FM
JANUARY 1943
PRICE—TWENTY-FIVE CENTS

RADIO-ELECTRONIC ENGINEERING & DESIGN

I.R.E. PRESIDENT
1943

Radio-Electronic Products Directory

THE JOURNAL OF WARTIME RADIO-ELECTRONIC DEVELOPMENT, ENGINEERING & MANUFACTURING ★ Edited by M. B. Sleeper ★

U. S. NAVY OFFICIAL PHOTOS

UTC CASE HISTORIES

Laboratory File No. S14-523

This unit helps "keep them flying." A UTC redesign combined two units in one . . . reduced quantity of critical materials 50% . . reduced weight and size 40% . . . reduced installation time 60% . . . reduced possible trouble points 50%

Laboratory File No. S14-312

This unit maintains ground communications at a more efficient level. Now plastic housed. Critical materials reduced 50%. UTC design reduced possible trouble points 50% . . . reduced difficulty of operation 50%.

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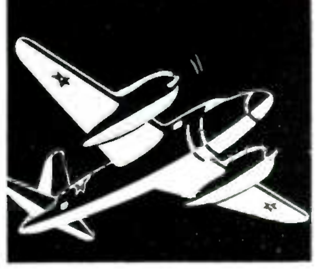
This unit is used at a number of points in aircraft communication. A UTC design reduced quantity of critical materials used 20% . . . reduced weight and size 20% . . . reduced possible trouble points 50%.

Laboratory File No. S9-474



This unit is a component in a piece of aircraft equipment. A UTC design reduced quantity of critical materials 60% . . . reduced weight and size 60% . . . made possible a similar reduction of size and weight in the complete equipment of which it is a component.

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RADIO-ELECTRONIC ENGINEERING & DESIGN

COMBINED WITH: APPLIED ELECTRONIC ENGINEERING

VOL. 3 JANUARY, 1943 NO. 2

CONTENTS

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Published by: FM COMPANY

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

Chicago Advertising Representative:
Howland & Howland, Inc., 360 N. Michigan Ave. Tel. STAte 1139

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

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

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Dr. Lynde Phelps Wheeler, 1913 president of the I.R.E., is a man of unusually broad experience in his profession. He achieved high scholastic standing as a Professor of Science at Yale Sheffield. He served in the U. S. Navy during the Spanish-American War and as a Signal Corps instructor during World War I. His work at the Naval Research Laboratory contributed much to the development of radio for aircraft and submarines. Since 1936, as the FCC's Chief of Technical Information, he has had an active part in the general progress of radio communications.

One Year

We have come a long way since Christmas 1941, all of us. American Amateurs have flocked to the colors — made themselves the backbone of the great Army Signal Corps and Navy Communications. Makers of Amateur equipment have put their entire effort into design and construction of Military communications units. For example, the Hallicrafters have, since Pearl Harbor, turned out production that would normally have taken seven years! ☆ We can all be proud that we have in one short year turned the tide of battle from almost unopposed conquest by the enemy to the first stages of the Victory drive on every front. And, let us all fervently hope that another wartime Christmas will be unnecessary.

W. J. Halligan

the hallicrafters co.
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ARMY E NAVY

