contrast, gradation, and tone values, it is necessary that the complete television system be subject to control. The author points out the desirability for standardization of the transmitted signal in order that correct tone effects may be obtained. While this proposal would limit the control which the receiving operator has over the picture, it would nevertheless provide a simple workable system by which uniform television pictures might be obtained. The television system is analogous to the radio system provided the transmissions are of high fidelity. Even though provided with a high fidelity signal, many listeners will prefer to mutilate their programs by means of the manual tone control. The proposal by Mr. Maloff for a standardized television signal may be considered, approximately, as a recommendation for providing the televiewer with a high quality signal; if he so desires, he may change it to his heart's content.

TELEVISING MOTORIST'S ERRORS

The British Broadcasting Company recently conducted a safety campaign by televising a series of staged driving errors and synthetic accidents. The purpose of these telecasts was to acquaint the televiewers with a visual picture along with the running commentary of the announcer. By this method it is hoped to reduce driving accidents

All-Glass Tubes

AN ARTICLE by Gus Prakke, J. L. H. Jonker and M. J. O. Strett, entitled "A New All-Glass Valve Construction," in the May issue of the *Wireless Engineer* describes the construction used by the Philips Company in the design of an all-glass tube similar to those introduced into the United States about a year ago.

According to the author's summary, this article deals with the properties and advantages of a new valve construction, called all-glass, using an unusual tube base. The general appearance of this new construction is dealt with, including a detailed discussion of the electrodes, their leads and screening, and of the tube heads and holder. Figures on the variation of the capacity between electrodes due to dielectric isolation between them as a func-

KEN-RAD RADIO TUBES ARE MADE IN THIS MODERN AND EFFICIENT PLANT

Ken-Rad has the plant facilities, the equipment, and the experience to make radio receiving tubes of the highest quality. The Ken-Rad engineering department is made up of men of outstanding ability in the design and development of radio tubes. The engineering laboratory is equipped with the most modern instruments and test equipment. The commercial engineering section is in constant contact with radio set manufacturers, supplying them with technical information that may be needed for new set design.

From an engineering standpoint Ken-Rad Radio Tubes are made to the highest standards. Skilled workmanship, multiple inspections, and close-limit testing, coupled with the latest improvements in design make them the logical choice of careful buyers everywhere.

KEN-RAD TUBE & LAMP CORPORATION

Manufacturers of Ken-Rad Radio Tubes and Ken-Rad Electric Lamps

Owensboro, Kentucky

YOU are cordially invited to visit Ken-Rad Headquarters at the Blackstone Hotel during the Radio Manufacturers Association Convention and the National Radio Parts Trade Show June 13-17, Hotel Stevens, Chicago.

tion of temperature are included, and show a marked improvement over those appertaining to the conventional construction. The short wave properties of the new all-glass construction are given. Since the input and output impedances are dependent on the length of the electrode lead, marked improvement is shown for the new construction, over the conventional construction, especially at high frequencies.

Although the tubes do not appear to be especially designed for ultra-high frequency operation, they are quite suitable for use at wave lengths of 5 to 7 meters.

Reports on Frequency Modulation

IN A SERIES of articles describing recent field tests on ultra-high frequencies in which comparisons were made between amplitude and frequency modulation, I. R. Weir points out the significance of the results obtained and indicates the relative advantages and disadvantages of the two modulation systems. The first of this series of articles, entitled "Field Tests of Frequency and Amplitude Modulation with Ultra-High Frequency Waves" appears in the May issue of the *General Electric Review*.

In the series of modulation tests conducted by the General Electric Co., two 50-watt transmitters were located at Schenectady. One of these is a frequency modulated device, whereas the other uses amplitude modulation. At Albany a 150-watt transmitter suitable for either frequency or amplitude modulation was put into operation. Measurements were made at a number of points from the emissions from these transmitters by means of a receiver (suitable for either frequency or amplitude modulation) mounted in an automobile.

Although the two types of transmitters at Schenectady were made as much alike as possible (considering the difference in modulation systems), it is interesting to observe that frequency modulated transmitters weighs 85 lb against 105 lb for the amplitude modulation transmitter and is only two-thirds the size of the amplitude modulated transmitter. The total input power taken by the frequency- and

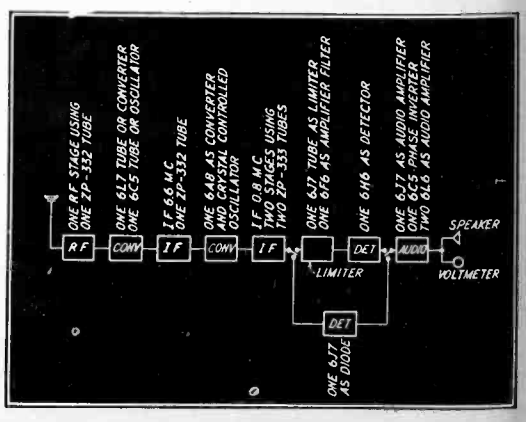
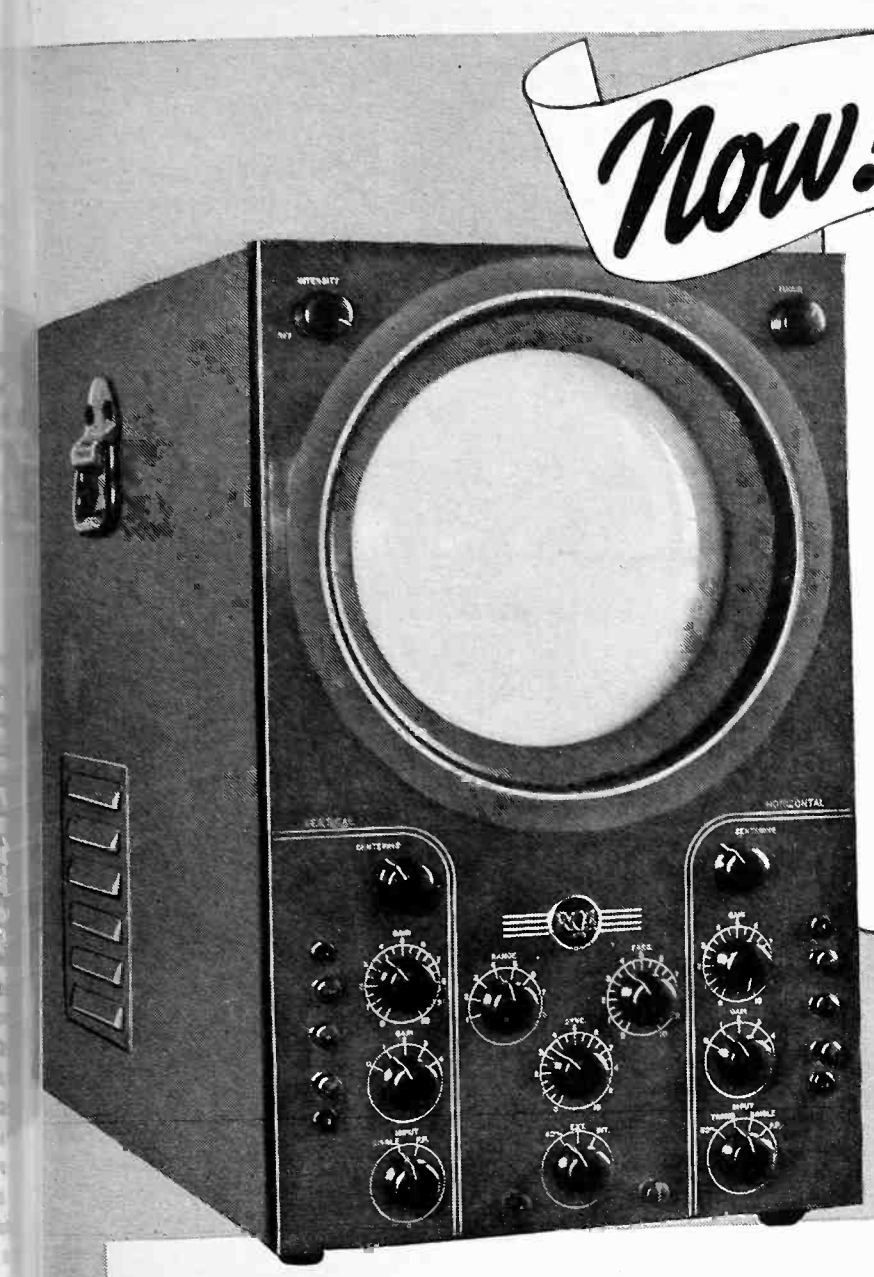


Fig. 1—Block diagram of receiver for amplitude- and frequency-modulated receiver



Now!... A 9-INCH CATHODE RAY OSCILLOGRAPH BY RCA!

This brand-new instrument is yours at surprisingly moderate cost!

This new RCA Oscillograph is just what you've been asking for! In design, in features, in performance—it's a high quality instrument—and its price is surprisingly low!

It's equipped with an RCA-914 High Vacuum Cathode Ray tube employing the electrostatic deflection principle. The trace is very sharp and brilliant and permits extremely fast photographic recordings of transients.

The deflection amplifiers are essentially flat over a frequency response range of from 4 cycles to 100,000 cycles and will faithfully reproduce square waves as low as 10 cycle frequency. The gain control does not appreciably alter the frequency response. The amplifiers are arranged for either push-pull input (balanced to ground) or single tube. Direct connection to the vertical deflection plates of the cathode ray tube is provided.

An additional amplifier is provided for modulation of the cathode beam from an external timing source, and provides a very convenient means for establishing a time constant of the trace.

All controls are symmetrically arranged on the front panel. The screen of the cathode ray tube is protected by a shatter-proof lens. Further details will be sent upon request.

