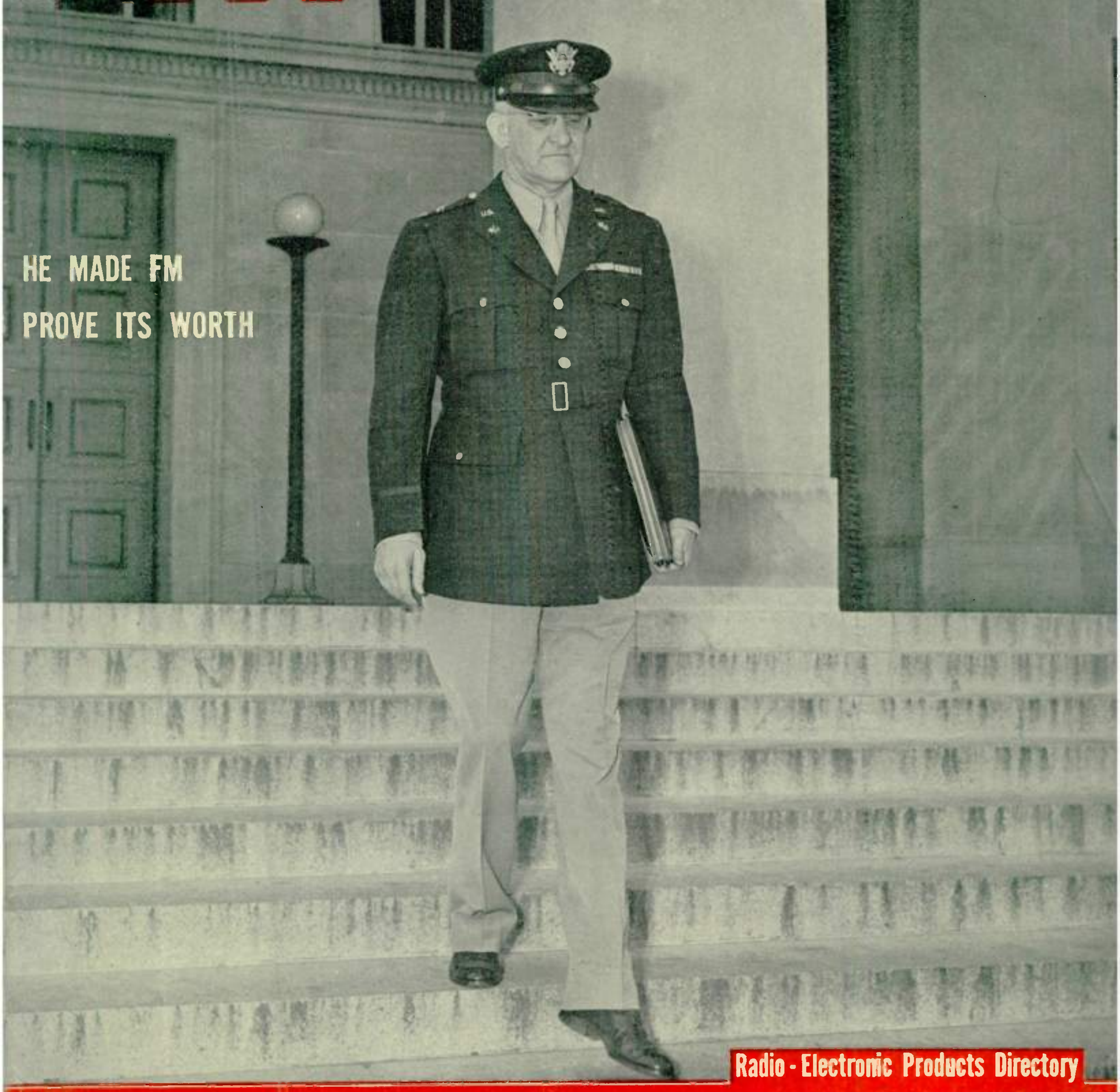
PRICE—TWE

FM RADIO-ELECTRONICS

NOV.—DEC. 1943



HE MADE FM PROVE ITS WORTH

Radio-Electronic Products Directory

ENGINEERING • MANUFACTURING • OPERATION

★ ★ *Edited by M. B. Sleeper* ★ ★

LOOKING FOR TROUBLE

You wouldn't find it much fun, sitting on a hill looking for Japs. That's what this soldier is doing, on a battlefield somewhere in the South Pacific. Every tree, every bush, every slightest movement must be scrutinized carefully. Everything may look peaceful enough, but there's plenty of trouble out there. And the big idea is to track it down, before it finds you.

This young lady, too, is on the lookout for trouble. With a microscope she is examining pivots to be used in Simpson electrical instruments and testing equipment.

From start to finish these pivots have been processed entirely right in the Simpson plant. Rounded on ends in true spherical form . . . specially heat-treated to make them hard for long wear, tough to withstand shocks and vibration . . . ground and lapped to a mirror finish to prevent rusting.

To the naked eye each one is a model of delicate precision. But Simpson doesn't stop there. It is this young lady's job to search out any microscopic flaw that might affect an instrument's accuracy.

The same meticulous care attends every step of manufacture. Why? Because Simpson instruments are going forth to posts of vital importance, on the home front and the fighting fronts alike. Because it is our job not only to make *all* we can, but to make them the *best* we can.

SIMPSON ELECTRIC COMPANY
5200-5218 Kinzie St., Chicago 44, Illinois

Simpson

INSTRUMENTS THAT STAY ACCURATE

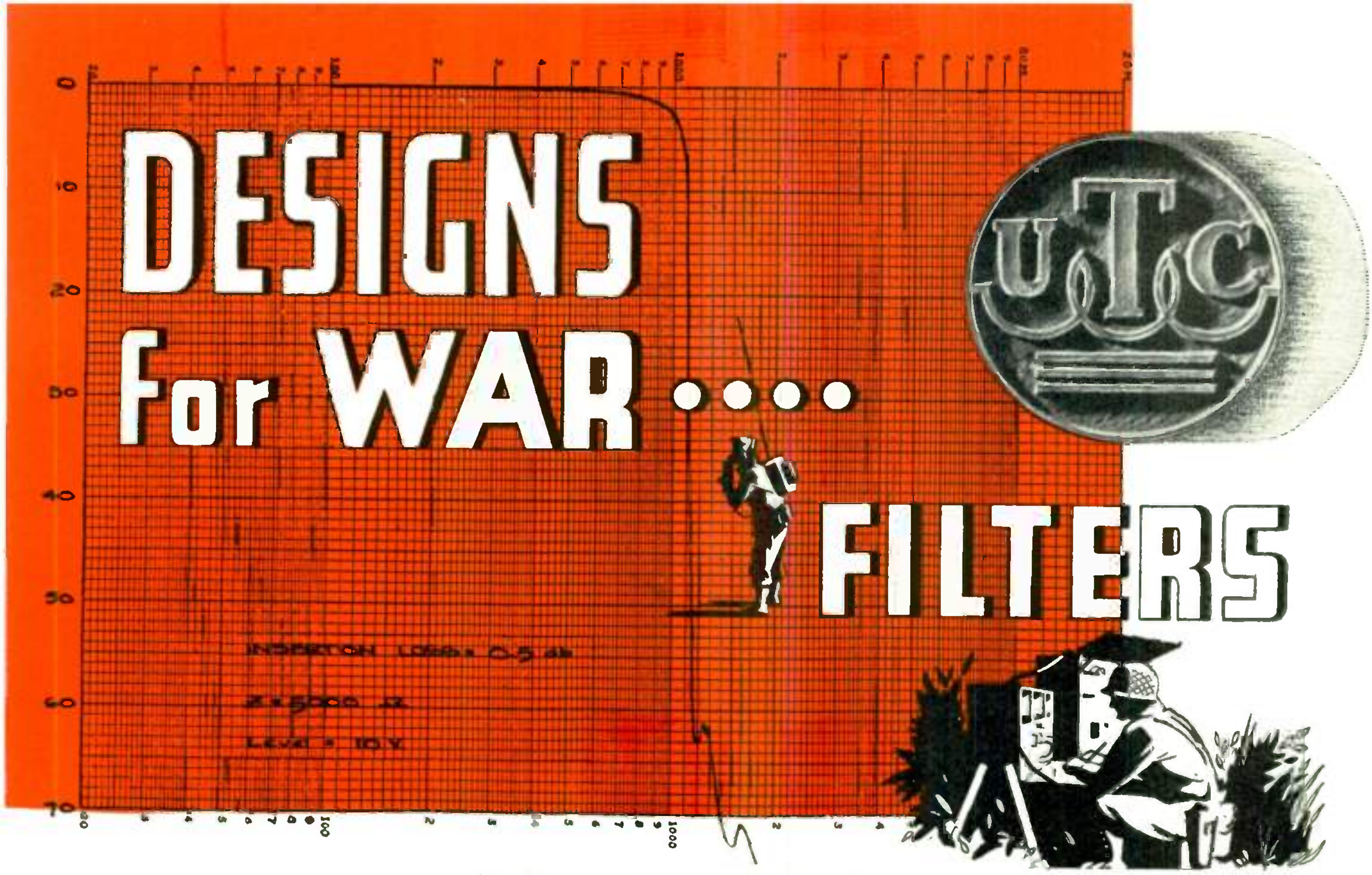
Buy War Bonds and Stamps for Victory

The men and women of National Company take great pride in the reception of the Army-Navy "E" Award for excellence in production. To us it brings a special satisfaction, for twenty-five years ago we received a similar award for service to the Nation in World War I. Old timers have set the pace in winning both awards, but new hands have joined with old skills in putting our difficult job across. It is our pride and our pledge that we of National Company shall keep our record of service bright.

NATIONAL COMPANY, INC.

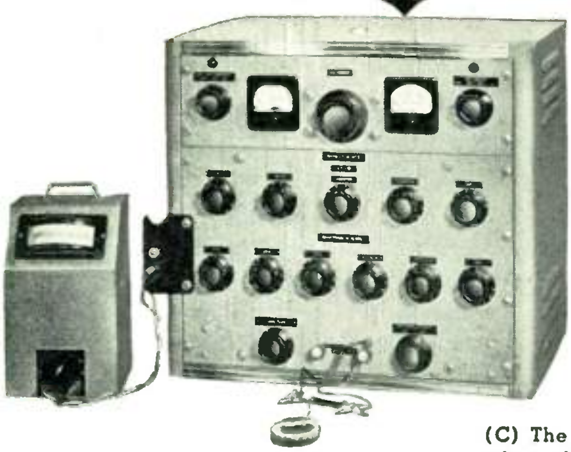
MALDEN, MASS., U. S. A.

DESIGNS For WAR .... FILTERS



(A) Filter performance is dependent upon three major factors, basic design . . . Q of coil and capacitor elements . . . and precision of adjustment. The superiority of UTC products in this field has been effected through many years of research and development on core materials and measuring apparatus. We illustrate below a typical filter formula and some of the UTC apparatus used to determine quantitative and qualitative values:

$$\frac{(LC\pi^2 f_\infty - 1)\left(\frac{1}{Q} + 1 - \left(\frac{f_\infty}{f}\right)^2\right)}{\frac{1}{Q^2} + \left(1 - \left(\frac{f_\infty}{f}\right)^2\right)^2} = U_m \text{ (ATTENUATION CONSTANT)}$$



(B) The UTC inductance bridge is capable of four digit accuracy and covers a range from extremely low values to over 100 Hys. The effective resistance and inductance values are direct reading, eliminating the possibility of error in conversion.

(C) The UTC oscillator is direct reading, where the frequency desired is set as in a four digit decade box, and is accurate within 1 cycle at 1,000 cycles. The range is 10 cycles to 100 kc. Accuracy of this type is essential with filters having sharp attenuation characteristics. This instrument is augmented by a UTC harmonic analyzer for the output measuring device.

(D) The UTC Q meter is a unique device which has helped considerably in the development of the special core materials used in our filters. It is also of importance in maintaining uniform quality in our production coils. The Q is read directly and covers the entire range of possible Q factors over the entire audio frequency band.

UNITED TRANSFORMER CO.

150 VARICK STREET • NEW YORK 13, N. Y.

EXPORT DIVISION: 13 EAST 40th STREET, NEW YORK 16, N. Y., CABLES: "ARLAB"

FM RADIO-ELECTRONICS

FORMERLY: FM RADIO-ELECTRONIC ENGINEERING & DESIGN
COMBINED WITH: APPLIED ELECTRONIC ENGINEERING

VOL. 3 NOVEMBER–DECEMBER, 1943 NO. 12

CONTENTS

★ ★ ★ ★ ★ ★

MILTON B. SLEEPER, *Editor and Publisher*
WILLIAM T. MOHRMAN, *Advertising Manager*
GORDON CROTHERS, *Circulation Manager*
Published by: FM COMPANY
Editorial and Advertising Office: 240 Madison Avenue, New York City, Tel. LE 2-8070
Chicago Advertising Representative:
MARIAN FLEISCHMAN, 360 N. Michigan Ave., Tel. STAte 4439

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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. Payments for contributions are made upon acceptance of final manuscripts.

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

THIS MONTH'S COVER

Major General Roger B. Colton is a graduate of Yale, and has an MS. degree from M.I.T. He was commissioned as a second lieutenant in 1910.

The first tests of FM for Signal Corps communications were made under his supervision while he was Director of the Ft. Monmouth Laboratories. He was eminently qualified for this task, both by engineering training and Army experience. The performance of FM under battle conditions on all fronts has confirmed the soundness of his decision to adopt Major Armstrong's system for tank communications. Its success in this service has led to its adoption by the Signal Corps for many other purposes.

IN CONFORMITY WITH WPB REGULATIONS FOR THE CONSERVATION OF PAPER, THE NOVEMBER AND DECEMBER ISSUES HAVE BEEN COMBINED. HOWEVER, ALL SUBSCRIPTIONS WILL BE EXTENDED ONE MONTH

WHAT'S NEW THIS MONTH

1. Civilian Set Production
2. Radio's Postwar Competition
3. Disassociating FM from Television

1. Word is getting around among radio dealers that civilian radio receivers will be put into production in substantial quantities soon, perhaps early in 1944.

Where this information originated, these dealers don't know, but they speak of it with a feeling of reasonable certainty. Pressed for details, they do not connect the news with any word from WPB. Rather, they seem to think that the manufacturers have an understanding of things to come which have not been made public yet.

What are the facts in this matter? Is there any likelihood that civilian sets will be produced in the near future? Or is this just an idle rumor without foundation in fact?

Anyone in a position to know what is going on in military radio manufacture can answer these questions very quickly. The answer would be: "No. There is not the slightest prospect of building civilian radios."

For the benefit of those who do not have the day-by-day understanding of what goes on, here are facts which explain why civilian sets cannot be built:

First of all, every radio manufacturer in the Country is building equipment for the Armed Forces. Consequently, if a company had parts on hand from prewar times, and began to assemble civilian radios, the Signal Corps or Navy Inspectors in the plant would report the activity, and the work would be stopped before it ever started.

In order to build sets legally, the WPB would have to allot materials. This the WPB would probably be pleased to do if the materials were available. But they aren't. Neither is there manpower to do the assembling and wiring or to produce either molded or wood cabinets.

Greatest shortage of all is in tube production. Dealers can figure out for themselves that at a time when they can't get replacement tubes for servicing sets now in use, there's no chance of getting tubes to put in newly manufactured receivers. And the shortage of tubes for civilian use will be much worse before there are any signs of relief.

(CONTINUED ON PAGE 52)

ADVERTISERS INDEX

Freed-Eisemann

...a name famous in peace-time for one of the world's great radio-phonographs

...a name famous in wartime for unsurpassed engineering skill and precision in the production of military communications equipment

Ever since radio became an amazing reality to the world, the Freed-Eisemann name has been identified with outstanding radio achievement. The first crystal sets were made by Freed-Eisemann, as were the first neutrodyne sets, and sets with self-contained speakers. Then, with the invention of Armstrong Frequency Modulation, Freed-Eisemann became the first to produce FM radio-phonographs *exclusively*.

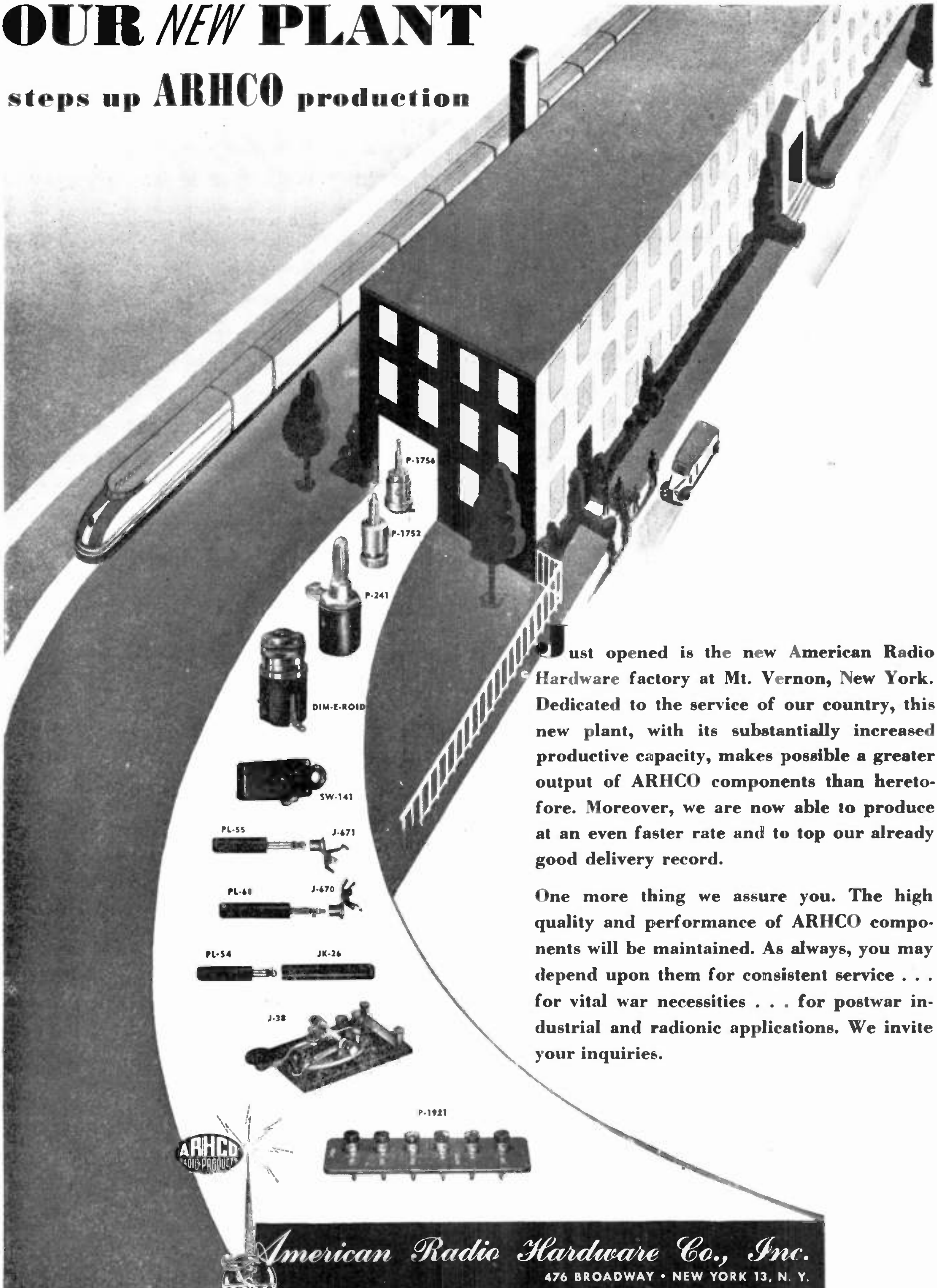
Famous for magnificent musical tone and cabinet design, these superb instruments rank with the world's *great* radio-phonographs. They represent Freed-Eisemann engineering genius at its peacetime best, and help to explain why Freed-Eisemann *wartime* production involves assignments calling for the highest degree of engineering skill and precision—in the manufacture of communications equipment and highly complex electronic devices for America's armed forces.

In war and in peace, the Freed-Eisemann watchword is *quality*.

FREED RADIO CORPORATION · 200 HUDSON STREET · NEW YORK, N. Y.

OUR *NEW* PLANT

steps up ARHCO production



Just opened is the new American Radio Hardware factory at Mt. Vernon, New York. Dedicated to the service of our country, this new plant, with its substantially increased productive capacity, makes possible a greater output of ARHCO components than heretofore. Moreover, we are now able to produce at an even faster rate and to top our already good delivery record.

One more thing we assure you. The high quality and performance of ARHCO components will be maintained. As always, you may depend upon them for consistent service . . . for vital war necessities . . . for postwar industrial and radionic applications. We invite your inquiries.

American Radio Hardware Co., Inc.

476 BROADWAY • NEW YORK 13, N. Y.

MANUFACTURERS OF SHORT WAVE - TELEVISION • RADIO • SOUND EQUIPMENT

"It pays to have rigid specifications — eh boys?"...

HYTRON TOLERANCES ARE TIGHTER THAN CUSTOMER TOLERANCES . . . . .

When measuring aesthetic curves, or when conducting electrical and mechanical tests on vacuum tubes, the more stringent the adherence to accepted standards, the more desirable the resulting selection.

Impracticable as it is to manufacture all tubes of a given type exactly alike, it is possible to insure against slight meter inaccuracies and the human element by observing specification tolerances tighter than customers' requirements. Each Hytron tube is thus made to fit precisely the circuit constants with which it must operate. For example, strict observance of specifications for grid-to-plate capacitance makes easier the adjustment of tuned circuits to any Hytron tube of the chosen type.

Simplify your design problems for initial and replacement tubes by taking advantage of Hytron's insistence upon close tolerances. Specify Hytron.

OLDEST EXCLUSIVE MANUFACTURER OF RADIO RECEIVING TUBES

HYTRON CORPORATION ELECTRONIC AND RADIO TUBES

HYTRON RADIO TUBES

SALEM AND NEWBURYPORT, MASS.

PAINTED FOR ELECTRONIC LABORATORIES, INC., BY BENTON CLARK

NOT HERE, Hirohito!

● **So sorry, son of heaven, but the answer is "NO! You can't land here!"** . . . Not with these gallant little sluggers, the PT boats, on the job. They're tough. They're fast. They never sleep. And whatever the occasion demands, they've got what it takes.

As a concentrated package of poison for the Axis, the PT boats are an outstanding example of the way American engineers, workers and management are teaming together to produce the deadliest weapons the world has ever known. And naturally, we're proud that ***E·L*** **equipment** is giving a good account of itself on PT boats.

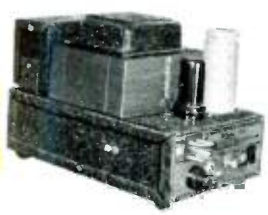
The widespread use of ***E·L*** Vibrator Power Supplies as standard equipment—on land, sea and air—for radio, lighting, communications, etc.—wherever electric current must be changed in voltage, frequency or type—is evidence of the efficiency and rugged dependability of ***E·L*** products.

Electronic

LABORATORIES, INC.

INDIANAPOLIS

E·L **ELECTRICAL PRODUCTS** — Vibrator Power Supplies for Communications . . . Lighting . . . Electric Motor Operation . . . Electric, Electronic and other Equipment . . . on Land, Sea or in the Air.



For Operation of Emergency Two-Way Radio Equipment from 115 Volts AC Line or DC from a 6-Volt Storage Battery *E·L* Model 619 Vibrator Power Supply. Input Voltage: 6 volts DC or 116 volts AC: Output Voltage: 300 volts DC at 100 ma. and 6.3 V AC at 1.75 amps.; Output Power: 60 watts: Dimensions: $5\frac{7}{16}$"x$2\frac{13}{16}$"x$5\frac{11}{16}$"; Weight: 10 pounds. Other *E·L* Vibrator Power Supplies are available with different combinations of input voltage and output wattage.

Hedges

There are a number of requirements for new transmitter equipment which broadcast station managers, their engineers and consultants must always bear in mind.

1. The equipment must function in a manner consistent with FCC performance requirements.
2. The equipment must meet FCC safety requirements for the protection of operators.
3. The equipment design must include safeguards which effectively protect it from damage due to overload.
4. The equipment design must include maximum assurance against failure during broadcasting.

RCA provides these assurances—"hedges" against trouble.

From microphone to antenna, RCA offers the broadcast station *complete* equipment of coordinated design—assuring superior performance, maximum operating economy and convenience, and *definitely fixed responsibility*.

RCA Victor Division, RADIO CORPORATION OF AMERICA, *Camden, N. J.*

RCA

RCA BROADCAST EQUIPMENT

★ *RCA's line of apparatus includes more of the equipment necessary for the efficient operation of modern broadcasting stations than that of any other manufacturer.*

★ *RCA is the only broadcast equipment supplier manufacturing a complete line of measuring and test equipment.*

FOR RADIO MEN IN THE SERVICE!

"WRITE A LETTER"

As you know, the Hallicrafters make a wide range of Radio Communications equipment, including the SCR-299 Mobile Communications unit. We are proud of our handiwork, proud of the job you men have been doing with them on every battlefront.

RULES FOR THE CONTEST

We want letters telling of actual experiences with this equipment. We will give $100.00 for the best such letter received during each of the five months of November, December, January, February and March! (Deadline: Midnight, the last day of each month.)

We will send $1.00 for every serious letter received so even if you should not win a big prize your time will not be in vain.

Your letter will be our property, of course, and we have the right to reproduce it in a Hallicrafters advertisement.

Good luck and write as many letters as you wish. V-Mail letters will do.

W. J. Halligan

BUY MORE BONDS!

the hallicrafters co.

CHICAGO, U.S.A.

2611 INDIANA AVENUE · CHICAGO, U.S.A.

MAKERS OF THE FAMOUS SCR-299 COMMUNICATIONS TRUCK

TELEVISION, LABOR, TAXES, AND PRICES

To the Other Problems Which Television Must Surmount Must Now Be Added Increased Costs Due to Higher Wages and Doubled Excise Tax

BY M. B. SLEEPER

"TO MAKE television a nation-wide broadcasting service will involve the investment of millions of dollars in studios and transmitters to be located in the key cities of the United States; and more millions of dollars for the building of network facilities and the production of suitable television advertising programs. Television cannot succeed without these services, but the answers to these problems would develop rapidly if the biggest problem of all were solved, namely, an acceptable low-cost radio television receiver. This is the No. 1 problem of the postwar television industry."

Here, in a few words, is a complete summary of the status of television today, stated frankly by a realist who is in a position to know the facts. The quotation is from an address given before a joint meeting of the American Television Society and the Advertising Club of New York, by Thomas F. Joyce, manager of the radio, phonograph, and television department of RCA Victor.

His statement, Mr. Joyce explained, was based on a survey in 11 cities, covering a cross section of the public by age, income, and sex. Among the questions asked were:

"Would you or your family consider buying a radio and television receiver if the price were $400?" To this, 10.3 per cent answered "yes."

Those who said "No" were asked: "Well, would you buy if the price were $300?" The cumulative percentage of affirmative answers then rose to 19.9 per cent.

Then those who would not spend $300 were asked, "Well, would you buy if the price were $250?" Responses to this question raised the cumulative percentage to 34.3 per cent.

Finally, to those who still said "No" the interrogators asked, "Well, would you buy if the price were $200?" At this price bracket, the cumulative percentage of affirmative answers rose to 61.3 per cent.

Mr. Joyce continued: "From the foregoing, the conclusion seems inescapable that when, in the postwar period, the radio industry produces a good television receiver in the $200 price range, a very high percentage of the homes of the United States will be ready to buy television receivers as soon as service is available to them. Such a receiver, I believe, is possible — based on 1940 labor and material costs, and assuming no excise taxes. Of course, the postwar price would be increased by the factors of inflation and excise taxes."

A Real Working Basis ★ It is a genuine service to the radio industry when a man in a position to know the facts presents them clearly and honestly, ungarnished by glittering generalities about "wartime production economies" which exist mainly in the minds of those who talk about them. Perhaps those who talk so freely now about one-hundred-dollar home television sets feel that, by promising them, the day of their realization can be hastened. Actually, however, failure to deal in the realities which control television development only serve to put television farther back from the corner it has been "just around" for so many years.

Although Mr. Joyce made no promise of a radio-television receiver priced at a figure within the means of a sufficient number of people to provide a nation-wide audience, he did give the industry a definite goal toward which it can work with reasonable certainty of economic reward when it is reached.

Furthermore, using his figure of $200 it is possible to examine present factors which affect costs and retail prices to see what obstacles must be overcome before popular-priced models can be made available.