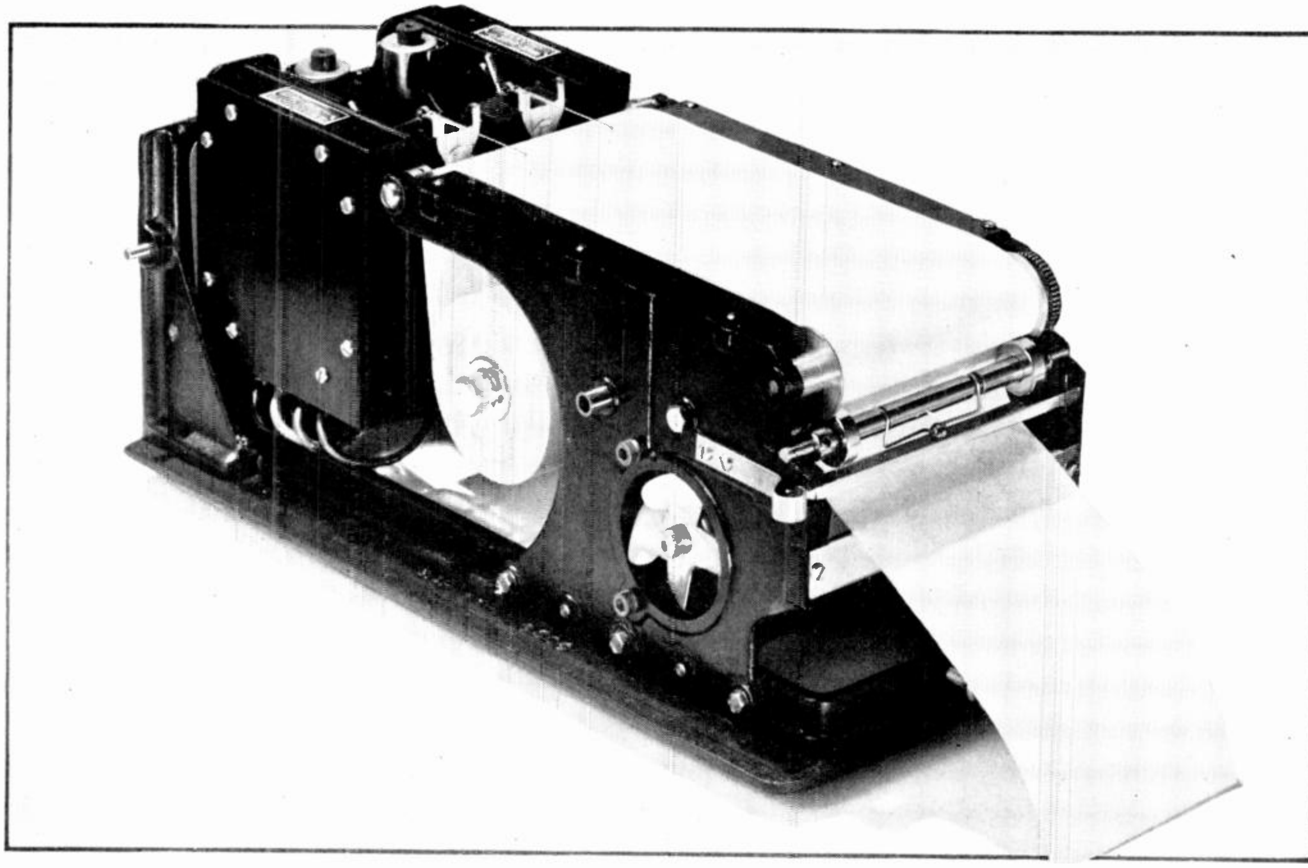


FIG. 1. BRUSH CRYSTAL-DRIVEN RECORDING OSCILLOGRAPH, WITH DUAL MECHANISMS TO RECORD TWO VOLTAGES SIMULTANEOUSLY

CRYSTAL-ACTUATED MECHANISMS

Possibilities of Rochelle Salts Crystals as Drivers for Mechanical Devices

BY CHARLES K. GRAVLEY*

ONE of the relatively unexplored fields of invention and development is that of mechanical devices actuated by the movement of crystal drivers in response to voltages applied by electronic circuits. This refers specifically to Rochelle salts crystals.

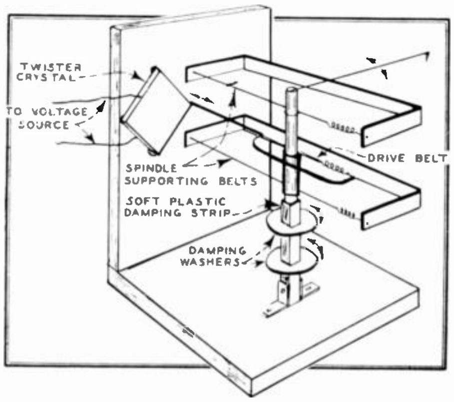
Motion of Crystals ★ The crystals used in headphones or photograph pickups are generally related to motion measured in micro-inches, rather than to movement that can be seen with the naked eye.

