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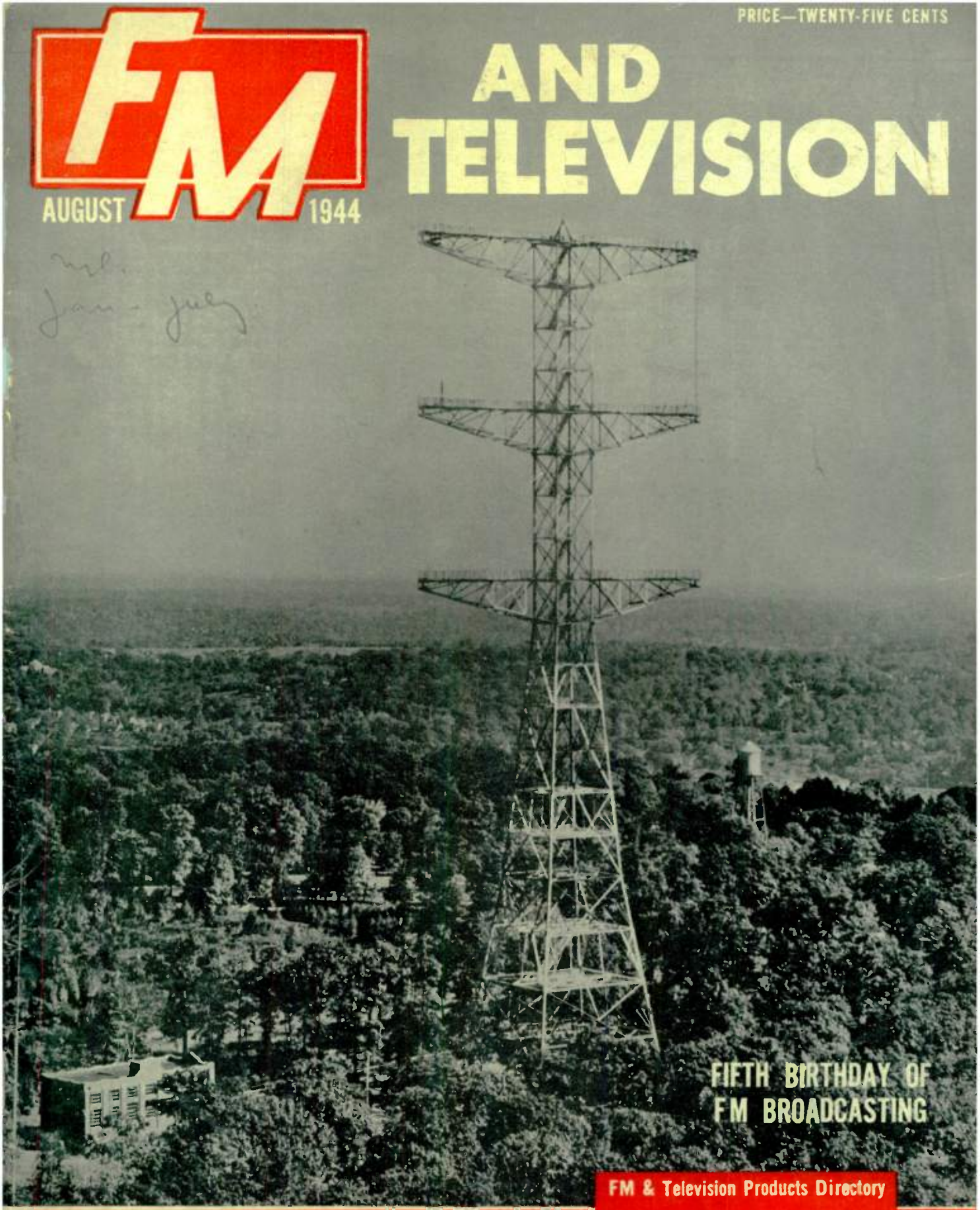
FM AND TELEVISION

AUGUST 1944

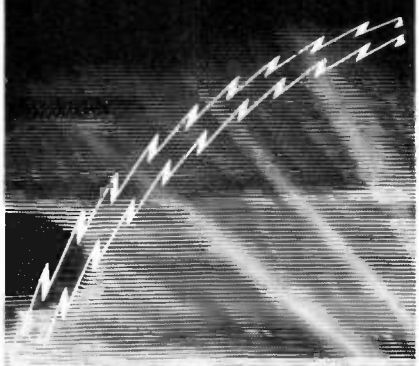


FIFTH BIRTHDAY OF FM BROADCASTING

FM & Television Products Directory

★ ★ Edited by Milton B. Sleeper ★ ★

WHAT WILL I SEE ON MY TELEVISION SCREEN?



I am Alec Electron, here again to keep you up to date on Television

1. Will I see important news events while they are happening?

Yes, *immediately* in the city in which the news event transpires. And distant events — when cable or radio relay networks link up our large cities. Until such time, motion picture newsreels will be rushed to your local Television station by swift planes and will be shown at once or held for regular newscast periods.

2. Will I see famous stars of stage, screen and radio?

Yes. In the past 3 years, hundreds of the great names of the entertainment world have been tested for Television. Every week brings new faces to DuMont's Station WABD, anxious to explore the thrilling possibilities of this great new medium.

3. Will I get "local news pictures" on my Television Set?

Yes, indeed, DuMont has designed "pickup trucks" for fast eye-and-ear coverage of everything that goes on in your community. As portable video cameras scan the parade passing 5th and Main, it will appear on your DuMont home receiver. You'll watch for your friends in style shows and amateur productions, graduations, street interviews, quizzes and other contests, inspections of crops, gardens, and new construction. You'll visit dedications, patriotic and political rallies, county fairs, fires. You'll take wonderful shopping tours — without leaving your favorite armchair.

4. Will I get big sporting events free?

Yes, national advertisers are already seeking options for telecasting the World Series, Madison Square Garden attractions, the races, football classics, etc. Because several Television cameras will be employed, you'll enjoy several "best seats" at each event.

5. What educational programs will Television offer?

Television will make education as exciting as a mystery adventure. Well-known scientists and engineers will take us on tours of great industries, mines and utilities, will entertain us in their laboratories. We shall enjoy conducted tours of art galleries, planetariums, museums, zoos, aquariums, historic sites and national parks. We shall sit in Congress, political conventions, town hall meetings and courts. We'll visit automobile and aviation shows, hospital clinics, kitchens of famous chefs, Army and Navy maneuvers, model farms and lecture halls.

6. Will I have to look at a parade of advertised products?

Television's commercial sponsors will mix a lot of entertainment with very little sales talk. For some time over Station WABD, DuMont has cooperated with national advertisers in developing techniques for putting product demonstrations and advertising messages high among the truly entertaining features of Television. They have many surprises in store for you — very pleasant ones.

7. Will I receive pictures in full color?

Don't expect them soon. Engineers in many laboratories — including DuMont's — are giving their days to war work and their spare time to the development of natural color telecasting. Truthfully, color transmission is still in the laboratory stage. It has too much flicker. It stands today where black-and-white telecasting stood when mechanical scanning was abandoned for the infinitely more rapid and reliable electronic scanning. Commercially practical color telecasting will probably be achieved by methods undreamed today . . . but how or when is anybody's guess.

8. Will I get standard radio programs on my Television Set?

Not unless you own a *combination* Television-Radio Receiver. A separate unit is required. Several new-model DuMont Television-Radio Receivers will provide Television, standard AM and FM (Frequency-Modulation) reception and an excellent phonograph record player. DuMont's impressive pioneering achievement in Television assures you of the very finest in electronic engineering and cabinet artistry . . . of unique performance in your peacetime Television Set.

DUMONT *Precision Electronics and Television*

ALLEN B. DuMONT LABORATORIES, INC., GENERAL OFFICES, 2 MAIN AVE., PASSAIC, N. J.
TELEVISION STUDIOS AND STATION WABD, 515 MADISON AVENUE, NEW YORK 22, N. Y.

HERMETIC SEALING

a type for every requirement

May we cooperate with you on design savings for your application . . . war or postwar?

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FM AND TELEVISION

FORMERLY: FM RADIO-ELECTRONICS

VOL. 4 AUGUST, 1944 NO. 8

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The publishers will be pleased to receive articles, particularly those well illustrated with photos and drawings, concerning radio-electronic developments. Contributions will be neither acknowledged nor returned unless accompanied by adequate postage, packing, and directions, nor will FM Magazine be responsible for their safe handling in its office or in transit. Payments are made upon acceptance of final manuscripts.

THIS MONTH'S COVER

THERE has been much controversy as to which was the first broadcasting station in the United States, but there is no argument over the No. 1 FM station. It is Major Armstrong's W2XMN, at Alpine, N. J. Although he set up his first experimental transmitter at the NBC's Empire State Building station in 1934, it was not used for scheduled broadcasting, and was dismantled in 1935. Another transmitter, erected at C. R. Runyon's station W2AG, was used for test purposes. However, W2XMN, shown on this month's cover as it appeared five years ago, signalled the start of scheduled FM broadcasting when it went on the air July 18, 1939.

WHAT'S NEW THIS MONTH

No Room on the Air for Pressure Politics

WE ARE now fighting to defend the United States in a war organized against us by methods of pressure politics conceived in Europe.

Yet CIO officials, favored by deferment from military service, have imported those pressure methods and are attempting to employ them against the very people who are making the greatest contribution to the defeat of our enemies by the Allied Nations.

Specifically, the *Radio Handbook*, issued by the CIO's Political Action Committee, sets forth the principles of pressure politics, and instructions for their use by CIO members in demanding free time on broadcast stations.

Because the NAB *Code of Ethics* frowns on the use of time for *any* membership drives, the unions are told to "shout" their demands, and "make it loud." When stations decline to give them time, they are instructed to get refusals in writing — to the end that pressure can be brought to bear on the management. Further, the unions are told to plan the erection of their own (FM) stations, and to demand that they be licensed by the FCC.

All this is for what? To serve public interest, convenience, and necessity? No, the methods of pressure politics are never employed for such a purpose.

They have never been used, and by their nature they cannot be used except to promote the dubious and selfish interests of minority pressure groups.

Any organization that employs these tactics in efforts to be heard on the air automatically excludes itself from the privilege of using the radio. If this statement requires confirmation, we have only to consider the similar use of radio in the Axis countries.

The text of the *Radio Handbook* is prima facie evidence that the CIO, under its present leadership, does not intend to use or operate radio broadcasting facilities in the service of public interest, convenience or necessity.

Their shouting, however loud, should fall on deaf ears. Their demands for refusals in writing should go unanswered. Any other attitude on the part of broadcast station operators or the FCC will be a grave disservice to the people of this Nation. — *Milton B. Sleeper.*

Pictures HEARD round the world—

Marines leap to the attack. News cameramen advance with them, recording the action. And, in short hours, those precious pictures taken under fire are telling their thrilling story to American newspaper readers.

Short-wave radio makes possible the transmission of news pictures direct to any part of the world. The blacks, grays and whites of a photograph are broadcast as an audible signal, varying in strength according to the shading of the picture. Thousands of land- and sea-miles away, the electronic facsimile recording tube "hears" the picture and reproduces it, line by line, on sensitized paper.

More and more news pictures of this war are recorded by Sylvania recorder tubes manufactured to one standard—the highest anywhere known. This Sylvania electron tube bears the same marked superiority you have long expected of Sylvania radio tubes. The Sylvania recorder tube is vital to quicker transmission than was formerly possible over news-cluttered commercial radio circuits, and it records clearer pictures that are more faithful to the original.

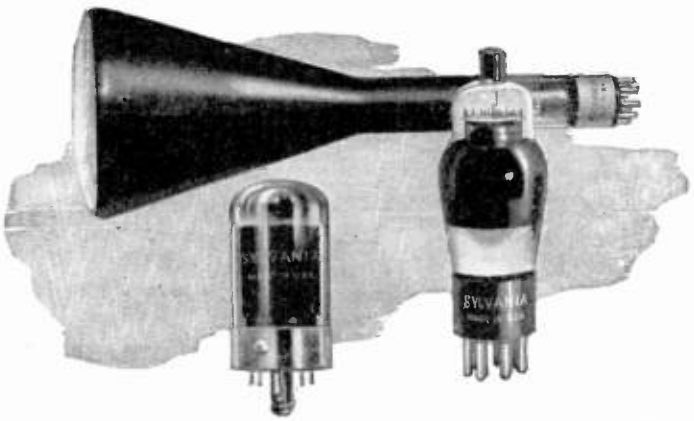
A reputation for radio tube manufacture, attained by serving you, brought Sylvania important wartime assignments in electronics. The recorder tube is one of many electron tubes other than radio that Sylvania now produces. This wide wartime experience will bring you ever finer radio tubes and cathode ray tubes to help you develop your postwar opportunities in the radio and television field.

Quality that serves the war shall serve the peace

SYLVANIA

ELECTRIC PRODUCTS INC.

RADIO DIVISION — EMPORIUM, PENNSYLVANIA



RADIO TUBES, CATHODE RAY TUBES, ELECTRONIC DEVICES, FLUORESCENT LAMPS, FIXTURES AND ACCESSORIES, INCANDESCENT LAMPS

ADVERTISERS INDEX

In designing a new electronic tube, mathematical calculations are invaluable, but as every designer knows, they are but preliminaries. After them, there usually come many tests of various experimental tubes. Machlett thought the cut-and-try method not only wasteful, but not productive of the best results. So we shortened and simplified the procedure by what our laboratory people call the "rubber model."

Here is a stretched rubber sheet. At the high end is a model of the cathode (electron emitter) of a proposed tube, and at the other end the anode, or target of an X-ray tube, plate of an oscillator or rectifier. The slope between the two is proportional to the desired potential difference. By means of an electro-magnet, a steel ball can be held in any position along the cathode, then released to roll under gravity to the anode, where the point it strikes can be observed and measured. *This is an electro-mechanical analogy.*

By means of this rubber model technique, months have been shortened into days, weeks into hours. More than that, new and higher performance has been achieved in the final product, so that when you buy a Machlett tube, you are assured of precise results, longer life, greater economy . . . Machlett Laboratories, Inc., Springdale, Connecticut.

The Machlett 880 is a radio oscillator tube for use in transmitters, and has a maximum output of 60 KW.

MACHLETT

RAY TUBES SINCE 1898

TODAY THEIR LARGEST MAKER

Mathematically, here's the inside story

THE FORMULA in the picture above is an expression of *bunching* as it takes place in the Klystron tube.

This Sperry tube converts DC energy into radio frequency energy by allowing an electron beam to become bunched, or pulsating, between spaced grids.

▶ **The ultra-high-frequency micro-waves thus generated can be concentrated into a narrow beam and directed with great accuracy.**

Various other forms of the Klystron have been developed by Sperry to aid in the amplification and reception of ultra-high-frequency waves. Today they are vital parts of many a device used by our Armed Forces.

The name "KLYSTRON" is a registered trade-mark of the Sperry Gyroscope Company, Inc. Like other Sperry devices, Klystrons are also being made during the emergency by other companies.

▶ **Klystrons are now being produced in quantities, and certain types are available. Write us for information.**

Sperry Gyroscope Company INC.

GREAT NECK, N. Y. • DIVISION OF THE SPERRY CORPORATION

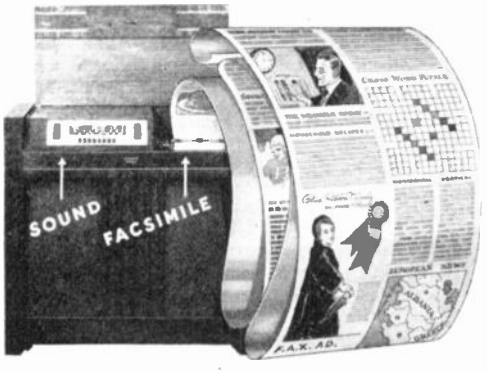
GYROSCOPICS • ELECTRONICS • AUTOMATIC COMPUTATION • SERVO-MECHANISMS

283 *Supply: Civil Estimates* HOUSE OF COMMONS *—Scientific Research* 284

From a speech in the House of Commons Spring-1944

Take a commodity which we all use—the newspaper. Do hon. Members realise that the newspaper as we know it to-day is completely obsolete? The newspaper of the future is going to be printed in our home by radio. It is completely obsolete to transport daily hundreds of tons of paper with news which will be stale when it reaches us when this news can be transported through the air. When you go to bed you will press a button on your radio set and according to you being a reader of the "Daily Express," the "Times" or the "Daily Herald." In the morning you will simply tear off your newspaper and read up to the minute news with features and photographs all ready for use. This apparatus, the "Finch Facimil," is in actual operation to-day and due to the genius of Commander Finch of the United States Navy, a scientist in telecommunication. Radio will go still further. It is going to give us a new method of travel. It will be obsolete to pack a bag and go into a train to board a ship and cross the sea to carry out our business. You will be able to detach your mind from your body for the purpose of business journeys. Park your body by the seaside and by your family and radio will detach your mind from your body and send it through the ether at the speed of light, carry out your business and bring it back with the same lightning speed.

"THE NEWSPAPER OF THE FUTURE WILL BE PRINTED BY *Radio!*"



Informed opinion abroad, as in America, is that newspapers of the future — however else they may be printed — will certainly be broadcast on paper by Facsimile, under basic Finch patents covering universal synchronization. At the time of Pearl Harbor, newspaper radio printing by Finch Synchronized Facsimile had already been found *practical* by more than a score of broadcasting stations. The new duplexing of sound and facsimile by FM promises to make it not only practical but *profitable*.

finch facsimile

FINCH TELECOMMUNICATIONS, INC., PASSAIC, NEW JERSEY

MATHEMATICAL THEORY VS. PHYSICAL CONCEPT

Emphasizing the Limitations of Mathematical Theory, and the Need of Physical Reasoning to Assure the Integrity of Conclusions

BY EDWIN H. ARMSTRONG*

IN THE invention of the FM system and its subsequent development, there is a fundamental lesson that ought to be brought home to the radio art. It is a lesson of much importance to the younger part of the engineering profession who, never in direct contact with the facts, of necessity get them second-hand from text books, technical journals, and writers of tales with axes to grind.

Anyone who has had actual contact with the making of the inventions that built the radio art knows that these inventions have been the product of experiment and work based on physical reasoning, rather than on the mathematicians' calculations and formulae. Precisely the opposite impression is obtained from many of our present-day text books and publications.

The invention of the FM system is an illuminating illustration of the point. This system gave a reduction of interfering noises of hundreds or thousands of times. It did it by proceeding in exactly the opposite direction that mathematical theory had demonstrated one ought to go to reduce interference. It widened instead of narrowed the band. And it employed a discarded method of modulation which also, in learned mathematical treatments, had been demonstrated to be totally useless or greatly inferior to amplitude modulation.

The student, picking up a text book or some analytical treatment of FM, does not get this picture. He finds, instead, a series of mathematical expressions almost totally divorced from any basis of physical reasoning. He gets the impression that he must learn to think in terms of trigonometrical functions, reams of calculations and tables of all sorts. Nothing could be more fantastic.

These writers, now knowing the result which the FM system produces, have merely set up new equations for it which "proves" that such a system eliminates noise. The effect, of course, is impressive. Yet if one looks back a few years one will find articles by some of these same writers, with other formulae, equally impressive, which proved that frequency modulation was quite useless. Seldom are these original treatments referred to, so that the impression has been created that in some magical way invention is connected with a bewildering maze of symbols and curves.

MAJOR Armstrong's observations on mathematical theory vs. physical reasoning are borne out by the demonstrated success of the FM system. This is a lesson which should be brought home to the many engineers who have entered the radio profession during the War and who, it is hoped, will remain to contribute further to the development of the radio art.

Without discounting the value of mathematics to science, it should be understood that the ability to see and sense physical concepts provides a dynamic approach to invention. Reliance on symbols and equations may create a scholarly atmosphere, but that is a static approach.

The vision of the man who works with physical concepts is limited only by his faith and the breadth of his experience.

Equations are inanimate and inflexible. They make no sounds. They do not change in temperature. Nor do they break down or come apart. They show no signs that point the way to improvement. As Major Armstrong warns, if mathematical theory is relied upon to the exclusion of physical reasoning, it may serve only to offer a choice of paths to the same ultimate error.

When the Editor of *FM* MAGAZINE suggested reprinting my original paper,[1] it occurred to me that an opportunity was at hand to point out the lesson that this invention and development teach. In that paper will be found the steps which bridged the gap between the discarded frequency modulation of the past and the frequency modulation system now in use and popularly referred to as "FM." The method employed was experimental, and was based entirely on physical reasoning.

In the historical treatment of the subject of frequency modulation in my original paper, the origin was traced back to some time after the invention of the Poulsen arc.[2] Exactly who first proposed and utilized the idea of signalling telephonically by means of a variation of the frequency — or wave length, as it was called in those days — is not clear. Reference is made to the subject in *Wireless Telegraphy and Telephony* by Mazzotto in 1906, and in *Wireless Telephony* by Ruhmer in 1907. Zenneck in his *Drahtlosen Telegraphie* in 1913, Fleming in his *Principles of Electric Wave Telegraphy and Telephony* in 1916, and Eccles in his *Wireless Telegraphy and Telephony* of the same year, all refer to it.

In 1918 in *Radio Telephony* by Goldsmith there appears the first definite stand to be taken against the use of frequency modulation. The following statement appears on page 11:

> "It is to be noted that a second method of radio telephony exists, which might be termed 'modulation by change of frequency (or wave length).' Instead of altering the amplitude of the radiated waves in accordance with the envelope speech curve, we might systematically increase and diminish the radiated frequency in proportion to the envelope curve. For example, while normally radiating at 50,000 cycles per second (6,000 meters wave length), we might alter the frequency say to 48,000 cycles at points corresponding to the peaks in

* Department of Electrical Engineering, Columbia University, New York City.

[1] See "The Original Disclosure of Frequency Modulation" by Edwin H. Armstrong, *FM* AND TELEVISION, June, July, August, 1944. This paper was originally presented before the Institute of Radio Engineers, New York City, Nov. 6, 1935.

[2] In the original paper all suggestions of signalling by altering the frequency, prior to the date of the Poulsen arc, were characterized as follows:

> "While there are some vague suggestions of an earlier date, it appears to have had its origin shortly after the invention of the Poulsen Arc. . . ."

The gap between a patent drawing showing a microphone attached to the oscillating circuit of a spark transmitter, and even the crude attempts to solve the modulation problem of the early Poulsen arc transmitter by varying its frequency, is too great to warrant their description in the same engineering terms. Many serious attempts were actually made to solve the problem of modulating the Poulsen arc by varying its frequency, and the method was used, although modulating its amplitude was the method eventually adopted.

A microphone connected across the oscillating circuit of the highly damped spark transmitter of those days was so incapable of producing any result properly associated with the name "modulation" that it was placed in the class of "vague suggestions." Anyone having any familiarity with the spark transmitters and the "tuned circuits" of the early days will appreciate the appropriateness of this classification. — *E. H. A.*

the audio frequency curve, to 49,000 cycles for points corresponding to halfway between peak and zero in the audio frequency curve, and so on. At the receiving station, the response in the detector circuit would then be proportional (or nearly so) to the speech curve in view of the tuning and detuning effects which would occur in the receiver as the rapidly varying frequency was received. This method permits keeping appreciably full load on the radio frequency generator at all times.

"It is the view of the writer that any such method is objectionable in that it distributes the radiated energy over a considerable range of wave lengths, thereby increasing the liability to interference with other stations. Furthermore, stray reduction will probably require the reception of a single sharply defined frequency."

Four years later Carson,[3] investigating the soundness of proposals to narrow the band required for the transmission of speech by means of frequency modulation, correctly exposed the fallacies of these proposals. He then went on to draw some further conclusions from his mathematics, which he expressed as follows:

"This system of modulation discriminates against high frequencies and therefore inherently introduces distortion,"

and further:

"This type of modulation inherently distorts without any compensating advantages whatever."

Seven years later, in 1929, Roder, investigating the same subject, arrived at the same erroneous conclusion concerning distortion. Writing in the *Telefunken Zeitung*, No. 53, in an article entitled "Über Frequenz-Modulation," he introduces his subject with the following statement:

"It is expected that frequency modulation will result in diminishing the width of the frequency band needed for telephone transmission. The theory shows that this is not the case. On both sides of the carrier wave a great number of side bands appear, being spaced from one another the distance of the low frequency.[4] Added to this distortion of the low frequency are amplitude distortions, so that this process is not suitable for telephonic transmission."

After reviewing Carson's mathematical treatment and following it with one of his own, Roder concludes:

"In recapitulation we may therefore state: The above characterized process of frequency modulation results in side bands on either side of the carrier wave, spaced from each other the distance μ, so that modulated frequencies μ, 2μ, 3μ, etc., appear. To these distortions of the low frequency are added distortions of the amplitude, so that this process is entirely unsuitable for telephonic transmitters."

In an article in the December, 1931 *Proceedings of the Institute of Radio Engineers* entitled "Amplitude, Phase and Frequency Modulation" the same writer re-examined the subject of distortion and stated the following conclusion:

"Since in phase and frequency modulation the amplitude of the radio frequency does not change, it is possible to operate the amplifier tubes at their full rated output and at good efficiency. This means that for a given tube in a phase or frequency modulated circuit the unmodulated carrier energy would be from 4 to 6 times as great as for the same tube amplitude modulated. This looks very advantageous for phase or frequency modulation, but represents only one portion of the analysis. Taking the receiver into account, we find that the signal has to be made audible, or in other words the modulation vector representing the set of first side bands has to be shifted by 90 degrees. Apart from the distortion inherent to such an operation when applied to a wide range of audio frequencies, it is evident that simultaneously a considerable loss in percentage modulation must be encountered. Thus, the efficiency and output which is gained in the transmitter is partly or totally lost at the receiver."

The rest of Roder's paper is devoted to the subject of how to eliminate undesired phase or frequency modulation from an amplitude modulated transmitter.

In 1932, in *Radio Engineering* by Terman, the following statement appeared:

"Frequency modulation is not particularly satisfactory as a means of transmitting intelligence. The frequency band is at least as great as that employed with amplitude modulation and is in general somewhat greater. Furthermore, the amplitude of the side-band components depends upon the signal frequency, so that the modulation index m_f is inversely proportional to the signal (audio) frequency. Thus, if the amplitude of the audio frequency is kept constant while the frequency is varied, the modulation index and hence the amplitude of the intelligence-carrying side bands will decrease as the signal frequency becomes greater, thus introducing distortion. The only advantage of frequency modulation is the ease with which it can be applied to high-power short-wave transmitters."

In 1933, in *High Frequency Measurements* by Hund in his treatment of modulation phenomena the subject is introduced with the following statement:

"Since a high-frequency current is characterized by its amplitude, frequency and phase, such a current can be modulated by amplitude and frequency as well as by phase changes. Though procedures for amplitude and frequency modulation were already known in the earliest days of radio, they are again being discussed because it has been thought that the width of the frequency channel for the transmission of speech and music could be made narrower if frequency modulation were employed. Phase modulation is usually an undesirable by-product, although there is no reason why it should not be used to advantage. A thorough understanding of the underlying principles and the actions of the three types of modulations is important and methods are given whereby all types of modulations can be determined from measurements under actual conditions. . . ."

Note the emphasis on "a thorough understanding of the underlying principles and the actions."

The author then proceeds with a treatment of the subject of some twenty-five pages, largely mathematical in character. The status of frequency modulation as of that date is set down by the author in the following words:

"It *is* the *phase relationship* and *not the width of the band* where frequency modulation differs fundamentally from amplitude modulation. Therefore, it is necessary that a circuit be inserted between the receiving aerial and the tube with a curved work characteristic which translates frequency modulation partially into amplitude variation. This can be readily done by using a *CL* circuit[5] which is *not* tuned to resonance with the carrier frequency F about which frequency modulations $\pm f$ take place, but on a suitable point P of the ascending or descending portion of the resonance curve (Fig. 301). The current in the *CL* circuit will then fluctuate between a maximum and minimum value about the value I, corresponding to the unmodulated carrier frequency F. Of course, this can also be done directly in the sender arrangement or in the sender as well as the receiver."

In 1935, in *Measurements in Radio Engineering* by Terman, the following appraisal of the usefulness of frequency modulation is made:

"Frequency and phase modulation are important because they often occur as undesired by-products of amplitude modulation. Frequency and phase modulation are essentially the same as far as the results are concerned, although produced by different faults in the transmitter."

In a paper published in the May, 1935 *Proceedings of the Institute of Radio Engineers*, by Chaffee, entitled "Detection of Frequency Modulated Waves," a wide-

[3] Notes on the Theory of Modulation," *Pro. I. R. E.*, February 1922.

[4] NOTE: By the term "low frequency" Roder is referring to the modulation frequency. — *E. H. A.*

[5] NOTE: The "CL circuit" referred to above is the ordinary tuned circuit. — *E. H. A.*

band frequency modulation system is compared with an amplitude modulation system, and the conclusion is reached that with an oscillator of the Barkhausen-Kurtz type the two systems give identical results. Regarding the ordinary type of oscillator, the following statement is made:

"If the conventional type of oscillator had been employed, the transmitter could not have been operated continuously at peak output during frequency modulation. In this case the unmodulated output of the transmitter would have been the same in the two instances, and the amplitude modulation system would have produced four times as much fundamental amplitude as the other system. This disparity could be remedied by increasing the high frequency gain of the receiver by six decibels."[6]

When the FM paper was presented before the Institute of Radio Engineers in November, 1935, no adverse discussion took place, yet little heed seems to have been paid to its findings. Perhaps the weight of outstanding authority against them at the time was too heavy.

Hence, in 1937, in *Radio Engineering* by Terman, appeared the statement:

"Frequency modulation is not particularly satisfactory as a means of transmitting intelligence. The frequency band is at least as great as that employed with amplitude modulation, and is in general somewhat greater. Also, the reception of frequency modulated signals is not so simple a matter as the reception of amplitude modulated waves."

In 1937, in *Communication Engineering* by Everett, appears the statement:

"While frequency and phase modulation have been used intentionally to only a limited extent, they are of importance because of the fact that they frequently occur unintentionally."

During 1937, however, the period of recantation arrived, brought about principally by the demonstrations carried on from Station W2AG in Yonkers, N. Y. The power of this station had been increased substantially since November 1935 and the quality of reproduction improved to a degree quite beyond anything before heard on the air.

In the May, 1937 issue of *Electronics* appeared an article by Roder (who had witnessed some W2AG demonstrations) entitled "Noise in Frequency Modulation: The first published mathematical demonstration of the validity of the noise-suppression effect in wide-band frequency modulation, by one of the outstanding authorities on modulation theory, which shows the necessity of a wide band and of proper 'limiter' action." The following is quoted from the introductory paragraph:

"The proposal to use frequency modulation in place of amplitude modulation was made early in radio development, but the hope of obtaining thereby greatly reduced band-widths was shattered in 1922 when Carson published his fundamental analysis. Despite his adverse criticism, much experimental research was done in the following years. In 1936, Major E. H. Armstrong announced and demonstrated the phenomenon of noise suppression with wide-band frequency modulation. This effect was made possible by the use of the ultra-high frequencies, which permitted the use of a band-width about 10 times greater than customary in amplitude modulation. The explanation of the noise-suppression effect has not, to the author's knowledge, been given a simple and satisfactory treatment. In view of the contrast between the predictions of earlier theories and the recent experimental results, it is desirable to extend the theory to the field of ultra-high frequencies and to greatly extended side-band coverage, as has been done in the practical attack on the problem."

Again, Roder, writing in the *Proceedings of the Institute of Radio Engineers* for December, 1937, in an article entitled "Effects of Tuned Circuits Upon a Frequency Modulated Signal" makes the following statement in the introductory paragraph:

"The principle of frequency modulation, which was repeatedly proposed and discussed during the last fifteen years in radio publications, has recently again aroused great interest. The fact that wide-band frequency modulation possesses the unique property of practically eliminating interfering signals and interfering noises, provided the interference is not excessively strong, threw an entirely new light on this type of modulation and indicated that wide-band frequency modulation might possibly some day serve to provide a high fidelity broadcast transmitting system at ultra-high frequencies practically unaffected by interference from static or man-made noise and from other signals."

The final paragraph contains the following appraisal of FM's future:

"The writer takes pleasure in expressing his thanks to Dr. W. R. G. Baker and Mr. I. J. Kaar for their helpful interest in a subject as remote at present from practical application as the one above. . . ."

The high point in intellectual integrity during this period, however, appears in the *Bell System Technical Journal* issue of October, 1937, in an article entitled "Variable Frequency Electric Circuit Theory With Application to the Theory of Frequency Modulation" by Carson and Fry, from which the following is quoted:

"Frequency modulation was a much talked of subject twenty or more years ago. Most of the interest in it then centered around the idea that it might afford a means of compressing a signal into a narrower frequency band than is required for amplitude modulation. When it was shown that not only could this hope not be realized, but that much wider bands might be required for frequency modulation, interest in the subject naturally waned. It was revived again when engineers began to explore the possibilities of radio transmission at very short wave lengths where there is little restriction on the width of the frequency band that may be utilized.

"During the past eight years a number of papers have been published on frequency modulation, as reference to the attached bibliography will show. That by Professor E. H. Armstrong deals with this subject in comprehensive fashion. In his paper the problem of discrimination against extraneous noise is discussed, and it is pointed out that important advantages result from a combination of wide frequency bands together with severe amplitude limitation of the received signal waves. His treatment is, however, essentially non-mathematical in character, and it is therefore believed that a mathematical study of this phase of the problem will not be unwelcome. This the present paper aims to supply by developing the basic mathematics of frequency modulation and applying it to the question of noise discrimination with or without amplitude limitation.

"The outstanding conclusions reached in the present paper, as regards discrimination against noise by frequency modulation, may be briefly summarized as follows:

"(1) To secure any advantage by frequency modulation as distinguished from amplitude modulation, the frequency band width must be much greater in the former than in the latter system.

"(2) Frequency modulation in combination with severe amplitude limitation for the received wave results in substantial reduction of the noise-to-signal power ratio. Formulas are developed which make possible a quantitative estimate of the noise-to-signal power ratio in frequency modulation, with and without amplitude limitation, as compared with amplitude modulation."

From this time on a number of writers appear to have had difficulty in facing the facts. Once again the men who think in terms of symbols and formulae are undertaking to become the prophets of the art. Thus, in 1942, in Hund's *Frequency Modulation*, under the heading "The Armstrong Indirect FM Transmitter," appears the following statement:

(CONTINUED ON PAGE 36)

[6] NOTE: At a signal-to-noise power ratio loss of four or the frequency modulation system. — *E. H. A.*

PANEL 6 OF RTPB REPORTS ON TELEVISION

Scope of Television Planning Is Disclosed in Requests for Frequencies Up to 10,000 Mc.

DISCUSSIONS of Panel 6 (television), running into hundreds of pages contained in 10 bound volumes, have been boiled down to specific recommendations for television standards and frequency allocations, and have been submitted to the Radio Technical Planning Board. It is not known, of course, what modifications will be made in these recommendations before they are passed on to the FCC.

In an accompanying letter to Dr. W. R. G. Baker, chairman of RTPB, signed by David B. Smith (Philco), chairman of Panel 6, it is stated that: "We believe that the program outlined in this report will provide a sound basis for postwar commercial broadcasting as well as for further development of the television art. In formulating this report, all technical matters relating to television standards and frequency allocations have been reviewed in the light of the best present-day knowledge. . . .

"In sending you this report at this time, we have been motivated by the feeling that it is essential that the pattern for postwar television be determined as soon as possible. It is our hope that by the time the industry can again take up problems of design and manufacture of television equipment, the standards and allocations will have been finally determined, and that nothing will stand in the way to prevent a rapid growth of a major industry."

Organization of Panel 6 ★ To facilitate handling the various problems that Panel 6 has been called upon to consider, six committees were established. These are:

COMMITTEE NO. 1 — TELEVISION CHANNEL

Chairman, D. E. Harnett (Hazeltine)
Vice chairman, Robert Shelby (NBC)

(a) To consider in general terms what new channels are needed and why.

(b) To determine what channels to standardize now.

(c) To make recommendations for band widths and possible deluxe service on higher channels.

(d) To determine a policy for color television.

COMMITTEE NO. 2 — SYNCHRONIZATION STANDARDS AND VIDEO MODULATION

Chairman, T. T. Goldsmith (Du Mont)
Vice chairman, A. V. Loughren (Hazeltine)

(a) Final resolution of synchronization standards.

(b) Final resolution of the question of AM vs. FM for video modulation.

COMMITTEE NO. 3 — REVIEW OF OLD STANDARDS AND PROPOSED NEW STANDARDS

Chairman, Dr. George Town (Stromberg-Carlson)
Vice chairman, D. G. Fink (Pentagon Bldg.)

(a) Reexamination of the NTSC standards for modification or ratification (except those specifically allocated to other Committees).

(b) Consideration of any suggested new standards.

(c) Consideration of the transmitter-receiver relationship.

COMMITTEE NO. 4 — FREQUENCY ALLOCATIONS AND SERVICE LIMITS

Chairman, B. R. Cummings (Farnsworth)
Vice chairman, R. Serrell (C.B.S.)

(a) Recommendations as to specific new channels in line with the policy of Committee No. 1.

(b) Establishment of technical values for service limits and service areas.

(c) Technical policy for allocations between cities.

COMMITTEE NO. 5 — STANDARDS OF GOOD ENGINEERING PRACTICE FOR TELEVISION TRANSMITTERS

Chairman, J. E. Brown (Zenith)
Vice chairman, J. R. Poppele (WOR)

(a) Specifications for sound modulation, frequency, fidelity, and distortion limits.

(b) Video modulation and distortion specifications.

(c) Recommended methods of measurements.

COMMITTEE NO. 6 — RELAY LINKS

Chairman, F. J. Bingley (Philco)
Vice chairman, H. B. Fancher (G.E.)

(a) Standards for establishing studio-to transmitter link systems.

(b) Standards for portable pickup radio link systems.

Frequencies Requested ★ The distribution of the 6-mc. bands requested is shown in the accompanying chart which also indicates the present allocations from 40 to 300 mc. It will be noted that Panel 6 does not suggest any change in the existing allocation of amateur bands. This is in accord with the policy expressed by the ARRL that they will not ask any additional frequencies, but the implication is that they are ready to go to the mat with anyone who proposes to take away what they now have.

In addition to the television bands marked out on the chart, Panel 6 has asked for frequencies for other services. The whole range of proposed bands has been classified by groups, in the following manner:

Group A: About 40 mc. to 162 mc.

13 channels, 6 mc. wide, are requested for immediate use for television broadcasting.

Group B: 162 mc. to 300 mc.