$200 Radio and Television ★ There is an element of optimism in the statement that, with pre-war wages and no excise tax, a good television receiver could be sold at $200. If my recollection is correct, only two such sets were brought out when television was launched during the New York World's Fair. These were table models with 5-in. tubes. One was a self-contained television receiver[1] which included the loudspeaker, manufactured by Andrea Radio Corporation. The other, an RCA model, was similar except that it had no speaker, although connections were provided for using the speaker of a broadcast receiver. They were priced at $187.50 and $199.50. They were competitive in design for, while experience showed that the RCA circuit was more sensitive, and so maintained synchronism on weaker signals and against stronger interference, the Andrea model offered the advantage of a built-in speaker.

However, experience at that time showed definitely that the 5-in. tube did not produce images large enough to be rated as satisfactory by the public.

Factors of Increased Cost ★ It should be pointed out that these television sets gave clear, sharp pictures of a quality comparable to sets with larger tubes, although the receiving radius was not equal to the larger models which employed higher sensitivity.

Accordingly, they can be used as a basis for estimating the postwar cost of types which will be acceptable to the general public. The factors of increased cost, which we shall examine separately, are:

1. Increased labor.
2. Addition of AM and FM broadcast tuning circuits.
3. Larger cathode ray tube.
4. Higher voltage of power circuits for larger tube.
5. Increased cost of materials.
6. Added receiving circuit for increased sensitivity.
7. Increased excise tax.
8. Cost of television antenna.

Base Price ★ For purposes of discussion, let us take $100 as the net selling price[2] of the prewar table models. On this, the manufacturer paid 5 per cent excise tax, which gives us a net of $95.00 against which were charged material, labor, overhead, general administrative, and selling expense, royalties, taxes, and profit.

It will be assumed that the postwar instrument can be housed in a table cabinet. No item of additional cost for a console has been provided for, since cabinets are of flexible design, and can be so easily held down or increased in cost.

Labor Costs ★ The largest items of cost in all radio equipment is labor. In the past two years, hourly rates have increased from an average of approximately 40¢ per hour to 80¢ according to official Government statistics. Neglecting overtime, which will not be necessary after the War, we must figure that labor cost has doubled, as of today. This does not refer merely to the

[1] For complete data and circuit diagrams on this model, see *Television Handbook*, by M. B. Sleeper. Price, $1.00. FM Company, 240 Madison Avenue, New York City 16.

[2] The models under discussion were sold originally at $187.50 and $199.50, subject to a discount which varied from 33⅓ per cent to 40 per cent. Subsequent reduction of list prices was made without regard to manufacturers' costs, in an effort to stimulate buying.

plants building radio sets. It applies equally to suppliers who furnish materials and components.

We cannot make a firm estimate of increased labor costs, and any amount set down now can be only a well informed guess. Manufacturers who have been consulted are of the opinion that this factor will increase the net selling price 25 per cent to 33⅓ per cent. Using the lower figure, then, we must add to the net of $95.00 an amount to cover increased labor of $23.75.

FM-AM Tuning ★ The lowest price FM-AM table model broadcast receiver which gave adequate FM performance was priced at $99.50. This set had reasonable good tone quality and limiter action, and can be considered acceptable for inclusion in our postwar television set. This chassis could be included at an increased net selling price of $40. Since we have charged the cabinet cost against the television receiver, this figure covers the radio chassis only.

It is doubtful if any economy could be effected by using the television power supply for the broadcast receiver, but there will be a saving if the audio end of the receiver and the speaker are used for television sound. That reduces the net extra cost of adding the broadcast receiver to about $30.

Larger Tube ★ Production facilities for the manufacture of cathode ray tubes have been increased enormously in the last two years, and the tubes themselves are now of finer quality. Tube life has been extended, too.

While exact figures are not available, it seems likely that 9-in. tubes will cost no more than the earlier 5-in. types. This will give us greatly improved video reception at little or no increased cost for the cathode ray tube.

Higher Voltage ★ Using a larger tube will add expense in another way. The 9-in. tube requires increased operating voltages, with correspondingly higher cost for the transformer and filter circuits. No economies have been effected here from any improved manufacturing methods. If anything, the prewar transformers and filters, even though they were for lower-voltage operation, were too much on the cheap side.

The larger tube, in consequence, will give us an increase in the cost of the power supply amounting to about $4.

Cost of Materials ★ Those who deal in generalities have the idea that if a radio set is built in large quantities, the prices of the components will be reduced. The fact is that the condensers, resistors, sockets, and other parts used in television sets are already being produced by the millions for use in all types of radio equipment.

The only difference is that some of the components for television circuits are more expensive because they call for closer tolerances, while others must withstand higher voltages than are employed in broadcast receivers. Postwar costs for materials and components will run somewhat higher than prewar levels. However, since we have already included a factor for increased labor, we might give our new television model the benefit of the doubt, and omit an additional figure for increased prices on these items.

Increased Sensitivity ★ Within certain limits, increased sensitivity is added protection against interference which tears the picture and causes it to drop out of synchronism. Higher sensitivity also means that the receiver will operate at a greater distance from the transmitter. Experience with the prewar table models indicated that, to assure general satisfaction, improved circuits are needed.

NOWADAYS, when so many opinions are being expressed on the subject of television, it is natural to ask: "Are those statements based on first-hand knowledge or just conjecture?"

In the case of this article, the information is not offered as coming from an expert who knows all the answers. However, it is based on experience as sales manager for Andrea Radio Corporation, one of the four companies which marketed television equipment during the World's Fair period of television broadcasting.

This activity started with participation in the design of receivers, and included the organization of a highly successful training course for some 200 service men, the conduct of sales and sales promotion, and the ultimate task of helping dealers to get such reception for their customers as would keep the sets sold.

Although the cost thus added will be small, it will represent an increase of approximately $2.

Excise Tax ★ The excise tax on radio and television equipment is an outstanding example of ill-conceived taxation. To take a simple example:

The tax on this equipment was 5 per cent, paid by the manufacturer on his net selling price. If a radio or television set sold retail at $200, with a 50 per cent discount to the trade, the manufacturer's price was $100, on which he paid a 5 per cent excise tax, or $5. Without the tax, the set would have been sold at a wholesale price of $95, or at retail for $190.

In other words, the $5 tax actually increased the price to the consumer by $10. Now, with a 10 per cent excise tax on radio and television sets, a manufacturer must sell the same set at $105.55 so that, after paying 10 per cent tax, he will still have $95. If the retail price is based on a 50 per cent discount, this means a retail price, under present conditions, of $211.10.

Without any tax, the same instrument would retail for $190. This shows the increase in cost to the consumer, due to the present 10 per cent tax, to be $21.10, although the Treasury Department collects only $10.55!

Right there we find an added element of price that will discourage many purchasers. Before the War, efforts were made to eliminate the tax on television sets, in order to encourage expansion in this field. Unfortunately, our lawmakers could not see it that way, and the tax was doubled.

Recapitulation ★ There may be some difference of opinion among manufacturers as to the exact amounts shown in the following recapitulation, but the figures are on the low side. Certainly they present a definite task on which engineers must work to accomplish the ultimate goal of bringing down the cost of receivers combining FM and AM broadcast reception and television to the $200 retail price that 60 per cent of our families are willing to pay.

PREWAR TELEVISION RECEIVER

Retail price of prewar RCA and Andrea table model television receivers with 5-in. tubes	$200.00
Manufacturer's price to trade	100.00
Excise tax paid by manufacturer	5.00
Manufacturer's net	95.00

POSTWAR FM-AM TELEVISION RECEIVER

	Manufacturer's net on prewar model	$ 95.00
1.	Increased labor cost	23.75
2.	Extra for FM-AM tuning	30.00
3.	Larger cathode ray tube (9-in.)	No Increase
4.	Higher voltage for larger tube	4.00
5.	Cost of materials	No Increase
6.	Higher sensitivity	2.00
	Manufacturer's net	$154.75
7.	10 per cent excise tax paid by manufacturer	17.20
	Manufacturer's price to trade	$171.95
	Retail price (subject to 50 per cent discount)	343.90
	Retail price (subject to 50 −10 per cent)	382.00
8.	Simple antenna, without labor	20.00

From the above, it will be seen that the $200-prewar table model television receiver, revised to use a 9-in. tube, will cost the public, postwar, about $340 if it is sold at a 50 per cent discount, or $380 at the customary 50–10 per cent discount, plus $20 for an average antenna if the purchaser installs it himself.

If the excise tax is eliminated, and it

(CONTINUED ON PAGE 62)

CANADIAN VIEW OF BROADCAST ANTENNA PROBLEM

Official Investigations of Interference Prove Need of Cooperation by Manufacturers and Dealers to Encourage Installation of Better Antenna Systems

PERHAPS because we have so much radio manufacturing and broadcasting in the U. S. A., we are inclined to accept our means and methods without comparing their merits with those in other countries. For example, the attitude toward interference and the protection afforded listeners in Canada is probably known to very few radio engineers and executives in the United States.

It has come to light in a letter from Mr. Walter A. Rush, Controller of Radio, in the Radio Division of the Canadian Department of Transport. His letter, and a copy of Canadian regulations relating to interference, are of such interest that they are presented here:

DEPARTMENT OF TRANSPORT
RADIO DIVISION
OTTAWA, CANADA
November 22, 1943

To the Editor:

Your very able discussion of the receiving antenna problem in the August issue of *FM* has been studied with great interest here, because of our close relations with the listening public established over a period of many years, in connection with the investigation and suppression of inductive interference throughout the Dominion of Canada.

This service is administered by the Radio Division, Department of Transport, whose functions are similar to those of the Federal Communications Commission in the United States. Interference suppression in Canada is carried out under authority of Section 23 of the Canadian Broadcasting Act, 1936, which is quoted hereunder; a copy of the Regulations passed under this Section is enclosed, also, for your information:

"23. (1) The Governor in Council may make regulations prohibiting or regulating the use of any machinery, apparatus or equipment causing or liable to cause interference with radio reception and to prescribe penalties recoverable on summary conviction for the violation or non-observance of any such regulation, provided, however, that such penalties shall not exceed fifty dollars per day for each day during which such violation or non-observance continues.

(2) Such regulations shall be published in the Canada Gazette, and shall take effect from the date of such publication or from the date specified for such purpose in such regulations, and shall have the same force and effect as if enacted herein."

The many thousands of investigations carried out by this Division have definitely shown that the performance of antennas used for broadcast reception generally is of a very low order. We have consistently adhered to the policy of recommending efficient outdoor antennas, whenever reception from distant stations is desired.

The general attitude of the radio trade has been to neglect the antenna problem almost entirely, and to refer the customer to the Radio Division, if reception should prove unsatisfactory. The matter was brought to the attention of the radio trade and they have compromised to the extent of recommending outside antennas, for other than local reception. As you know, this does not completely remedy the situation, because of the difficulty of properly coupling an outside antenna to a receiver originally designed for loop reception only. We therefore recommended that provision be made to disconnect the loop and cut in a suitable coupling unit for use with an outside antenna. Unfortunately the freezing of receiver design, due to wartime restrictions, prevented the possible adoption of this suggestion. It is to be hoped that this point will not be neglected when production is resumed after the war.

It would be greatly appreciated if you would grant us permission to make copies of your article, for distribution to our District Inspectors and to radio salesmen and servicemen, as opportunity permits. I am sure that the results would be of benefit to all concerned.

Yours faithfully,
WALTER A. RUSH
Controller of Radio

Following is the text of the Canadian Regulations for Controlling Radio Interference, referred to in Mr. Rush's letter:

(*Extract from* THE CANADA GAZETTE, *Saturday, February 8, 1941*)

AT THE GOVERNMENT HOUSE AT OTTAWA

Wednesday, the 22nd day of January, 1941.

PRESENT:

HIS EXCELLENCY THE GOVERNOR GENERAL IN COUNCIL

HIS Excellency the Governor General in Council, on the recommendation of the Acting Minister of Munitions and Supply and under the authority of Section 23 of The Canadian Broadcasting Act, 1936, being Chapter 24 of the Statutes of that year, is pleased to make the annexed regulations for the control of radio interference, to be cited as "Regulations for Controlling Radio Interference," and they are hereby made and established accordingly.

A. D. P. HEENEY
Clerk of the Privy Council.

REGULATIONS FOR CONTROLLING RADIO INTERFERENCE

1. In these regulations, unless the context otherwise requires:

(*a*) "Interference" means the detrimental effect to radio reception of a radio signal having a field strength of 500 microvolts per metre, or greater, on a receiving installation approved by the Minister as being satisfactory for the purpose, and in any prosecution or other proceedings under these regulations a certificate given by the Minister or by any person duly authorized by the Minister as to the detrimental effect of any interference shall be received as conclusive evidence of the facts stated in such certificate.

(*b*) "Interfering apparatus" means any mechanical, electrical or other device, apparatus, or circuit, which causes or is liable to cause interference.

(*c*) "Minister" means the Minister of Munitions and Supply and shall include the Deputy Minister of Transport in accordance with the provisions of Order in Council (P.C. 3076) dated July 8, 1940, made under the Public Service Re-arrangement and Transfer of Duties Act and the War Measures Act.

(*d*) "Radio Reception" means reception of radioelectric communication by means of Hertzian waves, including broadcasting, radiotelegraph, radiotelephone, the wireless transmission of writing, signs, signals, pictures and sounds of all kinds.

(*e*) "Suppress" means to replace the interfering apparatus with non-interfering apparatus, or to repair or alter the interfering apparatus in such a manner that it will not cause interference, or to associate with the interfering apparatus additional apparatus such as suppressors or shielding so that the interfering apparatus will not cause interference and "suppressed" and "Suppression" shall have corresponding meanings.

2. (*a*) No person shall use any interfering apparatus, provided, however, that no prosecution for such use shall be instituted in any case unless and until the Minister certifies that an expenditure of less than fifty dollars will be necessary to suppress such interference.

(*b*) Notwithstanding anything contained in paragraph (*a*) of this regulation, the Minister may, in any case, order the suppression of the interference and no person

(CONTINUED ON PAGE 57)

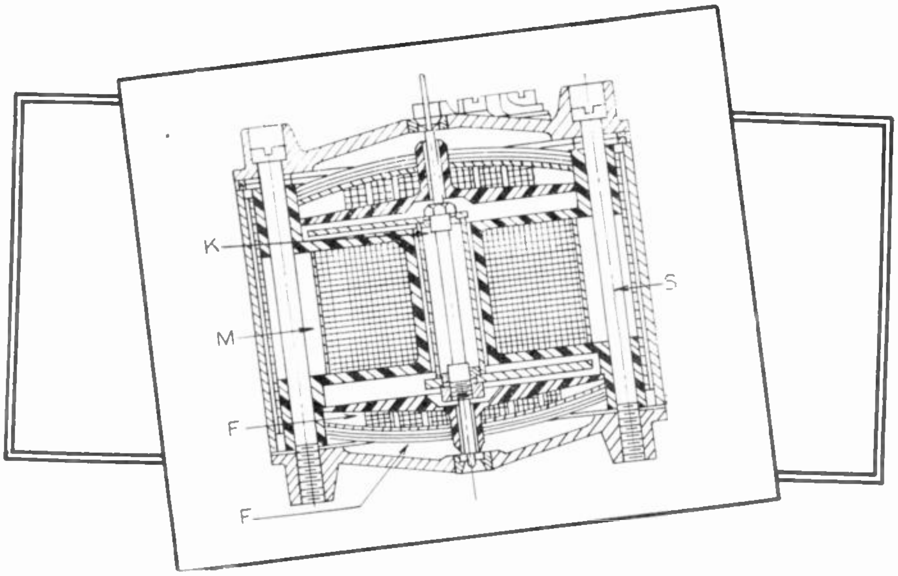


FIG. 1. CROSS SECTION SHOWS HOLLOW SHAFT, VANES, AND WINDINGS OF THE TELEGON

ELECTRO-MECHANICAL CONTROL

The Kollsman Telegon Can Be Used as a Virtually Frictionless Voltage Control, or as a Remote Synchronous Repeater

BY EDWARD M. GLASER*

THE Telegon unit, originally developed for aircraft instrument use, offers numerous possibilities to designers of radio-electronic equipment, not only as a remote indicator but as a means of obtaining variable voltage with the application of negligible torque.

This device, produced by the Kollsman Instrument Division of The Square D Company, is perhaps familiar to many designers through its use in multiple-scale indicators for aircraft instrument boards, and in the Sperry Gyroscope Flightray installations.

Less familiar, however, is the fact that the Telegon can be used as a variable voltage transformer, and that the variation of voltage can be obtained by means from which no power is available. This opens up a whole series of adaptations to electronically-controlled devices, and to new methods of electronic control.

The use of the Telegon as a remote indicator will be described first, as that will help to make clear its use as a variable voltage transformer.

*Senior Electrical Engineer, Kollsman Instrument Division, The Square D Company, Elmhurst, Long Island, N. Y.

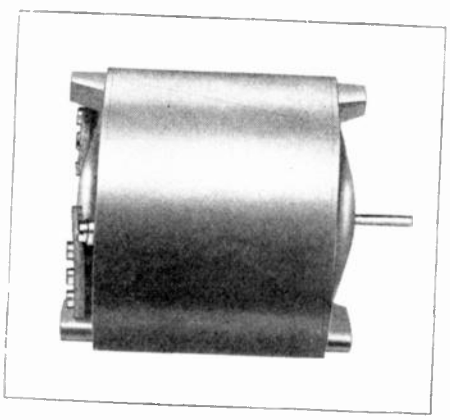


FIG. 2. EXACT SIZE OF TELEGON. THE TOTAL WEIGHT OF THIS UNIT IS ONLY 4 OUNCES

Remote Indicator ★ Self-synchronous motors have long been used in the electrical industry for duplicating motion at some point distant from its source. When two such motors are connected and energized by a source of alternating current, their rotors will always remain in exactly the same angular position with respect to their stators. Thus, if the rotor of one motor is moved by an outside force, the rotor of the other will follow automatically.

Basically, this is the principle of operation of the Telegon. However, the Telegon unit, Fig. 2, is designed especially for aircraft instrument use and, consequently, is radically different in construction from all other self-synchronous motors.

In order to reduce the weight of the rotor, the primary coil is separated from the rotating element, as shown in Fig. 1. A hollow, soft-iron shaft, carrying two vanes, is mounted on steel pivots. Because of its extremely light weight, it is supported by jewel bearings.

Separating the energizing coil from the rotor eliminates objectionable brushes or slip rings. Not only does this remove practically all friction, but it provides explosion-proof qualities required by certain operations. Due to the complete absence of electrical transients, it does not cause any radio interference.

The secondary circuit employs two phase windings, F and F, and disposed at right angles to each other, as shown in Figs. 1 and 4.

Fig. 3 shows a wiring diagram for two units. In this instance, one unit would be coupled mechanically to a transmitting instrument, while the other would be equipped with a pointer and dial.

When the primary coil is energized, a magnetic flux is induced in the center of the rotor K and transmitted to the vanes, the magnetic circuit being completed by the cylindrical outer shell S of soft iron. This shell also serves as a magnetic shield, preventing interaction between units when they are grouped in multiple indicators.

As the shaft assembly of the transmitting unit is rotated, the corresponding induced magnetic field is also rotated. This field pattern induces an E.M.F. in the phase winding F and F, the voltage in each phase being determined by the geometric alignment of the rotor with respect to the phase windings. The voltages thus induced give rise to proportional currents which flow in the phase windings of both the transmitting and the indicating units. This sets up a flux pattern in the indicating unit identical to the pattern in the transmitting unit.

The flux in the indicating unit reacts with the vanes, which are magnetized from the same source as the transmitting unit, causing the rotor to assume the same angular position as that in the transmitting unit.

The average accuracy with which the indicator shaft follows the position of the transmitter shaft is 3°. This can be compensated to an accuracy of $1\frac{1}{2}°$.

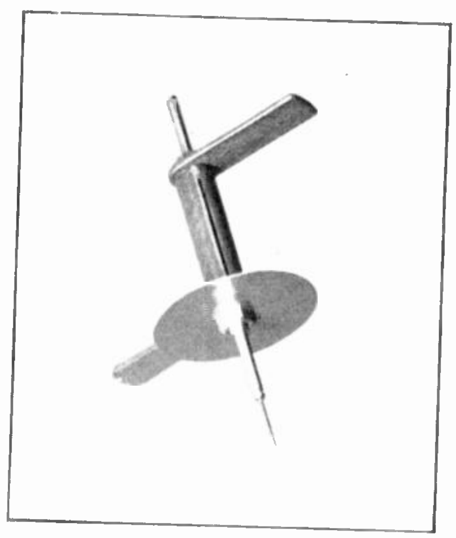


FIG. 3. THE SHAFT ASSEMBLY HAS STEEL PIVOTS, TURNING ON JEWEL BEARINGS

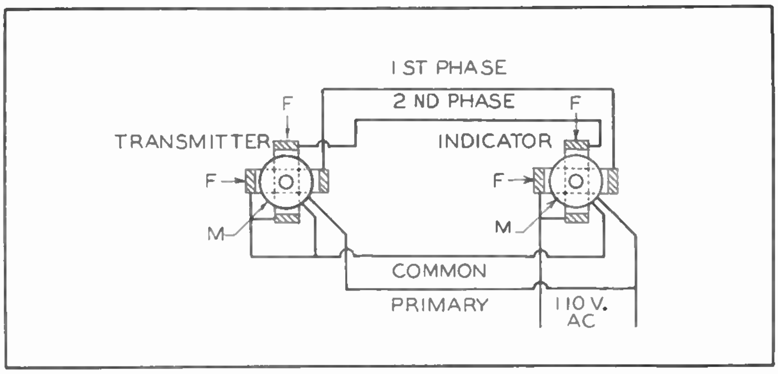


FIG. 4. CIRCUIT OF TRANSMITTER AND INDICATOR FOR AIRCRAFT INSTRUMENTS

Each Telegon motor draws 1.25 watts, operating on single-phase AC of 26 or 110 volts, 400 cycles. Power factor averages 40%. Temperature rise for continuous operation is 28° C.

The complete Telegon unit, Fig. 2, weighs 4 ounces, and is 1½ ins. outside diameter. Because of their small size, they can be conveniently grouped together for multiple-scale indicators.

Torque in measurable quantity is not available in the Telegon. It is comparable to standard instruments in this respect. One transmitter can operate two indicators and the torque, while small, is more than sufficient to move the pointers.

A modified Telegon motor serves as a synchroscope when used in conjunction with electric tachometers. In this instance, the primary circuit is connected to one tachometer generator, and the phase windings to the other. The rotor then acts as a beat frequency indicator, being stationary when a condition of synchronism is reached, and at other times rotating at a speed proportional to the difference in engine speeds.

Various standard housings and fittings are available for mechanical arrangements and wiring of Telegon units.

Variable Voltage Transformer ★ The other application of the Telegon is for purposes where, without the application of any appreciable amount of energy, the voltage of an independent circuit can be regulated by some mechanical device.

Suppose, for example, it is necessary to control substantial amounts of current by the delicate mechanism of a barometer. This instrument can do no work beyond moving a pointer. It cannot, obviously, move the shaft of a conventional variable voltage transformer.

However, such an instrument can turn the shaft of a Telegon. With a source of AC connected to the energizing coil of the Telegon, the voltage across each phase winding varies with the position of the vanes.

This variable voltage can then be applied to a suitable vacuum tube circuit from which any desired amount of power can be obtained.

Figs. 5 and 6 show voltage curves of the Telegon, in terms of the angular position of the shaft. These curves show the voltage across one phase winding. If both windings are connected in series, a 41% increase in voltage is obtained.

Fig. 5 is the voltage curve for one phase winding of a Telegon with 110 volts, 400 cycles applied to the energizing coil. Fig. 6 is a similar curve obtained with 36 volts, 60 cycles on the energizing coil.

From this it will be seen that the Telegon can be used wherever it is desired to transform the rotating motion of a delicate mechanism into corresponding, continuously variable voltage.

Important, also, is the fact that the use of an extremely light rotating element in the Telegon — only .06 ounce — makes it possible to use this unit or applications where the speed and direction of rotation changes rapidly.

Details of mechanisms to which the Telegon can be applied will not be discussed here, as the purpose of this article is rather to present information on this device which readers may find suited to their own needs and requirements.

The model most commonly used is the type 315S-971B Telegon. This operates on 110 volts, 400 cycles, drawing an input current of .018 ampere with an input power of 0.9 watts. Separate terminals are provided for the energizing coil and each phase winding.

Other standard units operate on 85 volts, 700 cycles, and on 26 volts, 400 cycles. From this it can be seen that, lacking a conventional AC current source, a vacuum tube oscillator can be used as the power supply.

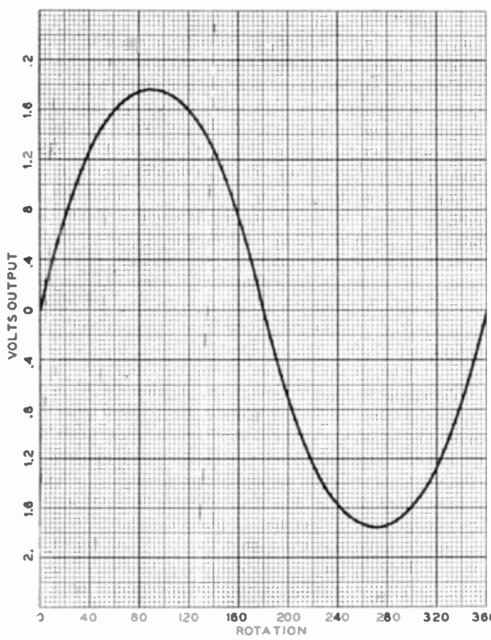


FIG. 5. OUTPUT VOLTAGE OF ONE PHASE WINDING WITH TELEGON OPERATING ON 110 VOLTS, 400 CYCLES INPUT

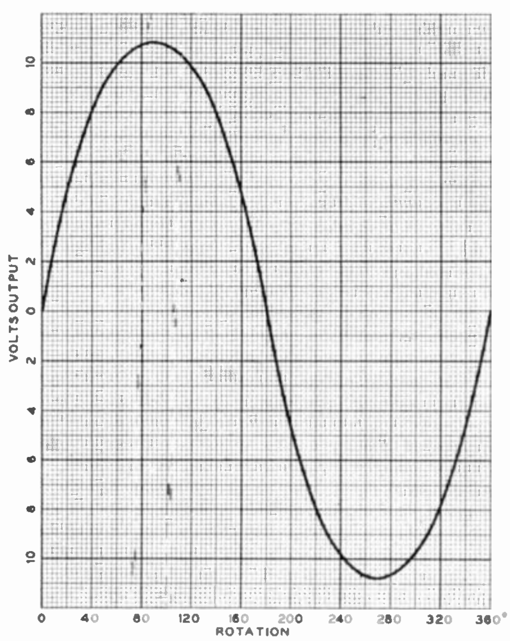


FIG. 6. OUTPUT VOLTAGE OF ONE PHASE WINDING WITH TELEGON OPERATING ON 36 VOLTS, 60 CYCLES INPUT

A BROADCASTER CHECKS FM RECEIVERS

Station WELD, the FM Affiliate of WBNS, Discloses Results of Hooper Holmes Surveys

BY LESTER H. NAFZGER*

WE HAVE conducted many surveys in the Columbus area to determine the strong points and the weak spots of our FM broadcasting service. They were intended for our own use, and the results were not distributed. However, the conclusions to be drawn from these surveys may shed factual light on points which are being discussed widely today. They are offered here for whatever value they may have to prospective FM station executives and to manufacturers of radio receivers.

Our FM station went on the air in November, 1941, with 6 kw. in the antenna from an REL transmitter, operating 12 hours a day. Originally W45CM, this was the first FM installation in Ohio. We are now in our third year of continuous operation, so that our staff has had an ample opportunity to become familiar with all the phases of FM technique and the reactions of FM listeners. One of the conclusions at which we have arrived is that the design of FM receivers is a matter of direct concern to broadcasters, and that the growth of FM audiences will depend to a large extent upon the types of receivers sold, and the ability of dealers to install and service them properly.

From these surveys and past experience, it is obvious that the number one item in good FM reception is a limiter action that really works. The antenna appears to be secondary consideration with respect to the limiter, but also an important one. We believe the wise approach to the antenna problem will be to provide a built-in antenna, with provision for an outside antenna. We find listeners in general do not feel the modern radio should require an outside antenna, and frequently they consider an outside antenna as expensive, unsightly, and difficult to install. We believe an efficient, economical, and easy-to-install outside antenna kit should be available with every FM receiver. Our experience with many FM antenna kits has shown an extremely high loss in the transmission lines, almost nullifying the intended advantage of the antenna.

