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FM RADIO-ELECTRONICS

APRIL 1943

Radio-Electronic Products Directory

THE JOURNAL OF RADIO-ELECTRONICS ENGINEERING & DESIGN ★ Edited by M. B. Sleeper ★

A BIG STEP FORWARD

EVERY TIME our fighting men win a new beach head . . . every time an enemy plane falls from the sky . . . every time the sun sets on a war-torn world . . . America is that much closer to Victory.

No man can know how many days there are between us and peace. We can only do our best to make those days as few as possible.

Hard work is what it takes — good old-fashioned hard work, and sweat, to save us blood and tears. Here at Simpson we hold this as a sacred trust — to send ever more and better Simpson Instruments into battle, and to make each working hour a big step forward toward America's inevitable Victory.

SIMPSON ELECTRIC CO.
5200-5218 Kinzie Street, Chicago, Illinois

Simpson

INSTRUMENTS THAT STAY ACCURATE

Buy War Bonds and Stamps for Victory

GLAD HE'S ON OUR SIDE!

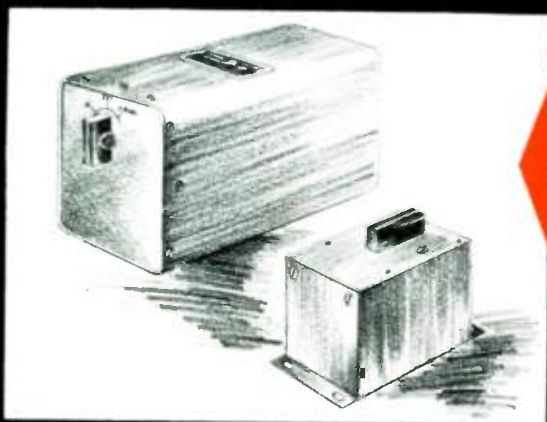
Glider pilots have a job to do. They have to set them down at a certain place at a certain time, slug the enemy where it hurts him most, and hold till reinforcements arrive. Coordination with other arms must be perfect, and radio makes this coordination possible. It's a tough job for tough men, and we're glad this Marine Lieutenant is on our side. . . . Wonder where he is now?

NATIONAL COMPANY, INC., MALDEN, MASS.

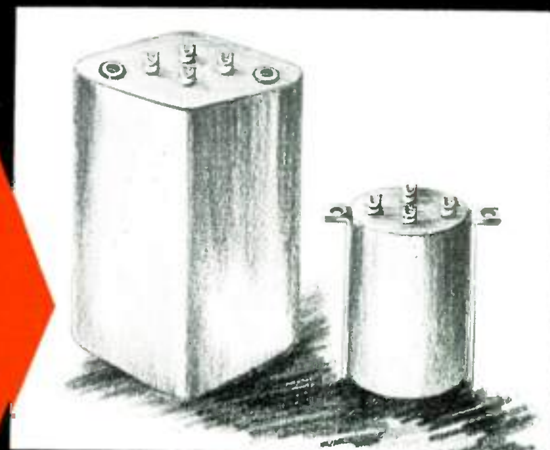
PHOTO BY OFF CE OF WAR INFORMATION

Waste is as damnable as sabotage

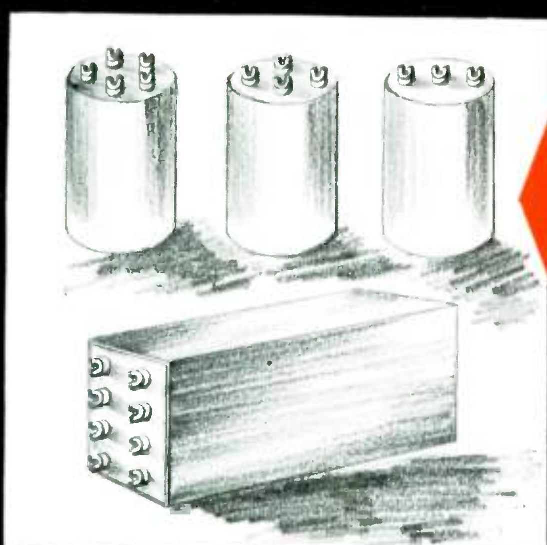
Electrical and mechanical design are the foundation of our military production. Small individual savings, when multiplied in mass production, add up to large savings in critical materials and labor time. Here are some examples from our organization:



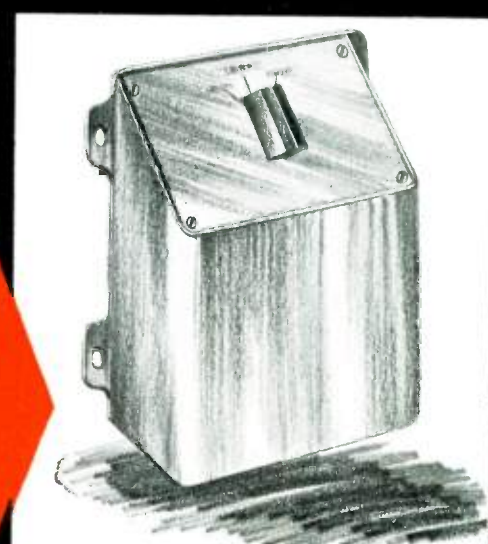
Cumulative electrical and mechanical redesign reduced the quantity of critical materials in this unit 60%, reduced total size and weight in direct proportion.



Through proper mechanical redesign, the weight and volume of this unit were halved, yet the same mounting centers were maintained for field replacements.



This application employed three of our Ouncer units. By combining the three in one case, we eliminated two aluminum housings, four terminals, two terminal strips, etc.



Electrical redesign reduced the amount of nickel iron alloy used in this filter by 50% . . . the mechanical redesign eliminated a dozen brass brackets and screws and cut installation time one-half hour.

UNITED TRANSFORMER CO.

150 VARICK STREET ★ NEW YORK, N. Y.

EXPORT DIVISION: 100 VARICK STREET NEW YORK, N. Y. CABLES: "ARLAB"

FM RADIO-ELECTRONICS

COMBINED WITH: APPLIED ELECTRONIC ENGINEERING

VOL. 3 APRIL, 1943 NO. 5

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Published by: FM COMPANY

Editorial and Advertising Office: 21 East 37th St., New York City, Tel. LE 2-8070

Chicago Advertising Representative:
Howland & Howland, Inc., 360 N. Michigan Ave., Tel. STAte 4439

FM Magazine is issued on the 20th of each month. Single copies 25¢ — Yearly subscription in the U. S. A. $3.00; foreign $4.00. Subscriptions should be sent to FM Company, 21 East 37th St., New York City.

A charge of 25¢ each will be made for duplicating copies returned because of subscriber's failure to give change of address.

The publishers will be pleased to receive articles, particularly those well illustrated with photos and drawings, concerning radio-electronic developments. Manuscripts should be sent to the publication office, at New York City. 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.

Advertising correspondence, copy, and cuts should be addressed to the advertising office at New York City.

THIS MONTH'S COVER

A substantial part of the current expenditures for radio equipment is going into transmitters rated at 1 kw. or more. Production of such equipment is handled by a relatively small number of companies. It calls for special engineering experience, facilities for fabricating and moving heavy elements, and for costly test equipment. This is particularly true of transmitters for freighters, transports, and fighting ships. Our cover picture shows a 1-kw. CW unit, produced by Transmitter Equipment Manufacturing Company, getting its final check at the hands of L. A. Sack.

a MESSAGE to Engineering Executives

Each issue of *FM* RADIO-ELECTRONICS contains some particular article which you want certain of your engineers to read.

Probably you are a subscriber, and you may try to pass your copy around. But one copy doesn't go far, particularly if someone takes it home to read. In that case, it may disappear altogether.

So, we'd like to make this suggestion: Appoint one of your associates to make up a group subscription among the men you think will benefit most by having *FM* RADIO-ELECTRONICS sent to their homes.

The cost is very small. A group of five subscriptions brings the price down to $1.60 per year for each one. Rates are given on the subscription blank bound into this issue.

We urge you to do this at once. On April 1st the WPB put into effect its second limitation order on paper. The third reduction, already projected, will peg the number of our subscriptions for the duration of the war.

The practical value of *FM* RADIO-ELECTRONICS to your associates is well worth a few moments of your time to make sure that they get this Journal every month. Don't let them wait until it's too late.

FM RADIO-ELECTRONICS

WHAT'S NEW THIS MONTH

THE following paragraphs are taken from a review by Major Edwin H. Armstrong of the various phases of future Frequency Modulation developments as indicated by its progress up to the present time:

"The FM system was fully explained in a technical paper before the Institute of Radio Engineers in November of 1935. Although the presentation of this paper removed the word 'impossible' from its hitherto inseparable connection with the problem of static elimination, a series of objections as to the system's practicability in broadcasting was immediately raised.

"Two weeks after the presentation, a syndicated article of an interview with a prominent engineer labeled it as a visionary dream and stated that the search for a practical noise reducing system must go on. As time went on, other objections were raised against the system. It was pointed out that the transmitters were too complicated for practical use, that the receivers would be too costly, and that broadcasting, in any event, was now established and the idea of changing over the complete system was entirely unthinkable."

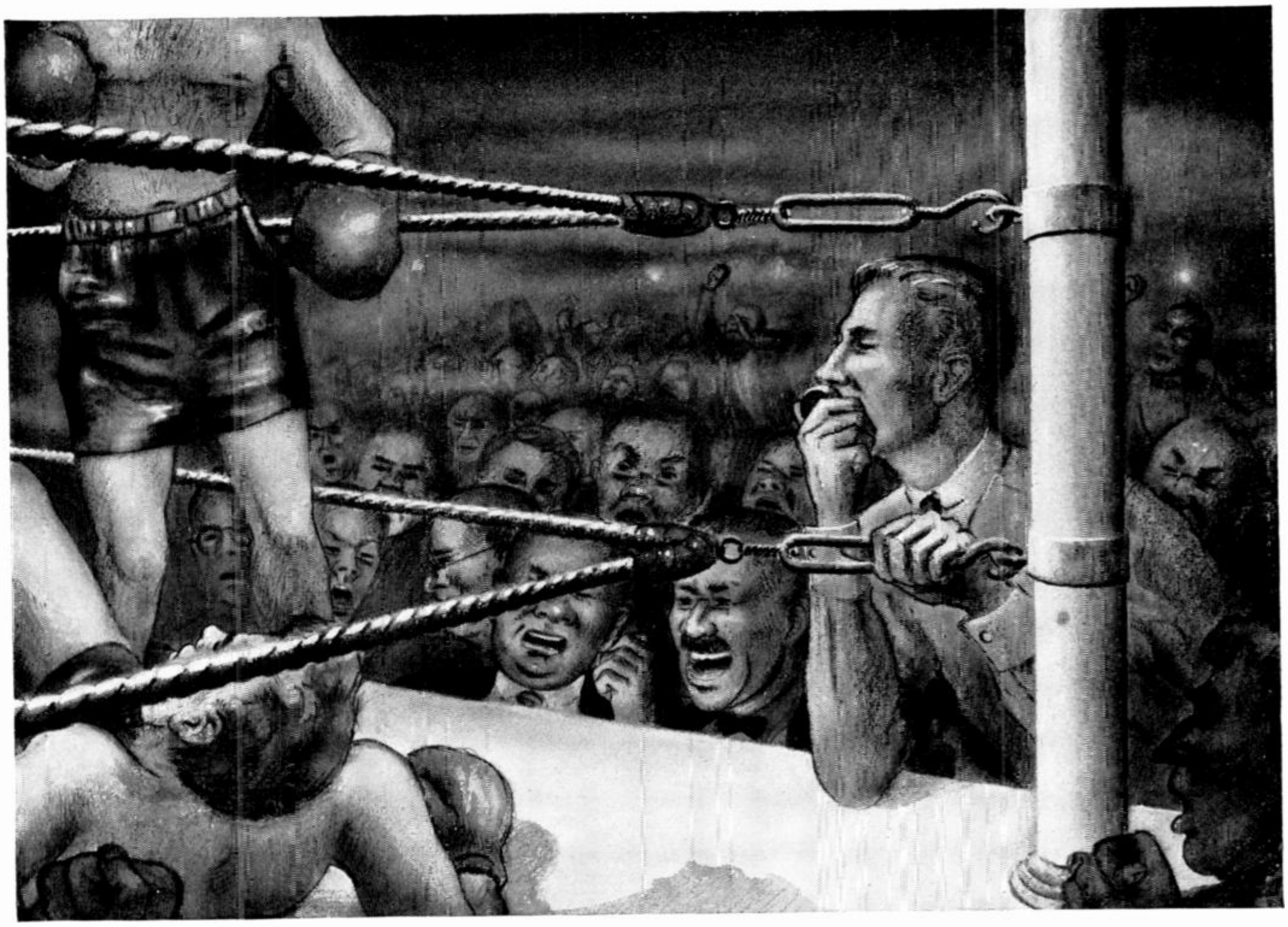
The foregoing serves to emphasize the now-established success of FM in the fields of broadcasting and police radio, as well as in military communications.

Major Armstrong's comments on the present and future are equally significant:

"With widespread industry and public acceptance, it is easy for anyone to form his own judgment of what will happen in the post-war period. The difficulties which have been overcome, whether real or fancied, were of a nature that required time and effort. Such problems as remain are principally of degree, and involve manufacturing technique rather than invention or pioneer mountain-top engineering of the type so brilliantly carried out by de Mars. . . .

"The performance of the Boston-Mount Asnebumskit relay was a rather startling surprise to the proponents of wire-line transmission. Experience has proven these links far superior to wire transmission, and infinitely less costly. Their effectiveness is still underestimated. It is not generally known that for well over a year a regional FM network has been set up and operated from Alpine to Mt. Washington several times a week.

(CONTINUED ON PAGE 41)



Effectively Eliminated

As far as future radio audiences are concerned, great, roaring crowds of sports fans no longer will distort the announcer's broadcast. He will be heard clearly and distinctly, above an adjustable volume of sound that may be retained for "color."

Newly designed Electro-Voice microphones make possible an almost complete suppression of annoying background noises. Full particulars may be furnished direct to government prime contractors who have specific need for such microphones with their equipment.

If, however, your limited quantity requirements can be met by any of our standard model microphones, with or without minor modifications, may we suggest that you contact your local radio parts distributor? He may be able to supply your immediate needs from remaining stocks. In all instances, his familiarity with our products and many of your problems will enable him to serve you well. Our distributors should prove to be vital links in expediting your smaller orders.

. . . Any model Electro-Voice microphone may be submitted to your local supplier for TEST and REPAIR at our factory .

Electro-Voice MICROPHONES

ELECTRO-VOICE MANUFACTURING CO., INC. 1239 SOUTH BEND AVENUE, SOUTH BEND, INDIANA

FIG. 1. WHEN SLEET STORMS CARRY AWAY TELEPHONE LINES IN RURAL DISTRICTS, THE STATE POLICE RADIO SYSTEM HANDLES A HEAVY TRAFFIC LOAD. THIS PHOTOGRAPH WAS TAKEN NEAR PRINCETON, MASS., AFTER THE ICE STORM OF LAST DECEMBER 31

FM POLICE INSTALLATIONS IN MASSACHUSETTS

Two Massachusetts State Departments Join the Move to FM for Emergency Services

BY JOHN A. DOREMUS *

TWO years ago, the Massachusetts Institute of Technology, through its Department of Industrial Coöperation, was engaged to make a survey of the communications facilities of the several State Departments of the Commonwealth of Massachusetts. This survey included a study of the radio and wire communications systems of the Massachusetts State Police and the Metropolitan District Commission.

The radio communication facilities of both departments were found to be inefficient, obsolete, and expensive to maintain, and recommendations were made for their complete replacement.

Survey ★ With the requirements of each of these departments in mind, a field survey was made of the entire state to determine first, the type and ratings of the equipment to be employed and, second, the most effective locations for fixed stations to provide service in the required areas.

It soon became evident that frequency-modulated equipment could provide better service to the required areas than amplitude-modulated equipment on either medium or ultra-high frequencies. The advantages were apparent in the form of a great reduction in noise in mobile receivers, elimination of fading within the service area, an increase in service range for a given amount of power, and reduced battery drain in cruiser installations.

After the choice of frequency-modulated equipment had been decided upon, all further tests were made with units of this type. For the purpose, equipment was made available by the Connecticut State Police, whose wholehearted coöperation was greatly appreciated by all those connected with this project. Special permission was obtained from the Federal Communications Commission to take these cars beyond their usual patrol areas.

Two cars completely equipped with 25-watt transmitters and roof-top antennas were used. One of the cars was stationed at a proposed transmitter site while the other car traveled throughout the probable area to be served from that location. The reliability of the two-way communication between the cars was judged and plotted on a map by means of colored pins.

Since the terrain of Massachusetts varies from 3,500-ft. mountains in the western part of the state to the flat sands of Cape Cod, a great many sites had to be tested. During the two-week period required for these tests, over five thousand readings were taken, and the test cars driven over four thousand miles. On some days, the tests were begun at daybreak

* Instructor, Massachusetts Institute of Technology, Cambridge, Massachusetts, Radio Engineer for the Commonwealth of Massachusetts.

FM EMERGENCY EQUIPMENT

Part 2. General Electric FM Transmitters for Patrol Car and Main Station Installations

THERE are four types of General Electric FM transmitters for emergency communications, three of which are similar to Fig. 7 in their appearance, while the fourth uses the same chassis, but is intended for standard rack mounting.

These are, respectively:

1. 30-watt output transmitter using a dynamotor operating on 6 volts DC
2. 60-watt output transmitter using a dynamotor operating on 6 volts DC
3. 60-watt output transmitter operating on 117 volts AC, 50–60 cycles.
4. 60-watt output transmitter, similar to above, but designed for standard rack mounting.

General Description ★ Figs. 7 and 9 show the general construction of the 30- and 50-watt models. The steel chassis which carries the components is fastened to a heavy steel base by means of two thumb nuts. These can be seen at the bottom of the front end in Fig. 7. The base is permanently secured to the floor of the baggage compartment in patrol car installations. When it is necessary to service a transmitter, it is loosened from the base, and another slipped into its place.

The cover is held in place by a clamping handle which engages the cross brace above the unit, as shown in Fig. 9, at the left. When required, the handle is fitted with a lock, to prevent unauthorized tampering with the unit.

Sockets are provided for the connecting cables, and jacks for plugging in test instruments and for a microphone to be used when checking the transmitter.

The mobile control box, for mounting on the lower edge of the dashboard, carries a combined volume control and on-off switch, receiver squelch control, microphone jack, power-on indicator light for the receiver and transmitter, and another power-on light which shows when voltage is applied to the plates of the transmitter tubes.

A similar set of controls are furnished on the fixed station control unit which also carries a loudspeaker.

Transmitter Circuit ★ The complete circuit of the transmitter is given in Fig. 8. It should be noted that parts marked with an asterisk in this diagram are for use in the 60-watt model only.

The quartz crystal Y109 oscillates at 1/32 of the assigned center frequency. The type 7B7 oscillator tube, V101, supplies excitation to the 7H7 modulator tube, V102, and to the first quadrupler tube, V103, through the coupling condenser C105.

The output of V103, operating at four times the crystal frequency, is coupled into the grid of the second quadrupler tube V104 by means of the tank circuit L4,C104, the coupling condenser C106 and the grid resistor R107.

In the second quadrupler tube V104 the frequency is once more multiplied by four, so that its output is 16 times the frequency of the crystal.

Next, the output of the second quadrupler tube V104 is coupled into the grid of the 6V6GT doubler tube, V105, which multiplies the frequency by two, giving a signal which is 32 times the crystal frequency. This output drives the power amplifier at the operating frequency.

In the case of the 30-watt unit, the power amplifier has one GL807, while the 60-watt type has two connected in parallel. These are tubes V106 and V107 in the wiring diagram.

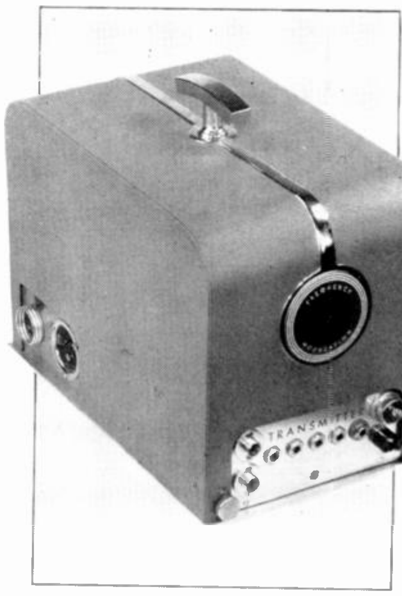


FIG. 7. 30- AND 60-WATT TRANSMITTERS ARE AVAILABLE ON THIS TYPE OF CHASSIS

The output of the power amplifier is fed into the antenna through the coupling condenser C117 and the antenna relay K101.

Frequency modulation is applied to the signal by the variable grid bias on the modulator tube V102 through the microphone transformer T101, and R126 and L3. The modulator tube, in conjunction with the resistor-condenser network C103, R123, and C102, serves as a variable reactance in shunt with the tuned circuit L1.

Thus, grid voltage variations produced by speaking into the microphone become reactance variations in tuned circuit L1. This variation of reactance causes a change in phase relationships which produce small frequency swings. This frequency swing is multiplied in the succeeding stage until, at the output frequency, the normal deviation from the assigned center frequency is plus or minus 15 kc.

This system produces *phase* modulation, which means that the phase swing of the radiated wave is proportional to the amplitude of the modulating audio signal, but independent of the audio frequency.

The relationship between *phase* swing and *frequency* swing is such that, for a constant phase swing, the frequency swing is proportional to the audio frequency. Thus, phase modulation is the equivalent of frequency modulation having an audio frequency characteristic rising at the higher audio frequencies.

Since the characteristics of the average human voice are such that most of the energy is concentrated at the lower voice frequencies, the use of phase modulation, accentuating the high frequencies, tends to produce more or less uniform modulation over the pass band.