OPERATING CHARACTERISTICS

Maximum deflection sensitivity—
no amplification . . 29 volts R.M.S. per inch
with amplification . 0.02 volts R.M.S. per inch
Amplifier input impedance—
push-pull . . . . . 1 megohm at 1000 cycles
single . . . . . 0.5 megohm at 1000 cycles
Maximum D.C. insulation . . . . . 250 volts
Timing axis frequency range . . 4-18,000 cycles
Amplifier frequency response . 4-100,000 cycles
Cathode Ray Tube . . 9" electrostatic deflection

POWER REQUIREMENTS

Voltage 110-120 volts
Frequency 50-60 cycles
Power . . . 150 watts
Fuse protection 5amps

PHYSICAL SPECIFICATIONS

Weight . . 100 pounds
Width . . . . 12 inches
Depth . . . . 25 inches
Height . . . 20½ inches

TUBES

1 RCA-914 High Vacuum Electrostatic
1 RCA-874 1 RCA-879 1 RCA-885
1 RCA-5Z3 8 RCA-6C6 2 RCA-6J7
1 RCA-6N7G 1 RCA-2A3

Over 335 million RCA radio tubes have been purchased by radio users . . . in tubes, as in parts and test equipment, it pays to go RCA All the Way.

RCA Test Equipment

RCA Manufacturing Co., Inc., Camden, N. J.
A SERVICE OF THE RADIO CORPORATION OF AMERICA

amplitude-modulated transmitter, while delivering equal carrier powers, is 325 and 625 watts respectively.

The receivers used for making measurements are double-conversion superheterodynes with provision for receiving either frequency or amplitude modulation merely by throwing a switch for the type of reception desired. A block diagram of the receiver is shown in Fig. 1. The selectivity curve for the receiver for both methods of modulation was practically the same; it was 220 kc wide at half the input voltage (6 db down) and 530 kc wide at 1/1000th of the voltage (60 db down).

Measurements were made of the signal-to-noise ratio from the Albany transmitter in regions comparatively quiet and free from external noise and in regions in which the external noise was high. The results of measurements on the Albany transmitter, operating at a mid-frequency of 41 Mc, are shown in Figs. 2 and 3. Since the

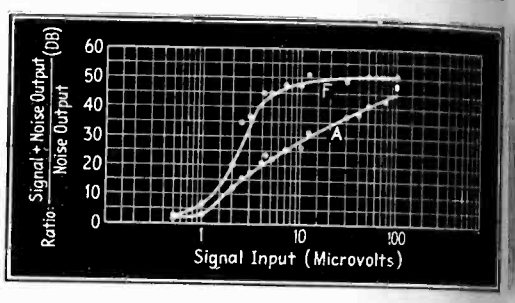


Fig. 2—Ratio of signal-plus-noise to noise for frequency (F) and amplitude modulated (A) receivers without external noise

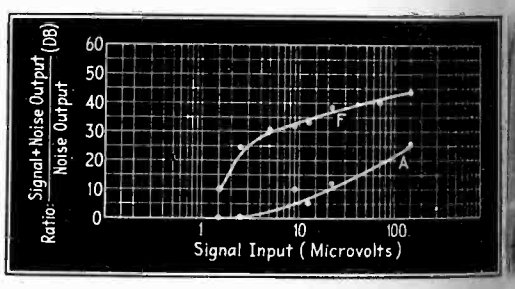


Fig. 3—Same characteristics as those of Fig. 2, but with noise present. Frequency modulation (F) and amplitude modulation (A) receivers used

ordinates of both of these curves are plotted in decibels, it is easily apparent that the frequency modulation system has considerable improvement over the amplitude modulation system for either quiet or noisy locations. The improvement is more marked, however, in the case of installations having a noisy background level. Measurements were also made on the two types of modulation using as a source the noise produced by the ignition system of an automobile.

Using the transmitters at Albany and Schenectady, measurements were made of the interference resulting from the operation of these two stations. When frequency modulation was used, only the Albany program could be heard when the test car was less than 11 miles from Albany, and only the Schenectady program could be heard

n the car was less than three miles
n Schenectady. There was a two-
region between both of these cities
which both programs could be heard
rmittently, the program being re-
ed depending upon the relative field
ngth from the two stations at the
icular location in question. Very
ly could both programs be heard
ltaneously in this two-mile area.
important result of these measure-
ts indicates that wherever the field
ngth of one frequency modulated
al was greater than twice the other
strength, the stronger signal
ld prevail 100 per cent of the time.
author points out that this two-
region should not be considered
interference area as would occur
amplitude modulation, but rather
ld it be regarded as an area where
r signal may be heard.
ccording to the author, the tests
ribed in this article reveal several
antages of frequency modulation
amplitude modulation. These may
ummarized as follows:
Improved signal-plus-noise-to-noise
o. Under some conditions this im-
vement is as high as 20 to 25 db.
s means there is a remarkable free-
from atmospheric and man-made
ic, such as X-rays, automobiles and
raft engines, commutator sparking,

. A more definite and uniform
vice area of a transmitter is es-
lished because in frequency modula-
signal-plus-noise-to-noise ratio
ains high until the field intensity
ches a very low value.
. Comparatively much smaller geo-

TWO-WAY COMMUNICATION FOR MOTORCYCLE POLICE

This motorcycle of the Beverly Hills Police Department is not only equipped with a receiver for picking up broadcasts, but is also provided with a transmitter enabling the officer to communicate with headquarters. The transmitter, using five tubes and weighing six pounds, is carried in two compact units behind the driver's seat. The officer is provided with a miniature camera for making photographic records

graphical interference area is obtained when two frequency modulated transmitters are operated simultaneously on the same frequency than when amplitude-modulated transmitters are so operated.

4. A frequency-modulated radio frequency amplifier is more efficient than one for amplitude modulation, because frequency modulation can be accomplished at low level followed by class B power amplification.

5. A given service area can be covered with considerably less power than with amplitude modulation, because of the improvements in signal-plus-noise-to-noise ratio obtained with frequency modulation.

6. For a given power output, smaller radio frequency amplifier tubes can be used in the transmitter.

7. The design and operation of transmitter equipment for frequency modulation is no more complicated than that required for amplitude modulation of equivalent power.

Since the latter part of 1935 when Major Armstrong first announced his system of frequency modulation, he had given a number of convincing demonstrations of the superiority of frequency modulation over amplitude modulation, especially for those areas having a low signal-to-noise ratio. He has, moreover, provided the editors of *Electronics* an excellent opportunity to witness for themselves the capability of this modulation system, as has been recorded in the March issue. Nevertheless, the article by Mr. Weir seems particularly significant since it is the first published material to present measurements on the two modulation systems.

• • •

TEST FOR DEAFNESS

Patients at the new Westminster Hospital formally opened April 20, by King George, will be tested for deafness in a soundproof room using this Western Electric audiometer. This instrument, made by experts in sound recording, is one of the benefits bestowed on medicine by radio research

C Components for w-Frequency Amplifiers

RAPHICAL METHOD of determining the C values for circuits designed to entuate the bass-frequencies is de-ibed in the March 1939 issue of *nktechnische Monatschefte* in an ar-le entitled, "On the Calculation of C Components for Bass Accentuation Low-Frequency Amplifiers" by Carl-inz Sturm.

The required values are determined thematically in a manner which kes possible the calculation of the ghest degree of bass accentuation for range of from 100 to 400 cycles with y chosen impedance values. Utilizing ese same formulae it is possible to termine the optimum conditions of eration for other frequency ranges. The circuit arrangement is shown in g. 1. The resistor R_3 is much greater an R_1, and its value depends on the pedance of the preceding tube. R_2 is cluded so that high-frequencies are t too highly attenuated.

The apparent impedance between ints A and B will have its maximum tio for two differing frequencies with given R-C combination. When ter-inals A and B are fed from a source a-c voltage having a high internal pedance (electron tube) through

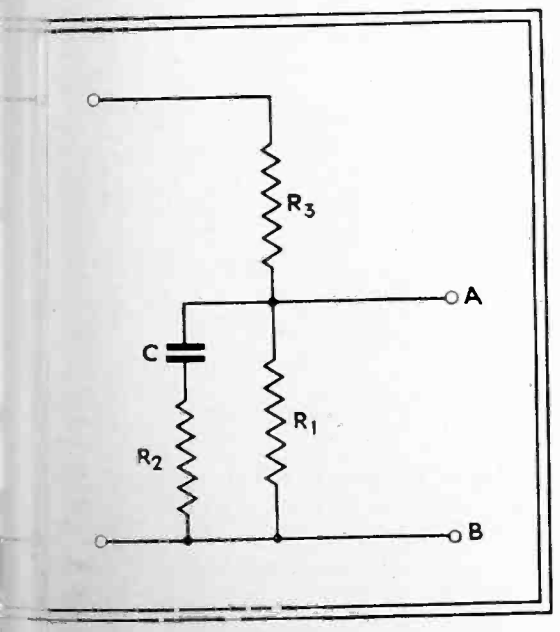


Fig. 1—Schematic wiring diagram of portion of amplifier circuit for low frequencies

resistor R_3, then the apparent impedance at these terminals will be in the same ratio as the voltage ratio for a given set of frequencies.

Setting up the relation for Z_a/Z_e, where Z_a is the impedance at one frequency and Z_e at another, and differentiating with respect to C then putting the result equal to zero, will give the value of the maximum impedance-ratio after solving the equation for C:

$$C = \sqrt{\frac{1}{\omega_a \cdot \omega_e R_2 (R_1 + R_2)}}$$

Substituting this value of C in the expression for Z_a and Z_e will give the corresponding values of these quantities. These are then made use of in determining the expression for $K = Z_a/Z_e$ which the author gives as:

$$K = \sqrt{\frac{(P + SNR_1)\ (NS + R_2)}{(PN + SR_1)\ (S + NR_2)}}$$

where $N = f_e/f_a$, $P = R_1R_2$, $S = R_1 + R_2$

The result is found to be somewhat clumsy to handle in this form and consequently the author has made a plot of the expression for a frequency ratio of $N=400/100$ which he uses to determine the required values of R and C in a typical example which concludes the article.