After our first six months of operation, we prepared a questionnaire covering information helpful to the station in its program efforts, on reception conditions in general. The accompanying tabulation and breakdown are taken from that survey. The survey was made by the Hooper Holmes Agency of Columbus, Ohio, visiting a total of 33 homes. This number they considered sufficient for sampling purposes on the total number of receivers in use.

We were interested in this tabulation and break-down to determine the relationship between the make of the receivers and the conditions of reception. We were also interested to determine 1) if reception conditions affected the listeners' attitude toward WELD (then W45CM) and toward FM as a service and source of entertainment and 2) whether or not those not obtaining satisfactory reception have tried an outside antenna or are using one.

Knowing those receivers having and not having limiter stages, it is of interest to see the relationship between reception results with and without this circuit. In the survey, a ratio of receiver makes to total receivers in use was used in making the interviews. Thus if more of a particular make receiver was in use, more were interviewed by the Hooper Holmes Agency. Inadvertently, one well-known receiver was not included by the agency in the survey. However, the quality of the particular receiver is such that it is, by our knowledge, doing a good job. Thus we are confident its inclusion would have further increased the percentage totals in favor of successful and satisfactory FM performance.

TABLE 1 — REPORTS OF FM PERFORMANCE

Total	Make	Good	Fair	Poor	FM Not Worth Extra Cost
14	A	7	6	1	5
7	B	5	2		
6	C	6			
3	D	2	1		2
2	E	2			
1	F	1			1
33		23	9	1	8

These totals indicate that approximately 70% had GOOD reception, 27% had FAIR reception, and 3% have POOR reception; 24% indicated they did not consider FM worth the extra price they paid for their receivers, which in turn shows that 76% did feel FM was worth the extra cost.

There is a relationship between reception difficulties and the FM user's attitude toward WELD and the service provided by FM as shown by the following breakdown:

TABLE 2 — RECEPTION DIFFICULTIES & ATTITUDE TOWARD FM

Receiver	Reception	Difficulties	Receiver Worth Extra Cost: Yes	Receiver Worth Extra Cost: No	Reasons for Receiver Not Being Worth Extra Cost
A	Good	None	Yes		
A	Good	None	Yes		
A	Good	None	Yes		
A	Good	None	Yes		
A	Good	None	Yes		
A	Good	None	Yes		
A	Good	Ignition noise		No	Picks up sound of cars
A	Fair	Sounds Distant		No	Improvement in reception
A	Fair	Ignition noise	Yes		
A	Poor	Lots of noise		No	Bad reception, noise
A	Fair	Comes in mushy		No	Need more volume
A	Fair	Noise of cars	Yes		
A	Fair	Static		No	Noise reception and programs
A	Fair	Noisy at times	Yes		
B	Good	None	Yes		
B	Fair	Ignition noise	Yes		
B	Good	None	Yes		
B	Good	None	Yes		
B	Good	None	Yes		
B	Fair	Noise at times	Yes		
B	Good	None	Yes		
C	Good	None	Yes		
C	Good	None	Yes		
C	Good	None	Yes		
C	Good	None	Yes		
C	Good	None	Yes		
C	Good	None	Yes		
D	Good	None	Yes		
D	Good	Weak		No	Not yet seems weak
D	Fair	Noisy		No	Noisy, no popular demand programs
E	Good	None	Yes		
E	Good	None	Yes		
F	Good	None		No	No complaints except less war news

Table 2 shows that, of the 8 FM receiver users who did not feel FM worth the extra cost, 7 or 87% were not getting good reception. Of these, 2 stated that, in addition to poor reception, they did not like the programs. The eighth user did not give specific reasons or any complaints. It is, therefore, logical to assume that at least 5 of the 7, or 62%, would consider their FM receivers worthwhile if they had good reception. Perhaps all seven would have been pleased with their investments

* Manager, FM Station WELD, operated by WBNS, Inc., Columbus, Ohio.

in FM receivers, for it is impossible to determine the merits of a program service under conditions of noisy reception, low volume, and distortion.

Of the 11 FM users experiencing noisy or weak reception only 3, or 27%, had installed or tried outside antennas; 4, or 36%, were interested in the installation of an outside antenna if it would improve reception; 3, or 27%, were not interested; and 1, or 10%, did not indicate his attitude, so that no conclusion can be drawn.

We were anxious to determine if there was a relationship between the makes of the receivers which were giving poor results, the attitude of the user toward his investment, and whether or not the unsatisfactory receivers had the limiter stages inherent to high-quality FM design for the rejection of noise factors. The following breakdown shows this relationship plus information on the type antenna used:

TABLE 3 — MAKE OF SET & TYPE OF ANTENNA RELATED TO ATTITUDE OF OWNER WHERE RECEPTION DIFFICULTIES WERE EXPERIENCED

Receiver Make	Reception Difficulties	Limiter Stage	Antenna	Attitude
A	Ignition noise	No	Built-in	Negative
A	Sounds distant	No	Built-in	Negative
A	Ignition noise	No	Built-in	Affirmative
A	Lots of noise	No	Built-in	Negative
A	Comes in mushy	No	Built-in	Negative
A	Noise of cars	No	Built-in	Affirmative
A	Static	No	Built-in	Negative
A	Noisy at times	No	Built-in	Affirmative
B	Ignition noise	Yes	Built-in	Affirmative
B	Noisy at times	Yes	Outside	Affirmative
D	Weak	Yes	Outside	Negative
D	Noisy	Yes	Outside	Negative

Of the 12 receivers experiencing reception difficulties 8, or 67%, were without limiters. Of the 12 receivers experiencing reception difficulties 9, or 75%, were using built-in antennas. Of the 12 receivers experiencing reception difficulties 8, or 67%, were Make A; 2, or 16%, were Make B; and 2, or 16%, were Make D. Of the 7, or 58%, not considering the extra cost of the receiver worthwhile, 72% owned Make A, and 28% owned Make D.

It is now interesting to see the relationship between the total receivers of a particular make in use and the percentage of dissatisfaction with reception. The breakdown follows:

TABLE 4 — SATISFIED & DISSATISFIED OWNERS

Receiver Make	Satisfied	Dissatisfied	% Total Satisfied	% Total Dissatisfied
A	7	5	58%	42%
B	7	0	100%	
C	6	0	100%	
D	1	2	33%	67%
E	2	0	100%	
F	1		100%	

Dividing the receivers into classifications of those having and not having limiter stages, it is shown that of owners of receivers without limiter stages 42% were not satisfied, and 58% were satisfied. It is shown that of those who owned sets with limiter stages, 10% were not satisfied and 90% were satisfied.

Conclusions ★ It is to be concluded, therefore, that there is a direct relationship between satisfaction on the part of the receiver owner and the quality of reception. It is also to be concluded that the elimination of poor reception would provide a percentage of 90% satisfied and 10% dissatisfied with the possibility that improved reception would have further increased this percentage ratio to 96% satisfied and 3% dissatisfied.

It is obvious that there is a direct relationship between poor reception and the use of receivers without limiters. There is the possibility of improvement in reception on those receivers not equipped with limiters, if outside antennas had been used. However, the ratio of 75% built-in antennas to 25% outside antennas on those receivers not providing good reception does not agree with the percentage of 90% satisfaction with all receivers having limiters and only 58% satisfaction on all receivers without limiters. It is apparent from this survey and other experiences that the average receiver owner prefers the built-in type antenna.

The more unsatisfactory the AM reception the more willing the listener is to install an outside FM antenna but where AM reception is good, he considers the need of an outside antenna on FM as an indication of incomplete development of the system. It is also a fact that the installation of an outside antenna must be qualified in that the antenna must be in the proper position [1] with respect to the location of the FM station received, and a good transmission line must be used. All too often neither condition is met.

In some instances, poor reception inherent to the design of the receiver has been blamed on the broadcast station by the radio dealers. WELD has been operating with 6 kw., although the station has a construction permit for 60 kw. Due to equipment shortages, we shall continue at 6 kw. until after the War. Many dealers depended on this increase in power to block out the receiver troubles.

From experience it is further evident that receivers without limiters do detect both the FM and AM components of the carrier, and thus detect any amplitude component in the transmitter, usually contributed by the high-power output stage. Those receivers with true FM circuits and limiters do not detect or respond to this amplitude component, and are thus free of the background of hum heard in the non-limiter receivers.

Non-limiter receivers, we found, necessitate very critical tuning, and with receivers not equipped with an electric tuning eye, the owner did not exert necessary care in tuning. This resulted in hum, noise and distortion. In addition, it has been found in the alignment of many non-limiter receivers that two volume peaks are found, each side of true resonance. The owners, trained in tuning for volume, failed to reach the resonant point. The resonant point in many instances was of lower volume than the side band peaks.

Service men have not been properly supplied with data on FM receivers, and in most instances equipment necessary to proper FM service has been unobtainable. It would appear that in the promotion and distribution of FM receivers, at least the distributor should have been fully equipped for this work, but in several instances this was not the case. It also appears that frequent or adequate meetings for service men would have created a better feeling between service men and distributors. This would have contributed much to the satisfaction of FM set owners.

In drawing these conclusions, it is not our intention to show favor or to discriminate between makes of receivers. It is our belief, however, that no receiver to date, without a limiter stage, has delivered true FM performance. We, as broadcasters, want to see all receivers operating properly. The service of our station will grow only by the growth of our audience. It means nothing to our future and the future of FM to have dissatisfied FM receiver owners. Our experience has shown one dissatisfied FM receiver user can freeze sales of many such receivers among his friends. Thus everyone concerned in the promotion of FM is penalized.

We, as broadcasters, recognize that there should be a price range in FM receivers. Certain of the inherent advantages of FM, we believe, can be built into low-price receivers, but we cannot compromise with severe short cuts where all the fundamental circuit elements of the FM system are eliminated, making FM a mere gadget and a worthless addition to

[1] This brings out the need for an efficient non-directional antenna for use where there are several FM stations. — *Editor's note.*

a radio, and failing to provide the inherent advantages of FM broadcasting. The purchaser of any FM receiver has the right to expect improved reception as compared to AM. Tone quality is a matter of personal taste and appreciation. The need of eliminating static interference and AM heterodyne squeals depends upon conditions where a receiver is used. Obtaining the required standard of performance at a particular home must depend, to some extent, upon the amount the owner chooses or can afford to invest.

And, in discussing FM receivers, it must not be forgotten that FM converters have had their disadvantages. These, we believe, can be corrected easily in future models. The FM converter is the economical way to hear FM. It may be the only way FM will reach some homes, and it may be the means of introduction to better receivers with built-in FM.

The converter, in any event, must do a good job. The disadvantages of FM converters have been in lack of de-emphasis and volume control within the converter itself. Many AM receivers have inadequate tone control to meet de-emphasis requirements, and have volume controls ahead of their audio stages. The result is poor quality or inability to control volume. Users have all too often decided that FM tone quality was not nearly equal to that of AM stations or, in trying to control excessive volume, have tuned the converter off resonance and thus received a mixture of program, noise, hum and distortion.

FUTURE BROADCASTING PLANS

Opinions Expressed Before the Interstate Commerce Committee

TESTIMONY heard before the Senate Interstate Commerce Committee at Washington shows a surprisingly unanimous belief on the part of broadcast engineers and executives that Frequency Modulation is destined to replace AM for local and regional stations as soon as the manufacture of broadcasting equipment can be resumed after the War.

Mr. O. B. Hanson, vice president and chief engineer of the National Broadcasting Company told the members of the Senate Committee:

"FM is a technical improvement which permits the reception of sound programs in the home with greater fidelity and with considerable less interfering noises. Natural static, to all intents and purposes, is eliminated and man-made electrical noises greatly reduced. Thus, Frequency Modulation provides a technical improvement in the reception of sound programs in the home. The signals from FM stations operating on the presently assigned frequencies do not travel long distances as do the standard-band wavelengths. Thus, it is possible, by proper geographical spacing, to have many stations operating on the same wavelengths or frequency assignments without interference between the services of the various stations.

"We now have approximately nine hundred standard broadcasting stations in the United States. Under existing rules and technical standards, I believe it is technically possible to have three thousand new FM sound broadcasting stations in the United States. If all these technically possible stations were built, it would represent a capital investment of roughly $150,000,000. However, there is some doubt in my mind as to whether the economics of sound broadcasting will support that many FM stations. Thus, it might be conservative to think in terms of 2,000 FM stations, or a total investment of approximately $100,000,000.

"They would employ perhaps forty thousand persons directly, and many additional thousands indirectly. . . . I believe that the industry, to avail itself of the technical improvement afforded by FM, must have a long-range, sound economic plan, and Government coöperation in that plan.

"I visualize such a plan in the following manner: The existing broadcasting operators should be permitted to erect FM stations to operate over a period of years as companion stations to their present standard-band transmitters, transmitting the present popular standard-band programs through both their standard-band transmitters and FM transmitters. Thus, as the public obtains FM receivers, they can hear their favorite programs through either the FM station or the standard-band station, whichever happens to give them better reception. Eventually, the majority of listeners will be equipped with FM receivers, and surveys taken from time to time will indicate how many homes are tuned to the FM station and how many to the standard band. When the surveys show that the majority are able to obtain full service from FM transmitters, it will be possible to discontinue transmission by the older method. There will be, of course, newcomers to the FM broadcasting field, the total number of stations at the end of the coming decade being several times the number now existing in the standard band.

"As has been pointed out, FM stations are limited in range and do not provide the long-distance nighttime coverage to the sparsely settled rural districts that is now provided through the standard-band, cleared-channel stations. It is desirable, therefore, that the long-range plan consider the future operation of a large number of high-power, clear-channel stations operating on the standard band, strategically located to provide rural coverage in sparsely settled parts of the Country.

"I would, therefore, visualize at the end of the coming decade our sound broadcasting services operating on Frequency Modulation stations in the large metropolitan centers, and medium and small cities, with rural coverage provided by clear-channel stations on the standard band. With local and regional stations in the standard band replaced by FM stations, space in the standard-band frequency allocations could be provided to increase the number of clear-channel stations, which I visualize as using powers of the order of 500 to 1,000 kilowatts instead of the now limited power of 50 kilowatts. An engineer does not regard 50 kilowatts as a large amount of power for so important a service as broadcasting. Fifty kilowatts is approximately 67 horsepower, or less than the power under the hood of an American automobile."

A similar opinion was expressed to the Senate Committee by John V. L. Hogan, well-known to the radio industry as a consulting engineer and as the chief stockholder of New York station WQXR and the affiliated FM station WQWQ.

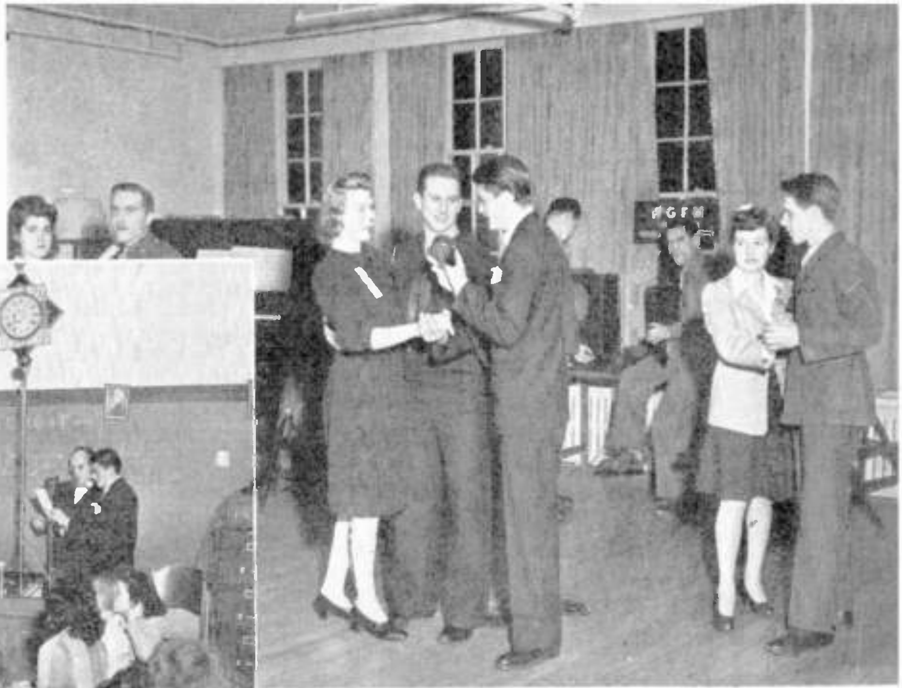
He told the Committee that the logical move would be to put all local and regional stations on FM, with AM retained for clear-channel stations which would insure adequate rural coverage. Shifting the vast majority of stations to FM, he explained, would relieve congestion on the present AM band, so that additional cleared channels would be made available. Radio listeners would then rely upon FM in cities and in populous areas, while the present standard band would be reserved for rural listeners.

Discussing briefly the matter of radio regulation, Mr. Hogan declared that an "unambiguous statement" was needed from Congress, outlining the extent of the authority of the Federal Communications Commission.

This authority, he continued, should be confined to the technical aspects of broadcasting. As for some of the FCC moves in other directions, he considered them "at least debatable." At this, Senator Bone remarked that Mr. Hogan's ideas might be too restrictive. "I may be radical in my belief that decent people can do a decent job," Mr. Hogan replied. Furthermore, he expressed the belief that the broadcasters have done a decent job, and that he has seen no improvement in programs resulting from Government steps in either the field of programming or business practices.

Further investigation of the FCC by the special House Committee will cover numerous charges of maladministration, abuse of power, grasping for power, and other accusations made against the members of the FCC by Eugene L. Garey, counsel for the Committee.

There is an unlimited supply of program material for FM stations in the activities of people and organizations known to the listeners. The reality of FM reception heightens the interest in such program sources as are shown on this page.



Above: WGFM, Schenectady, takes its microphone to a USO dance to interview service men and local hostesses. Left: Announcer Hubert Wilke and columnist Fowler pick up rehearsals of the high school glee club.

Live Talent for Local FM Programs

Above: Fire Chief Higgins proved to the FM audience that he could make good on his claim that the Schenectady engines required only 40 seconds to get out of the station after an alarm was sounded. The sound effects were marvellous over WGFM! Left: At Union College, the band put on a special performance because many of the boys were sons of parents who were listening to their program.

SPOT NEWS NOTES

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

New FMBI Members: Two newcomers in the ranks of FM Broadcasters, Inc. bring the total membership to 72. They are Zenith Radio Corporation, operating FM station WWZR Chicago, and the Omaha World-Herald, operating AM station KOWH Omaha, and applicant for an FM station for 45.5 mc. to cover 11,600 square miles.

Harold Shevers: Spread a happy smile when Lt. Colonel Walter B. Brown presented him with the "E" symbol on behalf of the Espey Manufacturing Company, during their Army-Navy award ceremonies at New York City.

Merger: As a step toward postwar plannings, Detrola Corporation, former manufacturer of midget radios, is to be merged with International Machine Tool Corporation, according to C. Russell Feldman, president of both concerns. New company will be called International Detrola Corporation.

International Tool now operates machine tool plants at Elkhart and Indianapolis, employing over 1,350 people. Net sales for 11 months ending September 30th were $22,239,000. The Detrola plant at Detroit employs about 1,250. Net sales for 10 months ending September 30th were $8,190,000.

Spartanburg, S. C.: The Spartanburg Advertising Company has filed an application for a construction permit for an FM transmitter to operate on 43.5 mc., with a coverage of 26,600 square miles. This is a radius of approximately 90 miles.

I.R.E. Winter Meeting: Scheduled for January 28th and 29th, 1944. This will be an important occasion for all radio-electronics engineers because the A.I.E.E. will hold its technical session earlier in the same week, and will reserve their communications papers for Thursday, the 27th. Thus, engineers who can be on hand for Thursday through Saturday can hear the radio papers of both societies.

On Thursday evening, at a joint session, Major General Roger B. Colton will speak on "Enemy Communications Equipment," and there will be an exhibit of the apparatus. Dr. L. P. Wheeler, retiring president of the I.R.E., will preside at a Friday morning conference at which Dr. W. R. G. Baker, head of RTPB, and several of the panel chairmen will discuss various technical problems.

Mr. E. K. Jett, chief engineer of the FCC, will head a discussion of problems which are now under consideration by the Commission.

At the I.R.E. banquet, Prof. H. M. Turner will be inaugurated as the 1944 President.

The meetings will be held at Hotel Commodore, East 42nd Street, New York City.

ST Radio: Longest studio-to-transmitter connection uses FM on 300 mc. to connect Gordon Gray's studio at Winston-Salem to his FM transmitter on Clingman's Peak. Air-line distance is 110 miles.

James T. Buckley: Chairman of the executive committee of Philco Corporation has been elected a director of the Federal Bank of Philadelphia for a 3-year term, beginning January 1, 1944.

FM Applicant: The New Jersey Broadcasting Company, operating WPAT Paterson, has filed an application for an FM transmitter on 49.9 mc. to cover 4,928 square miles.

Sales Engineers: To expand their services to radio manufacturers, Cannon Electric Development Company, Los Angeles, has appointed the following sales engineers: E. B. Glenn, 801 Healy Building, Atlanta; Douglas H. Loukota, 10 Light Street, Baltimore; Ray Perron & Company, Little Building, Boston; H. M. Welch, Crosby Building, Buffalo; George Sturman, 712 6th Avenue S., Minneapolis; J. Tinsley Smith, 108 17th Avenue S., Nashville; J. W. Beneke of E. L. Melton, 575 Arcade Building, St. Louis, Mo.

Page Mr. Marx: FCC Commissioner T. A. M. Craven is keeping tabs on Chairman Fly's excursions into the realm of social revolution. At least, he is well up on the nomenclature. Speaking of the Commission's doctrine of instituting reforms through seizing powers not granted to it, Mr. Craven said: "Such an attitude constitutes in a sense a trend toward cessation of gradualism, which I interpret as a method by which you impose social reforms of your own choosing without consulting the chosen representatives of the people." Some of us can remember when the controlling policy of the FCC was the service of public interest, convenience, and necessity.

Ralph A. Hackbusch: Vice president in charge of radio for Research Enterprises, Ltd., has now rejoined Stromberg-Carlson Company of Canada in the capacity of vice president and managing director. Research Enterprises, Ltd., was set up by the Canadian government in 1940 to handle research and production of optical glass, radio, and war equipment.

Gilbert Seldes: Director of television programs for CBS, speaking before the Dayton Kiwanis Club: "It may take between five and fifteen years following the War until television can be put into every home, so we cannot look to it to prevent an economic slump. Technical experts say that enough progress has not been made for television to become a 'ladder industry.'

"In order for it to serve this purpose, several million sets would have to be sold in a very short time immediately following the War. . . . In 1941, television equipment was good enough to put on an actual show, but it would be an error to begin where we left off. We would be wise to take a little time to get off to a good, strong start. This little period would allow us to incorporate the improvements that have been developed."

Lee McCanne: Explaining to the New York Sales Executives Club that Stromberg-Carlson and 16 other war plants in Rochester have instituted a plan to train war veterans as salesmen as part of their post-war employment program.

(CONTINUED ON PAGE 51)

NEWS PICTURE

LATEST and strangest development of radio communications equipment is the lip microphone, developed for the U. S. Army Ground Forces by Electro-Voice Manufacturing Company.

Breath shields, front and back, act as buffers against puffs of air from the mouth, which would otherwise cause confusing and unintelligible sounds to be transmitted. Outside noises enter at both sides of the diaphragm in equal volume, thus cancelling themselves, while speech enters the opening nearest the mouth with full intensity.

Frequency response is from 200 to 4000 cycles at normal altitude. The microphone can stand total immersion for about 10 minutes without injury to its mechanism.

Designed for use in tanks and under conditions where the use of both hands is required, and weighing only 2 ounces, the Army reports highly successful performance.

TECHNIQUE OF MOLDING LOW-LOSS BAKELITE

Information to Enable Engineers to Design Molded Parts Which Can be Produced from Dies Suited to the Characteristics of Bakelite Low-Loss Phenolics

BY C. M. CHASE, Jr. *

As HIGHER radio frequencies come into wider use, more and more engineers are being confronted with problems involving the use of mica-filled low-loss phenolics for the production of parts required in large quantities.

This calls for a working knowledge of the technique employed in molding Low-Loss Bakelite 1) because parts must be designed so that they can be produced from molds suited to the characteristics of the material, and 2) because, if production costs or rejections run excessively high, the designer is invariably called upon to defend himself against the claim by the molder that the part was not designed for economical production in the first place.

The truth is that parts are very often designed with regard only for the mechanical and electrical requirements of their use. Then the details and construction of the molds cannot be accommodated to the use of the best molding technique as dictated by the characteristics of the material.

On the other hand, it is possible that the responsibility for high rejections lies with an unskilled press operator, and not with the dies at all.

Armed with an integrated knowledge of the methods by which perfect pieces can be produced, the engineer is then in a position to design parts which will meet the end requirement of delivering satisfactory mechanical and electrical results with low production cost properly balanced against the amortization of expense for molds.

Lack of such knowledge results in failure to observe fundamental principles which govern the successful use of Bakelite low-loss materials. The penalty for this is dissatisfaction, delay, and excessive and unnecessary costs.

Fundamentals ★ The unifying principle that underlies this discussion is that molding is essentially getting the molding material into the cavity, and freeing the material and the mold cavity from air. To do this efficiently requires attention to numerous details of mold design, mold charge, and mold operation. Also required is an understanding of the nature of these materials, which, though called *Plastics*, are not very plastic. In addition to numerous examples of possible effects of failure to observe certain detailed principles, there is a guide for the correction of specific troubles which may be encountered. Though every effort has been made to provide simple rules for the correction of molding troubles, there can be no substitute for an intelligent understanding and application of the broad fundamental principles which are the basis of successful molding.

While low-loss phenolic materials are poor conductors of heat, they do heat up about 40% faster than general purpose phenolic materials. This difference is apparent in the shorter time required for material directly in contact with a hot mold surface to soften and then lose this limited mobility, or harden. When cold, these materials are deformed only with application of considerable pressure, and even when warm they do not even approach the consistency of a thick liquid.

The range of flow in which these materials are sold is somewhat harder than the range for general purpose materials. The rigidity of moldings of these materials at discharge, as they are commonly molded, varies from being fairly flexible to quite rigid. A material that is more flexible upon discharge from the mold may also show appreciable distortion at lower service temperatures. Low-loss materials may shrink from mold dimensions about ⅓ of the amount that general-purpose materials do, a difference that must be allowed for, particularly in designing molds.

These materials cover a range of values for loss factor at 1 mc. The better the loss factor value for a material, the more difficult the molding problem. Therefore it may be profitable to consider carefully how good the loss factor must be for a particular application.

Mold Design ★ This discussion is limited to the effect that various design elements may and do have on the success of the molding operation. These elements are: type and location of cut-off or parting line in compression molds, gating of transfer molds, provision of vents for escape of air and excess material, and means of ejecting a molding. To the designer, interested in function and form, these elements are necessary evils, but to the molder, concerned with production, they are vitally important. Careful consideration and proper selection of these elements of design will make the molding operation less critical, increase the rate of production, and cut costs.

Type of Cut-Off ★ In compression molds, the ideally shaped part is a shallow cup with uniform wall thickness, and the cut-off at the edge. This permits the placing of the charge well into the cavity in such a position that, as it is compressed, it flows up the side walls, sweeping the air out of the mold ahead of it. A semi-positive cut-off insures that the opening for escape of air and excess material is adequate until the final 1/16 in. of travel of the force, after which the escape is closed and the material is directly compressed. In a flash type cut-off, the escape of the material may be so great during closing that not enough remains at the final close for adequate transmission of pressure to all sections of even such a simple molding.

If the positive type cut-off is employed, the exact quantity of charge used will determine the thickness of the molding and there is the possibility that some of the air in the cavity will be trapped, thus preventing the formation of a sound, dense molding. From this it appears that the semi positive mold is a workable and generally satisfactory compromise between the flash type and the fully positive type. Choice of cut-off is determined by the relative need for escape of air at this section and the need for retaining material in the cavity.

Location of Cut-Off ★ The location of the cut-off should insure that the material will find it easier to fill all sections of the mold rather than escape from the mold. A guide for evaluating the location is to compare how similar its proposed location is to the location at the edge of a shallow cup. There are several condenser molds where the flash line is poorly placed in the center of the side wall instead of at top of the side wall. This location was dictated apparently by their solution of the problem of positioning the condenser insert. Observing the troubles experienced with this location, there are newer condenser molds with the cut-off at the top and their solution of the problem of positioning the insert is also practical. This single change in design facilitates the molding operation by helping to retain an adequate quantity of charge under pressure.