That is only, however, because crystals used in these familiar applications are of such small dimensions that a number of them can be put in a thimble. Actually, they may be 3/8 in. square by as little as .020 in. thick. These crystals, although they are not the smallest in common use, require the utmost skill of deft women workers who apply the foil used for electrodes and leads.

On the other hand, crystals required for some applications are of substantial dimensions, and their movement in response to an applied voltage may be as much as .01 in., or even more.

Types of Crystals ★ Typical "bimorph" crystals produced by the Brush Development Company consist of two crystals cemented together face to face. Each crystal carries foil electrodes on each face, with the negative poles cemented to each other. Therefore, the negative lead is brought out from the adjacent faces, and the positive lead from the two outer faces.

FIG. 2. CRYSTAL DRIVE AND MULTIPLIER



There are four specific advantages in the bimorph construction:

1. It affords a more efficient size and shape.
2. Greater sensitivity is achieved, with a possible gain of 15 times for practical shapes.
3. Saturation and hysteresis are practically eliminated.
4. Variations of the mechanical and electrical constants, due to changes in temperature, are reduced, particularly on thin crystals.

Crystal-Driven Oscillograph ★ A practical example of a crystal-driven device is the oscillograph illustrated in the accompanying photographs.

Figs. 1 and 3 show the actual instrument, with a sketch of the multiplying system in Fig. 2. The crystal is mounted at three corners, with the spindle drive at-

(CONTINUED ON PAGE 34)

*Chief Engineer, Brush Development Company, Cleveland, Ohio.

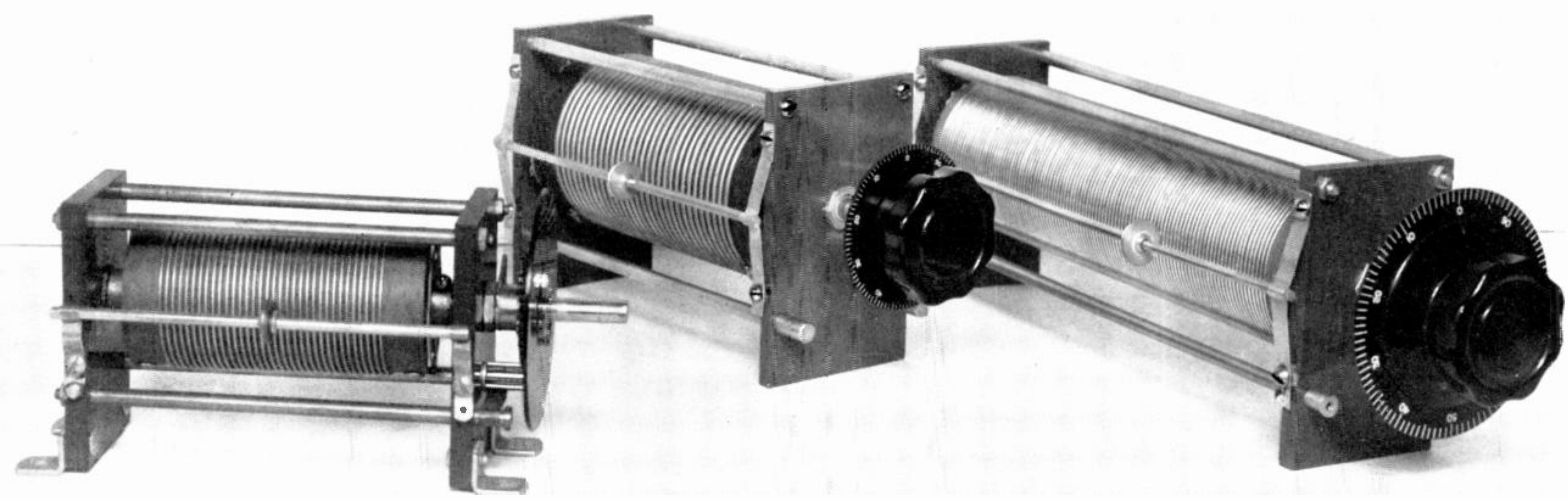


FIG. 1. THREE TYPES OF VARIABLE TUNING INDUCTANCES FOR USE WITH FIXED CONDENSERS IN HIGH-Q CIRCUITS

TUNING BY INDUCTANCE VARIATION

Utilization of Rotary Variable Inductors in Place of Variable Capacitors in Low- and Medium-Power Radio Transmitters