Phototube for Gauging

AN ARTICLE by Clifton Tuttle and William Bornemann in the February issue of *Instruments* describes "A Method of Dimensional Gauging with Photoelectric Cell." The underlying method is that the article to be measured is used as a diaphragm in an optical system which illuminates the phototube. Since the output of the photoelectric device is proportional to the total flux which it receives, the output can be interpreted in terms of the light socket power, and hence the dimensions of the object.

Several possible combinations of gauging by means of photoelectric devices are illustrated in this article. The simplest of these is shown in Fig. 1, in

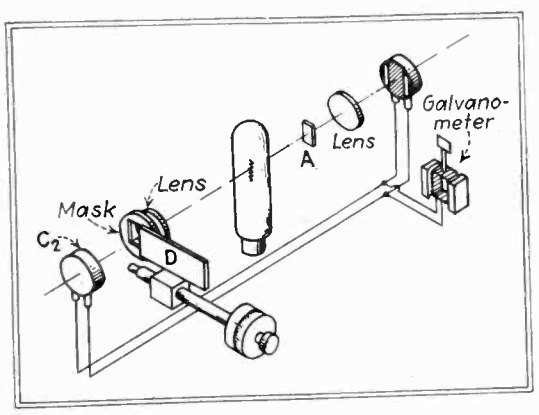


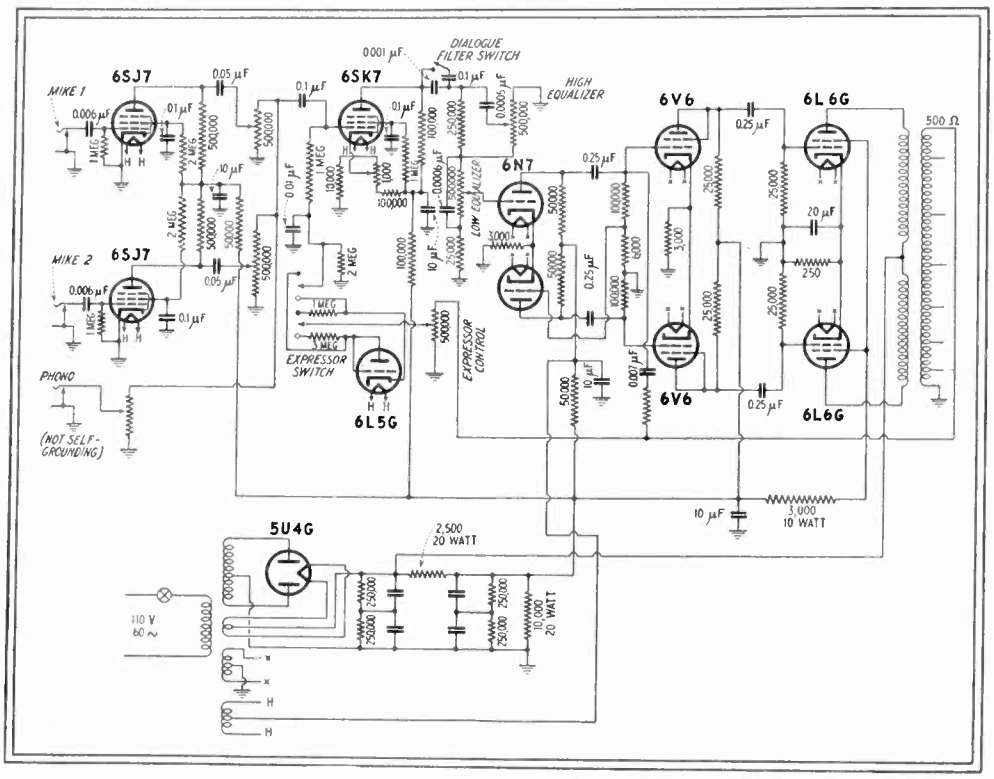
Fig. 1—Schematic diagram of phototube system for gauging

which the article to be measured is shown at A. An image of the article is formed on the cell C_1, thus light from the lamp falls upon the object A, and is then condensed to form an image on the photoelectric cell C_1. At the same time, the light passes through a lens and matching device so as to fall on the cell C_2. The output of both these photoelectric cells is in opposition and feeds the coil of the galvanometer purpose is to determine the condition of balance between the two photoelectric circuits.

With the proper optical and electrical system, the light on cell C_2 may be varied by means of the micrometer screw adjusting the mat. When a null or balanced indication is obtained, the light on both cells is equal and the dimensions of a simple object, such as that given at A, may then be determined in terms of the micrometer screw which adjusts the mat.

THE INDUSTRY IN REVIEW

A Resistance-Coupled High Fidelity Amplifier



A pair of 6L6Gs driven by a pair of 6V6Gs and two stage feedback are used. To suit various operating conditions, the characteristics may be varied by the audio frequency equalizers, dialogue filter, and the expansion and compression circuits

A HIGH-FIDELITY AUDIO amplifier with 24 watts output has been announced by the Amplifier Co. of America, 17 West 20th St., New York City. Its frequency range is from 20 cycles to 20,000 cycles within one db. The harmonic distortion of this amplifier, as measured by an independent laboratory, using a test frequency of 400 cycles is shown in the table. It is resistance-coupled throughout and has a pair of 6L6Gs operating in push-pull in the output stage, which are driven by a pair of 6V6Gs. It has two microphone channels and one phonograph channel. Each microphone feeds into a 6SJ7 preamplifier and the three channels are mixed in a 6SK7 mixer stage. The signal is then divided into two channels, with the proper phase relationship, in the 6N7 phase inverter tube to be delivered to the grids of the 6V6G driver tubes. The feedback signal is taken of the high side of the output transformer secondary and delivered to the grid of one 6V6G and to the grid of the phase inverter section of the 6N7. The output transformer has taps to accommodate line impedances ranging from 0.3 ohms to 500 ohms. The power supply consists of a 5U4G with the usual filter choke replaced by a 2500 ohm, 20 watt resistor. It is claimed that this introduces no appreciable hum in the output.

The amplifier is very flexible in its operation because of several devices designed to take care of a variety of operating conditions. By means of the audio frequency equalizers, it is possible to vary the response at either the high or low end of the frequency range. The response at either end may be varied independently of the other end. The equalizer control circuits are incorporated into the input circuit of the 6N7 phase inverter tube.

Output Voltage 500 Ohm Line	Power Watts	Distortion 2nd Harmonic	3rd	Total
7.07	0.1	Unmeasurable		
22.4	1.0	0.16%	0.14%	0.30%
55	6	0.50	0.36	0.86
70.7	10	0.85	0.32	1.17
89.5	16	1.22	0.13	1.35
100	20	1.0	0.14	1.14
107	23	1.3	0.89	2.2
114	26	1.6	4.7	6.3
118	28	6.5	14.0	20.5

The distortion of higher harmonics is of a negligible nature.

Under certain conditions of sound system operation, unintelligibility due to excessive bass results. To compensate for this, the dialogue filter cuts off the low frequencies. The filter is merely the substitution of 0.001 mfd for 0.1 mfd in the coupling circuit between the mixer and phase inverter stages. It is cut in and out by a switch on the side of the chassis.

The type of expansion circuit used increases the peaks of ten watts and above by eight db. The compression circuit reduces peaks of ten watts and above by about eleven db. Both expansion and compression have about one second time lag. The circuits are changed from expansion to compression by means of a dpdt switch.

News

✦ James Millen has announced his withdrawal from the National Company to form a new company to be known as the James Millen Manufacturing Co., Inc., 6 Pleasant St., Malden, Mass. It will be devoted primarily to the design and manufacture of new radio communication products . . . Precision Apparatus Corp. is now located in larger quarters at 647 Kent Ave., Brooklyn, N. Y. . . . Hygrade Sylvania will build a 50,000 sq.ft. addition to its Emporium, Pa. plant . . . Ralph T. Brengle has retired from the Clough-Brengle Co. He is succeeded as plant manager by William Meyenberg and his duties as treasurer are assumed by Arthur R. Hall . . . Another plant has been acquired by Sprague Specialties Co. in North Adams, Mass. . . . Westinghouse E. and M. Co. announces the transfer of R. B. Mildon to special sales assignments and the appointment of A. C. Streamer as General Manager of the East Pittsburgh division . . . Radio Engineering & Manufacturing Co. has moved to larger quarters at 58 W. 25th St., New York . . . Frank E. Mullen, Manager of the Department of Information, was elected Vice-president in Charge of Advertising and Publicity for RCA. Horton Heath, was promoted to Manager of the Department of Information, which will continue under Mr. Mullen's direction . . . Dr. William D. Coolidge, director of General Electric's Research Laboratory has been awarded the Faraday Medal for 1938 by the Institution of Electrical Engineers of England . . . Wilson E. Burgess, amateur radio operator of Westerly, R. I., will receive the William S. Paley Amateur Radio Award for 1938. Selection of Burgess was based

on his heroic performance during the devastating hurricane of last September . . . Transformer Corp. of America announces several changes in its organization: Roy Neusch assumes complete charge of the Clarion Institute of Sound Engineers; N. Manicardi becomes General Sales Manager; W. Whiteside is in charge of production; Frank Dostal is now Chief Engineer; and George J. Sandberg is now Engineer in charge of Mechanical Design . . . J. Kurts is now supervising both the engineering and manufacturing departments of the Callite Co. in Union City, N. J. H. M. Lush has been appointed to be his assistant.

Literature

Plastics. A discussion is given on the subject in "New Paths to Profit" a businessman's guide to modern plastic materials. Bakelite Corp., 247 Park Ave., New York City.

Conductivity Bridge. Model R. C. for measurement of resistance and electrolytic conductivity. Industrial Instruments, Inc., 162 W. 23rd St., Bayonne, N. J.

Loudspeakers. Bulletin PM-25 describes permanent magnet type trumpet units with aluminum diaphragm. Bulletin SP-101 describes a marine type exponential horn and unit. Atlas Sound Corp., 1447–51 39th St., Brooklyn, N. Y.