Transfer Molds ★ Transfer molds present many design problems but those design factors which affect the ease of molding may be evaluated by the extent to which

*Engineer, Bakelite Corporation, Bound Brook, N. J.

they fulfill the fundamental consideration of insuring the complete replacement of the air in the cavity with material under pressure. This is readily accomplished when the rapid flow of the material sweeps the air ahead of it and out vents placed in the area which is the last to be reached by the material.

A convenient means of obtaining a picture of just how the material does flow into a cavity with a particular design is to use several different quantities of charge in a series of moldings. Such a series may indicate that the material bypasses certain sections, blocks the available vents before all of the air is out of the mold, and then fails to fill these bypassed sections completely because there is no way for the trapped air to escape. The flow of the material, where there are several metal inserts in its path, and the shape of the molding is intricate, can be quite complex.

Naturally the location of the gate is a primary factor in the particular flow pattern and should be placed in accordance with our fundamental principle. The size of the gate is a compromise between being small enough to insure that the material is nearly at a uniform high temperature when it enters the cavity and large enough to permit the complete filling of the cavity with the pressure available in the short time (about 30 seconds) that phenolic materials remain plastic enough to transmit pressure to each small volume of the molding. For large moldings, more than one gate may be required to meet these conditions but their location must take into account the proper welding of the two streams of material into one composite whole.

In multiple cavity transfer molds it is customary to fill all cavities from a single pot. This does not present the problem of precisely balancing the quantity of charge in each pot as is the case when each cavity is fed from its own pot but does require that the location and size of the orifices leading from the single pot be properly balanced to insure all that cavities quickly receive adequate amounts of material.

Vents ★ Vents do much to simplify the molding operation. They need not be very large to permit the escape of air and a limited amount of material but they are useless as soon as they become blocked with reacted material. This requires that the location of the vents be chosen with care and that they be accessible for cleaning.

Vents may take various shapes and sizes. For example: they may be a loose fit where any two sections of a mold are in contact, knockout pins with a sloppy fit, clearance around pin or section that positions an insert, or grooves 1/8 in. or more wide and only .010 in. to .030 in. thick. The location should be at the point or points where air would be trapped if there were no vents or in what would commonly be called the "dead ends."

This is so simple and straightforward that its importance is often underestimated. When a charge is used in the form of powder, which has a bulk factor of 2.0 (most powder will have higher value for bulk factor), there is an amount of air in the charge equal to the volume of the molded piece. Even when a preform is used the bulk factor will be 1.3 or higher, which means that, though less than when powder is used, there is still an appreciable volume of air to be eliminated. How well the vents will serve their function will be influenced by how well the charge is compressed before becoming enveloped in a layer of partially reacted material, which may act as a seal and prevent any further escape of air or volatile matter, usually negligible in volume, from the granular unreacted center section. Thus, it is apparent that while proper venting is helpful, it is only one of several factors which contribute to successful molding.

Characteristics of

BAKELITE LOW-LOSS PHENOLICS

Specific gravity	1.90
Weight per cubic inch	31.3 gms.
Water absorption gain	0.07%
Molding shrinkage per inch	0.0025 in.
Heat resistance — not recommended for use where molded parts are to be subjected to temperatures higher than 275° F. (135° C.)	
Bulk factor	2.70
Recommended molding pressure — 3,000 to 5,000 lbs. per sq. in.	
Recommended molding temperature — 302 to 320° F. (150 to 160° C.)	
Power factor at 60 cycles	0.025
Power factor at 1,000 cycles	0.014
Power factor at 1 mc.	0.007
Dielectric constant at 60 cycles	5.5
Dielectric constant at 1,000 cycles	5.5
Dielectric constant at 1 mc.	5.0
Dielectric strength per mil at 60 cycles, inst.	475 volts
Dielectric strength per mil at 60 cycles, step by step	400 volts

This material, officially identified as BM 262 Natural, is generally known to radio designers as mica-filled Bakelite.

Ejection of the Part ★ Ejection of the molded article should be planned at the time the mold is designed. Any spoilage of parts or lost mold time in this phase of the operation will affect the production rate adversely. First considerations are to make sure that the side walls have at least 3° taper in the right direction, and that there are no undercuts even though experience with wood-flour filled materials has indicated slight undercuts to be unobjectionable.

As mentioned in the introduction of this article, low-loss materials shrink from mold dimensions only about one-third the amount that general purpose phenolic materials do. From the shape of the molding it may be possible to judge whether it will remain on the force or stay in the cavity when molded. If there is any doubt, a decision should be made as to where to make it stay, a means provided for doing this, and a means of ejection provided.

The area against which knockout pins work should be as large as is consistent with other elements of mold design. Knockout pins should be so placed that their tendency to distort the molding and thus interfere with its ejection will be reduced to a minimum. Some of these materials, those with lower heat distortion points, are more easily distorted after normal molding time at usual mold temperatures of 310° to 330° F., and this fact should be considered when providing for the ejection of an article to be molded from one of them. Air trapped between the mold surface and the molding may distort the molding to the extent that it tenaciously grips a mold surface, usually the force. Provision for venting this air during the molding operation or prior to opening the mold may greatly simplify the problem of removing the molding.

Surface Condition of Mold ★ The surface condition of the mold has a direct bearing on the ease with which moldings will be ejected. Chromium plating is highly recommended as providing a hard inert surface which will require much less maintenance than a steel surface. At the time of designing the mold this should be specified. The surface of the mold should be hard to resist any abrasion which the mineral fillers may cause though there is little evidence of actual scratching of a mold by the material.

Proper maintenance of the surface condition of the mold, by occasional use of a general purpose phenolic material and less frequently by repolishing, will simplify the problem of ejection and maintain a satisfactory molded appearance.

Multiple Cavity Molds ★ Multiple cavity molds are usually necessary for economical production, but the molding operation is much less critical if such a mold is composed of a series of identical cavities rather than several cavities of different size and shape. The cavities should be as nearly alike in all respects as possible. If they are different, it is often impractical, with the usual variations in charge weight, to insure that each cavity will receive the exact quantity of charge proper for it. Also, remembering that the normal variation in preform weight is 3% or more, it is apparent that a means must be provided for escape of excess material to some such extent. This will insure that several maximum weight preforms will not prevent the mold from closing normally and cause cavities with minimum weight preforms to have moldings lacking in density.

Mold Charge ★ Using a mold charge that is correct as to quantity, form, position, and temperature for a particular mold is especially important with low-loss phenolic materials and will do much to insure their economical molding. The object is to employ these factors to promote the maximum retention of material in the mold.

From the point of view of the production rate, it is important to realize that the time spent in preparing the mold charge need not interfere with the full utilization of the mold and press. On the contrary, intelligent preparation will substantially increase the production rate. Moldings of good quality are the direct result of precision and care with respect to each and every detail in the molding operation. This need for precision and care will appear troublesome only to the degree that a molder has acquired careless habits. However, once the molder become accustomed to taking certain precautions, and experiences for himself the decrease in rejections, he will think of his former unpredictable rejects as much more troublesome.

As these low loss materials are used in applications where it is essential that the moldings possess the maximum electrical properties inherent in the particular materials, it will not be possible to accept moldings only on the basis of satisfactory surface appearance. Approval must also be based on absence of any interior defects.

Quantity of Charge ★ The quantity of the charge used in any mold should be enough to provide a normal size molding of maximum density plus the amount that escapes as flash. A quite common tendency is to use less material than is required to achieve a molding of maximum density throughout.

Apparently this failure to use enough charge often is based on the observation that the quantity of flash seems normal or more than normal and, therefore, there is no need to use more. It is necessary to realize that material which escapes as flash may not have been forced out of the mold as surplus but may simply have escaped. Thus, the quantity of flash is not a valid basis on which to judge whether enough charge is being used.

With these materials especially, much of their apparent poor moldability can be corrected by using an adequate charge. To overcome poor moldability, the first step should be to increase the quantity of charge until either the moldings are satisfactory or the mold does not close as far as it should. In the event that the quantity of flash is excessive or the mold cannot be closed far enough, it may be possible to correct these faults by so forming and placing the charge that a lesser quantity can be used. In multiple cavity molds the balance between the quantity of charge in the individual cavities is important. When some good moldings and some poor moldings are obtained from a single mold cycle it should be apparent that some cavities are receiving an adequate or even an excessive charge while others are not. This is a common fault which can be corrected by balancing their charges properly. How closely balanced they need be is dependent upon the plasticity of the material and factors governing the ease with which surpluses can be expelled. Being on the "hard side", these material may require more uniform charges than softer materials.

Form of Charge ★ The charge is loaded into the mold as powder, or as one or more preforms (powder compressed into a particular shape), or a combination of the two. Powder loading should be avoided because of the amount of air intimately mixed with the particles of the material. This volume may be equal to that of the molded volume of the material, or it may range up to twice that volume.

As there may be factors in mold design or mold operation which will make it difficult to eliminate even a small amount of air from the charge, it is not wise to handicap the molding process by using powder. Other disadvantages of using powder are: it is dusty; some part of a charge may be inadvertently lost without being noticed; it cannot be placed accurately in the cavity, or placed very definitely; and powder may ride on flowing material and be carried out of the cavity.

Some mold designs, particularly those which have numerous metal inserts, appear to require that the form of the charge be powder. However, by the use of ingenuity, it may be found possible to use a specially-shaped preform or several preforms of similar or different shapes, or a combination of powder and one or more preforms. Unless a molder realizes the importance of the form of the charge, he will rarely exercise his ingenuity in this direction. Once he sees how greatly the use of a proper preform simplifies a particular molding problem, he will exert himself to obtain them. Preforms are now made in a great variety of shapes ranging from simple discs to modified rectangles with several indentations, holes, and projections.

The advantages of using preforms are: convenience in handling, reasonable uniform weight without weighing, and ability to place charge where most needed. When preforms are used they should be made with as little pressure as is consistent with their ability to withstand normal handling without breaking or chipping. Preforms, when first made, have been found to be considerably harder than those that have stood a week or more. This difference in the hardness of the preform may have an appreciable effect on the flow pattern of the material and thus on the quality of the molding.

One illustration will show the type of application where a combination of powder and preform may be used to advantage. A circular molding, essentially a thick-walled cup of 3 ins. outside diameter with three 1-in. projections, each with an area about 1/4 sq. in., extending from the bottom, presented a problem in the form of charge. Neither a shaped preform, a simple disc preform nor a powder charge were practical solutions. A very satisfactory solution was the use of enough powder to slightly more than fill the three projections when molded and a disc preform 2 1/2 ins. outside diameter and thick enough to supply the balance of the charge.

As the mold was closed, pressure was transmitted through the preform to the powder and the 1/4-in. clearance around the preform permitted the ready escape of the air displaced from the powder charge. Preforms with indentations or projections may be very helpful both in positioning inserts, such as those for condenser assemblies, and in making the molding operation less critical.

Position of the Charge ★ The position of the charge in the mold is important as it affects directly the ease with which it can be placed in the mold, and how much will be retained in the mold. The principle to follow in placing a charge is to make sure that the most inaccessible sections of a mold will fill first and that, as the material moves toward the cut-off or parting line, the air is forced ahead of it and out of the mold. Experienced operators become very clever at placing a charge just where it is needed to keep their rejects to a minimum.

With phenolic molding materials, which soften for a short time but never approach anything like a liquid state, it cannot be expected that the material will move readily to where it is needed in the mold. Molding material under pressure will follow the path of least resistance which, unless care has been exercised in placing the charge, may be a path right out of the mold cavity. As previously mentioned, preforms, particularly those designed for the mold, greatly facilitate placing the charge where it will do the most good. If powder has to be used, a properly designed loading tray may insure that the charge is uniformly placed in a particular section of each cavity of a multiple cavity mold.

Compression molds which have a combination of thin and thick sections in the direction of application of pressure present a difficult molding problem as the phenolic molding material in the thin section may become hard too quickly and prevent the necessary application of pressure to the thick section. One solution is to place the charge in the thick section where it will be under pressure before any of the material has been moved into the thin sections.

Capacitator cases are essentially deep cups, the walls of which form a rectangle when viewed from above, and extending at right angles from the rim are fastening lugs. In molding these cases, it is important that the charge be placed well into the cavity by using preforms rather than powder. If this is not done, material deposited in the section of the cavity forming the lugs may harden before the material in the side walls has been compressed to a dense molding. This lack of density in the side walls may result in light-colored streaks and the adhesion of particles of material to the mold surface.

Temperature of the Mold Charge ★ The temperature of the mold charge when it is placed in the mold determines, in combination with other factors, just how good a molding job will be done. The advantages of having the mold charged uniformly, at as high a temperature as is possible, cannot be over-estimated. Prewarming the charge not only eliminates moisture which could be very detrimental to the electrical properties of the molded piece, but it also drives out some of the air and provides, in advance, a considerable part of the heat energy needed to complete the reaction. Furthermore, it may make the charge more deformable.

A prewarmed charge, being already warm at its center, remains more uniform in consistency when placed in a hot mold, and compresses more uniformly, with less likelihood of entrapping pockets of gas or air which make molding difficult, and sound moldings unlikely to be achieved.

The charge, either as powder or preform, is a poor conductor of heat, though the denser preform is a proportionately better conductor than the powder. For this reason, if the charge is prewarmed, an appreciable time may be required to get heat to its center. This time can be lessened by keeping the mold charge, if powder, spread out in a layer not more than ¼ in. thick or, if preforms, restricting their thickness to ¼ in., or raising the temperature of the surrounding air. However, as the temperature is increased, the time for which the outside surface of the charge can stay at this temperature without reacting is decreased. By experience, a reasonable compromise between time and temperature has been found to be 30 minutes at 85° C. (185° F.) with the charge placed on a poor conductor of heat in an oven with circulating air.

As prewarming requires more handling of the charge, the advantage of using preforms becomes more apparent. There are circulating air ovens specially designed for this purpose with a number of drawers, each one to be used for the entire charge of a multiple cavity mold.

Considering the increase in production that can be directly attributed to prewarming, a molder can readily justify a considerable expenditure for the equipment necessary. This is another instance, similar to the design of shaped preforms, where considerable ingenuity can be exercised with profit.

For example: in molding small capacitors in a multiple cavity mold with 50 or more cavities and 2 preforms for each cavity, their prewarming presents a problem. If the complete molding cycle were 5 minutes, this problem could be solved by providing 14 loading trays of laminated sheet stock or plywood and 12 pairs of ledges on which to support all but 2 of them in an oven designed to circulate heated air between each layer. Once the oven were filled, the operator would proceed as without prewarming, except that he would take the loading trays for loading the mold out of the special oven and replace them with the pair he had just filled.

Mold Operation ★ As an introduction to the subject of mold operation, the importance of being able to control each factor closely, in order that it may be uniform from one cycle to the next, from day to day and from week to week, should be stressed. The mold mounted in the press appears so changeless and fixed that it is difficult to realize that there may be appreciable variation in the actual temperature of the mold surface, the pressure applied to the molding material, the rate of closing the mold, and the molding time.

The changes which do take place in the quality of moldings indicate that these may be variables, and not always under complete control. Therefore, all possible variables must be suspected of being guilty until proved innocent. There are automatic controls available and in use for each of the elements of mold operation. This indicates how important some molders consider this problem of reproducing mold operation.

> **THE War has given a tremendous impetus to the use of plastics for increasing production and reducing costs of many different items.**
>
> **In the radio industry, however, this has been true to a rather limited extent. This is largely because technical advances and changing requirements have kept electrical and mechanical designs in a state of flux.**
>
> **Another reason is the lack of assurance of continued production, which would justify the time and cost of molding dies. The steps from laboratory sample to preproduction model to the first line production on so much military radio-electronic equipment have been taken with mental reservations, therefore.**
>
> **When civilian manufacture of radio equipment can be resumed, production releases in large quantities will be under the control of the factory management. At that time, we may see broad revisions in apparatus design using to full advantage the many advances in molding technique. Assembly may be simplified by combining several elements into molded units. Mounting hardware will be replaced by bosses and other mechanical construction integral with parts they support. Brass and steel parts which require elaborate machining and stamping operations can be made less expensively by the use of metal-clad moldings.**
>
> **The radio engineer or designer who has a working knowledge of molding technique will enjoy a distinct advantage when he starts to work again on the design of civilian radio equipment, for he will be called upon to offset increased labor costs with new production economies.**

Mold Temperature ★ Mold temperatures control the rate at which phenolic molding materials will soften and then harden. The mean temperature of the mold surface during a molding cycle indicates the amount of energy available for completing the chemical reaction necessary to obtain an infusible molding.

Experience has shown that in a great many molds the optimum temperature is between 310° and 330° F. The mold temperature should be such that with the applied pressure the charge will warm through and compress evenly before the material in direct contact with the mold has become either excessively fluid or has started to harden. Lower mold-surface temperatures may, as a rule, reduce the molding speed, but by decreasing the rate at which materials harden it may be possible to compress the charge properly in thick sections without premature hardening in thin sections. Higher temperatures may as a rule, increase molding speed, but not when the material adjacent to the mold surface becomes extremely soft for a short period of time — so soft that it may be difficult to retain this material in the mold. If this happens, or if the material becomes hard before the granular center section has reached a softening temperature, the center section may not be compressed fully enough to eliminate the air and insure a molding of maximum density and best electrical properties. Even with longer molding time, molded pieces under these conditions will be poor in quality. With prewarmed, shaped preforms it is practical to use a higher temperature than is possible with a mold charge of powder at room temperature.

The alternate heating and cooling of a mold is a very unsatisfactory procedure and should be avoided. The operation wastes heat energy, usually decreases the production rate, and is difficult to control with precision. The rigidity of a molding increases as its temperature decreases.

The only time that cooling after molding may be entirely justified is to prevent the distortion of a sound, dense molding on ejection. While it has been fairly common practice to resort to cooling to overcome bulging or blistering, it is much better to change the mold design, the charge or the operation to prevent trapping of air. Upon cooling, the surface shell of the molding may become rigid enough to prevent the visual detection of the fault in its center.

However, the presence of such a fault may be noticed in a measurement of electrical properties, or visually noticed if the temperature of the molding either in service or in a test becomes sufficiently high. Certain jobs, where the most practical method of producing a sound molding is to load and close the mold while cool, may be speeded up if the mold is cooled as soon as the piece is ejected and heated at some time during the closing of the mold. This cold-hot cycle should not be confused with the hot-cold cycle as their effects on the material are different.

Pressure ★ Pressure is required to compress the mold charge, to make it fill out the mold, and to promote the transfer of heat from the mold surface to the material. The pressure available for the final close of the mold must be as high as is safe without danger of breaking the mold or any inserts. The pressure available is a considerable factor in determining the plasticity of a molding material which may be used, and still obtain well filled moldings with normal dimensions in the direction of the application of pressure. The characteristic of a given mass of thermosetting molding material to be deformed or plasticized at any instant is dependent upon its temperature, and the temperatures and heat to which it has been subjected.

Plasticity may vary both from point to point in the mass and with time. If the pressure available seems insufficient to close and properly fill out the mold, it may be possible to make it adequate by changing the form, distribution, or temperature of the mold charge, the mold, temperature or the rate of application of pressure. Low-loss Bakelite phenolic materials are offered in a limited range of plasticities or *flows*, to enable the molder to select to some extent the flow most nearly suited to his particular application.

Rate of Mold Closing ★ The rate of closing the mold has a direct bearing on the quality of the molding produced and must be done with precision, once the best rate has been determined from consideration of all of the factors involved.

The desired rate of close should insure slow and steady forcing of the air out of the mold as the material compresses and moves toward the cut-off. A common method which is satisfactory in some cases is to close the mold as far as possible with a low pressure (about 1,000 PSI on the molding), and then with high pressure (about 5,000 PSI on the molding).

However, if a mold closes too quickly, as may happen with this method, a softer surface layer of the mold charge may be carried right out of the mold without transmitting pressure to the core, the provisions for the escape of air and volatiles may be blocked off, and the resultant molding may be of less than maximum density. By adjusting a needle valve in the high pressure line, it is possible to determine, with no material in the mold, the setting for different slower rates of close from the moment high pressure is applied. This should be at the distance of ram travel where the force just touches the mold charge.

Then it is relatively simple to establish the best rate of close, which in many instances is from 15 to 20 seconds. If a mold closes too slowly, a surface layer, which softened first, may have hardened. Especially in thinner sections, where the transfer of heat will be more rapid, hard material may take the available pressure without deforming enough to put adequate pressure on thicker sections, where the transfer of heat will have been slower.

In most instances, once the material has been subjected to pressure, the pressure should not be released until the molding is ready to be ejected. Breathing, bumping, or degasing involves such a release of molding pressure and should be avoided. The object of such releases is to help eliminate the air and volatiles from the mold charge, but the same objective can be obtained by means less difficult to reproduce, and which will not separate the molded piece into two sections that may not weld together when pressure is reapplied.

Molding Time ★ Molding time is of primary importance to the molder, for it governs his production rate. A common practice is to use a molding time that is a little longer, about 10%, than is necessary to prevent the appearance of a bulge or blister.

This may lead to excessive molding times, if air has been trapped in the molding, for it will then be necessary to make the shell rigid enough to prevent the trapped air from distorting the molding. By changing elements in the mold charge or operation to permit the escape of air and the formation of a sound dense molding, the molding time can be reduced greatly. If moldings may be subjected to temperatures of about 100° C. (212° F.) in service or in assembly, a control test of baking a representative sample of moldings at 250° F. for 2 hours will detect any potential tendency to blister without destroying the satisfactory moldings.

In putting a new mold into production, it will be found helpful to cut moldings so as to expose a cross section, which, when sanded and buffed, will show how uniformly dense the molding is in this part. Since molding material, even at its maximum density, is a poor conductor of heat, it is obvious that adequate prewarming will greatly lessen the time required for any particular section of the mold charge to reach a given temperature. For this reason alone, prewarming would decrease molding time appreciably. As prewarming also facilitates the production of sound, dense moldings, the molded charges should be prewarmed because it increases the production rate, and permits shorter molding time.

Rectifying Unsatisfactory Moldings ★ When unsatisfactory moldings are being produced, the necessary changes to make them satisfactory are often obscure and may be small in magnitude. Though the trouble may be in the material, this possibility should not be assumed until possible faults in operation have been ascertained.

For the most permanent solution of molding troubles, the investigator should have a deepseated conviction that observed lack of quality in moldings can be due to unsound operation as well as to material. If the former is the fault, correction of the latter may have little permanent value.

The first step is to ascertain exactly and in detail what is wrong with the moldings. The second step is to consider whether factors in operation could cause these faults and, if so, what factors. The third step is to see if a correction in these factors will eliminate the faults. In the first step the following suggestions, where pertinent, may be helpful:

Make a qualitative description of the surface of the unsatisfactory molding and the cavity in which it was molded. In multiple cavity molds, observe the moldings from each cavity separately, as unsatisfactory moldings may be produced in only a limited number of cavities. Determine the density of the molding, which shows how well it is filled, by dividing the weight in air by the difference of the weight in water and the weight in air. Measure how much material is lost in flash by subtracting the weight of the molding without flash from the weight of charge used.

Measure with a micrometer the thickness of moldings in the direction of the application of pressure as a means of judging how much the quantity of charge may be increased. After such attention to detail, the investigator will be ready to correlate his findings with the factors in operation discussed in the preceding pages. A review of the principles set forth there should give a clue as to what might be done to improve the quality of the molded pieces.

Adhesion ★ Adhesion of actual particles of the material to the mold surface may be caused by a lack of pressure on the particular area. Often this adhesion is progressive, so that after a number of cycles the molding cannot be ejected or the mold opened.

The greater tendency of mineral-filled phenolic molding materials to adhere, compared to woodflour-filled materials, may be due to a lack of cohesion.

Though the natural reaction to adhesion is to consider the material as sticky, this does not help in overcoming the difficulty, and is not necessarily true, particularly if trouble is localized and large areas of a molding show no adhesion. Where there is evidence of lack of pressure on an area, one of the first steps taken for its correction should be to increase the quantity of charge until either the moldings are satisfactory or the mold does not close as far as it should. In the event that the flash is excessive or the mold cannot be closed far enough, these new faults should be corrected, according to the previous discussion, by alteration of such factors as will insure maximum retention of the material in the cavity.

Cracks ★ Cracks must be the result of a localized stress, which is greater than the strength of the material. One of the common causes of the stress may be different amounts of shrinkage in two sections of a molding, usually one thick section and a nearby thin section. The difference in shrinkage noticed in this case may be due to the abnormal shrinkage of the thick section which has not been molded to its maximum density while the thin section has been.

If this is the case, the crack may be prevented by insuring that the thick section as well as the thin section are molded to maximum density. The unequal rate of shrinkage of two sections of a molding may cause cracks. This may be due to the faster cooling and faster shrinking of one section as it comes into contact with a good conductor of heat. This can be corrected by insuring that all sections cool from molding temperature to room temperature at a uniform rate. Cracks may be due also to some internal pressure from trapped air which cannot distort the molding but can crack it.

Such a possibility should be investigated, particularly where a molding is cooled to considerable rigidity before releasing molding pressure. The shape and size of metal inserts may be a potential source of cracks even in moldings which are sound and dense throughout. The elimination of sharp corners or heavy knurling will be helpful, but sometimes an increase in the thickness of the material at the section where the crack occurs may be required.

Warping ★ Warping may be due to abnormal shrinkage in a section that is not molded to the density of the other sections. A flat piece with uniform cross section may warp from the unequal shrinkage of top and bottom surfaces. Molding material with greater moisture content at the time of molding shows a greater amount of shrinkage. Thus the top surface, towards which moisture may have been driven by holding the charge in the mold before application of pressure or by not turning the preform during prewarming, may shrink appreciably more than bottom surface.

Some warping may be due to an actual distortion of the molding when it is at a high enough temperature to be rather easily deformed. The correction for this is to prevent the distortion or to subject it to an opposite distortion by the use of a special fixture while it is still hot enough to be deformed.

Binding ★ Binding in the cavity or on the force may make it difficult to release the part. This is often inappropriately called *sticking*. It will be found helpful to avoid the use of the word *sticking*, and to distinguish between binding and adhesion by noting whether or not any particles have been removed from the molding.

Binding may be caused by the trapping of air between the molding and the mold surface. Uneven knockout pins can cause binding by distorting the molding to the point where it is difficult to remove.

Also, binding may be indistinguishable from incipient adhesion that is not sufficient to remove particles from the molding. To correct the binding, it may be possible to prevent the trapping of air between the molding and the mold surface by a change in the form of charge or the method of operation.

The provision of a properly placed vent in the mold design, permitting the escape of air during the molding operation or just prior to opening the mold will help eliminate the cause of binding. If adhesion causes difficulty in removing the molding from the mold, this might be determined by extra lubrication of the mold surface, though this might change the flow of the material and also tend to eliminate the trapping of air. If the difficulty seemed related to adhesion the steps outlined under Adhesion should be followed.

Pin or Insert Breakage ★ Pin or insert breaking is caused by the moving of material which is deformed only with difficulty against or beyond the inserts or pins. The hardness of the material is dependent entirely on the temperature and history of the small volume under consideration, and is not a fixed property of the material.

The desirable condition to prevent breaking is to have the inserts subject only to compression by placing and forming the charge so that the insert or pin is not in the path of a moving charge. In particular, the operation of the mold should insure as far as possible that the mold charge is uniformly plastic at the time the mold is finally closed.

Precure ★ Precure is in reality a short due to the reaction of material in the particular area too much before the final application of pressure. The first step is to consider it a short and add more material to the quantity of charge, increase the prewarming or decrease the rate of closing. If the appearance is poorer, it is a precure. Then it can be corrected by decreasing the amount of prewarming or the time the charge is in contact with the mold surface before pressure is applied, or by lowering the temperature of the mold surface.

Conclusion ★ The foregoing information is not offered with the thought of encouraging radio engineers to attempt the supervision of molding operations. That would require far more complete instruction, plus long experience which can be gained only in a molding plant.

On the other hand, it is necessary for the designer of molded parts to have a well-coördinated understanding of the use of and requirements for the dies from which his parts will be produced.

Molds must be designed to meet the requirements of good molding technique. Therefore, parts must be so designed that they can be made from molds designed in accordance with good molding practice. The part, the mold, and the method must each be considered in relation to the other two factors. Only when this is done can a completely satisfactory result be obtained.

MEMORANDUM ON NAVY RADIO APPARATUS DESIGN

Navy Department
Bureau of Ships
Washington, D. C.