13 channels, 6 mc. wide, to be used at present for television relay transmission. Subsequently, these channels would be made available for television broadcasting, and the relay services moved up into Group C or D.

Group C: 300 mc. to 1,000 mc.

20 channels, 10 mc. wide, for television relay service.

Group D: 1,000 mc. to 3,000 mc.

20 channels, 20 mc. wide, for relays and deluxe broadcast service.

Group E: 3,000 mc. to 10,000 mc.

60 channels, 20 mc. wide, for experimental work on relays, high-definition broadcasting, and theatre television.

Group F: 10,000 mc. and above

An unspecified number of 20-mc. channels, for experimental and developmental purposes.

These requests add up to 52% of all frequencies below 300 mc., and 18% of all frequencies from 300 to 10,000 mc.

Frequency Stability ★ The question of frequency stability of both transmitters and receivers will undoubtedly receive much attention from research engineers in the postwar period. That is because the percentage of drift which has been allowed for operation below 50 mc. approaches a substantial part of the total width of a channel at frequencies of 1,000 mc. or more.

The degree of stability recommended by Panel 6 is .01% for carriers below 300 mc., and .02 for carriers above 300 mc. At 200 mc., for example, this would represent a permissible carrier drift of .04 mc., or .2 mc. at 500 mc.

Standards for Commercial Broadcasting ★ The following specific recommendations have been submitted to the RTPB by Panel 6:

1. The width of the standard broadcast channel shall be six megacycles.

2. It shall be standard to locate the visual carrier 4.5 megacycles lower in frequency than the unmodulated aural carrier.

3. It shall be standard to locate the unmodulated aural carrier 0.25 megacycles lower than the upper frequency limit of the channel.

4. The standard visual transmission amplitude characteristic shall be that shown in Drawing 1, Report of Committee 3.

5. The standard number of scanning lines per frame period shall be 525, interlaced two to one.

6. The standard frame frequency shall be 30 per second and the standard field frequency shall be 60 per second.

7. The standard aspect ratio of the transmitted television picture shall be 4 units horizontally to 3 units vertically.

8. It shall be standard, during active scanning intervals, to scan the scene from left to right horizontally and from top to bottom vertically, at uniform velocities.

9. It shall be standard in television transmission to modulate a carrier within a single television channel for both picture and synchronizing signals, the two signals comprising different modulation ranges in amplitude.

10. It shall be standard that a decrease in initial light intensity cause an increase in radiated power.

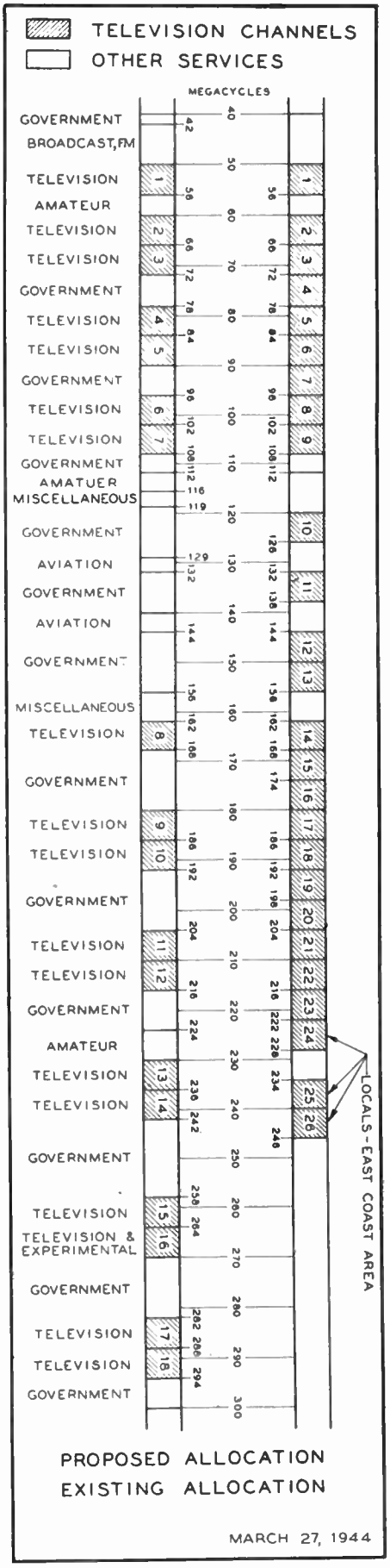
11. It shall be standard that the black level be represented by a definite carrier level, independent of light and shade in the picture.

12. It shall be standard to transmit the black level at 75 per cent (with a tolerance of plus or minus 2.5 per cent) of the peak carrier amplitude.

13. It shall be standard to use frequency modulation for the television aural transmission with a maximum frequency swing of 25 kilocycles.

14. It shall be standard to pre-emphasize the aural transmission in accordance with the impedance-frequency characteristic of a series inductance-resistance network having a time constant of 50 microseconds.

15. It shall be standard in television broadcast transmission to radiate a signal in conformity with the drawing "Television Synchronizing Waveform," Committee 2, Panel 6, RTPB, March 15, 1944, as modified by vestigial sideband operation as specified in Drawing I of the FCC Standards of Good Engineering Practice, dated April 30, 1941.



16. It shall be standard that the time interval between the leading edges of successive horizontal pulses shall vary less than one half of one per cent of the average interval.

17. It shall be standard in television transmission that the rate of change of the frequency of recurrence of the leading edges of the horizontal synchronizing signals be not greater than 0.15 per cent per second, the frequency to be determined by an averaging process carried out over a period of not less than 20, nor more than 100 lines, such lines not to include any portion of the vertical blanking signal.

18. It shall be standard to rate the visual transmitter in terms of its peak power when transmitting a standard television signal.

19. It shall be standard in the modulation of the visual transmitter that the radio frequency signal amplitude be 15 per cent or less of the peak amplitude, for maximum white.

20. It shall be standard to employ an unmodulated radiated carrier power of the aural transmission not less than 100% nor more than 150% of the peak radiated power of the picture transmission.

21. It shall be standard in television broadcasting to radiate signals having horizontal polarization.

It should be noted that the recommendations of any RTPB Panel are subject to modification by the RTPB, before they are submitted to the FCC. Then they will be made the subject of an FCC hearing. Consequently there is no telling what changes will be made in the standards before their official adoption, or what frequencies will be actually assigned.

It is hoped, however, that the final RTPB television report will be in the hands of the FCC before September 28th, opening day of the hearing at which the present and future needs of the various non-governmental services will be considered.

This is of the utmost importance to the television industry, for anything that prevents the immediate settlement of television frequency assignments may result in postponing indefinitely the initial production of receiving sets and the erection of transmitters.

The FCC has recognized this urgent need in its order for the hearing, stating that "it is essential in the interest of orderly planning that frequency allocations be determined before the manpower, materials, and manufacturing facilities now devoted to war production become available for production of civilian equipment."

286 FM STATIONS NOW OPERATING OR PROJECTED

39 States, Representing 167 Cities, Are Included in This Roster, Corrected to August 14, 1944

ALABAMA

Birmingham

	Call	Sq. Mi.	Mc.
Birmingham News Co		17,700	44.5
Voice of Ala Inc		17,200	45.9

Mobile

Pape Bestg Co		10,000	46.1

Montgomery

Montgomery Bestg Co Inc		17,299	43.5
G W Covington Jr (WCOV)		4,761	45.5

CALIFORNIA

Fresno

J E Rodman (KFRE)		24,752	44.1

Hollywood

C B S Inc		34,000	43.1

Los Angeles

Univ of Southern Calif			42.9
Blue Network Co Inc		21,024	43.1
Earle C Anthony Inc (KECA KFI)		34,000	43.7
N B C Inc			44.1
Don Lee Bestg Sys (KHJ)	KHJ-FM		44.5
Standard Bestg Co (KFVD)		7,000	45.3
Cons Bestg Corp Ltd		7,000	45.7
MGM Studios Inc			46.1

Oakland

Tribune Bldg Co (KLX)		1,216	46.5

Riverside

Bestg Corp of Amer (KPRO)		48,000	43.5

San Bernardino

High School District (Ed)		250 w	42.9
Sun Co of San Bernardino		17,101	44.1

San Francisco

Board of Education (Ed)	KLAW		42.1
Associated Bestrs Inc (KSFO)			43.1
Don Lee Bestg Sys (KFRC)		18,050	43.5
N B C Inc (KPO)			43.9

Stockton

E F Peffer (KGDM)		19,696	45.9

Ventura

Supt of County Schools (Ed)		1 kw	

COLORADO

Denver

KLZ Bestg Co (KLZ)		31,400	43.5
Satellite 100 w			43.5
N B C Inc (KOA)			43.9

CONNECTICUT

Hartford

Hartford Times Inc (WTHT)		21,900	43.7
Travelers Bestg Svc Corp (WTIC)	WTIC-FM	6,100[1]	45.3[1]
WDRC Inc (WDRC)	WDRC-FM		46.5

[1] Application filed to change to 15,563 sq. mi., 43.3 mc.

New London

Thames Bestg Co (WNLC)		3,500	44.5

DELAWARE

Wilmington

WDEL Inc (WDEL)		6,400	44.5

DISTRICT OF COLUMBIA

Washington

Jansky & Bailey (Exp)	W3XO	1 kw	43.2
N B C Inc (WRC)			44.3
Times Herald			46.3
Capital Bestg Co (WWDC)		8,020	46.7
Eve Star Bestg Co (WMAL)		5,600	47.1

FLORIDA

Jacksonville

Florida Bestg Co (WMBR)		11,700	44.7

Miami

Miami Bestg Co		3,630	46.5

Tampa

Tribune Co (WFLA)			

GEORGIA

Atlanta

Board of Education (Ed)		1 kw	42.5
Constitution Pub Co		7,380	45.3

ILLINOIS

Bloomington

WJBC Radio Station		6,660	45.3

Chicago

Board of Education (Ed)	WBEZ		42.5
Agricultural Bestg Co		10,624	44.7
WJJD Inc (WJJD)		10,800	44.7
Zenith Radio Corp	WWZR	10,800	45.1
WGN Inc (WGN)	WGNB	10,800	45.9
N B C Inc (WMAQ)		10,800	46.3
C B S Inc (WBBM)	WBBM-FM	10,800	46.7
Moody Bible Inst	WDLM		47.5
Chicago Fed of Labor (WCFL)		10,800	47.9
Oak Park Real & Am Co		10,800	47.9
WHFC Inc (WHFC)			48.3
Blue Network Co Inc (WENR)		11,000	48.7
Drovers Journal Pub Co. (WAAF)		10,800	48.7

Decatur

Commodore Bestg Inc (WSOY)		15,708	46.5

Evanston

Board of Education (Ed)			

Macomb

W Ill State Teachers Col (Ed)		1 kw	

Peoria

Peoria Bestg Co (WMBD)		11,613	48.7

Quincy

Illinois Bestg Corp (WTAD)		15,300	44.1

Rockford

Rockford Bestrs Inc (WROK)		3,900	47.1

Rock Island

Rock Island Bestg Co (WHBF)		3,000	44.5

Springfield

WCBS Inc		12,918	46.1
Commodore Bestg Inc		8,050	49.9

Urbana

Board of Education (Ed)	WIUC		42.9

INDIANA

Bloomington

Indiana Univ (Ed)			42.9

Evansville

Evansville on the Air	WMLL		44.5

Fort Wayne

Westinghouse Radio Stations Inc	WOWO-FM		44.9

Hammond

WJOB Radio Station (WJOB)		2,241	49.9

Indianapolis

Indianapolis Bestg Inc (WIRE)		13,640	45.3
Assoc Broadcasters Inc			47.3
WFBM Inc (WFBM)		15,430	47.7
Capitol Bestg Corp (WISH)		14,120	48.7

Muncie

Donald A Burton (WLBC)		9,600	46.5

Shelbyville

Shelbyville Radio Inc		3,730	46.1

South Bend

South Bend Tribune	WSBF		47.1

Terre Haute

Banks of Wabash Inc		7,440	48.7

West Lafayette

Purdue University (Ed)			42.7

IOWA

Cedar Rapids

Gazette Co		7,400	44.7

Davenport

Tri-City Bestg Co		7,400	46.3

Des Moines

Central Bestg Co (WHO)		18,200	46.1

Dubuque

Telegraph Herald (KDTH)		8,060	46.5

Waterloo

Josh Higgins Bestg Co (KXEL)		26,943	44.3

KANSAS

Lawrence

Univ of Kansas (Ed)		1 kw	42.9

KENTUCKY

Ashland

Ashland Bestg Co (WCMI)		4,160	46.1

Beattyville

Univ of Ky (Ed)	WBKY		42.9

Lexington

Amer Bestg Corp of Ky		6,300	45.1

Louisville

	Call	Sq. Mi.	Mc.
Courier-Journal, L'v'le Times		13,200	45.5
Northside Bestg Corp		8,665	46.3

Owensboro

Owensboro Bestg Co		7,250	47.9

LOUISIANA

Baton Rouge

Baton Rouge Bestg Co	WBRL		44.5

New Orleans

Times Picayune Pub Co			44.3
Loyola Univ (WWL)		8,478	44.9

MAINE

Portland

Portland Bestg Sys Inc (WGAN)		3,980	47.1

Augusta

Gannett Pub Co Inc		3,968	49.1

MARYLAND

Baltimore

Hearst Radio Inc		8,857	43.7
Balt Radio Show Inc (WFBR)		5,500	45.9
Monumental Radio Co (WCAO)		4,520	47.9
Baltimore Bestg Corp		3,600	48.3
Maryland Bestg Co (WITH)		2,904	48.9

Olney

FM Devel Foundation		18,844	43.9

Salisbury

Peninsula Bestg Co (WBOC)		6,000	48.9

MASSACHUSETTS

Boston

E Anthony & Sons Inc		19,650	43.5
C B S Inc (WEEI)		20,200	43.5
Yankee Network	WGTR		44.3
Worcester Tele Pub Co		7,000	45.3
Westinghouse Radio Stations Inc (WBZ)	WBZ-FM		46.7
Matheson Radio Co Inc (WHDH)		3,600	47.7

Fall River

Doughty & Welch Elec Co		2,120	47.3

Holyoke

Hampden-Hampshire Corp (WHYN)		14,340	44.1

Lawrence

Hildreth & Rogers Co (WLAW)		2,970	44.9

New Bedford

E Anthony & Sons Inc (WNBH)		1,787	45.7

Pittsfield

Monroe B England (WBRK)		950	45.7

Springfield

Westinghouse Radio Stations Inc (WBZA)	WBZA-FM		48.1

Worcester

Worcester Tele Pub Co (WTAG)	WTAG-FM		46.1[1]

[1] Application has been made for new station on 43.5 mc., 20,437 sq. mi.

MICHIGAN

Battle Creek

Federated Pubs Inc (WELL)		4,100	48.1

Benton Harbor

Palladium Pub Co		1,825	46.1

Dearborn

Herman Radner (WIBM)			49.5

Detroit

Board of Education (Ed)		1 kw	42.7
Evening News Assn (WWJ)	WENA		44.5
John Lord Booth (WMBC)	WLOU		44.9
WJR Goodwill Station (WJR)		6,800	45.3
James F Hopkins Inc (WJBK)		6,790	46.5
King-Trendle Bestg Corp		6,750	47.3

Grand Rapids

Fetzer Bestg Co		18,250	43.9
Leonard A Versluis		6,460	46.1
King-Trendel Bestg Corp		5,300	46.9

Jackson

Board of Education (Ed)			
WIBM Inc (WIBM)			49.5

Kalamazoo

West Mich Col of Ed (Ed)			42.5

Lansing

	Call	Sq. Mi.	Mc.
WJIM Inc (WJIM)		3,800	47.7

Mt. Pleasant

Board of Education (Ed)			

Muskegon

Ashbacker Radio Corp (WKBZ)		2,290	45.7

Port Huron

Times, Herald Co		5,600	47.7

Saginaw

Saginaw Bestg Co (WSAM)		2,100	45.5

MINNESOTA

St. Paul

WMIN Bestg Co		13,273	45.7

MISSOURI

Clayton

School District (Ed)		1 kw	

Kansas City

School District (Ed)		1 kw	42.5
Commercial Radio Equip Co	KOZY		44.9
Midland Bestg Co (KMBC)	KMBC-FM	6,700	46.5

St. Joseph

KFEQ Inc (KFEQ)			46.9

St. Louis

Star-Times Pub Co (KXOX)		13,083	44.7
St Louis Univ (WEW)		13,000	45.1
Missouri Bestg Corp		13,200	45.1
Pulitzer Pub Co (KSD)		13,391	45.5
C B S Inc		13,400	45.9
Globe-Democrat Pub Co		13,083	46.3

NEBRASKA

Omaha

World Pub Co (KOWH)		11,660	45.5

NEVADA

Las Vegas

Nevada Bestg Co		560	49.5

NEW HAMPSHIRE

Manchester

Radio Voice of N H Inc (WMUR)		31,630	43.5

Mt. Washington

Yankee Network	WMTW		43.9

NEW JERSEY

Jersey City

Bremer Bestg Co			49.5

Newark

Board of Ed (Ed)			42.5
N J Bestg Corp (WHOM)		6,200	49.1

Patterson

N Jersey Bestg Co Inc		4,928	49.9

Trenton

Mercer Bestg Co		3,200	49.9

NEW YORK

Albany

WOKO Inc (WOKO)		7,164	45.1

Binghampton

Wylie B Jones Advt Agency (WNBF)	WNBF-FM		44.9

Brooklyn

Frequency Bestg Corp		14,400	43.7

Buffalo

Board of Education (Ed)			42.9
WEBR Inc (WEBR)		3,420	46.5

Floral Park

Sewanhaka High School (Ed)			

Ithaca

Cornell University (WHCU)		15,000	43.3

Jamestown

James Bestg Co			46.1

New York

Board of Education (Ed)	WNYE		42.1
Edwin H Armstrong (Exp)	W2XMN		43.1
Municipal Bestg Sys (WNYC)	WNYC-FM		43.9
Musak Corp	WGYN		44.7
N B C Inc	W2XMN		45.1
WGH Finch			45.1
Marcus Loew Bkg Agency (WHN)	WHNF		46.3
C B S Inc (WABC)	WABC-FM		46.7
Bamberger Bestg Svc (WOR)	WBAM		47.1
Metro Television Inc	WABF		47.5
Amer Network Inc		8,840	47.9
Blue Network Inc (WJZ)		8,950	47.9
News Syndicate Co Inc		8,500	47.9
WBNX Bestg Co Inc (WBNX)		8,730	48.3
WMCA Inc (WMCA)		8,550	48.3
Hearst Radio Inc (WINS)		8,570	48.7
Debs Mem Radio Fund Inc		8,600	48.7
Greater N Y Bestg Corp		8,500	48.7

Ogdensburg

St Lawrence Bestg Corp			

Poughkeepsie

P'kpsie Newspapers Inc		10,198	44.3

Rochester

WHEC Inc (WHEC)	WHEF		44.7
Stromberg-Carlson Tel Co (WHAM)	WHFM		45.1

Schenectady

Capitol Bestg Co	WBCA		44.7
General Electric Co	WGFM		48.5

Syracuse

	Call	Sq. Mi.	Mc.
Onondaga Radio Bestg Corp		6,745	45.9
Central N Y Bestg Corp (WSYR)		6,800	46.3

Utica

WIBX Inc		10,290	45.7

Watertown

Brockway Co (WWNY)		4,145	47.3

White Plains

Westchester Bestg Corp (WFAS)		435	49.9

NORTH CAROLINA

Durham

Durham Radio Corp (WDNC)			

Greensboro

N C Bestg Co Inc		13,200	43.9

Raleigh

WPTF Radio Co (WPTF)		23,343	43.3

Winston-Salem

Gordon Gray	WMIT		44.1
Piedmont Pub Co (WSJS)		4,600	46.7
Wm Henry Alford			

NORTH DAKOTA

Grand Forks

University of N D (Ed)			

OHIO

Akron

Summit Radio Corp (WAKR)		922	46.5

Ashland

Beer & Koehl		8,494	48.9

Astabula

WICA Inc (WICA)		4,116	48.9

Canton

Ohio Bestg Co		8,499	46.1

Cincinnati

Crosley Corp (WLW) (Exp)	W8XFM	13,700	45.5
L B Wilson Inc (WCKY)		13,700	45.9
Cin Times Star Co		13,700	46.7

Cleveland

Board of Education (Ed)	WBOE		42.5
N B C Inc (WTAM)			43.7
WGAR Bestg Co (WGAR)		8,500	45.5
United Bestg Co (WCLE WHK)		8,420	48.5

Columbus

Central Ohio Bestg Co		21,010	43.1
WBNS Inc (WBNS)	WELD		44.5
Crosley Corp		12,400	46.5
United Bestg Co (WHCK)		12,400	48.1

Dayton

Crosley Corp		8,000	46.1

Steubenville

Valley Bestg Co (WSTV)			

Toledo

Toledo Blade Co		8,400	44.5

Wooster

Wooster Rep Ptg Co		7,780	49.3

Youngstown

WFMJ Bestg Co (WFMJ)		15,610	44.1

OKLAHOMA

Oklahoma City

Plaza Court Bestg Co (KOCY)		15,394	
WKY Radiophone Co (WKY)		21,000	44.5

Tulsa

Fred Jones Bestg Co		22,000	45.3
World Pub Co, Tulsa Tribune Co		23,850	45.7

OREGON

Portland

Oregonian Pub Co		13,382	46.1
Bestrs Oregon Ltd		5,826	48.5

PENNSYLVANIA

Bethlehem

Associated Bestrs Inc (WEST)		2,800	48.5

Easton

Associated Bestrs Inc		2,800	48.5

Harrisburg

Keystone Bestg Corp (WKBO)		4,000	44.7

Lancaster

WGAL Inc (WGAL)		1,200	45.5

Philadelphia

Penn Bestg Co (WIP)	WIP-FM		44.9
WFIL Bestg Co (WFIL)	WFIL-FM		45.3
Westinghouse Radio Stations Inc (KYW)	KYW-FM		45.7
Gibraltar Sve Corp		9,318	46.1
WCAU Bestg Co (WCAU)	WCAU-FM		46.9
Wm Penn Bestg Co (WPEN)	WPEN-FM		47.3
WDAS Bestg Station Inc (WDAS)		9,300	47.7

Pittsburgh

Liberty Bestg Co			
Walker-Downing Corp (WWSW)	WTNT		44.7
WCAE Inc (WCAE)		8,650	45.5
Pitts Radio Sup House (WJAS)		8,400	46.5
Westinghouse Radio Stations Inc (KDKA)	KDKA-FM		47.5

Reading

	Call	Sq. Mi.	Mc.
Hawley Bestg Co		4,275	46.5

Scranton

Scranton Bestrs Inc		19,557	48.1

Sharon

Sharon Herald Bestg Co (WPIC)		11,030	45.9

Uniontown

Fayette Bestg Corp		10,240	48.1

Wilkes-Barre

Louis G Baltimore (WBRE)			

Williamsport

WRAK Inc		11,675	47.7

York

Susquehanna Bestg Co (WSBA)		3,060	44.5
York Bestg Co (WORK)		1,550	45.1

RHODE ISLAND

Pawtucket

Pawtucket Bestg Co		3,760	45.1

Providence

A A Schechter		3,950	45.1
Cherry & Webb Bestg Co (WPRO)		6,207	47.5
Outlet Co (WJAR)		6,412	48.5

SOUTH CAROLINA

Charleston

Atlantic Coast Bestg Co		6,400	47.7

Spartanburg

Spartanburg Adv Co (WSPA)		26,600	43.5

TENNESSEE

Knoxville

Amer Bestg Corp (WBIR)		3,230	45.1

Nashville

Ntl Life & Acc Ins Co (WSM)	WSM-FM		44.7
Nashville Radio Corp		16,000	46.5

TEXAS

Abilene

Reporter Bestg Co		6,936	45.7

Amarillo

Amarillo Bestg Corp (KFDA)		5,600	45.1

Beaumont

KRIC Inc (KRIC)		6,650	43.1

Dallas

A H Belo Corp		22,700	43.7
KRLD Radio Corp		20,000	45.7

Houston

Houston Printing Corp (KPRC)		10,500	46.5
KTRH Bestg Co		14,300	47.7

San Angelo

KGKL Inc		6,936	45.3

San Antonio

Southland Industries Inc (WOAI)		16,500	44.5

Wichita Falls

Rhea Howard		12,800	46.5

UTAH

Salt Lake City

Radio Serv Corp of Utah (KSL)			44.7
Intermountain Bestg Corp		800	46.7

VIRGINIA

Norfolk

WTAR Radio Corp (WTAR)		5,702	46.5

Richmond

Havens & Martin Inc (WMBG)		12,130	46.1
Richmond Radio Corp		11,269	46.3

WASHINGTON

Spokane

Louis Wasmer Inc (KHQ)		12,609	45.7

WEST VIRGINIA

Beckley

Beckley Newspapers Corp		8,500	

Charleston

Charleston Bestg Co (WCHS)			

Morgantown

W Va Radio Corp		33,244	43.5
Satelite on 49.9 mc. at Pittsburgh 1,620 sq. mi.			
Satelite on 49.9 mc. at Wheeling 344 sq. mi.			

WISCONSIN

Green Bay

Green Bay Newspaper Co			

Milwaukee

Journal Co (WTMJ)	WMFM	8,500[1]	45.5

[1] Application filed to change to 17,829 sq. mi., 43.9 mc.

Oshkosh

Oshkosh Bestg Co (WOSH)		3,810	44.5

Racine

Racine Bestg Corp		2,540	49.1

Superior

Head of the Lakes Bestg Co (WEBC)	WDUL		44.5

Wausau

Record Herald			46.5

AN FM-AM COMMUNICATIONS RECEIVER

A Multi-Purpose Design for FM, AM, and CW Reception, Covering 27.8 to 143 Mc.

BY F. W. SCHOR*

THE use of Frequency Modulation is still regarded by many members of the radio industry as being limited to broadcasting music and entertainment with remarkable fidelity and freedom from noise and interference. Its other uses in the field of police and fire department communications and its military applications are not nearly so well known. The receiver to be described here, while capable of reproducing music and entertainment with all of the inherent advantages of FM, is primarily a VHF communications receiver and contains many interesting features not found in the usual FM broadcast receiver.

General Description ★ The new Hallicrafters model S-36A is the latest in a series of VHF FM-AM receivers that began with the well known S-27. Designed for maximum performance and versatility in the VHF portion of the spectrum, it receives FM, AM, or CW code transmissions equally well. The frequency range of 27.8 to 143 mc. is covered in three bands which are selected by means of a ceramic wave-band switch. Difficulties formerly encountered with band switching in VHF receivers have been overcome by the use of a switch design which reflects the lessons learned in the perfection of such components for military service.

Design Details ★ Acorn tubes are used in the high frequency circuits of this receiver, a type 956 pentode in the RF stage, a type 954 as the mixer or first detector, and a type 955 as a plate-tuned high frequency oscillator. Careful arrangement of components with particular attention to such details as short leads and the proper isolation of stages made possible the use of more or less conventional circuits. The layout of the RF components can be seen in Fig. 4. The high frequency inductances and trimmer capacitors are mounted directly on the switch wafers and the acorn tube sockets are placed on the vertical sides of the shields, between the stages. Note that the entire RF section is built on a separate sub-chassis that can be easily removed for servicing.

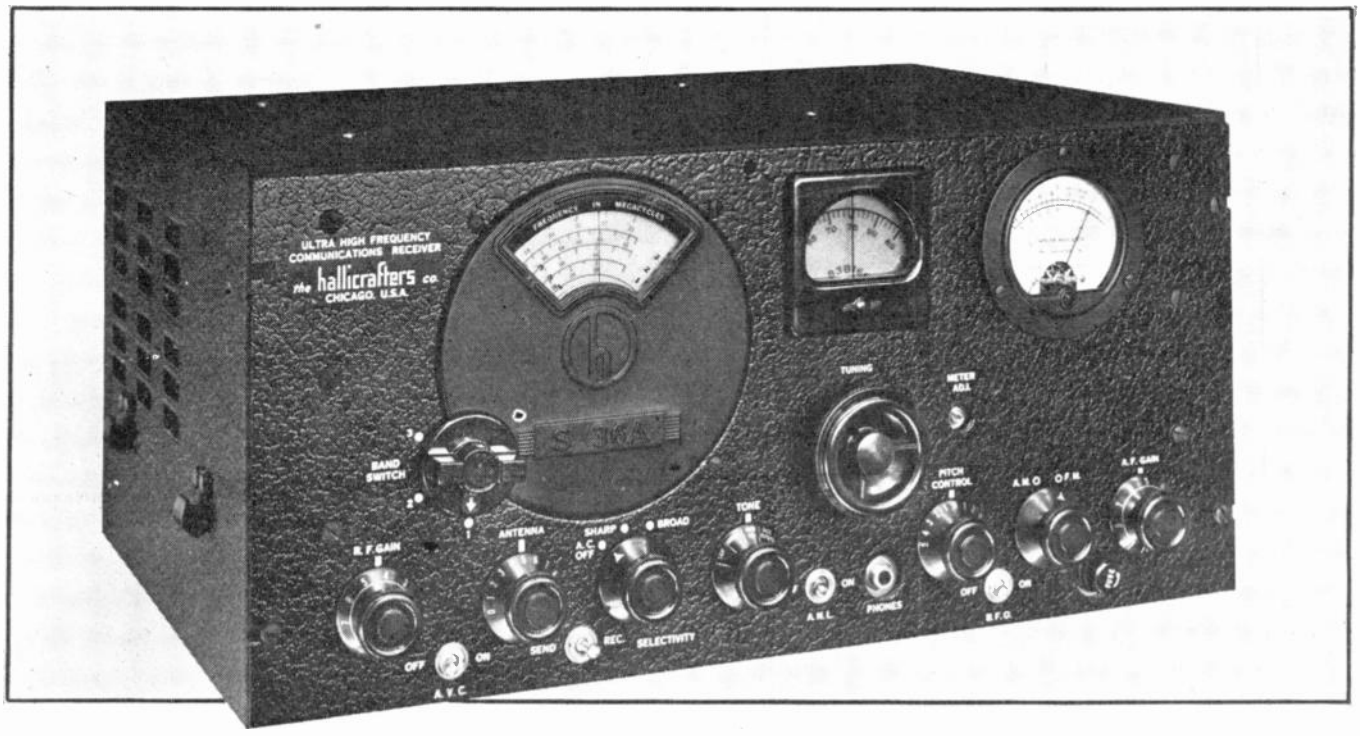
At the high frequencies at which this equipment operates, even the shortest wire has appreciable inductance and its capacity to ground is often sufficient to complete a resonant circuit. For this reason all RF leads are laid out to be short and direct. Power supply wires are bypassed to ground and are interrupted by 1,000-ohm non-inductive resistors to reduce the Q of any circuits which might exhibit resonant effects. As an illustration of the lengths to which it was necessary to carry this isolation of circuits, the shaft of the tuning capacitor includes insulating segments between the three rotor sections, and the rotors are individually grounded. Without this precaution, undesirable inter-stage coupling developed.

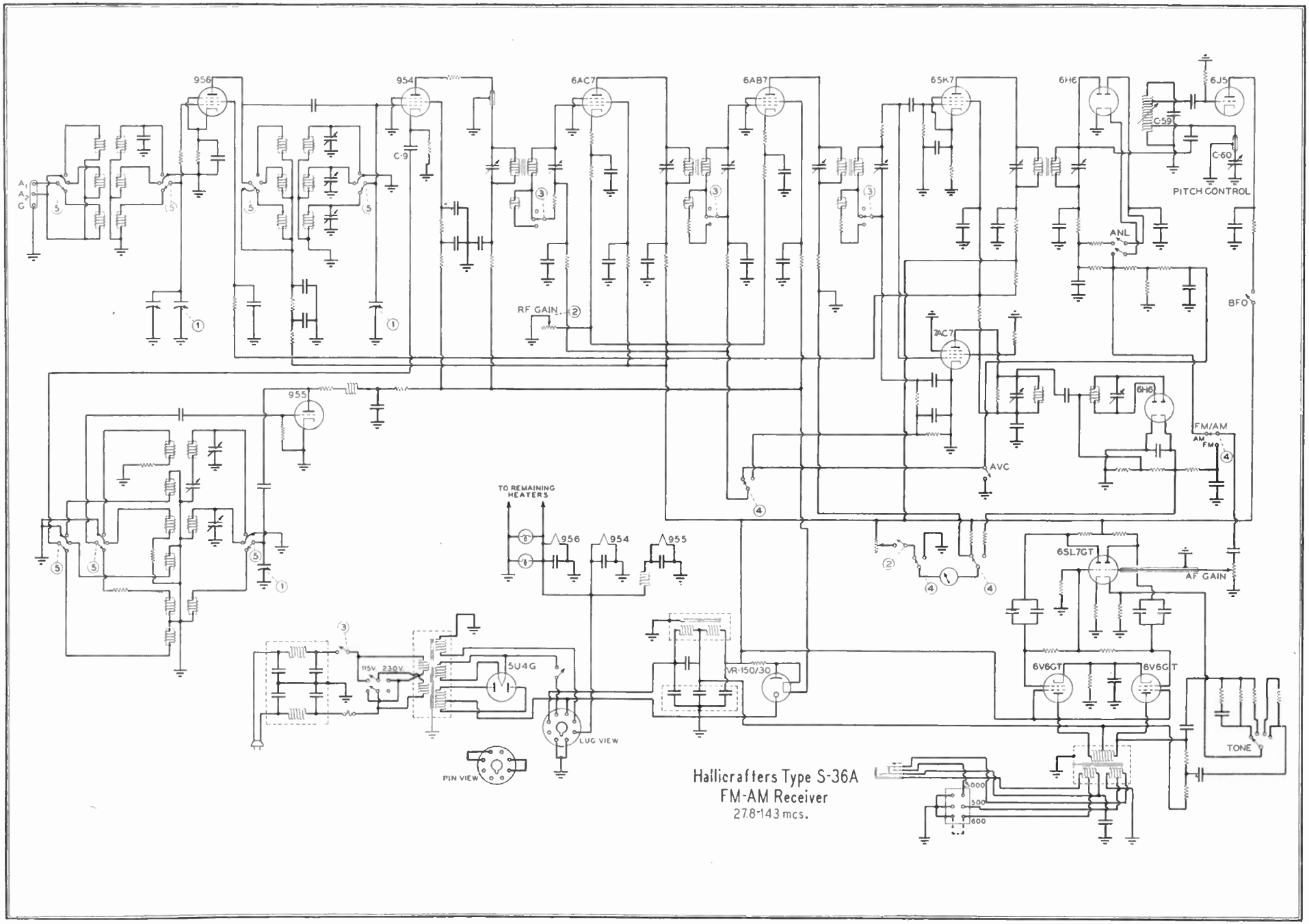
The coupling between the type 955 high frequency oscillator and the type 954 mixer presented another unusual problem. The ordinary methods were tried but either failed to provide sufficient oscillator injection or loaded the oscillator so heavily that its tuning was seriously affected and it failed to operate. The arrangement shown in the schematic diagram, using cathode coupling, was finally worked out and has proven entirely satisfactory. It will be noted that the suppressor of the 954 is grounded directly and the cathode is coupled through capacitor C-9 to a

FIG. 2. OPPOSITE, SCHEMATIC OF THE HALLICRAFTERS FM-AM TYPE S-36A

* Chief, Development Engineering Section, The Hallicrafters Company, 2611 Indiana Ave., Chicago 16, Ill.

FIG. 1. ONE OF THE FIRST RECEIVERS THAT CAN BE CONSIDERED A POSTWAR MODEL, IT FOLLOWS MILITARY DESIGN PRACTICE




956
954
6AC7
6AB7
6SK7
6H6
6J5
C-59
C-60
PITCH CONTROL
ANL
BFO
C-9
RF GAIN
7AC7
6H6
FM/AM
AM
FM
AVC
955
TO REMAINING HEATERS
956
954
955
6SL7GT
AF GAIN
115V 230V
5U4G
VR-150/30
6V6GT
6V6GT
TONE
PIN VIEW
LUG VIEW
5000
500
600
Hallicrafters Type S-36A
FM-AM Receiver
27.8-143 mcs.

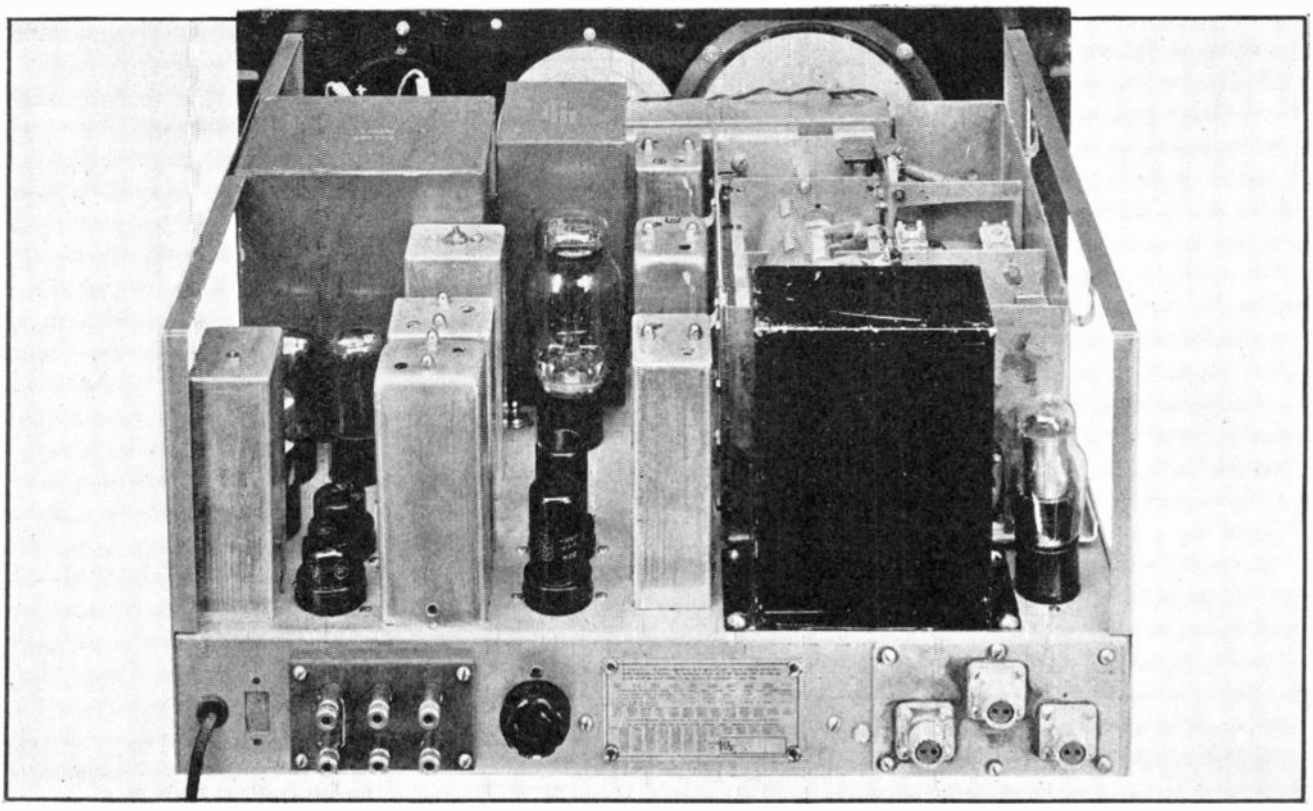


FIG. 3. UNUSUAL VERSATILITY OF CIRCUIT DESIGN CHARACTERIZES THIS FM-AM-CW RECEIVER

small winding on the HF oscillator transformer. This winding varies from one-half turn on the high-frequency range to two turns on the lowest frequency range.