Recording Discs. "Duralite" recording discs are described and suggestions for recording are given in bulletin by Musicraft Records, Inc., 12 W. 47th St., New York City.

Television Standards. Bulletin T-1 gives complete specifications and standards for high voltage condensers. Solar Mfg. Corp., 599 Broadway, New York City.

Permeability Tuner. Instruction bulletin issued on the Q control unit. Aladdin Radio Industries, Inc., 466 W. Superior St., Chicago.

Broadcast Units. Also their new automatic voltage regulator. Described in Bulletin 500-D "Tru-Fidelity" of Thordarson Elec. Mfg. Co., 500 W. Huron St., Chicago.

Impervium. A synthetic material which retains a rubbery flexibility and elasticity over a long period of time and which offers a good resistance to acids, alkalies, and oils, is described in a bulletin "Paradata" by Paramount Rubber Service, Inc., 1430 Rosedale Court, Detroit, Mich.

Vibrator Guide. For replacement for auto radio and battery operated household receivers. 20-page booklet also contains other useful information. P. R. Mallory & Co., Inc., Indianapolis, Ind.

Photoelectric Spectrophotometry. For quantitative chemical analysis. Is contained in "G-M Comments" of G-M Laboratories, Chicago, Ill.

Application Note. No. 103 on the operation of the 35L6-GT. RCA Mfg. Co., Harrison, N. J.

Megger Testing Instruments. Six different types of instruments which operate on the Megger cross-coil ohmmeter principle are described in Bulletin 1600. Jas. G. Biddle Co., 1211 Arch St., Philadelphia, Pa.

Characteristic Charts. Available from several companies on their respective products: New edition from Radio Tube Div., Tung-Sol Lamp Works, Inc., Newark, N. J.; Hygrade-Sylvania Corp., Emporium, Pa.; Videotron information from National Union Radio Corp., Newark, N. J., and Hytronic Labs., 76 Lafayette St., Salem, Mass., have data sheets for the new "Bantam" type tubes for battery operation at 1.4 volts.

Terminals and Lugs. Form A describes a line of solderless terminals and lugs. Rajah Co., Bloomfield, N. J.

Test Apparatus. Contained in "Preview of Test Apparatus" by Approved Technical Apparatus Co., 57½ Dey St., New York City.

Television Engineering Data. Technical data on picture i-f amplifiers. F. W. Sickles Co., 300 Main St., Springfield, Mass.

Plugs and Receptacles. Described in Bulletin No. 1140-1. General purpose plugs and receptacles described in Bulletin No. 1140–3. These bulletins supersede previous listings. The Pyle-National Co., 333 N. Michigan Ave., Chicago, Ill.

New Products

Fluorescent Materials

A COMPLETE LINE of fluorescent materials for cathode ray tubes is offered by Pfaltz & Bauer, Inc. Empire State Building, New York. There are nine primary colors augmented by a wide range of specially compounded colors for special requirements. The particles are of such size as to produce a uniform coating which is not harmed by heat treatment.

Vacuum Gauge

A PORTABLE McLEOD type vacuum gauge has been announced by F. J. Stokes Machine Co., Olney P. O., Philadelphia, Pa. A single reading is taken in from two to five seconds and continuous readings are made in rapid succession. The range covered is from 0 to 5,000 microns.

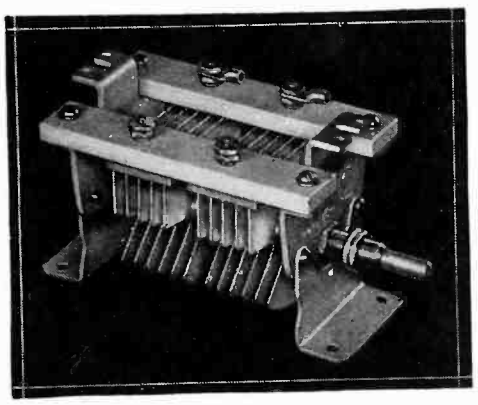
New Tubes

NEW MIDGET TUBES announced by Arcturus Radio Tube Co., Newark, N. J. include Type 6SA7GT and Type 12SA7GT single-ended Pentagrid Converters; Type 35Z5GT, a cathode type half-wave rectifier; and Type 25D8GT, a heater type diode-triode-pentode.

Hygrade-Sylvania Corp., 500 Fifth Ave., New York City, announced: Types 6AD6G, double tuning indicator; 6AF5G, a triode driver tube; 25AC5G, positive grid power output tube; 25C6G, similar to Type 6Y6G, but with a 25 volt heater; and 7A5, a loktal tube with a rating of 7 volts, .75 amps.

U-h-f Capacitor

A DUAL 50 $\mu\mu$f 3,000 volt condenser is an addition to the N series of u-h-f capacitors of the Allen D. Cardwell Mfg. Corp., 81 Prospect St., Brooklyn, N. Y. It has eleven buffed and polished plates with an air gap of 0.070 inches.



The minimum capacity is 7$\mu\mu$f. Isolantite insulation is provided. The capacity to ground is reduced by means of an inverted mounting. The regular mounting feet of the condenser provide a support for standard transmitting inductance coil jack bases.

Beryllium Alloys

NEW FACILITIES for the fabrication of beryllium have been completed by The Beryllium Corp. of Pa., Reading, Pa. It is now possible to fabricate rod, strip and wire under laboratory control so that uniform hardening can be guaranteed and a wide range of beryllium-copper alloys can be supplied.

Vacuum Pump

A ROTARY, SINGLE STAGE high vacuum pump which will maintain a vacuum of 10 microns in dry work and 50 microns in wet work has been announced by Beach-Russ Co., 50 Church St., New York. For evacuation work on radio tubes, etc. this pump can be supplied for a blank flange test of 2 to 4 microns. For applications where there is a partial vapor content, special corrosion resistant construction is available.

Aircraft Receiver

TYPE AVR-15 AIRCRAFT radio range and weather receiver, announced by RCA Mfg. Co., Camden, N. J., is of a size and weight to be easily carried by the smallest ships and is designed to satisfy the requirements of severe instrument conditions. The selectivity of this receiver is of the order recommended by the CAA. It uses a superheterodyne circuit and has a power output of more than 300 milliwatts into 600 ohm phones.

Burglar Alarm

A BURGLAR ALARM employing an infra-red light beam and a phototube pickup has been announced by A. C. Rehberger Co., 2134–38 Magnolia Ave., Chicago. The infra-red light source may be as much as 50 feet away from the pickup or Robot unit. This unit combines double phototube control, an anti-false-alarm relay, an automatically timed power valve switch and a visible adjustment meter.

Battery Charger

A COMPLETELY AUTOMATIC and self-regulating electronic battery charger called the Phano-Charger has been developed by General Electric Co., Schenectady, N. Y. It has no moving parts and is practically noiseless in operation. Three sizes are available: 4.5 amps and 12.5 amps for a single phase power supply and 25 amps for a three phase power supply.

Mica Condenser

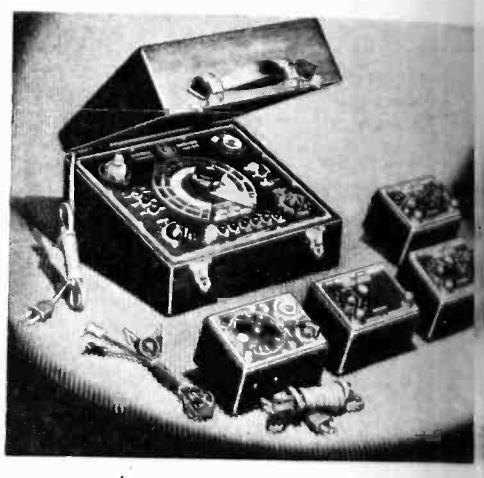
A NEW SILVER MICA condenser, Type K, has been announced by the Erie Resistor Corp., Erie, Penna. It has a temperature coefficient of approximately $+0.000025$ $\mu\mu f/\mu\mu f/°C$ and is unaffected by changes in humidity. According to the manufacturers, after 5 cycles of being subject to –30°F for five hours and then to 185°F for ten hours, the maximum change in capacity will be less than 0.15%. After 100 hours at 100% relative humidity and 40°C, the leakage reactance at 100 volts dc is still over 10000 megohms. The overall size is $\frac{7}{16}$ x $\frac{25}{32}$ inches.

Soldering Iron Stand

A SOLDERING IRON STAND with a "Magic Cup", which is a depression formed in the bottom of the stand and is filled with steel wool, is announced by Drake Electric Works, 3654 Lincoln Ave., Chicago. By twisting the tip of the soldering iron around in the steel wool, the oxide is removed and the iron is ready for use.

Capacitor Instruments

A NEW LINE OF capacitor test equ ment has been announced by Corn Dubilier Elec. Corp. S. Plainfield, N. The line consists of an Analyzer quick and accurate measurement of important characteristics of all ty of capacitors. It consists of a W Bridge connected to a single stage amplification, operating the detector. built-in power supply provides 4 volts d.c. for leakage and insulati resistance measurements. The Mid Capacitor Bridge (self-contained, c tains Wien Bridge) will measure types of capacitors between .00001 a 50 mfd, and operates from any 110 v 60 cycle power line. Three Dec Boxes have a capacity range betwe .0001 and 11.1 mfd, or they can be u



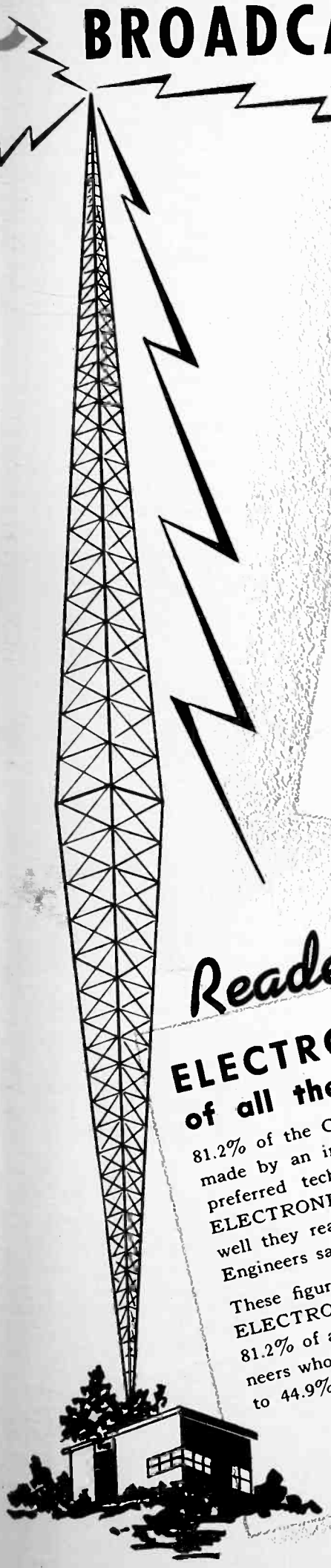
individually if desired. These boxes a for continuous use in circuits of more than 220 volts a.c., or 600 vo d.c. Catalog 167A describing the th units is available.