The following memorandum, originally prepared for limited distribution in the Design Branch of the Radio Division, has been approved for publication by the Office of Public Relations.

THE Bureau views with concern the trend toward increasingly complex radio and allied electronics equipment. This tendency is objectionable because of:

A. The large variety of slightly different components to be manufactured for initial production.

B. The difficulties confronting servicing personnel in maintaining equipment.

C. The astronomically large variety of components that must be carried in stocks throughout the world.

It is fully realized that in part the equipment complications arise in improvements intended to afford the Fleet with equipment of improved operating characteristics.

It is also realized that electronics designers have been schooled for years to strive, in particular, for perfect performance from each circuit. Frequently this urge to reach perfection has resulted in assemblages of circuits that not only meet the overall performance characteristics desired, but also have a large margin of unuseable capacity.

The Bureau desires design supervisors be instructed to examine carefully each proposed design with a view to the ultimate production of the simplest equipment possible, functionally satisfactory.

A *few* examples of the questions that should be considered during such an examination are:

A. Considering the overall performance desired, is this special component (transformer, condenser, etc.,) actually necessary or will a component now in production be really

(CONTINUED ON PAGE 62)

HIGH-FREQUENCY MARINE RADIO UNIT

A Companion Unit to the Intermediate-Frequency Installations for Liberty Ships

BY E. J. GIRARD *

THE intermediate-frequency Marine Radio Unit [1] which was developed by the Federal Telephone and Radio Corporation has substantially affected wartime shipbuilding, operators' training, and the operation and maintenance of ship radio equipment. This was officially recognized by the U. S. Maritime Commission through its award to the radio division of F.T. & R. of the "M" Pennant, Victory Fleet Flag, and Merit Badges.

Another original conception of our Company, now being adopted by ship architects in the U. S. A., is the high-frequency Marine Radio Unit. This is an entirely self-contained high-frequency ship installation which includes the transmitter, receiver, and power supply in a single housing, with a projecting shelf for operating purposes. This is illustrated in Fig. 1.

In addition to providing a simple, flexible, and effective way of supplying long-distance communications facilities over a continuously variable frequency range of 2 to 24 mc. to any ship, it possesses advantages as regards installation, training, operating, and service comparable with the intermediate-frequency Marine Radio Unit.

The development of these two communications equipments enables ship designers and marine architects to determine well in advance the exact space requirements needed for a complete, modern radio room installation, including both medium and high-frequency apparatus. As a result of the invariable dimensions of the two types of units, and consequent uniformity of installations, adequate but not excessive space accommodations can be provided in advance for radio operations quarters. Waste of valuable capacity in the hull construction can be avoided. In fact, this equipment is definitely setting the pattern for the design of radio rooms on many of the new vessels.

HF Unit ★ The cabinet of the new high-frequency unit is of the same height and depth as the preceding intermediate-frequency unit, so that they can be installed side-by-side as companion equipment. When the two are operated in conjunction, power for the high frequency circuits can be obtained from the motor-generator in the intermediate unit, so that no motor-generator need be included in the former assembly. The keying relays of the two transmitters can then be wired together, and the high-frequency transmitter keyed from the desk panel of the other unit.

FIG. 1. SELF-CONTAINED HIGH-FREQUENCY TELEGRAPH TRANSMITTER FOR SHIPS

As shown in Fig. 1, the transmitting circuits occupy the upper section, while the receiver is located in the center section, directly above the desk panel shelf. A motor-generator to provide high voltage DC, and AC for the filament transformer is located in the bottom compartment.

In line with its modern conception and design, the equipment embodies a number of features which contribute to overall efficiency, usefulness, and ease of operation. Of special importance for wartime operations is the provision for continuous tuning over the entire frequency range of 2 to 24 mc. Changeover to frequencies not ordinarily included in commercial ship-frequency bands can be effected to make detection of transmitted signals difficult for hostile forces. This also helps to make location of the transmitter by means of a direction-finder more difficult.

Continuous tuning is accomplished by the use of a self-excited oscillator. The oscillator tuning range is divided into 8 bands, with ample overlap. A micrometer-type precision dial makes it possible to duplicate any frequency setting with great accuracy.

The 10 crystals provided in this transmitter permit operation on 40 crystal-controlled frequencies. Fundamental oscillator frequencies are from 1 to 2 mc. and the resulting output frequencies from 2 to 24 mc. are obtained through multiplying stages. Frequency stability with the self-excited oscillator exceeds 0.05%, while with crystal operation it is better than 0.02%.

Circuit Features ★ Two 813 beam power tetrodes in parallel in the power amplifier circuit provide a minimum RF output of 200 watts in the range between 2 and 16 mc. when operated into a normal ship's antenna. The output between 16 and 24 mc. is 150 watts.

Special antennas are not required for obtaining these outputs, inasmuch as a matching network is employed for antenna tuning. This permits operation at any frequency into a wide variety of radiators. Consequently, the antenna used with the ship's intermediate-frequency transmitter will operate satisfactorily with the high-frequency equipment.

Beam power tubes, employed in all but the oscillating circuit, eliminate neutralizing. The oscillator is a 76 triode. Four 6L6 tetrodes link the oscillator to the power amplifier, the first connected as an isolating buffer, and the remaining three as frequency multipliers. Four output frequencies are obtained from each oscillator frequency by combination of the multiplier stages.

A special feature of the circuit is the method of connecting the power amplifier and the multiplier tubes in cascade. This can be seen in Fig. 3. The current first flows through the power amplifier tubes and a regulating resistor. Current flowing in the power amplifier stage, therefore, controls the potential applied to the multiplier plates and screens. The circuit further provides against high frequency voltages in the power amplifier plate circuit that would otherwise occur should the antenna circuit be detuned or opened. Decreasing current in the power amplifier plate circuit when the load is removed

*Commercial Director, Federal Telephone and Radio Corporation, Newark, N. J.

[1] "Federal Marine Radio Unit," *FM Magazine*, January, 1942.

results in an immediate decrease in the grid drive, so that current flowing in the driver stages, as well as in the power amplifier stages, is reduced to low values.

The following description is presented for those who are interested in the details of the frequency multiplier circuit, shown in Fig. 3:

A triode oscillator, housed in a shielded compartment at the base of the equipment, operates over the fundamental band of 1 to 2 mc. The oscillator band is divided into 8 sections which, with the micrometer dial employed, permit frequency selection and resettability of a high order. A crystal switch provides for the selection of any one of 10 crystals, connecting the desired crystal across the grid circuit of the oscillator tube. Another section of the crystal switch inserts a fixed condenser in the ground side of the grid feedback winding. This condenser maintains weak oscillation with the crystal removed, but does not affect crystal operation to any extent. An 11th position on this crystal switch grounds the grid circuit for self-excited operation. A triode tube is employed as an oscillator because it is less subject to frequency changes as a result of voltage variations and keying conditions than a pentode type.

A buffer amplifier tube is used to isolate the oscillator electrically from the succeeding stages, and to permit loading of the oscillator plate circuit to be reduced to a low value. This stage is untuned.

Both the oscillator and buffer tubes obtain their plate supply directly from the DC line through a filter system. Keying is in the cathode circuit of the oscillator tube. The separate oscillator plate supply prevents frequency change as a result of amplifier plate current variations.

Three frequency multiplying stages are employed to increase the oscillator frequency 2 to 12 times, resulting in output frequencies of 2 to 24 mc. Arrangement of the multiplier stages is as follows:

Osc. Range	*Mult. No. 1 Range*	*Mult. No. 2 Range*	*Mult. No. 3 Range*
1–2 mc.	2–4 mc.	4–8 mc.	8–16 mc.
			12–24 mc.

A frequency multiplier switch selects the number of multipliers required to produce the desired output frequency, disabling the unused multipliers by removing their plate and screen voltages. If, for instance, the output frequency desired is in the 8–16-mc. band, the multiplier switch is put in position 3, and all three multiplier stages are tuned. There will be but one point on any dial where resonance is indicated, and all three multiplier dials will be placed at similar readings. All three multipliers employ 6L6 tubes and tuned plate circuits. The first two stages are doublers, while the third stage functions as a doubler or a tripler to attain an overall frequency multiplication of 8 or 12 times, as the case may be.

The third stage incorporates two separate tuned circuits for doubling or tripling, the required combination being cut into circuit by the multiplying selector switch in the 3rd and 4th positions. The tuning condensers for both circuits are mounted on the same shaft, and the dial settings are similar. A milliammeter with an associated switch is used to read the plate-screen current of each frequency multiplier stage as it is tuned.

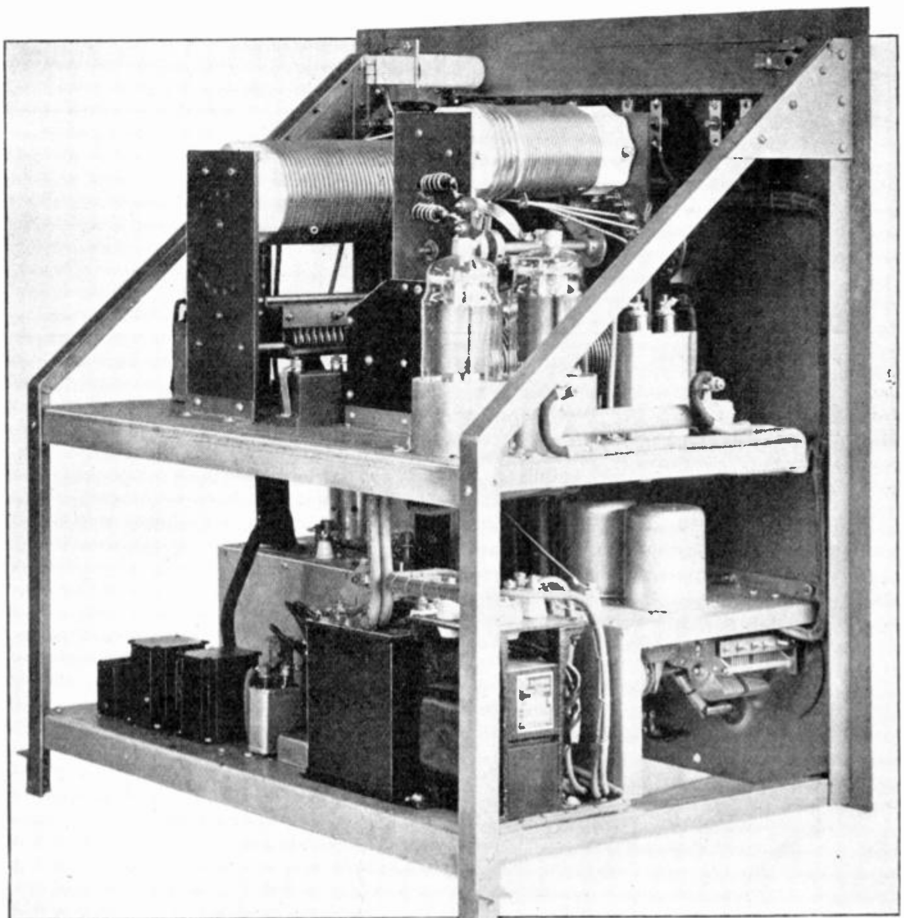
Two 813 beam power tubes in parallel are used in the power amplifier stage. The grids of these tubes are connected by means of the multiplier selector switch to the output of whichever frequency multiplier is required to produce the desired frequency.

Power Supplies ★ When the transmitter operates from its own power supply, the power source from the ship's mains can be either 115 or 230 volts DC. Two types of motor-generators can be furnished. Installations providing continuous-wave emission only are equipped with a motor-generator capable of supplying 1,750 volts DC at 0.4 ampere for the plate circuits, and 78 volts AC at 120 cycles for operating the tube filaments. The alternating current is obtained from slip rings on a DC motor.

For CW-MCW (A2) installations, a second type of motor-generator provides, in addition to the above outputs, 200 volts AC at 700 cycles for plate modulation. The motor starter for both types of rotating units consists of an escapement type of time starter, with suitable starting resistance to bring the motor up to speed without placing an excessive load on the DC line. In addition, the starter is equipped with a pair of auxiliary contacts which function as a time delay of approximately 15 seconds, to prevent keying until sufficient time has elapsed to permit the heater-type tubes in the driver stages to assume operating temperatures. If power for the high-frequency unit does not include 700-cycle AC, a separate motor-generator can be provided to supply AC at this frequency for MCW operation.

Installation ★ Installation of the complete high-frequency Marine Radio Unit, when it is furnished with its own power supply, is simply a matter of attaching the antenna lead to the post at the top of the cabinet, and connecting the terminals of the power circuits to the ship's mains. The latter connection is made through a knockout at the rear of the unit. If the high-frequency equipment is to be operated in conjunction with the intermediate-frequency Marine Radio Unit, suitable interconnections are made between the two equipments, so that power to operate the high-frequency unit can be obtained from the other unit. A switch must be installed in the intermediate-frequency

FIG. 2. CLOSE-UP OF TRANSMITTER. PANEL IS HINGED AT BOTTOM TO THE CABINET



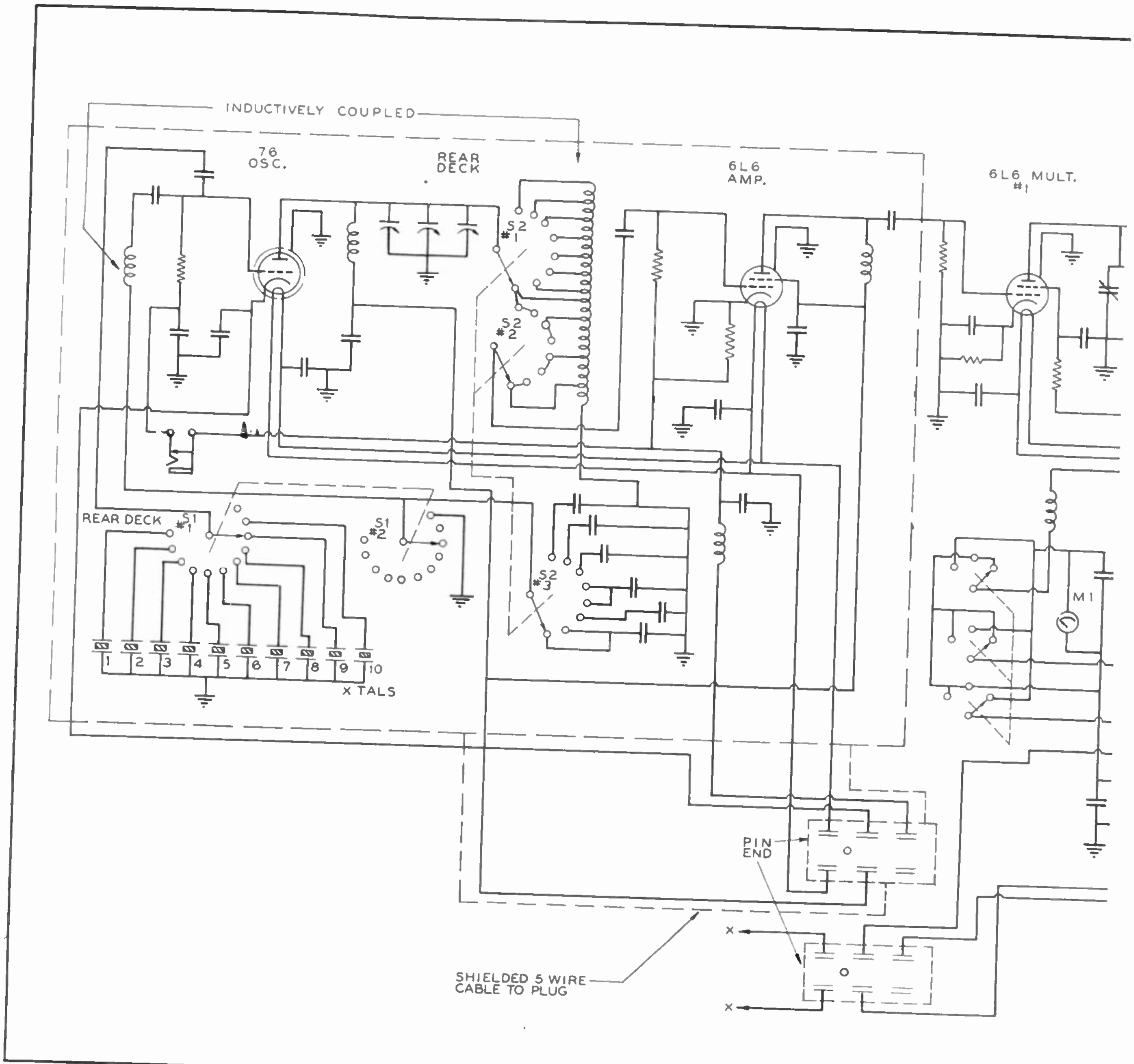


FIG. 3. CIRCUIT OF THE FEDERAL HIGH-FREQUENCY MARINE TRANSMITTER WHICH CAN BE INSTALLED MERELY BY CONNECTING

unit to permit switching the power supply from one to the other. The keying relays are connected in series, so that a single key serves for both.

As can be seen in Fig. 1, the entire transmitter panel is hinged at the bottom so that it can be dropped forward when in the cabinet, giving complete access to the tubes and components. Fig. 2 shows the transmitter panel removed from the cabinet. Unit construction and easy accessibility characterize the design of this assembly. The arrangement is compact and functional.

The arrangement of the meters and controls, reading from left to right and from the top down is as follows:

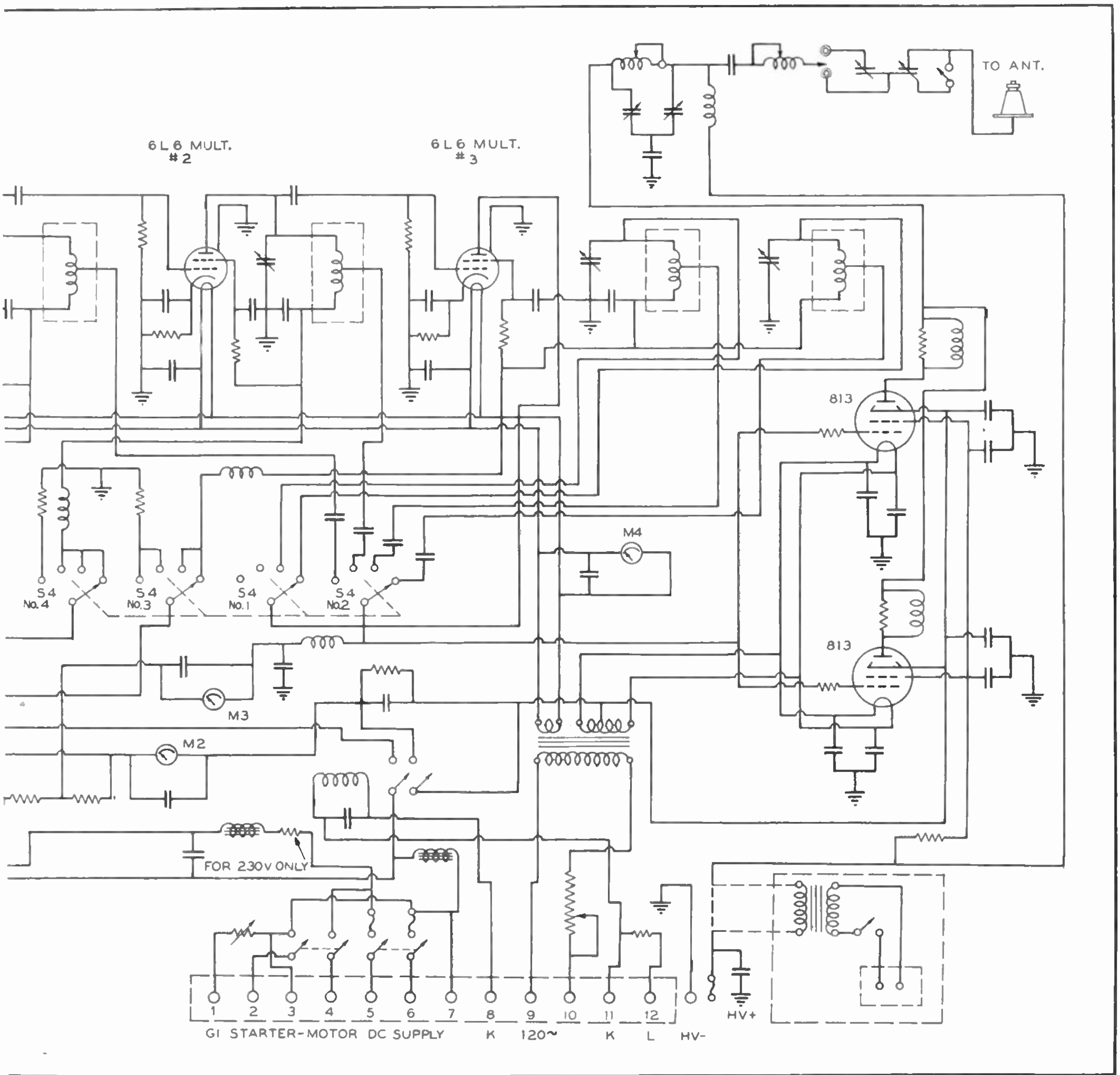
Meters: Amplifier grid current
Amplifier plate current
Multiplier plate current
Filament voltage
Antenna current

Controls: First row —
Amplifier range
Antenna switch
Antenna inductance
Second row —
Antenna coupling
Amplifier tuning
Antenna tuning
Center —
Plate current
Bottom row —
Multiplier No. 3
Multiplier selector
Multiplier No. 2
Frequency check
Multiplier No. 1
Oscillator range
Oscillator tuning
Crystal selector

The controls at the left of the receiver are for the field rheostat and the CW-MCW switch, and at the right, for the filament rheostat and the starter switch.

This arrangement brings all frequency adjustments and operating controls to the front panel, eliminating the necessity of making any internal adjustments with the transmitter panel let down.

Summary ★ This new high-frequency Marine Radio Unit makes available complete long-distance communications equipment employing the unit construction principle for shipboard radio installations. High-frequency radio transmitting and receiving equipment supplements the inter-



POWER SOURCE AND ANTENNA. THIS DIAGRAM SHOWS THE DETAILS OF THE MULTIPLYING CIRCUITS FOR TUNING FROM 2 TO 24 MC.

mediate-frequency installations on ships and permits, through the choice of proper operating frequencies, direct communication with points far beyond the range of the standard frequency apparatus.

Since long-distance communication is accomplished with relatively low power on high frequencies, economy of operating the ship's radio is maintained, while the range is vastly extended. With the elimination of ship-to-ship relaying of messages, accuracy and reliability are increased, and the delivery of messages to home ports is accelerated greatly.

War has increased the number of long marine voyages, with resultant need for high-frequency equipment. Ships located at the other side of the world must carry equipment capable of communication with their home ports directly, since it is no longer possible to route traffic through land radio stations and land networks, and submarine cables are not available in certain areas. Then, too, the indications are that the postwar period will impose similar necessity for long-distance ship communications.

The ability to maintain secrecy through the practice of changing frequency at predetermined intervals makes the continuous tuning features incorporated in this equipment of special value. Furthermore, this same feature is also useful in avoiding interference between stations, since it permits operation just far enough off the frequency of the interfering station to prevent interruption of communications, while staying in the same channel. This degree of flexibility is not afforded by straight crystal control.

Ease and simplicity of installation made possible through unit construction are especially important now, in saving man-hours and in speeding the completion of ships for our wartime fleet. As in the case of the assembly line, which has replaced the older methods of manufacture, this new type of construction may well be the precursor of all future ship's radio installations, in view of its inherent economy and efficiency, both from the standpoint of installation and maintenance. Compactness, made possible by this type of design, also offers many advantages to ship designers.

Standardizing on the location of operating controls was found, in the case of the original intermediate-frequency transmitter, to accelerate and simplify the training of radio operators.

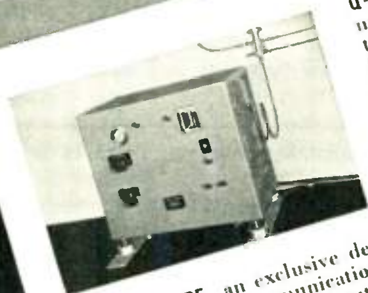
Ever "Call up" a Locomotive?

In the railroad systems of Tomorrow, it is possible that locomotives will be reached by telephone—as easily as you would "call up" the drug store today. By means of radiotelephony a yardmaster, for example, may contact locomotive engineers in their cabs, or conductors, yard foremen and other supervisory personnel in direct two-way communication.

Indeed, the postwar potentialities for expansion of communications through new applications of radio and television have only begun to be explored. In precisely what new directions this expansion may go, and how soon, is of course still anybody's guess.

Right now, the entire output of Communication Products is needed for war purposes. But with Victory, the items shown here will again be available for peacetime purposes. And if their contribution to the war program is any indication, these products will have a vital part to play in Tomorrow's applications.

Q-MAX A-27 is a remarkable new, extremely low-loss, fast air-drying lacquer for use in treatment or impregnation of radio frequency components. Applied by dipping and brushing.



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STERLING SWITCHES, with pure silver contacts for long electrical life, are available in two standard sizes. Of rugged construction, they are adaptable to many circuit arrangements.
ANTENNAS AND RADIATING SYSTEMS include all standard H.F. and U.H.F. models as well as special units to meet individual specifications.

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Galvin Mfg. Corp., Chicago, Ill.
★ Link, F. M., 125 W. 17th St., N. Y. C.
Premax Products, 4214 Highland Ave., Niagara Falls, N. Y.
★ Radio Eng. Labs., Inc., L. I. City, N. Y.
★ Snyder Mfg. Co., Noble & Darien Sts., Phila.
Tech. Appl. Co., 516 W. 34 St., N. Y. C.
Ward Products Corp., 1523 E. 45 St., Cleveland, O.

ANTENNAS, Tower Type

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

ATTENUATORS

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

BEADS, Insulating

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

BEARINGS, Glass Instrument

Bird, Richard H., Waltham, Mass.

BINDING POSTS, Plain

★ Amer. Hdware Co., 476 B'way, N. Y. C.
Radex Corp., 1308 Elston Ave., Chicago

BINDING POSTS, Push Type

★ Amer. Radio Hdware Co., 476 B'way, N. Y. C.
Eby, Inc., H. H., W. Chelten Ave., Phila.

BLOWERS, for Radio Equipment

L-R Mfg. Co., Torrington, Conn.
Trade-Wind Motorfans, Inc., 5725 S. Main St., Los Angeles

BOOKS on Radio & Electronics

Macmillan Co., 60 Fifth Ave., N. Y. C.
Maedel Pub. House, 593AE 38 St., Bklyn, N. Y.
McGraw-Hill Book Co., 330 W. 42 St., N. Y. C.
Pitman Pub. Corp., 2 W. 45 St., N. Y. C.
Radio Tech. Pub. Co., 45 Astor Pl., N. Y. C.
Rider, John F., 404 Fourth Ave., N. Y. C.
Ronald Press Co., 15 E. 26 St., N. Y. C.
Van Nostrand Co., D., 250 Fourth Ave., N. Y. C.
★ Wiley & Sons, John, 440 Fourth Ave., N. Y. C.

BRIDGES, Percent Limit Resistance

Leeds & Northrup Co., 4901 Stenton Ave., Phila.
★ Radio City Products Co., 127 W. 26 St., N. Y. C.
Shallcross Mfg. Co., Collingdale, Pa.

BRIDGES, Wheatstone

Industrial Instruments, Inc., Culver Ave., Jersey City, N. J.
Leeds & Northrup Co., 4901 Stenton Ave., Phila.
Shallcross Mfg. Co., Collingdale, Pa.