Compensation for this effect is provided at the receiver by attenuating the higher audio frequencies in the audio system, thereby giving essentially uniform response, with a substantial reduction of background noise.

Approximately 15 db of high-frequency accentuation or pre-emphasis between 500 and 3,000 cycles are used in this G.E. FM transmitter, with corresponding attenuation or de-emphasis of the high audio frequencies in the associated receivers. This value has been found, by tests under operating conditions, to provide the maximum signal-to-noise ration.

Audio frequencies above 3,000 cycles are attenuated in the transmitter to prevent the radiation of undesirable side bands, and in the receiver to reduce high audio-frequency background noise to minimum value.

Tubes ★ Following is the list of tubes used in the various models. Note that the 30-watt transmitter has only one GL807 tube, while all the 60-watt types have two, and that the GL1641 rectifier is used only for AC operation.

V101 Crystal oscillator, 7B7
V102 Modulator, 7H7
V103 1st quadrupler, 7B7
V104 2nd quadrupler, 7B7
V105 Doubler, 6V6GT
V106 Output, GL807
V107 Output, GL807
V108 Rectifier, GL1641

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It soon became evident that frequency-modulated equipment could provide better service to the required areas than amplitude-modulated equipment on either medium or ultra-high frequencies. The advantages were apparent in the form of a great reduction in noise in mobile receivers, elimination of fading within the service area, an increase in service range for a given amount of power, and reduced battery drain in cruiser installations.

After the choice of frequency-modulated equipment had been decided upon, all further tests were made with units of this type. For the purpose, equipment was made available by the Connecticut State Police, whose wholehearted coöperation was greatly appreciated by all those connected with this project. Special permission was obtained from the Federal Communications Commission to take these cars beyond their usual patrol areas.

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Since the terrain of Massachusetts varies from 3,500-ft. mountains in the western part of the state to the flat sands of Cape Cod, a great many sites had to be tested. During the two-week period required for these tests, over five thousand readings were taken, and the test cars driven over four thousand miles. On some days, the tests were begun at daybreak

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FIG. 2. NORTHAMPTON TROOP HEADQUARTERS OF THE MASSACHUSETTS STATE POLICE. THE OLD MEDIUM-HIGH FREQUENCY TRANSMITTER ANTENNA CAN BE SEEN IN THE BACKGROUND

FIG. 3, BELOW. A TYPICAL SUBSTATION OF THE MASSACHUSETTS STATE POLICE, AT YARMOUTH. AT THE LEFT CAN BE SEEN THE GUYED WINCHARGER TYPE OF ANTENNA MAST

and continued until after midnight. Every effort was made to expedite the survey and the subsequent drawing of plans, as it was quite apparent that equipment for building the proposed installations would be available from manufacturers for only a limited period of time.

At the conclusion of the survey, the many readings were plotted, and the plans for the systems began to take form. Specifications were prepared as soon as possible and submitted to manufacturers for bids. The contract for the equipment was awarded to Fred M. Link, of New York City. This included complete systems for the Massachusetts State Police and for the Metropolitan District Commission.

State Police ★ The Massachusetts State Police, made up of 300 uniformed officers with approximately 125 civilian assistants, is directed by the Commissioner of Public Safety, John F. Stokes, from the General Headquarters in Boston. The force is divided into four troops with headquarters at Framingham, Northampton, Holden, and Bridgewater. The officers of these troops are based in twenty-one substations, in addition to the Troop Headquarters, located at strategic points throughout the state. However, the police activity of each troop is directed from the four Troop Headquarters, and all communications facilities are controlled from this point.

The former radio system included 1,000-watt AM transmitters operating on 1,666 mc. at three of the four Troop Headquarters, with supplementary 300-watt transmitters at the fourth Troop Headquarters and certain of the substations. Mobile transmitters, over half of which were composite, had been installed in about one-third of the cars, and operated on a frequency of 35.78 mc. Due to the very high attenuation of the medium-high frequency in the east, and the high mountains in the west, this system gave satisfactory service to less than one-third of the state.

The first requisite of the proposed system was that it provide complete and dependable service to every part of the state. The results of the field survey indicated that this could be accomplished by the use of seven 250-watt FM stations located at geographically strategic points, controlled by telephone lines from the four Troop Headquarters. Thus some troops have more than one station. In these instances, both installations are controlled from the same operating position by means of a key switch permitting the use of either transmitter separately or the two simultaneously.

The complete coöperation of the Telephone Company has made possible the operation of these control lines which vary in length from 9 to 65 miles. To provide communication with the Islands of Nantucket and Martha's Vineyard, a 25-watt station has been set up at the State Police barracks at each of these locations.

Probably the most important single item in the establishment of effective communication is the antenna. Coaxial antennas were chosen, and these were mounted on towers made of seamless steel tubing varying in height from 90 to 125 ft., depending upon the character of the surrounding terrain. All are unguyed except two on the highest mountains. These are guyed with steel cables, and are designed to withstand 175-mile wind velocities.

At some of the transmitter sites, it was possible to secure space in existing buildings. However, in most cases it was necessary to construct transmitter houses. Concrete blocks were chosen for these buildings as they were available without priority ratings and because they provide better insulation against the wide range of temperatures experienced in Massachusetts.

Each station will be equipped eventually with a gasoline-driven emergency power supply which will start automatically when the normal source of power fails. At the same time, a signal will be sent down the control line to indicate that the station is operating on the emergency power source. In this way a man can be dispatched to investigate the difficulty without delay. Voltage-regulating transformers are included in each installation to insure constant transmitter output and prolonged tube life.

The fixed stations of the system operate on a frequency of 35.9 mc., while the mobile units operate normally on 35.78 mc., the mobile frequency used by the former AM system. Close grouping of the frequencies permits the car transmitters to operate on the fixed-station frequency as well as the mobile frequency. This is accomplished by a small relay which changes only the crystal. Transmitter circuits are not sufficiently detuned to show any appreciable reduction in output. Thus, three-way operation is possible, namely, from station to car, from car to station, and from car to car.

Mobile antennas are in general of the standard type which mount on the rear of the car above the trunk compartment. However, certain cars in the western sections have been equipped with roof-top antennas to take advantage of the non-directional properties of this type and the higher signal output.

A completely equipped maintenance shop is being set up at each of the Troop Headquarters, where a Radio Technician will make all repairs on equipment. A rigid inspection system, with accurate records, insures that the condition of all units is known at all times. An adequate number of spare units has been provided in order that any defective unit can be replaced quickly without unduly detaining the vehicle. Frequency measurements are made at regular intervals by means of accurate frequency-measuring devices assigned to each troop.

Performance ★ At the present time, approximately one-half of the system has been completed. All of the 105 cars operated by the State Police have been equipped.

In every case, the service areas of the stations have far exceeded the original proposals, and in some cases it has been possible to reduce the input power to the transmitters. This has resulted in increased tube life, thus effecting a real saving of critical materials and at the same time reducing the maintenance problems to a minimum.

Some of the stations have been in operation throughout the winter. This has given us valuable experience in operating equipment at remote locations. One of the stations is located at a point that is inaccessible by automobile during five months of the year. Periodic servicing of this station is accomplished after a seven-mile trek on snowshoes or skiis.

Metropolitan District Commission ★ The Metropolitan District Commission is a branch of the government of the Commonwealth, charged with the responsibility of constructing and maintaining the water supply and sewer system for greater Boston. Duties also include the supervising and policing of numerous parks, reservations, and many miles of parkways in the Boston area. Its operations cover approximately 825 square miles, including 43 municipalities near greater Boston, and the entire area of the Quabbin reservoir which is located in the central part of the state.

The Commission is headed by Commissioner Eugene C. Hultman whose General Headquarters are located in Boston. The Metropolitan District Commission Police Force is made up of 230 uniformed officers and men. The Force is divided into six divisions, and although the officers are based at the Division Headquarters, all

FIG. 4. DASHBOARD CONTROLS OF THE FM LINK 3-WAY CAR INSTALLATION. THE EXTENSIBLE HANDSET CORD IS KEPT AWAY FROM THE DRIVER'S FEET BY THE USE OF ELASTIC CONSTRUCTION

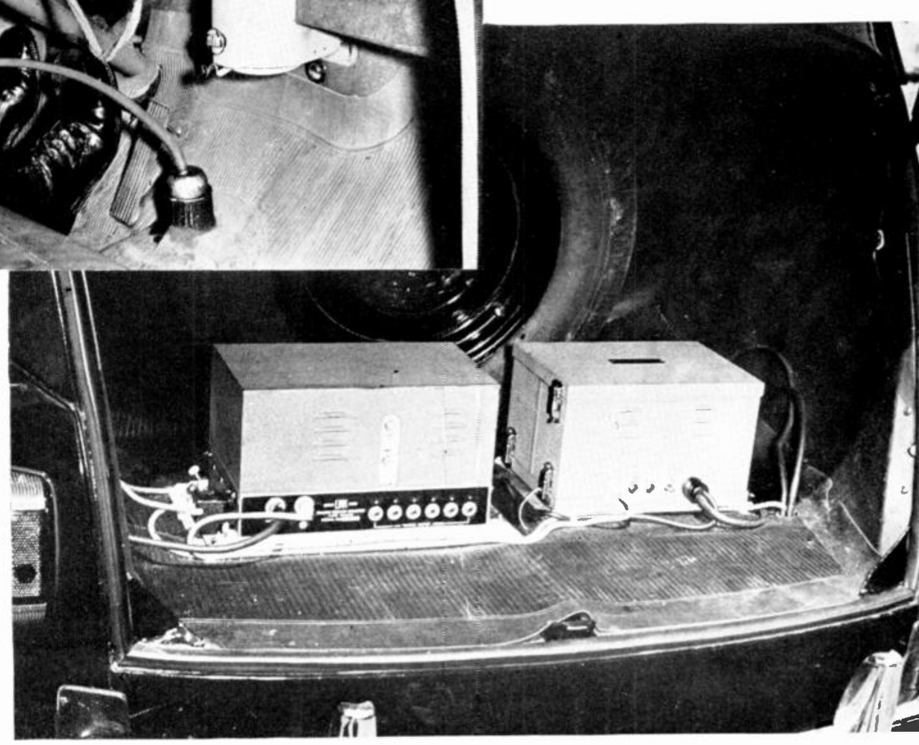


FIG. 5. THE NEWEST TYPE OF LINK FM TRANSMITTING AND RECEIVING EQUIPMENT AS IT IS INSTALLED IN THE BAGGAGE COMPARTMENT OF A PATROL CAR

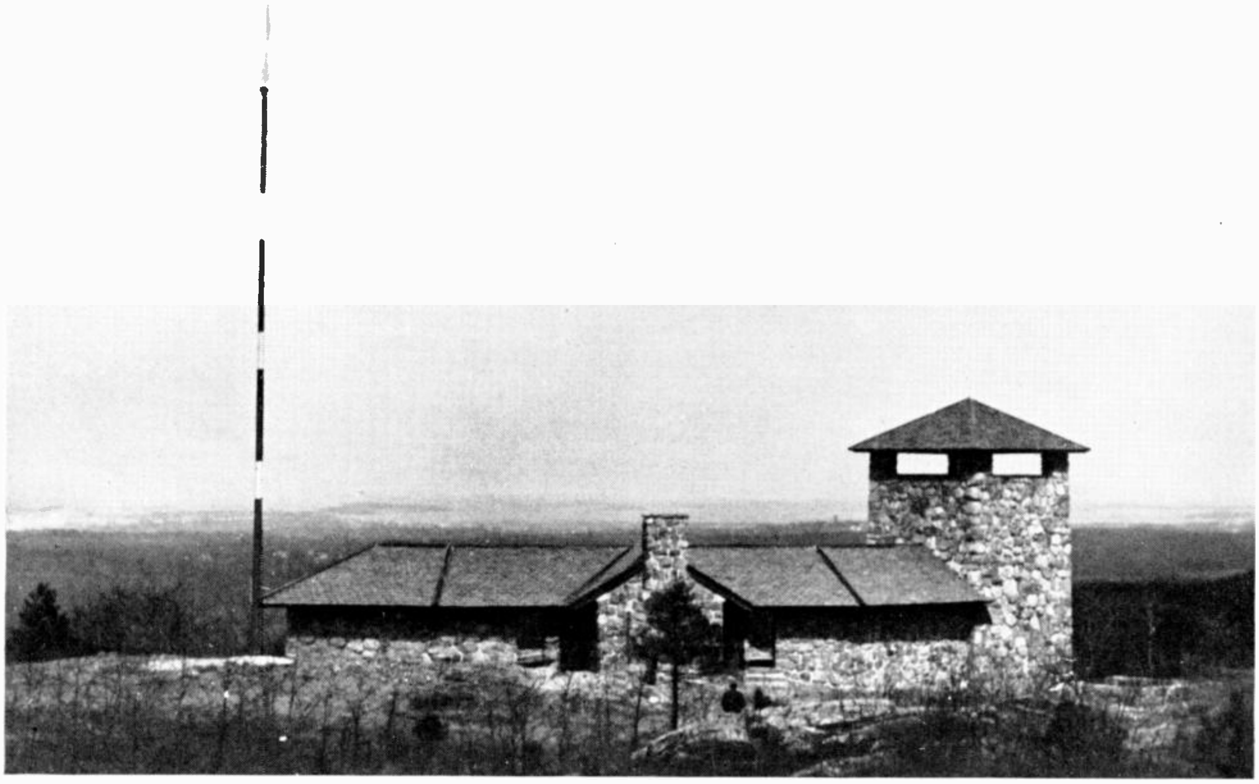


FIG. 6. MAIN STATION OF METROPOLITAN DISTRICT COMMISSION IS ON HIGH GROUND OVERLOOKING BOSTON HARBOR

police activity is directed from General Headquarters. Police duties include motorboat patrol of the Charles River, highway patrol by cruising cars of designated arterial highways and parkways, and patrol of certain reservations on horseback.

It is very fortunate that a hill over 600 ft. high is located within ten miles of Boston. This affords an ideal location for a fixed station to serve the entire Metropolitan Area. A transmitter house was easily constructed by utilizing a portion of a stone shelter building located near the summit of the hill. The station, thus located, is controlled over a single pair of telephone wires from the Communications Bureau at General Headquarters in Boston.

A 250-watt FM transmitter, operating on 37.5 mc., provides a service area that is more than adequate for the requirements of the Police Force. The transmitter output is connected by a gas-filled coaxial line to a coaxial antenna mounted on a sixty-foot, self-supporting antenna tower. Two receivers are mounted in the same cabinet as the transmitter. One is designed to receive FM signals from the mobile units of the system on 35.22 mc. The other is designed to receive AM signals on 37.5 mc. With this receiver, communication is maintained with several fixed and mobile stations located at strategic points along the aqueduct that carries water to greater Boston. Independent control is provided so that either receiver may be selected individually or both allowed to operate at the same time. The remote station is equipped with an emergency power supply which starts automatically when the normal source of power fails.

At the present time, mobile equipment has been installed in 24 patrol cars and 4 boats. These include 25-watt transmitters that operate in conjunction with ¼-wave antennas mounted on the rear of the car body near the trunk compartment. The boat antennas are mounted on the foredeck, and are equipped with springs to permit passing under the low bridges encountered along the patrol. All boat equipments are housed in boxes that are watertight but well ventilated to prevent overheating of the equipment.

Pick-up receivers are located at two points within the area, in addition to the main station. These permit selective reception from different portions of the Metropolitan Area and, at the same time, provide alternate reception points in the event of failure of either the control line or equipment at the main station. Pick-up receivers are also to be located in the six Division Headquarters to aid in coördinating the activities of the several Divisions.

Maintenance of the Metropolitan District Commission's equipment is conducted by a well qualified Radio Technician. A completely equipped radio repair depot has been set up at the most centrally located of the six Division Head-

Unattended FM Transmitters

MAJOR ARMSTRONG has suggested that remote, unattended transmitters may be found practical for low-power, local service FM broadcasting stations to be erected after the War. Economically, the idea would be sound, for a small station could not afford to operate a studio in the city and maintain an operating force at a remote point on high ground.

The soundness of this idea has been demonstrated over a period of several years by the highly satisfactory performance of state police FM installations where transmitters are controlled over land lines from police barracks. This plan, first employed in Connecticut, is used more extensively in Massachusetts.

Since its application to emergency communication, where uninterrupted service is vital, has worked out so successfully, there is not apparent reason why it should not be adopted for FM broadcast installations where conditions warrant it.

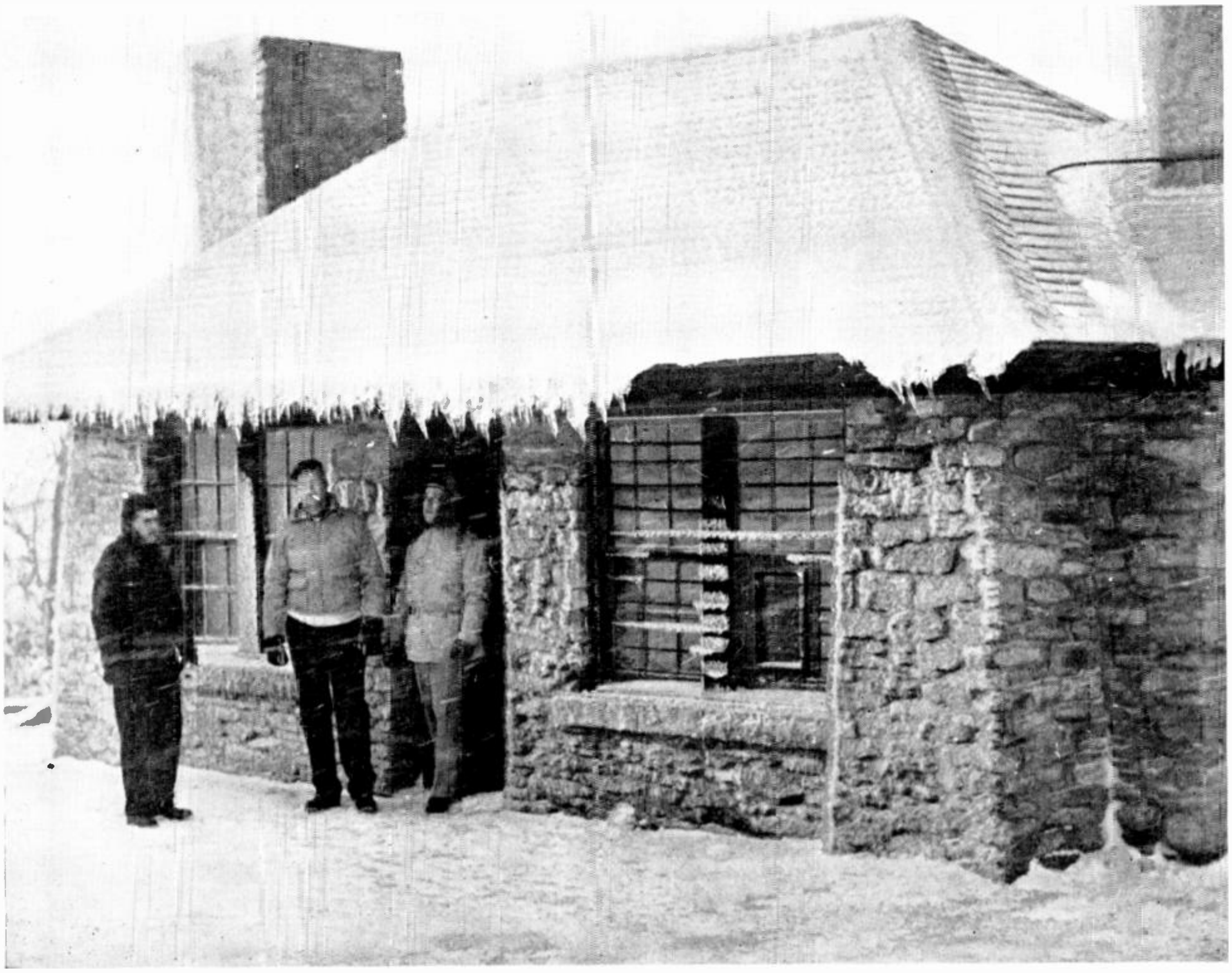


FIG. 7. WHEN PHOTO WAS TAKEN, 8-IN. COAT OF ICE HAD FORMED ON MT. WACHUSETT ANTENNA. RADIO WAS UNAFFECTED

quarters. Here, in what was once a three-car garage, the radio technician has his office, shop and storeroom. Spare equipment has been provided so that any failure of units in service can be corrected in the shortest possible time. This usually entails a simple substitution of a spare unit for the defective one, whereupon the car is returned immediately to its normal duties. In addition, monthly inspection of the equipment often shows up faulty elements before they actually fall in service.

The equipment making up the two systems just described has an enviable service record. The combination of high performance circuits and careful mechanical construction has produced equipment that is simple to operate and maintain. In the installation of the radio equipment for the Massachusetts State Police and the Metropolitan District Commission, no amount of effort has been spared to insure conformity with the engineering specifications. Only by such adherence to the original plan can a system be installed which will give uniformly dependable service over a long period of time.

USE OF ELECTROLYTIC CONDENSERS

SEVERAL letters of complaint and criticism were received in response to the statements made in Part 1 of NOTES ON MODERN APPARATUS DESIGN which appeared in our February issue, under section 19, headed "High Value Condensers."

Typical was a letter from P. R. Mallory & Company, Inc., in which the following comment was made:

"This article states that electrolytic condensers are ruled out of military equipment, and quite understandably we take exception to this statement since we are currently and have been for some time supplying hundreds of thousands of electrolytic capacitors for use in military equipment. As a matter of fact, the use of electrolytic capacitors is increasing and we expect will increase still further with full realization of what can be done with such new items as our BS-81, just now being prepared for production.