Other announcements from Corn include: For television receivers, Ty PC Dykanol Capacitors which a available in single, dual, and multi capacities at voltages between 2,(and 10,000 volts d.c. Also Type l etched foil dry electrolytic series wh are hermetically sealed in small cyl drical aluminum containers with t minals extruding for subpanel mou ing.

Vibrapacks

THREE NEW UNITS designed to sup B voltage have been added to the brator power supply line of P. Mallory & Co., Indianapolis, In VP-555 is a dual Vibrapack with rating of 300 volts and 20 ma lo 6.3 volts input, intended for police t way transmitters, PA equipment, a amateur service; VP-557 has an out of 400 volts at 150 ma, is a 6.3 v dual Vibrapack designed for automo PA systems, and amateur and po transmitters; and VP-558 a 32 v unit of the tube rectifier type sim to the VP-554 has a 300 volt 100 nominal output. This unit is for ra receivers on farms, boats, etc.

REASONS WHY electronics IS THE BROADCAST ENGINEERS Nº 1 PAPER



Editorial Leadership!

ELECTRONICS CARRIES 54% MORE Editorial Material for the Broadcast Engineer

During the last six months of 1938, ELECTRONICS led the nearest publication by 54% in number of column inches of editorial material of interest to the Broadcast Station Engineer. In number of articles, features, items, etc., ELECTRONICS led the second paper by 167% in that period. Here is the record:

	ELECTRONICS	PAPER No. 2	ELECTRONICS CARRIED
JULY	834½	513½	62% MORE
AUGUST	496½	471½	5% MORE
SEPT.	654	392	67% MORE
OCT.	540	371½	45% MORE
NOV.	730½	327¼	123% MORE
DEC.	765	535	43% MORE
TOTAL	4,020½	2,610¾	54% MORE

It is natural then that the Broadcast Station Engineer should look to ELECTRONICS each month as the number one publication. Natural, too, that with this editorial leadership ELECTRONICS should be the most effective, and still most economical, advertising medium for manufacturers selling broadcast station equipment.

Reader Preference!

ELECTRONICS IS PREFERRED BY 81% of all the CHIEF ENGINEERS of U. S. Stations

81.2% of the Chief Engineers of U. S. Broadcast Stations who answered a survey made by an independent organization stated they read ELECTRONICS as their preferred technical magazine. And (this is important) 47.7% said they read ELECTRONICS and *no other paper!* ELECTRONICS serves these engineers so well they read it to the exclusion of all other technical publications. 100% of the Engineers said they read the advertisements.

These figures are important to the manufacturer of Broadcast Equipment. Using ELECTRONICS as his advertising medium, the manufacturer not only reaches 81.2% of all the Chief Engineers, but his sales message is read by a group of Engineers who read no other publication but ELECTRONICS — and this group amounts to 44.9% of all the Chief Engineers in the country, certainly a sizeable market.

Add ELECTRONICS to your Sales Organization and let it sell this Broadcast Equipment Market thoroughly and at a remarkably low cost. The July issue is the time to start.

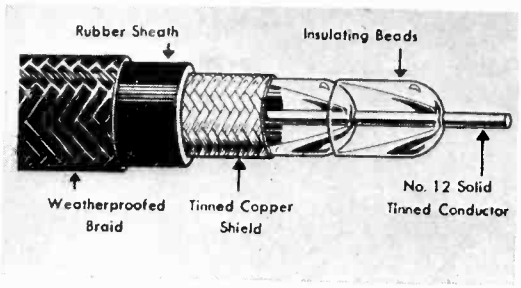
electronics

A McGraw-Hill Publication

330 West 42nd Street, New York City

Coaxial Cable

A TRANSMISSION CABLE which uses air as the principal dielectric is announced by Belden Manufacturing Co., 4689 W. Van Buren St., Chicago. It consists of a size 12 solid tinned copper conductor over which is threaded a newly designed low loss insulating bead. Over



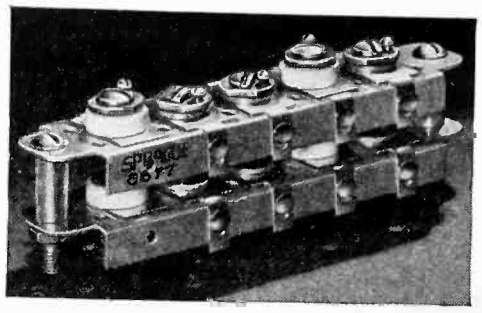
the series of beads is a closely woven tinned copper shield. The shield, in turn, is sheathed in rubber and the whole cable covered with a weatherproofed braid. The db loss per 100 feet at ten Mc is 0.275. Literature is available.

Loudspeaker

A LOUDSPEAKER for public gatherings where listeners are scattered over a broad area such as expositions, outdoor concerts, etc., has been announced by Western Electric Co., New York City. Its frequency response is substantially uniform over a range from 110 to 6500 cycles, and it is capable of radiating approximately 17 watts of acoustical energy when driven by a 50-watt amplifier. The speaker consists of a single metallic horn which is driven by two dynamic driving units enclosed within a moisture proof aluminum housing. Permanent magnet fields are used.

Tuner Strip

A TWO-DECK, 5-gang trimmer strip, adjusted by a single screw, has been announced by Sprague Specialties Co., North Adams, Mass. These two-deck strips facilitate and make possible the use of push button tuning in two-circuit



receivers with ease in adjustment and can be used in conjunction with permeability coil-tuned or trimmer-tuned oscillator circuits for three-circuit receivers and requiring only two adjustments.

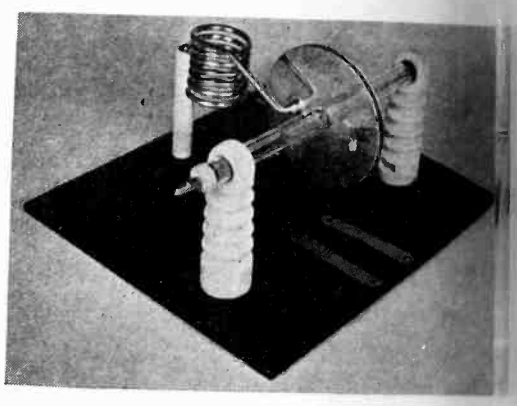
Voltage Regulator

A NEW ALTERNATOR voltage regula which extends its line of automa rheostatic types to permit regulati of large a-c generators has been a nounced by Ward-Leonard Electric C Mount Vernon, N. Y. The new co mutating unit and contact bar make possible to handle synchronous gene ators up to 2000 kva, 3 phase, cycles.

Also announced by this company a safety relay designed to preve repetition of the accidents in whi several experimenters were fatally i jured. It discharges the filter co densers of a high voltage power supp as soon as the power is turned off.

High Q Loop

A HIGH EFFICIENCY tuned circuit fo the ultra-high-frequencies is announce by Lindberg Manufacturing Co., 184 West 14th St., Chicago. It is avai able for both the 5 meter and 10 mete amateur bands. The circuit consist of an air wound coil of stiff coppe wire supported at its center tap by a



Alsimag support. The ends of the in ductance coil are connected to a pai of circular copper plates. Means o supporting and adjusting the plates ar provided. It is supplied, less base, i kit form.

Switches

A 40 AMP TAP SWITCH with a maximum of twelve contacts has been announced by Ohmite Manufacturing Co., 4835 Flournoy St., Chicago. It is four inches in diameter and features all-enclosed and all-porcelain construction, silver to silver contact, low contact resistance, positive cam and roller snap-action and single or tandem action.

A SWITCH WHICH is fastened to the chassis by means of a rivet instead of the conventional shaft and bushing and saves considerable cost is announced by the Wirt Company, 5221 Greene St., Germantown, Philadelphia, Pa.

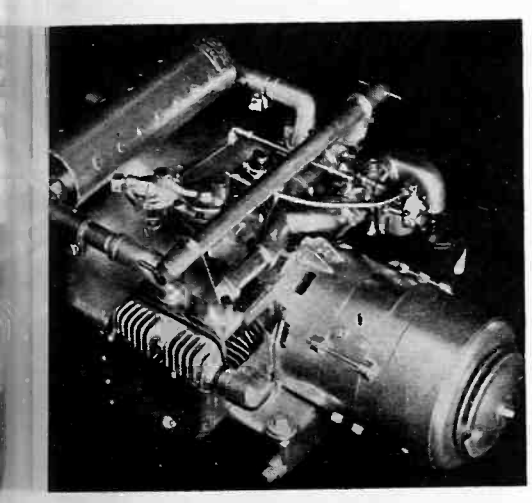
nplifiers

AMPLIFIER WITH a frequency re-nse from 30 to 15,000 cps and an tput of 20 watts at 5% distortion has n announced by Thordarson Elec- Mfg. Co., 500 W. Huron St., Chi-go. This unit has a gain of 114.3 db the microphone channels and 73.2 on the phono channel (based on ,000 ohms grid impedance).