BY McMURDO SILVER*

THE use of rotary variable inductors for circuit tuning in low- and medium-power transmitters is not new in the fields of aircraft, maritime and military equipment. Yet it appears to be relatively unfamiliar to a considerable number of radio engineers. In view of the distinct advantages which frequently inhere to the application of variable inductance in place of variable capacitance tuning of radio frequency circuits, what follows may be of interest because of the sparsity of practical data on the subject.

Advantages of Inductance Tuning ★ It has been common practice in high-frequency radio transmitters, ranging up to 200 watts carrier power output, to employ fixed inductance and variable capacity for tuning. This is possibly because a wide range and variety of variable capacitors has been readily available on the market; because it is not particularly difficult to match such capacitors with one or more fixed inductors; and because there has been apparently no single rotary variable inductor available to equipment designers as a standard product. In a multi-band transmitter, the disadvantages of the variable-capacitor-fixed-inductor tuning system are numerous.

In condenser-tuned circuits, high frequency-stability requires expensive and complex construction involving substantially zero temperature-coefficient metals. There are other disadvantages which inductance tuning eliminates.

* Vice-President-in-Charge Engineering Fada Radio and Electric Co., Inc., Long Island City, N. Y.

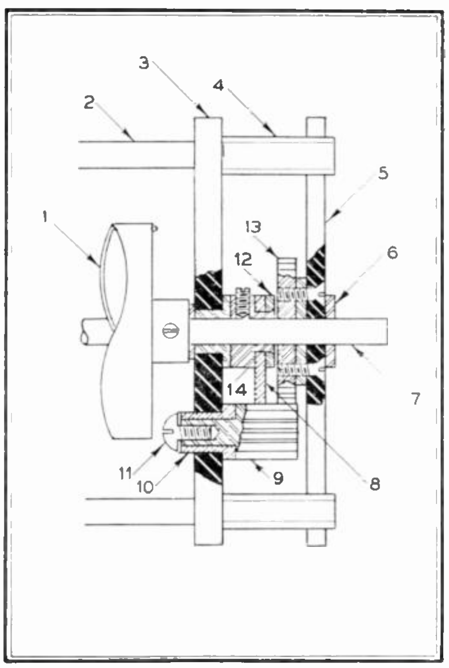


FIG. 3. MECHANISM OF THE TURN INDICATOR

Among these are the variation in Q with frequency in the case of the fixed-inductance system. The radio frequency resistance of the fixed inductor is always present, but is low when associated with relatively high values of tuning capacity. However, with condenser tuning, as the capacity of the variable capacitor is reduced, the Q diminishes rapidly due to the preponderance of total circuit RF resistance in the inductor. This condition is greatly improved when using fixed capacity in conjunction with variable inductance, since the total inductance in circuit is not in excess of that required to resonate at any particular frequency with an always relatively large tuning capacitor.

The relative Q uniformity, varying over the range of a little more than 2:1 through the 7:1 frequency range of 1700 to 12,000 kcs. is illustrated in Fig. 2. A capacity-tuned circuit covering this unusually wide frequency range of 7:1 would be distinctly inferior.

In multi-band transmitters, the cubic volume occupied by a series of inductors associated with a single variable tuning capacitor may frequently be so great as to be distinctly disadvantageous in certain classes of equipment where weight and size are of paramount importance. At this point the variable inductor tuning system, involving but one sizable component associated with a physically small selector switch and a bank of high-quality mica capacitors, provides a significant saving in space and weight. A secondary and finite advantage in terms of size lies in the fact that there are no multiplicity of coils to cause frequent "suck-in points" resulting from unused inductors falling at the points where optimum performance is mandatory, as is the seemingly invariable case of such phenomena.