NEW LISTINGS ADDED THIS MONTH

Company addresses will be found in the Directory listings

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

RADIO RECEIVERS, TRANSMITTERS

Abbott Instrument, Inc.
Aircraft Radio Corp.
Air Communications, Inc.
Air King Products Co.
Airplane & Marine Inst., Inc.
Andrea Radio Corp.
Amplex Engineering, Inc.
Arnessen Electric Co.
Automatic Radio Mfg. Co.
Bassett, Inc.
Belmont Radio Corp.
Bendix Radio, Div. of Bendix Aviation Corp.
Berger Electronics
Boes Co.
Browning Laboratories, Inc.
Bunnel & Co., J. H.
Burnett Radio Lab.
Colonial Radio Corp.
Communications Co., Inc.
Conn. Tel. & Electric Co.
Continental Radio & Telev. Corp.
Cover Dual Signal Systems, Inc.
Crosley Corp.
de Forest Labs.
Delco Radio
Detrola Corp.
De Wald Radio Mfg. Corp.
Dictaphone Corp.
Echophone Radio Co.
Eckstein Radio & Telev. Co., Inc.
Electrical Ind. Mfg. Co.
Elect. Research Lab., Inc.
Electronic Communications Co.
Electronic Specialty Co.
Emerson Radio & Phono. Corp.
Espey Mfg. Co., Inc.
Fada Radio & Electric Corp.
Federal Electronics Div.
Federal Tel. & Radio Corp.
Finch Telecommunications, Inc.
Fisher Research Lab.
Freed Radio Corp.
Garod Radio Corp.
Gates Radio & Supply Co.
General Communication Co.
General Electric Co.
General Telev. & Radio Corp.
Gibbs & Co.
Gilfillan Bros., Inc.
Girdler Corp.
Gray Mfg. Co.
Gray Radio Co.
Grenby Mfg. Co.
Guided Radio Corp.
Hadley Co., R. M.
Hallicrafters Co.
Halstead Traffic Com. Corp.
Hamilton Radio Corp.
Hammarlund Mfg. Co.
Harrel, D. H.
Harvey Machine Co., Inc.
Harvey Radio Labs. Inc.
Hazeltine Electronics Corp.
Herbach & Rademan Co.
Hollywood Electronics Co.
Horni Signal Mfg. Co.
Howard Radio Co.
Hudson American Corp.
Jefferson-Travis Radio Mfg. Corp.
Karadio Corp.
Kemlite Labs.
Lear Avia, Inc.
Lewyt Corp.
Link, F. M.
Machlett Laboratories, Inc.
Magnavox Co.
Majestic Radio & Tel. Corp.
McElroy Mfg. Corp.
Megard Corp.
Midwest Radio Corp.
Millen Mfg. Co., Inc.
National Co., Inc.
Noblitt-Sparks Ind., Inc.
North Amer. Philips Co.
Operadio Mfg. Co.
Panoramic Radio Corp.
Philco Corp.
Philharmonic Radio Corp.
Pierson-De Lane, Inc.
Pilot Radio Corp.
Powers Electronic & Communication Co.
Precision Tube Co.
Press Wireless, Inc.
Radio Corp. of Amer.
Radio Engineering Labs.
Radio Frequency Labs.
Radio Mfg. Engineers, Inc.
Radiomarine Corp. of Amer.
Radio Receptor Co., Inc.
Radio Transceiver Labs.
Richardson-Allen Corp.
Rosen Co., Raymond
Rauland Corp.
Sanborn Co.
Schuttig & Co.
Scott Radio Labs., Inc.
Seeburg Corp., J. P.
Sentinel Radio Corp.
Setchell-Carlson, Inc.
Smith Co., Maxwell
Sonora Radio & Telev. Corp.
Sparks-Withington Co.
Sperry Gyroscope Co.
Sperti, Inc.
Stewart-Warner Corp.
Stromberg-Carlson Co.
Transmitter Equip. Mfg. Co.
Trebor Radio Co.
Troy Radio & Telev. Co.
Warwick Mfg. Corp.
Watterson Radio Mfg. Co.
Waugh Laboratories
Western Electric Co.
Westinghouse Elect. & Mfg. Co.
Wilcox Electric Co.
Zenith Radio Corp.

BUSHINGS, Hermetic Sealing

Corning Glass Works, Corning, N. Y.
Westinghouse Elect. & Mfg. Co., E. Pittsburgh, Pa.

BUSHINGS, Terminal Sealing

Corning Glass Works, Corning, N. Y.
Peerless Electrical Prod. Co., 6920 McKinley Ave., Los Angeles 1
Westinghouse Elect & Mfg. Co., E. Pittsburgh, Pa.

CABLE, Coaxial

American Phenolic Corp., 1830 S. 54 Av., Chicago
Anaconda Wire & Cable Co., 25 B'way, N. Y. C.
★ Andrew Co., Victor J., 363 E. 75 St., Chicago
Belden Mfg. Co., 4673 W. Van Buren, Chicago
Boston Insulated Wire & Cable Co., Boston
★ Communications Prods. Co., Jersey City, N. J.
Cornish Wire Co., 15 Park Row, N. Y. C.
Doolittle Radio, Inc., 7521 S. Loomis Blvd., Chicago
General Cable Corp., 420 Lexington, N. Y. C.
General Insulated Wire Corp., 53 Park Pl., N. Y. C.
Johnson Co., E. F., Waseca, Minn.
Radex Corp., 1308 Elston Ave., Chicago
Simplex Wire & Cable Corp., Cambridge, Mass.

CABLE, Coaxial, Solid Dielectric

American Phenolic Corp., 1830 S. 54 Ave., Chicago
★ Federal Tel. & Radio Corp., E. Newark, N. J.
Simplex Wire & Cable Corp., Cambridge, Mass.

CABLE, Microphone, Speaker & Battery

Alden Prods. Co., Brockton, Mass.
Anaconda Wire & Cable Co., 25 Broadway, N. Y. C.
Belden Mfg. Co., 4633 W. Van Buren, Chicago
Boston Insulated Wire & Cable Co., Dorchester, Mass.
Gavett Mfg. Co., Brookfield, Mass.
Holyoke Wire & Cable Corp., Holyoke, Mass.

CABLES, Preformed

Belden Mfg. Co., 4633 W. Van Buren St., Chicago

CASES, Wooden Instrument

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

CASTINGS, Die

Aluminum Co. of Amer., Pittsburgh, Pa.
American Brass Co., Waterbury, Conn.
Dow Chemical Co., Dow Metal Div., Midland, Mich.

CERAMICS, Bushings, Washers, Special Shapes

Akron Porcelain Co., Akron, O.
Amer. Lava Corp., Chattanooga, Tenn.
Centralab, Div. of Globe-Union Inc., Milwaukee, Wis.
Corning Glass Works, Corning, N. Y.
Electronic Mechanics, Inc., Paterson, N. J.
Gen'l Ceramics & Steatite Corp., Keasbey, N. J.
Isolantite, Inc., Belleville, N. J.
Lapp Insulator Co., Leroy, N. Y.
Louthan Mfg. Co., E. Liverpool, O.
Star Porcelain Co., Trenton, N. J.
Steward Mfg. Co., Chattanooga, Tenn.
Stupakoff Ceramic & Mfg. Co., Latrobe, Pa.
Victor Insulator Co., Victor, N. Y.
Westinghouse Elect. & Mfg. Co., E. Pittsburgh, Pa.

CHASSIS, Metal

See STAMPINGS, Metal

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
Gen. 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.

COIL FORMS, Phenolic, Cast without Molds

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

COILS, Radio

See Transformers, IF, RF

CONDENSERS, Ceramic Case Mica 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, 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 Ave., N. Y. C.
Automatic Winding Co., E. 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.

Eimac gets another "E"

Mass production of a device that has always been hand made in a laboratory is an achievement in itself. But when the whole nation gives pause to *recognize outstanding excellence in this mass production* the achievement becomes all the more striking.

Such honors have been bestowed upon the Eimac organizations not once but twice. First to the San Bruno, California, plant (September 1942) and second, less than a year later, to a plant in Salt Lake City, Utah, that is little more than one year old.

Where does the credit go?... to the men and women at the Salt Lake City plant now for their recent triumph ... and to the men and women of both plants always for their collective cooperation and hard work.

Follow the leaders to **Eimac** REG. U.S. PAT. OFF. **TUBES**

EITEL-McCULLOUGH, INC, SAN BRUNO, CALIF.

Plants Located at: San Bruno, Calif., Salt Lake City, Utah

Export Agents: FRAZAR & HANSEN, 301 Clay Street, San Francisco, California, U. S. A.

Cosmic Radio Co., 699 E. 135th St., N. Y. C.
Crowley & Co., Henry, 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.
Guthman & Co., Edwin I., 15 S. Throop St., Chicago
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
Noma Electric Corp., 55 W. 13 St., N. Y. C.
Polymet Condenser Co., 699 E. 139 St., N. Y. C.
Potter Co., 1950 Sheridan Rd., N. Chicago
★ RCA Mfg. Co., Camden, N. J.
Sangamo Elec. Co., Springfield, Ill.
Sickles Co., F. W., Chicopee, Mass.
Solar Mfg. Corp., Bayonne, N. J.
Sprague Specialties Co., N. Adams, Mass.
Teleradio Engineering Corp., 484 Broome St., N. Y. C.
Westinghouse Elect. & Mfg. Co., E. Pittsburgh, Pa.

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.
General Electronics, Inc., Paterson, N. J.

CONDENSERS, Small Ceramic Tubular

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

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 Clybourn 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., 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.
Airadio, Inc., Stamford, Conn.
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., 363 E. 75 St., 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
Kellogg Switchboard & Supply Co., 6650 S. Cicero Ave., Chicago
Mallory & Co., P. R., Indianapolis, Ind.
Monowatt Electric Co., Providence, R. I.
Northam Warren Corp., Stamford, Conn.
★ Radio City Products Co., 127 W. 26 St., N. Y. C.
Remler Co., Ltd., 2101 Bryant St., San Francisco
Schott Co., W. L., 9306 Santa Monica Blvd., Beverly Hills, Calif.
Selectar Mfg. Co., L. I. City, N. Y.
★ Universal Microphone Co., Ltd., Inglewood, Calif.

SCHEDULE OF DIRECTORIES

RADIO-ELECTRONIC PRODUCTS
February, April, June, August, October, December

CHIEF ENGINEERS OF BROADCAST STATIONS
March, September

POLICE RADIO COMMUNICATIONS OFFICERS
January, July

CHIEF ENGINEERS OF RADIO MANUFACTURERS
May, November

Under this schedule, FM RADIO-ELECTRONICS presents up-to-date listings, with complete corrections and additions, which are available in no other publication.

CONTACT POINTS

Brainin Co., C. S., 233 Spring St., N. Y. C.
Callite Tungsten Corp., Union City, N. J.
Mallory & Co., Inc., P. R., Indianapolis, Ind.

COUPLINGS, flexible

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

CRYSTAL GRINDING EQUIPMENT

Cons. Diamond Saw Blade Corp., Yonkers Ave., Yonkers 2, N. Y.
Felker Mfg. Co., Torrance, Calif.

CRYSTAL HOLDERS

REC Mfg. Co., Holliston, Mass.

CRYSTALS, Quartz

Aircraft Accessories Corp., 9 Rockefeller Plaza, N. Y. C.
Bausch & Lomb Optical Co., Rochester, N. Y.
Bliley Elec. Co., Erie, Penna.
Collins Radio Co., Cedar Rapids, Iowa
Crystal Prod. Co., 1519 McGee St., Kansas City, Mo.
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.
Henney Motor Co., Omaha, Nebr.
Higgins Industries, Santa Monica, Calif.
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.
Knights Co., The James, Sandwich, Ill.
Meck Industries, John, Plymouth, Ind.
Miller, August E., North Bergen, N. J.
Monitor Piezo Prod. Co., S. Pasadena, Calif.
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.
Reeves Sound Labs., 62 W. 47 St., N. Y. C.
Scientific Radio Products Co., Council Bluffs, Ia.
Scientific Radio Service, Hyattsville, Md.
Standard Piezo Co., Carlisle, Pa.
Valpey Crystals, Holliston, Mass.
★ Wallace Mfg. Co., Wm. T., Peru, Ind.
Zeiss, Inc., Carl, 485 Fifth Ave., N. Y. C.

DIAL LIGHTS

See PILOT LIGHTS

DIALS, Instrument

Crowe Name Plate Co., 3701 Ravenswood Ave., Chicago
General Radio Co., Cambridge, Mass.
Gits Molding Corp., 4600 Huron St., Chicago
Mica Insul. 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

ENAMELS, Wood & Metal Finish

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

ENGRAVING MACHINES

★ Auto-Engraver Co., 1776 B'way, N. Y. C.

ETCHING, Metal

Crowe Name Plate & Mfg. Co., 3701 Ravenswood Ave., Chicago
Etched Prod. Corp., 39-01 Queens Blvd., Long Island City, N. Y.
Premier Metal Etching Co., 21-03 44th Ave., Long Island City, N. Y.

FACSIMILE EQUIPMENT

Alden Products Co., Inc., Brockton, Mass.

FASTENERS, Separable

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

FELT

Amer. 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
Com. Equip. & Eng. Co., N. Parkside Ave., Chicago
★ Freed Radio Corp., 200 Hudson St., N. Y. C.
Kellogg Switchboard & Supply Co., 6650 S. Cicero Ave., Chicago
Mallory & Co., Inc., P. R., Indianapolis, Ind.
Miller Co., J. W., 5917 S. Main St., Los Angeles
Tobe Deutschmann Corp., Canton, Mass.

FINISHES, Metal

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

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 Corp., Boonton, N. J.
North Amer. Philips Co., Inc., 419 Fourth Ave., N. Y. C.

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.
Quaker City Gear Wks., Inc., N. Front St., Phila.
Thompson Clock Co., 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, Electronic AC

Communication Meas. Lab., 118 Greenwich St., N. Y. C.

GENERATORS, Gas Engine Driven

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

GENERATORS, Hand Driven

Burke Electric Co., Erie, Pa.
Carter Motor Co., 1608 Milwaukee, Chicago
Chicago Tel. Supply Co., Elkart, Ind.

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.

GLASS, Electrical

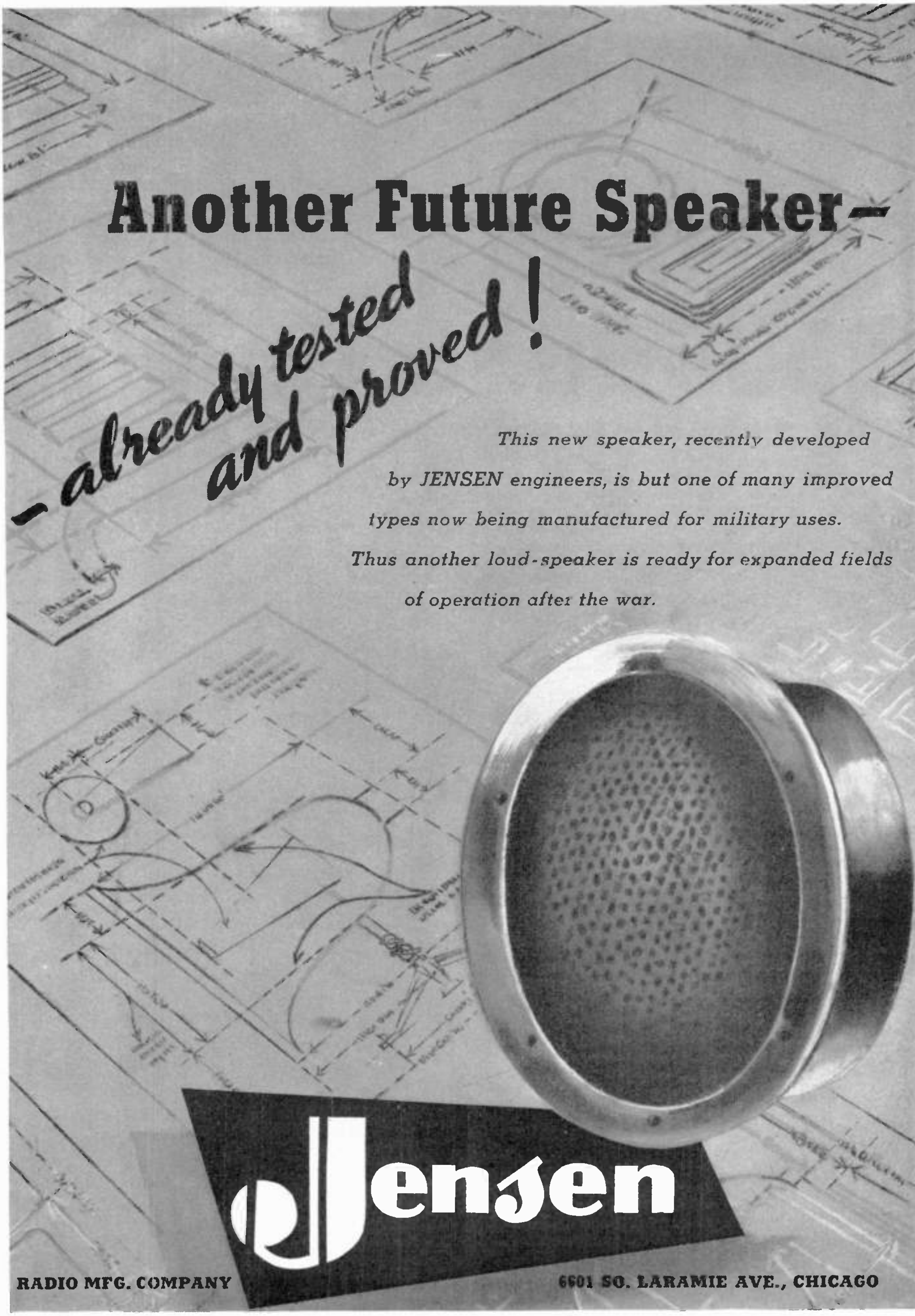
Corning Glass Works, Corning, N. Y.

GREASE, for Electrical Contacts & Bearings

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

HEADPHONES

Brush Development Co., Cleveland, O.
Conn. Tel. & Electric Co., Meriden, Conn.
Cannon Co., C. F., Springwater, N. Y.
Carron Mfg. Co., 415 S. Aberdeen, Chicago
Connecticut Tel. & Elec. Co., Meriden, Conn.
Consolidated Radio Prod. Co., W. Erie St., Chicago
Elec. Ind. Mfg. Co., Red Bank, N. J.
Kellogg Switchboard & Supply Co., 6650 S. Cicero Ave., Chicago
Murdock Mfg. Co., Chelsea, Mass.
Permoflux Corp., W. Grand Ave., Chicago
Telephonics Corp., 350 W. 31 St., N. Y. C.
Trimm Radio Mfg. Co., 1770 W. Berteau, Chicago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—already tested and proved!
This new speaker, recently developed by JENSEN engineers, is but one of many improved types now being manufactured for military uses. Thus another loud-speaker is ready for expanded fields of operation after the war.
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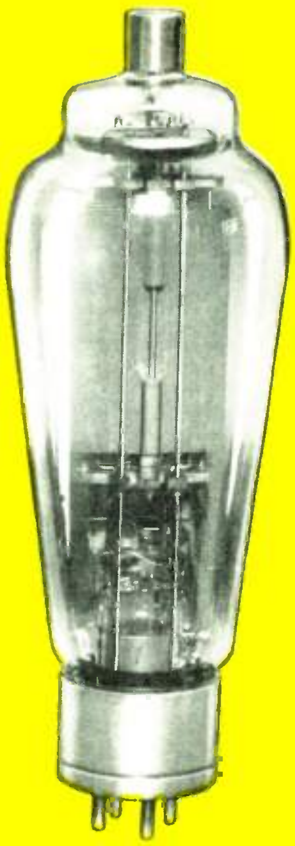

GL-169 (and GL-159)

Transmitting triodes—for police radio

Old price $80
NEW PRICE $60

GL-880

High-frequency triode—for international short-wave, frequency modulation

Old price $850
NEW PRICE $600

GL-893

Transmitting triode—for broadcast, international short-wave, and also for high-frequency heating

Old price $750
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UTAH'S ON THE JOB! . . . Code messages must go through! Every piece of communication equipment must work with precision and perfection.

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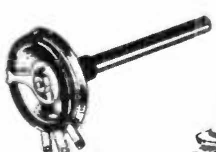
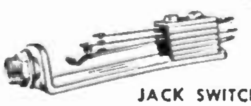


POTENTIOMETER

PUSH-BUTTON SWITCH

TU-WAY PHONE PLUG

TRANSFORMER



JACK SWITCH

BI-DIRECTIONAL SPEAKER

Brilhart Co., Arnold, Great Neck, N. Y.
Catalin Corp., 1 Park Av., N. Y. C.
Celanese Celluloid Corp., 180 Madison Av., N. Y. C.
Chicago Molded Prods. Corp., 1024 N. Kolmar, Chicago
Continental-Diamond Fibre Co., Newark, Del.
Creative Plastics Corp., 963 Kent Ave., B'klyn, N. Y.
Dow Chemical Co., Midland, Mich.
Durez Plastics & Chemicals, Inc., N. Tonawanda, N. Y.
Extruded Plastics, Inc., Norwalk, Conn.
Formica Insulation Co., Cincinnati, O.
★ General Electric Co., Plastics Dept., Pittsfield, Mass.
General Industries Co., Elyria, O.
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.
Remler Co., Ltd., 2101 Bryant St., San Francisco
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, Materials

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

PLASTICS, Transparent

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

PLATING, Metal on Molded Parts

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

PLUGS (Banana), Spring Type

★ Amer. Radio H'dw're Co., 476 B'way, N. Y. C.
Birnbach Radio Co., 145 Hudson St., N. Y. C.
Eastman Kodak Co., Rochester, N. Y.
Eby, Inc., Hugh H., Philadelphia, Pa.
Franklin Mfg. Corp., 175 Varick St., N. Y. C.
General Radio Co., Cambridge, Mass.
Johnson Co., E. F., Waseca, Minn.
Mallory & Co., Inc., P. R., Indianapolis, Ind.
Ucinite Co., Newtonville, Mass.

PLUGS, Telephone Type

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

PLYWOOD, Metal Faced

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

RACKS, Standard Aircraft Types

Delco Radio, Kokomo, Ind.

RACKS & PANELS, Metal

See STAMPINGS, Metal

RADIO RECEIVERS & TRANSMITTERS

Abbott Instrument, Inc., 8 W. 18 St., N. Y. C. 3
Aircraft Radio Corp., Boonton, N. J.
Air Communications, Inc., 2233 Grant Ave., Kansas City, Mo.
Air King Products Co., 1523 63rd Ave., Brooklyn, N. Y.
Airplane & Marine Inst., Inc., Clearfield, Pa.
Andrea Radio Corp., 43-20 34th St., Long Island City, N. Y.
Amplex Engineering, Inc., New Castle, Ind.
Arnessen Electric Co., 116 Broad St., N. Y. C.
Automatic Radio Mfg. Co., 122 Brookline Ave., Boston, Mass.
Bassett, Inc., Rex, Ft. Lauderdale, Fla.
Belmont Radio Corp., 5921 Dickens Ave., Chicago
Bendix Radio, Div. of Bendix Aviation Corp., Baltimore, Md.
Berger Electronics, 109 01 72nd Rd., Forrest Hills, N. Y.
Boes Co., The W. W., Dayton, O.
Browning Laboratories, Inc., Winchester, Mass.
Bunnell & Co., J. H., 215 Fulton St., N. Y. C.
Burnett Radio Lab., 4814 Idaho St., San Diego, Calif.
Colonial Radio Corp., Rano St., Buffalo, N. Y.
Communications Co., Inc., Coral Gables, Fla.
Conn. Tel. & Elec. Co., Meriden, Conn.
Continental Radio & Telev. Corp., 3800 W. Cortland St., Chicago
Cover Dual Signal Systems, Inc., 125 W. Hubbard St., Chicago
Crosley Radio Corp., Cincinnati, O.
de Forest Labs, Lee, 5106 Wilshire Blvd., Los Angeles
Delco Radio, Kokomo, Ind.
Detrola Corp., 1501 Beard Ave., Detroit, Mich.
De Wald Radio Mfg. Corp., 436 Lafayette St., N. Y. C.
Dictaphone Corp., 420 Lexington Ave., N. Y. C.
Echophone Radio Co., 201 E. 26 St., Chicago
Eckstein Radio & Telev. Co., Inc., 1400 Harmon Pl., Minneapolis, Minn.
Electrical Ind. Mfg. Co., Red Bank, N. J.
Elect. Research Lab., Inc., Evanston, Ill.
Electronic Communications Co., 36 N. W. B'way, Portland, Ore.
Electronic Specialty Co., Glendale, Calif.
Emerson Radio & Phone Corp., 111 8th Ave., N. Y. C.
Espey Mfg. Co., Inc., 305 E. 63 St., N. Y. C.
Fada Radio & Elec. Corp. 30-20 Thomson Ave., Long Island City, N. Y.
Federal Electronics Div., 209 Steuben St., B'klyn, N. Y.
Federal Tel. & Radio Corp., Newark, N. J.
Finch Telecommunications, Inc., Passaic, N. J.
Fisher Research Lab., Palo Alto, Calif.
Freed Radio Corp., 200 Hudson St., N. Y. C.
Garod Radio Corp., 70 Washington St., B'klyn, N. Y.
Gates Radio & Supply Co., Quincy, Ill.
General Communication Co., 681 Beacon St., Boston, Mass.
General Electric Co., Schenectady, N. Y.
General Telev. & Radio Corp., 1240 N. Homan Ave., Chicago
Gibbs & Co., Thomas B., Delavan, Wis.
Gilfillen Bros., Inc., 1815 Venice Blvd., Los Angeles, Calif.
Girdler Corp., Louisville, Ky.
Gray Mfg. Co., Hartford, Conn.
Gray Radio Co., West Palm Beach, Fla.
Grenby Mfg. Co., Plainville, Conn.
Guided Radio Corp., 161 6th Ave., N. Y. C.
Hadley Co., R. M., 707 E. 61 St., Los Angeles
Hallicrafters Co., 2611 Indiana Ave., Chicago
Halstead Traffic Com. Corp., 155 E. 44 St., N. Y. C.
Hamilton Radio Corp., 510 Sixth Ave., N. Y. C.
Hammarlund Mfg. Co., 460 W. 34th St., N. Y. C.
Harrel, D. H., 1527 E. 74 Pl., Chicago
Harvey Machine Co., Inc., 6200 Avalon Blvd., Los Angeles
Harvey Radio Labs, Inc., Cambridge, Mass.
Hazeltine Electronics Corp., Great Neck, N. Y.
Herbach & Rodeman Co., 522 Market St., Phila.
Hollywood Electronics Co., 800 Sunset Blvd., Los Angeles
Horni Signal Mfg. Co., 310 Hudson St., N. Y. C.
Howard Radio Co., 1731 Belmont Ave., Chicago
Hudson American Corp., 62 W. 47 St., N. Y. C.
Jefferson-Travis Radio Mfg. Corp., 245 E 23 St., N. Y. C.
Karadio Corp., 1400 Harmon Pl., Minneapolis, Minn.
Kemlite Labs., 1809 N. Ashland Ave., Chicago
Lear Avia, Inc., Piqua, O.
Lewyt Corp., 60 B'way, B'klyn, N. Y.
Link, F. M., 125 W. 17 St., N. Y. C.
Machlett Labs., Inc., Springdale, Conn.
Magnavox Co., Indianapolis, Ind.
Majestic Radio & Tel. Corp., 2600 W. 50 St., Chicago
McElroy Mfg. Corp., Brookline Ave., Boston
Megard Corp., 381 W. 38 St., Los Angeles, Calif.
Midwest Radio Corp., Cincinnati, O.
Millen Mfg. Co., Inc., Malden, Mass.
National Co., Inc., Malden, Mass.
Noblitt-Sparks Ind. Inc., Columbus, Ind.
North Amer. Philips Co., 100 E. 42 St., N. Y. C.
Operadio Mfg. Co., St. Charles, Ill.
Panoramic Radio Corp., 245 W. 55 St., N. Y. C. 19
Philco Corp., Tioga & C Sts., Philadelphia, Pa.
Philharmonic Radio Corp., 216 Williams St., N. Y. C.
Pierson-DeLane, Inc., 2345 W. Washington Blvd., Los Angeles
Pilot Radio Corp., Long Island City, N. Y.
Powers Electronic & Communication Co., Glen Cove, N. Y.
Precision Tube Co., 3828 Terrace St., Phila. 28
Press Wireless, Inc., 1475 B'way, N. Y. C.
Radio Corp. of Amer., Camden, N. J.
Radio Engineering Labs., Long Island City, N. Y.
Radio Frequency Labs., Inc., Boonton, N. J.
Radio Mfg. Engineers, Inc., Peoria, Ill.
Radiomarine Corp. of Amer., 75 Varick St., N. Y. C.
Radio Receptor Co., Inc., 251 W. 17 St., N. Y. C.
Radio Transceiver Labs., 86 27 115th St., Richmond Hill, L. I.
Richardson-Allen Corp., 15 W. 20 St., N. Y. C.
Rosen Co., Raymond, 32 & Walnut Sts., Phila.
Rauland Corp., Chicago, Ill.
Sanborn Co., Cambridge 39, Mass.
Schuttig & Co., 9th & Kearny Sts., Washington, D. C.
Scott Radio Labs, Inc., 4450 Ravenswood Ave., Chicago
Seeburg Corp., J. P., 1500 N. Dayton St., Chicago
Sentinel Radio Corp., Evanston, Ill.
Setchell-Carlson, Inc., 2233 University Ave., St. Paul, Minn.
Smith Co., Maxwell, 1027 N. Highland Ave., Hollywood, Calif.
Sonora Radio & Telev. Corp., 325 N. Hoyne Ave., Chicago
Sparks-Withington Co., Jackson, Mich.
Sperry Gyroscope Co., Garden City, N. Y.
Sperti, Inc., Cincinnati, O.
Stewart-Warner Corp., 1826 Diversey Pkwy., Chicago
Stromberg-Carlson Co., Rochester, N. Y.
Transmitter Equip. Mfg. Co., 345 Hudson St., N. Y. C.
Trebor Radio Co., Pasadena, Calif.
Troy Radio & Telev. Co., 1144 S. Olive St., Los Angeles, Calif.
Warwick Mfg. Corp., 4640 W. Harrison St., Chicago
Watterson Radio Mfg. Co., 2608 Ross Ave., Dallas, Tex.
Waugh Laboratories, 420 Lexington Ave., N. Y. C.
Western Electric Co., 195 B'way, N. Y. C.
Westinghouse Elec. & Mfg. Co., Wilkens Ave., Baltimore, Md.
Wilcox Electric Co., 14th & Chestnut Sts., Kansas City, Mo.
Zenith Radio Corp., 6001 Dickens Ave., Chicago, Ill.