"Originally there was some objection to electrolytic capacitors because they were not of much value at −40° C., and there was also some concern with regard to their life expectancy. The BS-81 capacitor has an impedance change of approximately 60% at −40° C., as compared to room temperature, and this relatively small change compared to former electrolytic units has proved quite startling to the 'powers that be' in military circles.

"Frankly, we believe that quite a prominent retraction should be made to neutralize the impression caused by the statement in *FM RADIO-ELECTRONICS*, since the article was exceedingly well written otherwise, and will undoubtedly receive very close attention by the trade in general.

"This matter is quite vital not only to the Mallory Company but, we believe, to the other dry electrolytic capacitor manufacturers as well.

Yours very truly
P. R. MALLORY & CO., INC.
P. Newton Cook"

Note: Mr. Cook's position is quite fairly taken, and we are glad to publish his protest on behalf of P. R. Mallory and the other manufacturers of electrolytic condensers.

Mr. Cook's letter emphasizes the soundness of the policy adopted by the Army and Navy in avoiding standardization which might have the effect of discourag-

(CONTINUED ON PAGE 43)

IF CHARACTERISTICS OF FM RECEIVERS

A Symposium of Engineering Opinions Which Look Forward to Post-War Designs

NOT long ago, at a conference which included both civilians and engineering officers engaged in the design of military equipment, a question arose concerning the IF characteristics of FM receivers. The designs of FM sets now in use were explored for the purpose of obtaining the background of opinions and practices, but the result yielded very little of value.

When this situation was brought to the attention of your Editor, letters were sent to the chief engineers of companies which had been producing FM sets asking:

1. What, in your opinion, should be the intermediate frequency of receivers for the 42 to 50 mc. band?

2. What, in your opinion, should be the band pass characteristics of FM receivers for this service?

Replies were received from nearly all the chief engineers to whom the questions were sent. They are published in full in the following text:

Browning Laboratories, Inc. ★ In answer to your questions as to what standard IF frequency should be adapted for FM receivers and the band width of the IF amplifier, it is our opinion that the prerequisites for the intermediate frequency amplifiers in FM receivers are as follows:

1. The frequency band covered by the IF amplifier should be sufficiently wide so that there would be no appreciable percentage reduction in audio amplitude on high level passages over that of the original music or speech.

2. The intermediate frequencies for FM should be chosen so that there are no powerful stations transmitting on the IF frequency which might be picked up directly on the IF amplifier or the grid of the mixer tube and cause interference in the receiver.

The first prerequisite dictates a frequency from about 2½ mc. to 10 mc. From the standpoint of gain and ease of construction, the relatively lower frequencies for the IF channel would be advantageous.

The second prerequisite is relatively unimportant, for the IF amplifier is usually well shielded in order to make its performance satisfactory. It should be kept in mind that any signal that is one-third (a conservative figure) the strength of the wanted signal causes practically no interference in the reception of desired signals. Thus, the problem of interference due to IF pickup is not to be compared to the similar problem in AM receivers.

After a considerable amount of experimenting, the engineering staff at the Browning Laboratories found that 3 mc. transformers correctly designed were sufficiently high that the IF band width necessary for good FM reception was obtained, and that this frequency was sufficiently low that, with reasonable manufacturing care, the IF amplifier gave very little trouble in production.

G. H. Browning

There was no interference experienced from fixed station transmitters and aeronautical transmitters which are assigned to the region near 3 mc. We see little advantage in going to a higher IF frequency, although the amount of difference between the 3 and 4.5 mc. would not result in any difficulty.

There is no reason why band width of the IF amplifier should not be rated the same as IF transformers used in AM receivers. That is, giving the band width for say two times, ten times, one hundred times, one thousand times the signal strength. The table that follows gives the band widths that we have found satisfactory in practice. Broader band transformers than this were employed in the early days of FM and in areas where there were numerous FM transmitters operating on the old adjacent channel allocation some interference was encountered. However, with present channel allotments, the selectivity given in the table appears adequate, and there can be no question of volume compression on the high level passages.

Band Width in KC	*Signal Strength*	*Decibels Down*
150 KC.		1 db
180 KC.	at 2X	6 db
310 KC.	at 10X	20 db
520 KC.	at 100X	40 db
900 KC.	at 1000X	60 db

G. H. Browning

ONE of the factors of FM receiver design which calls for the most careful consideration before civilian radio equipment is put into production again is the characteristics of the IF circuits. In his book, "Frequency Modulation," August Hund gives a very interesting discussion of this subject. However, his findings have been criticized as being based on theory rather than practice. From the opinions expressed here, it appears that there is no general agreement among engineers who designed the FM receivers now in use by the public.

We shall be glad to publish communications from our readers in further discussion of the subject of standardizing on IF characteristics of FM receivers, or suggested methods for developing such standards — the Editor.

Espey Manufacturing Company, Inc. ★ In reply to your inquiry about FM receivers, we should like to express the following opinions:

In answer to the first question, we believe that while 4.3 mc. have proven more satisfactory than the lower frequencies for the intermediate frequency of FM receivers, a higher frequency would be more suitable for reduction of image interference.

A frequency above 15 mc. is not entirely out of order. Since we are led to believe that, in the light of techniques that are being and have been developed, stability of alignment and ease of manufacture will both be available on a commercial scale. The use of the higher frequency may, of course, be a stepping stone to a "2-gang" FM receiver, but we feel that since a high quality audio section will be required to take full advantage of FM reception, this will not lead to a "cheap" receiver.

In answer to the second question, after reviewing various frequency modulation receivers which we have manufactured, we find that the attenuation at the specified band width varied from 2 db down to 6db down, depending upon the receiver. In each case, these receivers met with full consumer acceptance.

J. Rosenbaum

Fada Radio & Electric Company ★ The absence of accepted standards makes it impossible for a radio manufacturer to offer any single opinion which may fairly be regarded as authoritative.

What follows, therefore, is simply the opinion of the Fada Engineering Department:

1. It is believed that if there be any frequency which may be called standard for intermediate frequency in FM broadcast receivers, 4.3 mc. would probably be it.

This organization is not familiar with any standard specification for IF band width. In our opinion, and assuming 75 kc. deviation either side of center frequency, an acceptable band width would be 100 kc., 2 times down and 185 kc., 5 times down.

In our opinion, we would be entirely agreeable to standardization upon 4.3 mc. as a standard intermediate frequency for FM broadcast receivers. A number of factors enter into the formation of any opinion in this matter, but it would appear that 4.3 mc. will permit of the economical attainment of adequate pass-band width for satisfactory broadcast service, and that this frequency offers the advantage of causing image points to fall outside the present 42 to 50 mc. FM band.

It is our opinion that the band width for IF amplifiers for FM broadcast receivers might acceptably be established upon the following basis:

100 k.c. 2 x down
150 k.c.
to
185 k.c. 5 x down
200 k.c. 10 x down
400 k.c. 100 x down

It is probable that the suggestions which will be made after reviewing the opinions which you may receive, will probably serve as a sound basis leading toward at least preliminary standardization upon the topic about which you have inquired.

McMurdo Silver,
Executive Vice President

Freed Radio Corporation ★ The answer to question 1, in my opinion, is as follows:

The IF frequency that should be adopted as a standard frequency for FM receivers that operate in 42 to 50 mc., band is 8 mc.

The reason that I suggest 8 mc. as a standard IF frequency is that the images will fall outside the 42 to 50 mc., band, and will not cause any interaction between two FM receivers placed in close proximity.

It has been noticed by dealers using the present FM receivers with IF frequencies of 4.3 mc., or lower that when two FM receivers are being operated at the same time, one receiver may blanket the other and stop the operation of the unit.

The answer to question No. 2 is this:

At 75 k.c., above or below the signal, the maximum drop should be 6 db.

Murray Weinstien,
Chief Engineer

The Hallicrafters Company ★ The design characteristics of FM equipment which we have made for reception in the standard FM band are as follows:

1. The standard IF frequency should be 4.3 mc.

2. The band width at 6 db down should be plus and minus 75 kc., from the center frequency (or a total band width of 150 kc.) and the band width at 60 db down should be approximately 200 kc., plus and minus the center frequency (or a total band width of not over 440 kc.).

We have followed these figures in the design of our models S-27, S31 and S-36 receivers.

R. E. Samuelson,
Chief Engineer

National Company, Inc. ★ Frankly, my opinions on the subjects in question are not original, but I am glad to coöperate in your efforts to bring attention to the problems of IF circuits for FM receivers:

The usual compromise must be made in choosing the most satisfactory intermediate frequency for FM receivers operating in the 420 to 50 mc. band: A low frequency is desirable in order to obtain good selectivity, gain, and discriminator sensitivity, while a high frequency is helpful in eliminating image signals and other spurious response. Excellent selectivity and gain can be easily obtained in a 3-mc. IF channel, while image frequencies between 42 and 50 mc. are automatically eliminated through the use of any frequency higher than 4 mc. The principal spurious response occurs when the frequency difference between two signals equals the intermediate frequency.

These facts taken together indicate that the most satisfactory intermediate frequency will be 4 mc. plus an odd number of tenth mc., and the choice of 4.3 mc., as has been previously suggested by various agencies, appears to represent the most satisfactory solution.

The use of this intermediate frequency does not, however, assure satisfactory receiver performance with respect to interfering signals outside the 42 to 50 mc. band. Since there are almost innumerable possibilities of interference arising from sum or difference frequencies of other services, the use of a particular intermediate frequency still does not eliminate the need for adequate preselection.

The problem of determining the most satisfactory characteristic is more difficult. In order to minimize distortion (particularly in the reception of weak signals) without relying too much upon the action of the limiter circuits, the response of the IF amplifier should be uniform over the 150 kc. pass-band. At 4.3 mc., response may be easily maintained with less than 1db variation, and this would appear to be a desirable limit.

Adjacent channel attenuation requirements will be determined largely by the proximity of frequencies assigned to transmitters in a given area. Since future conditions cannot be predicted, it seems unwise to attempt standardization of this phase of the subject, especially in view of the limited data that has as yet become available. However, if a tentative standard must be established, it is suggested that a figure of 20 db for attenuation of signals 200 kc., off resonance would probably be suitable.

Dana Bacon,
Chief Electrical Engineer

Stromberg-Carlson Company ★ After due consideration, the following is proposed in answer to the questions concerning IF amplifier characteristics for FM receivers:

1. In regard to establishing a standard of IF for FM receivers operating in the 42 to 50 mc. broadcast band, it is recommended that no standard be set up at the present time. Further experience is required in the field under a wide variety of operating conditions before a decision can be made.

2. With respect to band width of IF amplifiers, it has been determined by our engineering force on the basis of laboratory measurement and field experience that the transmission characteristic of the amplifier can indicate an attenuation of 6 db at 75 kc., removed from resonance without measurable added distortion. This is with operation under the condition referred to as "solid" limiting. The cut-off beyond 75 kc. should be specified in terms of the attenuation in db relative to the center frequency.

Frederic C. Young,
Vice President & Chief Engineer

Zenith Radio Corporation ★ To answer specifically your request for certain information on FM receivers:

1. The standard IF frequency for FM receivers in the 42 to 50 mc. band should be 8.3 mc.

2. The band width of the IF amplifier should be 125 kc., at two times down. At 1,000 times down, it should be in the vicinity of 600 to 700 kc. wide.

In selecting the IF frequency there are many factors which must be borne in mind, and the particular frequency specified is based on our findings in the distribution of a large number of FM receivers.

We have found that frequencies lower than 8 mc. can cause considerable trouble since it is possible for two FM stations to be spaced apart in the frequency spectrum by 8 mc. or less. There are also image problems.

At the same time, the use of a relatively high IF frequency eliminates the necessity of the use of sweep oscillators and oscillographs for line-up of the receiver by servicemen in the field. Most servicemen do not possess this equipment and avoiding the use of over-coupled circuits permits the IF to be lined up on a straight AM basis.

The definition of band width of the IF amplifier is, in our opinion, a good practical compromise and one which will result in the reception of FM signals from stations spaced as close as the FCC permits in the FM band even under the conditions of considerable difference in field strengths from desired and undesired stations.

G. E. Gustafson,
Vice President in Charge of Engineering

Jeep Radio: Special 12-volt generators are being mounted on jeeps, between the front seats. The drive is through a power take-off attached to the rear of the transfer case. This is to provide for high-power transmitters required for communications on long-distance reconnaissance trips.

More Condensers: Aerovox Corporation has opened a second plant at Taunton, Mass., with 60,000 square feet devoted exclusively to mica condenser production. This brings the Company's total space up to more than 11 acres.

SPOT NEWS NOTES

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

More and More: Anyone who is inclined to discredit the status of FM broadcasting should read the NAB Convention issue of BROADCASTING, dated April 26, 1943. The subject of FM received more attention in articles by men prominent in broadcasting circles than any other subject. If you missed this, send 15 cents to BROADCASTING, 870 National Press Building, Washington, D. C.

No Faking: We have had several criticisms of the way the trace on the cathode-ray tube shown on our March cover was retouched. The fact is that the original photograph was not retouched! However, a line had been painted on the tube to show the characteristic to be matched for acceptable performance — a common practice in laboratories and test cages.

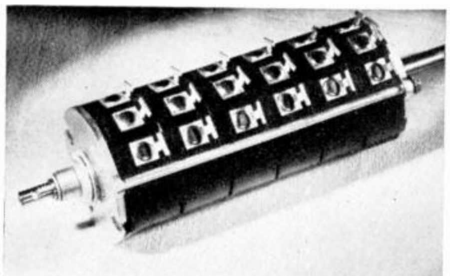
RKO Holdings Sold: $6,500,000 was the price at which a group headed by Dillon, Reed & Company bought RCA's holdings in RKO. As announced by RCA president David Sarnoff, these securities comprised 44,757 shares of 6% preferred, 316,328 shares of common stock, and 555,253 option warrants.

Lt. Col. C. J. McIntyre: "Great pains must be taken in advance to guard against the effects of all types of interference: impairment of reception by atmospherics, by unwanted signals, and by the effects of electrical apparatus or machinery (in military tanks). To take fullest advantage of the most recent developments of electronic science in reducing the effects of interference, frequency modulation has been adopted for use in tanks, tank destroyers, and the Field Artillery."

$44,000: Is the approximate cost of the radio equipment installed in a B-17 bomber.

WOR W71NY: Included in studies being made by WOR's postwar planning committee are considerations of FM expansion, including antenna design, transmitter improvement, and bringing present studio equipment up to date.

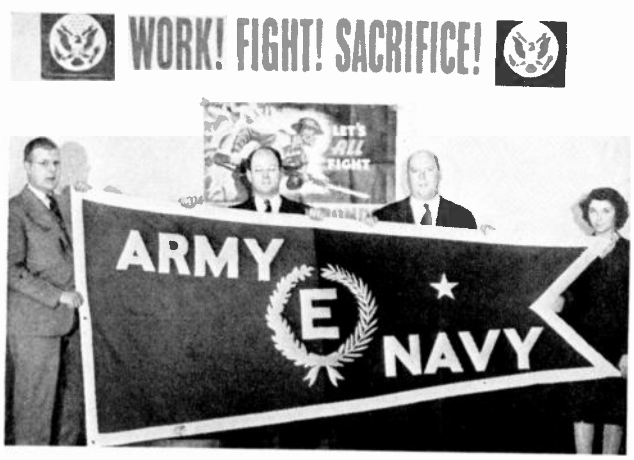
Radiosonde: Leo A. Weiss, in a recent paper before the Radio Club of America, detailed developments in radiosonde equipment with which few radio engineers are familiar. Of particular interest was his description of system used by Simmonds Aerocessories, Inc., Rockefeller Center, New York City, in which indications of pressure, temperature and humidity are transmitted by the time spacing of impulses, rather than by varying audio modulation of carrier frequency. Reduction of error is claimed for the new system, and greater ease of rating values from tape recorder on the ground.



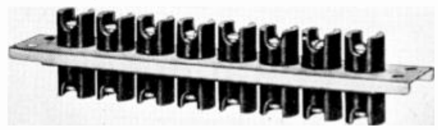
AS MANY AS 24 CIRCUITS CAN BE CONTROLLED BY ONE KNOB WITH CLAROSTAT SERIES "42" GANGED VARIABLE RESISTORS

R.E. Onstad: Elected president and general manager of Thordarson Electric Manufacturing Company, succeeding C. H. Thordarson, who, at the age of 76, has resigned but will carry on as technical consultant. L. G. Winney, former treasurer, has been named vice president and treasurer.

White Star: The first white star to be flown on an "E" flag at any Chicago radio plant was awarded to Belmont Radio Corporation, according to an announcement from Parnell S. Billings, Belmont president.



INTERNATIONAL RESISTANCE COMPANY GETS WHITE STAR FOR SIX MONTHS "E" RECORD, FIRST RESISTOR FIRM TO BE ACCORDED THIS HONOR. IN THIS PICTURE, LEFT TO RIGHT, ARE GEO. BERRY, LOCAL PRESIDENT; HARRY EHLE, I.R.C. VICE PRESIDENT; DAN FAIRBANKS, JOBBER SALES MANAGER; ALICE FLANNERY, UNION SECRETARY



MULTIPLE FEED-THRU TERMINAL BLOCKS IN UNITS OF 1 TO 10, PRODUCED BY CURTIS DEVELOPMENT & MFG. CO., CHICAGO. RATED FOR 300 V., 20 AMPS., ⅝ IN. CENTERS

Error: In the caption of the News Picture page of our March issue, it was stated that: "The transmitter is a G.E. installation." While the receivers were of G.E. manufacture, the FM transmitter was built and installed by RCA.

NEWS PICTURE

Two very spectacular "E" presentations were held in New York City last month. First came that of Fred M. Link, followed a few days later by ceremonies for Solar Manufacturing Corporation. Among the interesting and well-known personalities who attended were those to be seen in the photographs on the page opposite:

Top left — Miss May Murphy, one of the blind workers in the Solar plant who have shown such remarkable dexterity in handling mica plates for condensers, and Brig. Gen. A. A. Farmer who presented the award. Miss Murphy's Seeing Eye dog nearly stole the show.

Top right — At the Link dinner, following the "E" presentation, standing, l. to r.: Capt. Jack Geist, contracting officer, Signal Corps Procurement; Mr. Wilson, WPB Compliance; Walter Peterman, senior radio inspector, New York I.N.M. office, and Mrs. Peterman; Lieut. Don Larimer, USNR; Allen B. DuMont, president, DuMont Laboratories. Seated: Mrs. Paul Troast; Ted Johnson, Jr., General Electric Company; Miss Joanne Link and her father, Fred M. Link, whose Company has just received the "E" award; Mrs. Fred M. Link; Paul Troast, president, Mahony-Troast Company; Miss Wisefeld, vice president of Lindetieves, Inc.

Right center — Harry Gawler, whose career dates back to the early days of ship-to-shore radio when he was radio inspector in Boston, addressed the Link gathering.

Lower left — Edward Lopez, president of Radio Local 437, Otto Paschkes, president of Solar Manufacturing Corp. and Staff Sgt. William Caldwell, veteran of the Southwest Pacific fighting and speaker.

Lower right — Fred M. Link, Maj. William S. Marks, Jr. who made the "E" presentation speech, and Frederick T. Budelman, chief engineer and master of ceremonies.

SEE PAGE OPPOSITE

FM EMERGENCY EQUIPMENT

Part 2. General Electric FM Transmitters for Patrol Car and Main Station Installations

THERE are four types of General Electric FM transmitters for emergency communications, three of which are similar to Fig. 7 in their appearance, while the fourth uses the same chassis, but is intended for standard rack mounting.

These are, respectively:

1. 30-watt output transmitter using a dynamotor operating on 6 volts DC
2. 60-watt output transmitter using a dynamotor operating on 6 volts DC
3. 60-watt output transmitter operating on 117 volts AC, 50–60 cycles.
4. 60-watt output transmitter, similar to above, but designed for standard rack mounting.

General Description ★ Figs. 7 and 9 show the general construction of the 30- and 50-watt models. The steel chassis which carries the components is fastened to a heavy steel base by means of two thumb nuts. These can be seen at the bottom of the front end in Fig. 7. The base is permanently secured to the floor of the baggage compartment in patrol car installations. When it is necessary to service a transmitter, it is loosened from the base, and another slipped into its place.

The cover is held in place by a clamping handle which engages the cross brace above the unit, as shown in Fig. 9, at the left. When required, the handle is fitted with a lock, to prevent unauthorized tampering with the unit.

Sockets are provided for the connecting cables, and jacks for plugging in test instruments and for a microphone to be used when checking the transmitter.

The mobile control box, for mounting on the lower edge of the dashboard, carries a combined volume control and on-off switch, receiver squelch control, microphone jack, power-on indicator light for the receiver and transmitter, and another power-on light which shows when voltage is applied to the plates of the transmitter tubes.

A similar set of controls are furnished on the fixed station control unit which also carries a loudspeaker.

Transmitter Circuit ★ The complete circuit of the transmitter is given in Fig. 8. It should be noted that parts marked with an asterisk in this diagram are for use in the 60-watt model only.

The quartz crystal Y109 oscillates at 1/32 of the assigned center frequency. The type 7B7 oscillator tube, V101, supplies excitation to the 7H7 modulator tube, V102, and to the first quadrupler tube, V103, through the coupling condenser C105.

The output of V103, operating at four times the crystal frequency, is coupled into the grid of the second quadrupler tube V104 by means of the tank circuit L4,C104, the coupling condenser C106 and the grid resistor R107.

In the second quadrupler tube V104 the frequency is once more multiplied by four, so that its output is 16 times the frequency of the crystal.

Next, the output of the second quadrupler tube V104 is coupled into the grid of the 6V6GT doubler tube, V105, which multiplies the frequency by two, giving a signal which is 32 times the crystal frequency. This output drives the power amplifier at the operating frequency.

In the case of the 30-watt unit, the power amplifier has one GL807, while the 60-watt type has two connected in parallel. These are tubes V106 and V107 in the wiring diagram.