Also announced is a 28 watt unit igned to handle any type of sound nforcement requirement. It is a volt d.c., 115 volt a.c. mobile am-ier.

wer Plant

A SERIES OF ELECTRIC power plants for craft or other lightweight require-nts has been announced by D. W. an & Sons, 39 Royalston Ave., Min-polis, Minn. Twenty-one different nerators are available to supply a de range of voltages and frequencies



f a-c or d-c voltages. Dual current odels are also supplied. Power out-uts up to 7500 watts are available. two cylinder four cycle opposed type asoline engine which operates at 1800 3600 rpm is used. Units are manual-tarting, self-starting or fully auto-natic.

Timeter

A NEW TIMETER with indicating lamp, announced by National Instrument Co., 44 School St., Boston, keeps an accurate record of actual production hours and shows operation of a machine at a glance.

Transmitter

A NEW AMATEUR transmitter, Type 510, is a product of Radio Transceiver Laboratories, 8627 115th St., Richmond Hill, New York City. It is crystal controlled with 28 and 56 Mc band switching; has an output of 12 watts and is portable.

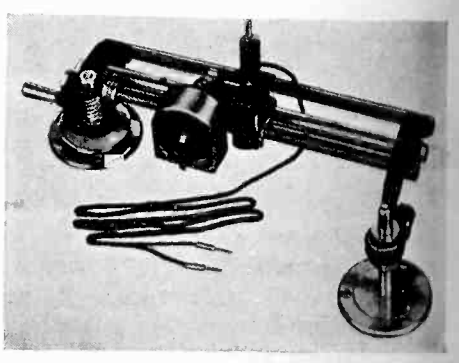
New Recorders

A NEW LINE OF recorders is announced by David Bogen Co., 663 Broadway, New York, the prices of which range from $179.50 to $445.00. The line will include both twelve inch and sixteen inch models to operate at 33⅓ and 78 rpm. An indicator for depth of cut is incorporated into each unit. Also announced by this company is a new type recording disc which is flexible, non-inflammable and more durable than acetate. It is manufactured by the lamination process with no dipping or spraying.

A SMALL SIZE, LOW COST, complete recorder in one unit which will record on twelve inch acetate or aluminum discs with five and one-half minutes playing time is announced by Universal Microphone Co., Inglewood, Cal. A microphone and p-m speaker are included in the equipment so that the unit may also be used as a small PA system.

A FILM RECORDER, the Model BB Filmgraph, is announced by Miles Reproducer Co., 812 Broadway, New York. Frequency range is 50 to 6000 cps. Twenty-eight sound tracks may be indented across the width of 16 mm film so that 112 minutes of sound may be recorded on 100 feet of film. A dual unit for continuous recording is also available.

A RECORDING MECHANISM for attachment to a recording motor and turntable has been announced by Rek-O-



Kut Corp., 254 Canal St., New York. It operates at 33⅓ or 78 rpm and is available for 12 or for 16 inch discs.

Resistors

CERAMIC-JACKETED, fully-sealed precision non-inductive wire-wound resistors in a wide range of values up to three megohms in ratings of ½, 1, 1½, and 2 watt ratings have been announced by Clarostat Mfg. Co., 285–7 North 6th St., Brooklyn, N. Y. Standard tolerance is 1% with as low as 1/10 of 1% available on special order.

A NEW LINE of wire-wound resistors has been announced by Consolidated Wire and Associated Corps., 520 So. Peoria St., Chicago. There are four sizes of adjustable resistors available—10, 25, 50, and 75 watts and four sizes of fixed resistors are available—5, 10, 20 and 50 watts.

British Patents

Counting Apparatus. Movement for operating the count indicator in a counting-equipment is effected in response to successive electrical impulses derived from the articles to be counted, the movement being produced in an eddy current rotor by means of out-of-phase fluxes derived from the impulses. No. 494,154. Igranic Electric Co.

Register Control. A wrapping machine comprises means for moving continuously a web of wrapping material, means for depositing articles one after another on the moving web, and a photoelectric device for controlling the deposition of each article so that it is placed in a definite position on the web. No. 495,946. S. J. Campbell.

Cathode-ray Tubes. A mesh, particularly a metal mesh for use as an electrode in an electric discharge device, is made in the following manner. An existing mesh is laid on a supporting surface and carbon is deposited through it, for example from a gas flame, and the mesh then removed leaving a carbon mosaic on the surface. Metal such as silver or aluminium or other material is then deposited by vaporization, cathode sputtering or otherwise over the whole and the carbon and the material deposited thereon are washed away, leaving an adherent mesh of deposited material. The mesh may be removed from the supporting surface, if necessary after thickening by electrodeposition, or when the support is of insulating material such as glass or mica the mesh may be retained thereon. After removal of the original carbon mosaic and before removal of

(Continued on page 86)

COMPILING WEATHER DATA FOR TRANSATLANTIC FLIGHTS

The United States Coast Guard has undertaken to provide weather information on the high seas over the northern route for transatlantic flights. Here Chief Radioman Ellis Holden in the radio room of the Cutter Chelan is shown watching the instruments which record radio waves received from radio equipped balloons. Analysis of the signals from these balloons enables weather predictions to be made

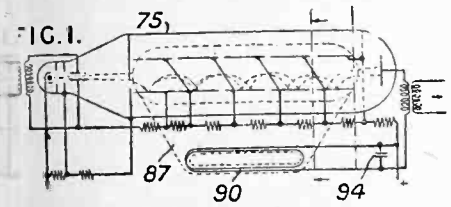
the deposited mesh, carbon may be deposited in adherent form, for example by spraying from a suspension, so that, on removal of the mesh, an adherent carbon mosaic is left on the surface. In performing the operations described, a mica sheet may be mounted over a metal block, preferably slightly curved, and the pattern mesh mounted over it by means of a stretching frame as described in Specification 479,024. 490,537, H. E. Holman.

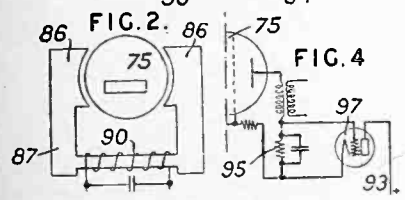
Mosaic. The mosaic structure of a cathode-ray tube comprises a nonconductive base with a thin layer of insulating material flashed on one side thereof in vacuo and minute separated photosensitive particles on the thin layer there being a layer of conducting material on the opposite side of the base. In one form, a sheet of mica is coated on the underside with a film of platinum and on the other side with a film of cryolite, calcium fluoride or sodium fluoride. The film of fluoride etc is then dusted with silver oxide then reduced by heating to minute separated particles of silver. Alternatively the silver may be applied as a metallic film which is then broken up into particles by heat treatment. The coated mica sheet is then mounted in the tube envelope which is evacuated and the silver particles oxidized and exposed to caesium vapour. The tube is then baked and any caesium deposited between the particles is taken up by a stannic oxide getter. The particles may finally be given a thin coating of nickel or silver by evaporation from an appropriately coated filament in the tube. The mica is coated with insulation by mounting it in an envelope containing a tungsten filament which has been coated with the fluoride or other insulating material, the container then being evacuated and the filament heated to flash off the material. 491,292, Marconi.

Push-pull Amplifier. In a push-pull amplifier in which the grid bias remains constant and has a value such that the valves are working at the maximum permissible anode dissipation, the load impedance is so chosen that the valves are swung asymmetrically, i.e. the anode current variations resulting from a positive grid voltage half cycle are, at maximum swing, at least twice as large as those resulting from a negative half cycle. A suitable value is between ½ and ¼ of the commonly accepted "optimum load" $Ra = \frac{h.Eb^2}{Ao}$ where h is a constant between ·6 and ·8, Eb is the steady anode voltage as at Ao the maximum allowable anode dissipation. The grid bias source must be independent of the anode current and the impedance of the anode supply must be as low as possible. A pair of valves which give an output of 10 watts with a noise faction of 5 per cent when worked class A factor, give an output of 30 watts and the same noise factor when worked in accordance with the invention. No. 493,136, Telefunken.

Electron Multipliers

e following patents have been ed recently in Great Britain relat- various means and apparatus for on multiplication: No. 490,229 to seh. No. 490,230 to Baird. No. 35 to General Electric Co. No. 69 to British Thomson-Houston No. 491,425 to Marconi Co. No. 73 to Standard Telephones. No. 55 to General Electric Co. Also 92,059 to General Electric Co. No. 98 to G. Weiss. No. 493,043 to . Loewe. No. 493,048 to Baird. 493,217 to Standard Telephones. 93,296 to Fernseh. No. 493,714 to seh. No. 493,801 to Farnsworth. 93,861 to Marconi Co. No. 493,968 ompagnie pour la Fabrication des oteurs et Materiel D'Usines a Gaz. 94,208 to General Electric Co. No. 130 to Telefunken. No. 494,329 to pagnie pour la Fabrication des oteurs et Materiel D'Usines a Gaz.





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LOST RADIUM FOUND IN ASHES

Electron tube equipment came into use when a Geiger counter was employed to find $12,000 worth of radium which had been lost in a Cambridge hospital. Dr. Cramer Hudson, left, and Russell F. Cowing are examining the ashes in which the radium was ultimately found. The platinum tube in which the radium had been contained was melted, and the radium was dispersed through the ashes, but it is expected that 90% of it can be recovered

U. S. Patents

Variable Indicator. Method of in cating relation between pressure a time in the cylinders of an inter combustion engine. E. M. Dodds, W ford, England. No. 2,133,437.

Phototube Circuit. A pair of phot tubes of the barrier layer type, a cu rent responsive device, and a netwo connecting the cells and device to su ject said device to the differential a tion of currents generated by the cel W. N. Goodwin, Weston Electrical I strument Corp. Reissue 20,823.