RECTIFIERS, Current

Benwood Linze Co., St. Louis, Mo.
Continental Elec. Co., 903 Merchandise Mart, Chicago
★ Electronics Labs., Indianapolis, Ind.
Fansteel Metallurgical Corp., N. Chicago, Ill.
★ General Electric Co., Bridgeport, Conn.
Green Elect. Co., Inc., 130 Cedar St., N. Y. C.
International Tel. & Radio Mfg. Corp., E. Newark, N. J.
Mallory & Co., P. R., Indianapolis, Ind.
Nothelfer Winding Labs., Trenton, N. J.
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.
Birtcher Corp., 5087 Huntington Dr., Los Angeles 32
Electrical Prod. Supply Co., 1140 Venice Blvd., Los Angeles 15
G-M Laboratories, Inc., 4313 N. Knox Ave., Chicago
Guardian Elec. Co., 1400 W. Wash. Blvd., Chicago
Potter & Brumfield Co., Princeton, Ind.
Sigma Instruments, Inc., 76 Freeport St., Boston, Mass.
Struthers Dunn, Inc., 1326 Cherry St., Philadelphia
Ward-Leonard Elec. Co., Mt. Vernon, N. Y.

RELAYS, Small Telephone Type

Amer. Automatic Elect. Sales Co., 1033 W. Van Buren St., Chicago
Clare & Co., C. P., 4719 W. Sunnyside Ave., Chicago
Guardian Elec. Co., 1400 W. Wash. Blvd., Chicago
Wick Organ Co., Highland, Ill.

RELAYS, Stepping

Advance Elect. Co., 1260-A W. 2nd St., Los Angeles
Automatic Elect. Co., 1032 W. Van Buren St., Chicago
Autocall Co., Shelby, O.
Guardian Elect. Mfg. Co., 1620 W. Walnut St., Chicago
Presto Elect. Co., N. Y. Ave., Union City, N. J.
Struthers Dunn, Inc., Arch St., Phila.

RELAYS, Time Delay

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

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.
★ Utah Radio Prod. Co., 842 Orleans St., Chicago
Ward-Leonard Elec. Co., Mt. Vernon, N. Y.
White Dental Mfg. Co., 10 E. 40th St., N. Y. C.
Wirt Co., Germantown, Pa.

RESISTORS, Fixed Precision

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 Laboratory Type

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

RESISTORS, Variable

★ Aerovox Corp., New Bedford, Mass.
Allen-Bradley Co., Milwaukee, Wis.
Amer. 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
Kellogg Switchboard & Sup. Co., 6650 S. Cicero Ave., Chicago
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

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, Clutch Head

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

SCREWS, Recessed Head

American Screw Co., Providence, R. I.
Bristol Co., The, Waterbury, Conn.
Chandler Prods. Co., Cleveland, O.
Continental Screw Co., New Bedford, Mass.
Corbin Screw Corp., New Britain, Conn.
Federal Screw Prod. Co., 224 W. Huron St., Chicago
International Screw Co., Detroit, Mich.
Lamson & Sessions, Cleveland, O.
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.
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.

SHEETS, Electrical

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

SHIELDS, Tube

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

SHOCK ABSORBERS

See MOUNTINGS, Shock Absorbing

SOCKETS, Cathode Ray Tube

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

SOCKETS, Tube

Aladdin Radio Industries, 501 W. 35th St., Chicago
Alden Prods. Co., Brockton, Mass.
Amer. Phenolic Corp., 1830 S. 54th Av., Chicago
★ Amer. Radio 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.
Nat'l Fabricated Products, W. Belden Ave., Chicago
Ucinite Co., Newtonville, Mass.

SOLDER, Self-fluxing

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

SOLDER POTS

★ Elec. Soldering Iron Co., Inc., Deep River, Conn.
Lectrohm, Inc., Cicero, Ill.
Westinghouse Elect. & Mfg. Co., E. Pittsburgh, Pa.

SPEAKERS, Cabinet Mounting

Cinaudagraph Speakers, Inc., 3911 S. Michigan Ave., Chicago
Crescent Industries, Inc., Belmont Ave., Chicago
★ Jensen Radio Mfg. Co., 6601 S. Laramie St., Chicago
John Meck, Industries, Plymouth, Ind.
Magnavox Co., Fort Wayne, Ind.
Rola Co., Inc., Superior St., Cleveland, O.
★ 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
Ace Mfg. Corp., 1255 E. Erie Ave., Phila. 24
American Spring & Mfg. Corp., Holly, Mich.
American Steel & Wire Co., Rockefeller Bldg., Cleveland, O.
Barnes Co., Wallace, Bristol, Conn.
Crescent Industries, Inc., 4132 W. Belmont Ave., Chicago
Cuyahoga Spring Co., Cleveland, O.
Gibson Co., Wm. D., 1800 Clybourn Av., Chicago
Hubbard Spring Co., M. D., Pontiac, Mich.
Hunter Pressed Steel Co., Lansdale, Pa.
Instrument Specialties Co., Little Falls, N. Y.
Muehlhausen Spring Corp., Logansport, Ind.
Peck Spring Co., Plainville, Conn.
Raymond Mfg. Co., Corry, Pa.
Security Steel Equip. Corp., Avenel, N. J.
Standard Spring & Mfg. Co., Ind., 236–42 St., Brooklyn, N. Y.
★ Willor Mfg. Corp., 794 E. 104 St., N. Y. C. 54

STAMPINGS, Metal

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

STEATITE, See Ceramics

SUPPRESSORS, Parasitic

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

SWITCHES, Aircraft Push

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

SWITCHES, Key

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

SWITCHES, Micro

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

The Browning Electronic Signal System is the answer to the new call to reduce the Guard Force personnel at war plants and at public utility installations . . .

"PRODUCT OF
BROWNING LABORATORIES RESEARCH"

RELEASES GUARD FORCE PERSONNEL

MORE and more war plants and public utilities are reducing the cost of property protection by the use of Browning Electronic Signal System installations.

Now the War Department and Navy Department have announced plans to provide more man-power for the production of vitally needed matériel by reducing the number of men engaged in guard duty at privately owned war plants.

"A similar program already carried out by the Ordnance Department in Government and privately owned explosive plants in which it has security control has resulted in a reduction of approximately 14,000 guard personnel."

The effectiveness with which the Browning Electronic Signal System replaces military police has been demonstrated by long service. Data on Browning Systems now in use is available on request to executives of war production plants and public utilities.

The Browning Electronic Signal System not only sounds an alarm when an intruder approaches a restricted area, but actuates a location indicator. This protection is applicable within buildings or outdoors where electrical installations, storage tanks, and flying fields must be under guard continuously.

No lights are used. There is nothing to indicate that the restricted area is equipped with an alarm system. It is not necessary for the intruder to touch any part of the installation. There is no exposed part of the system that could be rendered inoperative. The electronic unit, illustrated above, is rugged in construction, yet so enormously is its sensitivity multiplied that it sets off an alarm when any person merely approaches wires connected to it.

Installation can be made quickly and easily. Maintenance is simple. The cost is so low that it is soon paid by the saving in wages effected by the guard personnel it replaces.

BROWNING LABORATORIES, INC. WINCHESTER MASS.

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

SYNTHETICS, Wood & Metal Finish

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

TERMINALS, Hermetically Sealed

See BUSHINGS, Terminal Sealing

TERMINALS, Soldered or Solderless

See LUGS, Soldering and Solderless

TERMINAL STRIPS

Burke Electric Co., Erie, Pa.
Cinch Mfg. Corp., W. Van Buren St., Chicago
Curtis Devel. & Mfg. Co., N. Crawford Ave., Chicago
Franklin Mfg. Corp., 175 Varick St., N. Y. C.
Jones, H. B., 2300 Wabansia, Chicago
Kulka Electric Mfg. Co., Mt. Vernon, N. Y.

TEST CHAMBERS, Temperature, Humidity, Altitude, Salt Spray

American Coils Co., 25 Lexington St., Newark, N. J.
Industrial Filter & Pump Mfg. Co., W. Carroll Ave., Chicago
Kold-Hold Mfg. Co., 446 N. Grand Ave., Lansing, Mich.
Mobile Refrigeration, Inc., 630–5th Ave., N. Y. C.
Northern Engineering Labs., 50 Church St., N. Y. C.
Tenney Engineering, Inc., Montclair, N. J.

TRACING PAPERS, CLOTH, CELLOPHANE

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

TRANSFORMERS, Constant-Voltage Power

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

TRANSFORMERS, IF, RF

Aladdin Radio Industries, 501 W. 35th St., Chicago
Amer. Transformer Co., Newark, N. J.
Automatic Windings Co., E. Passaic, N. J.
★ Browning Labs., Inc., Winchester, Mass.
Cambridge Thermionic Corp., Concord Ave., Cambridge, Mass.
Caron Mfg. Co., 415 S. Aberdeen, Chicago
D-X Radio Prods. Co., 1575 Milwaukee, Chicago
Essex Specialty Co., Inc., Broad St., Newark, N. J.
Gen'l Winding Co., 420 W. 45 St., N. Y. C.
Greyhound Equip. Co., 1720 Church Ave., Brooklyn, N. Y.
Guthman & Co., 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.
Radex Corp., 1308 Elston Ave., Chicago
Sickles Co., F. W., Springfield, Mass.
Standard Winding Corp., Newburgh, N. Y.
Super Elec. Prod. Corp., Jersey City, N. J.
Teleradio Eng. Corp., 484 Broome St., N. Y. C.
Triumph Mfg. Co., 4017 W. Lake, Chicago

TRANSFORMERS, Receiver Audio & Power

Acme Elec. & Mfg. Co., Cuba, N. Y.
Amer. Transformer Co., Newark, N. J.
Amplifier Co. of Amer., 17 W. 20th St., N. Y. C.
Audio Devel. Co. N. Minneapolis, Minn.
Chicago Transformer Corp., 3501 Addison St., Chicago
Cinaudagraph Speakers, Inc., 3911 S. Michigan, Chicago
Dinion Coil Co., Caledonia, N. Y.
Dongan Elec. Co., 74 Trinity Pl., N. Y. C.
Electronic Trans. Co., 515 W. 29 St. N. Y. C.
Ferranti Elec., Inc., 30 Rockefeller Plaza, N. Y. C.
Freed Trans. Co., 72 Spring St., N. Y. C.
Gen'l Radio Co., Cambridge, Mass.
General Trans. Corp., 1250 W. Van Buren, Chicago
Halldorson Co., 4500 Ravenswood, Chicago
Jefferson Elec. Co., Bellwood, Ill.
Kenyon Transformer Co., 840 Barry St., N. Y. C.
Magnetic Windings Co., Easton, Pa.
★ Merit Coil & Trans. Corp., 311 N. Desplaines St., Chicago 6
Newark Transformer Co., Newark, N. J.
New York Transformer Co., 51 W. 3rd, N. Y. C.
Norwalk Transformer Corp., S. Norwalk, Conn.
Raytheon Mfg. Co., Waltham, Mass.
Rola Co., Inc., Superior St., Cleveland, O.
Standard Transformer Corp., 1500 N. Halsted, Chicago
Super Elect. Prod. Co., Jersey City, N. J.
Superior Elec. Co., Bristol, Conn.
Thermador Elect. & Mfg. Co., Riverside Dr., Los Angeles
Thordarson Elec. Mfg. Co., 500 W. Huron, Chicago
★ Utah Radio Prods. Co., 820 Orleans St., Chicago
★ United Transformer Co., 150 Varick St., N. Y. C.
Westinghouse Elect. & Mfg. Co., E. Pittsburgh, Pa.

TRANSFORMERS, Variable Voltage

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

TUBE MANUFACTURING MACHINES

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

TUBES, Cathode Ray

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

TUBES, Current Regulating

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

TUBES, Photo-Electric

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 & Northrop Co., Philadelphia
Nat'l Union Radio Corp., Newark, N. J.
Photobell Corp., 123 Liberty St., N. Y. C.
★ RCA Mfg. Co., Camden, N. J.
Rectron Corp., 2159 Magnolia Av., Chicago
Westinghouse Lamp Div., Bloomfield, N. J.
Western Elec. Co., 195 B'way, N. Y. C.
Weston Elec. Inst. Corp., Newark, N. J.

TUBES, Receiving

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

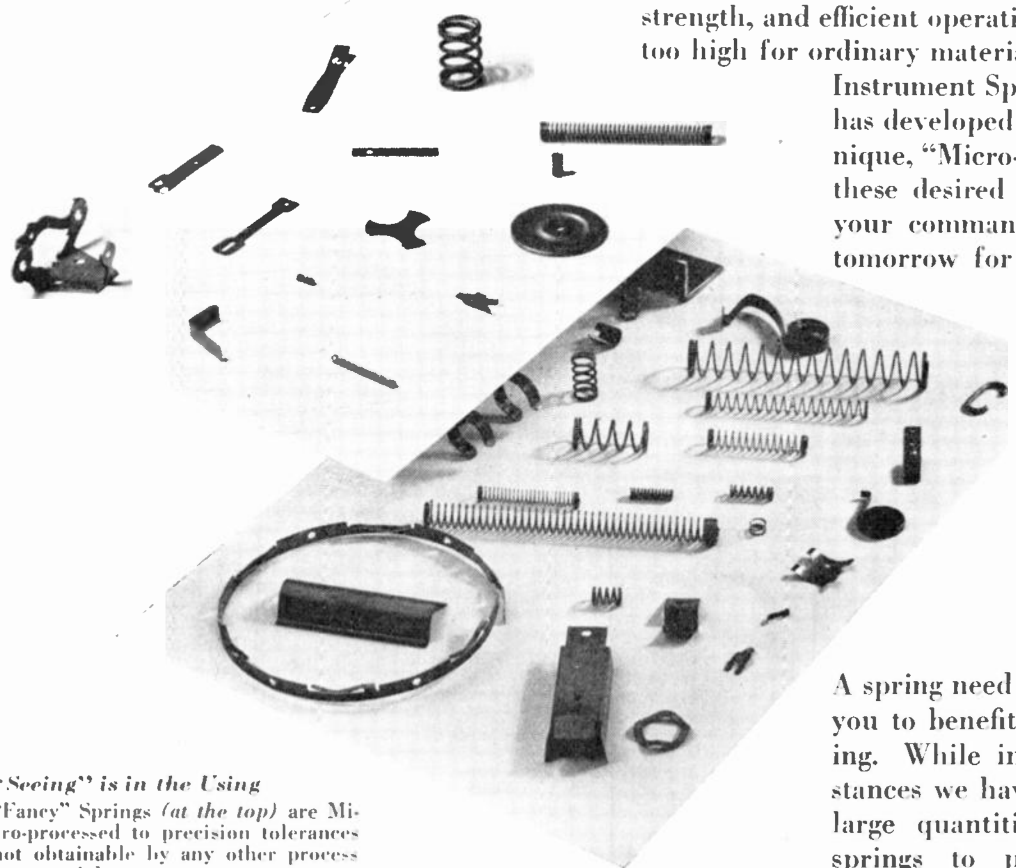
TUBES, Transmitting

Amperex Electronic Prods., Brooklyn, N. Y.
★ Eitel-McCullough, Inc., San Bruno, Cal.
★ Electronic Enterprises, Inc., 65 Sixth Av., N. Y. C.
★ Federal Telephone & Radio Corp., Newark, N. J.
★ General Elec. Co., Schenectady, N. Y.
Heintz & Kaufman, S. San Francisco, Cal.
★ Hytron Corp., Salem, Mass.
Ken-Rad Tube & Lamp Corp., Owensboro, Ky.
Nat'l Union Radio Corp., Newark, N. J.
North Amer. Philips Co., Inc., Dobbs Ferry, N. Y.
Raytheon Prod. Corp., 420 Lexington Av., N. Y. C.
★ RCA Mfg. Co., Camden, N. J.

We expect you to expect more of your SPRINGS

The tough spring jobs go to beryllium copper in this war. for of all spring materials. this metal offers the best combination of all critical spring requirements—maximum electrical conductivity with high tensile strength, minimum drift, resistance to corrosion, high endurance strength, and efficient operation at temperatures too high for ordinary materials.

Instrument Specialities Company has developed the one exact technique, "Micro-processing," to put these desired spring qualities at your command—today for war, tomorrow for peace.



"Seeing" is in the Using

"Fancy" Springs *(at the top)* are Micro-processed to precision tolerances not obtainable by any other process or material.

For "Average" Springs *(below)* Micro-processing delivers closer tolerances and better physical properties than obtainable by ordinary processing methods.

A spring need not be "fancy" for you to benefit by Micro-processing. While in a number of instances we have Micro-processed large quantities of exceptional springs to perform functions never before expected of any springs: in hundreds of other cases we have added materially to the life of such every day products as brushes, motors, instruments, etc., by improving the quality of "average" springs.

I-S gets the most out of springs by putting the required maximum into them. We stand ready to prove our statements on your own springs. A time-saving data sheet is available on request, or send drawings and specifications for Micro-processed samples. Why not expect more of your springs?

INSTRUMENT SPECIALTIES CO., INC.

DEPT. B, LITTLE FALLS., NEW JERSEY

Slater Electric & Mfg. Co., Brooklyn, N. Y.
Sperry Gyroscope Co., Inc., Brooklyn, N. Y.
★ Sylvania Elect. Prod., Inc., Emporium, Pa.
Taylor Tubes, Inc., 2341 Wabansia, Chicago
United Electronics Co., Newark, N. J.
Western Elec. Co., 195 B'way, N. Y. C.
Westinghouse Lamp Div., Bloomfield, N. J

TUBES, Voltage-Regulating

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

TUBING, Laminated Phenolic

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

TUBING, Precision Metal

Superior Tube Co., Norristown, Pa.

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

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

TURNTABLES, Phonograph

General Industries Co., Elyria, O.
★ R C A Mfg. Co., Camden, N. J.
Western Electric Co., 125 B'way, 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 Av., 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 Av., Chicago
★ Zophar Mills, Inc., 112–26 St., Bklyn., N. Y.

VARNISHES, Wrinkle Finish

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

VIBRATION TEST EQUIPMENT

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

VIBRATORS, Power Supply

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

VOLTMETERS, Vacuum Tube

Ballantine Labs., Inc., Boonton, N. J.
General Radio Co., Cambridge, Mass.
Hewlett Packard Co., Palo Alto, Calif.
★ Measurements Corp., Boonton, N. J.
★ Radio City Prod. Co., Inc., 127 W. 26 St., N. Y. C.

WAXES & COMPOUNDS, Insulating

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

WELDING, Gas, Aluminum & Steel

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

WIRE, Bare

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

WIRE, Glass Insulated

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

WIRE, Hookup

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

WIRE, Magnet

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

WIRE, Rubber Covered

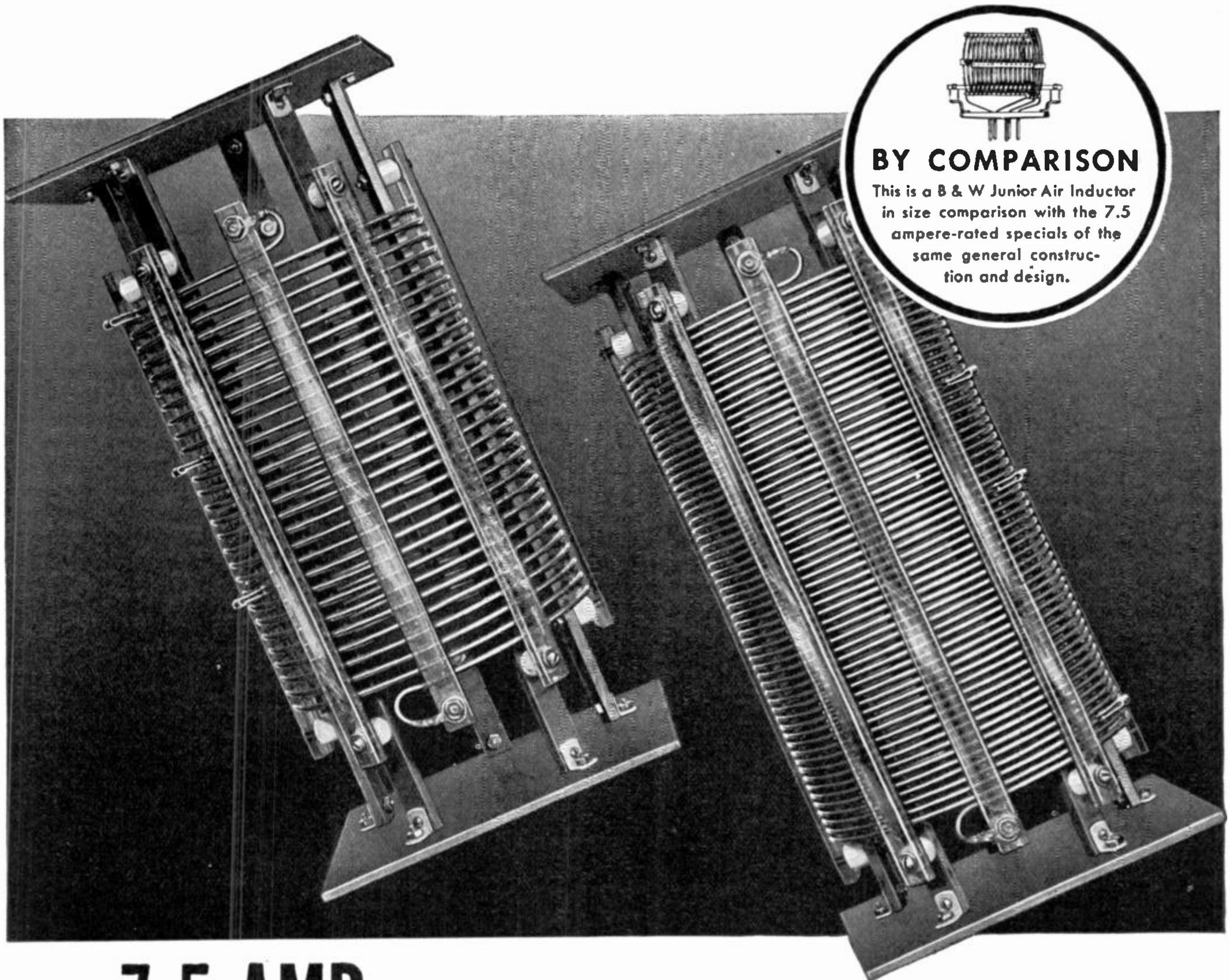
Crescent Ins. Wire & Cable Co., Trenton, N. J.
General Cable Corp., Rome, N. Y.
Hazard Ins. Wire Works, Wilkes-Barre, Pa.
Simplex Wire & Cable Co., Cambridge, Mass.

WOOD, Laminated & Impregnated

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

WOOD PRODUCTS, Cases, Parts

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

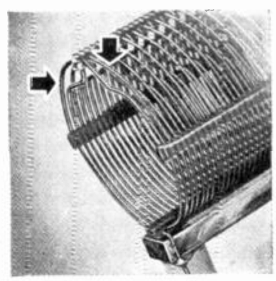


7.5 AMP. CONTINUOUS RATING

But the only thing "Special" is the size

Actually, these 20" giant B & W Air Inductors, wound with #8 solid wire, are simply grown-up war versions of the famous B & W Junior "Air Wound" Coils of amateur radio fame. The only special feature is the size plus, of course, the attendant bracing of triple x bakelite strips and plates for absolute mechanical rigidity. They're attractive in appearance, sturdy as you'd ever expect coils to be, and serve as interesting examples of B & W's unexcelled facilities for the production of special units—often with only a minimum of change from standard designs of unquestioned dependability.

Coils of this type are available through the entire broadcast frequency range. Adaptations are available for specific applications on any frequency. Other B & W coils in both "Air Wound" and form-construction types can be supplied for practically any inductance requirement. Details on any type, or quotations to your specifications, gladly sent.



HOW TO TAP SMALL COILS—EASILY

Ever try to tap a tiny coil where the turns were so close together you felt as though you were trying to fasten a rope to a middle tooth of a fine-tooth comb? Then you'll appreciate this special B & W small coil indent feature. The windings on either side of the turn you want to tap are indented out of the way, thus making tapping quick and easy, anywhere on the Inductor.

B&W

AIR INDUCTORS

BARKER & WILLIAMSON, 235 FAIRFIELD AVE., UPPER DARBY, PA.

NILES TRAMMELL SPECIFIES 9 POINTS FOR NEEDED RADIO LEGISLATION

Addressing the Senate Interstate Commerce Committee at Washington, Niles Trammell, president of the National Broadcasting Company, concluded his testimony on the White-Wheeler bill with a statement of 9 points to be considered in drafting new radio legislation. These were:

"1. Guarantee, by definite declaration, that radio broadcasting has full rights under the 1st amendment to the Constitution.

"2. Prohibit the licensing authority from exercising any business or program control of broadcasting station operation.

"3. Provide for long-term or permanent licenses, subject only to revocation for specific causes.

"4. Provide that the license for a broadcasting station may be revoked only by Government suit in the Federal Court where the station is located, with trial of the facts by jury; with the Government authorized to prosecute such complaints only for specified causes such as those now provided in the Communications Act.

"5. Eliminate any right of the Commission to administer the Anti-Trust laws and eliminate the 'death penalty' for a violation of those laws, so that licensees will be subject to the same penalties as anyone else for violation of the Anti-Trust laws.

"6. Separate the regulation of radio in the common carrier field from the regulation of broadcasting.

"7. Provide that it be made mandatory on the Government to issue experimental licenses and to encourage the development of new radio services.

"8. Prohibit discrimination on the basis of occupation or business in the grant of licenses for broadcast stations.

"9. Adopt the recommendations of the FCC Bar Association and the NAB for revision of the procedural sections of the law."

SPOT NEWS NOTES

(CONTINUED FROM PAGE 20)

David T. Siegel: Founder and president of Ohmite Manufacturing Company has been elected to the board of trustees of Illinois Institute of Technology. This board formulates the governing policies of what has become one of the nation's largest engineering schools. Formed in 1940 by the merger of Armour and Lewis Institutes, Illinois Tech now has over 7,000 students, including 691 Navy V-12 men, and 501 Army Specialized Training students.

10th Anniversary: Celebrated by the Hallicrafters Company of Chicago. According to an announcement from president Halligan, this Company has manufactured and delivered more than $44,000,000 worth of short-wave communications equipment to the Armed Forces and Lend-Lease in the two years since Pearl Harbor.

This represents a step-up in production from $2,000,000 in 1941, $9,700,000 in 1942, and $34,300,000 estimated for the year ending December 7, 1943, with a 1944 backlog at this time of more than $20,000,000.

Maj. Isaac Brimberg: The former chief engineer of New York City's municipal station WNYC died suddenly at Brookley Field, Mobile, Alabama, on November 24th.

A graduate of M.I.T., Major Brimberg had been at WNYC from its opening in 1924 until May, 1942, when he was granted duration leave to accept a commission as Lieutenant in the Signal Corps. Eight months later, he was made a Captain, and this summer, at Brookley Field, he was raised to the rank of Major.

Los Angeles: The Standard Broadcasting Company has applied for a construction permit to erect an FM station to operate on 54.3 mc., covering 7,000 square miles. This is a radius of approximately 45 miles.