FIG. 7. 30- AND 60-WATT TRANSMITTERS ARE AVAILABLE ON THIS TYPE OF CHASSIS

The output of the power amplifier is fed into the antenna through the coupling condenser C117 and the antenna relay K101.

Frequency modulation is applied to the signal by the variable grid bias on the modulator tube V102 through the microphone transformer T101, and R126 and L3. The modulator tube, in conjunction with the resistor-condenser network C103, R123, and C102, serves as a variable reactance in shunt with the tuned circuit L1.

Thus, grid voltage variations produced by speaking into the microphone become reactance variations in tuned circuit L1. This variation of reactance causes a change in phase relationships which produce small frequency swings. This frequency swing is multiplied in the succeeding stage until, at the output frequency, the normal deviation from the assigned center frequency is plus or minus 15 kc.

This system produces *phase* modulation, which means that the phase swing of the radiated wave is proportional to the amplitude of the modulating audio signal, but independent of the audio frequency.

The relationship between *phase* swing and *frequency* swing is such that, for a constant phase swing, the frequency swing is proportional to the audio frequency. Thus, phase modulation is the equivalent of frequency modulation having an audio frequency characteristic rising at the higher audio frequencies.

Since the characteristics of the average human voice are such that most of the energy is concentrated at the lower voice frequencies, the use of phase modulation, accentuating the high frequencies, tends to produce more or less uniform modulation over the pass band.

Compensation for this effect is provided at the receiver by attenuating the higher audio frequencies in the audio system, thereby giving essentially uniform response, with a substantial reduction of background noise.

Approximately 15 db of high-frequency accentuation or pre-emphasis between 500 and 3,000 cycles are used in this G.E. FM transmitter, with corresponding attenuation or de-emphasis of the high audio frequencies in the associated receivers. This value has been found, by tests under operating conditions, to provide the maximum signal-to-noise ration.

Audio frequencies above 3,000 cycles are attenuated in the transmitter to prevent the radiation of undesirable side bands, and in the receiver to reduce high audio-frequency background noise to minimum value.

Tubes ★ Following is the list of tubes used in the various models. Note that the 30-watt transmitter has only one GL807 tube, while all the 60-watt types have two, and that the GL1641 rectifier is used only for AC operation.

V101 Crystal oscillator, 7B7
V102 Modulator, 7H7
V103 1st quadrupler, 7B7
V104 2nd quadrupler, 7B7
V105 Doubler, 6V6GT
V106 Output, GL807
V107 Output, GL807
V108 Rectifier, GL1641

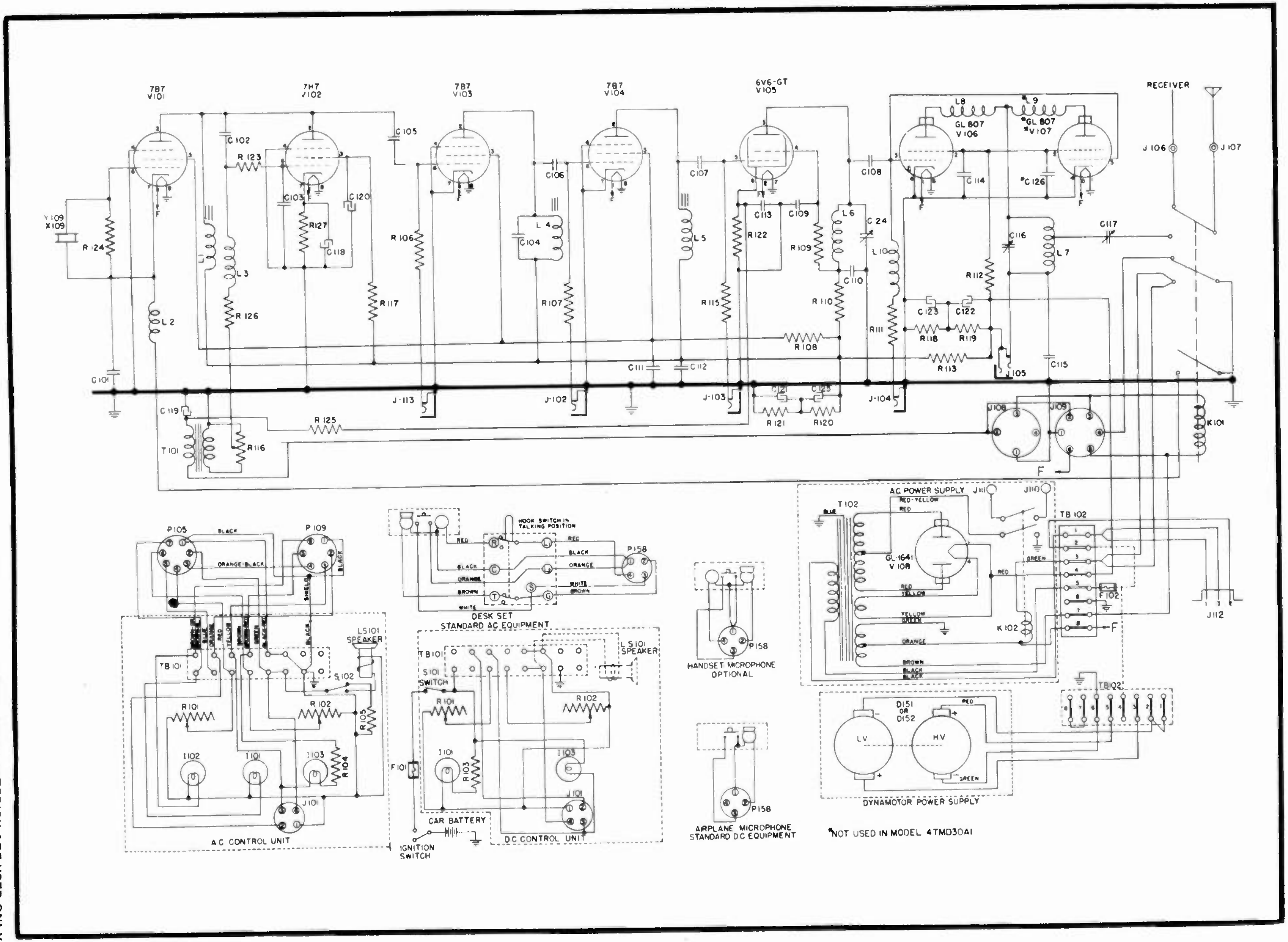


FIG. 8. DIAGRAM OF 30- AND 60-WATT TRANSMITTERS WITH AC OR BATTERY POWER. PARTS MARKED WITH ASTERISK ARE USED ONLY ON 60-WATT MODEL. FM TRANSMITTERS ARE REMARKABLE FOR THEIR SIMPLICITY AND HIGH OUTPUT WITH LOW BATTERY DRAIN

Power Consumption ★ Battery drain for the 30-watt car transmitter is 2.1 amperes in the standby position, when only the heaters are drawing current, or 26.5 amperes during actual transmission.

The 60-watt type for battery operation draws 3.0 amperes during standby periods, and 41.5 amperes during actual transmission.

These figures assume that the 6-volt battery is fully charged. It should be noted that, since the transmitter is under control by a push-to-talk button, the operator can do much to conserve the battery by making his words as brief as possible, and by pressing down the button only during actual periods of transmission. It has been noted that, all other things being equal, some operators have more battery trouble than others, due to their care or carelessness in using the transmitter control button.

Circuit Details ★ The following information is given to supplement the circuit diagram in Fig. 8:

CONDENSERS

C101 Cathode bypass, 22 mmf. mica
C102 Coupling, 220 mmf. mica
C103 Grid bypass, 12 mmf. mica
C104 Plate tuning, 47 mmf. ceramic
C105 Coupling, 100 mmf. ceramic
C106 Coupling, 100 mmf. ceramic
C107 Coupling, 100 mmf. ceramic
C108 Coupling, 100 mmf. mica
C109 Screen bypass, .001 mfd. mica
C110 Decoupling, .001 mfd. mica
C111 Screen voltage bypass, .05 mfd. metal-cased paper
C112 B+ voltage bypass, .05 mfd. metal-cased paper
C113 Cathode bypass, .001 mfd. mica
C114 Screen bypass, 470 mmf. mica
C115 Plate bypass, .001 mfd. mica
C116 Output tank tuning, 65 mmf. trimmer
C117 Antenna tuning, 75 mmf. trimmer
C118 Cathode bypass, 20. mfd. 25-volt electrolytic, combined with C119, C120, and C121
C119 Modulation transformer bypass, 10. mfd. 450-volt electrolytic
C120 Screen bypass, 15. mfd. 450-volt electrolytic
C121 B+ filter, 30. mfd. 450-volt electrolytic
C122 B+ filter, 20. mfd. 450-volt electrolytic
C123 B+ filter, 20. mfd. 450-volt electrolytic
C24 Doubler tuning, 60 mmf. trimmer
C125 B+ filter, 10. mfd. 450-volt electrolytic
C126 Screen bypass, 470 mmf. mica

INDUCTANCES

L1 Oscillator plate coil
L2 Oscillator choke
L3 Modulator choke
L4 1st quadrupler RF coil
L5 2nd quadrupler RF coil
L6 Doubler plate coil
L7 Final tank coil
L8 Parasitic choke
L9 Parasitic choke (for 60-watt models)
L10 Output grid choke

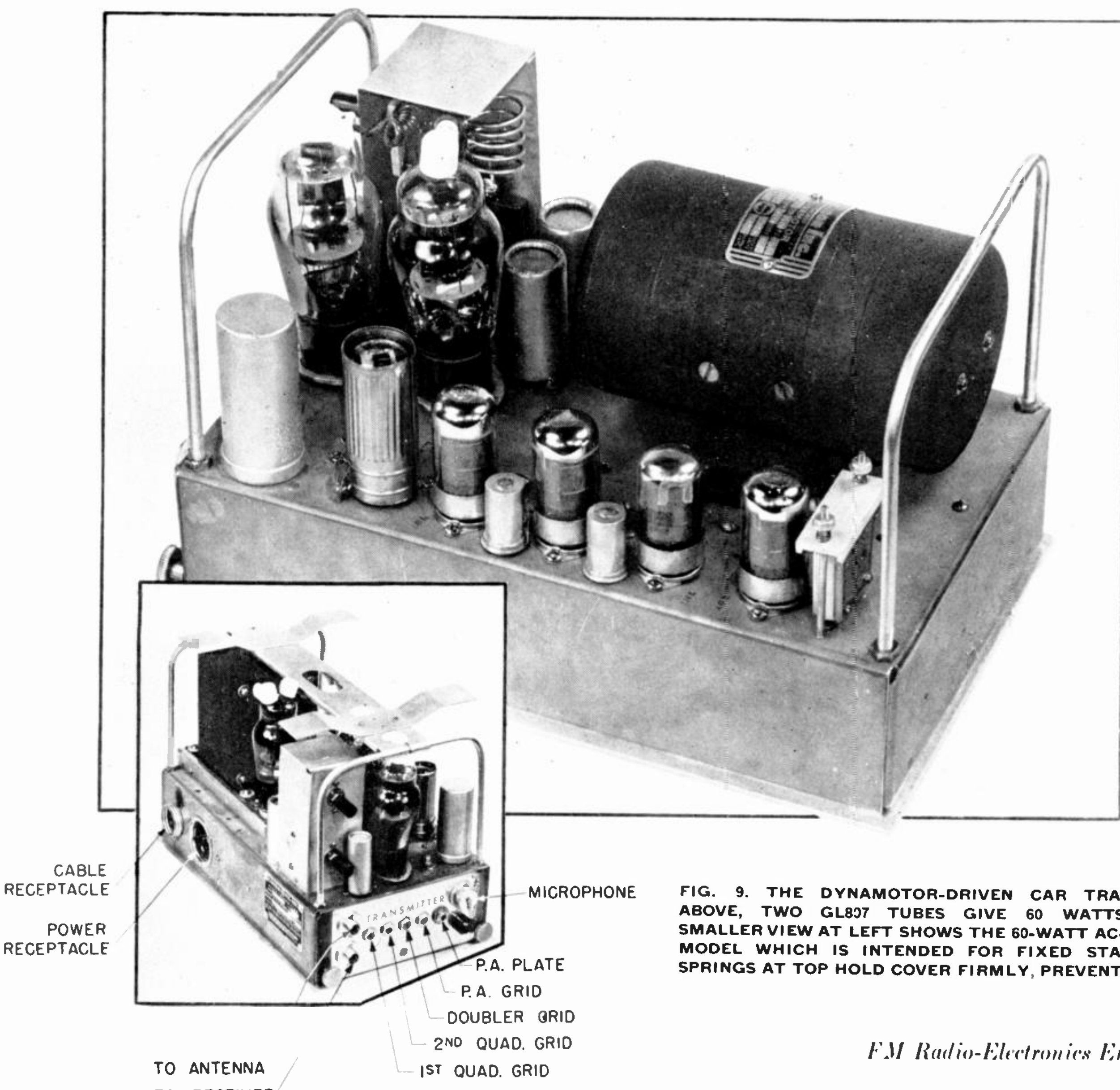


FIG. 9. THE DYNAMOTOR-DRIVEN CAR TRANSMITTER, ABOVE, TWO GL807 TUBES GIVE 60 WATTS OUTPUT. SMALLER VIEW AT LEFT SHOWS THE 60-WATT AC-OPERATED MODEL WHICH IS INTENDED FOR FIXED STATION USE. SPRINGS AT TOP HOLD COVER FIRMLY, PREVENT RATTLING

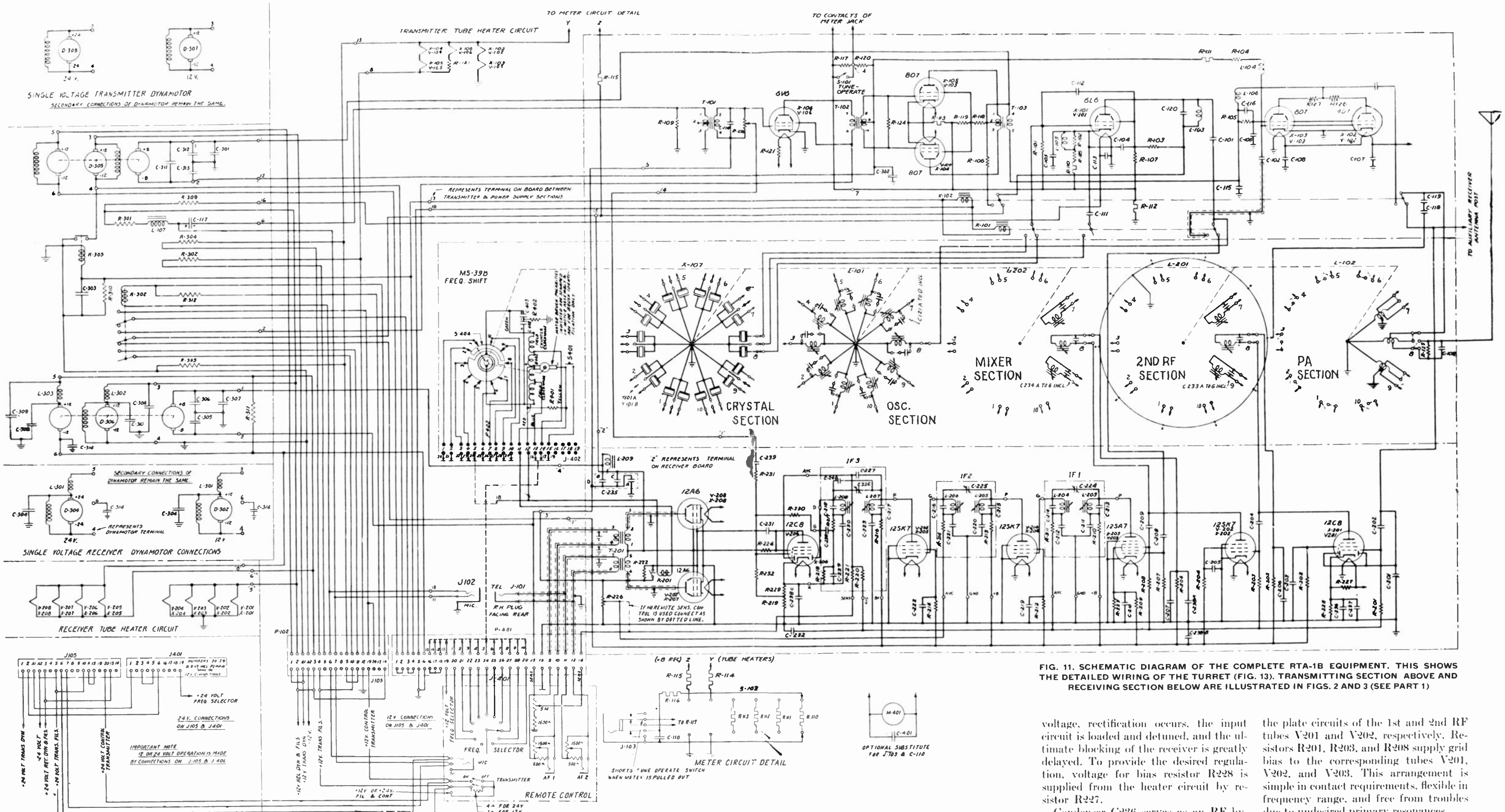


FIG. 11. SCHEMATIC DIAGRAM OF THE COMPLETE RTA-1B EQUIPMENT. THIS SHOWS THE DETAILED WIRING OF THE TURRET (FIG. 13). TRANSMITTING SECTION ABOVE AND RECEIVING SECTION BELOW ARE ILLUSTRATED IN FIGS. 2 AND 3 (SEE PART 1)

6L6 oscillator tube V101, the crystal changeover occurring whenever relay K101 is operated by the microphone push-to-talk button. During reception, relay K102 causes transmitter output inductors L102 to function as receiver input inductors. If inductors L102 are tuned for transmitting, they are also tuned for receiving at the same frequencies. Variable condenser C201 compensates for the difference in capacity between the transmitter plate circuit and the receiver grid circuit, the adjustment being made from underneath the chassis. When the transmitter has been properly tuned, condenser C201 is then set for maximum receiver sensitivity, and should require no further adjustment.

The diode plates of the 12C8 first RF tube V201, connected directly across the tuned input circuit L102, are biased by resistor R228 and, normally, present no load until the signal voltage across circuit L102 is comparatively high. When the signal voltage is greater than the bias voltage, rectification occurs, the input circuit is loaded and detuned, and the ultimate blocking of the receiver is greatly delayed. To provide the desired regulation, voltage for bias resistor R228 is supplied from the heater circuit by resistor R227.

Condenser C236 serves as an RF bypass, and C237 prevents dynamotor ripple or other audio components present in the heater circuit from modulating the received signal at the threshold point of the signal-limiting circuit.

Coupling elements L201, C233 and L202, C234 are single-tuned inductances in the plate circuits of the 1st and 2nd RF tubes V201 and V202, respectively. Resistors R201, R203, and R208 supply grid bias to the corresponding tubes V201, V202, and V203. This arrangement is simple in contact requirements, flexible in frequency range, and free from troubles due to undesired primary resonances.

The cathodes of RF and mixer tubes V202, V203, 1st and 2nd IF tubes V204, V205, and AF output tubes V207, V208 are grounded. Voltage drop across resistor R226 furnishes a common bias supply.

The injector grid of mixer tube V203 receives voltage from the oscillator tube

V101 circuit. The proper crystal for receiver operation is automatically connected upon release of the microphone button.

The desired selectivity characteristic can be obtained by adjustment of the variable capacitors C224, C225, and C226 of the IF transformer assemblies.

Separate diode plates in the 2nd detector, 1st AF tube V206 are used for signal detection and AVC functions. Relatively high delay is employed in the AVC circuit to provide the flattest possible AVC action. In order to use this high delay, comparatively large overall RF gain is incorporated in the receiver design.