Stroboscope. Apparatus for inspec ing a moving element and for indica ing the frequency of the periodic m tion thereof. A. A. Kucher and Flo E. Gray, Dayton, Ohio. No. 2,127,60

Testing Apparatus. A vacuum tul testing instrument for the detection electro-magnetic fields adjacent to cu rent carrying wires or other condu tors, or objects which have become co ductors as a result of proximity wires or conductors. Merwyn B Leesburg, Va. No. 2,109,189.

Collision Prevention. High frequen circuit for indicating close proximity one craft to another. F. W. Dunmor Washington, D. C. No. 2,146,724.

Flight Detection. Method of detec ing the passage of a projectile past given point by collecting at the point a induced static charge from the stat charge residing on a projectile in figh J. V. Dunham, Southampton, and E. Rechel, Philadelphia, Pa. No. 2,146,72

Electronic Switching System. C. Shumard, RCA. No. 2,146,862.

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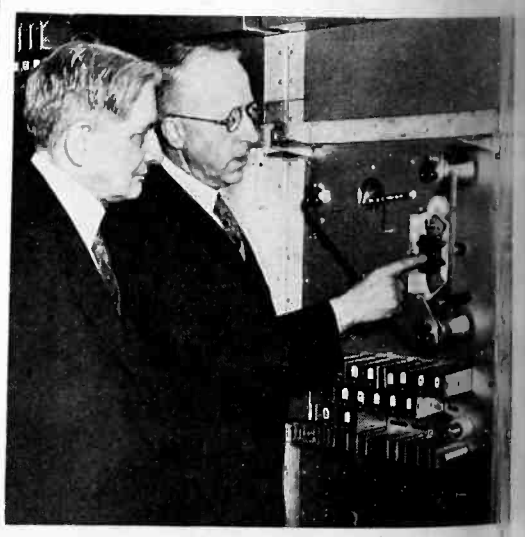
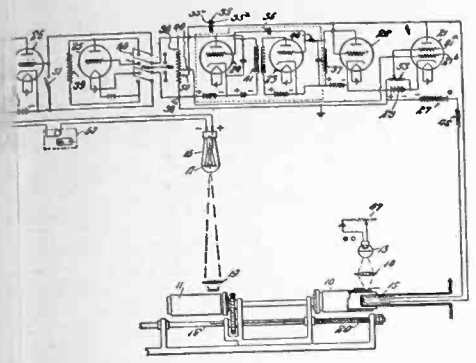
WEATHER DATA, AUTOMATICALLY BY PHONE



Persons in New York wishing weather forecasts can dial the proper number and listen to reproductions from the magnetic tape recorder. The operation of the recorder is being explained to Weather Meterologist, Dr. James H. Kimball, by Ralph E. Walker, vice president of the Bell Telephone Company.

inting Plate. Apparatus for mak- contrast image from a continu- one original by electronic means.



Hardy, Interchemical Corp., New , N. Y. No. 2,136,340.

gn. A luminous discharge tube ated from high frequency current. ph Fodor, London, England. 2,139,815.

avity Meter. Apparatus for de- mining variations of gravity by an ic member, tubes, etc. S. A. rbatskoy, Tulsa, Okla. No. ,219.

rnace Control. A. L. Sweet, G.E. No. 2,136,256.

apacity Measurement. Tube oscil- r system. L. A. Sharland, London, land. No. 2,135,017.

Welding Apparatus. Spot welding equipment. R. N. Stoddard and E. H. Vedder, WE&M Co. No. 2,134,538.

Electric Eye Rifle. J. E. Vivaudou, New York, N. Y. No. 2,139,530.

Follow-up System. Tube apparatus used in gyro compasses. Sperry Gyroscope Co. No. 2,139,558.

Integration Circuit. Apparatus for measuring the sum of the squares of a currentamplitude integrated over a predetermined time interval. F. H. Shepard, RCA. No. 2,139,474.

Prefocusing Lamps. Apparatus for accurately locating the filament of an incandescent lamp by light sensitive means. D. E. Elmendorf, GE Co. No. 2,136,237.

Timing Control. C. Stansbury, Cutler-Hammer, Inc. No. 2,146,863.

Neon Tube Apparatus. Tube method of supplying voltage to break down the gaseous discharge in neon tubes. R. W. Reitherman, Chicago. No. 2,136,924.

Inspection. Method of magnetizing a ferro-magnetic object for the purpose of locating a supposed defect therein. A. V. de Forest, assigned to the Magnaflux Corp. No. 2,136,375.

Control System. Automatic regulating apparatus comprising an electrically interpretable variable quantity to be regulated, a grid controlled space discharge tube, etc. R. W. Gilbert, Western Electrical Instrument Corp. No. 2,136,682.

Measuring Apparatus. Electron tube equipment for indicating the position of an object. R. E. Woolley, Bailey Meter Co. No. 2,136,900.

Oscillograph. Device for indicating oscillograph curves as stationary. F. Bedell, General Radio Co. Reissue No. 0,945.

Control Apparatus. No. 2,140,355 to F. H. Gulliksen and No. 2,140,350 to J. W. Dawson, both to WE&M Co.

Sign. A luminous discharge tube operated from high frequency current. Joseph Fodor, London, England. No. 2,139,815.

Wattmeter. Apparatus for measuring a high-frequency ac power quantity. Reuben Lee, WE&M Co. No. 2,140,364.

Light Control. A photoelectric relay adapted to be subjected to the varying intensity of daylight. Pieter Juchter, G.E. Co. No. 2,140,387.

RADIO TRANSMITTER DIRECTS AUTOISTS

W. S. Halstead, New York communication engineer, demonstrating new highway safety system he developed. The system employs a small automatic radio transmitter which may be mounted on telephone poles or traffic light stanchions. The unit warns pedestrians of impending signal changes and directs automobile traffic through radio system which makes use of automobile radio receivers. The unit also employs a magnetic tape recorder which effects continuous repetition of a given traffic bulletin addressed to the pedestrian or motorist

TELEVISION FIELD

(*Continued from page* 15)

several hundred per cent improved quality. It is this sort of thing that makes engineers grind their teeth. The remedy seems to be more careful instructions, on the part of the manufacturer, to dealers. The same remarks apply of course to the instructions which go to the ultimate purchaser.

Those sets employing large picture tubes (12 and 14 inches in diameter) seem to be doing a uniformly good job in resolving the detail of the image. In one case, a receiver on demonstration in a midtown store was actually resolving *all* the detail in the test pattern (i.e. 350-line resolution in both vertical and horizontal directions). Other sets of the same type were limited to about 300 lines in the horizontal direction while in a few cases the horizontal definition seemed to be no greater than 250 lines (in the latter case perhaps reflections were the cause). In the five-inch picture-tube receivers the detail performance is considerably lower. In the first place, the spot size of the tube is large, rela

tive to the picture dimensions, and the fine detail is not resolved for this reason. Also the band-width passed by these smaller receivers is purposely limited to meet the capabilities of the scanning spot, and to obtain the necessary gain in fewer tubes. About 250 lines, vertical resolution, is good performance, whereas 250 lines horizontally seems to be the best obtainable in models viewed by the writer. Some of the smaller sets resolve less than 200 lines, horizontally, but a very acceptable picture is nevertheless produced.

The scanning and synchronization performance seems to be on a high plane in nearly all of the commercial products. Accuracy of interlace, which can be judged carefully only on the larger tubes, seems to be somewhat less universal, although in one full ten-minute performance, during which the lines were viewed from a distance of four or five inches, the interlace remained substantially perfect.

The presence of slight interference from cw stations operating within the i-f pass band of the picture circuits can be discerned on receivers which do not employ an r-f stage. In these cases, the interfering station is usually within a few blocks of the receiving location.

Sight-sound reactions

Interaction between the sight and sound systems can be observed to a limited degree in nearly every receiver viewed by the writer. Most commonly this interference takes the form of a slight crossing of the sound modulation into the picture, but in most cases the amount is so small that it would not be noticed unless it were looked for. If the signal level is extremely strong, the picture signal may be heard in the loudspeaker, especially in receivers whose converter is connected directly to the antenna circuit. This effect was noticed in a set constructed by the writer for home use, when fed with a signal of about 0.2 volts. When the set was removed to the suburbs, where the signal is roughly 1/100th as strong, the trouble disappeared entirely. This suggests the utility of an attenuator in the antenna circuit to prevent excess signal voltage on the converter grid, which may cause cross-modulation.

Details of set designs are as yet

fairly scarce. We have permission to reproduce here, however, the complete circuit diagram of the type TRK-12 RCA receiver, whose interior arrangements are shown in the frontispiece. The complexity of the diagram and the small space in which it must be printed make the diagram somewhat difficult to read, but it will repay study on the part of engineers who desire to familiarize themselves the details of a modern television receiver. The circuit as shown includes the complete sight system, and the sound system up to the output of the second detector. An 11-tube all-wave radio receiver chassis, included in the cabinet, contains the audio output tubes and loudspeaker.—D.G.F.

PROGRESS REPORT

(*Continued from page* 27)

Recent developments in the production of ultra-steatite by the General Ceramics Corp., make it particularly suitable for critical insulation in the u-h-f range; the material displays a loss factor of 0.31 compared with 0.08 to 0.12 for fused quartz. General Plastics, Inc., announce the ability of Durez phenolics to mold accurately in extremely small parts, such as pins and tumblers of volume-control switches. New antenna relays using low-loss ceramic insulation and wide-spaced contacts are available from Guardian Electric Mfg. Co. Heintz and Kaufman have produced a six-position band-switch for use in high power transmitters, capable of handling a kilowatt of r-f power. Hygrade-Sylvania has just announced five-inch "short" cathode-ray tubes with green or white fluorescent screens. The newest tube in the Hytron line is an extremely compact pentode with control grid and plate brought out to grid caps, designed as a mate to the triode of similar construction which is already available.