FM-AM Operation: Testifying before the Senate Interstate Commerce Committee, A. Earl Cullum, Jr., associate director of the Radio Research Laboratory at Harvard University, urged that the privilege of obtaining FM station licenses should be extended to operators of AM transmitters, on the ground that AM licensees already know the broadcasting business. If, Mr. Cullum said, FM is made available only to strangers, development would be retarded.

Newspaper FM Ruling: The FCC may announce a ruling on the ownership of FM broadcasting stations before the first of the new year. This matter has been pending for more than two years.

WHAT'S NEW THIS MONTH?

(CONTINUED FROM PAGE 4)

The amount by which production of components has been increased runs into telephone numbers, but the 1944 requirements of our Armed Forces have been upped about $33\frac{1}{3}\%$ over 1943. (*FM, September, page 4*) This isn't a large amount when expressed in percentage, but the dollar value of this increase is $1,250,000,000, added to the $3,250,000,000 production in 1943!

Meeting this additional load next year will be all that the industry can do without trying to build civilian radios.

As if that weren't enough, here is another aspect to consider: There aren't enough factory workers now employed to meet next year's requirements. Nearly 75,000 more will be needed. Most of them will be women without previous experience. About 80% of radio factory workers at this time are women, by the way.

Despite all the talk about deferring men engaged in radio manufacture, they are still being called into the Service. Manpower, therefore, is another factor entering into the matter of civilian set production.

And that's not all. There is to be a change in the FM tuning band. It will probably be extended from the present range of 42 to 50 mc., but how far it will be extended no one knows yet. The 40 channels aren't going to be enough to accommodate all the projected postwar FM stations. Consequently, the band may be extended to 56 or even 60 mc.

Until this is settled, manufacturers will not know how they should design tuning circuits. This subject was discussed at the November 17th conference at Washington, which included representatives of the Radio Technical Planning Board, the FCC, WPB, Bureau of Standards, and the Board of War Communications.

The urgent need of settling this question was emphasized in a statement concerning the conference, issued by the FCC:

"It was suggested that studies should be completed at the earliest possible time to determine the best frequencies for television, FM broadcasting, aviation, and other services so that manufacturers can be ready with plans to produce equipment when materials are made available again."

When the time approaches for the resumption of home radio production, there will be so much advance discussion in the press that there'll be no need for conjectures about it.

2. There is a lot of smug talk throughout the radio industry about the huge volume of postwar sales that will be made. These sales are to come from people who will then want to replace old sets, from

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WHAT'S NEW THIS MONTH?

(CONTINUED FROM PAGE 52)

those whose sets have finally gone to the junk pile, and from those who have never owned radios. The dollar value of these sales-in-prospect seems impressive.

Furthermore, a rosy light is thrown upon the scene by estimates from the Department of Commerce that the beginning of 1944 will find $84,000,000,000 salted away by the buying public of this country. That sum is represented by personal bank balances, privately-owned bonds, and back debts paid up. Yes, Mr. and Mrs. John Q. Public are going to have a lot of money to spend when the time comes that they can use it.

In fact, people are becoming very conscious of the purchasing power they are accumulating. It means that they will be able, one of these days, to buy a number of things. Right there is a real flag for the radio industry — a red flag warning that radio manufacturers can't just sit back and assume that radio sets top the list of early postwar purchases!

What's more, it is no secret that bank accounts and safe deposit vaults are beginning to bulge with pent-up buying power. All the other industries are eying this stock-pile of cash and credit, too, and they are laying plans to divert as large a part of it in the direction of their products as possible.

The first measure of competition that radio will face from other lines is indicated in a survey published in the December issue of *Fortune*. It tabulates answers to the question, "What one or two things do you plan to buy as soon as times are peaceful again?" Omitting clothes, fur coats, and farm machinery, radio sets appear as the 10th item on the list of things most wanted, while radio-phonograph combinations appear in 16th place. This is not a favorable showing, particularly when it is considered that only 3.4% of the people interrogated said they plan to buy radio receivers, and only .7% mentioned radio-phonographs!

The actual figures, in order of preference, are:

ITEMS PEOPLE PLAN TO BUY POSTWAR

1. Cars	21.0%
2. Houses	13.3
3. Furniture	9.2
4. Mechanical refrigerators	8.6
5. House repairs	5.3
6. Washing machines	5.1
7. Stoves	4.5
8. Electrical appliances	4.3
9. Rugs	3.6
10. Radios	3.4
11. Misc. furnishings	2.7
12. Household fixtures	1.5
13. Farms	1.4
14. Heating equipment	1.0
15. Property	0.9
16. Radio-phonographs	0.7

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WHAT'S NEW THIS MONTH?

(CONTINUED FROM PAGE 53)

Breaking down the figures further into income brackets, the interest in radios and combinations showed up in this way:

INCOME	RADIOS	COMBINATIONS
High	3.8%	1.1%
Upper middle	3.3	1.3
Lower middle	4.3	.4
Low	2.5	.3
Negro	1.6	1.1

While these answers may be "letters to Santa Claus," as *Fortune* points out, it is disturbing to find that more people want rugs than radios, that stoves show up at 7th place compared to radio sets at 10th place. The desire for washing machines is 50% greater than for radios, and 153% higher for refrigerators.

Further information is disclosed by comparing the dollar value, at 1941 average prices, of these items, for that indicates the potential markets represented. Here are the available figures in the order first listed:

AVERAGE 1941 PRICES

1. Cars	$ 950
2. Houses	4,800
3. Furniture	—
4. Mechanical refrigerators	150
5. House repairs	—
6. Washing machines	80
7. Stoves	75
8. Electrical appliances	—
9. Rugs	—
10. Radios	30
11. Misc. furnishings	—
12. Household fixtures	—
13. Farms	—
14. Heating equipment	—
15. Property	—
16. Radio-phonographs	80

From the data given, while it is difficult to estimate sales in dollars, we can arrive at relative figures. That is, for every person who wants a radio-phonograph, 19 want to buy homes (first Table). And each person who buys a home will average to spend 60 times as many dollars as for a radio-phonograph (third Table). This shows that $1140 may be spent for homes to $1 for radio-phonographs. Continuing this comparison, we arrive at these figures:

COMPARATIVE INDICATED SALES FOR EACH DOLLAR TO BE SPENT ON RADIO-PHONOGRAPHS

Cars	$ 357
Houses	1,140
Mechanical refrigerators	23
Washing machines	7
Stoves	6
Radios	1.80
Radio-phonographs	1

In other words, the survey indicates that $357 will be spent for cars to every $2.80 that will go in radios and radio-

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WHAT'S NEW THIS MONTH?

(CONTINUED FROM PAGE 54)

phonographs combined. The indicated dollar volume for stove manufacturers is more than twice that for radio manufacturers. This assumes that the radio industry will go right back to making the cheap sets it was producing before the War.

The most direct means of stepping up radio sales would be a concerted drive on the part of manufacturers to bring up the average unit-price from the 1941 level of $30. This move had started with the introduction of Frequency Modulation, and was gaining momentum steadily at the time production was stopped.

Experience at that time indicated that little could be done to raise the unit of sale on straight AM receivers, but it was being done with great success on FM-AM consoles and combinations. That is one angle.

Against this, however, is the great confusion being created by wide publicity given to the future uncertainties of television and acts of the FCC. The best things that could happen as far as postwar radio set sales are concerned would be the elimination of the negative influence of these two factors by 1) telling the public nothing more about television until it is possible to demonstrate reception untroubled by reflections, from moderately priced receivers, and 2) pinning the FCC down to the administration of the radio laws in the service of public interest, convenience and necessity, in accordance with the original intention, and keeping it out of the field of social reform. Neither of these things is liable to come about, unfortunately.

As a result, sales will be lost today because people will continue to wait for what they think they'll be able to buy tomorrow.

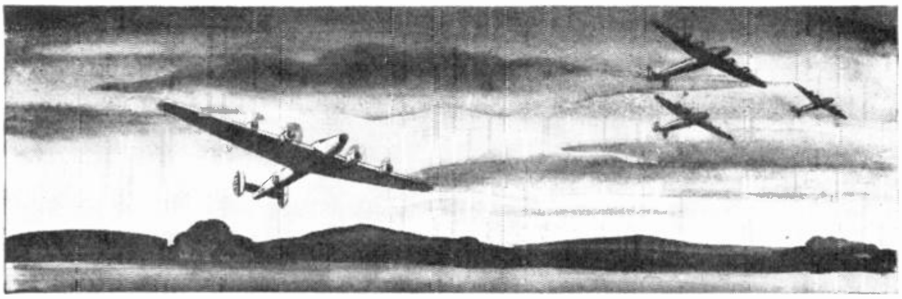
There is one inference to be drawn from the survey data that has possibilities which should not be overlooked. It is to be found in the figure of $1,140 to be spent for new homes against each dollar to be invested in radio-phonographs. It prompts the question: "How can radio sales be tied to that soaring figure of expenditures for houses?"

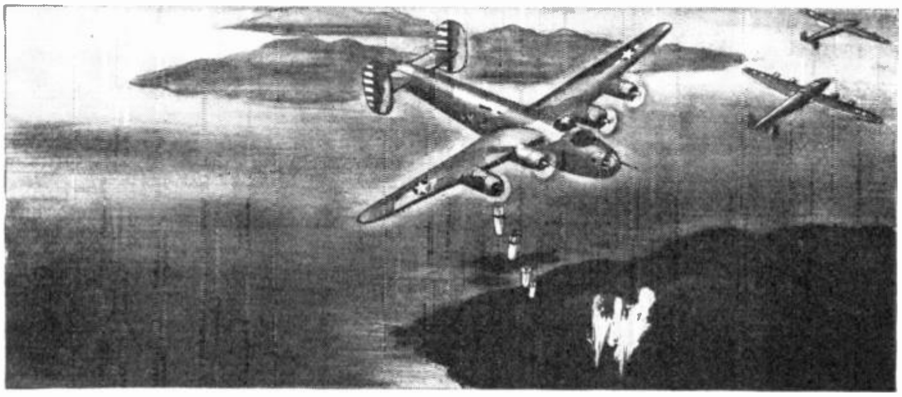
Perhaps there's an answer. If radio installations are promoted as a part of home construction, to be built in along with the electric lighting system, the plumbing, and the heating equipment, they will be financed as a part of building loans, and not as separate, short-term installment purchases.

Contractors have found built-in ironing boards and easy-lift garage doors to be extremely effective point-of-sale features. How much more impressive a built-in, built-to-last radio-phonograph chassis and speaker system would be!

If the radio industry can't fight the new-home competition for postwar dollars, why not tie in and ride along with it?

(CONTINUED ON PAGE 56)





WHAT'S NEW THIS MONTH?

(CONTINUED FROM PAGE 55)

3. Somehow, the progress of Frequency Modulation and television have become associated together in the minds of so many people that the idea of some relationship between the two is beginning to spread.

Neither FM broadcasting nor AM broadcasting has anything in common with television. Broadcasting by either method does not compete with potential development of television. If television today were an accomplished fact commercially, there would still be the need of improving broadcast service.

Frequency modulation transmitters and receivers are fully developed, and their advantages have been demonstrated over a period of years. These advantages have been recognized by the FCC through establishment of the 42- to 50-mc. band for FM broadcasting.

The expansion of FM service after the War is assured by the great number of pending applications for FM station construction permits. This number is now increasing from month to month. The expansion of FM broadcasting is assured because it performs a needed service to radio listeners. It will not be retarded or advanced whether we have commercial television next year or ten years from now.

To be sure, FCC regulations require the transmission of television sound by FM. Many engineers expect that Frequency Modulation will be used for picture transmission, also. But that has nothing to do with FM for broadcasting service.

If we disassociate FM broadcasting from television, particularly in addressing the public and in discussing future commercial aspects of the radio business, we will avoid creating the confusing impression that the two are in any way interdependent or competitive.

FM IN NEW YORK CITY

November 29, 1943

To the Editor:

In response to your inquiry as to why our affiliated FM station announces itself as "WQXQ, New York's first FM Station," I would advise that final modified construction permit for station W2XQR, of which WQXQ is the lineal descendant, was granted on October 3, 1939. Our REL 1,000-watt FM transmitter was promptly installed, and tests began on November 8, 1939. The station was licensed on December 11, 1939, at which date it went on the air with regular broadcast programs from the WQXR studios. So far as I know, at that time there was no other FM broadcasting station in this area with the exception of Major Armstrong's

(CONTINUED ON PAGE 57)

FM IN NEW YORK CITY

(CONTINUED FROM PAGE 56)

W2XMN at Alpine, N. J. which, I believe, is the pioneer FM station of the world.

It may be interesting for you to note that W2XQR has been on the air with broadcast programs substantially continuously since December 11, 1939, the only service interruption that I recall having been from December 8 to December 15, 1941, when the original transmitter was moved from Long Island City to its present location on the Chanin Building.

Sincerely yours,
JOHN V. L. HOGAN, *President*
Interstate Broadcasting Company, Inc.

CANADIAN VIEW OF ANTENNA PROBLEM

(CONTINUED FROM PAGE 13)

shall, after receiving notice of such order thereafter use the apparatus nor resume the use thereof until the interference is suppressed to the satisfaction of the Minister.

(*c*) Any person who violates any of the provisions of this regulation shall be liable, on summary conviction, to a penalty not exceeding fifty dollars per day, for each day during which such violation continues.

3. (*a*) No person shall operate any device emitting radio frequency oscillations for purposes other than radio communications licensed by the Minister except with the approval, in writing, of the Minister.

(*b*) The expression "device" used in paragraph (*a*) of this regulation shall include, but not so as to restrict the generality thereof, any device or apparatus which emits radio frequency oscillations for the purpose of playing phonograph records or retransmitting broadcast programmes or lighting luminous signs.

(*c*) Any person, who violates the provisions of this regulation, shall be liable, on summary conviction, to a penalty not exceeding fifty dollars per day for each day during which such violation continues.

4. No prosecution for an offence against these regulations shall be commenced except with the consent of the Minister and, without limiting the generality of the foregoing, the Minister may withhold such consent when, in his opinion, the device or apparatus was used for essential purposes in an emergency and the user submits a full report in writing to the Controller of Radio of the Department of Transport, not later than five days after the use thereof, and, on the requisition of the Minister, furnishes satisfactory proof that the use of the apparatus was for essential purposes in an emergency.

5. Neither the Minister nor any employee of the Department of Transport shall recognize or assume any responsibility for claims for payment of charges or expenses incident to tests or investigations in connection with the enforcement of these regulations. 32-1

SYLVANIA 28D7 FOR AIRCRAFT RADIO

DETAILS of Sylvania's type 28D7 tube, for aircraft radio equipment, were given by Walter R. Jones at the Rochester IRE-RMA convention.

The 28-volt power supply system has come into wider use on Army and Navy planes, but difficulties have been encountered in selecting tubes for filament operation on this voltage.

The new tube uses 28 volts direct from the storage batteries for both screen and plate. Two beam power amplifier units are contained in the same envelope, with the control grid and plate of each section brought out to separate pins. There is a common terminal for the cathodes and screen grids. Heaters are connected internally in series, but the cathodes are not tied to either heater terminal.

Mr. Jones stated that the high power output of the 28D7 makes it suitable for use as a power supply. Power output up to 725 milliwatts at medium voltages of 50 to 250 volts, and output voltages of 500 to 600 volts for low power requirements can be obtained by rectifying and filtering the voltage developed across a coil coupled to the tank circuit of the tube as a self-excited oscillator, with only 28 volts power supply.

The two sections of the tube can be operated separately, connected in parallel, or in push-pull. When each section is used as a single-ended amplifier, the load on each section should be 4,000 ohms to insure reasonably low second and third harmonics.

With the two sections in parallel, the load is approximately one-half. For push-pull operation, the load should be 3,000 ohms.

RADIO DESIGNERS' ITEMS

RF Thermocouple Standards: A new American War Standard, C3 9.4–1943, has been announced by the American Standards Association.

This Standard, covering thermocouples rated at .120 to 10 amperes, was formulated to facilitate production of these devices and the equipment in which they are used.

This Standard will be used by the Armed Forces in the design of new equipment and for replacement parts wherever possible. It should be used as extensively as possible by designers of equipment, and the Standard should control in the preparation of new manufacturing facilities. It will aid maximum production and simplify repairs in the field.

Thermocouple converters covered by this standard are being manufactured widely in the trade, and form part of the aircraft radio installations in every transport and bomber. This standard covers an estimated 90% of the thermocouple

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RADIO DESIGNERS' ITEMS

(CONTINUED FROM PAGE 58)

converters used in radio and electronic equipment. Although there are additional styles now in service by the Armed Forces which are not covered by this standard, it is intended that their manufacture will be continued for the present.

This War Standard has been prepared through the coördinated efforts of representatives of industry and the Armed Forces at the request of the War Production Board. Both the Signal Corps Standards Agency and the Radio Division, United States Navy Department, Bureau of Ships, have adopted the new standard for procurement.

Copies of the Standard can be obtained at 10 cents each from the American Standards Association, 29 West 39th Street, New York 18, N. Y.

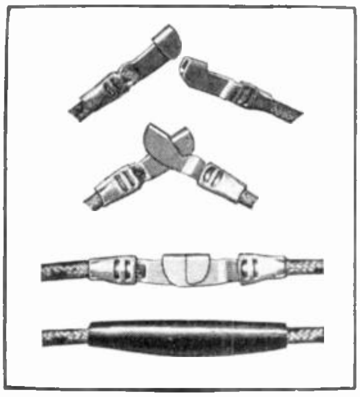


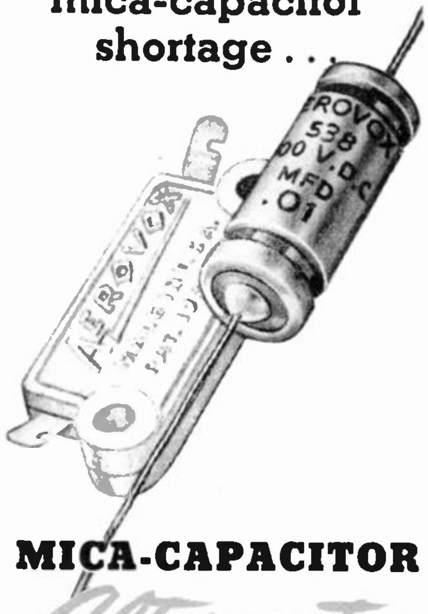
FIG. 1. SOLDERLESS SPLICING TERMINAL FROM AIRCRAFT-MARINE PRODUCTS

Solderless Splicing Terminal: Two identical parts are used for a solderless splicing terminal, Fig. 1, announced by Aircraft-Marine Products, Inc., Harrisburg, Pa. With the parts clipped together, a four-point contact of large area assures a low-resistance connection. Crimping pliers are used to make a positive, solderless joint with the wire. The contour of the finished splice is smooth enough that the insulation sleeving slips on easily, and is held firmly in place. An advantage of this splice is that the two parts are identical. Thus there is only one item to identify and carry in stock. A bulletin giving further information is available on request to the manufacturer.

Trimmer Condenser: A trimmer condenser which is mechanically and electrically interchangeable with the conventional rotary plate types, but of greatly simplified design, is being produced by the Grenby Manufacturing Company of Plainville, Conn.

It will be described in detail in the December issue of *FM* RADIO-ELECTRONICS. A feature of the new design is the introduction of a negative temperature coefficient effect which offsets the tendency of the structure to increase the capacity from expansion under the influence of exposure to increased temperature.

Meeting the mica-capacitor shortage . . .



MICA-CAPACITOR *Alternates*

● Sooner or later you may come across radio or electronic assemblies in which tiny oil-filled capacitors replace mica types. While it's a war measure — getting around the mica shortage — remember, nothing has been sacrificed in performance or life, if those substitutions are with Aerovox Type-38 units.

These mica alternates are miniature oil-filled metal-case tubulars. Require no more space than mica capacitors replaced. Conservatively rated. Meet all standard specs for paper-dielectric capacitors used as mica alternates.

Aerovox Type-38

In three sizes: 5/16 x 1-3/16"; 7/16 x 1-3/16"; 7/16 x 1".

300 to 800 v. D.C.W. .001 to .01 mfd.

Both terminals insulated, or with one grounded to case. Normally without outer sleeve. Can be had with insulating sleeve.

Vegetable (Aerovox Hyvol) or mineral oil impregnant and fill.

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The new Andrew glass insulated terminal is an outstanding development that provides you with a 100% *air-tight, gas-tight* system for gas filled coaxial cables. Permanent, leak-proof operation of Andrew terminals is insured because of a unique design using a glass-to-metal seal. A special design that minimizes shunt capacity makes them ideally suited to high frequency operation. Dielectric losses are reduced over the standard ceramic type insulated terminals because of reduced volume of glass in regions where the electric field is greatest.

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BOOK REVIEW

A PRIMER OF ELECTRONICS, by Don P. Caverly, 235 pages, 125 illustrations, cloth bound, 5½ by 8 ins. Published by McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 18, N. Y. Price $2.00.

The author, as Commercial Engineer for Sylvania Electric Products, Inc., is a man of wide practical experience in the field of applied electronics. Called upon frequently to address meetings of salesmen and non-technical executives, he prepared the Primer to answer fully, and in detail, the questions that have been put to him by various audiences.

It is, as Mr. Caverly explains, a digest of the very basic principles involved in the study of the behavior of electrons and their control, presented for the men, and women too, who are interested in reading the popular science columns of the semi-technical press. In this effort, he has succeeded admirably, and the book will certainly be recommended by many technicians to friends whose questions they are reluctant to attempt to answer.

The Primer of Electronics will, undoubtedly, encourage other writers to attempt similar volumes. Mr. Caverly used his first 64 pages to discuss electric currents and magnetism, and 88 pages more for electromagnetic radiation before he showed a picture of a vacuum tube. Only on his very last page did he reach the point of stating that: "Basically, electron tubes are devices to produce and control a flow of electrons, and nothing else."

In the opinion of this reviewer, that should have been the first sentence in the book, and the text should have gone forward from that statement, with explanations of electricity, magnetism, and radiation introduced as required.

However, the need for such a book is very great, and the value of Mr. Caverly's effort far outweighs the details of its arrangement.

At a press luncheon given by Sylvania Electric Products, Inc., Keith Henney, editor of *Electronics*, introduced the author on behalf of the publisher. In his remarks, he told of receiving a letter from a woman in the South, asking how she could invest one hundred dollars in electronics that would give her as much return as her friend had received from putting a similar amount into Coca-Cola.

This amusing incident underlines the great need for wider understanding of the subject of electronics, both on the part of the general public and also on the part of those who are technicians in other unrelated fields. We are now coming to realize that only through a broader knowledge of the possibilities and limitations of electronics can this science be introduced in all the fields and applications where it can render effective service.

NAVY RADIO APPARATUS DESIGN

(CONTINUED FROM PAGE 27)

satisfactory though slightly less efficient?

B. Considering the overall performance desired, and all of the resistors (or condensers) used of approximately the same size, as a block, would it be undesirable or impractical to use the same resistor (or condenser) value at all circuit points? Could that value be a standard one?

C. Considering the overall performance desired, is it necessary to use so many different tube types? Or would it be desirable, from a broad viewpoint, to use fewer types even, perhaps, at the expense of an added stage?

D. Have the layouts and wire plans become complicated because of a desire for such ultimate performance, particularly gain, from each stage, that excessive overall performance has been obtained at the expense of ease of maintenance?

E. On the other hand, are there components included that are marginal in design. That is, do the transformers, condensers, etc., have sufficient factors of safety against excessive current or voltage to insure trouble-free operation? Are tubes being worked beyond their ratings?

While it is fully appreciated that the problem posed is not easy, it is believed that in the forward rush of the War the virtues of simplicity are in danger of neglect. The Bureau has no desire at all to impair performance to secure pure simplicity, but is not at all convinced that all present complexities are necessary.

The earnest coöperation of all design agencies will be appreciated. It is now thought that the result of such action will be better equipment for the ultimate purpose which is Victory.

TELEVISION, LABOR, TAXES & PRICES

(CONTINUED FROM PAGE 12)

certainly should be, the retail price, allowing a 50 per cent trade discount, will then drop to $309.50, or $344 at the 50–10 per cent discount. The cost of the antenna must be added to these figures.

The FM-AM broadcast receiver included in such a set would be on the cheap side, of course, and would not give the full quality of FM programs. It would not have an automatic phonograph. And it would be a large and awkward table model of the type which has never been accepted by women purchasers.

Competing against the $330 to $400

(CONTINUED ON PAGE 63)

TELEVISION, LABOR, TAXES & PRICES

(CONTINUED FROM PAGE 62)

table model radio-television installation would be FM-AM radio-phonograph consoles, delivering the finest quality of music, at $275 to $350.

Television Antenna ★ Engineers have concentrated their efforts on the perfection of the television equipment itself to the extent that they have neglected that vital link between the transmitter and receiver — the receiving antenna.

So far, no means has been perfected which will assure proper reception of television signals (free of reflections) under all circumstances within a reasonable radius from the transmitter.

Records in any area now served by television stations will show the most contradictory results. Sometimes a few feet of wire are adequate as an antenna. In one specific case in New York City, a very elaborate antenna was erected at a cost of several hundred dollars, to insure perfect results. But, no matter how the antenna was oriented, four to six or more reflections were picked up. The solution was to discard this fine installation, and to use an indoor antenna.

On the other hand, at suburban homes located on busy highways, the only way to overcome automobile interference was to raise the television dipole higher and higher, thus reducing ignition pickup and increasing signal pickup.

There is no way — and this statement is made from personal experience with solving the troubles of dissatisfied purchasers of television sets — to tell in advance what kind of an antenna will be required to give good television reception at a given home or apartment. Perhaps 10 ft. of wire on the floor will be adequate. On the other hand, the expense for a mast or tower, dipole, and reflectors may run to $100 or even much more.

This is certain — and again this is written from personal experience — the reluctance of the customer to pay more than $10, or $15, for a television antenna increases as the square of the cost!

Conclusions ★ This is purely factual data. It does not represent wishful thinking. The figures have not been adjusted to prove a point in favor of television or against it. The whole purpose of this discussion is to present information which will picture accurately the price problem of television in terms of present-day costs and conditions.

It does emphasize the importance of eliminating the excise tax. If that cannot be done, a considerable saving to the public, without loss of revenue to the Treasury Department, can be effected by reducing the tax to 5 per cent, and having it added by the dealer to the retail price, as is now done with furs and jewelry.

Royal V. Howard, KSFO; Frank A. Gunther, REL; Paul A. De Mars, Yankee Network; Clifton Howell, KSFO; Gustavus Reiniger, REL

First FM on the Pacific Coast

THE first demonstration of Frequency Modulation to be given on the Pacific Coast occurred in August, 1940, during the N.A.B. convention at San Francisco.

On this occasion REL, already playing the leading role in making known the advantages of FM over AM, installed a 1-kw. model 518 transmitter at the Palace Hotel. This was done with the cooperation of KSFO engineers and the F.M.B.I.

Receiving equipment was set up in the auditorium of the St. Francis Hotel, where the N.A.B. meetings were held.

The performance of the REL transmitter, using Armstrong phase-shift modulation with crystal frequency control, was so far superior to conventional AM performance that many of the broadcast engineers and executives, hearing FM for the first time, could hardly believe that they were listening to radio transmission.

But REL's record of pioneering means much more than doing many things first. It has given the REL organization unequalled experience in the design, manufacture, and installation of FM broadcasting stations.

That is why no other concern can match REL's record of successful FM transmitters now on the air, ranging in power up to 50 kw. And every REL installation has been put in operation without extra cost or loss of time for changes and experimenting.

We shall be ready, as soon as restrictions are lifted, to deliver and install new FM transmitters, complete from console to radiator, which will continue the REL leadership in this field.

LOOK TO REL FOR PEACETIME LEADERSHIP

Engineering improved equipment for War today, REL is planning further improvements for Peace tomorrow. Among these will be REL "packaged" FM broadcast stations, low in cost and easy to erect, for communities which now lack adequate, enjoyable, static-free radio entertainment.

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NEW JERSEY (RADIO ROOM)

Performance

DIFFICULT TO MATCH

The original 250 watt transmitter and its associated system was placed in operation March, 1933.

This installation was a genuine achievement for Link, being the FIRST COUNTY-WIDE Police System in the country to be licensed by the Federal Communications Commission.

The original transmitter (to the right) is still on active duty for standby service. More than TEN YEARS of performance, substantiating the Link claim of the "First still going strong."

FM AM

Engineer • Manufacturer

Fred M. Link

Telephone: CHelsea 2-3838

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New York 11, New York