The function of the first AF stage is not to contribute to the overall gain of the receiver, but to reduce the impedance shunting the grids of the output tubes V207 and V208. To attenuate cross-channel voltages created by the grid-to-plate capacity of tubes V207 and V208, the impedance shunting the grids should be as low as possible. Since no apprecia-

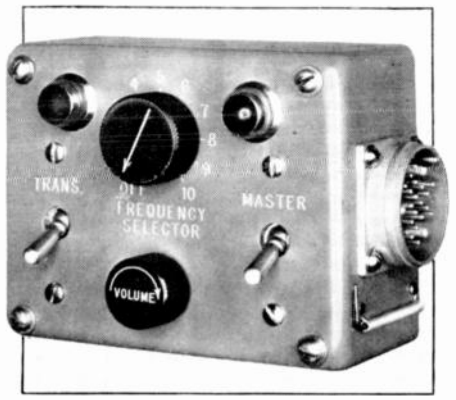


FIG. 11. TYPICAL REMOTE CONTROL BOX

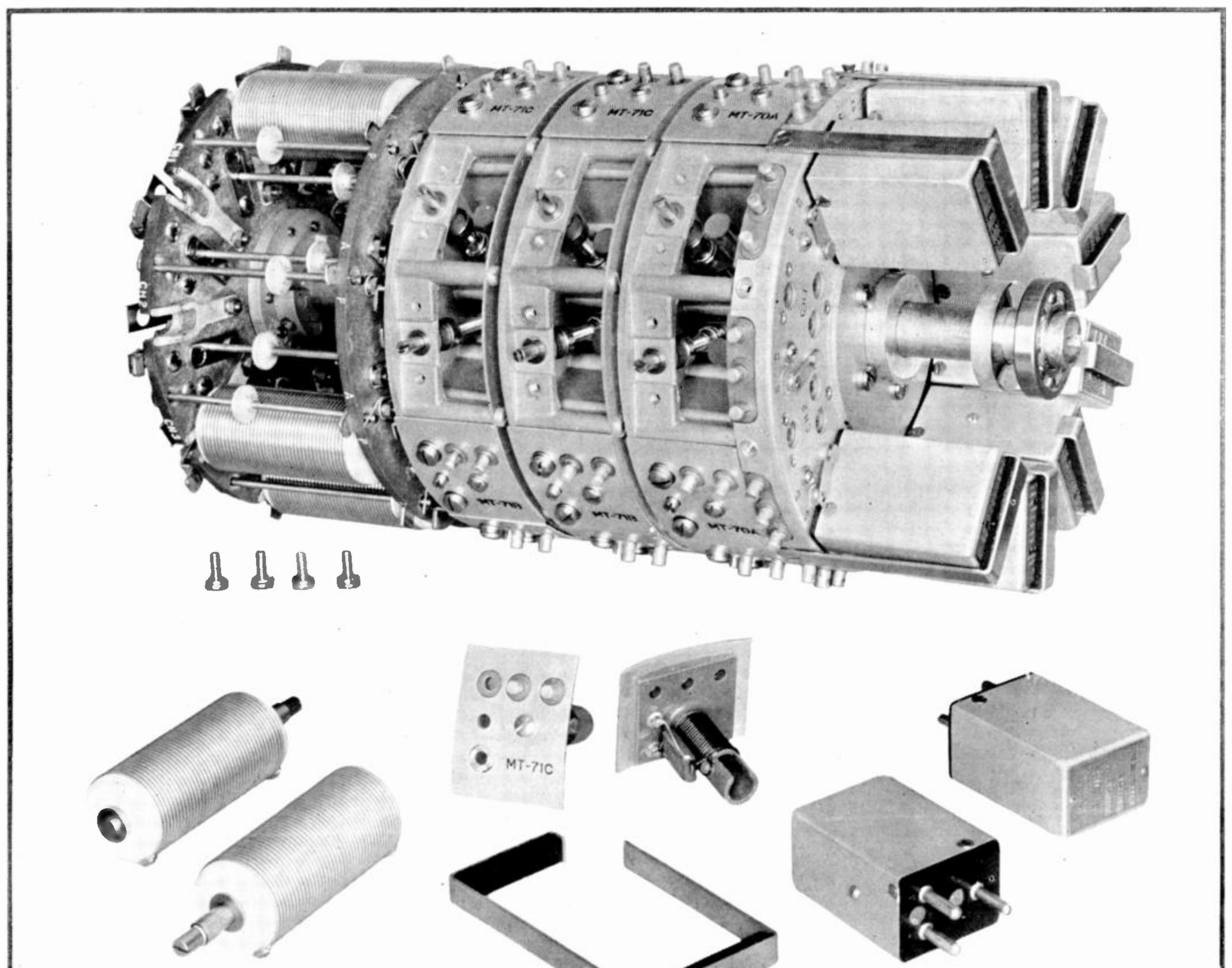
ble gain is required in the first AF stage, plate resistor R224 is given a low resistance value, allowing it to function as the desired shunt for the grids of the output tubes.

Both output transformers T201 are housed in a single assembly, but in such a manner that coupling between them is practically zero.

Sidetone potentiometer R108 is shunted by the secondary of the microphone input transformer T101. Thus, potentiometer R108 supplies sidetone voltage for the first AF amplifier V206 through blocking condenser C239 and series resistor R231. Since the audio stages are always in operation, transmitter sidetone is heard in the headphones connected to the output stages.

In order to understand the foregoing explanation, a careful study should be made of the diagrams in Figs. 8 and 11, comparing them with the actual views of the equipment which appear in Figs. 1, 2, 3, and 4 of Part 1, and the details of the turret which can be seen in Fig. 13. Numbers on the components in Fig. 8 correspond with those which appear in the schematic diagram, Fig. 11. The circuit detail in Fig. 8 is connected to the rest of the equipment by plug P402 and the jack J402.

FIG. 13. THE TURRET OF THE RTA-1B IS AN OUTSTANDING EXAMPLE OF MECHANICAL DESIGN APPLIED TO RADIO EQUIPMENT. LEFT HAND END SHOWS CONSTRUCTION OF VARIABLE INDUCTANCES, WITH IRON-CORE INDUCTORS A CRYSTAL HOLDERS IN FRONT



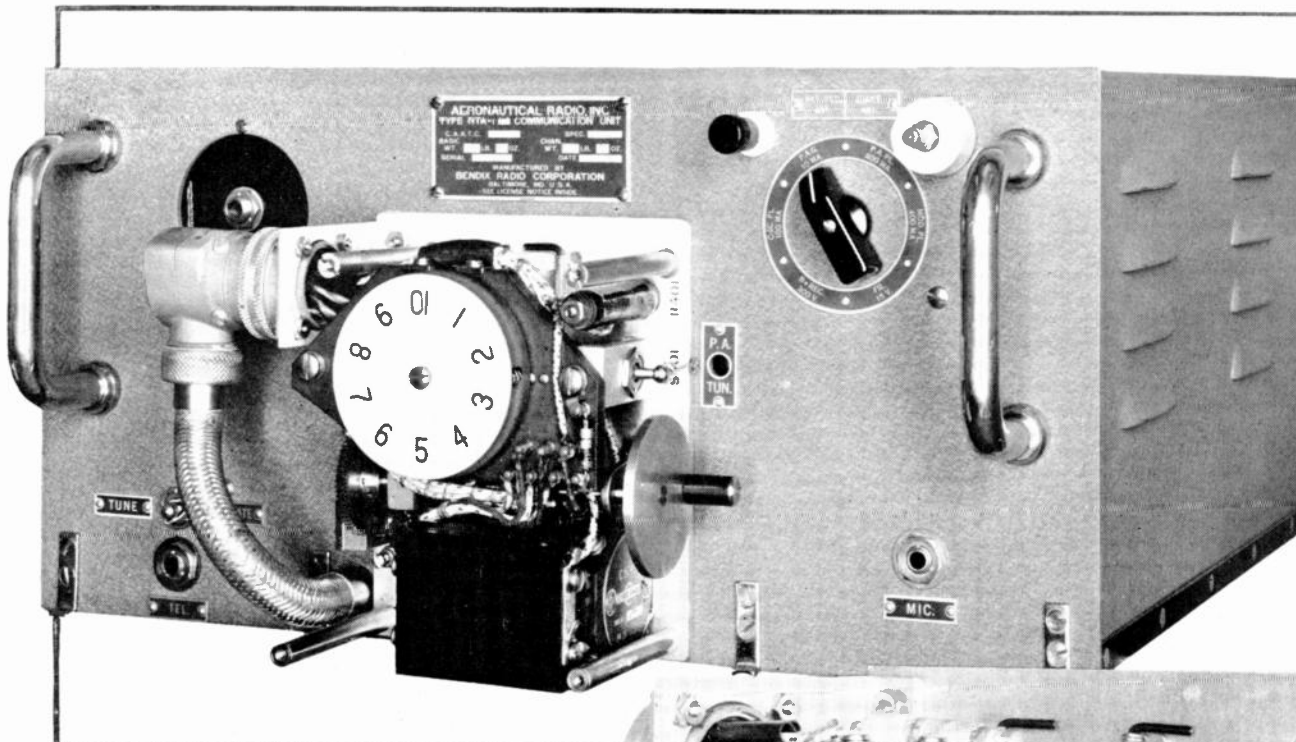


FIG. 9, ABOVE. IN THIS ILLUSTRATION, THE COVER HAS BEEN REMOVED FROM THE DRIVING MECHANISM WHICH SELECTS THE DESIRED TRANSMITTER AND RECEIVER FREQUENCIES BY ROTATING THE TURRET (FIG. 13). THE USE OF WOVEN WIRE CONDUIT AND CONNECTOR FITTINGS IS TYPICAL OF AIRCRAFT RADIO DESIGN PRACTICE

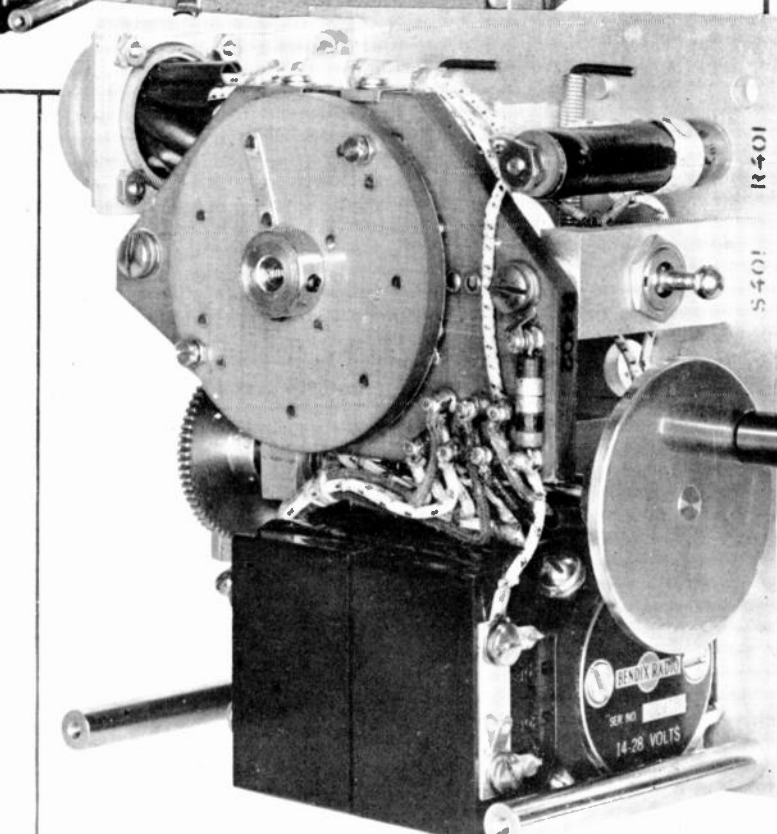


FIG. 10, RIGHT. THIS CLOSE-UP VIEW OF THE DRIVING UNIT IS INTERESTING BECAUSE IT SHOWS THE ATTENTION TO DETAILS WHICH IS CHARACTERISTIC OF BENDIX DESIGNS AND METHODS. NOTE THE USE OF PHENOPLEX TUBING OVER THE LEADS TO THE SOCKET, THE NUMBERING OF THE PARTS, CODED WIRES AND TERMINAL PINS, AND THE SPRING HOLDERS FOR THE ALLAN SET SCREW SOCKET WRENCHES.

use. These contacts extend from the end of the turret at the extreme left.

Plate circuit shunt condensers C118, C119 are provided for use at frequencies below 5 mc. for the sole purpose of suppressing harmonic radiation from the transmitter. Condensers C118, C119 are automatically connected or disconnected by the proper setting of the turret contact for the channel in use.

Microphone current is supplied through filter choke L107, and is blocked from the primary of transformer T101 by blocking condenser C117.

With a 12- to 14-volt power source, the transmitter and receiver tube heaters and relays are automatically connected in parallel (except transmitter heater series groups). They are automatically connected in series-parallel groups with a 24- to 28-volt power source plugged in. Muting relay K201 operates on either supply voltage, and is energized only when channel-control motor B402 operates.

The heater of crystal oscillator V101 and the heaters of all the receiver tubes V201 to V208 inclusive are on continually at full voltage.

Heater voltages of transmitter tubes V102 to V106 inclusive are varied as follows: (1) 75% when transmitter switch is off; (2) 95% when transmitter switch is on; (3) 100% when transmitter is on the air.

Description of the Receiver ★ The receiver section, of which detailed views were given in Figs. 2 and 3, employs a superheterodyne circuit, with delayed automatic volume control, dual audio output channels, and an input-voltage limiting circuit.

Both receiver and transmitter use the

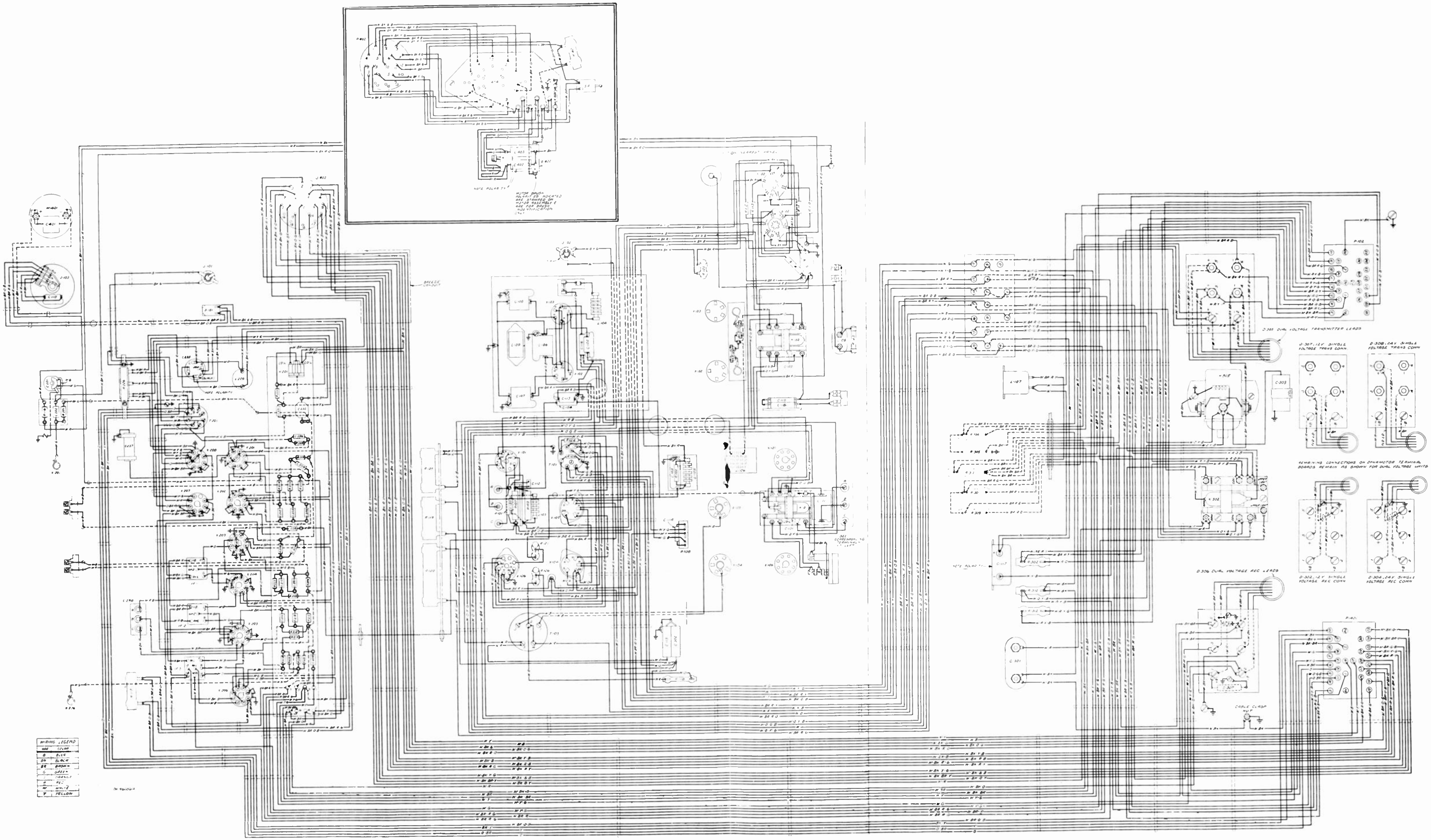


FIG. 8. A BETTER UNDERSTANDING OF THIS WIRING DIAGRAM CAN BE OBTAINED BY COMPARING IT WITH THE TOP AND BOTTOM VIEWS OF THE CHASSIS SHOWN IN FIGS. 2 AND 3, PART 1 OF THIS ARTICLE, WHICH ALSO CONTAINED FURTHER DATA ON THE TRANSMITTING AND RECEIVING CIRCUITS.

FIG. 1. AN ENGRAVING MACHINE ESPECIALLY DESIGNED FOR WOMEN WORKERS

PRODUCTION ENGRAVING

Bench Type Machines Designed to Meet Convenience of Women Operators in Plants Producing Military Radio Equipment

BY MORRIS L. ALEXANDER*

THE influence of women, and consideration for their preference and convenience is now felt even by designers of machine tools. The reason, of course, is that the employment of women workers is increasing so rapidly that the output of a given machine may be affected favorably or adversely by its suitability to the physical limitations of women operators.

The engraving machines shown in the accompanying illustrations were designed specifically to meet this new factor of wartime production. Until now, such machines were only operated by men, and men stand at their machines. Consequently, it had become standard practice to design equipment of this type for floor mounting. The fact that countershaft drive required a belt moving at very high speed was not a consideration, since there was no danger of catching a man's hair.

Today, these are both essential factors in the selection of engraving machines. A woman operator wants to sit on a stool that is low enough for her to feel secure. If she has to hold her arms up high, she tires quickly. And the hazard of a fast-moving, unprotected belt running up from a machine that she leans over to operate is too great for present-day standards of safety.

Applications of these and other considerations of convenience resulted in the design of the production-type engraving machines shown here.

The model illustrated in Figs. 1 and 3 is intended to carry work of substantial dimensions, and to give a large working area at a single setting of the work.

Two sizes are available. The smaller machine has a copy table 11 ins. long by $7\frac{1}{2}$ ins. wide with 5 slots for master letters. The work table measures 11 ins. long by 6 ins. wide, and has cross T-slots for clamps. Pieces up to 3 ins. in thickness can be accommodated. Working area covered by the cutter at a single setting is indicated by the following dimensions:

Ratio of Reduction	*Area Length*		*Area Width*
1 to 1	8 ins.	x	2 ins.
	to 3	x	4
1 to $\frac{3}{4}$	6	x	1
	to 2	x	3
1 to $\frac{1}{2}$	4	x	1
	or 2	x	2

The larger model of the same type has a copy table 16 ins. long by 10 ins. wide, with 6 slots for master letters, and a work table 16 ins. long by 8 ins. wide. Vertical adjustment permits pieces up to $4\frac{1}{2}$ ins. thick to be mounted on the work table. The following data shows the overall areas which are covered by the cutter at a single setting of the work:

Ratio of Reduction	*Area Length*		*Area Width*
1 to 1	18 ins.	x	2 ins.
	to 8	x	7
1 to $\frac{7}{8}$	16	x	2
	to 8	x	6
1 to $\frac{3}{4}$	12	x	$2\frac{1}{4}$
	to 7	x	5
1 to $\frac{5}{8}$	$9\frac{1}{2}$	x	2
	to 4	x	$4\frac{1}{2}$
1 to $\frac{1}{2}$	7	x	2
	to 4	x	$3\frac{1}{4}$

Fig. 1 shows the way in which the machine should be set on the bench. In this position, the lifting lever for the cutter and the stylus for following the letters are equidistant from the operator. Thus, she can sit in a natural position. It is not necessary to fasten either model to the bench. Their weight, 125 lbs. and 250 lbs., respectively, is enough to keep either machine in position permanently.

A second type of machine, intended for quantity production of small parts and particularly nameplates, is shown in Fig. 2. The copy table, with slots for 4 rows of master letters, is $12\frac{1}{2}$ ins. long by $6\frac{1}{2}$ ins. wide, while the work table is 8 ins., which is ample to take the largest nameplates. An idea of the area covered by the cutter at a single setting of the work is given by the following dimensions:

Ratio of Reduction	*Area Length*		*Area Width*
1 to $\frac{1}{2}$	11 ins.	x	1 ins.
	to 5	x	$2\frac{1}{2}$
1 to $\frac{1}{3}$	7	x	1
	to 3	x	$1\frac{3}{4}$
1 to $\frac{1}{4}$	4	x	1
	to 2	x	$1\frac{1}{2}$
1 to $\frac{1}{5}$	$3\frac{1}{2}$	x	$\frac{3}{4}$
	to 2	x	1

*General Manager, Auto Engraver Company, 50 W. 46th Street, New York City.

AIRCRAFT RADIO APPARATUS DESIGN

Mechanical and Electrical Details of the Bendix RTA-1B Communications Unit, Part 2

BY R. B. EDWARDS*

THE functions of the tubes indicated in Figs. 8 and 11 are:

Transmitter —

V101	Oscillator
V102	Power amplifier
V103	Power amplifier
V104	Modulator
V105	Modulator
V106	Speech amplifier

Receiver —

V201	1st RF & diode input limiter
V202	2nd RF
V203	1st detector mixer
V204	1st IF
V205	2nd IF
V206	2nd detector, AVC, 1st audio
V207	Audio output
V208	Audio output

Description of the Transmitter★

The transmitter section of the Bendix RTA-1B equipment is provided with a 6V6 class A speech amplifier indicated as V106 in Figs. 8 and 11. The speech amplifier drives two 807 class AB_2 push-pull modulators V104, V105, providing 100% modulation.

A 6L6 crystal oscillator tube V101, connected either as a conventional Miller or modified Pierce oscillator, drives two 807 tubes, V102 and V103, in parallel. These, in turn, serve as the final plate-modulated RF class C amplifier.

There is a small switch on the crystal mounting plate to select the type of crystal circuit to be used. The Miller circuit is employed for frequencies between 2.5 and 7 mc., when the final output frequency is the same as the crystal frequency. The modified Pierce circuit is used when the output frequency is twice the crystal frequency. The crystal oscillator plate circuit is always tuned to the output frequency.

In Fig. 13, the crystal switches can be seen on the right end of the turret, where the crystal holders have been removed. The two positions are marked S and D, for singling and doubling. Each holder carries a receiver crystal and a transmitter crystal.

While receiving, one set of contacts on relay K101 always switches the crystal oscillator circuit to the Pierce type, regardless of the transmitter's circuit status, because the receiver crystals differ in frequency from the transmitter crystals.

When operating on the fundamental, the receiver crystals are 455 kc. lower in frequency than the transmitter crystals. When doubling, they are 227.5 kc. lower. This difference is due to the receiver IF of 455 kc. Condenser C111 shunts the following cathode series elements when the crystal oscillator is connected in a Miller circuit: RF choke L105, bypass condenser C105, and resistors R102, R125, and R110.