The Megabridge, a new insulation resistance tester with ranges available up to 100,000 megohms, is made by Industrial Instruments, Inc. A new design of wire-wound resistance controls especially suitable for rugged service and minimum noise has been produced by the International Resistance Co. New indicator

by the H. R. Kirkland Com-
feature easy renewal of lamps
a wider variety of colored
es. The Lampkin Laboratories
produced a frequency meter
e readings extend as high as
Ic, consisting of an oscillator
h is beat with the measured
, a non-selective detector and a
fier. The Lenz Electric Com-
has recently announced a wire
cially suitable for the loop an-
as used in portable receivers.
lfuse Inc. has produced the
eo" fuse, at current ratings of
1½ ma up, especially suitable
protecting the users of high volt-
power supply circuits. The fuses
k the circuit when the overload
dent to bodily contact occurs.
nprovements in switches which
fair to replace tubes in some ap-
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is the "short" five inch tube
wn as the 5AP4/1805P4. Re-
t products of the Ohmite Manu-
facturing Company include a power tap switch, suitable for transferring high power connections reliably and quickly. The Operadio Company has a new mixer and preamplifier for broadcast use, capable of operating two lines individually. "Little General" is the name of the 2-inch permanent magnet dynamic speaker produced by Oxford-Tartak, a speaker little larger than a pack of cigarettes. Pacent Engineering Corp. announces a high fidelity phonograph-radio combination of the finest available construction. Charles Parrag, American representative of the Telegraph Construction Company of England, has a wide variety of coaxial cables, some employing gutta-percha as insulation (cross section of insulation is star-fish shaped, giving large air space) others having styrol spacers. The Precision Paper Tube has developed new coil bobbins of acid-free kraft paper dielectric. The Photobell Corp. announces a phototube relay with the entire "works" incorporated in one housing, a mirror being used to reflect the light beam.

RCA (Camden) has a simplified television system (type 510A) com-

plete in one cabinet which contains sync impulse generator, a two-inch oscilloscope tube power supplies for camera tube and picture tube, line amplifier, shading circuits and brightness and contrast control. Associated with the system is a standard iconoscope camera (type 500A) and in the cabinet is a 12-inch picture tube which reproduces what the camera sees. The whole system operates on R.M.A. Standards and is suitable for use whenever sight must be transferred over wires, or as a test generator for the manufacture of television sets. A new insulation material known as Rub-Erok is available from the Richardson Corp; it is suitable for trimmers, leaf spacers, terminal strips etc. A 60-cps frequency meter with dial-illuminating case is available from Roller-Smith Corp. Two new microphones, the "Rocket" and the "Unidyne" have been produced by the Shure Brothers Co.; the former a dynamic type (70–7000 cps response) the latter a cardioid pattern moving coil unit (40–10,000 cps response).

Constant voltage transformers of the saturating magnetic core type have been announced by the Sola Electric Company. A new meth of molding paper capacitors in w has been developed by the Sol Manufacturing Co., which effectual prevents moisture from entering t body of the capacitor at any poi thus giving a probable life of fro 2 to 5 times that of convention paper tubular units. The Sout Bend Microphone Company has ju gone into production on a new mo ing coil dynamic microphone rugge enough for industrial service. midget radio frequency relay sui able for general r-f switching wo has been developed by Struther Dunn Inc.; capacity 6 amperes 500 volts, r-f. A television antenn in di-pole form of heavy duralumi rods, with optional reflector, is avai able from the Technical Applianc Corp. A band-spread beat frequenc oscillator known as an "audio spec trum divider" with a spread of 0–1 cps over 3600 degrees is the lates product of the Televiso Corp. Trip lett Electrical Instruments announc a new condenser bridge, model 164 including capacitance scales fro 0.00025 to 250 microfarads, and d- leakage tests at 600 volts. The ap plication of television radiator struc

SEARCHLIGHT SECTION

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Discount of 10% if full payment is made in advance for four consecutive insertions of undisplayed ads (not including proposals).

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An advertising inch is measured ⅞" vertically on one column, 3 columns—30 inches —to a page.

(New advertisements must be received by June 29th for the July issue)

POSITIONS WANTED

(See also "Selling Opportunity Wanted")

FORMER CUSTOM RADIO ENGINEER, now employed in well known manufacturer's electronics division, available for employment by radio components, transmitter, or receiver manufacturer. Prefer location either in New York or New England. Highly inventive, versatile, with experience over wide range. Age 28, single. Salary subject to discussion. Photo and details upon request. PW-206, Electronics, 330 W. 42nd St., New York, N. Y.

RADIO OPERATOR: Radiotelephone first class and radiotelegraph second class licenses. Graduate RCA Inst., previously 3 years of electrical engineering at U. of Toledo. Amateur for many years. Would prefer communications field. Age 24, single. Desires opportunity more than a salary. Available anywhere. Reference on request. PW-208, Electronics, 520 N. Michigan Ave., Chicago, Ill.

RADIO OPERATOR RADIOTELEPHONE first class and radiotelegraph second class license. Can copy code on typewriter. Age 27, single, available at any location. Seeking employment radio operator. PW-209, Electronics, 520 N. Michigan Ave., Chicago, Ill.

OPPORTUNITY WANTED

WE OFFER SALES AND ENGINEERING SERVICE in Chicago Area for the right Manufacturer. Successful small organization can serve a manufacturer, selling, contacting, engineering, servicing manufacturers in Chicago territory. Engineering service by graduate electrical engineer. We maintain our own laboratory to work out users' problems. Also maintain warehouse space with excellent shipping facilities. If desired, can handle jobber-distributor accounts. We know what we can do and will gladly work out a commission basis. Address our Advertising Agency: Earle Ludgin, Inc., 230 North Michigan Ave., Chicago, Ill.

WANTED

ANYTHING within reason that is wanted in the field served by Electronics can be quickly located through bringing it to the attention of thousands of men whose interest is assured because this is the business paper they read.

s to the top of existing broadcast
r radiators is a new service of
Truscon Steel Co. The United
es Electric Mfg. Corp. has a full
of batteries for "battery-port-
e receivers, fitted with standard
jack connectors. Ward Leo-
s safety relay for radio trans-
rs operating at up to 2000 volts
just been announced; the relay
arges the filter capacitors when
station is shut down. The
on portable u-h-f signal gen-
r has found one use, among
s, as a checker of police-car
mitter frequencies. The in-
ed use of flexible shafting for
mitter tuning controls has
sitated several new sizes and
es, manufactured by S. S. White
al Mfg. Co. The Wholesale
o Service, Inc. has a combina-
battery-operated ac-dc power
operated portable radio receiver.
emely small washers are among
new fasteners developed by the
ught Washer Co., measuring
0.07 inch in diameter. The
ar Mills have completed the de-
lopment of a new line of waxes
coil treatment where high Q is
ntial.

IRE MEETING

(Continued from page 31)

oltage variations, contact poten-
changes, etc., which are trouble-
e in directly-connected d-c am-
iers. The system uses balanced
dulators, with a tube to detect
ier unbalance, the unbalance be-
in proportion to the signal to be
lified. The amplifier is especially
ful for amplifying small low fre-
ncy and transient voltages to a level suitable for use in recording or controlling mechanisms.

F. A. Polkinghorn of the Bell Laboratories reviews the progress in receiving transoceanic broadcasts, which has been made possible by various researches into the angles of arrival of the signals and the diurnal variations. The steerable antenna, a direct result of these researches is described. Two papers on noise measurement and control, one by C. V. Aggers of Westinghouse, and the other by Aggers, D. E. Foster (RCA License Laboratory) and C. S. Young (Pennsylvania Light and Power Co.) review the sources of noise, the application of shunt and series filters with the relative advantages of each. The second paper includes the recommendations of the Joint EEI, NEMA, RMA Coordination Committee on the nature, characteristics, and performance of an instrument suitable for measuring radio noise. C. A. Lahar and L. Hewitt of RCA (Camden) describe the problems of serving a large exposition (the San Francisco International Exposition) with a public address system of adequate power and quality.

Scientific Investigations

The four remaining papers to be delivered have to do with the results of investigations which, for the present at least, are more scientific than engineering in nature, although they have important engineering implications. P. A. Ekstrand of Heintz and Kaufman has investigated the potentials at which spark-overs occur between gaps at radio frequencies. The voltage was measured by measuring the current through a known capacitance. It was found that ultraviolet light has a marked effect on

minimum spark-over potential (and hence acceptance tests should be conducted in its presence), and that the spark-over voltages at radio frequencies are considerably lower than those at 60 cycles. An investigation of the effect of the sun spot cycle on the critical frequency exhibited by the F_2 layer of the iconosphere was reported by W. M. Goodall of the Bell Labs, who obtained good correlations with the activity of the "calcium" flocculi in sun spots. Atmospherics and other transmission phenomena in the tropics are reported by K. W. Kenrick and P. J. Sammon of the University of Puerto Rico. These tests range from 16 kc to 42.5 Mc, and indicate among other things that the magnetic susceptibility of signals in the tropics is considerably less than that reported in northern latitudes. The authors describe an automatic record specially developed for this study. The division of the space current between the plate and grid of a triode tube, when the grid draws appreciable current, has been investigated in detail by Karl Spangenberg of Stanford University, who reports his findings. The effective area of the grid is found to increase by as much as 180 per cent when equal positive voltages are applied to both plate and grid. Nomographs for finding this increase in terms of other controlling factors have been developed. The theory advanced has been checked with considerable accuracy by measurements. Among the practical uses of the investigation is the possibility of changing the grid-current characteristic of a tube, in a predetermined amount, by changing electrode dimensions, without changing the amplification factor or grid-plate transconductance of the tube.

A paper entitled "Electron Optics in Television" is the subject of Dr. V. K. Zworykin of RCA (Camden). Dr. Zworykin points out the effect of scanning and picture signals on the "refractive index" of the electron optical medium. Among the electronic pick-up devices discussed are the Iconoscope and the Image Dissector. The gain of sensitivity through the use of stored charge is limited by unfavorable field conditions, which have been partially overcome in improved forms of the iconoscope, notably the two-sided mosaic type, the image-tube type and the electron multiplier type.