In the VHF portion of the spectrum, receiver instability becomes a real problem, and in designing the S-36A receiver every effort has been made to overcome this difficulty. Both the mixer and the high frequency oscillator are operated at reduced plate voltage, stabilized by a type VR150 voltage regulator tube. This same regulated supply furnishes screen voltage for the mixer and the second IF stage. Exceptionally heavy construction throughout helps to prevent instability due to mechanical causes.

The intermediate frequency of 5.25 mc. provides a good image ratio. The iron core IF transformers include small extra windings tightly coupled to the primaries. When these windings are connected in series with the secondaries, they expand the band width until it is adequate for FM reception. A panel switch is provided to control broad or sharp IF selectivity.

FM-AM Operation ★ The antenna stage, mixer, high frequency oscillator, and first two IF stages are used for all types of reception but separate channels, following the second IF stage, make provision for FM, AM, or CW. For AM or CW operation, a third conventional IF stage is used, transformer-coupled to a standard diode detector. The other half of the type 6H6 double diode is connected as a noise limiter for optional use on AM reception. A type 6J5 tube in a beat-frequency oscillator circuit permits the reception of CW telegraphy. This BFO is coupled to the diode detector through capacitor C-59 and its pitch is controlled by means of capacitor C-60 which is shunted across a small portion of the inductance. Automatic volume control for AM operation is taken from the diode detector in the usual manner.

For FM reception, a limiter stage and double diode discriminator are connected in place of the third IF stage and diode detector. The type 6AC7 limiter is operated without bias and with reduced plate and screen voltages. At small signal voltages, the tube acts as an amplifier but as the signal voltage increases, grid rectification causes a current to flow through the grid resistor and the grid becomes negative, thus preventing the plate current from increasing. By this means the output voltage arrives at a saturation point as the input voltage is increased. A small amount of AVC voltage taken from the limiter is applied to the IF amplifier to keep the tubes from overloading.

Selectivity switch SW7 has 3 positions. In position 1, it opens the AC power supply. Position 2 is for sharp tuning, and 3 is for broad tuning. When the switch is in position 2 or 3, the AC circuit through the power transformer is closed.

It will be noted from the schematic diagram that the grids of the 6SK7 third IF stage and the 6AC7 FM limiter stage are connected at all times. The FM-AM switch SW8 connects the output of either the AM detector or the FM discriminator to the audio system. As this receiver is designed for widely differing forms of reception it was necessary to include an exceptionally versatile audio system.

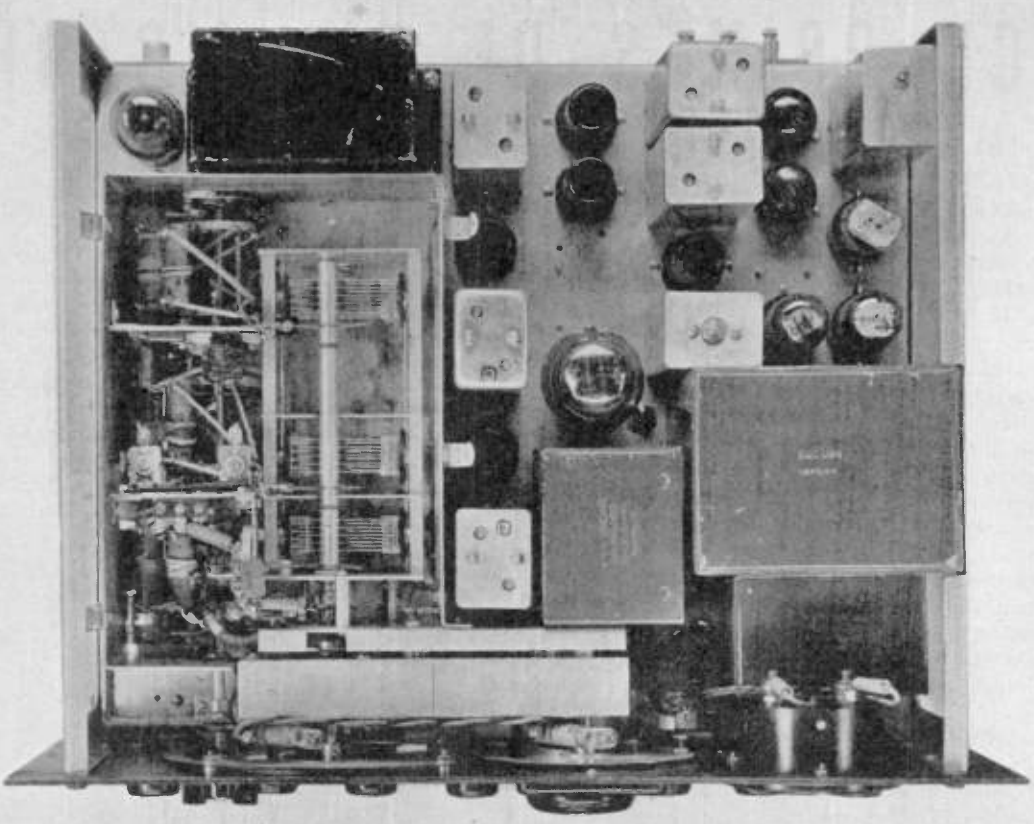
Accordingly, the entire amplifier was made capable of high fidelity reproduction and then was equipped with a 4-position tone switch to provide suitable audio response for the different types of reception. Position 1 provides bass boost, 2 is for high fidelity, 3 is normal, and 4 is low response.

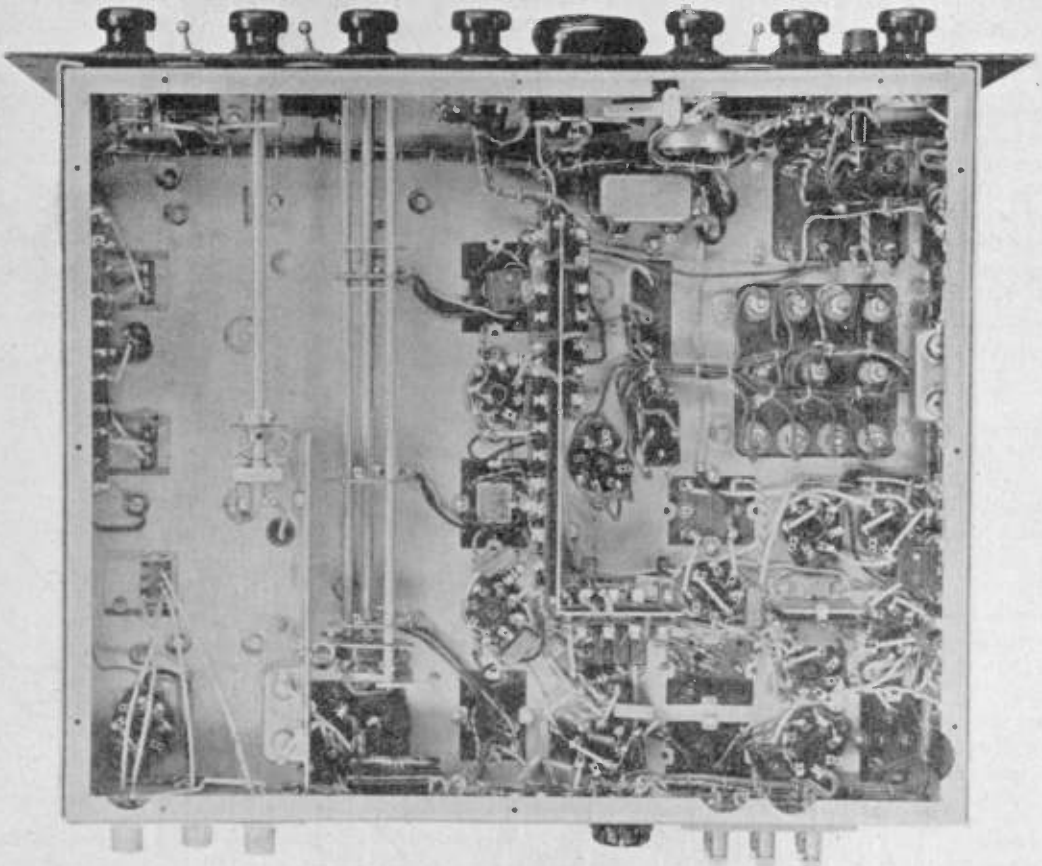
A type 6SL7GT, used as a balanced phase inverter, drives two 6V6GTs in push-pull. The multi-tap output transformer has terminals for 500-ohm, 5,000-ohm, and 600-ohm center-tapped outputs. In addition, the 600-ohm balanced output is brought out to a jack on the front panel.

Power Supply ★ The S-36A may be operated on either 115 or 230 volts AC, or from batteries. The AC input runs directly to a special line filter to keep power line noises as low as possible. The change from 115 to 230 volts is accomplished by means of a switch on the chassis. An octal socket on the rear of the chassis makes it possible

FIG. 4, RIGHT. TOP AND BOTTOM VIEWS SHOW THE COMPONENTS AND WIRING

(CONTINUED ON PAGE 56)





HIGH POINTS OF FM HISTORY

As Told by the Log Book Entries at Westhampton Beach and at Alpine

WHILE the technical details of Major Armstrong's invention of Frequency Modulation were told in his original I.R.E. paper, the story of his work was described only in terms of measurements and apparatus.

However, every engineer who has worked over the solution of problems that required original thinking knows that the facts of science are only the outward manifestations of the very human struggle by which they are produced.

Inventions are not created by mathematics and equipment. They are only tools. They are merely the means to the end sought by the man who uses them. They are of value only as he can relate what they show to other knowledge, and thus find the path which leads to ultimate success.

To many an inventor, there is satisfaction enough in finding the way to the solution of a problem But that is purely selfish satisfaction for, if effort stops at that point, there is no benefit to society, and nothing real has been gained. Indeed, the work is wasted, and the invention is lost if it is not carried on to a state of reality in which it can perform useful service.

It is very interesting to see how these two phases in the invention of the FM system were marked by log book entries in the records kept at Westhampton Beach, Long Island, and at Alpine, N. J.

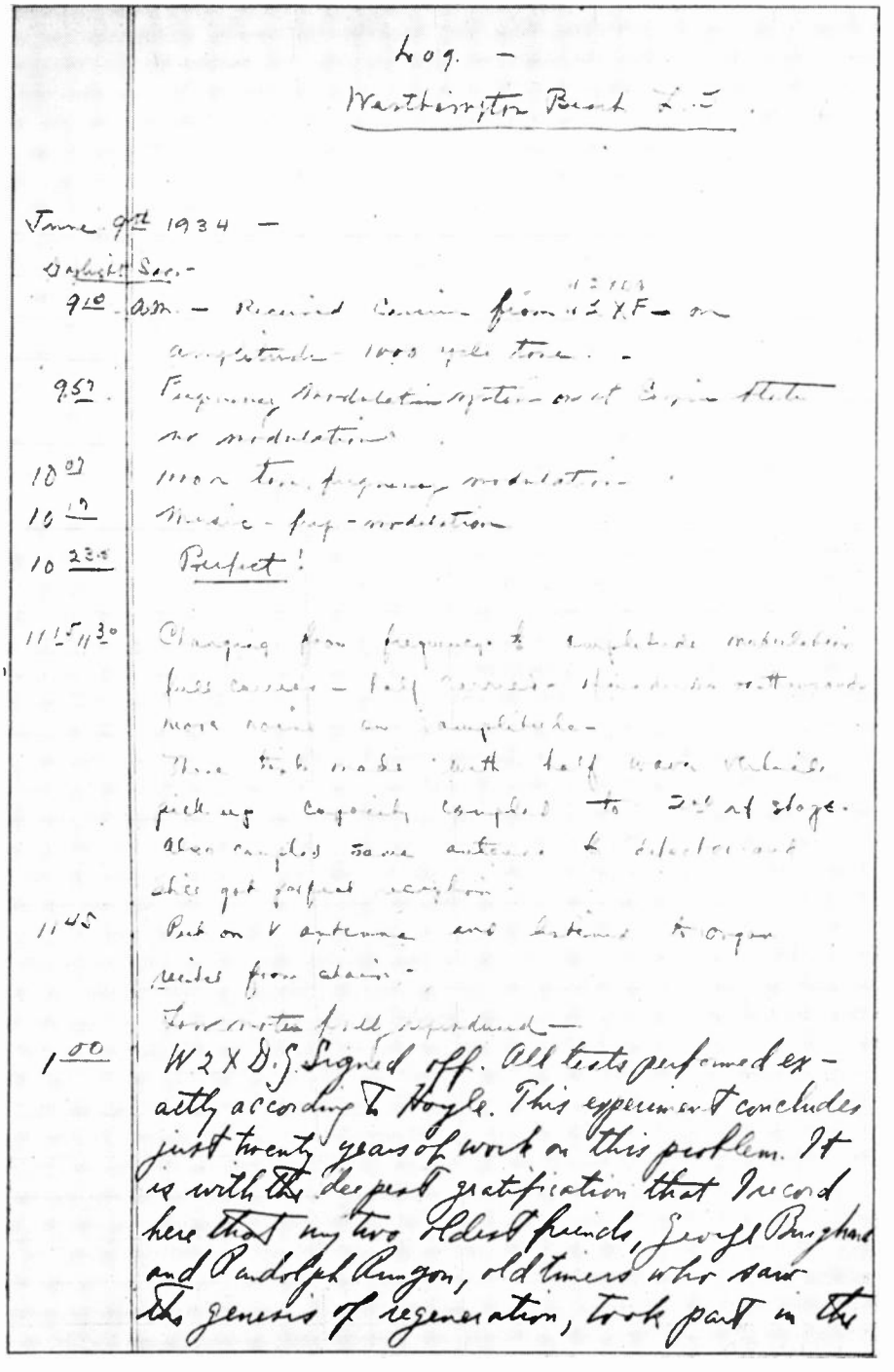
The former was the location of the receiving equipment used for the first long-distance tests of FM transmission from the NBC station at the Empire State Building. Alpine was the site of FM broadcast station No. 1, set up by Major Armstrong.

The Westhampton tests, proving that the FM system did show a tremendous reduction of static over AM *on the same frequency*, represent the completion of the first phase of this invention.

Exactly what took place on this occasion is described in the entries reproduced here from the original log. The first part is in the handwriting of C. R. Runyon. Entries from 11:15 to 11:45 were made by George E. Burghard, at whose home the equipment was set up. The conclusion was written by Major Armstrong. Because the reproduction is not entirely clear, this record is set in type below:

Log —
Westhampton Beach, L. I.
June 9, 1934 — Daylight Saving.

9:10 A.M. Received carrier from W2-XDG (W2XF) — on amplitude — 1,000 cycle tone.
9:57 A.M. Frequency Modulation system on at Empire State no modulation.
10:07 A.M. 1,000 cycle tone, frequency modulation.
10:17 A.M. Music — freq — modulation.
10:23.5 A.M. Perfect!
11:15–11:30 A.M. Changing from frequency to amplitude modulation full carrier — half carrier — Hundreds or thousands (of times) more noise on amplitude.


Log. —
Westhampton Beach L.I.
June 9th 1934 —
Daylight Sav. —
9:10 am — Received Carrier from W2XF — on amplitude — 1000 cycle tone. —
9:57 Frequency Modulation system on at Empire State no modulation.
10:07 1000 cycle frequency modulation.
10:17 Music — freq — modulation.
10 23.5 Perfect!
11:15/11:30 Changing from frequency to amplitude modulation full carrier — half carrier — Hundreds or thousands (of times) more noise on amplitude —
Music high notes with half wave rectifier picking especially coupled to 2nd stage. Also coupled to one antenna & detector and this got perfect reception.
11:45 Put on V antenna and listened to organ inside from chair.
Tone control full experienced —
1:00 W2XDG Signed off. All tests performed exactly according to Hoyle. This experiment concludes just twenty years of work on this problem. It is with the deepest gratification that I record here that my two oldest friends, George Burghard and Randolph Runyon, oldtimers who saw the genesis of regeneration, took part in the

LOG ENTRIES DESCRIBING FIRST FM RECEPTION AT WESTHAMPTON BEACH

culmination of this work. An era as new and distinct in the radio art as that of regeneration is now upon us.
After ten years of eclipse my star is again rising.
Edwin H. Armstrong

CONCLUDING REMARKS ON FIRST LONG-DISTANCE FM RECEPTION TESTS

These tests made with half wave vertical pick up capacity coupled to 2nd rf stage. Also coupled same antenna to detector and still got perfect reception.

11:45 A.M. Put on V antenna and listened to organ recital from chain. Low notes fully reproduced.

1:00 P.M. W2XDG signed off. All tests performed exactly according to Hoyle. This experiment concludes just twenty years of work on this problem. It is with the deepest gratification that I record here that my two oldest friends, George Burghard and Randolph Runyon, old timers who saw the genesis of regeneration, took part in the culmination of this work. An era as new and distinct in the radio art as that of regeneration is now upon us.

After ten years of eclipse, my star is again rising.

Edwin H. Armstrong

The "culmination of this work" represented only the inventor's personal satisfaction over the evidence that he had truly overcome static and that, in so doing, had not sacrificed but had improved the quality of reception.

He might very well have stopped at that point, for the system and its performance were received by the industry with complete indifference. Actually, on June 9th, 1934, while he was recording the conclusion of the first phase of his work, the log shows that he was preparing to bring about that "era as new and distinct in the radio art as that of regeneration."

The second phase extended over a period of five years, spent in laying the groundwork for the commercial application of FM in the service of public interest, convenience, and necessity.

A year's work at the Empire State Building transmitter brought no progress in the adoption of FM, and in the summer of 1935 he was asked to remove his apparatus to make room for television. Comments on Major Armstrong's paper at the November, 1935 meeting of the I.R.E. with a few exceptions, generally expressed the feeling that the system was "a visionary development many years in advance of broadcasting's capacity to utilize it."

The exceptions were limited to engineers whose experience dated back to the days before broadcasting began, for they had seen other revolutions take place. Those who had come into radio with the advent of broadcasting were unable to visualize a revolutionary change.

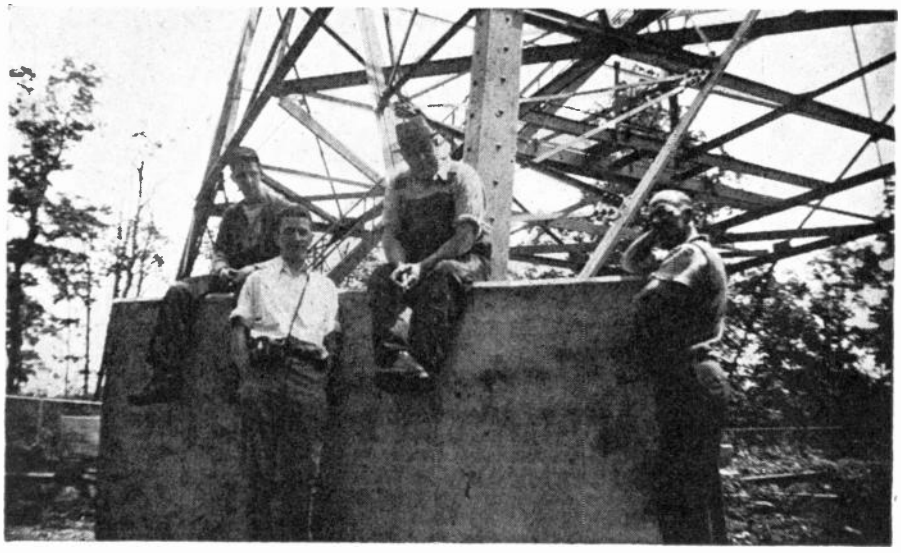
Some engineers expressed surprise that the man who had made such practical contributions to the art as regeneration, the superheterodyne, and super-regeneration should propose the use of a system so radical that it would require revision of the entire broadcasting structure. Nor did these engineers foresee that future circumstances would bring about the widespread use of FM in the police and emergency fields, or that it would serve on every front of a total war!

Since the demonstrations of transmission from the Empire State Building had reached an inconclusive end in the spring of 1935, so far as commercial application was concerned, Major Armstrong set about planning a 20-kw. FM transmitter of his own. During this period, he had recourse

CONSTRUCTION OF THE ALPINE STATION WAS STARTED EARLY IN 1937

to amateur station W2AG, owned by C. R. Runyon, at whose home an FM transmitter was installed. This was used for the demonstration at the November, 1935 I.R.E. meeting, and for scores of other demonstrations up to the time Alpine went on the air. The log of W2AG is highly interesting, and its story may be told some day.

There was opposition to this idea in the engineering department of the FCC, but in July, 1936 he was granted a construction permit for such a station to be erected at Alpine, N. J. The permit did not become effective until the end of 1936. In the spring of 1937, construction was started. Some of the photographs taken while the tower was under construction are reproduced on these pages.



ALPINE'S CHIEF ENGINEER PERRY OSBORN, STANDING LEFT, AND RIGGER CHARLEY FOWLER, STANDING RIGHT, ARE STILL ON THE JOB AT W2XMN

Here were new difficulties to be overcome, but the log of station W2XMN was finally opened, and this entry was made on page 1:

April 10, 1938

4:10 P.M. Frequency — Carrier on — 43.7 mc/600 watts input to transmitter (Using temporary antenna).

This was not for purposes of transmission, but only to test for the proper termination of the antenna transmission line.

Subsequent entries were made during the further progress of the installation until, on page 132, the start of the first regular schedule of FM broadcasting was recorded:

Tuesday, July 18, 1939

First day — regular schedule on the air at 10:50 A.M. — 80-kw. input. Programs consisted of records played at Alpine.

4:01 P.M. WQXR programs 11:00 P.M.

Thus the second phase of the invention of FM drew to a close, for the performance of the Alpine station was conclusive and convincing evidence to broadcasters and manufacturers alike that a new era had come to radio.

The manner in which it came about, however, was not anticipated at that time. While the early commercial stations were being installed, and receivers for home use were started in production, a statewide, 2-way FM communications system was going into service for the Connecticut State Police. Also, the performance of FM, successful even beyond the hopes of its sponsors, attracted the attention of the Signal Corps, and led to a gruelling series of AM vs. FM tests of communication with tanks. When the scores were added, FM was found to be far in the lead, and orders were placed for quantities of FM tank installations.

In the midst of all this activity came the attack on Pearl Harbor, followed by the freeze order which stopped all production of civilian military radio equipment. This did not stop the progress of FM. On the contrary, it was accelerated immediately, for the war brought a heavy demand from police departments, particularly in cities along our coasts, for 2-way FM apparatus.

At the same time, the mobile nature of the fighting created the need for radio equipment in every type of military vehicle. Up to this time of writing, FM equipment to the value of over ¼ billion dollars has been produced for our Armed Forces. Col. Grant A. Williams, Chief Signal Officer of the 1st Army, recently said this of its performance: "Wherever FM and AM equipments are used for the same purpose, FM proves distinctly superior."

Meanwhile, the evolution of FM broadcasting has continued steadily. Since Pearl Harbor nearly 300 applications have been filed with the FCC for construction permits to erect FM stations, and FM circuits will be provided in all but the cheap models of the new home radios.

All this has come about because Major Armstrong did not stop ten years ago when the radio industry merely shrugged its shoulders over an invention too far "in advance of broadcasting's capacity to utilize it."

Few people remember now, if in fact many ever knew, the cheerful predictions of some ten years ago that FM transmitters, and more particularly FM transmitters of the phase-shift type, were just too complicated for broadcast work in any practical sense of the word. Nor do many people know that the proposal to put and keep on the air a 20-kw. 7-meter transmitter was relegated to the realms of nebulous experimentalism by nearly all our very best talent.

How strange and foolish today seem the statements accepted then that: "You can't get that much power on the ultra-high frequencies." Today it is a demonstrated fact that FM stations with up to 50 kw. can operate with the regularity and reliability of standard broadcast practice. For over five years the Alpine transmitter has met this standard, most of the time with 40-kw. operation.

The gap between the predictions of ten years ago and the performance of high power FM transmitters today means, of course, that someone must have done a great deal of very good and very hard work. The success of the operation of station W2XMN has depended on the work of two individuals. Major Armstrong gives Perry Osborn, the chief engineer, the full credit for working an experimental transmitter, giving a problematical 20 kw. for a short time, into a device capable of supplying 50 kw. in accordance with all requirements of broadcast station reliability. Charley Fowler, rigger, is given the credit for keeping in operation a complicated antenna structure through the severe storms of every kind, including one hurricane, which have been encountered since the station was erected.

The multitude of difficulties, expected and unexpected, and the manner of their solution, would make an interesting and instructive story.

Now, as his Alpine station enters its sixth year of scheduled transmission, FM's period of service to men at war draws to a close. Soon its era of service to society at peace will begin in earnest.

Note: In the cover photo of the Alpine tower, the antenna used for broadcasting can be seen suspended between the top and center arms.

RTPB PANEL 5 REPORTS ON FM BROADCASTING

Recommendations Cover Only Items of Immediate Importance, with Others Still Open

THE agenda of RTPB Panel 5, covering standards and frequency allocations for postwar FM broadcasting, is made up of the following items:

1. Recommendations respecting the type of modulation to be used in the VHF (30 to 300 mc.) band
2. Position of VHF broadcasting in the spectrum
3. Width of channel
4. Number of channels required for an adequate VHF broadcast structure
5. Polarization
6. Classes of stations and service areas
7. Geographical distribution of stations
8. Transmitter power and service areas
9. Receiver intermediate frequency standard
10. Standards of good engineering practice:

(a) audio band pass standard
(b) pre-emphasis and de-emphasis
(c) distortion standards
(d) maximum permissible AM modulation
(e) out-of-channel radiation
(f) transmitter frequency stability
(g) FM noise level

As of June 4th, recommendations have been submitted to the RTPB on only the first five items, despite the efforts of chairman C. M. Jansky, Jr. (Jansky & Bailey) and vice chairman W. R. David (G. E.) to get over the wrangling and witch-baiting which consumed much of the time spent in Panel 5 meetings.

Here are the recommendations actually adopted, with excerpts of comments made in the report to the RTPB:

1. It is recommended that FM be the system of modulation for sound broadcasting within the band specified.

This was passed unanimously. A committee composed of men having access to classified radio information studied the question as to whether or not any undisclosed developments would offer advantages superior to FM. The committee reported that there are no systems, classified or otherwise, which show indications of being either as good as or better than the FM system now in use. This report was accepted unanimously.

2. The present position of FM broadcasting in the spectrum should not be changed.

Technical evidence, corroborated by a letter from Dr. J. H. Dellinger, chief of Interservice Radio Propagation Laboratory of the United States Government, and practical operating experience "have shown that FM can provide a satisfactory service in its present position in the frequency spectrum."

It was also found that "there is no technical evidence to indicate that certain erratic propagation characteristics of the presently assigned portion of the spectrum would be improved by any shift in the present allocation, or that there would be any other advantages through the use of other locations of the spectrum."

3. The present channel width of 200 kilocycles should be retained.

At its first meeting, the Panel adopted a resolution to the effect that it saw no reason for changing the present FM channel width of 200 kc. Subsequently, a motion was made to reopen this question, but the motion was rejected by a vote of 18 to 16.

Those voting to reopen the question were G. L. Beers (RCA), L. M. Clement (Crosley), T. T. Goldsmith (DuMont), O. B. Hanson (NBC), G. W. Lang (WGN) and S. C. Spielman (Philco).

4. A minimum of 80 to 100 channels for commercial and non-commercial broadcasting stations is necessary for the development of an adequate nation-wide FM broadcast structure, and these 80 or 100 channels, comprising a band of 16 to 20 mc., should start in the vicinity of 40 mc., and be so assigned that they shall be continuous with and include the present FM band. This is based on Panel 5's decision to use 200 kc. channel widths for FM broadcasting.

Originally, the words "Start in the vicinity of 40 mc." and "with and include the present FM band," as well as the reference to 200-kc. channels, were omitted, but their reinsertion was approved by a vote of 23 to 4. Dissenting votes were cast by R. K. Potter (Bell Labs.), S. C. Spielman (Philco), T. T. Goldsmith (DuMont), and Walter Lukas (Emerson). Goldsmith filed a report urging that FM be moved to some other part of the spectrum, and Lucas supplemented his vote with the suggestion that the channel width be cut to 100 kc.

5. Horizontal polarization should be considered standard for FM broadcasting.

There was some very interesting discussion on this point, particularly by H. C. Forbes (Colonial), but the motion was carried by a vote of 20 to 4.

The opinion was expressed by Forbes that the use of horizontal polarization would have an adverse effect on automobile reception of FM stations. Raymond Guy (NBC) summed up the problem by pointing out that "you can use horizontal antennas for transmitting and for home reception, and you can use anything that you can conveniently mount on an automobile. It is never going to be possible to have an ideal receiving antenna on a car, but automobile reception will probably be a small part of all reception, and if home reception is made the best possible by a horizontal antenna, that would be the determining factor."

One of the most important factors of FM broadcasting expansion does not appear on the agenda of Panel 5. That is the subject of FM program relay systems. The Television Panel has a special committee at work on television relays, and a very great number of frequencies have been requested for that service. It is not clear from the Panel 5 minutes why FM broadcasting relays were not even mentioned in their discussions. It is extremely important that this be brought to the attention of the FCC during the hearing on frequency allocations.

FCC CALLS HEARING ON ALLOCATIONS SEPT. 28

A HEARING on frequency allocations for non-governmental services will be held before the FCC *en banc* commencing at 10:30 A.M., September 28th, at the offices of the Commission. This is for the purpose of: 1) ultimately assigning frequencies to the non-governmental services, 2) securing an understanding of the conflicting problems which confront the industry and the FCC in the selection of frequencies, 3) encouraging experimentation along such lines as may be justified from evidence presented, 4) considering frequency allocations to be proposed by the RTPB, 5) obtaining information with respect to possible conflicts between non-governmental services and allocations proposed by the Interdepartmental Radio Advisory Committee for Government services, 6) assisting the Government in its preparations for future International Conferences, and 7) determining what recommendations, if any, the FCC should make to the Congress for the enactment of additional legislation on matters covered by this order.

SPOT NEWS NOTES

Items and comments, personal and otherwise, about manufacturing, broadcasting, communications, and television activities

Railroad Radio Hearing: Set by FCC for September 13th will be of great interest to many engineers and radio executives. Witnesses will include representatives from Association of American Railroads, Aeronautical Radio, Inc., CAA, RTPB, and the War Department. No immediate determination of policy by FCC is contemplated, for this matter will be kept open until there has been adequate time for experimentation and development of data. Further hearings will be held as they may appear necessary. Commissioners Walker (chairman), Case and Jett will preside at this first hearing.

Military Radio Production: Dropped again in May. Index shows 117% against year's high in January of 129%, and wartime high of 139% in December, 1943. These compare with 100% as the 1943 average monthly production. A further breakdown shows that ground radio equipment dropped 17% from April, but airborne equipment rose 12%, and ship equipment was up slightly.

James L. Fouch: President of Universal Microphone, looks very pleased over the award of the Army-Navy "E" to his Company, on July 26th, at Inglewood, Calif. Vice president Cecil L. Sly was master of ceremonies. The presentation speech was delivered by Col. Stanley of the Signal Corps.

Anti-Stalling Rule: Adopted by FCC specifies that, "Unless otherwise determined by the Commission upon proper showing in any particular case, in the event construction shall not have begun upon a project involving an expenditure of more than $50,000 within 12 months from date of the Commission's authorization, or all or part of the proposed facilities shall not have been placed in operation within 36 months after such date, such authorization shall terminate at the end of such 12 or 36 months period, as the case may be; in the case of projects involving an expenditure of $50,000 or less, the authorization therefor shall terminate at the end of 9 months or 18 months, as the case may be, in the event construction thereof shall not have been commenced, or the facilities placed in operation, within such respective periods."

In other words, the practice of filing an application for a construction permit to erect an FM or television station merely as a gesture, or for if-as-and-when protection against competition will not be countenanced after the war. If such pressure had been applied prewar, some of the FM applicants who were deliberately stalling would have been on the air before new construction was stopped.

Brooklyn: A reorganization of Amperex Electronic Products, Brooklyn, N. Y., has taken place effective July 1, 1944, according to an announcement by Mr. A. Senauke, whereby the business will be continued as Amperex Electronic Corporation, newly organized under the laws of the State of Delaware.

SAM NORRIS, SALES V.P. OF AMPEREX

Mr. Senauke expressed regret at the protracted illness of Mr. N. Goldman, senior partner, which forced his retirement. Otherwise, the personnel, management, and policies of Amperex remain unchanged.

The directors and officers of the company are: A. Senauke, president; Nicholas Anton, vice president in charge of manufacturing; and Samuel Norris, vice president in charge of sales. In the reorganization, Amperex becomes affiliated with North American Philips Company, Inc.

C.P.'s for Television: Granted to Gus Zaharis, South Charleston, W. Va., for an experimental station to operate with 200 watts visual, 110 watts aural; and to William B. Still, Jamaica Radio Television Company, Jamaica, New York, for an experimental station with 400 watts visual and 100 watts aural.

Newcomer: Is Madison Electrical Products Corporation, Madison, N. J., organized to manufacture precision and wire-wound resistors, electrical and radio assemblies, coil windings, and other components. John G. Ruckelhaus is president and chief engineer. A. L. Livera, formerly assistant chief engineer for Hardwick-Hindle, will be in charge of the plant.

Television Course: Starting October 2nd, NBC will offer a 4-week course in television for the engineering personnel of its affiliated stations. There will be 20 sessions, running from 9:00 A.M. to 4:00 P.M., held in Room 666 at the NBC Building, Rockefeller Center. The list of lecturers, drawn from the NBC engineering department, is assurance of the value of this course. The first enrollment will be limited to 35 students.

Radiophone Operators: FCC is issuing lists of names compiled from surveys of men holding first- and second-class radiophone licenses who have indicated their availability for employment in the communications and broadcasting fields. Latest list, containing 600 names, is available on request from the Federal Communications Commission, Washington 25, D. C.

Louis Burroughs: Chief engineer of Electro-Voice Manufacturing Co., Inc., South Bend, is the serious fellow at the right in this picture, taken in the department where T-45 lip-mikes are produced. With him is Lt. Col. John M. Nichaus.

LT. COL. NICHAUS AND BURROUGHS, CHIEF ENGINEER OF ELECTRO-VOICE

(CONTINUED ON PAGE 61)

NEWS PICTURE

SAN FRANCISCO's Police Chief Charles W. Dullea meets FM, as radio technician Henry L. Bogardus (left) returns the Chief's car with its new 3-way radio installation, while Frank E. Winters, director of the Bureau of Criminal Information, wonders if the little black box is on the level. Fifty cars now have 2-way G.E. equipment, and fourteen others can also talk car-to-car. Because of San Francisco's hilly contour, five fixed receivers, connected to headquarters through a mixing panel, pick up the car signals. Previously, this city had only 1-way AM.

The original disclosure of

FREQUENCY MODULATION BROADCASTING

A Method of Reducing Disturbances in Radio Signaling By a System of Frequency Modulation

BY EDWIN H. ARMSTRONG

CONTINUED FROM THE JULY ISSUE

Interference and Fading ★ Reference has heretofore been made to the difficulty of comparing the amounts of interference produced in amplitude and frequency modulation systems by the transient type of disturbance, particularly when, as in ignition noise, the peaks are greater in amplitude than the signal carrier. The best method of comparison seems to be that of observing how much greater signal level from the standard signal generator must be introduced into the receiving system when it is arranged to receive amplitude modulation than is required for the same signal-to-noise ratio on a frequency modulated system. The experimental procedure of making such comparison is to change the connection of the speaker rapidly from one receiver to the other, simultaneously changing the level of the local generator until the two disturbances as perceived by the ear are equal. At all times, of course, the amplification in the amplitude modulation receiver is correspondingly changed as the signal generator level is varied to apply the same voltage to the amplitude as to the frequency modulation detector so that the audio-frequency signal level which will be produced by the two systems is the same. The square of the ratio of the two voltages of the signal generator gives the factor by which the *carrier* power of the amplitude modulated transmitter must be increased to give equal performance. While the measurement is difficult to make, the following approximations may give some idea of the magnitudes involved.

If the peak voltage of the ignition noise is twice the carrier level of the frequency modulation system, about 150 to 200 times the power must be used in the carrier of the amplitude modulation system to reduce the disturbance level to the same value. When the peak voltage is five times as great, about 35 to 40 times the power in the amplitude modulation carrier is sufficient to produce equality.[17] These observations have been checked aurally and by the oscilloscope. The results of measurements where the disturbances are due solely to the thermal and shot effects have been compared to those obtained with the method previously described and are found to check with it. The chief value of this method of measurement, however, lies in the ability to predict with certainty the signal level required to suppress all ignition noise. An experimental determination made at Haddonfield shows that a signal introduced from the local generator which produces at the current limiter ten times the voltage of the Empire State signal is sufficient to suppress the disturbance caused by the worst offender among the various cars tested. These cars were located as closely as possible to the doublet antenna shown in Fig. 25, the distance being about forty feet. The increase in field strength necessary to produce this result can be readily obtained by an increase in the transmitter power to twenty or twenty-five kilowatts and the use of a horizontally directional antenna array. An increase in the field strength of three or four to one by means of an array is within the bounds of engineering design so that the practical solution of the problem of this type of interference is certainly at hand up to distances of one hundred miles.

So also is the solution of the problem at its source. It has been determined experimentally that the introduction of 10,000 ohms (a value of resistance which is not injurious to motor performance) into the spark plug and distributor leads of the car referred to eliminates the interference with the Empire State signal.