The power supply dynamotors are under control of the press-to-talk button on the microphone. When the button is pressed, relay K302 is energized and causes relays K305, K102, and K101 to close. Thereupon, transmitter dynamotor D305 (or D307 or D308) supplies plate and screen voltages for crystal oscillator V101, power amplifier tubes V102, V103, and modulator tubes V104, V105. At the same time, receiver dynamotor D302 (or D304 or D306) supplies plate and screen voltage for the transmitter speech amplifier tube V106 and receiver dual audio output amplifiers V207 and V208.

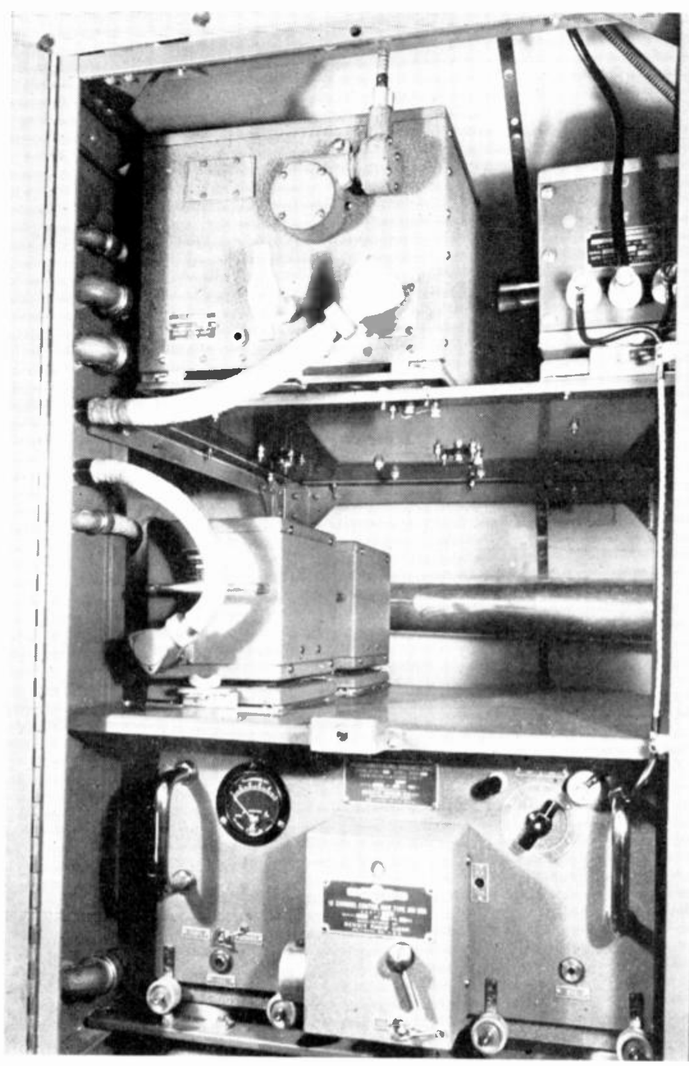
Upon releasing the microphone button, the receiver goes into operation. Receiver Dynamotor D302 (or D304 or D306) supplies all the tubes V201 to V208 inclusive, and provides bias for the transmitter speech amplifier tube V106.

Iron cores are used for tuning the Receiver RF and mixer inductors L201, L202, the IF inductors L203 to L208 inclusive, and the crystal oscillator inductors L101. Details of the components can be seen in Fig. 13.

Transmitter output circuit L102 acts as a tuned receiver input circuit, and is tuned by rotating each inductor by means of a screwdriver slot at the grounded end of the shaft. Small rollers, carried on spring-suspended rods, are used as antenna and plate contacts to the inductors. The relative positions of these rollers determine the degree of coupling to the antenna. The two rollers for each inductor are shown in Fig. 13.

Series antenna condenser C109 is provided for use at frequencies at which the antenna becomes inductive, and is automatically connected or disconnected by the setting of the antenna condenser contact for the channel in

FIG. 7. BENDIX AIRCRAFT RADIO EQUIPMENT INSTALLED IN A DOUGLAS DC-3. THE RTA-1B UNIT IS MOUNTED IN THE BOTTOM OF THE RADIO COMPARTMENT



*Project Engineer, Bendix Radio, Division of Bendix Aviation Corporation, Baltimore, Md.

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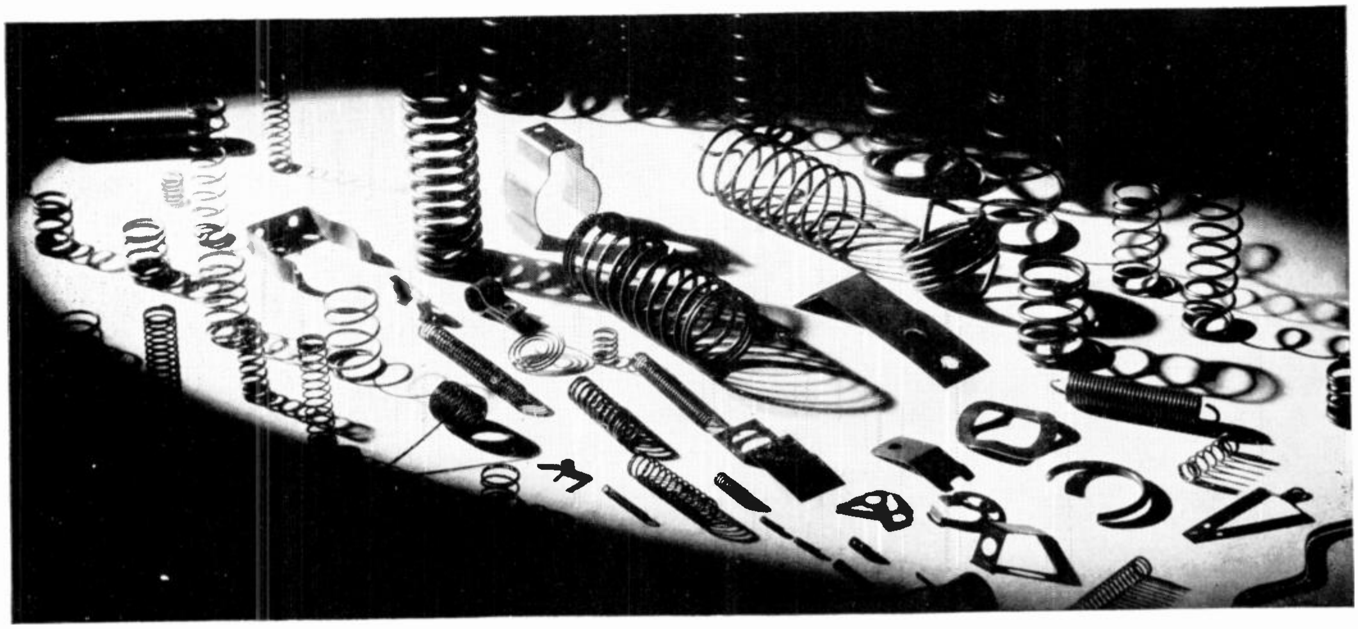

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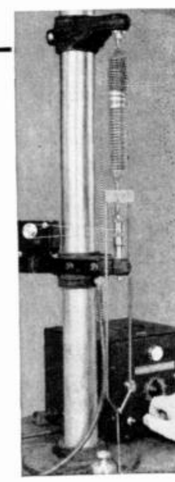

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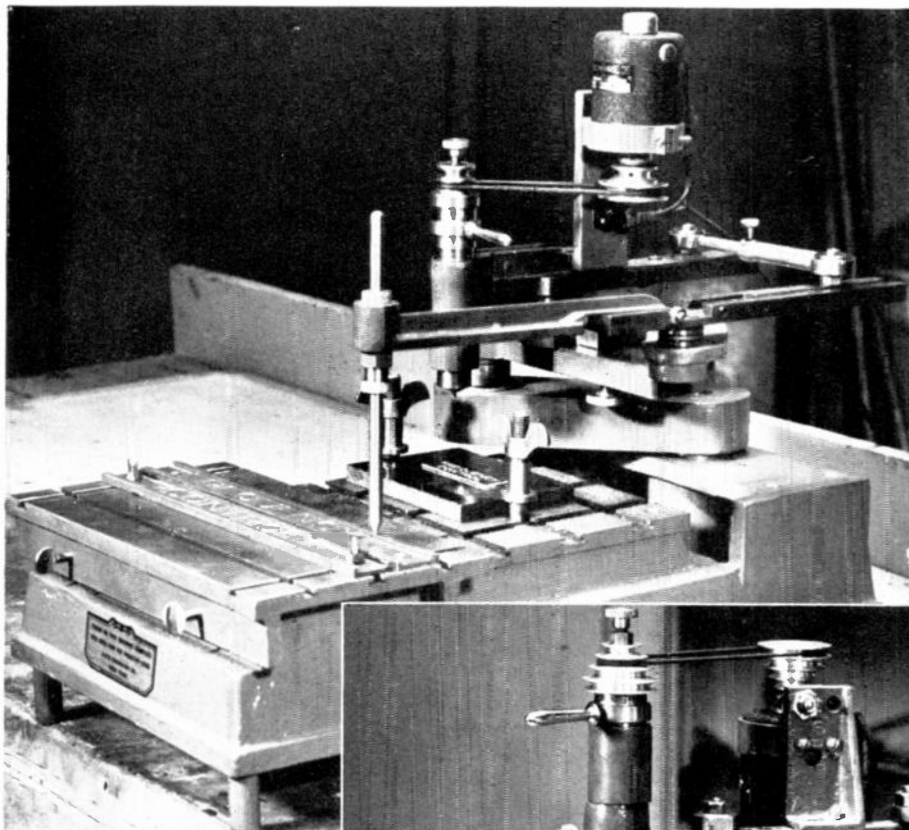

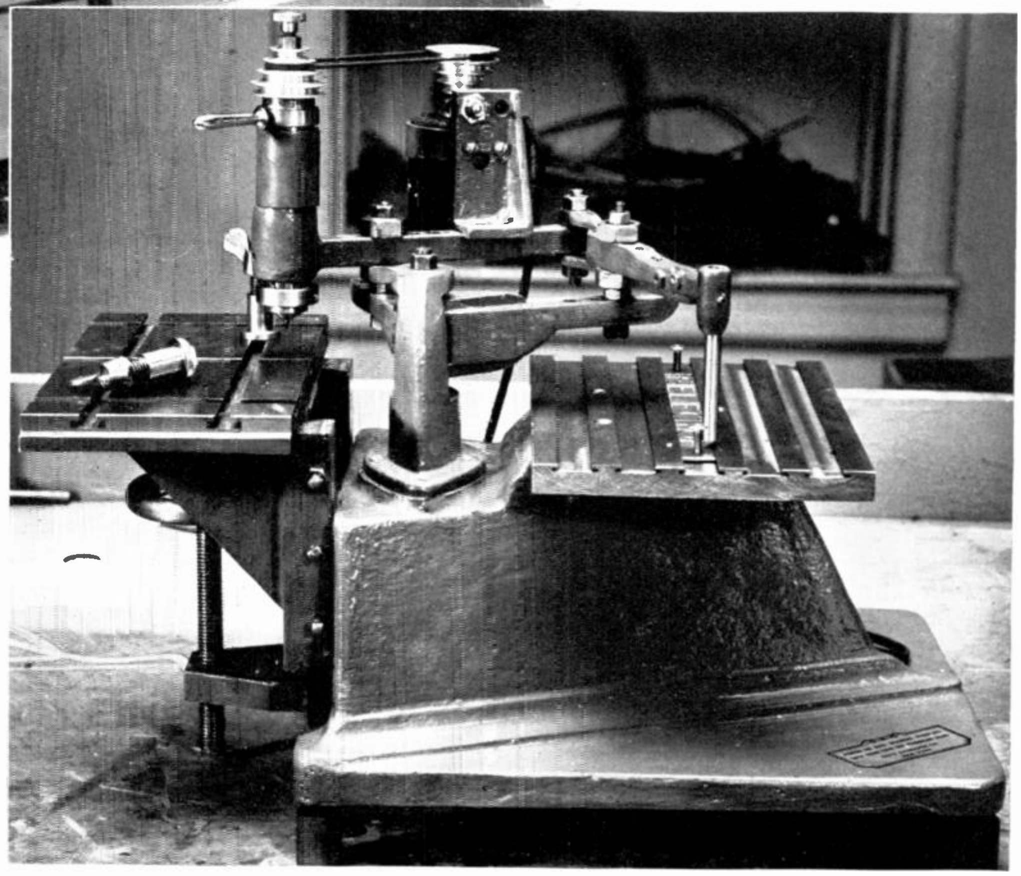

FIG. 2, ABOVE. THIS MACHINE IS IDEAL IN ITS DESIGN FOR WOMEN OPERATORS BECAUSE THE COPY IS AT THE FRONT, IN THE NATURAL POSITION. HOWEVER, THE SIZE OF THE WORK IT CAN ACCOMMODATE IS LIMITED BECAUSE IT IS PLACED BETWEEN THE MAIN BEARING AND THE COPY TABLE

FIG. 3. ANOTHER VIEW OF THE ENGRAVING MACHINE SHOWN IN FIG. 1. NOTICE HOW THE BELT HAZARD IS ELIMINATED COMPLETELY BY MOUNTING THE MOTOR DIRECTLY ON THE PANTOGRAPH ARM

All these machines are driven by 115-volt AC-DC motors, thus eliminating one problem which sometimes occasions much inconvenience. Four pulleys give an adjustment of the cutter speed from approximately 3,000 to 8,000 rpm. Ball bearings are used throughout on the pantograph to assure extreme accuracy over years of service.

It will be noticed that the reduction ratios are somewhat different from those usually provided on engraving machines. However, the same sort of work can be done because of the sizes of master letters used. On the two larger models, letters ¼ in. high are furnished. The small model, Fig. 3, has a different ratio series, so that it used letters ⅝ in. high.

In addition to conventional engraving work, these machines are finding wide application for an entirely different purpose. In many cases they are being used to spot or drill holes with great accuracy from a master template. Advantage is taken of the pantograph reduction to assure uniformity and interchangeability of fit. Exact control of depth is also possible if the holes are to be drilled only part way through the piece, or if small holes are to be counterbored.

RADAR AND TELEVISION

In many quarters, statements that research on military equipment has contributed to the advance of the television art have met with much skepticism.

However, the truth of these claims is made evident by the release of information on the nature of radar equipment, a development which has been kept so secret that any reference to such apparatus in print has been forbidden in recent months.

This does not mean that any technical information on radar can be published. While both Germany and England, and probably Japan are using such apparatus, the competition to improve its performance will continue to be keen. It will still be necessary, therefore, for each side to maintain strict secrecy as to the state of development of what many consider the most important contribution to military science.

As for the much-discussed future of television in the immediate post-War period, while it is certain that manufacturers will make every effort to get under way quickly, too much speed may not produce the best results.

It will be necessary to revise the pre-War television standards almost entirely. Since this must be done through the FCC organization, considerable time may be required before equipment can be designed for production. The one certainty now is that a start can be made after the War.

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CHOKES, RF

Aladdin Radio Industries, 501 W. 35th, Chicago
★ Alden Prods. Co., Brockton, Mass.
American Communications Corp., 306 B'way, N. Y. C.
Barker & Williamson, Upper Darby, Pa.
Coto-Coil Co., Providence, R. I.
D-X Radio Prods. Co., 1575 Milwaukee, Chicago
General Winding Co., 420 W. 45 St., N. Y. C.
Guthman & Co., Edwin, 400 S. Peoria, Chicago
Hammarlund Mfg. Co., 424 W. 33 St., N. Y. C.
Johnson Co., E. F., Waseca, Minn.
Lectrohm, Inc., Cicero, Ill.
★ Meissner Mfg. Co., Mt. Carmel, Ill.
Miller Co., J. W., Los Angeles, Cal.
Muter Co., 1255 S. Michigan, Chicago
★ National Co., Malden, Mass.
Ohmite Mfg. Co., 4835 W. Flournoy St., Chicago
Radex Corp., 1328 Elston Av., Chicago
Sickles Co., F. W., Chicopee, Mass.
Teleradio Eng. Corp., 484 Broome St., N. Y. C.
Triumph Mfg. Co., 4017 W. Lake St., Chicago

CLIPS, Connector

Mueller Electric Co., Cleveland, O.

CLIPS & MOUNTINGS, Fuse

★ Alden Prods. Co., Brockton, Mass.
Dante Elec. Mfg. Co., Bantam, Conn.
Ilsco Copper Tube & Prods., Inc., Station M., Cincinnati
Jefferson Elec. Co., Bellwood, Ill.
Jones, Howard B., 2300 Wabansia, Chicago
Littlefuse, Inc., 4753 Ravenswood, Chicago
Patton MacGuyer Co., Providence, R. I.
Sherman Mfg. Co., H. B., Battle Creek, Mich.
Stewart Stamping Co., 621 E. 216 St., Bronx, N. Y.
Zierick Mfg. Co., 385 Girard Ave., Bronx, N. Y. C.

CLOTH, Insulating

Acme Wire Co., New Haven, Conn.
Brand & Co., Wm., 276-4th Av., N. Y. C.
Endurette Corp. of Amer., Cliffwood, N. J.
Insulation Mfgrs. Corp., 565 W. Wash. Blvd., Chicago
Irvington Varnish & Insulating Co., Irvington, N. J.
Mica Insulator Co., 196 Varick, N. Y. C.

CONDENSERS, Fixed

Aerovox Corp., New Bedford, Mass.
American Condenser Corp., 2508 S. Michigan, Chicago
Art Radio Corp., 115 Liberty, N. Y. C.
Atlas Condenser Prods. Co., 548 Westchester Av., N. Y. C.
Automatic Winding Co., East Newark, N. J.
Bud Radio, Inc., Cleveland, O.
Cardwell Mfg. Corp., Allen D., Brooklyn, N. Y.
Centralab, Milwaukee, Wis.
Condenser Corp. of America, South Plainfield, N. J.
Condenser Prods. Co., 1375 N. Branch, Chicago
Cornell-Dubilier Elec. Corp., S. Plainfield N. J.
Cosmic Radio Co., 699 E. 135th St., N. Y. C.
Crowley & Co., Henry L., W. Orange, N. J.
Deutschmann Corp., Tobe, Canton, Mass.
Dumont Elec. Co., 34 Hubert St., N. Y. C.
Electro-Motive Mfg. Co., Willimantic, Conn.
Erie Resistor Corp., Erie, Pa.
Fast & Co., John E., 3123 N. Crawford, Chicago
General Radio Co., Cambridge, Mass.
Girard-Hopkins, Oakland, Calif.
H. R. S. Prods., 5707 W. Lake St., Chicago
Illinois Cond. Co., 1160 Howe St., Chicago
Industrial Cond. Corp., 1725 W. North Av., Chicago
Insuline Corp. of America, Long Island City, N. Y.
Johnson Co., E. F., Waseca, Minn.
Kellogg Switchb'd & Supply Co., 6650 Cicero, Chicago
Magnavox Co., Fort Wayne, Ind.
Mallory & Co., P. R., Indianapolis, Ind.
Micamold Radio Corp., Brooklyn, N. Y.
Muter Co., 1255 S. Michigan, Chicago
Potter Co., 1950 Sheridan Rd., N. Chicago
RCA Mfg. Co., Camden, N. J.
Sangamo Elec. Co., Springfield, Ill.
Solar Mfg. Corp., Bayonne, N. J.
Sprague Specialties Co., N. Adams, Mass.
Teleradio Engineering Corp., 484 Broome St., N. Y. C.
★ Polymet Condenser Co., 699 E. 139 St., N. Y. C.

CONDENSERS, Gas-filled

Lapp Insulator Co., Inc., Leroy, N. Y.

CONDENSERS, High-Voltage Vacuum

Centralab, Milwaukee, Wis.
★ Eitel-McCullough, Inc., San Bruno, Calif.
Erie Resistor Corp., Erie, Pa.
★ General Electric Co., Schenectady, N. Y.

CONDENSERS, Small Ceramic Tubular

Centralab; Div. of Globe-Union, Inc., Milwaukee, Wis.
Erie Resistor Corp., Erie, Pa.

CONDENSERS, Tubular Ceramic Transmitting

Aerovox Corp., New Bedford, Mass.
Cornell-Dubilier, S. Plainfield, N. J.
RCA Mfg. Co., Inc., Camden, N. J.
Sangamo Electric Co., Springfield, Ill.
Solar Mfg. Corp., Bayonne, N. J.

CONDENSERS, Variable Receiver Tuning

★ Alden Prods. Co., Brockton, Mass.
American Steel Package Co., Defiance, Ohio
Barker & Williamson, Ardmore, Pa.
Bud Radio, Inc., Cleveland, O.
Cardwell Mfg. Corp., Allen D., Brooklyn, N. Y.
General Instrument Corp., Elizabeth, N. J.
Hammarlund Mfg. Co., 424 W. 34th St., N. Y. C.
Insuline Corp. of Amer., L. I. City, N. Y.
★ Meissner Mfg. Co., Mt. Carmel, Ill.
Millen Mfg. Co., Malden, Mass.
★ National Co., Malden, Mass.
Oak Mfg. Co., 1267 Clybowon Ave., Chicago
Radio Condenser Co., Camden, N. J.
Rauland Corp., Chicago, Ill.

CONDENSERS, Variable Transmitter Tuning

Barker & Williamson, Upper Darby, Pa.
Bud Radio, Cleveland, O.
Cardwell Mfg. Corp., Allen D., Brooklyn, N. Y.
Hammarlund Mfg. Co., 424 W. 33 St., N. Y. C.
Insuline Corp. of Amer., L. I. City, N. Y.
Johnson, E. F., Waseca, Minn.
Millen Mfg. Co., James, Malden, Mass.
★ National Co., Malden, Mass.
Radio Condenser Co., Camden, N. J.