A very marked advantage of the rotary variable inductor system of tuning is that the manual frequency control acts *directly* upon the circuit frequency control element. In cases where precise resetability is important, there is no loss of such accuracy due to play in gear trains required

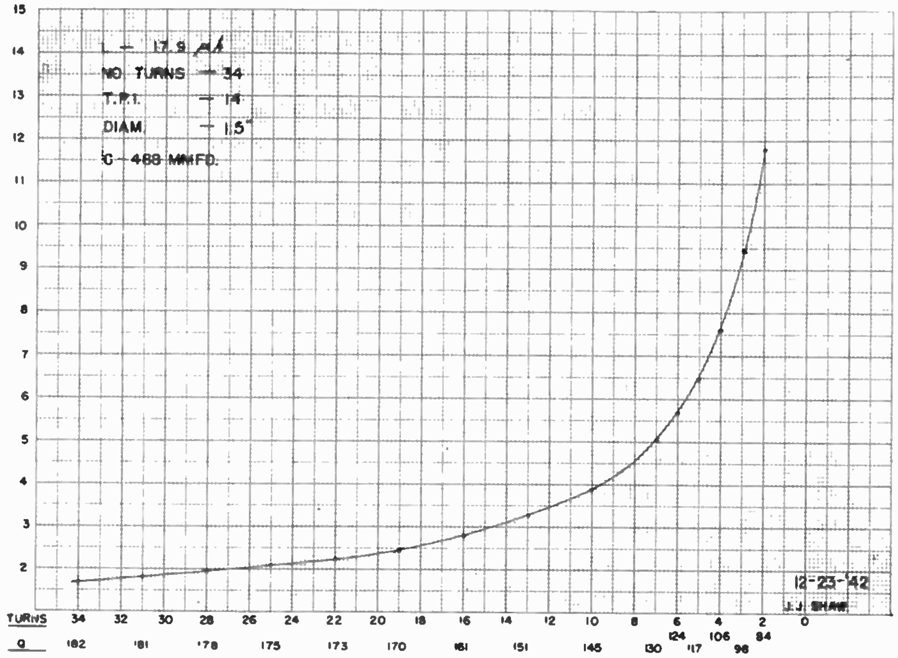


FIG. 2. Q OF THE SMALL VARIABLE INDUCTANCE SHOWN IN FIG. 1, AT THE LEFT

to provide a high order of readability, as there is with a condenser which can be rotated only 180°. With the rotary inductor, a given frequency band can be covered by several rotations of the dial, each representing a single turn of the coil. Thus the dial can be made readable to 1 part in 2,000 for each turn.

Still another advantage of the rotary inductor is that while the relatively long but small-diameter inductor forms may not provide an ideal form factor over the entire tuning range, the form factor improves as the number of turns is diminished in the process of reaching higher frequencies. This, through judicious proportioning of circuit components, can result in a variation in form factor with tuning which operates to flatten out the Q-versus-frequency curve in an advantageous manner.

In the matter of frequency stability, if the inductor is wound on a suitable ceramic or other form, having desirable temperature-coefficient characteristics, it is in no way inferior to a fixed-inductor of essentially identical construction. In cases where an extreme order of frequency stability versus temperature is required, the winding may be of silver-plated Invar or other wire of substantially zero coefficient.

Disadvantages of Inductance Tuning ★ Two objections to the rotary inductor system of tuning are obvious. One is dead-end losses due to the unused portion of the inductor winding, which are closely coupled to the used portion. In practice this appears a mental rather than a real hazard. It is usually adequate to take but two circuit connections from the inductor — the "hot" end of the winding through its bearing and the low potential end through the trolley rod. However, in some cases, it may appear desirable to short-circuit the unused portion of the winding by bringing out a suitable connection through the second bearing, which then may be directly connected to the trolley rod.