Since active steps are now being taken by the manufacturers of motor cars to solve the more difficult general problem, the particular one of interference with sets located in the home will thus automatically disappear. The problem of eliminating the disturbance caused by an automobile ignition system in a receiving set whose antenna is a minimum of fifty feet away from the car is obviously a much simpler one than that of eliminating the interference in a receiver located in the car or in another car a few feet away.

During the course of the experimental work in the laboratory a very striking phenomenon was observed in the interference characteristics between frequency modulation systems operating within the same wave band. The immunity of a frequency modulation system from interfer-

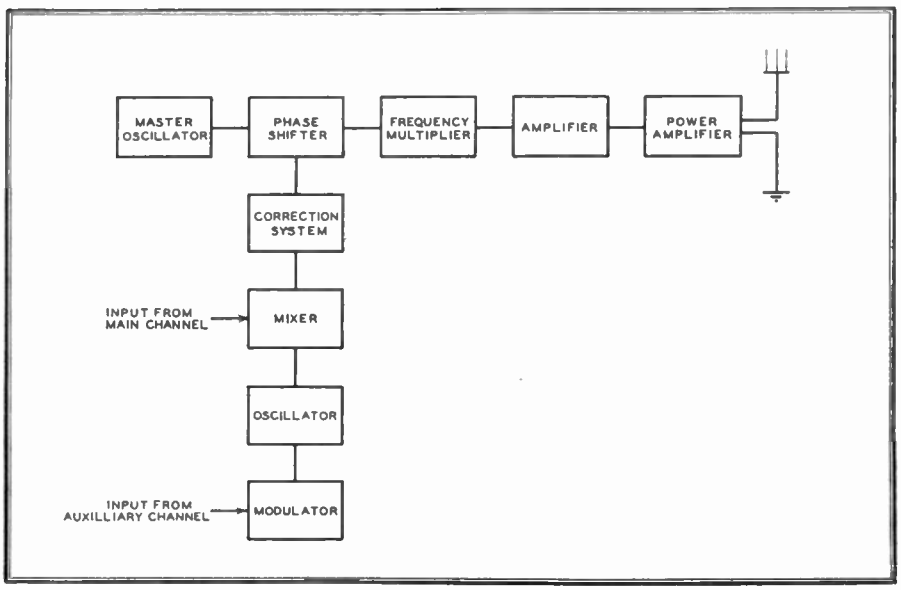


FIG. 27. FIRST METHOD OF FM MULTIPLEX TRANSMITTER OPERATION

[17] Linear detection was used in the amplitude modulation receiver but no limiting was employed.

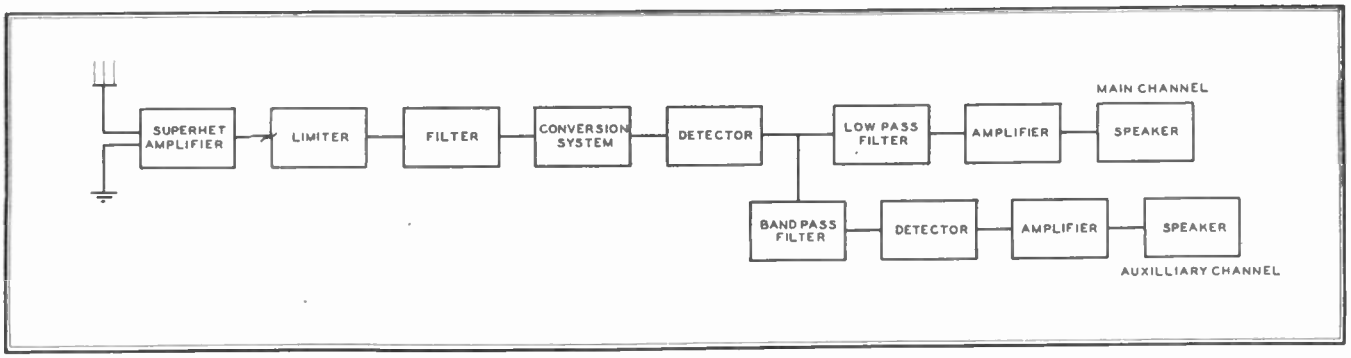


FIG. 28. FIRST METHOD OF FM MULTIPLEX RECEIVER OPERATION, AS DESCRIBED IN THE ACCOMPANYING TEXT

ence created by another frequency modulated transmission is of the same order of magnitude as the immunity with regard to tube noises. This property merits the most careful study in the setting up of a broadcast system at those wave lengths at which the question of interstation interference is a major factor. It is well known that when the carriers of two amplitude modulated transmitters are sufficiently close in frequency to produce an audible beat that the service range of each of them is limited to that distance at which the field strength of the distant station becomes approximately equal to one per cent of the field strength of the local station. As a consequence of this, the service area of each station is very greatly restricted; in fact the service area of the two combined is but a small percentage of the area which is rendered useless for that frequency due to the presence thereon of the two interfering stations. With the wide band frequency modulation system, however, interference between two transmissions does not appear until the field strength of the interfering station rises to a level in the vicinity of fifty per cent of the field strength of the local one. The reason for this lies in the fact that while the interfering signal in beating with the current of the local station under such conditions may be producing a fifty per cent change in the voltage applied to the current limiter, the system is substantially immune to such variations in amplitude. The only way in which the interfering signal can make its presence manifest is by cross modulation of the frequency of the local signal. Since, under the conditions, this cross modulation produces less than a thirty-degree phase shift and since the characteristics of the wide band receiver are such that, at least within the range of good audibility, thousands of degrees of phase shift are necessary to produce full modulation, it is clear that a thirty-degree phase shift will not produce very much of a rectified output. For example, assuming two unmodulated carriers are being received, that their amplitudes have a ratio of two to one, and that their frequencies differ by 1,000 cycles, then for a system having a wide band (of the order of 150,000 cycles) the modulation produced by the interaction of the two carriers would be of the order of one per cent of that produced by full modulation of the stronger carrier. This example, however, represents perhaps the worst possible condition as during modulation of either station, with the proper type of conversion system, the aural effect of the disturbance is greatly reduced. The whole problem of interference between unmodulated carriers may, however, be entirely avoided by separating them in frequency by an amount beyond the audible range. Hence it follows that with two wide band frequency modulated transmitters occupying the same frequency band that only the small area located midway between the two wherein the field strength of one station is less than twice the field strength of the other will be rendered useless for reception of either station. This area may well be less than ten per cent of the total area. Even in this area reception may be effected as a receiving station located within it has only to erect directional aerials having a directivity of two to one to receive either station. The two-to-one ratio of field strength which has been referred to as the ratio at which interference appears is not by any means the limit but rather one which can be realized under practically all conditions. Better ratios than this have been observed, but the matter is not of any great importance since by the use of the directional antennas referred to it becomes possible to cover the sum of the areas which may be effectively covered by each station operating alone, subject only to the limitations of the noise level. The problem of the interference due to overlapping has been completely wiped out. One precaution only should be observed — the unmodulated carriers should be offset in frequency by an amount beyond the audible limit.

In the above analysis it has been assumed, of course, that the distance between stations has been selected so that the "no-mans land" between stations is not sufficiently distant from either one to be within the zone where any large amount of fading occurs. If the distance between stations is such that the signal strength varies appreciably with time then the directivity of the receiving antennas must be greater than two to one.

Difficulties and Precautions ★ The principles which have been described herein were successfully applied only after a long period of laboratory investigation in which a series of parasitic effects that prevented the operation of the system were isolated and suppressed. The more important of these effects, which will be of interest to those who may undertake work in this field, will be referred to briefly.

It was observed in the early work in the laboratory that it was at times impossible to secure a balance in the detector system, and that the amplitudes of the currents in the rectifiers varied in very erratic fashion as the frequency of the first heterodyne was changed. Under these conditions it was not possible to produce any appreciable noise suppression. The effect varied from day to day and the cause defied detection for a long period of time. Ultimately the presence of two side frequencies in the detector circuits was discovered, one of these frequencies lying above and the other below the unmodulated intermediate frequency by an amount equal to the initial crystal frequency of the transmitter. It was then discovered that the trouble had its origin in the transmitting system and that a current having the fundamental frequency of the crystal, (in the present case 57.33 kilocycles), passed through the first doubler circuits in such phase relation to the doubled frequency as to modulate the doubled frequency at a rate corresponding to 57.33 kilocycles per second. This modulation of frequency then passed through all the transmitter doubler stages, increasing in extent with each frequency multiplication and appearing finally in the forty-four-megacycle output as a fifty-seven-kilocycle frequency modulation of considerable magnitude. In the first doubler

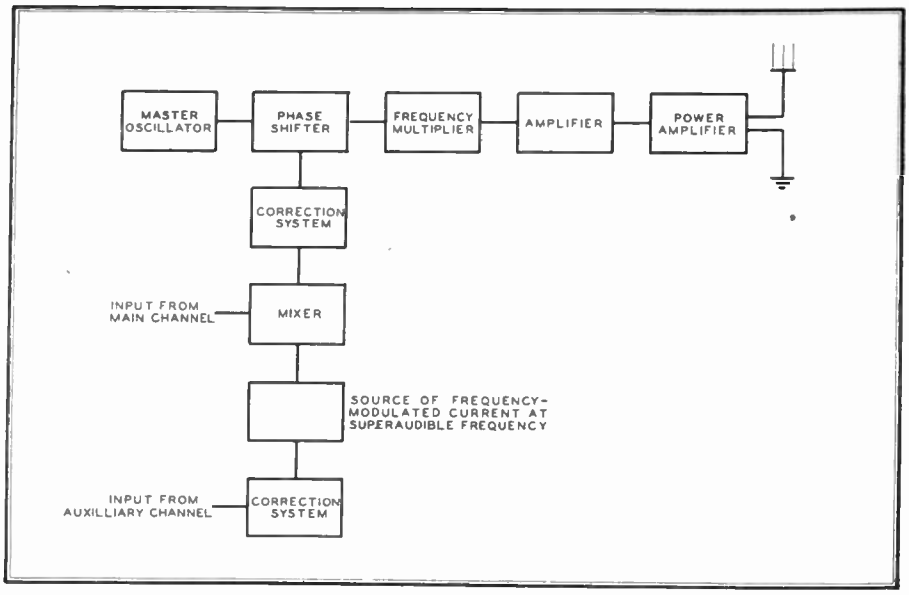


FIG. 29. THE SECOND METHOD OF FM MULTIPLEX TRANSMITTER OPERATION

tank circuit of the transmitter a very slight change in the adjustment of the tuning of the circuit produced a very great change in the magnitude of this effect. A few degrees shift in the tuning of the first doubler tank condenser, so small that an almost unnoticeable change in the plate current of the doubler occurred, would increase the degree of the modulation to such extent as to make the first upper and lower side frequencies in the forty-four-megacycle current greater than the carrier or mid-frequency current (when no audio modulation was applied). Under such conditions the proper functioning of the receiving system was impossible.

The delay in uncovering this trouble lay in the fact that it was obscured by the direct effect of harmonics from the transmitter doubler stages which had to be set up in an adjoining room and by the numerous beats which can occur in a double intermediate-frequency superheterodyne. To these effects were added an additional complication caused by the presence of harmonics in the circuits of the selective system resulting from the action of the limiter which the filtering arrangements did not entirely remove. The coincidence of one of these harmonics with the natural period of one of the inductances in the branch circuits likewise interfered with the effectiveness of the noise suppression. The causes of all these spurious effects were finally located and necessary steps taken to eliminate them.

With the removal of these troubles a new one of a different kind came to light, and for a time it appeared that there might be a very serious fundamental limitation in the phase shifting method of generating frequency modulation currents. There was found to be in the output of the transmitter at forty-four megacycles a frequency modulation which produced a noise in the receiver similar to the usual tube hiss. The origin of it was traced to the input of the first doubler or the output of the crystal oscillator where a small deviation of the initial frequency was produced by disturbances originating in these circuits. While the frequency shift in this stage must have been very small, yet on account of the great amount of frequency multiplication (of the order of 800 times) it became extremely annoying in the receiver; in fact for low levels of receiver noise that noise which originated in the transmitted wave was by far the worse. For a time it seemed as though the amount of frequency multiplication which could be used in the transmitter was limited by an inherent modulation of the frequency of the oscillator by disturbances arising in the tube itself. The proper proportioning of the constants of the circuits, however, reduced this type of disturbance to a point where it was no longer of importance and frequency multiplications as high as 10,000 have since been effectively used. On account of the very large amount of frequency multiplication, any troubles in these low-frequency circuits caused by noisy grid leaks, improper by-passing of power supply circuits, or reaction of one circuit upon another become very much more important than they would normally be. Difficulties of all these kinds were encountered, segregated, and eliminated.

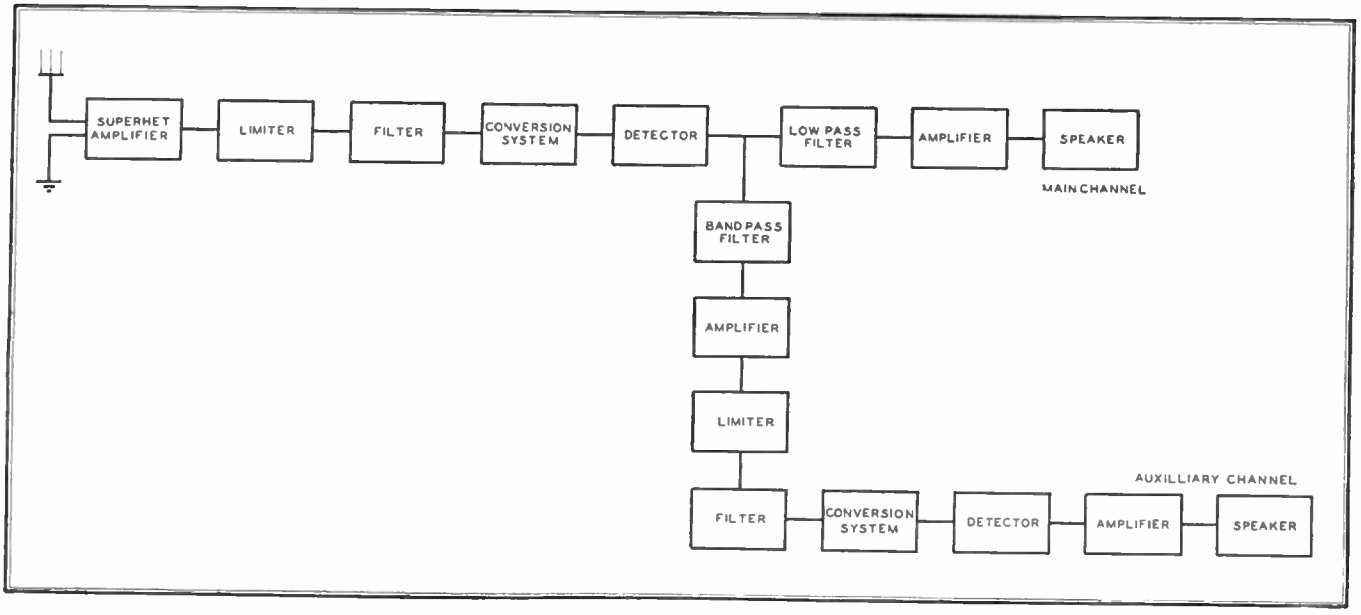


FIG. 30. SECOND METHOD OF FM MULTIPLEX RECEPTION. NOTE: ERRORS IN NUMBERING THESE FOUR DIAGRAMS IN THE ORIGINAL PAPER AS IT WAS PUBLISHED IN THE I.R.E. PROCEEDINGS HAVE BEEN CORRECTED IN THIS TEXT

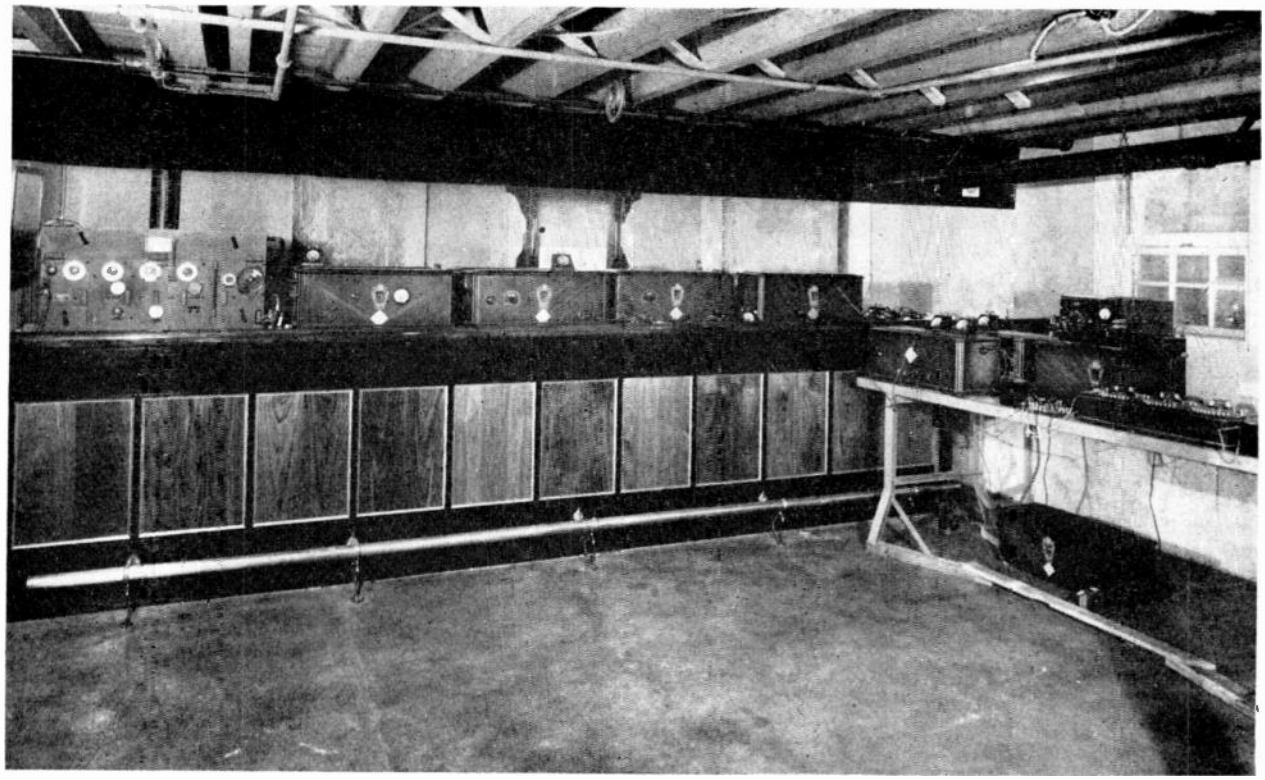


FIG. 33. RECEIVING APPARATUS AFTER IT HAD BEEN MODIFIED AND INSTALLED AT HADDONFIELD, N. J.

Another source of trouble was discovered in the correction system. Because of the range in frequency required, particularly in multiplex work where thirty to 30,000 cycles were frequently used, the output voltage of the correction system at the higher frequencies became very much less than the input voltage, hence any leakage or feed-forward effect due to coupling through the power supply circuits developed a voltage across the output much higher than that required by the inverse frequency amplification factor as determined by the correction network. Hence, the frequency swing for the upper frequencies of modulation would frequently be several hundred per cent greater than it should be. Likewise, at the lower frequency end of the scale various reactions through the power supply were very troublesome. All these effects, however, were overcome and the correction system designed so that its accuracy was within a few per cent of the proper value.

From the foregoing it might be assumed that the transmitting and receiving apparatus of this system are inherently subject to so many new troubles and complications that their operation becomes impracticable for ordinary commercial applications. Such is not the case. The difficulties are simply those of design, not of operation. Once the proper precautions are taken in the original design these difficulties never occur, except as occasioned by mechanical or electrical failure of material. During the period of over a year in which the Empire State transmitter was operated, only two failures chargeable to the modulating system occurred. Both were caused by broken connections. Even the design problems are not serious as methods are now available for detecting the presence of any one of the troubles which have been here enumerated.

FIGS. 31 AND 32. VIEWS OF THE MODULATING EQUIPMENT AS FINALLY ARRANGED AT THE EMPIRE STATE BUILDING STATION. (THESE ILLUSTRATIONS ARE NOT SHOWN BECAUSE THE ORIGINAL PHOTOGRAPHS ARE MISSING)

These troubles were serious only when unsegregated and en masse they masked the true effects and made one wonder whether even the laws of electrical phenomena had not been temporarily suspended.

Multiplex Operation ★ During the past year, two systems of multiplexing have been operated successfully between New York and Haddonfield and it has been found possible to transmit simultaneously the red and blue network programs of the National Broadcasting Company, or to transmit simultaneously on the two channels the same program. This last is much the simpler thing to accomplish as the cross-talk problem is not a serious one. The importance of multiplexing in point-to-point communication services has long been recognized. In broadcasting there are several applications which, while their practical application may be long deferred, are clearly within view.

Two general types of multiplexing were used. In one type a current of superaudible frequency is caused to modulate the frequency of the transmitted wave. The frequency at which the transmitted wave is caused to deviate is the frequency of this current and the extent of the deviation is varied in accordance with modulation of the amplitude of the superaudible frequency current. At the receiver detection is accomplished by separating the superaudible current and its component modulations from the rectified audible frequency currents of the main channel and reproducing the original modulating current from them by a second rectification. The general outline of the system is illustrated in Figs. 27 and 28. The setting of the levels of the main and auxiliary channels must be made in this system of modulation with due regard to the fact that the deviation of the transmitted wave produced by the superaudible frequency current of the second channel is a variable one and changes between the limits of zero and double the unmodulated deviation.

In the second method of multiplexing a superaudible current produces a frequency modulation of the transmitted wave of constant deviation, the rate of the deviation being varied in accordance with the

In High Quality Microphones

for AM Broadcasting, FM Broadcasting and Television Sound

TWELVE years ago, RCA engineers startled the industry by announcing the development of a revolutionary new microphone, "the microphone without a diaphragm."

That microphone was the first velocity microphone—and, back in 1932, it was a daring innovation. There was some shaking of heads over the fact that it looked different, worked differently, and moved the pre-amplifier from the microphone case to the equipment rack.

But, the broadcasting industry—which was just then moving into high gear—quickly found out that the Velocity Microphone was more convenient, more dependable and of far better quality than the condenser microphones then in use.

With one accord, broadcasters adopted the RCA Velocity Microphone for all high-quality pickups, and they have been using them in constantly increasing numbers ever since.

Meantime, RCA engineers, not content with the first velocity microphone, have gone on improving it. They designed new mountings, used new materials to achieve higher output, added new finishes. In 1935 they brought out the Uni-directional Microphone, a velocity-type microphone which has a single-sided pickup (as contrasted to the two-sided pickup of the standard velocity microphone). And in 1939, the "Combination" Microphone—a model which provides uni-directional, bi-directional or non-directional pick-up at the turn of a switch.

Today RCA broadcast microphones are the standard of the industry. Used by NBC, CBS, the BLUE and nearly all regional networks—as well as by most of the independent stations, large and small.

For the best in microphones—and the best in all radio equipment—look to RCA!

RCA

BUY MORE WAR BONDS

RADIO CORPORATION OF AMERICA

RCA VICTOR DIVISION • CAMDEN, N. J.

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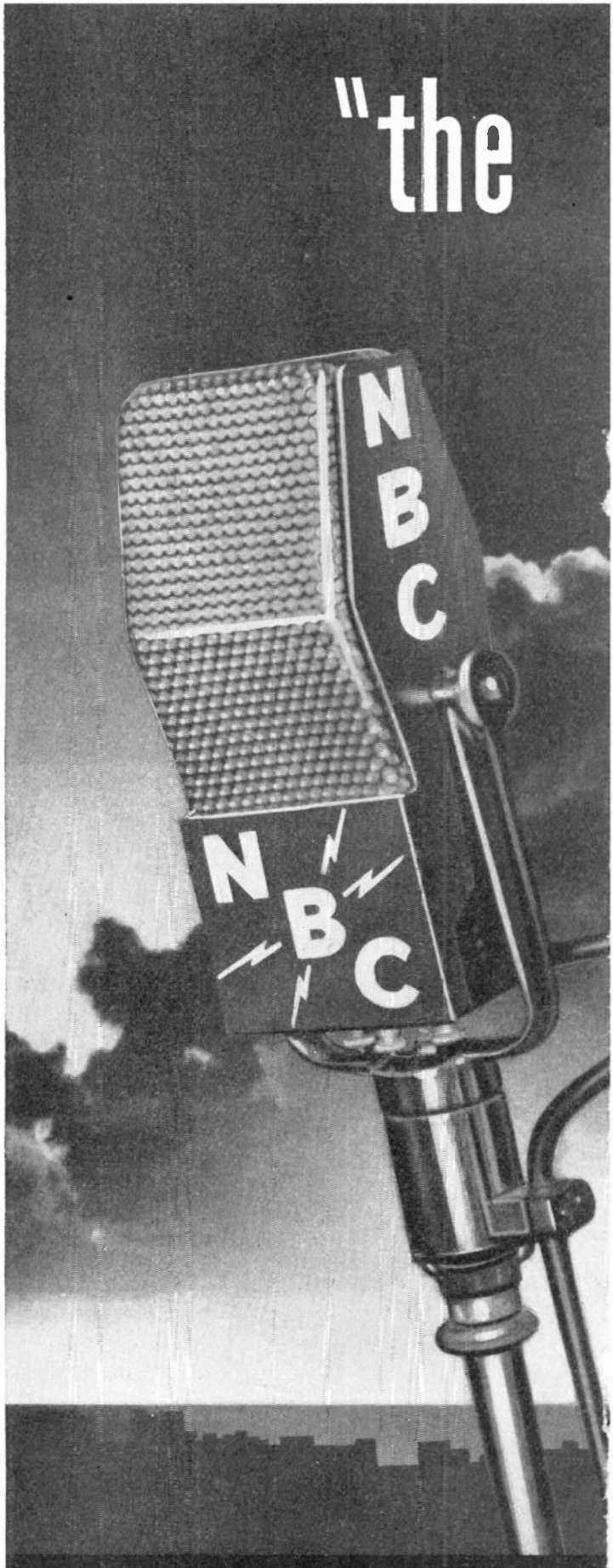

The RCA 44BX Velocity Microphone—favorite for high-quality studio pickups. A frequency response which (when used with RCA pre-amplifiers) is uniform from 30 to 15,000 cycles, makes the 44BX the ideal microphone for FM broadcasting and for high-quality AM broadcasting.

microphones the networks use"

THESE THREE USE ALL THREE
—and so do most of the regional networks—and the best-operated independent stations

The RCA 77-C1 Special-purpose Microphone. Provides a uni-directional, bi-directional or non-directional response as desired. Change from one to another by turn of a switch. Frequency response constant through entire operating angle. A combination of flexibility and quality which is unequaled.

The RCA 88-A Pressure Microphone. A rugged, non-critical unit—especially suited for remote pickups. Weighs only a pound, provides a high output level, has a moisture-proof, molded styrol diaphragm and a protecting wind screen. Response of 60 to 10,000 cycles makes it suitable for many studio uses as well as remotes.

frequency of the superaudible current and modulation being produced by varying the frequency of this auxiliary current and thereby the rate at which the superimposed modulation of frequency of the transmitted wave changes. The operations which must be carried out at the receiver are the following: After suitable amplification, limiting, and filtering, an initial conversion and rectification produces in the output of the detector the audible frequencies of the main channel and a superaudible constant amplitude variable frequency current. This last is selected by means of a band-pass filter, passed through a second conversion system to translate the changes in the frequency into variations of amplitude, and then rectified to recreate the initial modulating current of the auxiliary channel. The general arrangement of the system is illustrated in Figs. 29 and 30. This latter method of multiplexing has obvious advantages in the reduction of cross modulation between the channels and in the fact that the deviation of the transmitted wave produced by the second channel is constant in extent, an advantage being gained thereby which is somewhat akin to that obtained by frequency, as compared to amplitude, modulation in simplex operation. The subject of the behavior of these systems with respect to interference of various sorts is quite involved and will be reserved for future treatment as it is beyond the scope of the present paper.

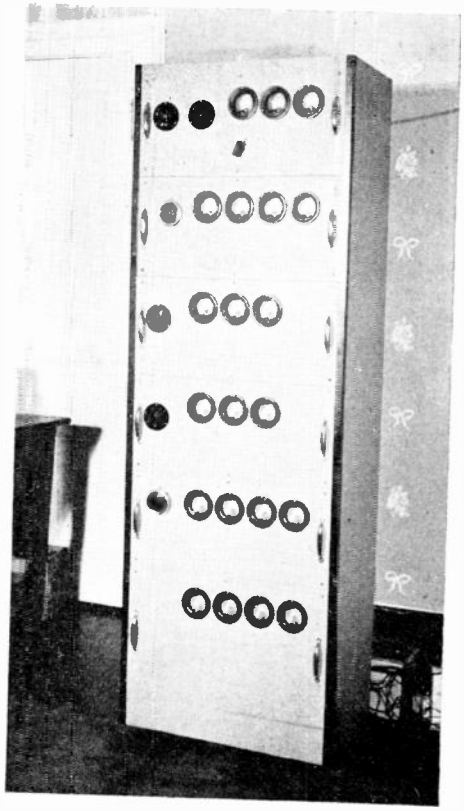

FIG. 36. MODULATING EQUIPMENT FOR THE 110-MC. FM STATION AT YONKERS

The final arrangement of the modulating equipment installed at the Empire State station is illustrated in Figs. 31 and 32. The main channel apparatus is shown on the five tables located on the right side of the room. The vertical rack in the left center contains three channels for transmitting facsimile by means of the amplitude modulation method of multiplexing already described. In Fig. 32, located on the four tables on the left of the room is shown the auxiliary channel of the frequency modulation type already described. The comparatively low frequency of this channel was obtained by the regular method of phase shifting and frequency multiplication, the frequency multiplication being carried to a high order and the resultant frequency modulated current heterodyned down to twenty-five kilocycles (mid-frequency). A deviation up to ten kilocycles was obtainable at this frequency.

The receiving apparatus located at Haddonfield is illustrated in Figs. 33 and 34. Fig. 33 shows the modified Westhampton receiver and Fig. 34 the multiplex channels of the receiver. The vertical rack to the right holds a three-channel receiver of the amplitude modulation type. The two panels in the foreground constitute the frequency modulation type of auxiliary channel.

Some of the practical results may be of interest. It was suggested by C. J. Young of the RCA Manufacturing Company that it might be possible to transmit

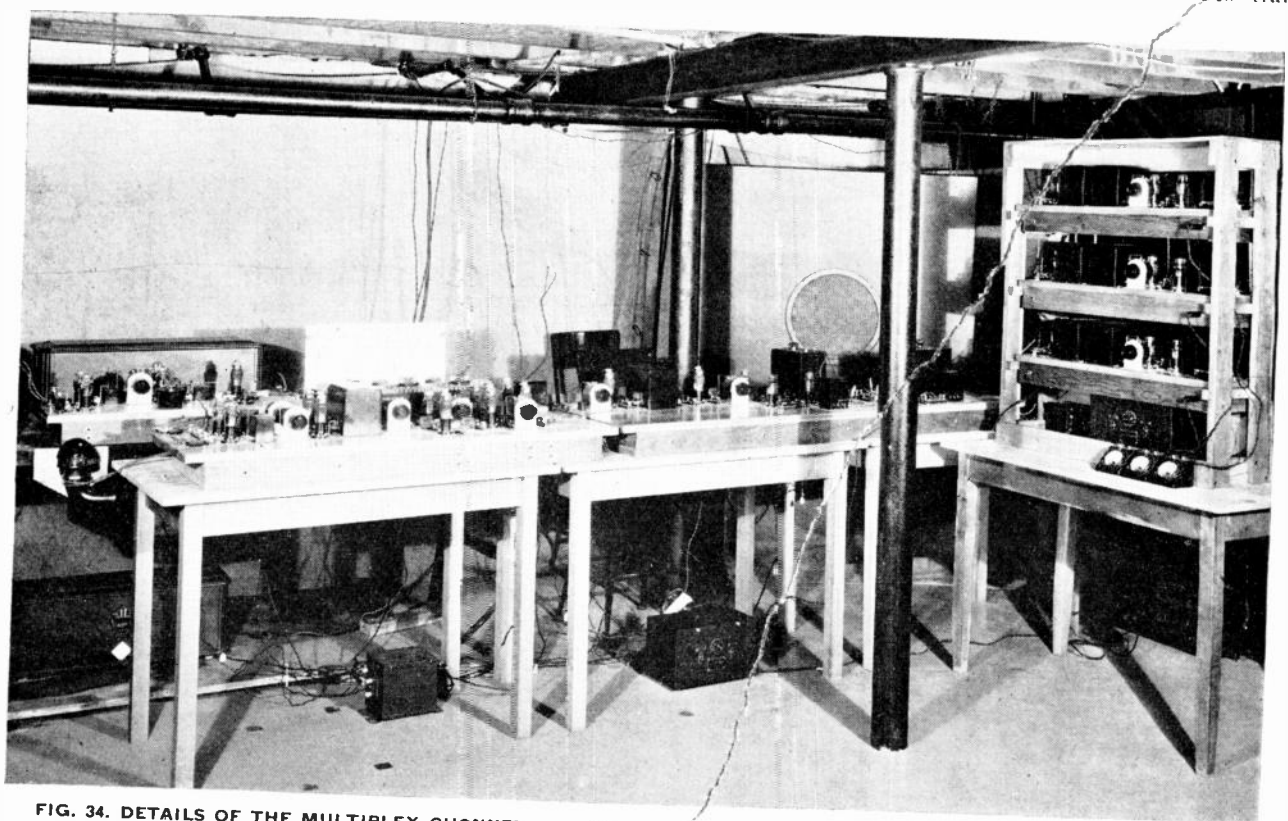

FIG. 34. DETAILS OF THE MULTIPLEX CHANNELS OF THE RECEIVER, INSTALLED FOR TESTS AT HADDONFIELD, N. J.

New York Times.

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NEW YORK, SATURDAY, NOVEMBER 24, 1934. TWO CENTS

VANDERBILT WRIT CALLS ON CAREW TO DEFEND RULING

Definite Decision Is Sought on Habeas Corpus Action to Pave Way for Appeal.

GUARDIAN FIGHT RESUMED

Reply to Mother's Plea Asserts She Is Not Qualified to Fill Such a Position.

Mrs. Gloria Morgan Vanderbilt carried her efforts to obtain custody of her 10-year-old daughter, Gloria, to the Appellate Division yesterday, obtaining from Presiding Justice Edward R. Finch a show cause order in mandamus proceedings against Supreme Court Justice John F. Carew.

At the same time, Justice Carew's decision earlier this week placing Gloria in custody of her aunt, Mrs. Harry Payne Whitney, for five days a week, was followed in Surrogate's Court by action bearing on the child's $2,000,000 estate. George W. Wickersham and Thomas R. Gilchrist, as co-guardians, opposed the plea of Mrs. Vanderbilt that she be made a guardian, also, of the estate.

After the show cause order had been signed by Presiding Justice Finch it was served upon Justice Carew in his chambers by Louis D. Frohlich, associate of Nathan Burkan, Mrs. Vanderbilt's counsel. The order directed the justice to show cause on Nov. 30 why he should not be required either to sustain or dismiss the writ of habeas corpus sought by Mrs. Vanderbilt in the Supreme Court case.

Clear Way for Appeal.

This was done. It was explained, to clear the way for an appeal from

SOVIET ARMY TO AID FRANCE IF INVADED, DEPUTIES ARE TOLD

Reporter of Budget Declares Russia Would Help Repel Any German Attack.

MILITARY FUNDS APPROVED

French War Minister Announces Term of Conscript Service Will Not Be Raised.

By F. J. PHILIP.

Special to The New York Times.

PARIS, Nov. 23.—An understanding by which Soviet Russia has offered her army to aid France in case of attack by Germany was reported in the Chamber of Deputies today by Leon Archimbaud, Reporter of the Budget.

In the course of the debate on the army appropriations, Deputy Archimbaud declared that he puts his hopes for the preservation of peace in a union of strength between France and Russia.

"Only that union," he said, "can stabilize Europe and peace. Russia has a solid, well-equipped army which she offers us in case of conflict with Germany. It may be regrettable that twenty years after the war we should come back to the old policy of a balance of power, but it is not our fault.

"It cannot be denied that an undeniable crisis between the two countries."

After the debate, it was declared in government circles that the Deputy was not speaking for the Cabinet, but was only expressing his idea of what Russia would be likely to do in case of German aggression against France. It was M. Archimbaud who, in his report of

U. S. AND BRITA AS NAVY TALKS JAPAN TO DEN

PACT ASSAILED BY SAITO

Ambassador Says Tokyo Will End It No Matter What Occurs at London.

HOLDS HONOR IS AT STAKE

Tells Philadelphia Audience Ratios Show Japan Is Looked Down On as 'Spoiled Child.'

OPPOSES BUILDING RACE

Declares Tokyo Is Willing to Enter an Agreement to Guard Philippine Independence.

Text of the address by Ambassador Saito, Page 6

Special to The New York Times.

PHILADELPHIA, Nov. 23.—So long as a navy retains its character as a "fighting unit" instead of becoming merely a "patching force," Japan cannot give up her claim for equality in naval strength, Ambassador Hiroshi Saito of Japan said here tonight in an address before the American Academy of Political

Japan's Warn... In a Long C...

By The Asso...

TOKYO, Nov. ... of the budget" ... army and navy ... teen-hour session ... Cabinet.

Before the gove... to give these do... than one billion ... General Sanjuro H... of War, had three... of his demands we... and Admiral Mi... ter of the Navy, ... "the international... be considered."

In the end thes... resistance of S... Minister of Fi... tempted in vain ... from appropriati... limits of the curr...

Details of the 6-... were not revealed... demanded 17,000 ... ships, 78,000,000 ... tonnage, 44,000,000 ... tion of warships ... expansion and ... the air force and ... for new weapons ...

Major army req... 650,000 yen for ne... munitions and ... pansion of the ar...

HULL ENC... UNITY WIT...

For Channel Operation
(1) Music from chain
(2) Synchronizing channel
(3) Facsimile signal
(4) Telegraph channel
Empire State & Haddonfield N. J. W2XOG on 41 megacycles operating on 61 megacycle antenna.