CONDENSERS, Variable Trimmer

★ Alden Prods Co., Brockton, Mass.
American Steel Package Co., Defiance, O.
Bud Radio, Inc., Cleveland, O.
Cardwell Mfg. Corp., Allen, Brooklyn, N. Y.
Centralab, Milwaukee, Wis.
Fada Radio & Elec. Corp., Long Island City, N. Y.
General Radio Co., Cambridge, Mass.
Guthman, Inc., E. I., 400 S. Peoria, Chicago
Hammarlund Mfg. Co., 424 W. 33 St., N. Y. C.
Insuline Corp. of America, Long Island City, N. Y.
Johnson Co., E. F., Waseca, Minn.
Mallory & Co., Inc., P. R., Indianapolis, Ind.
★ Meissner Mfg. Co., Mt. Carmel, Ill.
Millen Mfg. Co., James, Malden, Mass.
Miller Co., J. W., Los Angeles, Cal.
Muter Co., 1255 S. Michigan Av., Chicago
★ National Co., Malden, Mass.
Potter Co., 1950 Sheridan Rd., N. Chicago
Sickles Co., F. W., Chicopee, Mass.
Solar Mfg. Corp., Bayonne, N. J.
Teleradio Eng. Corp., 484 Broome, N. Y. C.

CONNECTORS, Cable

Aero Electric Corp., Los Angeles, Calif.
★ Alden Prods., Brockton, Mass.
Amer. Microphone Co., 1915 S. Western Av., Los Angeles
Amer. Phenolic Corp., 1830 S. 54th St., Chicago
American Radio Hardware Co., 476 B'way, N. Y. C.
Andrew, Victor J., 6429 S. Lavergne Av., Chicago
Astatic Corp., Youngstown, O.
Atlas Sound Corp., 1442 39th St., Brooklyn, N. Y.
Birnbach Radio, 145 Hudson St., N. Y. C.
Breeze Mfg. Corp., Newark, N. J.
Brush Development Co., Cleveland, O.
Bud Radio, Cleveland, Ohio
Cannon Elec. Development, 3209 Humboldt, Los Angeles
Eby, Inc., Hugh H., Philadelphia
Electro Voice Mfg. Co., South Bend, Indiana
Franklin Mfg. Corp., 175 Varick St., N. Y. C.
General Radio Co., Cambridge, Mass.
Harwood Co., 747 N. Highland Ave., Los Angeles
Insuline Corp. of Amer., L. I. City, N. Y.
Jones, Howard B., 2300 Wabansia, Chicago
Mallory & Co., P. R., Indianapolis, Ind.
Monowatt Electric Co., Providence, R. I.
★ Radio City Products Co., 127 W. 26 St., N. Y. C.
Selectar Mfg. Co., Long Island City, N. Y.
★ Universal Microphone Co., Ltd., Inglewood, Calif.

CONTACT POINTS

Callite Tungsten Corp., Union City, N. J.
Mallory & Co., Inc., P. R., Indianapolis Ind.

COUPLINGS, flexible

Cardwell Mfg. Corp., Allen D., Brooklyn, N. Y.
Johnson Co., E. F., Waseca, Minn.
Millen Mfg. Co., James, Malden, Mass.
★ National Co., Inc., Malden, Mass.

CRYSTAL GRINDING EQUIPMENT

Felker Mfg. Co., Torrance, Calif.

CRYSTALS, Quartz

Bausch & Lomb Optical Co., Rochester, N. Y.
Bliley Elec. Co., Erie, Penna.
Burnett, Wm. W. L., San Diego, Cal.
Collins Radio Co., Cedar Rapids, Iowa
Crystal Prod. Co., 1519 McGee St., Kansas City, Mo.

Additions This Month

7 NEW LISTINGS

64 NEW MANUFACTURERS' NAMES

This Directory is revised every month, so as to assure engineers and purchasing agents of up-to-date information. We shall be pleased to receive suggestions as to company names which should be added, and hard-to-find items which should be listed in this Directory.


ANOTHER JENSEN WARRIOR!
There is nothing visionary about this product. It is at war
every day helping to make our navy the best navy in the
world. Many other Jensen loud speakers are at war, too;
some of them are standard Jensen prewar products . . .
all of which we believe is interesting commentary on the
eternal quality and reliability of Jensen products whether
in war, prewar or postwar times.
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6601 S. LARAMIE AVENUE, CHICAGO

Crystal Research Labs., Hartford, Conn.
DX Crystal Co., W. Carroll Ave., Chicago
Electronic Research Corp., 800 W. Washington Blvd., Chicago
Federal Engineering Co., 37 Murray St., N. Y. C.
General Electric Co., Schenectady, N. Y.
General Radio Co., Cambridge, Mass.
Harvey-Wells Communications, Southbridge, Mass.
Hipower Crystal Co., 2035 W. Charleston, Chicago
Hunt & Sons, G. C., Carlisle, Pa.
Jefferson, Inc., Ray, Westport, L. I., N. Y.
Kaar Engineering Co., Palo Alto, Cal.
Meck Industries, John, Plymouth, Ind.
Miller, August E., North Bergen, N. J.
Peterson Radio, Council Bluffs, Iowa
Precision Piezo Service, Baton Rouge, La.
Premier Crystal Labs., 63 Park Row, N. Y. C.
Radell Corp., Guilford Ave., Indianapolis, Ind.
RCA Mfg. Co., Camden, N. J.
Scientific Radio Service, Hyattsville, Md.
Standard Piezo Co., Carlisle, Pa.
Valpey Crystals, Holliston, Mass.
Zeiss, Inc., Carl, 485 Fifth Av., N. Y. C.

DIALS, Instrument

Crowe Name Plate Co., 3701 Ravenswood Ave., Chicago
General Radio Co., Cambridge, Mass.
Gits Molding Corp., 4600 Huron St., Chicago
Mica Insulator Co., 198 Varick St., N. Y. C.
★ National Co., Inc., Malden, Mass.
★ Rogan Bros., 2003 S. Michigan Ave., Chicago

DISCS, Recording

Advance Recording Products Co., Long Island City, N. Y.
Allied Recording Products Co., Long Island City, N. Y.
Audio Devices, Inc., 1600 B'way, N. Y. C.
Federal Recorder Co., Elkhart, Ind.
Gould-Moody Co., 395 B'way, N. Y. C.
Presto Recording Corp., 242 W. 55 St., N. Y. C.
RCA Mfg. Co., Camden, N. J.

DYNAMOTORS—

See Motor-Generators

ETCHING, Metal

Crowe Name Plate & Mfg. Co., 3701 Ravenswood Ave., Chicago

FASTENERS, Separable

Camloc Fastener Co., 420 Lexington Ave., N. Y. C.
Shakeproof, Inc., 2501 N. Keeler Ave., Chicago

FELT

American Felt Co., Inc., Glenville, Conn.
Western Felt Works, 4031 Ogden Ave., Chicago

FIBRE, Vulcanized

Brandywine Fibre Prods. Co., Wilmington, Del.
Continental-Diamond Fibre Co., Newark, Del.
Insulation Mfgrs. Corp., 565 W. Wash. Blvd., Chicago
Mica Insulator Co., 196 Varick, N. Y. C.
Nat'l Vulcanized Fibre Co., Wilmington, Del.
Spaulding Fibre Co., Inc., 233 B'way, N. Y. C.
Taylor Fibre Co., Norristown, Pa.
Wilmington Fibre Specialty Co., Wilmington, Del.

FILTERS, Electrical Noise

Avia Products Co., 737 N. Highland Ave., Los Angeles
Mallory & Co., Inc., P. R., Indianapolis, Ind.
Tobe Deutschmann Corp., Canton, Mass.
★ Freed Radio Corp., 200 Hudson St., N. Y. C.

FINISHES, Metal

Alrose Chemical Co., Providence, R. I.
Aluminum Co. of America, Pittsburgh, Pa.
Ault & Wiborg Corp., 75 Varick, N. Y. C.
Hilo Varnish Corp., Brooklyn, N. Y.
Maas & Waldstein Co., Newark, N. J.
New Wrinkle, Inc., Dayton, O.

FREQUENCY METERS

Bendix Radio, Towson, Md.
★ Browning Labs., Inc., Winchester, Mass.
General Radio Co., Cambridge, Mass.
Lavoie Laboratories, Long Branch, N. J.
★ Link, F. M., 125 W. 17 St., N. Y. C.
Measurements Corporation, Boonton, N. J.

FREQUENCY STANDARDS, Primary

General Radio Co., Cambridge, Mass.

FREQUENCY STANDARDS, Quartz Secondary

Garner Co., Fred E., 43 E. Ohio St., Chicago
Hewlett-Packard Co., Palo Alto, Calif.
Millen Mfg. Co., Inc., Malden, Mass.

FUSES, Enclosed

Dante Elec. Mfg. Co., Bantam, Conn.
Jefferson Elec. Co., Bellwood, Ill.
Littlefuse, Inc., 4753 Ravenswood Av., Chicago

GEARS & PINIONS, Metal

Continental-Diamond Fibre Co., Newark, Del.
Gear Specialties, Inc., 2650 W. Medill, Chicago
Perkins Machine & Gear Co., Springfield, Mass.
Thompson Clock Co., H. C., Bristol, Conn.

GEARS & PINIONS, Non-Metallic

Brandywine Fibre Prods. Co., Wilmington, Del.
Formica Insulation Co., Cincinnati, O.
Gear Specialties, Inc., 2650 W. Medill, Chicago
★ General Electric Co., Pittsfield, Mass.
Mica Insulator Co., 196 Varick St., N. Y. C.
National Vulcanized Fibre Co., Wilmington, Del.
Perkins Machine & Gear Co., Springfield, Mass.
Richardson Co., Melrose Park, Ill.
Spaulding Fibre Co., Inc., 233 B'way, N. Y. C.
Synthane Corp., Oaks, Pa.
Taylor Fibre Co., Norristown, Pa.
Wilmington Fibre Specialty Co., Wilmington, Del.

GENERATORS, Gas Engine Driven

Hunter-Hartman Corp., St. Louis, Mo
Kato Engineering Co., Mankato, Minn.
Pioneer Gen-E-Motor, 5841 W. Dickens Ave., Chicago, Ill.

GENERATORS, Hand Driven

Carter Motor Co., 1608 Milwaukee, Chicago

GENERATORS, Standard Signal

Boonton Radio Corp., Boonton, N. J.
Ferris Instrument Co., Boonton, N. J.
General Radio Co., Cambridge, Mass
Hewlett-Packard Co., Palo Alto, Calif.
Measurements Corp., Boonton, N. J.

GENERATORS, Wind-Driven, Aircraft

General Armature Corp., Lock Haven Pa.

HEADPHONES

Brush Development Co., Cleveland, O.
Conn. Tel. & Electric Co., Meriden, Conn.
Carrier Microphone Co., Inglewood, Cal.
Cannon Co., C. F., Springwater, N. Y.
Carron Mfg. Co., 415 S. Aberdeen, Chicago
Chicago Tel. Supply Co., Elkhart, Ind
Connecticut Tel. & Elec. Co., Meriden, Conn.
Elec. Industries Mfg. Co., Red Bank, N. J.
Kellogg Switchboard & Supply Co., 6650 S. Cicero Av., Chicago
Murdock Mfg. Co., Chelsea, Mass.
Telephonics Corp., 350 W. 31 St., N. Y. C.
Trimm Radio Mfg. Co., 1770 W. Berteau, Chicago
★ Universal Microphone Co., Inglewood, Cal.

HORNS, Outdoor

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.

INSTRUMENTS, Radio Laboratory

Ballantine Laboratories, Inc., Boonton, N. J
General Radio Co., Cambridge, Mass.
Hewlett Packard Co., Palo Alto, Calif
Measurements Corporation, 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.

Bright but cool lights now simplify live-talent programming at G-E Television Station WRGB

Studio lighting bright as daylight . . . and cool

An Example of General Electric's Complete Service to Radio and Television Broadcasters

Once television actors had to work under hot studio lights that brought beads of perspiration through make-up, wilted costumes, caused discomfort, hindered good production.

Today at General Electric's proving-ground Television Station WRGB, Schenectady, made-up faces stay cool, costumes don't wilt. Excessive studio air conditioning is no longer necessary. For the handicap of high heat from studio lights is on its way to being completely licked by G-E developed, mercury-filled capillary lamps. They give illumination of daylight intensity with less than half the heat of the noonday sun. Water-cooled, and three to a unit, they have a light efficiency more than double — and heat output one-tenth — that of incandescent lamps. And one control panel aims a dozen of them, noiselessly, independently, anywhere in the studio.

These lamps that give cool studio lighting are another example of the bold research that will enable G-E electronics engineers to build improved cathode-ray scanning and picture tubes, cameras, transmitters, and other equipment for post-war television.

All this so that television may more quickly find its proper place in the peacetime scheme of things as a vital medium of public entertainment and education. . . . *Electronics Department, General Electric, Schenectady, New York.*

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Locke Insulator Co., Baltimore, Md.
Millen Mfg. Co., Malden, Mass.
★ National Co., Inc., Malden, Mass.

IRON CORES, Powdered

Crowley & Co., Henry L., West Orange, N. J
Gibson Elec. Co., Pittsburgh, Pa.
Mallory & Co., P. R., Indianapolis, Ind.
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
Electric Soldering Iron Co., Deep River, Conn.
★ General Electric Co., Schenectady, N. Y.
Hexacon Electric Co., Roselle Park, N. J.
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., Long Island City, 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 Hardware Co., Inc., 476 Broadway, N. Y. C.
Bunnell & Co., J. H., 215 Fulton St., N. Y. C.
Mossman, Inc., Donald P., 6133 N. Northwest Hy., Chicago
Signal Electric Mfg. Co., Menominee, Mich.
Telephonics Corps., 350 W. 31 St N. Y. C.

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.
★ Radio City Products Co., 127 W. 26 St., N. Y. C.
★ Rogan Bros., 2001 S. Michigan, Chicago

LABELS, Removable

Avery Adhesives, 451 3rd St., Los Angeles

LABELS, Stick-to-Metal

Ever Ready Label Corp., E. 25th St., N. Y. C.

LABORATORIES, Electronic

★ Browning Labs., Inc., Winchester, Mass.
Hazeltine Electronics Corp., 1775 B'way, N. Y. C.
Sherron Metallic Corp., Flushing Ave., Brooklyn, N. Y.

LUGS, Soldering

Burndy Engineering Co., 459 E. 133rd St., N. Y. C.
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 Av., Providence, R. I.
Sherman Mfg. Co., Battle Creek, Mich.
Thomas & Betts Co., Elizabeth, N. J.
Zierick Mfg. Co., 385 Girard Ave., Bronx, N. Y. C.

LUGS, Solderless

Aircraft Marine Prod., Inc., Elizabeth, N. J.
Burndy Eng. Co., 107 Eastern Blvd., N. Y. C.

MACHINES, Impregnating

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

MACHINES, Numbering

Altair Machinery Corp., 55 VanDam, N. Y. C.
Numberall Stamp & Tool Co., Huguenot Park, Staten Island, N. Y.

MACHINES, Riveting

Chicago Rivet & Machine Co., Bellwood, Illinois
★ Wiedeman Machine Co., Phila., Pa.

MACHINES, Screwdriving

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

MAGNETS, Permanent

★ General Elec. Co., Schenectady, N. Y.
Thomas & Skinner Steel Prod. Co., Indianapolis, Ind.

MAIL ORDER SUPPLY HOUSES

Allied Radio Corp., 833 W. Jackson Blvd., Chicago
★ Burstien-Applebee Co., Kansas City, Mo.
Harrison Radio Corp., 12 W. B'way, N. Y. C.
★ Sun Radio Co., 212 Fulton St., N. Y. C.

MARKERS, Wire Identification

Brand & Co., Wm., 276 4th Ave., N. Y. C.
Ntl. Varnished Prod. Corp., Woodbridge, N. J.

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.
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, 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., Philadelphia
Triplett Elec. Inst. Co., Bluffton, O.

MICA

Brand & Co., Wm., 276 Fourth Av., N. Y. C.
Insulation Mfgrs. Corp., 565 W. Wash. Blvd., Chicago
Macallen Co., Boston, Mass
Mica Insulator Corp., 196 Varick, 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.
Carrier Microphone Co., Inglewood, Cal.
Elect. Industries Mfg. Co., Red Bank, N. J.
★ Electro Voice Mfg. Co., South Bend, Ind.
Kellogg Switchboard & Supply Co., 6650 S. Cicero, Chicago
Radio Speakers, Inc., 221 E. Cullerton, Chicago
Philmore Mfg. Co., 113 University Pl., N. Y. C.
Permoflux Corp., 4916 W. Grand Av., 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.

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Men and Women

The COLONIAL RADIO CORPORATION needs immediately, for WAR RADIO WORK, the following technically trained personnel:

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CALIBRATION TECHNICIANS

MECHANICAL ENGINEERS

TOOL DESIGNERS

ELECTRO-MECHANICAL ENGINEERS

MECHANICAL DRAFTSMEN

ENGINEERING SPECIFICATION WRITERS

FIELD ENGINEERS—RADIO

FIELD INSPECTORS—RADIO

MODEL MAKERS

TECHNICAL ASSISTANTS—RADIO

These are **NOT** temporary positions. Satisfactory employees may expect **PERMANENT** employment. Qualified applicants, NOT NOW IN WAR WORK, should write, giving full history of education, experience, and salary desired

COLONIAL
RADIO CORPORATION
254 RANO ST.
Buffalo, N.Y.

COLONIAL

MOTOR-GENERATORS, Dynamotors, Rotary Converters

Alliance Mfg. Co., Alliance, O.
Air-Way Mfg. Co., Toledo, O.
Bendix, Red Bank, N. J.
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.
Elcor, Inc., 1060 W. Adams, Chicago
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.
Webster Co., Chicago, Ill.
Westinghouse Elect. Mfg. Co., Lima, O.
Wincharger Corp., Sioux City, Iowa

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

★ General Electric Co., Schenectady, N. Y.
Mycalex Corp. of Amer., Clifton, N. J.

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.

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.
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)

PILOT LIGHTS

★ Alden Prods. Co., Brockton, Mass.
Amer. Radio Hardware Co., Inc., 467 B'way, N. Y. C.
Dial Light Co. of America, 90 West, N. Y. C.
Drake Mfg. Co., 1713 W. Hubbard, Chicago
General Control Co., Cambridge, Mass.
★ General Elec. Co., Lamp Dept., Nela Specialty Div., Hoboken, N. J.
Gothard Mfg. Co., Springfield, Ill.
Herzog Miniature Lamp Works, 12-19 Jackson Av., Long Island City, N. Y.
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 Fourth Ave., N. Y. C.
Extruded Plastics, Inc., Norwalk, Conn.
Irvington Varnish & Insulator Co., Irvington, N. J.

PLASTIC, Sheet for Name Plates

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

PLASTICS, Injection Molded

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.
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.
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.
Gits 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.
Macallen 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.
Richardson Co., Melrose Park, Ill.
★ Rogan Bros., 2000 S. Michigan Ave., Chicago
Rohm & Haas 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, Transparent

Celanese Celluloid Corp., 180 Madison Ave., N. Y. C.
du Pont de Nemours & Co., E. I., Arlington, N. J.
Plax Corp., Hartford, Conn.
★ Printloid Corp., 93 Mercer St., N. Y. C.
Rohm & Haas Co., Washington Sq., Philadelphia

PLATING, Metal on Molded Parts

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

PLUGS (Banana), Spring Type

Birnbach Radio Co., 145 Hudson St., N. Y. C.
Eastman Kodak Co., Rochester, N. Y.

PLUGS & JACKS, Spring Type

Eby, Inc., Hugh H., Philadelphia, Pa.
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., 1627 W. Walnut, Chicago
Insuline Corp. of Amer., Long Island City, N. Y.
Johnson Co., E. F., Waseca, Minn.
Jones, Howard B., 2300 Wabansia Av., Chicago
Mallory & Co., Inc., P. R., Indianapolis, Ind.
Remler Co., Ltd., Bryant St., San Francisco
★ Universal Microphone Co., Ltd., Inglewood, Calif.
Utah Radio Prod., Orleans St., Chicago.

PLYWOOD, Metal Faced

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

PRESSES, Stamping

Stokes Machine Co., F. J., Philadelphia
Watson-Stillman Corp., The, Roselle Park, N. J.
★ Wiedeman Machine Co., Phila., Pa.

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.
International Tel. & Radio Mfg. Corp., E. Newark, N. J.
Mallory & Co., P. R., Indianapolis, Ind.
Nothelfer Winding Labs., Trenton, N. J.
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.
Spencer Thermostat Co., Attleboro, Mass.

REGULATORS, Voltage

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

RELAYS, Small Switching

Allied Control Co., Inc., 223 Fulton St., N. Y. C.
Amperite Co., 561 Broadway, N. Y. C.
G-M Laboratories, Inc., 4313 N. Knox Ave., Chicago
Guardian Electric, W. Walnut St., 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

Amer. Automatic Elect. Sales Co., 1033 W. Van Buren St., Chicago
Clare & Co., C. P., 4719 W. Sunnyside Ave., Chicago
Guardian Electric Co., 1625 W. Walnut St., Chicago
Wick Organ Co., Highland, Ill.

RELAYS, Time Delay

Amperite Co., 561 Broadway, N. Y. C.
Haydon Mfg. Co., Inc., Forestville, Conn.
Industrial Timer Corp., Newark, N. J.
Sangamo Elec. Co., Springfield, Ill.