Nov. 24, 1934

Nov. 24, 1934

Nov. 24, 1934

FIG. 35. FACSIMILE RECEPTION FROM 4-CHANNEL MULTIPLEXED OPERATION

simultaneously a facsimile service at the same time that a high quality broadcast program was being transmitted. With the assistance of Mr. Young and Maurice Artzt this was accomplished over a year ago between New York and Haddonfield, New Jersey, the two services operating without interference or appreciable loss of efficiency at the distance involved. Two additional channels, a synchronizing channel for the facsimile and a telegraph channel, were also operated. The character of the transmission is illustrated in Fig. 35, which shows a section of the front page of the *New York Times*. This particular sheet was transmitted under considerable handicap at the transmitter as due to a failure of the antenna insulator on the forty-one-megacycle antenna it had become necessary to make use of the sixty-megacycle antenna for the forty-one-megacycle transmission. It is an interesting comment on the stability of the circuits that all four were kept in operation at the transmitter by one man, Mr. Buzalski, who was alone in the station on that day. The combined sound and facsimile transmission has been in successful operation for about a year, practically perfect copy being obtained throughout the period of the severe atmospheric disturbances of the past Summer. The subject of this work and its possibilities can best be handled by Mr. Young, who is most familiar with it.

Acknowledgment ★ On account of the ramifications into which this development entered with the commencement of the field tests many men assisted in this work. To some reference has already been made.

I want to make further acknowledgment and express my indebtedness as follows:

To the staff of the National Broadcasting Company's station W2XDG for their help in the long series of field tests and the conducting of a large number of demonstrations, many of great complexity, without the occurrence of a single failure;

To Mr. Harry Sadenwater of the RCA Manufacturing Company for the facilities which made possible the Haddonfield tests and for his help with the signal-to-noise ratio measurements herein recorded;

To Mr. Wendell Carlson for the design of many of the transformers used in the modulating equipment;

To Mr. M. C. Batsel and Mr. O. B. Gunby of the RCA Manufacturing Company for the sound film records showing the comparison, at Haddonfield, of the Empire State transmission with that of the regular broadcast service furnished by the New York stations;

To Mr. C. R. Runyon for his development of the two-and-one-half-meter transmitters and for the solution of the many difficult problems involved in the application of these principles of modulation thereto;

To Mr. T. J. Styles and particularly to Mr. J. F. Shaughnessy, my assistants, whose help during the many years devoted to this research has been invaluable.

Conclusion ★ The conclusion is inescapable that it is technically possible to furnish a broadcast service over the primary areas of the stations of the present-day broadcast system which is very greatly superior to that now rendered by these stations. This superiority will increase as methods of dealing with ignition noise, either at its source or at the receiver, are improved.

Appendix ★ Since the work which has been reported in this paper on forty-one megacycles was completed attention has been paid to higher frequencies. On the occasion of the delivery of the paper a demonstration of transmission on 110 megacycles from Yonkers to the Engineering Societies Building in New York City was given by C. R. Runyon, who described over the circuit the transmitting apparatus which was used. A brief de-

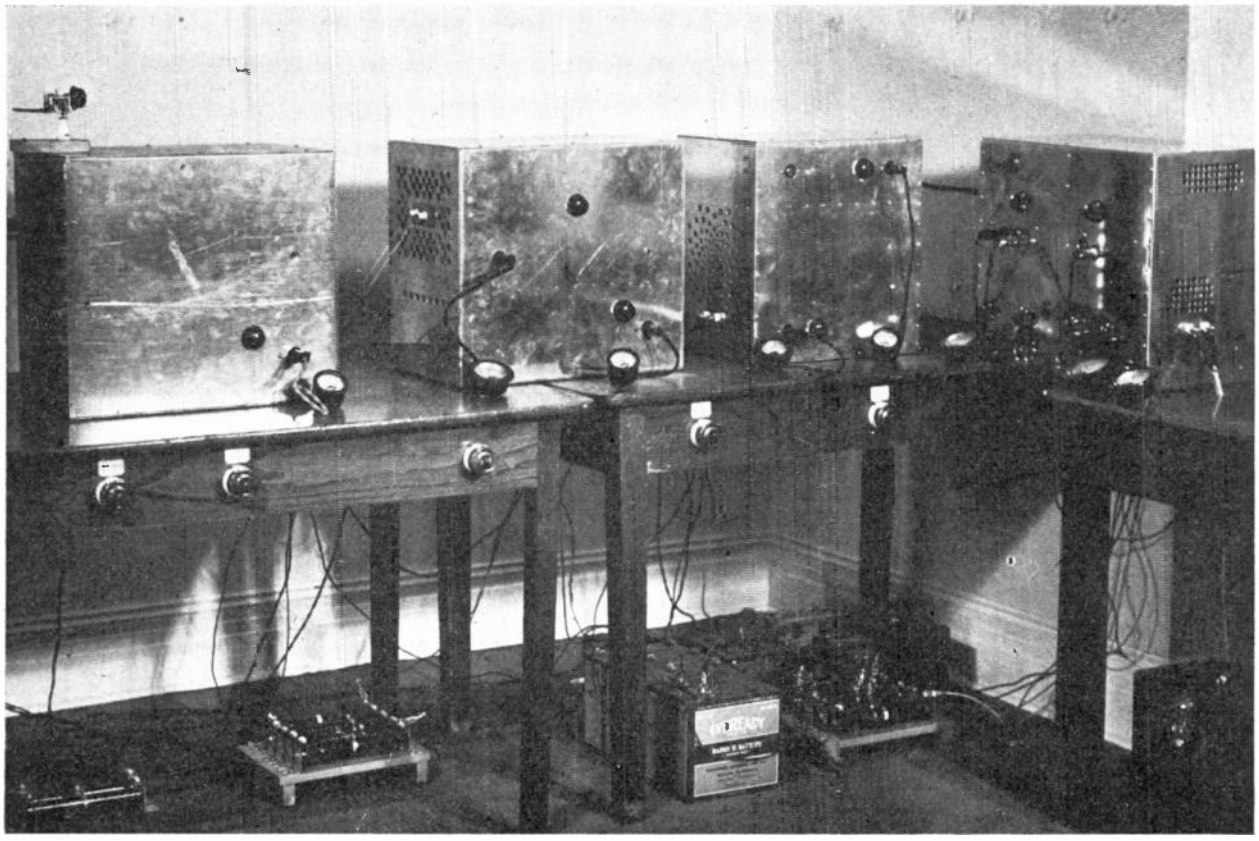


FIG. 37. HIGHER POWER MULTIPLIER AND POWER AMPLIFIER OF THE 110-MC. YONKERS STATION, USED FOR I.R.E. DEMONSTRATION

scription of this transmitter is reproduced here.

The power delivered to the antenna was approximately 100 watts at 110 megacycles and the deviation (one half total swing) used during the demonstration was under 100 kilocycles. Fig. 36 illustrates the modulating equipment for this transmitter and the low power frequency multiplication stages. Fig. 37 shows the higher power frequency multiplier and power amplifier stages of the transmitter.

The rack shown in Fig. 36 consists of six panels. Panel number one at the top contains the correction system. Panel number two contains the master oscillator of 100 kilocycles and the modulator circuits. Panel number three contains a pair of doublers for multiplying the 100-kilocycle frequency to 400 kilocycles and the necessary filtering means for avoiding the modulation of the currents in the succeeding doubler stages by the 100-kilocycle oscillator current. Panel number four contains the doubling apparatus for raising the frequency to 3200 kilocycle and panel number five the multipliers for raising it to 12,800 kilocycles. Panel number five also contains a heterodyning and conversion system for beating the 12,800 kilocycles down to 2292 kilocycles. Panel number six contains a doubler for raising this to 4584 kilocycles and an amplifier for increasing the level sufficiently to drive the succeeding power stage. The output of this amplifier is fed through a transmission line to the metal box at the extreme right of Fig. 37 which contains a series of doublers and amplifiers for increasing the level and raising the frequency to 36,672 kilocycles. Adjacent to this box is a second box which contains a fifty-watt amplifier. This amplifier drives a tripler located in the third box and the tripler in turn drives the power amplifier located at the extreme left at 110 megacycles. The transmitter circuits were designed for total frequency swing of 500 kilocycles and may be effectively so operated. Because of the limitation of the receiver available at that time the demonstration was carried out with a swing of 200 kilocycles.

This concludes Major Armstrong's original FM paper, delivered Nov. 6, 1934.

THEORY VS PHYSICAL REASONING

(CONTINUED FROM PAGE 13)

"Since it was E. H. Armstrong's important engineering developments that paved the way for frequency modulation in broadcasting, it may not be out of place to present first his type of transmitter.

"Some of the important theoretical contributions that were made prior to any important engineering applications did not exactly predict great advantages for FM over AM. The reason for this was, perhaps, that general solutions of just one phase, i.e., of FM by itself, without taking the difference between wide-band and narrow-band FM into consideration, did not show any particular advantages for FM. Naturally, any system of modulation, if ideally applied, should do the same as any other system of modulation. A modulation current does not realize, if it could, whether it is deformed in amplitude, phase, or in frequency. . . ."

Just what these words mean I do not know. But what Mr. Hund seeks to imply is that if some mathematician had sat down with his equations and thought about frequency modulation he might have made the present invention. History does not support this view. Too many able mathematicians have investigated the subject of frequency modulation and the problem of static reduction with results entirely negative.

The "important theoretical contributions" Mr. Hund refers to were important only because they predicted great disadvantages for frequency modulation as compared to amplitude modulation. It was in the face of these barriers of false conclusions that the experimental method based on physical reasoning laid bare the hidden phenomena which led to the invention of the FM system.

It is a great disservice to the cause of engineering education to try to teach the student of the art the opposite lesson.

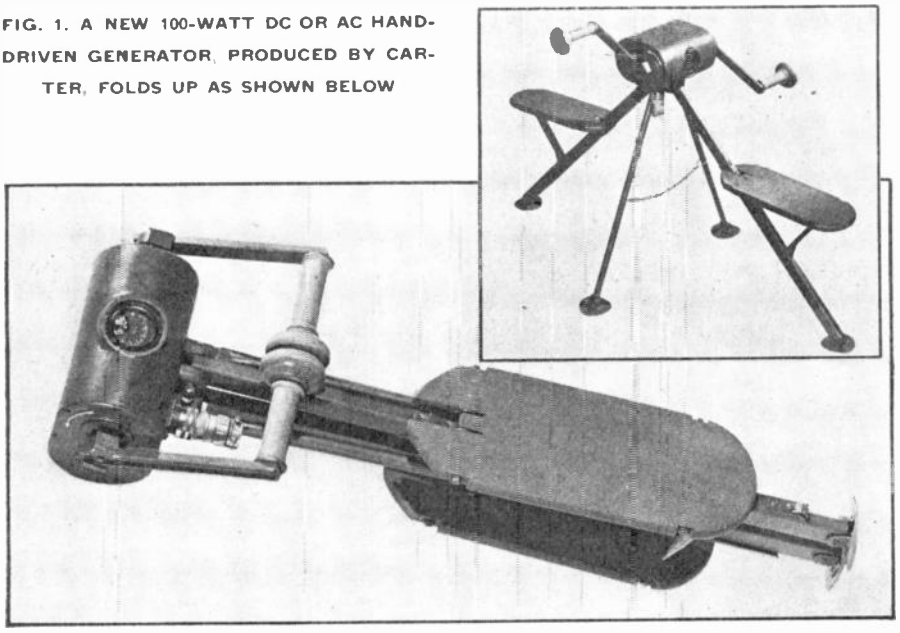


FIG. 1. A NEW 100-WATT DC OR AC HAND-DRIVEN GENERATOR, PRODUCED BY CARTER, FOLDS UP AS SHOWN BELOW

RADIO DESIGNERS' ITEMS

Notes on Methods and Products of Importance to Design Engineers

Hand Generator: Output of hand-operated generators has been stepped up to 100 watts by Carter Motor Company, 1608 Milwaukee Avenue, Chicago. Such a model is illustrated in Fig. 1. This unit, designed for military use, employs a permanent-magnet field, thus saving about 10 watts of power otherwise required to activate field coils.

The oval frame of the generator accommodates a ripple filter and a meter placed so that one of the two men operating the cranks can observe the output. The needle and the operating line on the scale are tipped with phosphorescent material, for night use. Seals on the shafts give waterproof protection to the interior, and the all-temperature grease in the gear train cannot leak out. A 4-pin connector is provided for connection to the two output voltages.

A wide choice of DC voltages suit all operating requirements up to 500 volts for plate supply, plus the filament voltage. There is also a 117-volt AC model. Total weight of the complete unit illustrated is 37 lbs.

Oscillograph: The Du Mont type 248 is a moderately-priced portable oscillograph and power supply suitable for laboratory or production test purposes. The oscillograph and power supply shown in Fig. 2 are connected by a 6-ft. plug-in shielded cable, facilitating handling and installation. A removable cover protects the oscillograph panel when it is not in use. Power supply weighs 80 lbs.; oscillograph, 30 lbs. Each unit measures 14 by 18 by 21 ins. deep.

Either transient or recurrent phenomena are reproduced. It also accommodates phenomena of inconstant repetition rate. The leading edge of short pulses is not obliterated. Accelerating potential applied to the cathode-ray tube is great enough to permit the study of extremely short pulses with low repetition rates, usually observed only with specialized and costly oscillographic equipment. Timing markers are available for quantitative or calibration purposes.

Among the features of this oscillograph are a wide-band vertical axis amplifier usable to 10 mc. and 4,000 volts accelerating potential applied to cathode-ray tube, allowing observations of fast writing-rate phenomena. An extremely flexible time base generator displays signals which heretofore required special sweep circuits. There is a delay network in the vertical channel, permitting observation of entire wave shapes of short duration phenomena. Convenient mechanical design permits placing the separate power supply on the floor or on a shelf beneath the laboratory bench. Storage space for cable and leads is provided in power unit. Additional information is available from Allen B. Du Mont Laboratories, Inc., 2 Main Avenue, Passaic, N. J.

Miniature Tubes: Three types have been added by Hytron Corporation, Salem, Mass. They are: 6AK5 sharp-cutoff RF pentode; 6AL5 very high frequency twin diode; and 6AQ6 double diode triode.

Small Voltage Regulator: Is available from American Transformer Company, 178 Emmet Street, Newark, N. J. It offers the advantages of the transformer type regulator with high rating-to-size ratio. The brush arm is an accurately machined die casting which permits good heat dissipation, provides a simple means for changing brushes, and protects the commutator from short-circuiting with the brush holder.

The shaft can be removed by drawing one pin. Thus the unit can be changed quickly from panel to table mounting, or

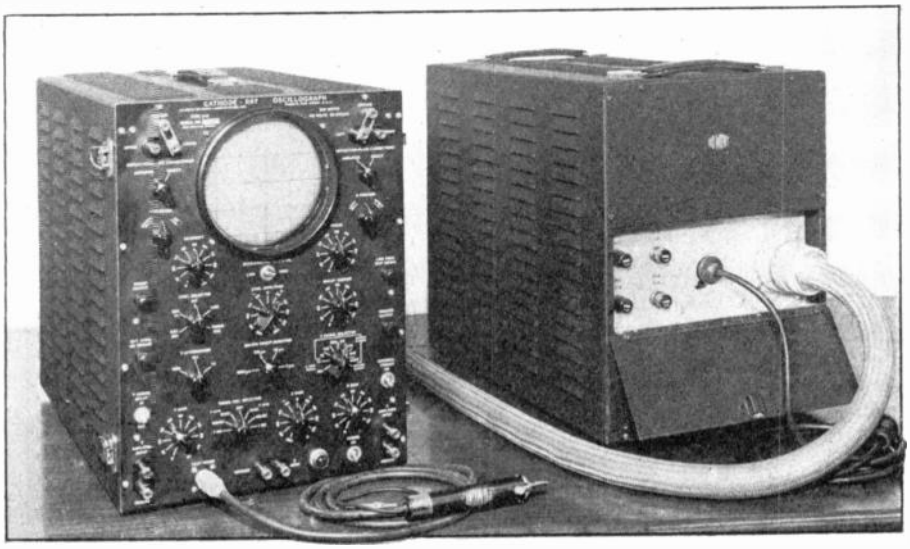


FIG. 2. A NEW DU MONT OSCILLOGRAPH HAS BEEN DESIGNED WITH FEATURES WHICH PERMIT STUDY OF SPECIAL PHENOMENA. SEPARATE POWER PACK ADDS CONVENIENCE

ganged with others for polyphase or simultaneous single-phase control.

The winding is of vinyl acetate insulated wire, and the coil and core are impregnated with a polymerizing synthetic phenolic resin and baked. Metal fittings are corrosion resistant.

Constant Voltage Transformer: To meet the trend toward using built-in automatic voltage regulation of filament supplies, Sola Electric Company, 2525 Clybourn Avenue, Chicago 14, is furnishing units as shown in Fig. 3.

This particular transformer, rated at 6.3 volts and 2.75 amperes, maintains an output constant within 1% under line voltage variations of 12 to 15%, or 95 to 125 volts. E-C oscillators and other circuits, operated with such a constant voltage transformer, deliver stable performance without the use of manual controls and voltmeters for correction.

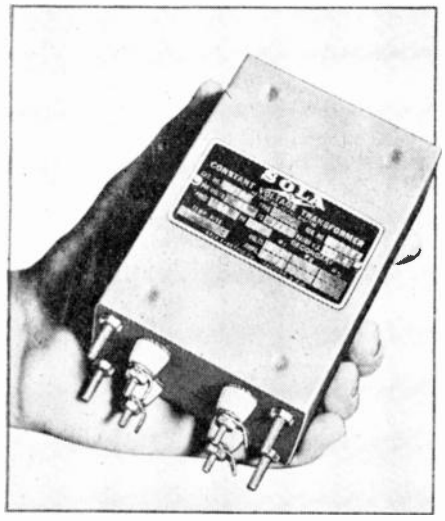


FIG. 3. CONSTANT VOLTAGE TRANSFORMER

Considerable development in the use of these transformers has come about and is expected in the future for equipment where performance, particularly with regard to frequency, is affected by AC line-voltage fluctuations.

New designs of constant voltage transformers are fully described in a new manual 5CV-102 which will be released shortly by Sola.

Cam Switch: A new master cam lever switch, model MCL-CS, is announced by General Control Company, 1200 Soldiers Field Road, Boston 34, Mass. This switch, Fig. 4, is designed for controlling multiple circuits on electronic and communications equipment.

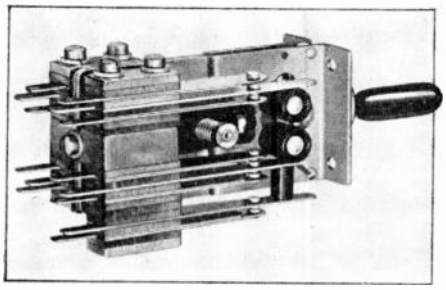


FIG. 4. MASTER CAM LEVER SWITCH

The positive positioning cam has roller detents which eliminate friction and contact bounce. Coil springs are used on both sides of the cam so that equalized pressure is assured regardless of the number or arrangement of contact assemblies.

The assembly is static-shielded, and is of non-corrosive construction. All contacts can be removed from the frame by removing a single bolt. Control knob can be supplied with light or stiff action. Contact rating is 10 amps. at 125 volts AC, or 2 amps. at 125 volts DC.

UHF Signal Generator: Federal Manufacturing & Engineering Corp., 211 Steuben Street, Brooklyn 6, N. Y., is producing type 804-CS1 and 804-CS2 UHF signal generators covering 7.6 to 330 mc., accurate to plus or minus 2%. Output is controlled by a calibrated attenuator network from 1 to 20,000 microvolts. The instrument is illustrated in Fig. 5.

The output is arranged so that an internal source of modulation at 1,000 cycles can be used, or an external source of modulation can be used between 30 and 20,000 cycles. The modulation is adjustable from 0 to 60%, indicated by a direct-reading modulation meter.

A special input circuit is provided so that, by a circuit-switching device on the panel, it is possible to modulate the generator from an external source having very steep wave fronts and extending in rapidity to pulses of about 20 micro-seconds.

Stray field leakage is held to a minimum by thorough shielding and RF filters. A built-in stabilized power supply operates on 115 volts or 230 volts AC., 40 to 60 cycles, single phase, insuring a minimum of frequency change due to power line fluctuations.

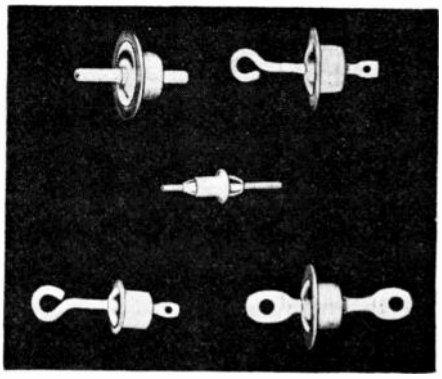


FIG. 6. HERMETIC TERMINAL SEALS

Accessories include a 3-ft. coaxial output cable of 75 ohms impedance, a fixed 10:1 attenuation reduction unit, a special terminal unit, adapter plug, line cord, extra blank plug-in coil form, spare pilot lamps, and fuses.

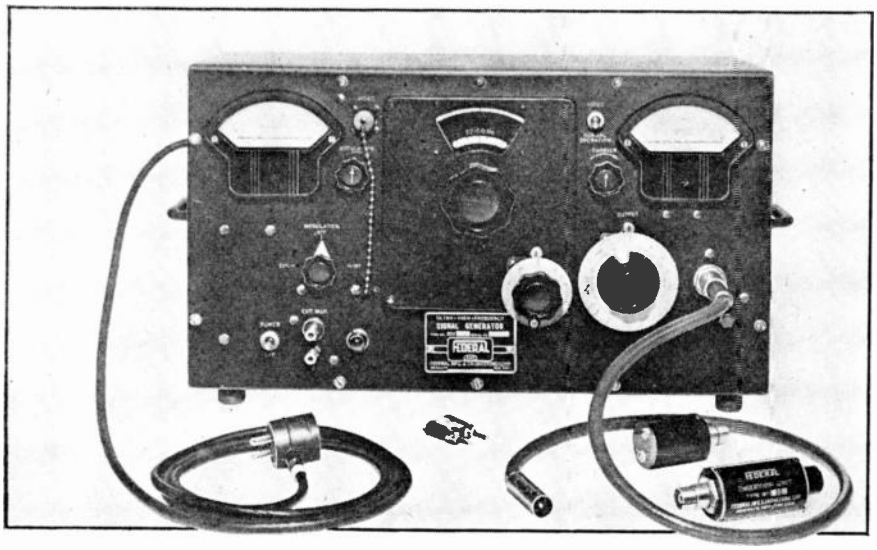
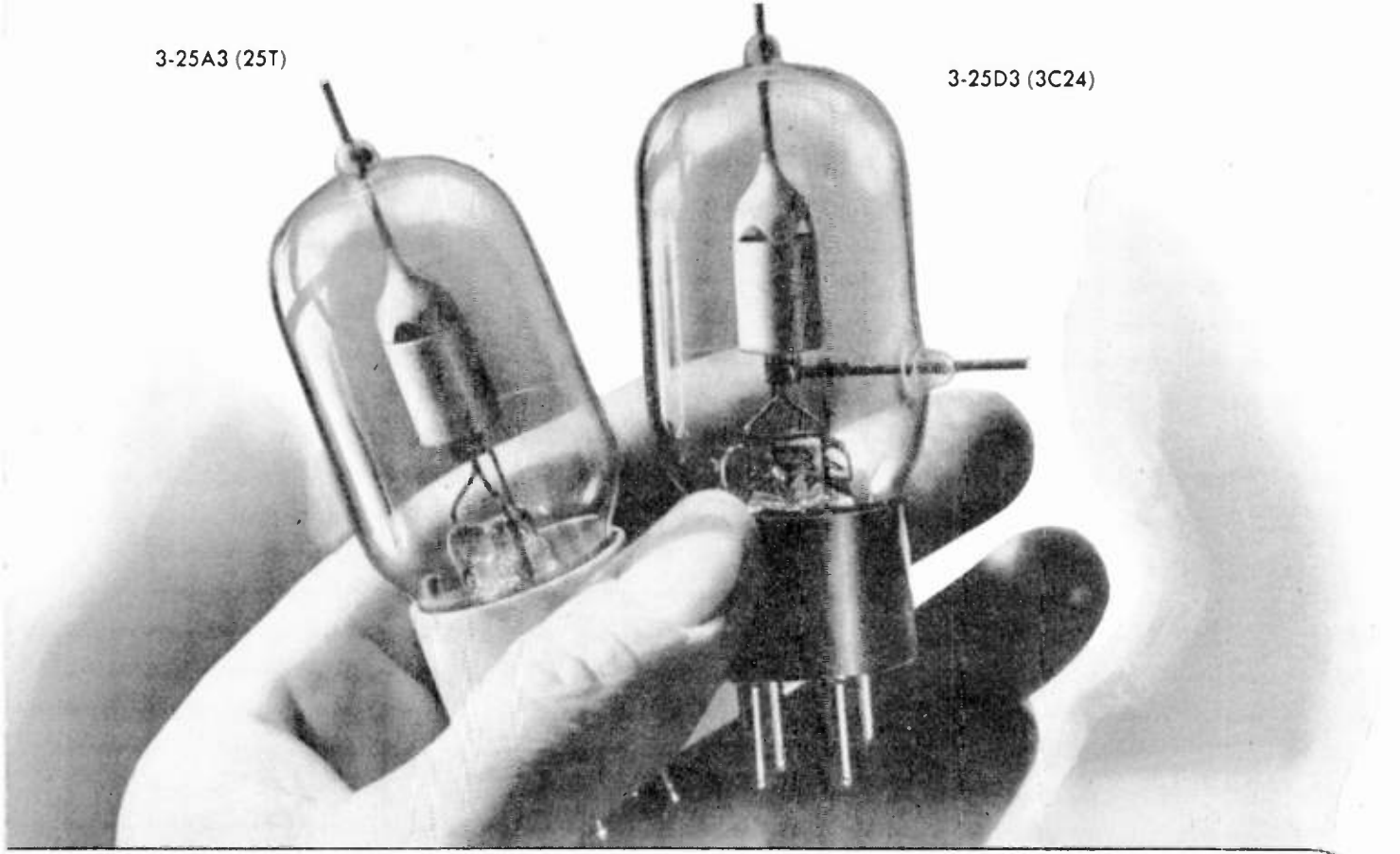


FIG. 5. SIGNAL GENERATOR FOR USE AT FREQUENCIES OF 7.6-330 MC.

Hermetic Seals: Several types of hermetic seals using Kovar electrodes and Pyrex glass are shown in Fig. 6. They are manufactured by Electrical Industries, Inc., 42 Summer Avenue, Newark 4, N. J. Pyrex glass is used to assure high dielectric strength, minimum surface leakage and maximum water-shedding properties, with immunity from reasonable thermal or mechanical shock.

Kovar electrodes, described as ideal for soldering, brazing, or welding, can be obtained in a wide variety of sizes and shapes for all standard applications. This combination of metal and glass is intended to furnish a gas- and moisture-tight bond,

(CONTINUED ON PAGE 56)



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	3-25A3(25T)	3-25D3(3C24)
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Amplification Factor	25	25
Filament Volts	6.3	6.3
Filament Current (amps.)	3.0	3.0
Interelectrode Capacities:		
Grid to Plate	1.6	1.6
Grid to Filament	2.5	1.8
Plate to Filament	0.2	0.2
Maximum Ratings (Class C amplifier):		
Plate Voltage (DC)	2000 volts	2000 volts
Plate Current (DC)	75 mills	75 mills
Grid Current (DC)	20 mills	20 mills
Maximum Plate Dissipation (watts)	25	25

Smaller brothers of the Eimac 35T and 35TG, these two triodes are filling a need in high-frequency equipment of relatively low-powered class. They attain a high order of efficiency on frequency in the VHF range and perform equally well at lower frequencies.

In every way these two are worthy additions to the Eimac family . . . embodying all the Eimac features including complete freedom from premature emission failures due to gas released internally.

Complete data is available without obligation. Write for it today. Also ask for your complimentary copy of *Electronic Telesis*, a sixty-four page booklet which gives the fundamentals of Electronics and many of its applications. Written in layman's language, this booklet will assist engineers in explaining the art to novices.

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SPRINGFIELD, Cushing, T. F.
WORCESTER, Radio Maint. Supply Co.

MICHIGAN
FLINT, Shand Radio Spec., W. Kearsley St.

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Harrison Radio Corp., 12 W. B'way
Harvey Radio Co., 103 W. 43 St., N. Y. C.
Radio Wire Television, Inc., 100 Sixth Ave.
Sanford Electronics Corp., 136 Liberty St.
Sun Radio & Electronics Co., 212 Fulton St.
Terminal Radio Corp., 85 Cortlandt St.
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OHIO
CLEVELAND, Goldhamer, Inc., Huron Rd.

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HARRISBURG, D & H Distributing Co., 3115 Cameron St.
PHILADELPHIA, Radio Elec. Service Co., 7th & Arch Sts.
PITTSBURGH, Cameradio Co., 963 Liberty St.
WILLIAMSPORT, Williamsport Auto Parts Co.

RHODE ISLAND
PROVIDENCE, Edwards Co., W. H., 94 B'way

SOUTH DAKOTA
SIOUX FALLS, Power City Radio Co., S. Main Ave.

TENNESSEE
KNOXVILLE, McClung Co., C. M.
MEMPHIS, Bluff City Dist. Co., Union Ave.
NASHVILLE, Electra Dist. Co., W. End Ave.

TEXAS
HOUSTON, Hall, R. C. & L. F., Caroline St.

UTAH
SALT LAKE CITY, Radio Studios, Inc., E. B'way

VIRGINIA
DANVILLE, Five Forks Battery Station
RICHMOND, Wyatt-Cornick, Inc., Grace St.

WASHINGTON
SEATTLE
Seattle Radio Supply, Inc., 2nd Ave.
Sobrist Co., 2016 Third Ave.

WEST VIRGINIA
CHARLESTON, Chemcity Radio Elec. Co. E. Washington St.
MORGANTOWN, Trenton Radio Co.

WISCONSIN
RACINE, Standard Radio Parts Co., State St.

NEW LISTINGS ADDED THIS MONTH

Company addresses will be found in the Directory listings

We shall be pleased to receive suggestions as to company names and hard-to-find items which should be added to this Directory

NOTE: For the convenience of engineers and purchasing agents, we have added, under the heading "SUPPLY HOUSES," a list of parts jobbers in 48 cities. These houses carry large stocks of components, instruments, and tubes, and are prepared to fill mail or telegraph orders.

SUPPLY HOUSES
Harvey Radio Co.

ANTENNAS, Mobile Whip & Collapsible
Air Associates, Inc.

BUSHINGS, Terminal Sealing
Electrical Industries, Inc.
Sperti, Inc.

CHOKES, RF
Automatic Winding Co., Inc.

FREQUENCY STANDARDS, Secondary
American Time Products

IRONS, Soldering
Ungar, Inc., Harry A.

MICROPHONES
Radio Corp. of America

MOTORS, Very Small
Eastern Air Devices, Inc.

RADIO TRANSMITTERS & RECEIVERS
Air Associates, Inc.
Farnsworth Tele. & Radio Corp.
Radiation Products, Inc.

RELAYS, Transmitter Switching and Keying
Leach Relay Co.

TURNTABLES, Phonograph
Fairchild Camera & Instrument Co.
General Instrument Corp.
Presto Recording Corp.
Seeburg Corp., J. P.
Webster Products

AIRPORT RADIO Installations

Aircraft Accessories Corp., Funston Rd., Kansas City, Kans.
Air Associates, Inc., Los Angeles, Calif.
Bendix Radio, Towson, Md.
Communications Equip. Corp., 134 Colorado St., Pasadena, Calif.
Erco Radio Labs. Inc., Hempstead, L. I., N. Y.
Radio Receptor Co., Inc., 251 W. 19 St., N. Y. C.

ANTENNAS, Mobile Whip & Collapsible

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Aircraft Accessories Corp., Funston Rd., Kansas City, Kans.
Bendix Aviation Corp., Pacific Div., 116 Sherman Way, N. Hollywood
Birnbach Radio Co., 145 Hudson St., N. Y. C.
Brach Mfg. Corp., L. S., Newark, N. J.
Camburn Elec. Co., 484 Broome St., N. Y. C.
★ Galvin Mfg. Corp., Chicago, Ill.
★ Link, F. M., 125 W. 17th St., N. Y. C.
Premax Products, 4214 Highland Ave., Niagara Falls, N. Y.
★ Radio Eng. Labs., Inc., L. I. City, N. Y.
★ Snyder Mfg. Co., Noble & Darien Sts., Phila.
Tech. Appl. Co., 516 W. 34 St., N. Y. C.
Ward Products Corp., 1523 E. 45 St., Cleveland, O.

ANTENNAS, Tower Type

Blaw-Knox Co., Pittsburgh, Pa.
★ Harco Steel Cons. Co., E. Broad St., Elizabeth, N. J.
Lehigh Structural Steel Co., 17 Battery Pl., N. Y. C.
★ Lingo & Son, John E., Camden, N. J.
Truscon Steel Co., Youngstown, O.
★ Wincharger Corp., Sioux City, Iowa

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General Radio Co., Cambridge, Mass.
International Resistance Co., 429 Broad St., Phila.
Malbry & Co., P. R., Indianapolis, Ind.
Ohmite Mfg. Co., 4835 W. Fleurnoy St., Chicago
Remler Co., Ltd., 2101 Bryant St., San Francisco
Shallcross Mfg. Co., Collingdale, Pa.
Tech Laboratories, Lincoln St., Jersey City, N. J.
Utah Radio Prod. Co., 842 Orleans St., Chicago

BEADS, Insulating

Amer. Lava Corp., Chattanooga, Tenn.
Corning Glass Works, Corning, N. Y.
Dunn, Inc., Struthers, 1321 Cherry, Phila., Pa.
Star Porcelain Co., Trenton, N. J.
Steward Mfg. Co., Chattanooga, Tenn.

BEARINGS, Glass Instrument

Bird, Richard H., Waltham, Mass.

BINDING POSTS, Plain

Amer. Hdware Co., Mt. Vernon, N. Y.
Franklin Mfg. Corp., 175 Varick St., N. Y. C.
Radex Corp., 1308 Elston Ave., Chicago

BINDING POSTS, Push Type

Amer. Radio Hdware Co., Mt. Vernon, N. Y.
Eby, Inc., H. H., W. Chelten Ave., Phila.

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Shallcross Mfg. Co., Collingdale, Pa.

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Peerless Electrical Prod. Co., 6920 McKinley Ave., Los Angeles 1
Sperti, Inc., Cincinnati, O.
Westinghouse Elect. & Mfg. Co., E. Pittsburgh, Pa.

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Par-Metal Prod. Corp., 32-49th St., L. I. City, N. Y.
Insuline Corp. of Amer., Long Island City, N. Y.

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Tillotson Furniture Co., Jamestown, N. Y.

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Anaconda Wire & Cable Co., 25 B'way, N. Y. C.
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Belden Mfg. Co., 4673 W. Van Buren, Chicago
Boston Insulated Wire & Cable Co., Boston
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Doolittle Radio, Inc., 7521 S. Loomis Blvd., Chicago
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General Insulated Wire Corp., 53 Park Pl., N. Y. C.
Johnson Co., E. F., Waseca, Minn.
★ Lenz Electrical Mfg. Co.
Radex Corp., 1308 Elston Ave., Chicago
Simplex Wire & Cable Corp., Cambridge, Mass.

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Simplex Wire & Cable Corp., Cambridge, Mass.

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Anaconda Wire & Cable Co., 25 Broadway, N. Y. C.
Belden Mfg. Co., 4633 W. Van Buren, Chicago
Boston Insulated Wire & Cable Co., Dorchester, Mass.
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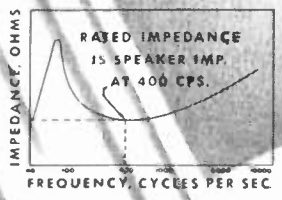

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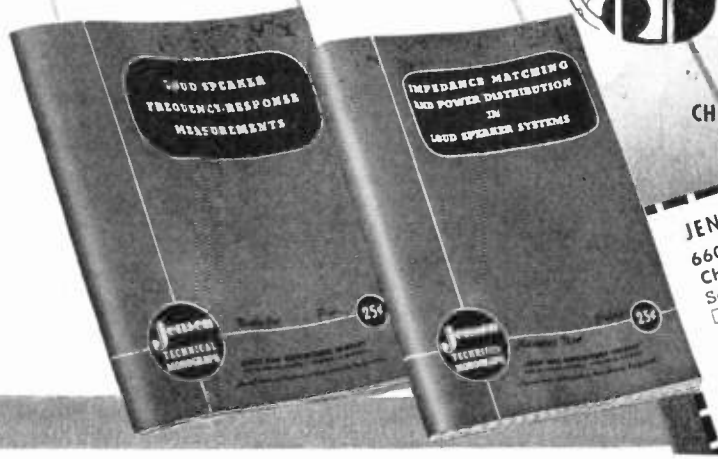

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General Managers & Chief Engineers — May, November

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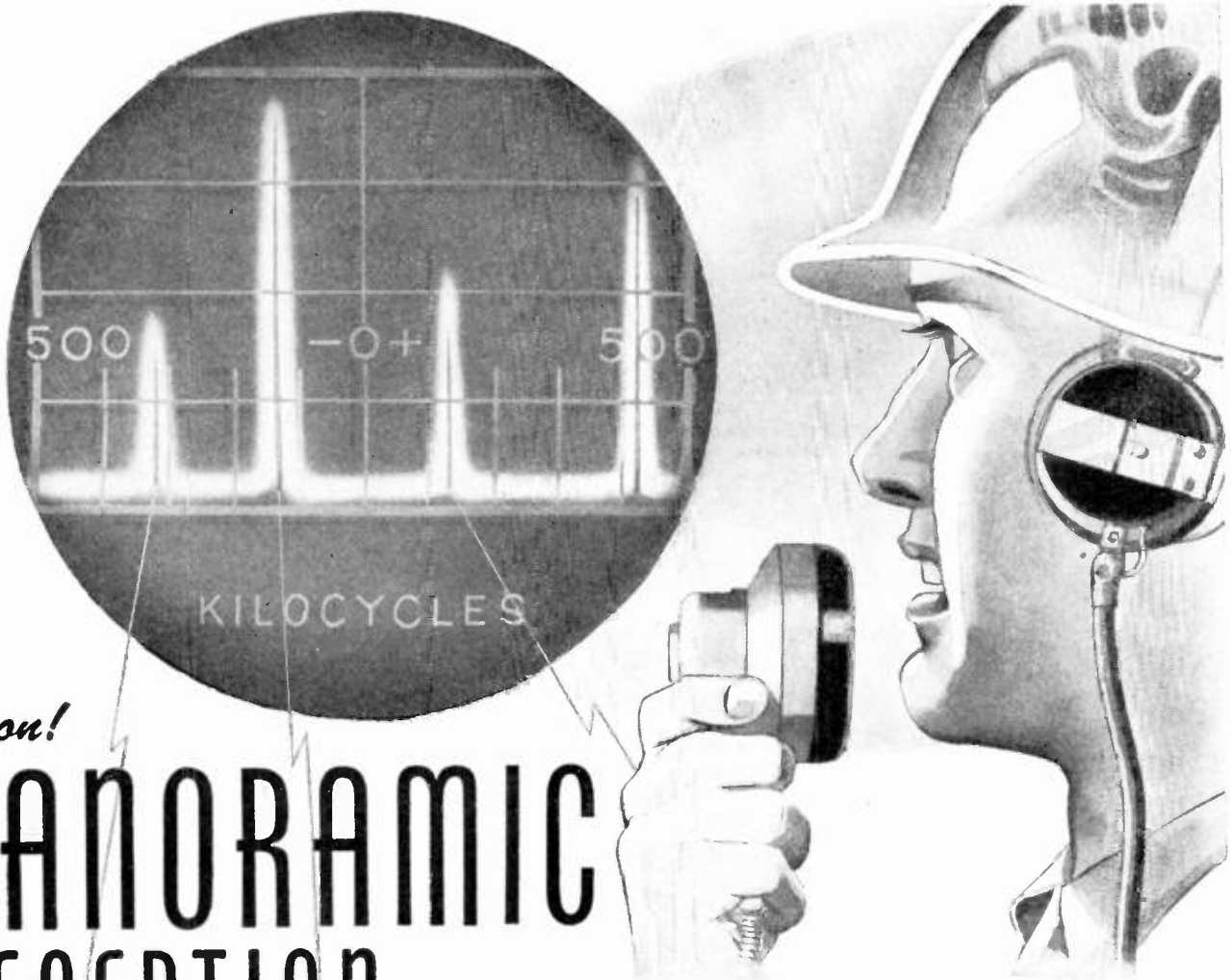

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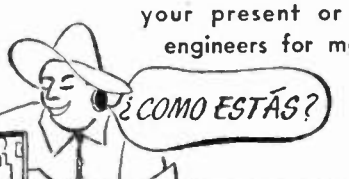

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Royal Engineering Co. (Royco Grease), East Hanover, N. J.