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., Brooklyn, 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.
Shallcross Mfg. Co., Collingdale, Pa.
Speer Resistor Corp., St. Marys, Pa.
Sprague Specialties Co., N. Adams, Mass.
Stackpole Carbon Co., St. Marys, Pa.
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

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

RESISTORS, Flexible

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

RESISTORS, Variable

★ Aerovox Corp., New Bedford, Mass.
Allen-Bradley Co., Milwaukee, Wis.
Amer. Instrument Co., Silver Spring, Md.
Atlas Resistor Co., N. Y. C.
Biddle Co., James G., Arch St., Phila., Pa.
Centralab, Milwaukee, Wis.
Chicago Tel. Supply Co., Elkhart, Ind.
Cinema Eng. Co., Burbank, Cal.
Clarostat Mfg. Co., Brooklyn, 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.
Hardwick, Hindle, Inc., Newark, N. J.
Instrument Resistors, Inc., Little Falls, N. J.
Intern'l Resistance Co., Philadelphia
Lectrohm, Inc., 5125 W. 25 St., Cicero, Ill.
Mallory & Co., P. R., Indianapolis, Ind.
Ohio Carbon Co., Cleveland, Ohio
Ohmite Mfg. Co., 4835 W. Flournoy St., Chicago
Shallcross 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

Hardwick, Hindle, Inc., Newark, N. J.
Lectrohm, Inc., 5125 W. 25 St., Cicero, Ill.
Ohmite Mfg. Co., 4835 Flournoy St., Chicago

RIVETS, Plain

Central Screw Co., 3519 Shields Av., Chicago
Progressive Mfg. Co., Torrington, Conn.
Republic Steel Corp., Cleveland, O.

SCREW MACHINE PARTS, Brass, Steel

Ward Products Corp., E. 45 St., Cleveland, O.

SCREW MACHINE PARTS, Non-Metallic

Continental-Diamond Fibre Co., Newark, Del.

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

SELECT *for*

SERVICE

NEW HYTRON TUBES

Type	Description†	Price
836	Half-wave, high-vacuum rectifier	$11.50
837	12-watt, r.f. pentode	7.50
954	Sharp cut-off, acorn pentode	5.00
955	Acorn triode	3.00
956	Remote cut-off, acorn pentode	5.00
1616	Half-wave, high-vacuum rectifier‡	5.75
1625	25-watt, r.f. tetrode (12-v. heater)	3.50
1626	5-watt, triode oscillator	2.50
E1148	3.5-watt, u-h-f triode	2.25
VR105-30	Gaseous voltage regulator	1.25
VR150-30	Gaseous voltage regulator	1.25

OTHER POPULAR HYTRON TUBES*

Type	Description†	Price
2C25	15-watt, medium-mu triode	$3.80
2C45	7.5-watt, triode (modulator)†	2.50
10Y	15-watt, general-purpose triode‡	1.50
801A/801	20-watt, general-purpose triode‡	2.50
HY61/807	25-watt, r.f. beam tetrode	3.50
841	15-watt, high-mu triode‡	2.25
864	Non-microphonic voltage-amp. triode	1.00
HY24	2-watt, power triode‡	1.50
HY31Z	30-watt, high-mu twin triode‡	3.50
HY65	15-watt, r.f. beam tetrode‡	3.00
HY69	40-watt, r.f. beam tetrode‡	3.95
HY75	15-watt, u-h-f triode‡	3.95
HY1148	(2C24) 1.8-watt, u-h-f triode‡	2.25
HY615	3.5-watt, u-h-f triode	2.25

*This is not a complete list. Wattage ratings indicate maximum plate dissipation.
‡Instant-heating filament.
†For complete characteristics consult Government specifications.

On this list of tubes which have recently joined the growing legions of Hytron types already marching on to Victory, you may find just the ones you want for your War equipments. Whether you choose the tiny "acorns" or the husky 1616 rectifier, you will discover the same high quality and design refinements which have made other Hytron tubes famous. If you place your orders well in advance, you will also be pleased by Hytron's on-schedule deliveries. Not too infrequently, deliveries are made from stock.

HYTRON CORPORATION

SALEM AND NEWBURYPORT • MASS.

Since 1921 Manufacturers of Radio Tubes

HYTRON RADIO TUBES

SHEETS, Electrical

American Rolling Mill Co., Middletown, O.
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

SHIELDS, Tube

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

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 Hardware Co., 476 B'way, N. Y. C.
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.

SOLDER, Self-fluxing

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

SOLDER POTS

Lectrohm, Inc., Cicero, Ill.

SPEAKERS, Cabinet Mounting

Cinaudagraph Speakers, Inc., 3911 S. Michigan Ave., Chicago
★ Jensen Radio Mfg. Co., 6601 S. Laramie St., Chicago
Magnavox Co., Fort Wayne, Ind.
Utah Radio Prod. Co., 842 Orleans St., Chicago

SPEAKERS, Outdoor Type

★ 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
★ American Spring & Mfg. Corp., Holly, Mich.
American Steel & Wire Co., Rockefeller Bldg., Cleveland, O.
Barnes Co., Wallace, Bristol, Conn.
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.
Standard Spring & Mfg. Co., Ind., 236 42 St., Brooklyn, N. Y.

STAMPINGS, Metal

Bud Radio, Inc., E. 55 St., Cleveland, O.
★ Goat Metal Stampings, Inc., 314 Dean St., Brooklyn, N. Y.
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.

SUPPRESSORS, Parasitic

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

SWITCHES, Aircraft Push

Square D Co., Kollsman Inst. Div., Elmhurst, N. Y.

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, Micro

Micro Switch Corp., Freeport, Ill.

SWITCHES, Rotary Gang, Bakelite Wafer

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

SWITCHES, Rotary Gang, Ceramic Wafer

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, Conn.
Industrial Timer Corp., 115 Edison Pl., Newark, N. J.
Sangamo Elect. Company, Springfield, Ill.

TERMINAL STRIPS

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, Howard B., 2300 Wabansia Ave., Chicago

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
Kold-Hold Mfg. Co., 446 N. Grand Ave., Lansing, Mich.
Mobile Refrigeration, Inc., 630 5th Ave., N. Y. C.
Tenney Engineering, Inc., Montclair, N. J.

TRACING PAPERS

Keuffel & Esser, Hoboken, N. J.

TRANSFORMERS, Constant-Voltage Power

Dongan Elec. Co., 74 Trinity Pl., N. Y. C.
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.
Caron Mfg. Co., 415 S. Aberdeen, Chicago
D-X Radio Prods. Co., 1575 Milwaukee, Chicago
Gen'l Winding Co., 420 W. 45 St., N. Y. C.
Greyhound Equip. Co., 1720 Church Ave., Brooklyn, N. Y.
Guthman & Co., 400 S. Peoria St., 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., Los Angeles, Cal.
★ Nat'l Co., Malden, Mass.
Sickles Co., F. W., Springfield, Mass.
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.
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
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

WHAT'S NEW THIS MONTH

(CONTINUED FROM PAGE 4)

(Alpine, Meriden, Paxton, Mt. Washington, and Schenectady.)

"Despite the fact that in all but one instance reception and retransmission are accomplished by going down to audio on the incoming signal and remodulating a transmitter on the outgoing signal, the quality on the far end of the link is superior to wire-line transmission.

"At the Meriden station, however, there has been in use for several years a frequency conversion system which changes the incoming frequency of Alpine to the transmission frequency of W65H. . . .

"With sufficient wavelengths available, so as to accommodate every community capable of supporting a station, the way is opened for mass production of moderately powered broadcasting transmitters on a scale that has never been dreamed of. This is bound to result in substantial reductions of initial costs. The ever increasing reliability of operation of the FM type of transmitter means an ever decreasing cost of maintenance and operation. Transmitters in the lower power class, remotely controlled from the studio, are engineering possibilities.

"In respect to tube cost, it may be a matter of more than passing interest to note that the latest design power amplifier tubes at the Alpine transmitter gave a life of 8,500 and 8,600 hours. . . .

"With the standards now set by the FCC, with most of the receiver manufacturers now thoroughly experienced in FM set design, and with the new mass-production techniques now being learned, it will be the story of the Superheterodyne all over again — a receiver suitable for every purse.

"An enormous replacement demand is being built up daily, both by general obsolescence and the breakdown of sets. It is certain that most of these sets will be replaced by FM-AM combinations. With the increase in the number of FM receivers, it follows automatically that it will no longer be possible to withhold the popular programs from FM stations. The listeners will determine that. . . .

"The industry will unquestionably accept as self-evident these things which have been here set down. Were I to make any predictions, however (and they would be made entirely on the basis of work carried out before the War), it would be that the ease with which relaying can be accomplished and the excellence of performance will be the next surprise."

Finally, Major Armstrong, whose faculty for being right has disconcerted many scientists whose conclusions are apt to be theoretical rather than practical, expressed the belief that the conclusion is inescapable that "within five post-War years the existing broadcast system will be largely superseded."

Halldorson Co., 4500 Ravenswood, Chicago
Jefferson Elec. Co., Bellwood, Ill.
Kenyon Transformer Co., 840 Barry St., N. Y. C.
Magnetic Windings Co., Easton, Pa.
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.
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.

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.
Nat'l Union Radio Corp., Newark, N. J.
RCA Mfg. Co., Camden, N. J.
★ Sylvania Elect. Prod., Inc., Emporium, 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 Electric Co., 195 Broadway, N. Y. C.

TUBES, Photo-Electric

Bradley Labs., New Haven, Conn.
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 & Northrup Co., Philadelphia
Nat'l Union Radio Corp., Newark, N. J.
Photobell Corp., 123 Liberty St., N. Y. C.
RCA Mfg. Co., Camden, N. J.
Rehtron Corp., 2159 Magnolia Av., Chicago
Westinghouse Lamp Div., Bloomfield, N. J.
Western Electric Co., 195 Broadway, N. Y. C.
Weston Elec. Inst. Corp., Newark, N. J.

TUBES, Receiving

★ General Electric 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.

TUBES, Transmitting

Amperex Electronic Prods., Brooklyn, N. Y.
★ Eitel-McCullough, Inc., San Bruno, Cal.
Electronic Enterprises, Inc., 65 Sixth Ave., N. Y. C.
Federal Telegraph Co., Newark, N. J.
★ General Elec. Co., Schenectady, N. Y.
Heintz & Kaufman, S. San Francisco, Cal.
Hytron Corp., Salem, Mass.
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.
Taylor Tubes, Inc., 2341 Wabansia, Chicago
United Electronics Co., Newark, N. J.
Western Electric Co., 195 Broadway, 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 & SLEEVING, Varnished Cambric, Glass-Fibre, Spaghetti

Bentley-Harris Mfg. Co., Conshohocken, Pa.
Band & Co., Wm., 276 Fourth Av., N. Y. C.
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 Insulator Co., 196 Varick St., N. Y. C.

VARNISHES, Insulating, Air-Drying

John C. Dolph Co., Newark, N. J.
Irvington Var. & Ins. Co., Irvington, N. J.
Stille-Young Corp., 2300 N. Ashland Ave., Chicago
Zophar Mills, Inc., 112–26 St., Bklyn., N. Y.

VARNISHES, Insulating, Baking

John C. Dolph Co., Newark, N. J.
Irvington Var. & Ins. Co., Irvington, N. J.
Stille-Young Corp., 2300 N. Ashland Ave., Chicago
Zophar Mills, Inc., 112–26 St., Bklyn., N. Y.

VIBRATION TEST EQUIPMENT

Vibration Specialty Co., 1536 Winter St., Philadelphia

VIBRATORS, Power Supply

Amer. Telev. & Radio Co., St. Paul, Minn.
Electronic Labs., Indianapolis, Ind.
Mallory & Co., Inc., P. R., Indianapolis, Ind.
Turner Co., Cedar Rapids, Ia.

VOLTMETERS, Vacuum Tube

Ballantine Laboratories, Inc., Boonton, N. J.
General Radio Co., Cambridge, Mass.
Hewlett Packard Co., Palo Alto, Calif.
Measurements Corp., Boonton, N. J.

WAXES & COMPOUNDS, Insulating

Western Elec. Co., 195 Broadway, N. Y. C.
Zophar Mills, Inc., 112-26 St., Bklyn., N. Y.

WIRE, Bare

American Steel & Wire Co., Cleveland, O.
Anaconda Wire & Cable Co., 25 Broadway, 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., Philadelphia
Rea Magnet Wire Co., Fort Wayne, Ind.
Roebling's Sons Co., John, Trenton, N. J.

WIRE, Hookup

Gavitt Mfg. Co., Brookfield, Mass.
Lenz Electrical Mfg. Co., 1751 N. Western Ave., Chicago
Rockbestos Prod. Corp., New Haven, Conn.

WIRE, Magnet

Acme Wire Co., New Haven, Conn.
American Steel & Wire Co., Cleveland, O.
Anaconda Wire & Cable Co., 25 Broadway, N. Y. C.
Ansonia Elec. Co., Ansonia, Conn.
Belden Mfg. Co., 4633 W. Van Buren, Chicago
Collyer Ins. Wire Co., Pawtucket, R. I.
Crescent Ins. Wire & Cable Co., Trenton, N. J.
Electric Auto-Lite Co., The, Port Huron, Mich.
General Cable Corp., Rome, N. Y.
★ General Elec. Co., Bridgeport, Conn.
Holyoke Wire & Cable Corp., Holyoke, Mass.
Hudson Wire Co., Winsted, Conn.
Rea Magnet Wire Co., Fort Wayne, Indiana
Rockbestos Prods. Corp., New Haven, Conn.
Roebling's Sons Co., John, Trenton, N. J.
Wheeler Insulated Wire Co., Bridgeport, Conn.

VIRE, Rubber Covered

Crescent Ins. Wire & Cable Co., Trenton, N. J.
General Cable Corp., Rome, N. Y.
Hazard Ins. Wire Works, Wilkes-Barre, Pa.
Simplex Wire & Cable Co., Cambridge, Mass.

WOOD, Laminated & Impregnated

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

USE OF ELECTROLYTIC CONDENSERS

(CONTINUED FROM PAGE 11)

ing the program of development which American manufacturers are maintaining.

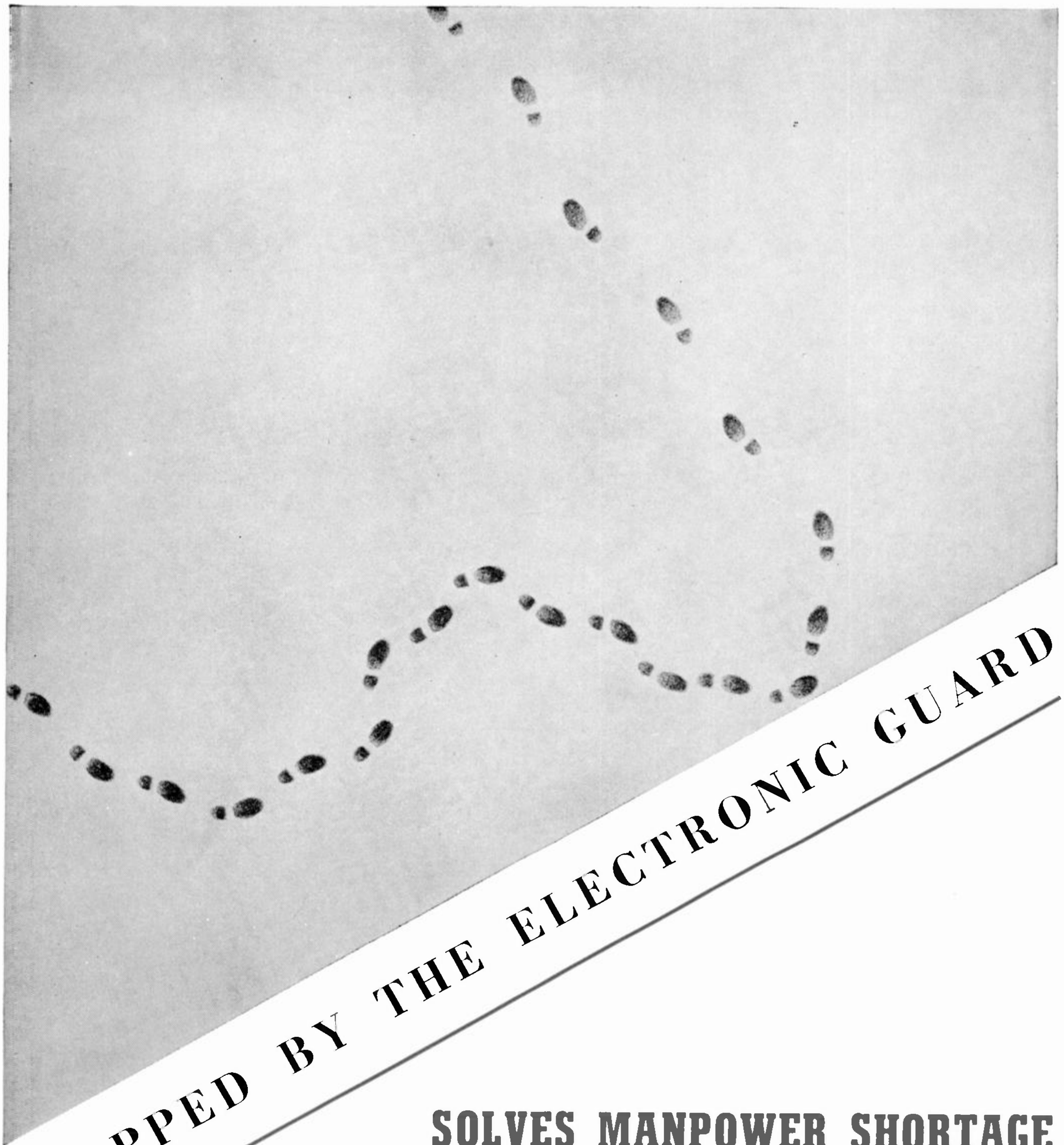
This was the thought behind the remark in the article under discussion: ". . . this might well have the effect of closing the door against the exercise of engineering ingenuity and originality at a time when it is not desirable to freeze the design of radio-electronic equipment, or to put up any bars to improvement."

The Navy leaves the way open to the use of dry electrolytic condensers by specifying that they shall be used only upon approval by the Bureau of Ships for each specific application. The Navy further provides that if they are used they shall have sufficient excess capacity, that they shall be so constructed as to provide satisfactory performance at −32° C., and shall be mounted so as to be readily accessible.

Signal Corps requirements restrict the use of dry electrolytic condensers to DC operating voltages not to exceed 32 volts, and require that they perform their circuit functions at −40° C.

Both Services have modified specifications from time to time in step with developments and improvement in the design of components and the techniques employed in their manufacture, and this policy will, undoubtedly, be continued in the future.

M. B. Sleeper, *Editor*



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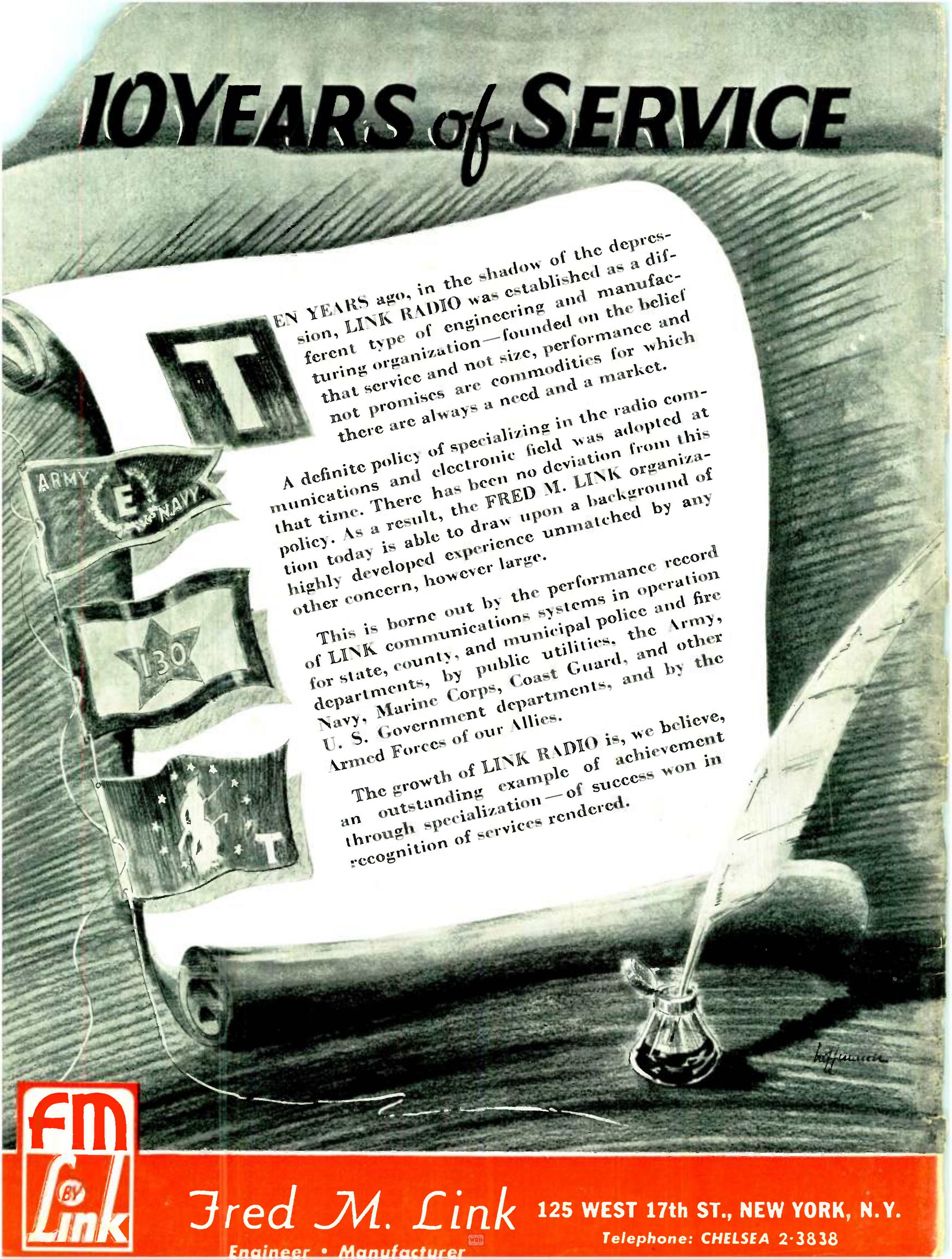
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