HANDSETS, Telephone

Automatic Electric Co., 1033 W. Van Buren, Chicago
Western Electric Co., 195 B'way, N. Y. C.

HEADPHONES

Brush Development Co., Cleveland, O.
Cannon Co., C. F., Springwater, N. Y.
Carron Mfg. Co., 415 S. Aberdeen, Chicago
Connecticut Tel. & Elec. Co., Meriden, Conn.
Consolidated Radio Prod. Co., W. Erie St., Chicago
Elec. Ind. Mfg. Co., Red Bank, N. J.
Kellogg Switchboard & Supply Co., 6650 S. Cicero Ave., Chicago
Murdock Mfg. Co., Chelsea, Mass.
Permoflux Corp., W. Grand Ave., Chicago
Telephonics Corp., 350 W. 31 St., N. Y. C.
Trimm Radio Mfg. Co., 1770 W. Berteau, Chicago
★ Universal Microphone Co., Inglewood, Cal.
Utah Radio Prod. Co., 842 Orleans St., Chicago

HORNS, Outdoor

Altec Lansing Corp., 1680 N. Vine, Hollywood 28
Graybar Elect. Co., Lexington Ave. at 43 St., N. Y. C.
★ Jensen Radio Mfg. Co., 6601 S. Laramie Ave., Chicago
Operadio Mfg. Co., St. Charles, Ill.
Oxford Tartak Radio Corp., 915 W. Van Buren St., Chicago
Racon Electric Co., 52 E. 19 St., N. Y. C.
★ RCA Mfg. Co., Camden, N. J.
University Laboratories, 225 Varick St., N. Y. C.

INDUCTION HEATING EQUIPMENT

Induction Heating Corp., 389 Lafayette St., N. Y. C.
Lepel High Frequency Labs., 39 W. 60 St., N. Y. C.

INDUCTORS, Transmitter

Barker & Williamson, Upper Darby, Pa.

INDUCTORS, Variable Tuning

Barker & Williamson, Darby, Upper Pa.

INSTRUMENTS, Radio Laboratory

Ballantine Laboratories, Inc., Boonton, N. J.
Boonton Radio Corp., Boonton, N. J.
Ferris Inst. Corp., Boonton, N. J.
★ General Electric Co., Schenectady, N. Y.
General Radio Co., Cambridge, Mass.
Hewlett-Packard Co., Palo Alto, Calif.
★ Measurements Corp., Boonton, N. J.

INSULATORS, Ceramic Stand-off, Lead-in, Rod Types

America Lava Corp., Chattanooga, Tenn.
Corning Glass Works, Corning, N. Y.
Electronic Mechanics, Inc., Clifton, N. J.
Isolantite, Inc., Belleville, N. S.
Johnson Co., E. F., Waseca, Minn.
Lapp Insulator Co., Inc., Leroy, N. Y.
Locke Insulator Co., Baltimore, Md.
Millen Mfg. Co., Malden, Mass.
★ National Co., Inc., Malden, Mass.

IRON CORES, Powdered

Aladdin Radio Industries, Inc., 501 W. 35 St., Chicago
Crowley & Co., Henry, W. Orange, N. J.
Ferrocart Corp. of Amer., Hastings-on-Hudson, N. Y.
Genl. Antline Wks., 485 Hudson St., N. Y. C.
Gibson Elec. Co., Pittsburgh, Pa.
Magner Mfg. Co., Inc., 444 Madison Ave., N. Y. C.
Mallory & Co., P. R., Indianapolis, Ind.
Pyroferric Co., 175 Varick St., N. Y. C.
Stackpole Carbon Co., St. Marys, Pa.
Western Electric Co., 195 Broadway, N. Y. C.
Wilson Co., H. A., Newark, N. J.

IRONS, Soldering

Acme Electric Heating Co., 1217 Washington St., Boston
Amer. Electrical Heater Co., 6110 Cass Ave., Detroit
Drake Elec. Wks., Inc., 3656 Lincoln Ave., Chicago
★ Electric Soldering Iron Co., Deep River, Conn.
★ General Electric Co., Schenectady, N. Y.
Hexacon Elec. Co., Roselle Park, N. J.
Sound Equipment Corp. of Calif., 6245 Lex. Ave., Los Angeles 38
Ungar, Inc., Harry A., 615 Ducommun St., Los Angeles 12
Vasco Electrical Mfg. Co., 4116 Avalon Blvd., Los Angeles
Vulcan Electric Co., Lynn, Mass.

JACKS, Telephone

Alden Prods. Co., Brockton, Mass.
Amer. Molded Prods. Co., 1753 N. Honore St., Chicago
Chicago Tel. Supply Co., Elkhart, Ind.
★ Guardian Elec. Mfg. Co., 1627 W. Walnut St., Chicago
Insuline Corp. of Amer., L. I. C., N. Y.
Johnson, E. F., Waseca, Minn.
Jones, Howard B., 2300 Wabansia Ave., Chicago
Mallory & Co., Inc., P. R., Indianapolis, Ind.
Mangold Radio Pts. & Stamping Co., 6300 Shelbourne St., Philadelphia
Molded Insulation Co., Germantown, Pa.
★ Universal Microphone Co., Inglewood, Calif.
Utah Radio Prod. Co., Orleans St., Chicago

KEYS, Telegraph

Amer. Radio Hdware Co., Mt. Vernon, N. Y.
Bunnell & Co., J. H., 215 Fulton, N. Y. C.
Mossman, Inc., Donald P., 6133 N. Northwest Hy., Chicago
Renier Co., Ltd., 2101 Bryant St., San Francisco
Signal Electric Mfg. Co., Menominee, Mich.
Telegraph App. Co., 325 W. Huron St., Chicago
Telephonics Corp., 350 W. 31 St., N. Y. C.
Winslow Co., Inc., Liberty St., Newark, N. J.

KNOBS, Radio & Instrument

Alden Prods. Co., Brockton, Mass.
American Insulator Corp., New Freedom, Pa.
Chicago Molded Prods. Corp., 1025 N. Kolmar, Chicago
General Radio Co., Cambridge, Mass.
Gits Molding Corp., 4600 Huron St., Chicago
Imperial Molded Prods. Corp., 2921 W. Harrison, Chicago
Kurtz Kasch, Inc., Dayton, O.
Mallory & Co., Inc., P. R., Indianapolis, Ind.
Millen Mfg. Co., James, Malden, Mass.
★ Nat'l Co., Inc., Malden, Mass.
Northeastern Molding, Inc., 584 Commonwealth Ave., Boston 15, Mass.
Radio City Products Co., 127 W. 26 St., N. Y. C.
★ Rogan Bros., 2001 S. Michigan, Chicago

LABELS, Coding

Western Litho. Co., 600 E. 2nd, Los Angeles

LABELS, Removable

Avery Adhesives, 451 3rd St., Los Angeles
Western Litho. Co., 600 E. 2nd, Los Angeles

LABELS, Stick-to-Metal

Ever Ready Label Corp., E. 25th St., N. Y. C.
Tablet & Ticket Co., 1021 W. Adams St., Chicago
Western Litho. Co., 600 E. 2nd, Los Angeles

LABORATORIES, Electronic

★ Browning Labs., Inc., Winchester, Mass.
★ Electronic Corp. of Amer., 45 W. 18 St., N. Y. C.
Hazeltine Electronics Corp., 1775 B'way, N. Y. C.
Sherron Metallic Corp., Flushing Ave., Brooklyn, N. Y.
Worner Electronic Devices, 848 N. Noble St., Chicago 22

LACQUERS, Wood & Metal Finish

Sullivan Varnish Co., 410 N. Hart St., Chicago 22

LOCKWASHERS, Spring Type

Natl. Lock Washer Co., Newark, N. J.

LUGS, Soldering

Cinch Mfg. Corp., W. Van Buren St., Chicago
Dante Elec. Mfg. Co., Bantam, Conn.
Ideal Commutator Dresser Co., Sycamore, Ill.
Ilsco Copper Tube & Prods., Inc., Station M, Cincinnati
Krueger & Hudepohl, Third & Vine, Cincinnati, O.
Patton-MacGuyer Co., 17 Virginia Ave., Providence, R. I.
Sherman Mfg. Co., Battle Creek, Mich.
Zierick Mfg. Co., 385 Girard Ave., Bronx, N. Y. C.

LUGS, Solderless

Aircraft Marine Prod., Inc., Harrisburg, Pa.
Burndy Eng. Co., 107 Eastern Blvd., N. Y. C.
Thomas & Betts Co., Elizabeth 1, N. J.

MACHINES, Impregnating

Stokes Machine Co., F. J., Phila., Pa.

MACHINES, Screwdriving

Detroit Power Screwdriver Co., Detroit, Mich.
Stanley Tool Div. of the Stanley Works, New Britain, Conn.

MAGNETS, Permanent

Arnold Engineering Co., 147 E. Ontario St., Chicago 11
★ General Elec. Co., Schenectady, N. Y.
Indiana Steel Prod. Co., 6 N. Michigan Ave., Chicago, Ill.
Thomas & Skinner Steel Prod. Co., Indianapolis, Ind.

MAIL ORDER SUPPLY HOUSES

See listing at head of Directory

MARKERS, Wire Identification

Brand & Co., Wm., 276 4th Ave., N. Y. C.
Irvington Varnish & Ins. Co., Irvington, N. J.
Minn. Mining Co., 155 Sixth Ave., N. Y. C.
Ntl. Varnished Prod. Corp., Woodbridge, N. J.

MARKING MACHINES, Letters, Numbers

Marken Machine Co., Keene, N. H.

METAL, Thermostatic

Baker & Co., 113 Astor, Newark, N. J.
C. S. Brainin Co., 20 VanDam, N. Y. C.
Callite Tungsten Corp., Union City, N. J.
Chace Co., W. M., Detroit, Mich.
Metals & Controls Corp., Attleboro, Mass.
Wilson Co., H. A., 105 Chestnut, Newark, N. J.

METERS, Ammeters, Voltmeters, Small Panel

Cambridge Inst. Co., Grand Central Terminal, N. Y. C.
De Jur-Amsco Corp., Shelton, Conn.
★ General Electric Co., Bridgeport, Conn.
Hickok Elec. Inst. Co., Cleveland, O.
Hoyt Elec. Inst. Works, Boston, Mass.
McClintock Co., O. B., Minneapolis Minn.
Readrite Meter Works, Bluffton, O.
Roller-Smith Co., Bethlehem, Pa.
★ Simpson Elec. Co., 5218 W. Kinzie, Chicago
Triplett Elec. Inst. Co., Bluffton, O.
Westinghouse Elec. & Mfg. Co., E. Pittsburgh, Pa.
Weston Elec. Inst. Corp., Newark, N. J.
Wheelco Inst. Co., 847 W. Harrison St., Chicago

METERS, Frequency

Bendix Radio, Towson, Md.
★ Browning Labs., Inc., Winchester, Mass.
General Radio Co., Cambridge, Mass.
Higgins Industries, Inc., 2221 Warwick Ave., Santa Monica, Calif.
Lavoie Laboratories, Long Branch, N. J.
★ Link, F. M., 125 W. 17 St., N. Y. C.
★ Measurements Corp., Boonton, N. J.
North Amer. Philips Co., Inc., 419 Fourth Ave., N. Y. C.

METERS, Q

Boonton Radio Corp., Boonton, N. J.

METERS, Vacuum Tube Volt

Ballantine Laboratories, Inc., Boonton, N. J.
Ferris Instrument Corp., Boonton, N. J.
General Radio Co., Cambridge, Mass.
Hewlett-Packard Co., Palo Alto, Calif.
★ Measurements Corp., Boonton, N. J.
Radio City Products Co., 127 W. 26 St., N. Y. C.

METERS, Vibrating Reed

Biddle, James G., 1211 Arch St., Phila.
J-B-T Instruments, Inc., New Haven 8, Conn.
Triplett Elec. Inst. Co., Bluffton, O.

MICA

Brand & Co., Wm., 276 Fourth Av., N. Y. C.
Ford Radio & Mica Corp., 538 63rd St., Bklyn, N. Y.
Insulation Mfgrs. Corp., 565 W. Wash. Blvd., Chicago
Macallen Co., Boston, Mass.
Mica Insulator Corp., 196 Varick, N. Y. C.
Mitchell-Rand Insulation Co., 51 Murray St., N. Y. C.
New England Mica Co., Waltham, Mass.
Richardson Co., Melrose Park, Ill.

MICROPHONES

Amer. Microphone Co., 1015 Western Av., Los Angeles
Amperite Co., 561 B'way, N. Y. C.
Astatic Corp., Youngstown, O.
Brush Development Co., Cleveland, O.
Electro Voice Mfg. Co., South Bend, Ind.
Kellogg Switchboard & Supply Co., 6650 S. Cicero, Chicago
Philmore Mfg. Co., 113 University Pl., N. Y. C.
Permoflux Corp., 4916 W. Grand Av., Chicago
Radio Corp. of Amer., Camden, N. J.
Radio Speakers, Inc., 221 E. Cullerton, Chicago
Rowe Industries, Inc., Toledo, O.
★ Shure Bros., 225 W. Huron St., Chicago
Telephonics Corp., 350 W. 31 St., N. Y. C.
Turner Co., Cedar Rapids, Ia.
★ Universal Microphone Co., Inglewood, Cal.

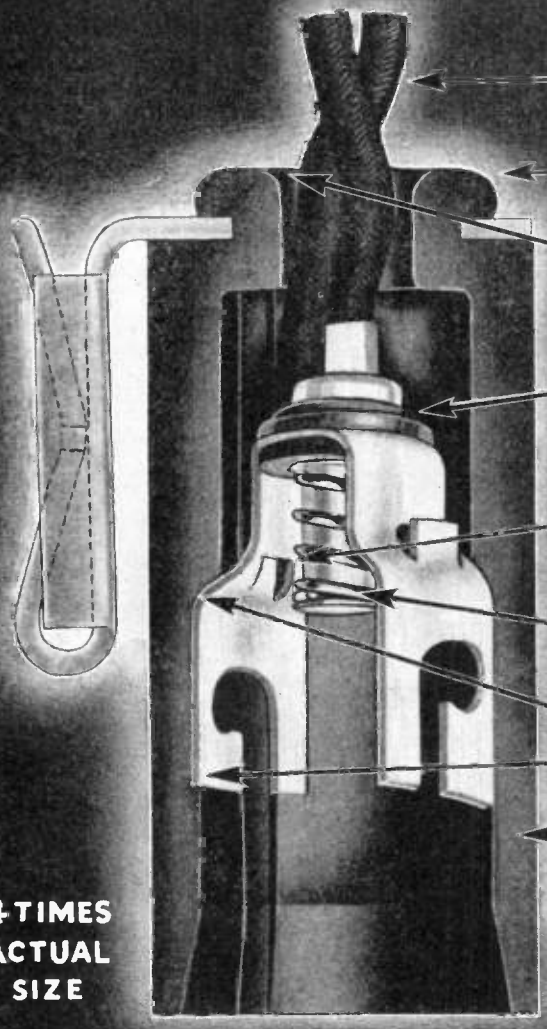
MONITORS, Frequency

★ General Electric Co., Schenectady, N. Y.
General Radio Co., Cambridge, Mass.
★ RCA Mfg. Co., Camden, N. J.

MOTOR-GENERATORS, Rotary Converters

Alliance Mfg. Co., Alliance, O.
Air-Way Mfg. Co., Toledo, O.
Bendix Aviation Corp., Pacific Div., 11600 Sherman Way, N. Hollywood
Black & Decker Mfg. Co., Towson, Md.
Bodine Elec. Co., 2262 W. Ohio, Chicago
Carter Motor Co., 1608 Milwaukee, Chicago
Clements Mfg. Co., Chicago, Ill.
Continental Electric Co., Newark, N. J.
Delco Appliance, Rochester, N. Y.
Diehl Mfg. Co., Elizabethport, N. J.
Dormeyer Co., Chicago, Ill.
Eclipse Aviation, Bendix, N. J.
Elcar, Inc., 1060 W. Adams, Chicago
Electric Indicator Co., Stamford, Conn.
Electric Motors Corp., Racine, Wis.
Electric Specialty Co., Stamford, Conn.
Electrolux Corp., Old Greenwich, Conn.
Eureka Vacuum Cleaner, Detroit, Mich.
General Armature Corp., Lock Haven, Pa.
★ General Electric Co., Schenectady, N. Y.
Jannette Mfg. Co., 558 W. Monroe, Chicago
Knapp-Monarch, St. Louis, Mo.
Leland Electric Co., Dayton, O.
Ohio Electric Co., 74 Trinity Pl., N. Y. C.
Pioneer Gen-E-Motor, 5841 W. Dickens Av., Chicago
Redmond Co., A. G., Owosso, Mich.
Russell Co., Chicago, Ill.
Small Motors, Inc., 1308 Elston Ave., Chicago
Webster Co., Chicago, Ill.
Webster Products, 3825 Armitage Ave., Chicago
Westinghouse Elect. Mfg. Co., Lima, O.
★ Wincharger Corp., Sioux City, Iowa

a New and Superior DIAL LIGHT SOCKET



- Tensile strength of leads and connections far in excess of requirements.
- Tough, plastic shell molded around bracket providing a secure bond with mechanical strength far beyond any normal requirement.
- Rounded edge will not cut or fray wire insulation.
- Voltage Breakdown between contacts—1200 Volts. Voltage Breakdown to ground —5000 Volts.
- Lug on contact fits in groove in shell so that contact cannot be turned or twisted when inserting lamp.
- Center contact mounted so that it cannot protrude from shell and short on chassis when lamp is removed.
- Plastic shell is recessed for contacts, which cannot be pushed or pulled out of position.
- Stronger, tougher, heavy walled plastic shell.
- A variety of different mounting bracket styles available, suitable for practically any mounting.

For Your Present and Post-War Production

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This year Lenz celebrates its 40th year of service to the communications industry.

Lenz Dial Light Sockets have always been known for their superior mechanical qualities and electrical characteristics.

Now these sockets are still further improved, with even greater mechanical strength. A stronger, tougher plastic shell is attached to the bracket with a new type of construction that provides a virtually unbreakable bond between shell and bracket. Its excellent electrical characteristics are maintained.

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MOTORS, Very Small Types

Eastern Air Devices, Inc., 585 Dean St., Bklyn, 17, N. Y.
Kollsman Instrument Div., Elmhurst, Long Island, N. Y.
Utah Radio Prod. Co., 842 Orleans St., Chicago

MOUNTINGS, Shock Absorbing

Lord Mfg. Co., Erie, Pa.
Pierce-Roberts Co., Trenton, N. J.
U. S. Rubber Co., 1230–6th Ave., N. Y. C.

MYCALEX

Colonial Kolonite Co., 2212 W. Armitage Ave., Chicago
★ General Electric Co , Schenectady, N. Y.
Mycalex Corp. of Amer., Clifton, N. J.
Precision Fabricators, Inc., Rochester, N. Y.

NAME PLATES, Etched Metal

See ETCHING, Metal

NAME PLATES, Plastic

Crowe Name Plate & Mfg. Co., 3700 Ravenswood Ave., Chicago
Hopp Press, Inc., 460 W. 34 St., N. Y. C.
Parisian Novelty Co., 3502 S. Western Ave., Chicago
Virginia Plate Co., 270 Madison Ave., N. Y. C. 16

NICKEL, Sheet, Rod, Tubes

Eagle Metals Co., Seattle, Wash.
Pacific Metals Co., Ltd., San Francisco, Calif.
Steel Sales Corp., 129 S. Jefferson St., Chicago
Tull Metal & Supply Co., J. M., Atlanta, Ga.
Whitehead Metal Prod. Co., 303 W. 10th St., N. Y. C.
Williams and Co., Inc., Pittsburgh, Pa.

NUTS, Self-locking

Boots Aircraft Nut Corp., New Canaan, Conn.
Elastic Stop Nut Corp., Union, N. J.
Palnut Co., Inc., Irvington, N. J.
Standard Pressed Steel Co., Jenkintown, Pa.

OSCILLATORS, AF

General Radio Co., Cambridge, Mass.
Hewlett-Packard Co., Palo Alto, Calif.
Jackson Electrical Inst. Co., Dayton, O.

OSCILLOSCOPES, Cathode Ray

★ Du Mont Laboratories, Inc., Allen B., Passaic, N. J.
★ General Electric Co., Schenectady, N. Y.
General Radio Co., Cambridge, Mass.
Millen Mfg. Co., Malden, Mass.
★ Panoramic Radio Corp., 242 W. 55 St., N. Y. C.
Reiner Electronics Co., 152 W. 25 St., N. Y. C.
RCA Mfg. Co., Inc., Camden, N. J.
Radio City Products Co., Inc., 127 W. 26 St., N. Y. C.

OVENS, Industrial & Laboratory

★ General Elec. Co., Schenectady, N. Y.
Trent Co., Harold E., Philadelphia

PANELS, Metal Etched (See Etching, Metal)

PANELS, Phenolic, Cast without Molds

Creative Plastics Corp., 963 Kent Ave., B'klyn, N. Y.

PILOT LIGHTS

Alden Prods. Co., Brockton, Mass.
Amer. Radio Hdware Co., Mt. Vernon, N. Y.
Dial Light Co. of Amer., 90 West, N. Y. C.
Drake Mfg. Co., 1713 W. Hubbard, Chicago
General Control Co., Cambridge, Mass.
Gothard Mfg. Co., Springfield, Ill.
Herzog Miniature Lamp Works, 12–19 Jackson Av., Long Island City, N. Y. C.
Kirkland Co., H. R., Morristown, N. J.
Mallory & Co., P. R., Indianapolis, Ind.
Signal Indicator Corp., 140 Cedar St., N. Y. C.

PHOSPHOR BRONZE

American Brass Co., Waterbury, Conn.
Bunting Brass & Bronze Co., Toledo, O.
Driver-Harris Co., Harrison, N. J.
Phosphor Bronze Smelting Co., Philadelphia
Revere Copper & Brass, 230 Park Av., N. Y. C.
Seymour Mfg. Co., Seymour, Conn.

PLASTICS, Extruded

Blum & Co., Inc., Julius, 532 W. 22 St., N. Y. C.
Brand & Co., Wm., 276 4th Ave., N. Y. C.
Extruded Plastics, Inc., Norwalk, Conn.
Industrial Synthetic Corp., Irvington, N. J.
Irvington Varnish & Insulator Co., Irvington, N. J.

PLASTIC SHEET, for Name Plates

Mica Insulator Co. 200 Varick St., N. Y. C.

PLASTICS, Injection Molded

Remler Co., Ltd., 2101 Bryant St., San Francisco
Tech-Art Plastics, 41–01 36th Ave., Long Island City, N. Y.
Universal Plastics Corp., New Brunswick, N. J.

PLASTICS, Laminated or Molded

Acadia Synthetic Prods., 4031 Ogden Av., Chicago
Alden Prods. Co., Brockton, Mass.
American Cyanamid Co., 30 Rockefeller Plaza, N. Y. C.
American Insulator Corp., New Freedom, Pa.
American Molded Prods. Co., 1753 N. Honore, Chicago
Auburn Button Works, Auburn, N. Y.
Barber-Colman Co., Rockford, Ill.
Brandywine Fibre Prods. Co., Wilmington, Del.
Brilhart Co., Arnold, Great Neck, N. Y.
Catalin Corp., 1 Park Av., N. Y. C.
Celanese Celluloid Corp., 180 Madison Av., N. Y. C.
Chicago Molded Prods. Corp., 1024 N. Kolmar, Chicago
Continental-Diamond Fibre Co., Newark, Del.
Creative Plastics Corp., 963 Kent Ave., B'klyn, N. Y.
Dow Chemical Co., Midland, Mich.
Durez Plastics & Chemicals, Inc., N. Tonawanda, N. Y.
Extruded Plastics, Inc., Norwalk, Conn.
Formica Insulation Co., Cincinnati, O.
★ General Electric Co., Plastics Dept., Pittsfield, Mass.
General Industries Co., Elyria, O.
Glen Molding Corp., 4600 Huron St., Chicago
Imperial Molded Prods. Co., 2921 W. Harrison, Chicago
Industrial Molded Prods. Co., 2035 Charleston, Chicago
Kurz-Kasch, Inc., Dayton, O.
Macalloy Co., Boston, Mass.
Mica Insulator Co., 196 Varick, N. Y. C.
Monsanto Chemical Co., Springfield, Mass.
National Vulcanized Fibre Co., Wilmington, Del.
Northern Industrial Chemical Co., Boston, Mass.
Printloid Corp., 93 Mercer St., N. Y. C.
Radio City Products Co., 127 W. 26 St., N. Y. C.
Remler Co., Ltd., 2101 Bryant St., San Francisco
Richardson Co., Melrose Park, Ill.
★ Rogan Bros., 2000 S. Michigan Ave., Chicago
Rohm & Hass Co., Philadelphia
Spaulding Fibre Co., Inc., 233 B'way, N. Y. C.
Stokes Rubber Co., Joseph Trenton, N. J.
Surprenant Elec. Ins. Co., Boston
Synthane Corp., Oaks, Pa.
Taylor Fibre Co., Norristown, Pa.
Westinghouse Elec. & Mfg. Co., E. Pittsburgh, Pa.
Wilmington Fibre Specialty Co., Wilmington, Del.

PLASTICS, Materials

Bakelite Corp., 30 E. 42 St., N. Y. C.
Carbide & Carbon Chemicals Corp., 30 E. 42 St., N. Y. C.

PLASTICS, Transparent

Carbide & Carbon Chemicals Corp., 30 E. 42 St., N. Y. C.
Celanese Celluloid Corp., 180 Madison Ave., N. Y. C.
Dow Chemical Co., Midland, Mich.
du Pont de Nemours & Co., E. I., Arlington, N. J.
Plax Corp., Hartford, Conn.
Printloid Corp., 93 Mercer St., N. Y. C.
Rohm & Hass Co., Washington Sq., Philadelphia

PLATING, Metal on Molded Parts

Metaplast Corp., 205 W. 19 St., N. Y. C.

PLUGS (Banana), Spring Type

Amer. Radio H'dw're Co., Mt. Vernon, N. Y.
Birnbach Radio Co., 145 Hudson St., N. Y. C.
Eastman Kodak Co., Rochester, N. Y.
Eby, Inc., Hugh H., Philadelphia, Pa.
Franklin Mfg. Corp., 175 Varick St., N. Y. C.
General Radio Co., Cambridge, Mass.
Johnson Co., E. F., Waseca, Minn.
Mallory & Co., Inc., P. R., Indianapolis, Ind.
Ucinite Co., Newtonville, Mass.

PLUGS, Telephone Type

Alden Prods. Co., Brockton, Mass.
American Molded Prods. Co., 1753 N. Honore, Chicago
Chicago Tel. Supply Co., Elkhart, Ind.
★ Guardian Elec. Mfg. Co., 1400 W. Wash. Blvd., Chicago
Insuline Corp. of Amer., L. I. City, N. Y.
Johnson Co., E. F., Waseca, Minn.
Jones, H. B., 2300 Wabansia, Chicago
Mallory & Co., Inc., P. R., Indianapolis, Ind.
Remler Co., Ltd., Bryant St., San Francisco
Trav-Ler Karenola Corp., 1030 W. Van Buren St., Chicago 7
★ Universal Microphone Co., Ltd., Inglewood, Calif.
Utah Radio Prod., Orleans St., Chicago

PLYWOOD, Metal Faced

Haskelite Mfg. Corp., 208 W. Washington St., Chicago

RACKS, Standard Aircraft Types

Delco Radio, Kokomo, Ind.

RACKS & PANELS, Metal

See STAMPINGS, Metal

RADIO RECEIVERS & TRANSMITTERS

Abbott Instrument, Inc., 8 W. 18 St., N. Y. C. 3
Air Associates, Inc., Los Angeles
Aircraft Accessories Corp., Funston Rd., Kansas City, Kans.
Aircraft Radio Corp., Boonton, N. J.
Aircraft Radio Equip. Corp., 6244 Lex. Ave., Hollywood, Calif.
Air Communications, Inc., 2233 Grant Ave., Kansas City, Mo.
Air King Products Co., 1523 63rd Ave., Brooklyn, N. Y.
Airplane & Marine Inst., Inc., Clearfield, Pa.
Andrea Radio Corp., 43–20 34th St., Long Island City, N. Y.
Amplex Engineering, Inc., New Castle, Ind.
Arnessen Electric Co., 116 Broad St., N. Y. C.
Automatic Radio Mfg. Co., 122 Brookline Ave., Boston, Mass.
Bassett, Inc., Rex, Ft. Lauderdale, Fla.
Belmont Radio Corp., 5921 Dickens Ave., Chicago
Bendix Aviation Corp., Pacific Div., 11600 Sherman Way, N. Hollywood
Bendix Radio, Div. of Bendix Aviation Corp., Baltimore, Md.
Boes Co., The W. W., Dayton, O.
★ Browning Laboratories, Inc., Winchester, Mass.
Bunnell & Co., J. H., 215 Fulton St., N. Y. C.
Burnet Radio Lab., 4814 Idaho St., San Diego, Calif.
Colonial Radio Corp., Rano St., Buffalo, N. Y.
Communications Co., Inc., Coral Gables, Fla.
Conn. Tel. & Elec. Co., Meriden, Conn.
Continental Radio & Telev. Corp., 3800 W. Cortland St., Chicago
Cover Dual Signal Systems, Inc., 125 W. Hubbard St., Chicago
Crosley Radio Corp., Cincinnati, O.
de Forest Labs, Lee, 5106 Wilshire Blvd., Los Angeles
Delco Radio, Kokomo, Ind.
Detrola Corp., 1501 Beard Ave., Detroit, Mich.
De Wald Radio Mfg. Corp., 436 Lafayette St., N. Y. C.
Dictaphone Corp., 420 Lexington Ave., N. Y. C.
★ Du Mont Labs., Inc., Allen B., Passaic, N. J.
Echophone Radio Co., 201 E. 26 St., Chicago
Eckstein Radio & Telev. Co., Inc., 1400 Harmon Pl., Minneapolis, Minn.
Electrical Ind. Mfg. Co., Red Bank, N. J.
Elect. Research Lab., Inc., Evanston, Ill.
Electronic Communications Co., 36 N. W. B'way, Portland, Ore.
★ Electronic Corp. of Amer., 45 W. 18 St., N. Y. C.
Electronic Specialty Co., Glendale, Calif.
Emerson Radio & Phone Corp., 111 8th Ave., N. Y. C.
Erco Radio Labs., Inc., Hempstead, N. Y.
Espey Mfg. Co., Inc., 305 E. 63 St., N. Y. C.
Fada Radio & Elec. Corp, 30–20 Thomson Ave., Long Island City, N. Y.
Farnsworth Tele. & Radio Corp., Ft. Wayne 1, Ind.
Federal Electronics Div., 209 Steuben St., B'klyn, N. Y.
Federal Tel. & Radio Corp., Newark, N. J.
Finch Telecommunications, Inc., Passaic, N. J.
Fisher Research Lab., Palo Alto, Calif.
Freed Radio Corp., 200 Hudson St., N. Y. C.
★ Galvin Mfg. Corp., 4545 Augusta Blvd., Chicago
Garod Radio Corp., 70 Washington St., B'klyn, N. Y.
Gates Radio & Supply Co., Quincy, Ill.
General Communication Co., 681 Beacon St., Boston, Mass.
★ General Electric Co., Schenectady, N. Y.
General Telev. & Radio Corp., 1240 N Homan Ave., Chicago
Gibbs & Co., Thomas B., Delavan, Wis.
Gilfillen Bros., Inc., 1815 Venice Blvd., Los Angeles, Calif.
Girdler Corp., Louisville, Ky.
Gray Mfg. Co., Hartford, Conn.
Gray Radio Co., West Palm Beach, Fla.
Grenby Mfg. Co., Plainville, Conn.
Guided Radio Corp., 161 6th Ave., N. Y. C.
★ Hallicrafters Co., 2611 Indiana Ave., Chicago
Halstead Traffic Com. Corp., 155 E. 44 St., N. Y. C.
Hamilton Radio Corp., 510 Sixth Ave., N. Y. C.
★ Hammarlund Mfg. Co., 460 W. 34th St., N. Y. C.
Harrel, D. H., 1527 E. 74 Pl., Chicago
Harvey Machine Co., Inc., 6200 Avalon Blvd., Los Angeles
★ Harvey Radio Labs, Inc., Cambridge, Mass.
Harvey-Wells Com., Inc., Southbridge, Mass.
Hazeltine Electronics Corp., Great Neck, N. Y.
Herbach & Rademan Co., 522 Market St., Phila.
Higgins Industries, Inc., 2221 Warwick Ave., Santa Monica, Calif.
Hollywood Electronics Co., 800 Sunset Blvd., Los Angeles
Howard Radio Co., 1731 Belmont Ave., Chicago
Hudson American Corp., 62 W. 47 St., N. Y. C.
Jefferson, Inc., Ray, Freeport, N. Y.
Jefferson-Travis Radio Mfg. Corp., 245 E 23 St., N. Y. C.
Karadio Corp., 1400 Harmon Pl., Minneapolis, Minn.
Kemlite Labs., 1809 N. Ashland Ave., Chicago
Lear Avia, Inc., Piqua, O.
Lewyt Corp., 60 B'way, B'klyn, N. Y.
★ Link, F. M., 125 W. 17 St., N. Y. C.
★ Machlett Labs., Inc., Springdale, Conn.
Magnavox Co., Indianapolis, Ind.
Majestic Radio & Tel. Corp., 2600 W. 50 St., Chicago
McElroy Mfg. Corp., Brookline Ave., Boston
Megard Corp., 381 W. 38 St., Los Angeles, Calif.
Midwest Radio Corp., Cincinnati, O.
Millen Mfg. Co., Inc., Malden, Mass.
★ National Co., Inc., Malden, Mass.
Noblitt-Sparks Ind. Inc., Columbus, Ind.
North Amer. Philips Co., 100 E. 42 St., N. Y. C.
Operadio Mfg. Co., St. Charles, Ill.
★ Panoramic Radio Corp., 245 W. 55 St., N. Y. C. 19
Philco Corp., Tioga & C Sts., Philadelphia, Pa.
Philharmonic Radio Corp., 216 Williams St., N. Y. C.
Pierson-DeLane, Inc., 2345 W. Washington Blvd., Los Angeles
Pilot Radio Corp., Long Island City, N. Y.
Powers Electronic & Communication Co., Glen Cove, N. Y.
Precision Tube Co., 3828 Terrace St., Phila. 28
Press Wireless, Inc., 1475 B'way, N. Y. C.
Radiation Products, Inc., 1142 S. Wall, Los Angeles 15
★ Radio Corp. of Amer., Camden, N. J.
Radio Craftsmen, 1340 S. Mich. Ave., Chicago
★ Radio Engineering Labs., Long Island City, N. Y.
Radio Frequency Labs., Inc., Boonton, N. J.
Radio Mfg. Engineers, Inc., Peoria, Ill.
Radiomarine Corp. of Amer., 75 Varick St., N. Y. C.
Radio Receptor Co., Inc., 251 W. 17 St., N. Y. C.
Radio Transceiver Labs., 86–27 115th St., Richmond Hill, L. I.
Richardson-Allen Corp., 15 W. 20 St., N. Y. C.
Rosen Co., Raymond, 32 & Walnut Sts., Phila.
Rauland Corp., Chicago, Ill.
Sanborn Co., Cambridge 39, Mass.
Schuttig & Co., 9th & Kearny Sts., Washington, D. C.
Scott Radio Labs, Inc., 4450 Ravenswood Ave., Chicago
Seeburg Corp., J. P., 1500 N. Dayton St., Chicago
Sentinel Radio Corp., Evanston, Ill.
Setchell-Carlson, Inc., 2233 University Ave., St. Paul, Minn.
Smith Co., Maxwell, 1027 N. Highland Ave., Hollywood, Calif.
Sonora Radio & Telev. Corp., 325 N. Hoyne Ave., Chicago
Sparks-Withington Co., Jackson, Mich.
Sperry Gyroscope Co., Garden City, N. Y.
Sperti, Inc., Cincinnati, O.
Stewart-Warner Corp., 1826 Diversey Pkwy., Chicago
Stromberg-Carlson Co., Rochester, N. Y.
Templetone Radio Co., Mystic, Conn.
Transmitter Equip. Mfg. Co., 345 Hudson St., N. Y. C.
Warwick Mfg. Corp., 4640 W. Harrison St., Chicago
Watterson Radio Mfg. Co., 2608 Ross Ave., Dallas, Tex.
Waugh Laboratories, 420 Lexington Ave., N. Y. C.
Western Electric Co., 195 B'way, N. Y. C.
Westinghouse Elec. & Mfg. Co., Wilkens Ave., Baltimore, Md.
Wilcox Electric Co., 14th & Chestnut Sts., Kansas City, Mo.
Zenith Radio Corp., 6001 Dickens Ave., Chicago, Ill.

RECTIFIERS, Current

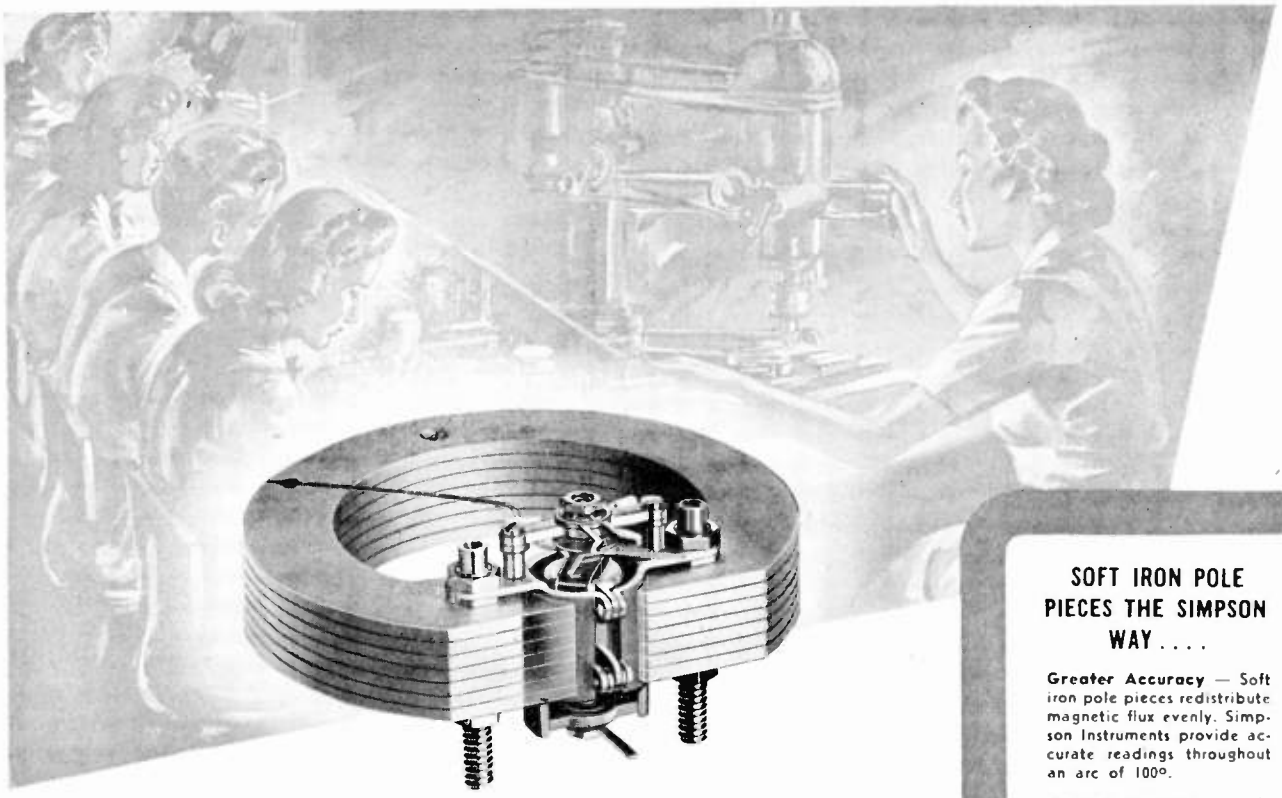
Benwood Linze Co., St. Louis, Mo.
Continental Elec. Co., 903 Merchandise Mart, Chicago
Electronics Labs., Indianapolis, Ind.
Fansteel Metallurgical Corp., N. Chicago, Ill.
★ General Electric Co., Bridgeport, Conn.
Green Elect. Co., Inc., 130 Cedar St., N. Y. C.
International Tel. & Radio Mfg. Corp., E. Newark, N. J.
Mallory & Co., P. R., Indianapolis, Ind.
Nothelfer Winding Labs., Trenton, N. J.
Selenium Corp. of Amer., 1800 W. Pico Blvd., Los Angeles
United Cinephone Corp., Torrington Conn.
Westinghouse Elec. & Mfg. Co., E. Pittsburgh, Pa.

RECTIFIERS, Instrument & Relay

Selenium Corp. of Amer., 1800 W. Pico Blvd., Los Angeles

REGULATORS, Temperature

Allen-Bradley Co., Milwaukee, Wis.
Dunn, Inc., Struthers, 1321 Cherry, Philadelphia
Fenwal Inc., Ashland, Mass.
★ General Electric Co., Schenectady, N. Y.
Mercoid Corp., 4217 Belmont, Chicago
Minneapolis-Honeywell Regulator, Minneapolis, Minn.



These soft iron pole pieces tell the story—

EXPERIENCE is a much used, and too often abused, word. Yet in any field experience is the only source of practical knowledge—the only sound basis for further advance.

Measured in terms of time alone, the experience of the Simpson organization is impressive enough. For more than 30 years this name has been associated with the design and manufacture of electrical instruments and testing equipment. But the real value of this experience is to be found in the many fundamental contributions Simpson has made to instrument quality.

The use of soft iron pole pieces in the patented Simpson movement serves as an example. An admittedly finer type of design, these soft iron pole pieces have been employed by Simpson to provide maximum strength as well as accuracy, and to achieve a simpler assembly that permits faster, more economical manufacture.

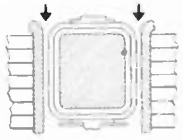
For today's vital needs, this experience enables Simpson to build "instruments that stay accurate" in greater volume than ever before. For your postwar requirements it will insure the correct interpretation of today's big advances.

SOFT IRON POLE PIECES THE SIMPSON WAY . . . .

Greater Accuracy — Soft iron pole pieces redistribute magnetic flux evenly. Simpson Instruments provide accurate readings throughout an arc of 100°.

Greater Strength — Pole pieces are used to anchor full bridges across top and bottom of movement. Moving assembly is locked in permanent alignment.

Smooth Walled Air Gap No cracks or irregularities to invite dust or other foreign particles, which might interfere with movement of armature. Reamed to accurate dimensions after assembly.



Speed and Economy—Pole pieces are stamped, not machined. This is one of many ways Simpson has speeded construction, and lowered costs, of this basically better movement.

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5200-5218 Kinzie St., Chicago 44, Ill.

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Acme Elec. & Mfg. Co., Cuba, N. Y.
Adams & Westlake Co., Elkhart, Ind.
Amperite Co., 561 Broadway, N. Y. C.
Ferranti Elec., Inc., 30 Rockefeller Plaza, N. Y. C.
★ General Elec. Co., Schenectady, N. Y.
H-B Electric Co., 6122 N. 21 St., Phila.
Sola Electric Co., 2525 Clybourn Av., Chicago
★ United Transformer Corp., 150 Varick St., N. Y. C.

RELAYS, Small Switching

Advance Elec. Co., 1260 W. 2nd, Los Angeles
Allied Control Co., Inc., 223 Fulton St., N. Y. C.
Amperite Co., 561 Broadway, N. Y. C.
Automatic Elec. Co., 1033 W. Van Buren, Chicago
Bendix Aviation Corp., Pacific Div., 11600 Sherman Way, N. Hollywood
Birtcher Corp., 5087 Huntington Dr., Los Angeles 32
Cook Elec. Co., 2700 Southport Ave., Chicago
Electrical Prod. Supply Co., 1140 Venice Blvd., Los Angeles 15
G-M Laboratories, Inc., 4313 N. Knox Ave., Chicago
★ Guardian Elec. Co., 1400 W. Wash. Blvd., Chicago
Potter & Brumfield Co., Princeton, Ind.
Sigma Instruments, Inc., 76 Freeport St., Boston, Mass.
Struthers Dunn, Inc., 1326 Cherry St., Philadelphia
Ward-Leonard Elec. Co., Mt. Vernon, N. Y.

RELAYS, Small Telephone Type

Advance Elec. Co., 1260 W. 2nd, Los Angeles
Allied Control Co., 2 E. End Ave., N. Y. C.
Automatic Elect. Co., 1033 W. Van Buren, Chicago
Clare & Co., C. P., 4719 W. Sunnyside Ave., Chicago
Cook Elec. Co., 2700 Southport Ave., Chicago
★ Guardian Elec. Co., 1400 W. Wash. Blvd., Chicago
Wick Organ Co., Highland, Ill.

RELAYS, Stepping

Automatic Elect. Co., 1032 W. Van Buren St., Chicago
Autocall Co., Shelby, O.
★ Guardian Elect. Mfg. Co., 1620 W. Walnut St., Chicago
Presto Elect. Co., N. Y. Ave., Union City, N. J.
Struthers Dunn, Inc., Arch St., Phila.

RELAYS, Time Delay

Advance Elec. Co., 1260 W. 2nd, Los Angeles
Amperite Co., 561 Broadway, N. Y. C.
Automatic Elec. Co., 1033 W. Van Buren, Chicago
Haydon Mfg. Co., Inc., Forestville, Conn.
H-B Electric Co., 6122 N. 21 St., Phila.
Industrial Timer Corp., Newark, N. J.
Sangamo Elec. Co., Springfield, Ill.
Ward-Leonard Elec. Co., Mt. Vernon, N. Y.

RELAYS, Transmitter Switching and Keying

Leach Relay Co., 5915 Avalon Blvd., Los Angeles

RELAY TESTERS, Vibration

Kurman Electric Co., Inc., 3030 Northern Blvd., L. I. City, N. Y.

RESISTORS, Fixed

Acme Elec. Heating Co., Boston, Mass.
★ Aerovox Corp., New Bedford, Mass.
Allen-Bradley Co., Milwaukee, Wis.
Atlas Resistor Co., 423 Broome St., N. Y. C.
Carborundum Co., Niagara Falls, N. Y.
Centralab, Milwaukee, Wisconsin
Clarostat Mfg. Co., 130 Clinton St., Bklyn, N. Y.
Cont'l Carbon, Inc., Cleveland, O.
Daven Co., 158 Summit St., Newark, N. J.
Dixon Crucible Co., Jersey City, N. J.
Erie Resistor Corp., Erie, Pa.
Globar Div. Carborundum Co., Niagara Falls, N. Y.
Hardwick, Hindle, Inc., Newark, N. J.
Instrument Resistors Co., Little Falls, N. J.
Intern'l Resistance Co., Philadelphia
Lectrohm, Inc., Cicero, Ill.
Mallory & Co., Inc., P. R., Indianapolis, Ind.
Ohmite Mfg. Co., 4835 W. Flournoy, Chicago
Sensitive Research Inst., Corp., 4545 Bronx Blvd., N. Y. C.
Shalleross Mfg. Co., Collingdale, Pa.
Speer Resistor Corp., St. Marys, Pa.
Sprague Specialties Co., N. Adams, Mass.
Stackpole Carbon Co., St. Marys, Pa.
Utah Radio Prod. Co., 842 Orleans St., Chicago
Ward-Leonard Elec. Co., Mt. Vernon, N. Y.
White Dental Mfg. Co., 10 E. 40th St., N. Y. C.
Wirt Co., Germantown, Pa.

RESISTORS, Fixed Precision

Inst. Resistors, Inc., Little Falls, N. J.
Intern'l Resistance Co., Philadelphia
Ohmite Mfg. Co., 4835 Flournoy St., Chicago
Shalleross Mfg. Co., Collingdale, Pa.

RESISTORS, Flexible

Clarostat Mfg. Co., Inc., Brooklyn, N. Y.

RESISTORS, Variable Laboratory Type

Biddle Co., J. G., 1211 Arch St., Phila.
Sticht Co., Inc., H. H., 27 Park Pl., N. Y. C.

RESISTORS, Variable

★ Aerovox Corp., New Bedford, Mass.
Allen-Bradley Co., Milwaukee, Wis.
Amer. Inst. Co., Silver Spring, Md.
Atlas Resistor Co., N. Y. C.
Biddle Co., James G., Arch St., Phila.
Centralab, Milwaukee, Wis.
Chicago Tel. Supply Co., Elkhart, Ind.
Cinema Eng. Co., Burbank, Cal.
Clarostat Mfg. Co., 130 Clinton, Bklyn, N. Y.
Cutler-Hammer, Inc., Milwaukee, Wis.
DeJur Amsco Corp., Shelton, Conn.
Electro Motive Mfg. Co., Willimantic, Conn.
General Radio Co., Cambridge, Mass.
G-M Labs., Inc., Chicago, Ill.
Inst. Resistors, Inc., Little Falls, N. J.
Intern'l Resistance Co., Philadelphia
Lectrohm, Inc., 5125 W. 25th, Cicero, Ill.
Mallory & Co., P. R., Indianapolis, Ind.
Ohio Carbon Co., Cleveland, Ohio
Ohmite Mfg. Co., 4835 W. Flournoy St., Chicago
Shalleross Mfg. Co., Collingdale, Pa.
Stackpole Carbon Co., St. Marys, Pa.
Utah Radio Prods. Co., 820 Orleans St., Chicago
Ward-Leonard Elec. Co., Mt. Vernon, N. Y.
Wirt Co., Germantown, Pa.

RESISTORS, Variable, Ceramic Base

Lectrohm, Inc., 5125 W. 25th, Cicero, Ill.
Ohmite Mfg. Co., 4835 Flournoy St., Chicago

SCREW MACHINE PARTS, Brass, Steel

Chicago Aviation Co., 1200 N. Claremont, Chicago
Ward Products Corp., E. 45 St., Cleveland, O.

SCREW MACHINE PARTS, Non-Metallic

Continental-Diamond Fibre Co., Newark, Del.

SCREWS, Clutch Head

United Screw & Bolt Corp., 71 Murray St., N. Y. C.

SCREWS, Recessed Head

American Screw Co., Providence, R. I.
Bristol Co., The, Waterbury, Conn.
Chandler Prods. Co., Cleveland, O.
Continental Screw Co., New Bedford, Mass.
Corbin Screw Corp., New Britain, Conn.
Federal Screw Prod. Co., 224 W. Huron St., Chicago
International Screw Co., Detroit, Mich.
Lamson & Sessions, Cleveland, O.
Manufacturers Screw Prod., 216 W. Hubbard St., Chicago 10
Nat. Screw & Mfg. Co., Cleveland, O.
New England Screw Co., Keene, N. H.
Parker Co., Charles, The, Meriden, Conn.
Parker-Kalon Corp., 198 Varick, N. Y. C.
Pawtucket Screw Co., Pawtucket, R. I.
Pheoll Mfg. Co., Chicago
Russell, Burdsall & Ward Bolt & Nut Co., Port Chester, N. Y.
Scovill Mfg. Co., Waterbury, Conn.
Shakeproof, Inc., 2501 N. Keeler Av., Chicago
Southington Hardw. Mfg. Co., Southington, Conn.
Whitney Screw Corp., Nashua, N. H.

SCREWS, Self-Tapping

American Screw Co., Providence, R. I.
Central Screw Co., 3519 Shields Av., Chicago
Continental Screw Co., New Bedford, Mass.
Federal Screw Prod. Co., 224 W. Huron St., Chicago
Manufacturers Screw Prod., 216 W. Hubbard St., Chicago 10
Parker-Kalon Corp., 198 Varick, N. Y. C.
Shakeproof, Inc., 2501 N. Keeler, Chicago

SCREWS, Set and Cap

Allen Mfg. Co., Hartford, Conn.
Federal Screw Prod. Co., 224 W. Huron St., Chicago
Manufacturers Screw Prod., 216 W. Hubbard St., Chicago 10
Parker-Kalon Corp., 198 Varick, N. Y. C.
Republic Steel Corp., Cleveland, O.
Shakeproof, Inc., 2501 N. Keeler Av., Chicago

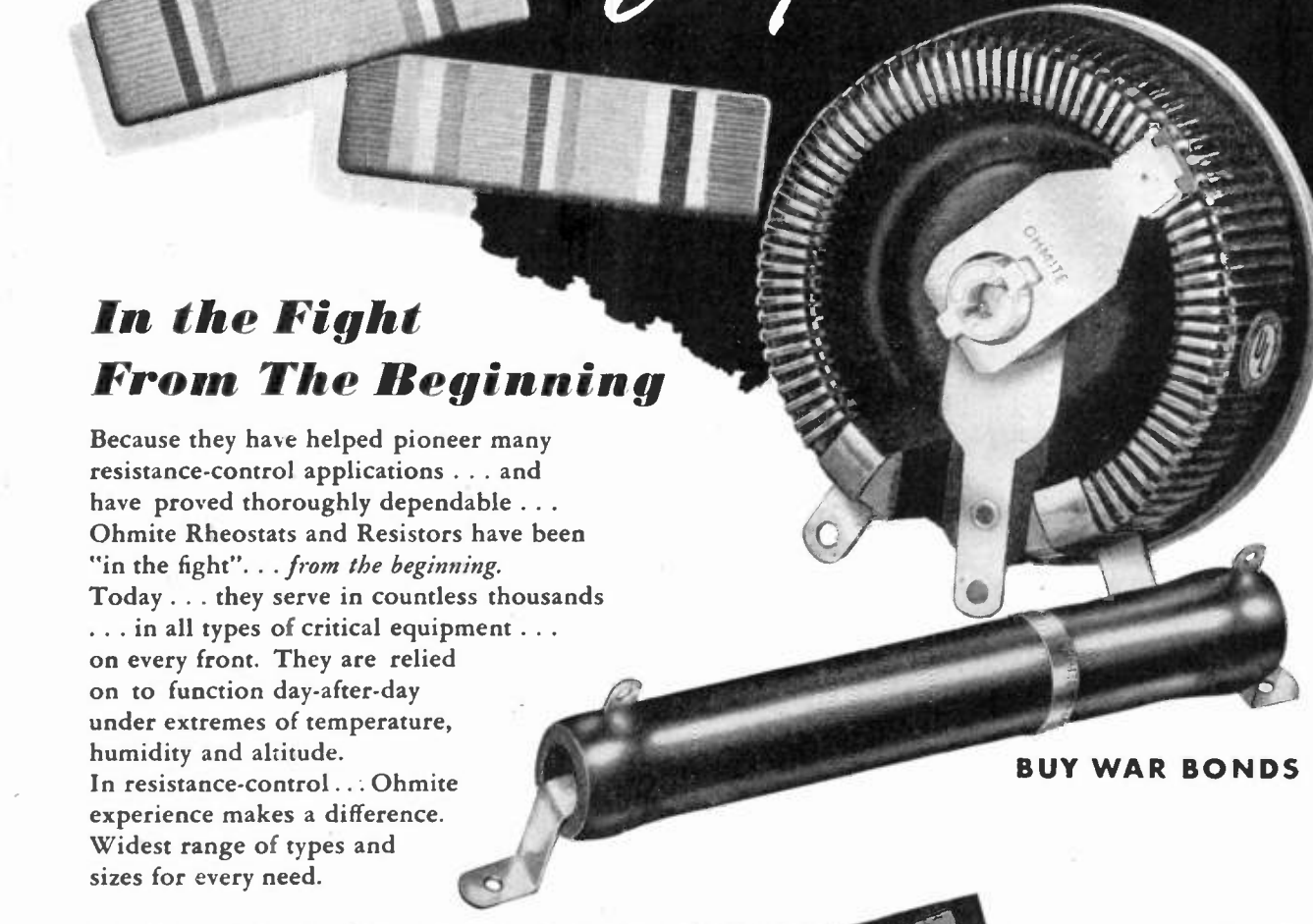
SCREWS, Hollow & Socket Head

Allen Mfg. Co., Hartford, Conn.
Central Screw Co., 3519 Shields, Chicago
Federal Screw Prod. Co., 224 W. Huron St., Chicago

OHMITE

RHEOSTATS AND RESISTORS

Veterans of Service on Every Battle Front



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Parker-Kalon, 198 Varick, N. Y. C.
Stand. Pressed Steel Co., Jenkintown, Pa.

SELENIUM

Federal Tel. & Radio Corp., S. Newark, N. J.
Benwood Linze Co., St. Louis, Mo.
Selenium Corp. of Amer., 1800 W. Pico Blvd., Los Angeles

SHAFTING, Flexible

Breeze Corps., Inc., Newark, N. J.
Mall Tool Co., 7708 S. Chicago Ave., Chicago
Steward Mfg. Corp., 4311 Ravenswood Ave., Chicago
Walker-Turner Co., Inc., Plainfield, N. J.
White Dental Mfg. Co., 10 E. 48 St., N. Y. C.

SHEETS, Electrical

Amer. Rolling Mill Co., Middletown, Conn.
Carnegie-Illinois Steel Corp., Pittsburgh, Pa.
Follansbee Steel Corp., Pittsburgh, Pa.
Granite City Steel Co., Granite City, Ill.
Newport Rolling Mill Co., Newport, Ky.
Republic Steel Corp., Cleveland, O.
Ryerson & Son, Inc., Jos. T., Chicago
Westinghouse Elect. & Mfg. Co., E. Pittsburgh, Pa.

SHIELDS, Tube

★ Goat Metal Stampings, Inc., 314 Dean St., Brooklyn, N. Y.

SHOCK ABSORBERS

See MOUNTINGS, Shock Absorbing

SIGNAL GENERATORS

See GENERATORS, Standard Signal

SOCKETS, Cathode Ray Tube

Franklin Mfg. Corp., 175 Varick St., N. Y. C.

SOCKETS, Tube

Aladdin Radio Industries, 501 W. 35th St., Chicago
Alden Prods. Co., Brockton, Mass.
★ Amer. Phenolic Corp., 1830 S. 54th Av., Chicago
Amer. Radio Hdware Co., Mt. Vernon, N. Y.
Birnbach Radio Co., 145 Hudson, N. Y. C.
Bud Radio, Inc., Cleveland, O.
Cinch Mfg. Co., 2335 W. Van Buren St., Chicago
Cont'l-Diamond Fibre Co., Newark, Del.
Eagle Elec. Mfg. Co., Brooklyn, N. Y.
Eby, Inc., H. H., Philadelphia
Federal Screw Prods. Co., 26 S. Jefferson, Chicago
Franklin Mfg. Corp., 175 Varick, N.Y.C.
★ Hammarlund Mfg. Co., 424 W. 33 St., N. Y. C.
Johnson Co., E. F., Waseca, Minn.
Jones, Howard B., 2300 Wabansia, Chicago
Micarta Fabricators, Inc., 4619 Ravenswood, Chicago
Millen Mfg. Co., James, Malden, Mass.
Miller Co., J. W., Los Angeles, Cal.
★ Nat'l Co., Malden, Mass.
Remler Co., San Francisco, Cal.

SOCKETS, Tube, Ceramic Base

Johnson Co., E. F. Waseca, Minn.
★ National Co., Inc., Malden, Mass.
Nat'l Fabricated Products, W. Belden Ave., Chicago
Ucinite Co., Newtonville, Mass.

SOLDER, Self-fluxing

Garden City Laboratory, 2744 W. 37th Pl., Chicago
Gardiner Metal Co., S. Campbell Ave., Chicago
★ General Elec. Co., Bridgeport, Conn.
Kester Solder Co., 4209 Wrightwood Ave., Chicago
Ruby Chemical Co., Columbus, O.

SOLDER POTS

★ Elec. Soldering Iron Co., Inc., Deep River, Conn.
Lectrohm, Inc., Cicero, Ill.
Sound Equip. Corp. of Calif., 6245 Lex. Ave., Los Angeles 38
Westinghouse Elect. & Mfg. Co., E. Pittsburgh, Pa.

SPEAKERS, Cabinet Mounting

Altec Lansing Corp., 1680 N. Vine, Hollywood 28
Cinaudagraph Speakers, Inc., 3911 S. Michigan Ave., Chicago
Crescent Industries, Inc., Belmont Ave., Chicago
★ Jensen Radio Mfg. Co., 6601 S. Laramie St., Chicago
John Meck, Industries, Plymouth, Ind.
Magnavox Co., Fort Wayne, Ind.
Quam-Nichols Co., 33rd Pl., Chicago 16
Rola Co., Inc., Superior St., Cleveland, O.
Utah Radio Prod. Co., 842 Orleans St., Chicago

SPEAKERS, Outdoor Type

Altec Lansing Corp., 1680 N. Vine, Hollywood 28
Cinaudagraph Speakers, Inc., 3911 S. Michigan Ave., Chicago
★ Jensen Radio Mfg. Co., 6601 S. Laramie St., Chicago
University Labs., 225 Varick St., N. Y. C.

SPRINGS

Accurate Spring Mfg. Co., 3817 W. Lake, Chicago
Ace Mfg. Corp., 1255 E. Erie Ave., Phila. 24
American Spring & Mfg. Corp., Holly, Mich.
American Steel & Wire Co., Rockefeller Bldg., Cleveland, O.
Barnes Co., Wallace, Bristol, Conn.
Crescent Industries, Inc., 4132 W. Belmont Ave., Chicago
Cuyahoga Spring Co., Cleveland, O.
Gibson Co., Wm. D., 1800 Clybourn Av., Chicago
Hubbard Spring Co., M. D., Pontiac, Mich.
Hunter Pressed Steel Co., Lansdale, Pa.
Instrument Specialties Co., Little Falls, N. Y.
Muehlhausen Spring Corp., Logansport, Ind.
Peck Spring Co., Plainville, Conn.
Raymond Mfg. Co., Corry, Pa.
Security Steel Equip. Corp., Avenel, N. J.
Standard Spring & Mfg. Co., Ind., 236–42 St., Brooklyn, N. Y.
★ Willor Mfg. Corp., 794 E. 104 St., N. Y. C. 54

STAMPINGS, Metal

Bud Radio, Inc., E. 55 St., Cleveland, O.
★ Goat Metal Stampings, Inc., 314 Dean St., Brooklyn, N. Y.
Hadley Co., R. M., 707 E. 61st, Los Angeles
Insuline Corp. of Amer., Long Island City, N. Y.
Par-Metal Prod. Corp., Long Island City, N. Y.
Stewart Stamping Corp., 621 E. 216 St., N. Y. C.
Willor Mfg. Corp., 288-A Eastern Blvd., N. Y. C.

STEATITE, See Ceramics

SUPPRESSORS, Parasitic

Ohmite Mfg. Co., 4835 Flournoy St., Chicago

SWITCHES, Aircraft Push

Square D Co., Kollsman Inst. Div., Elmhurst, N. Y.
★ Universal Microphone Co., Inglewood, Calif.

SWITCHES, Key

Audio Development Co., Minneapolis, Minn.
Chicago Tel. Supply Co., Elkhart, Ind.
General Control Co., Cambridge, Mass.
Mossman, Inc., Donald P., 6133 N. Northwest Hy., Chicago

SWITCHES, Midget Snap

Allied Control Co., Inc., E. End Ave., N. Y. C.
Aero Electric Co., 3167 Fulton Rd., Cleveland
Micro Switch Corp., Freeport, Ill.

SWITCHES, Rotary, Bakelite Wafer

Mallory & Co., Inc., P. R., Indianapolis, Ind.
Stackpole Carbon Co., St. Marys, Pa.

SWITCHES, Rotary, Ceramic Wafer

Comm. Prods. Co., 744 Broad, Newark, N. J.
Oak Mfg. Co., 1267 Clybourn Ave., Chicago
Ohmite Mfg. Co., 4835 Flournoy St., Chicago
Shallcross Mfg. Co., Collingsdale, Pa.

SWITCHES, Time Delay

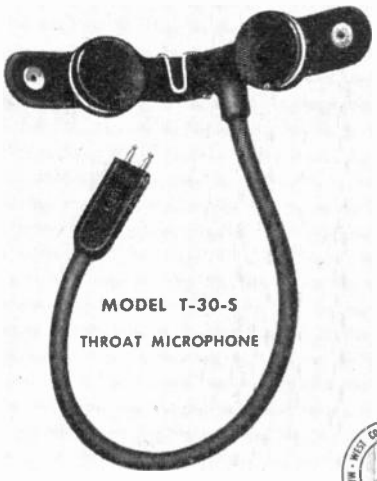
Haydon Mfg. Co., Inc., Forestville, Ct.
Industrial Timer Corp., 115 Edison Pl., Newark, N. J.
Sangamo Elect. Co., Springfield, Ill.

SYNTHETICS, Wood & Metal Finish

Sullivan Varnish Co., 410 N. Hart St., Chicago 22

History of Communications Number Five of a Series

NIGHT COMMUNICATIONS ON THE HIGH SEAS



In those early days when our Navy was first organized night communication was made by lantern from the masthead. This was the only communication between ships at sea during through which many times news from home was transmitted.

Today, through the use of Universal Microphones and voice communication components, vital communications of War are speedily transmitted equally as well from small sea-craft and battle cruiser to home port.

Many new types of Universal microphones shall be developed from the experience obtained from the production of military units, for the private citizens in the marine pleasure-craft in the days after Victory is ours.

< Model T-30-S, illustrated at left, is but one of several military type microphones now available to priority users through local radio jobbers.

UNIVERSAL MICROPHONE COMPANY
INGLEWOOD, CALIFORNIA

FOREIGN DIVISION: 301 CLAY STREET, SAN FRANCISCO 11, CALIFORNIA ·· CANADIAN DIVISION: 560 KING STREET WEST, TORONTO 1, ONTARIO, CANADA

TERMINALS, Hermetically Sealed

See BUSHINGS, Terminal Sealing

TERMINALS, Soldered or Solderless

See LUGS, Soldering and Solderless

TERMINALS (Turret Lugs)

★ Cambridge Thermionic Corp., 443 Concord Ave., Cambridge 38, Mass.
Manufacturers Screw Prod., 216 W. Hubbard St., Chicago 10
Ucinite Co., Newtonville, Mass.

TERMINAL STRIPS

Burke Electric Co., Erie, Pa.
Cinch Mfg. Corp., W. Van Buren St., Chicago
Curtis Devel. & Mfg. Co., N. Crawford Ave., Chicago
Franklin Mfg. Corp., 175 Varick St., N. Y. C.
Jones, H. B., 2432 W. George, Chicago
Kulka Electric Mfg. Co., Mt. Vernon, N. Y.

TEST CHAMBERS, Temperature, Humidity, Altitude, Salt Spray

American Coils Co., 25 Lexington St., Newark, N. J.
Industrial Filter & Pump Mfg. Co., W. Carroll Ave., Chicago
Jackson Elec. Inst. Co., Dayton, O.
Kold-Hold Mfg. Co., 446 N. Grand Ave., Lansing, Mich.
Mobile Refrigeration, Inc., 630–5th Ave., N. Y. C.
Northern Engineering Labs., 50 Church St., N. Y. C.
Radio City Prod. Co., Inc., 127 W. 26 St., N. Y. C.
★ Radio Corporation of America, Camden, N. J.
Supreme Inst. Corp., Greenwood, Miss.
Tenney Engineering, Inc., Montclair, N. J.
Weston Electrical Inst. Co., Newark, N. J.

TRACING PAPERS, CLOTH, CELLOPHANE

Arkwright Finishing Co., Providence, R. I.
Brown & Bro., Arthur, 67 W. 44 St., N. Y. C.
Keuffel & Esser, Hoboken, N. J.

TRANSFORMERS, Constant-Voltage

Dongan Elec. Co., 74 Trinity Pl., N. Y. C.
★ General Electric Co., Schenectady, N. Y.
Raytheon Mfg. Co., Waltham, Mass.
Sola Electric Co., 2525 Clybourn Ave., Chicago

TRANSFORMERS, IF, RF

Aladdin Radio Industries, 501 W. 35th St., Chicago
Amer. Transformer Co., Newark, N. J.
Automatic Windings Co., E. Passaic, N. J.
★ Browning Labs., Inc., Winchester, Mass.
★ Cambridge Thermionic Corp., Concord Ave., Cambridge, Mass.
Caron Mfg. Co., 415 S. Aberdeen, Chicago
D-X Radio Prods. Co., 1575 Milwaukee, Chicago
Essex Specialty Co., Inc., Broad St., Newark, N. J.
Gen'l Winding Co., 420 W. 45 St., N. Y. C.
Greyhound Equip. Co., 1720 Church Ave., Brooklyn, N. Y.
Guthman & Co., 15 S. Throop, Chicago
★ Hammarlund Mfg. Co., 424 W. 33 St., N. Y. C.
Meissner Mfg. Co., Mt. Carmel, Ill.
Millen Mfg. Co., James, Malden, Mass.
Miller Co., J. W., 5917 S. Main, Los Angeles, Cal.
★ Nat'l Co., Malden, Mass.
Radex Corp., 1308 Elston Ave., Chicago
Sickles Co., F. W., Springfield, Mass.
Sound Equip. Corp. of Calif., 6245 Lex. Ave., Los Angeles 38
Standard Winding Corp., Newburgh, N. Y.
Super Elec. Prod. Corp., Jersey City, N. J.
Teleradio Eng. Corp., 484 Broome St., N. Y. C.
Triumph Mfg. Co., 4017 W. Lake, Chicago

TRANSFORMERS, Receiver Audio & Power

Acme Elec. & Mfg. Co., Cuba, N. Y.
Altec Lansing Corp., 1680 N. Vine, Hollywood 29
Amer. Transformer Co., Newark, N. J.
Amplifier Co. of Amer., 17 W. 20th St., N. Y. C.
Audio Devel. Co., N. Minneapolis, Minn.
★ Chicago Transformer Corp., 3501 Addison St., Chicago
Cinaudagraph Speakers, Inc., 3911 S. Michigan, Chicago
Dinion Coil Co., Caledonia, N. Y.
Dongan Elec. Co., 74 Trinity Pl., N. Y. C.
Electronic Trans. Co., 515 W. 29 St., N. Y. C.
Ferranti Elec., Inc., 30 Rockefeller Plaza, N. Y. C.
Freed Trans. Co., 72 Spring St., N. Y. C.
Gen'l Radio Co., Cambridge, Mass.
General Trans. Corp., 1250 W. Van Buren, Chicago
Hadley Co., R. M., 707 E. 61st, Los Angeles
Halldorson Co., 4500 Ravenswood, Chicago
Jefferson Elec. Co., Bellwood, Ill.
Kenyon Transformer Co., 840 Barry St., N. Y. C.
Magnetic Windings Co., Easton, Pa.
★ Merit Coil & Trans. Corp., 4427 N. Clark, Chicago 40
Newark Transformer Co., Newark, N. J.
New York Transformer Co., 51 W. 3rd, N. Y. C.
Norwalk Transformer Corp., S. Norwalk, Conn.
Raytheon Mfg. Co., Waltham, Mass.
Rola Co., Inc., Superior St., Cleveland, O.
Standard Transformer Corp., 1500 N. Halsted, Chicago
Super Elect. Prod. Co., Jersey City, N. J.
Superior Elec. Co., Bristol, Conn.
Thermador Elect. & Mfg. Co., Riverside Dr., Los Angeles
Thordarson Elec. Mfg. Co., 500 W. Huron, Chicago
Utah Radio Prods. Co., 820 Orleans St., Chicago
★ United Transformer Co., 150 Varick St., N. Y. C.
Westinghouse Elect. & Mfg. Co., E. Pittsburgh, Pa.

TRANSFORMERS, Variable Voltage

Amer. Transformer Co., Newark, N. J.
General Radio Co., Cambridge, Mass.
Superior Electric Co., Bristol, Conn.

TUBE MANUFACTURING MACHINES

Hilton Eng. Labs., Redwood City, Calif.
Eisler Eng. Co., 7518 13th St., Newark, N. J.

TUBES, Cathode Ray

★ Dumont Labs., Allen B., Passaic, N. J.
Farnsworth Tele. & Radio Corp., Ft. Wayne, Ind.
★ General Elec. Co., Schenectady, N. Y.
Ken-Rad Tube & Lamp Corp., Owensboro, Ky.
Nat'l Union Radio Corp., Newark, N. J.
North Amer. Philips Co., Inc., Dobbs Ferry, N. Y.
Rauland Corp., Chicago, Ill.
★ RCA Mfg. Co., Camden, N. J.
★ Sylvania Elect. Prod., Inc., Emporium, Pa.
Westinghouse Elect. & Mfg. Co., E. Pittsburgh, Pa.

TUBES, Current Regulating

Amperite Co., 561 Broadway, N. Y. C.
Champion Radio Works, Danvers, Mass.
★ Hytron Corp. & Hytronic Labs., Salem, Mass.
★ RCA Mfg. Co., Camden, N. J.
★ Sylvania Elec. Prod., Inc., Emporium, Pa.
Western Elec. Co., 195 B'dway, N. Y. C.

TUBES, Photo-Electric

Cont'l Elec. Co., Geneva, Ill.
De Jur-Amsco Corp., Shelton, Conn.
De Vry, Herman A., 1111 W. Center, Chicago
Electronic Laboratory, Los Angeles, Cal.
Emby Prods. Co., Los Angeles, Cal.
★ General Elec. Co., Schenectady, N. Y.
General Scientific Corp., 4829 S. Kedzie Av., Chicago
G-M Labs., 4313 N. Knox Av., Chicago
Leeds & Northrop Co., Philadelphia
Nat'l Union Radio Corp., Newark, N. J.
Photobell Corp., 123 Liberty St., N. Y. C.
★ RCA Mfg. Co., Camden, N. J.
Rectron Corp., 2159 Magnolia Av., Chicago
Westinghouse Lamp Div., Bloomfield, N. J.
Western Elec. Co., 195 B'way, N. Y. C.
Weston Elec. Inst. Corp., Newark, N. J.

TUBES, Receiving

★ General Elec. Co., Schenectady, N. Y.
★ Hytron Corp., Salem, Mass.
Ken-Rad Tube & Lamp Corp., Owensboro, Ky.
Nat'l Union Radio Corp., Newark, N. J.
Raytheon Prod. Corp., 420 Lexington Av., N. Y. C.
★ RCA Mfg. Co., Camden, N. J.
★ Sylvania Elect. Prod., Inc., Emporium, Pa.
Tung-Sol Lamp Works, Newark, N. J.

LIEUT. BASIL CUTTING, CHIEF RADIO ENGINEER, N. H. STATE POLICE

New Hampshire State Police Use Eight

BROWNING FREQUENCY METERS

THE speed and accuracy with which police radio equipment can be checked makes the BROWNING Crystal-Controlled Frequency Meter worth twice its cost to hard-pressed engineers.

No one knows this better than Lieut. Basil Cutting, Chief Radio Engineer of the New Hampshire State Police. He maintains single-handed a state-wide system employing a unique combination of FM and AM. Still, he finds time to coöperate with municipal officials.

The BROWNING Frequency Meter is always ready for use. It is AC operated, eliminating the need of dry cells. Accuracy is better than required by FCC standards.

Models are available on prompt delivery for use on one, two, three, or four frequencies at any specified points between 1.5 and 120 mc. Calibration at specific frequencies makes these instruments quick, easy, and accurate to use.

For further details and prices address:

BROWNING LABORATORIES, Inc.

751 MAIN STREET WINCHESTER, MASS.

TUBES, Transmitting

Amperex Electronic Prods., Brooklyn, N. Y.
★ Eitel-McCullough, Inc., San Bruno, Cal.
Electronic Enterprises, Inc., 65-67 Av., Newark, N. J.
Federal Telephone & Radio Corp., Newark, N. J.
★ General Elec. Co., Schenectady, N. Y.
Heintz & Kaufman, S. San Francisco, Cal.
★ Hytron Corp., Salem, Mass.
Ken-Rad Tube & Lamp Corp., Owensboro, Ky.
Nat'l Union Radio Corp., Newark, N. J.
North Amer. Philips Co., Inc., Dobbs Ferry, N. Y.
Raytheon Prod. Corp., 420 Lexington Av., N. Y. C.
★ RCA Mfg. Co., Camden, N. J.
Slater Electric & Mfg. Co., Brooklyn, N. Y.
Sperry Gyroscope Co., Inc., Brooklyn, N. Y.
★ Sylvania Elect. Prod., Inc., Emporium, Pa.
Taylor Tubes, Inc., 2341 Wabansia, Chicago
United Electronics Co., Newark, N. J.
Western Elec. Co., 195 B'way, N. Y. C.
Westinghouse Lamp Div., Bloomfield, N. J.

TUBES, Voltage-Regulating

Amperite Co., 561 Broadway, N. Y. C.
Hytron Corp., Salem, Mass.
★ RCA Mfg. Co., Camden, N. J.
★ Sylvania Elec. Prod., Inc., Salem, Mass.

TUBING, Laminated Phenolic

Brandywine Fibre Prods. Co., Wilmington, Del.
Formica Insulation Co., Cincinnati, O.
★ General Electric Co., Pittsfield, Mass.
Insulation Mfgrs. Corp., 565 W. Washington Blvd., Chicago
Mica Insulator Co., 196 Varick, N. Y. C.
Nat'l Vulcanized Fibre Co., Wilmington, Del.
Richardson Co., Melrose Park, Ill.
Spaulding Fibre Co., 233 B'way, N. Y. C.
Synthane Corp., Oaks, Pa.
Taylor Fibre Co., Norristown, Pa.
Westinghouse Elec. & Mfg. Co., E. Pittsburgh, Pa.
Wilmington Fibre Specialty Co., Wilmington, Del.

TUBING, Precision Metal

Superior Tube Co., Norristown, Pa.

TUBING & SLEEVING, Varnished Cambric, Glass-Fibre, Spaghetti

Bentley-Harris Mfg. Co., Conshohocken, Pa.
Brand & Co., Wm., 276 Fourth Av., N. Y. C.
Electro Tech. Prod., Inc., Nutley, N. J.
Endurette Corp. of Amer., Cliffwood, N. J.
★ General Elec. Co., Bridgeport, Conn.
Insulation Mfgrs. Corp., 565 W. Washington Blvd., Chicago
Irvington Var. & Ins. Co., Irvington, N. J.
Mica Insul. Co., 196 Varick St., N. Y. C.
Mitchell-Rand Insulation Co., 51 Murray St., N. Y. C.
Varflex Corp., Rome, N. Y.

TURNTABLES, Phonograph

Fairchild Camera & Inst. Co., 88-06 Van Wyck Blvd., Jamaica 1, N. Y.
General Industries Co., Elyria, O.
General Instrument Corp., Elizabeth 3, N. J.
Presto Recording Corp., 242 W. 45 St., N. Y. C.
★ R C A Mfg. Co., Camden, N. J.
Seeburg Corp., J. P., 1510 N. Dayton St., Chicago
Webster Products, 3825 Armitage Ave., Chicago
Western Electric Co., 125 B'way, N. Y. C.

VARNISHES, Insulating, Air-Drying & Baking

Comm. Prods. Co., 744 Broad, Newark, N. J.
Dolph Co., John C., Newark, N. J.
Irvington Var. & Ins. Co., Irvington, N. J.
Mitchell-Rand Insulation Co., 51 Murray St., N. Y. C.
Stille-Young Corp., 2300 N. Ashland Av., Chicago
Zophar Mills, Inc., 112-26 St., Bklyn., N. Y.

VARNISHES, Wrinkle Finish

Sullivan Varnish Co., 410 N. Hart St., Chicago

VIBRATION TEST EQUIPMENT

Vibration Specialty Co., 1536 Winter St., Philadelphia
All American Tool & Mfg. Co., 1014 Fullerton Ave., Chicago

VIBRATORS, Power Supply

Amer. Telev. & Radio Co., St. Paul, Minn.
Electronic Labs., Indianapolis, Ind.
Mallory & Co., Inc., P. R., Indianapolis, Ind.
Radiart Corp., W. 62 St., Cleveland, O.
Turner Co., Cedar Rapids, Ia.
Utah Radio Prod. Co., Orleans St., Chicago

WAXES & COMPOUNDS, Insulating

Irvington Varnish & Ins. Co., Irvington, N. J.
Western Elec. Co., 195 B'dway, N. Y. C.
Zophar Mills, Inc., 112-26 St., Bklyn., N. Y.

WELDING, Gas, Aluminum & Steel

Treitel-Gratz Co., 142 E. 32 St., N. Y. C.

WIRE, Bare

Amer. Steel & Wire Co., Cleveland, O.
Anaconda Wire & Cable Co., 25 B'dway N. Y. C.
Ansonia Elec. Co., Ansonia, Conn.
Belden Mfg. Co., 4633 W. Van Buren, Chicago
Copperweld Steel Co., Glassport, Pa.
Crescent Ins. Wire & Cable Co., Trenton, N. J.
★ General Elec. Co., Bridgeport, Conn.
Phosphor Bronze Smelting Co., Phila.
Rea Magnet Wire Co., Fort Wayne, Ind.
Roebling's Sons Co., John, Trenton, N. J.
Vellfff Mfg. Corp., Southport, Conn.

WIRE, Glass Insulated

Bentley, Harris Mfg. Co., Conshohocken Pa.
Garitt Mfg. Corp., Brookfield, Mass.
Holyoke Wire & Cable Corp., Holyoke, Mass.
Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago 6
Owens-Corning Fiberglas Corp., Toledo, O.

WIRE, HOOKUP

Bentley, Harris Mfg. Co., Conshohocken, Pa.
Gavitt Mfg. Co., Brookfield, Mass.
★ Lenz Elec. Mfg. Co., 1751 N. W. Av. Chicago
Rockbestos Prod. Corp., New Haven, Conn.
Runzel Cord & Wire Co., 4723 Montrose Ave., Chicago
Whitney Blake Co., New Haven, Conn.

WIRE & CABLE

Acme Wire Co., New Haven, Conn.
Amer. Steel & Wire Co., Cleveland, O.
Anaconda Wire & Cable Co., 25 B'dway, N. Y. C.
Ansonia Elec. Co., Ansonia, Conn.
Belden Mfg. Co., 4633 W. Van Buren, Chicago
Collyer Ins. Wire Co., Pawtucket, R. I.
Consolidated Wire Co., 1634 Clinton St., Chicago
Crescent Ins. Wire & Cable Co., Trenton, N. J.
Elec. Auto-Lite Co., The, Port Huron, Mich.
General Cable Corp., Rome, N. Y.
★ General Elec. Co., Bridgeport, Conn.
Hazard Ins. Wire Works, Wilkes-Barre, Pa.
Holyoke Wire & Cable Corp., Holyoke, Mass.
Hudson Wire Co., Winsted, Conn.
Rea Magnet Wire Co., Fort Wayne, Ind.
Rockbestos Prods. Corp., New Haven, Conn.
Roebling's Sons Co., John, Trenton, N. J.
Runzel Cord & Wire Co., 4723 Montrose Ave., Chicago
Simplex Wire & Cable Co., Cambridge, Mass.
Western Ins. Wire, Inc., 1000 E. 62 St., Los Angeles
Wheeler Insulated Wire Co., Bridgeport, Conn.

WOOD, Laminated & Impregnated

Canfield Mfg. Co., Grand Haven, Mich
Formica Insulation Co., Cincinnati, O.

WOOD PRODUCTS, Cases, Parts

Hoffstatter's Sons, Inc., 43 Ave. & 24 St., Long Island City, N. Y.
Tillotson Furniture Co., Jamestown, N. Y.

The men who lead the parade of set manufacturers and broadcasters are building all their postwar plans on FM and Television ★ ★ ★ The logical way, then, to bring your products to the attention of the men whose postwar business you want is to use advertising space in *FM* AND TELEVISION Magazine right now ★ ★ ★

AN FM-AM RECEIVER

(CONTINUED FROM PAGE 20)

to disconnect the internal power supply and connect an external battery supply directly to the receiver. This socket is normally shorted out by an octal plug.

When an external DC supply is used, 270 volts are connected to the octal socket, the plus to pin 3, and minus to pin 5. A 6-volt source must be connected also with the plus to pin 7 and the minus to pin 8. In addition, a remote standby switch goes across pins 1 and 5. These numbers appear in the wiring diagram, Fig. 2.

Tuning Meter ★ A dual purpose carrier indicator or "S" meter is incorporated in this receiver. When receiving amplitude modulated signals, this meter functions in the usual manner to show carrier level, but when used for FM reception the FM-AM switch connects the meter as an exceptionally effective FM tuning indicator.

The zero position of the meter is approximately ¾ of the way across the scale. When operating on FM, the indicator is connected as a volt meter across the discriminator diode load resistors. If the receiver is perfectly tuned to an incoming FM signal, no voltage appears across these resistors and the meter points to the zero position. When tuning in to an FM signal the meter reaches a peak on one side, falls through zero and swings through a peak on the other side. The signal is tuned in perfectly as the meter passes through the zero point between these two peaks.

Mechanical Features ★ The S-36A is ruggedly built for operation in all climates. Transformers and filter reactors are hermetically sealed, as are the oil-impregnated paper condensers. Insulating covering on wiring is moisture proof. The entire receiver is treated to resist fungus growth and other tropical hazards.

In common with other Hallicrafters equipment that has seen wide use in the Armed Forces, this receiver is designed for maximum accessibility and ease of servicing. Resistors and fixed capacitors are securely mounted on terminal boards where they may be replaced, if necessary, with the minimum amount of labor. In addition, all major components are identified by circuit symbols so that inexperienced personnel can perform any necessary maintenance operations without trouble. All essential controls, including the "S" meter adjustment and a line fuse, are conveniently arranged on the front panel.

The military applications of this equipment are, of course, restricted information and may not be described at this time. It can be stated, however, that in addition to its normal communications uses, the S-36A is in demand as a laboratory instrument where its unusual versatility is of value in VHF research.

RADIO DESIGNERS' ITEMS

(CONTINUED FROM PAGE 38)

permitting the maintenance of internal pressure, if required.

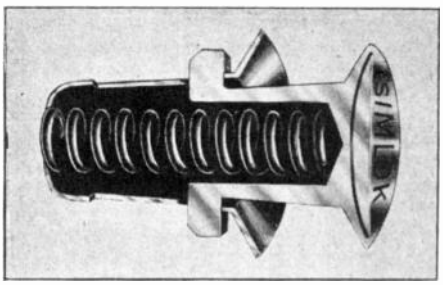


FIG 7. CROSS-SECTION OF FASTENER

Fasteners: Various designs of quarter-turn fasteners for panels and plates on radio equipment are shown in a catalog issued by the Simlok division of Simmons Machine Tool Corporation, Albany, N. Y. Studs have either slotted or wing heads, and are retained in the outer plate by a simple locking ring. Countersunk head on the stud, Fig. 7, gives a clean, flush appearance when the stud is locked down.

Several types of receptacles, into which the stud is locked, are available. They can be rolled in place, or secured with rivets. Small size makes them convenient to use.

A particular advantage of this fastener is that the stud is kept under tension at all times and, when it is unlocked, the spring forces the stud upward, signaling in that way that it is unfastened.

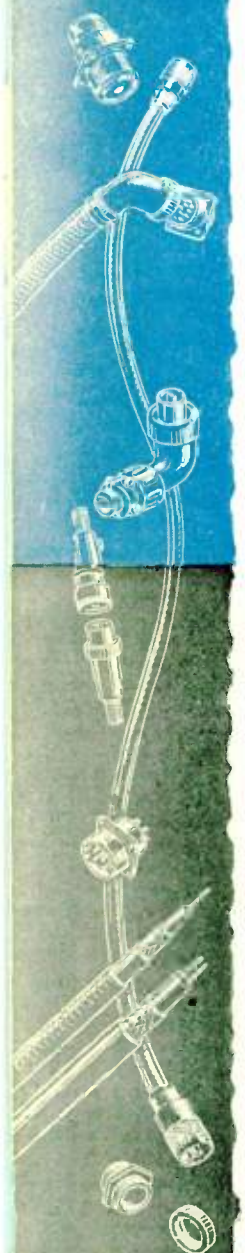
OVER 8,500 AMPHENOL PRODUCTS FOR ELECTRICAL TRANSMISSION

Save this— For future reference. For information you need now— Use the Coupon.

If in your products you use electrical transmission equipment, there is in these Data Sheets information that you can use to advantage, if not today then on postwar products.

Amphenol equipment is used where the requirements are tough. There are Amphenol products for current of low or high frequency. Wherever you use electricity you need the best of equipment—Amphenol.

Use the coupon to send for the information you want



AN and 97 CONNECTORS
Where electrical connections must be positive and secure, where they must be made or broken quickly—as on aircraft, tanks or ships—these connectors are used. Made with from one to forty-eight contacts. On the coupon check **Section A.**

SPECIAL CONNECTORS
These are the special service connectors—explosion proof, moisture proof, thermo-coupling, grounding, instrument, special mounting, etc. Mark the coupon **Section A1.**

CONDUIT FITTINGS
Conduit couplings—straight, 45° and 90°, coupling nuts, ferrules, clamps, etc. Designed for secure connections. Properly finished to avoid abrasion of wire insulation. On coupon check **Section B.**

AIRCRAFT ELECTRICAL CONDUIT and CABLE ASSEMBLIES
Flexible metal and plastic conduit, cable assemblies, wiring harnesses, etc. Ample facilities for quantity production. On coupon check **Section B1.**

SPECIAL TOOLS
Conduit ferrule crimping machines, saw vises for cutting conduit and cable. Special tools for good work on this type of electrical equipment. Mark on the coupon **Section C.**

U. H. F. CABLES AND CONNECTORS
For ultra high frequency transmission—Amphenol low-loss cables and connectors—a complete line. This includes the full list of RG type cables. On coupon check **Section D.**

BRITISH CONNECTORS
In quality, type, range of size and application these are similar to Amphenol AN and 97—but built to specifications of the British Air Ministry. Mark the coupon **Section E.**

RADIO PARTS AND ACCESSORIES
For Radio, FM, Television, Electronic and Sound equipment—connectors, sockets, plugs, etc. Also special tools for wiring. On the coupon check **Section F.**

SYNTHETICS FOR ELECTRONICS AND INDUSTRY
The story of Amphenol's facilities for making plastic parts or products by compression or injection molding, extrusion or machining. On the coupon check **Section G.**

Depend upon **AMPHENOL** *Quality*

Connectors
Fittings
Conduit
Cable
Radio Parts
Synthetics

AMERICAN PHENOLIC CORPORATION
1830 S. 54th Avenue, Chicago 50, Illinois

AMERICAN PHENOLIC CORPORATION
1830 S. 54th Avenue, Chicago 50, Illinois

Please send me information and Data Sheets as checked below—without obligation.

☐ Section A	☐ Section B1	☐ Section E
☐ Section A1	☐ Section C	☐ Section F
☐ Section B	☐ Section D	☐ Section G

Signed_____

Company_____

Address_____

City and State_____

NO SUBSTITUTE NEEDED!

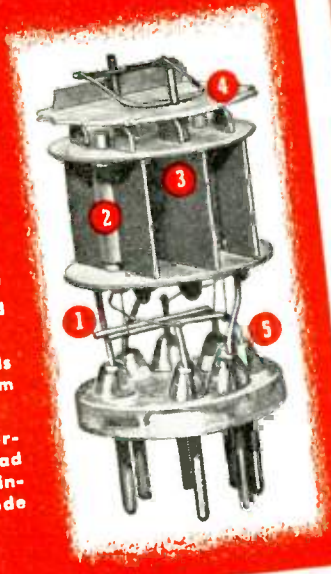
USE HYTRON 6AL5 VERY-HIGH-FREQUENCY TWIN DIODE

TYPE 6AL5
(Developmental Hytron D27)

BASING
Pin 1 — Cathode 1
Pin 2 — Plate 2
Pin 3 — Heater
Pin 4 — Heater
Pin 5 — Cathode 2
Pin 6 — Shield
Pin 7 — Plate 1

CONSTRUCTIONAL FEATURES

1. Rugged mount is supported by short, heavy stem leads as well as by top mica.
2. Close cathode-to-plate spacing gives high perveance. (Note plate cooling fins.)
3. Electrostatic shield connects to pin 6.
4. Baffle mica shields the elements from getter spray.
5. Miniature stem permits negligible lead inductance and minimum interelectrode capacitances.



The 6AL5 fills the need for a high perveance twin diode with the low voltage drop required for many special r.f. circuit applications. WPB and the Services consider diode connection of the 6J6 twin triode (and other triodes) to be a wasteful misuse. With minor changes of socket wiring, the 6AL5 easily replaces the diode-connected 6J6.

Specifically manufactured and rated as a diode, the 6AL5 is tested as a diode. Close production control keeps within a narrow range the cutoff characteristic in the contact potential region. Designed throughout for efficiency on high and very-high radio frequencies, the 6AL5 has a separately connected shield which may be grounded to isolate the two diodes and their associated circuits. A midget miniature bulb permits extra space savings.

Possible uses include: Detector and AVC, clipper, limiter, FM frequency discriminator, special high-frequency diode, power rectifier.

HYTRON TYPE 6AL5
Very-High-Frequency Twin Diode

ELECTRICAL CHARACTERISTICS

Heater potential (AC or DC)	6.3 volts
Heater current	0.3 amperes
Peak inverse potential†	460 max. volts
Heater-cathode potential†	350 max. volts
Peak plate current per plate†	60 max. ma.
Average plate current per plate†	10 max. DC ma.

INTERELECTRODE CAPACITANCES

Plate 1 to plate 2	0.015 mmf.
Plate to cathode*	2.8 mmf.
Cathode to all*	3.8 mmf.

Capacitances are averages with close-fitting shield.

PHYSICAL CHARACTERISTICS

Bulb	T-5½ midget
Base	Miniature button 7-pin
Height overall	1.82 inches max.
Diameter	0.75 inch max.

† Maximum ratings shown are absolute; design maximums should be approximately 10% lower to allow for line voltage variations.
* Value is for one of the two twin diode sections.

OLDEST EXCLUSIVE MANUFACTURER OF RADIO RECEIVING TUBES

HYTRON CORPORATION ELECTRONIC AND RADIO TUBES
SALEM AND NEWBURYPORT, MASS.

HYTRON RADIO TUBES

BUY ANOTHER WAR BOND

ENGINEERING SALES

General Electric: W. C. Walsh will serve as G.E.'s district representative for their electronics department at 235 Montgomery Street, San Francisco. He will be responsible for products of the tube and specialty divisions in California, Oregon, Washington, Montana, Wyoming, Nevada, Utah, Colorado, Arizona, and Northern New Mexico.

Sylvania: Latest addition to radio tube equipment sales staff is Raymond Kenneth Burnet. He will make his headquarters at the Chicago office, 135 South LaSalle Street. Burnet, a newcomer to radio, is a graduate of Colgate University.

Karp: New representatives appointed by Karp Metal Products are: Paul R. Sturgeon, 25 Huntington Avenue, Boston, for New England; E. W. McGrade Co., Porter Building, Kansas City, Mo., for Missouri and Kansas; Samuel K. MacDonald, Liberty Trust Building, Broad & Arch Streets, Philadelphia, for New Jersey from Trenton south, Pennsylvania except the 3 northwest counties, Maryland, District of Columbia, Virginia, and West Virginia.

Zenith: Harry C. Bonfig, right, vice president in charge of household radio, is setting the wheels in motion for postwar

E. DAVIS, JIM PAUSE, AND H. C. BONFIG

distribution. Here he is at a cocktail party for Zenith distributors, getting down to business with E. L. Davis and Jim Pause of Reinhard Brothers, who have this line in Minneapolis, Fargo, and Aberdeen.

David Bogen: Has appointed J. M. Cart-

(CONTINUED ON PAGE 60)

ENGINEERING SALES

(CONTINUED FROM PAGE 59)

wright, 1276 Peabody Ave., Memphis, as representative for Mississippi and western Tennessee, to handle their line of sound equipment.

Cannon Electric: Has appointed five new engineering representatives. These are:

James L. Wright, Jr., 6109 North Meridian St., Indianapolis 5.
Franklin Sales Company, Central Savings Bank, Denver 2.
Bruner Corp., 418 W. North Ave., Milwaukee 12.
Southern Sellers, 918 Union St., New Orleans 13.
Mountain States Engineering Co., 215 W. Second St., Salt Lake City 1.

Merit Coil & Transformer: Has appointed John I. Crockett, Jr., as sales manager. Previously with Thordarson Electric as chief expediter, Crockett will have the job of creating a distributing organization and developing sales of Merit coils, transformers, and associated products.

Taylor Tubes: Rex L. Munger (W9LIP) is back at his old post, managing sales and advertising for Taylor. For the last 2½ years, he served as technical advisor and representative of Douglas Aircraft in Africa and the Middle East, playing a part in the game of tag with Rommel. He visited radio distributors in South Africa, Egypt, Palestine, India, Australia, and New Zealand in the course of his travels.

R.C.A.: Has appointed Bickford of Buffalo, Inc. as distributor of radios, tubes, and records in the counties of Chautauqua, Erie, Niagara, Genesee, Orleans, Wyoming, Cattaragus, and part of McKean. The new company has taken over the building formerly occupied by Bickford Brothers, together with an adjoining building. Principals are Paul and Louis Wolk. Charles Corcoran is general sales manager; Bert Dean, record sales manager; Roy Paulder, inside manager; and Sheridan Held is credit manager.

Admiral: Luthe Hardware Company, Des Moines, Ia., will handle distribution of Admiral sets in the central section of Iowa. In the New York City, Newark, and Hartford areas, the Admiral jobber will be Dale Distributing Company, headed by Maurice S. Despres, who is a director of the Admiral Corporation.

Philco: William E. Kress has been named middle western sales manager, with headquarters in Chicago. He succeeds John M. Otter, who is now sales manager of the home radio division.

Boes: The R. A. Adams Company, 18288 Appoline Street, Detroit and 2576 McAllister Street, San Francisco, has been appointed factory sales representatives for Boes meters and test instruments. Adams Company will provide technical assistance to engineers, and also aid jobbers in planning postwar instrument sales promotion.

Sylvania: Has appointed E. Bruce McEvoy, Jr., assistant to L. S. Raynor, eastern division tube equipment sales manager. McEvoy, who served as a 1st Lieutenant at Casablanca, has been given a medical discharge by the Army. He will make his headquarters at Sylvania's executive offices, 500 Fifth Avenue, New York City.

Hoffman: R. J. McNeely, prewar sales manager of Hoffman Radio Corp., Los Angeles, who has served as plant superintendent since Pearl Harbor, has resumed his original post. He is now getting ready to set up distribution of postwar products.

Stewart-Warner: Contrary to the opinion held by some of the other radio manufacturers, Stewart-Warner will take an active part in the postwar production of home radio receivers. Floyd D. Masters has announced that the first jobber signed up for the S-W distributor franchise is Butler Brothers, who will handle the line on an exclusive basis in the St. Louis and Dallas territories. C. E. Gunther, general manager of Butler's home furnishings division will be in charge.

Parts Distribution: A great many deals will be concluded at the Chicago Parts Conference, Hotel Stevens, October 19–21, for the distribution of components lines. Record attendance is assured.

Galvin: Has announced the appointment of William H. Kelley as general sales manager. Kelley resigned recently as regional manager for RCA in San Francisco, after 20 years with that Company. According to president Paul V. Galvin, this completes the sales management setup, with Elmer H. Wavering in charge of car radios, Walter H. Stellner as manager of home radio sales, Norman E. Wunderlich managing police radio sales, and Victor A. Irvine handling advertising and sales promotion.

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Leslie G. Thomas: Recently appointed works manager of Solar Manufacturing Corporation, Bayonne, N. J., according to an announcement from the New York City headquarters. Previously, he held a similar position at International Resistance Corporation.

Expansion: Output of Merit Coil & Transformer Corporation has been increased greatly by the completion of a newly equipped plant at 4427 N. Clark Street, Chicago 40. The company's general offices will be moved shortly to this address. President of Merit is Charles H. Koch, and Harold Jones is chief engineer.

William C. Speed: One of the founders and vice president of Audio Devices, Inc., and Audio Manufacturing Corporation, New York City, has been elected president of both companies, following the resignation of Hazard E. Reeves, former president.

FCC Opinions: Commenting on the fact that networks control 95% of night time broadcasting, Commissioner Durr said: "This tremendous concentration should not be extended to television and FM."

Commissioner Jett, expressing the belief that FM will give AM broadcasting real competition, said: "The number of FM channels should be at least doubled, to give everyone a chance." A Senate-approved treaty limits the number of AM channels, but the FCC can increase the FM allocations on its own orders.

Frank J. Hajek: Former secretary and treasurer of Taylor Tubes, Inc., Chicago, has been elected president. He has been associated with the company since its beginning. New secretary and treasurer are Joseph F. Hajek and Jerry Worrel, respectively. In a move to prepare for reconversion, James C. Filmer has been appointed vice president in charge of engineering. Rex L. Munger, back from service with Douglas Aircraft, has resumed his post as sales and advertising manager.

More Space: A new building has been completed by Audio Development Company, Minneapolis, to house general and engineering offices, experimental and design laboratory, and model shop. Floor space

TECHNICAL NOTES

Excerpts from New Home Study Lessons Being Prepared under the Direction of the CREI Director of Engineering Texts

Phase Inverter Circuit

LAST MONTH, CREI presented the first part of a technical article describing the Phase Inverter Circuit. Part 2, which appears in the September issue of "THE CREI NEWS," gives a typical numerical example of the Phase Inverter Circuit and indicates the type of performance that can be expected.

Derivations are then made of the gain and stability of gain of such a stage and it is shown that very good results can be expected. Finally, an analysis of the input admittance is made, as well as remarks on some practical features of the circuit.

Each month "THE CREI NEWS" features such a technical article, in addition to other interesting features concerning The Institute and the industry. We shall be glad to add your name to the mailing list without obligation. Simply write to The Institute at the address below and request the September issue of "THE CREI NEWS" containing the article on the Phase Inverter Circuit.

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SPOT NEWS NOTES

(CONTINUED FROM PAGE 61)

previously occupied by these departments will be used for production, permitting a 25% increase in factory space.

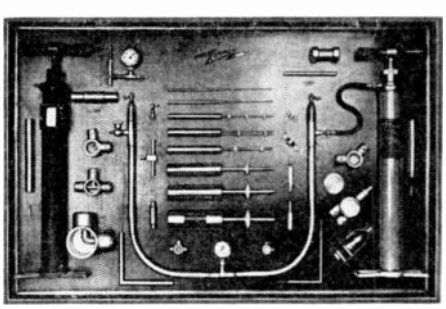
FM Satellite: Construction permit has been granted by FCC to *The Milwaukee Journal* station WMFM for an experimental satelite station of 100 watts to operate on 45.5 mc., the same frequency as WMFM.

R. J. Biele: Appointed assistant engineer of General Electric receiver division, at Bridgeport, Conn. He has been at G.E. since he received his B.S. degree in electrical engineering at University of Utah, 1935.

New Publication: In the radio field is *Bendix Radio Engineer*. It is published quarterly by the Radio Division of Bendix Aviation Corporation, of which W. P. Hilliard is general manager, and W. L. Webb (see cover of *FM*, Jan. 1943) is chief engineer. The first issue, dated July, contains a number of excellent articles, very attractively presented. Editorial staff is comprised of George Engelbert, editor; Harryette Creasy, associate editor; John M. Sitton, art editor; and assistant editors Willis G. Jones, Cecelia Muth, and Dolores Snider. Subscription price is $2 per year. Address: Baltimore 4, Md.

Television Conference: First annual conference of Television Broadcasters Association, Inc. will be held in New York City on December 7th and 8th. Complete information can be obtained from T.B.A., Inc., 500 Fifth Avenue, New York 18.

UHF Plumbing: An interesting and informative display of coaxial cable, fittings, and



ANDREWS UHF PLUMBING EXHIBIT

accessories has been made up by the Andrew Company, 363 E. 75th Street, Chicago 19. The purpose of the display is to serve as an exhibit for lectures on the subject of ultra high frequencies. Arrangements to borrow this display for use at

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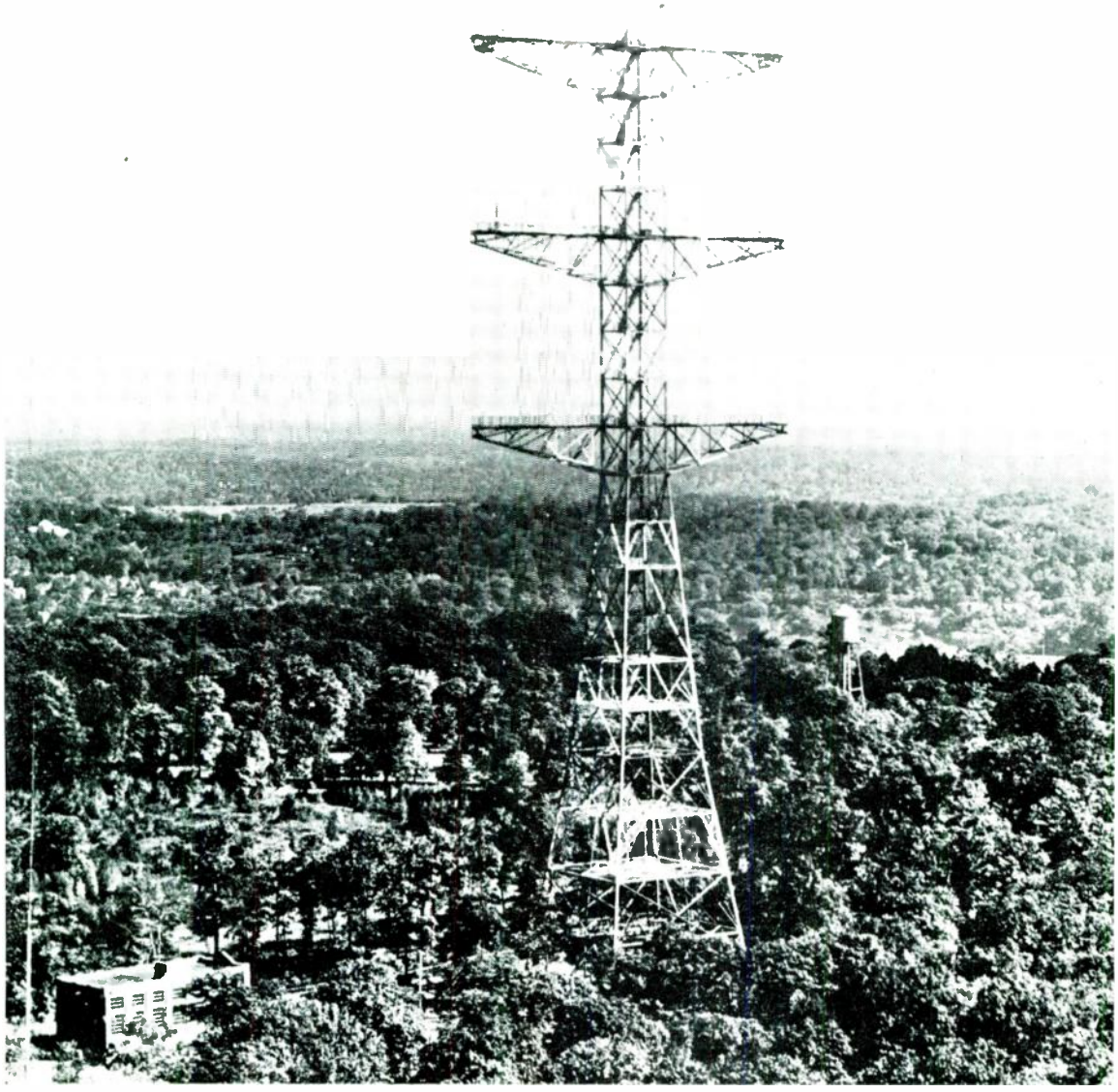
conventions and technical meetings can be made with the Andrew Company.

B-29: Carries approximately one ton of radio and intercommunications equipment. Selection of equipment and initial installation was handled at Wright Field.

Walter F. Kean: Will head the newly organized Field Engineering and Allocation Service of the Andrew Company, Chicago 19. This new department will assist FM and standard broadcast stations in the solution of their antenna problems in accordance with modern design practice. Walter Kean, who comes to the Andrew Company from Western Electric, is a graduate of the University of Wisconsin.

What Are Your Plans? This will be the main topic of discussions between manufacturers and jobbers at the Parts and Equipment Conference scheduled at the Stevens, Chicago, October 19th–21st. Sponsors are Association of Electronic Parts and Equipment Manufacturers, National Electronic Distributors Association, parts division of R.M.A., and the eastern division of the Sales Managers Club. Registration should be made at once so as to assure a place at the three luncheons. Requests for information should be addressed to William O. Schoning, P. O. Box 5070A, Chicago 80.

Magnesium Assn: Perry D. Helser, formerly Chief of the Magnesium Branch of the War Production Board in Washington, has been selected as Secretary-Director of the newly-formed Magnesium Association, with headquarters at 30 Rockefeller Plaza, New York. The membership of this Association, consisting of producers, fabricators, smelters, and consumers of magnesium, numbering 33, represents a substantial portion of the industry. Its purpose is to develop and increase the use of magnesium and its products, and to correlate technological progress in the industry. The production of magnesium before the war was 6 million pounds per year, whereas the present capacity is 600 million pounds. E. S. Christiansen, vice president of Apex Smelting Company, Chicago, is president; C. C. Loomis, president of New England Lime Company, Canaan, Conn., is vice president; and C. E. Larson, manager of operations at White Metal Rolling & Stamping Corp., Brooklyn, is treasurer.



FM BROADCASTING STARTED HERE

THE first FM transmitter to be put in service was built for Major Armstrong by REL, and installed at his Alpine station W2XMN. It employed the Armstrong crystal-controlled phase shift modulation.

Since then, REL has been more active in the FM transmitter field than any other manufacturer. This was evident from the many exclusive features in the prewar REL line of deluxe equipments, ranging from 1 kilowatt up to 50 kilowatts output.

The postwar REL line will reflect a vast store of added experience since Pearl Harbor. As soon as reconversion permits, broadcasters will be able to obtain quick delivery from REL on the finest and most reliable FM equipment, suited to the particular needs of each installation.

This will be possible because REL plans to continue its specialization in the manufacture of FM broadcasting equipment.

PEACETIME LEADERSHIP

Before you make any decision on the purchase of a postwar transmitter, let us give you the facts and data on REL stations now in use.

REL

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Long Island City 1 New York

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2040 Grand River Ave. W., Detroit, Michigan
310 Fifteenth St., Denver, Colorado

PIONEER MANUFACTURERS OF FM TRANSMITTERS EMPLOYING ARMSTRONG PHASE-SHIFT MODULATION

RADIO ENGINEERING LABS., INC.

Long Island City, N.Y.

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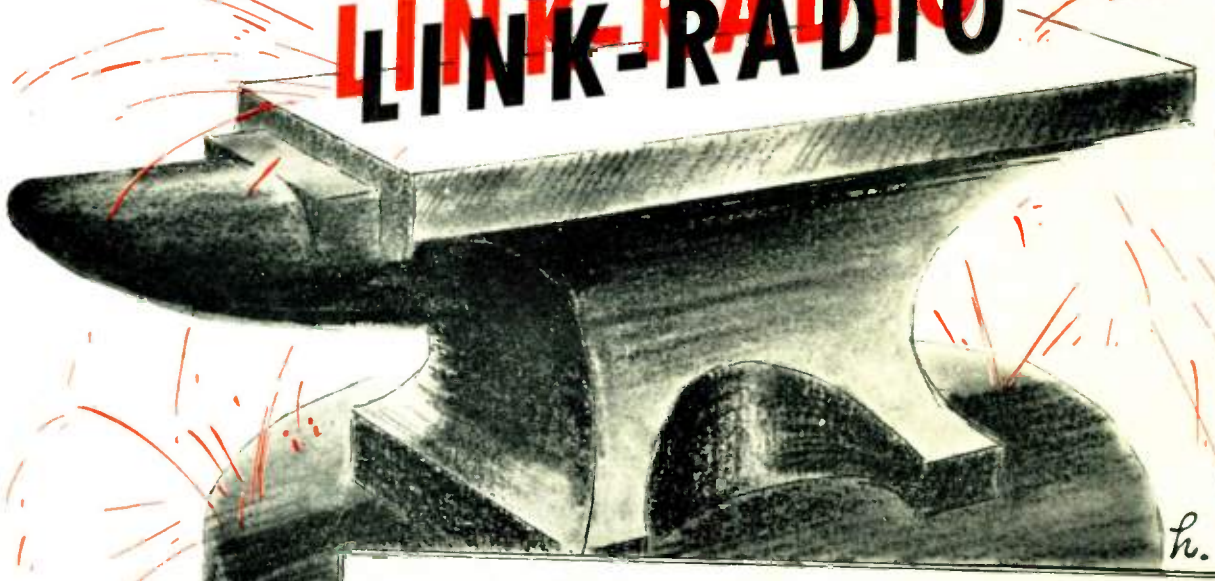
FM LINK-RADIO



FORGED-

It is not mere coincidence that FM Link and FM Radio have become inseparably bonded to represent the best in radio communication.

F.M. Link has long been a builder of FM RADIO. Experience and concentration has lifted Link Equipment into the Preferred class.

This devotion to FM has produced radios that are serving Police, Fire, Forestry, Railway, Public Utility, Government and other Emergency Services with distinction.

Today it is our privilege and duty to serve the Armed Forces. Tomorrow we will again be "at your service" . . . . to make F.M. Link mean the best in FM Radio for YOU.

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