This appears to be frequently disadvantageous inasmuch as the absorption of power in the closed loop, formed by the unused portion of the inductor, may be appreciable. It therefore seems best in most cases to leave the unused portion of the inductor open, with the trolley connected to the low potential side of the circuit so that the unused inductor portion is pendent from and electrically connected to the low-potential side of the circuit.

A second obvious objection may be the question of contact resistance between the roller contactor, the successive turns of the inductor, and the rod upon which the trolley both rotates and slides. Suitable design can keep the RF resistance through such contacts at satisfactorily low values. The assembly itself, unlike the average capacitor bearing, is open and readily accessible for cleaning during routine service operations.

Typical Designs ★ Three examples of practicable variable inductors are illustrated in Fig. 1. Each is a preliminary model made up from Bakelite, copper wire, and brass fittings. In the production version of these items, the inductor form and its two end plates are of ceramic material. The design was first established and preliminary computations confirmed with the more easily produced Bakelite models illustrated. The basic structure is clearly apparent from examination of the three types shown in Fig. 1.

Each consists fundamentally of two end plates joined by four tie-rods with the two separate short shafts, which do not project into the windings, positioned by means of suitable spiders at each end of the inductor form. They are carried by suitable bearings in the two end plates. A knob and 360 degree dial, which may be either direct or right-angle drum type, rotates the inductor through a range equalling all or as many turns as may be desired in a particular application. Electrical connections are taken out from either or both ends of the inductor form by joining the winding ends to the spiders carrying the metallic shafts.

The other contact is taken from the small trolley seen on the left side of each inductor, arranged to rotate freely on a rod paralleling the inductor axes. This rod is supported by suitable springs to insure positive contact between the trolley roller, grooved to conform to the diameter of the

(CONTINUED ON PAGE 33)

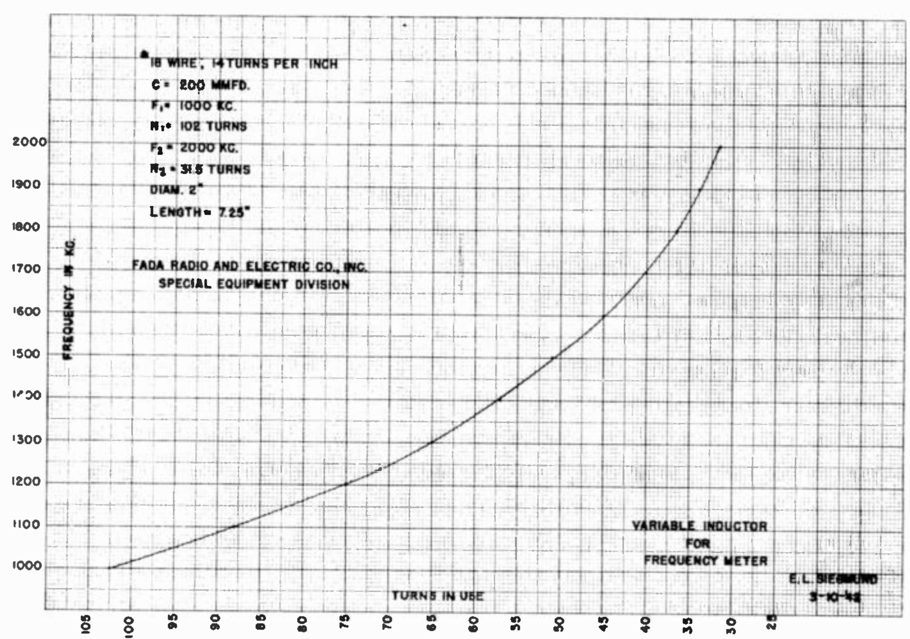


FIG. 4. VARIABLE INDUCTANCE RANGE OF COIL ON 2-IN. FORM, WOUND WITH NO. 18 WIRE

STANDARD SIGNAL CORPS DRY BATTERIES

THERE are 30 types of dry batteries which have been given standard Signal Corps numbers. Characteristics and dimensions are given in the table. Drawings opposite are ⅛th actual size.

All the batteries are rectangular in shape except those of which a top view is given. Some of the batteries have sockets for terminals. In these cases, the socket is drawn above the battery.

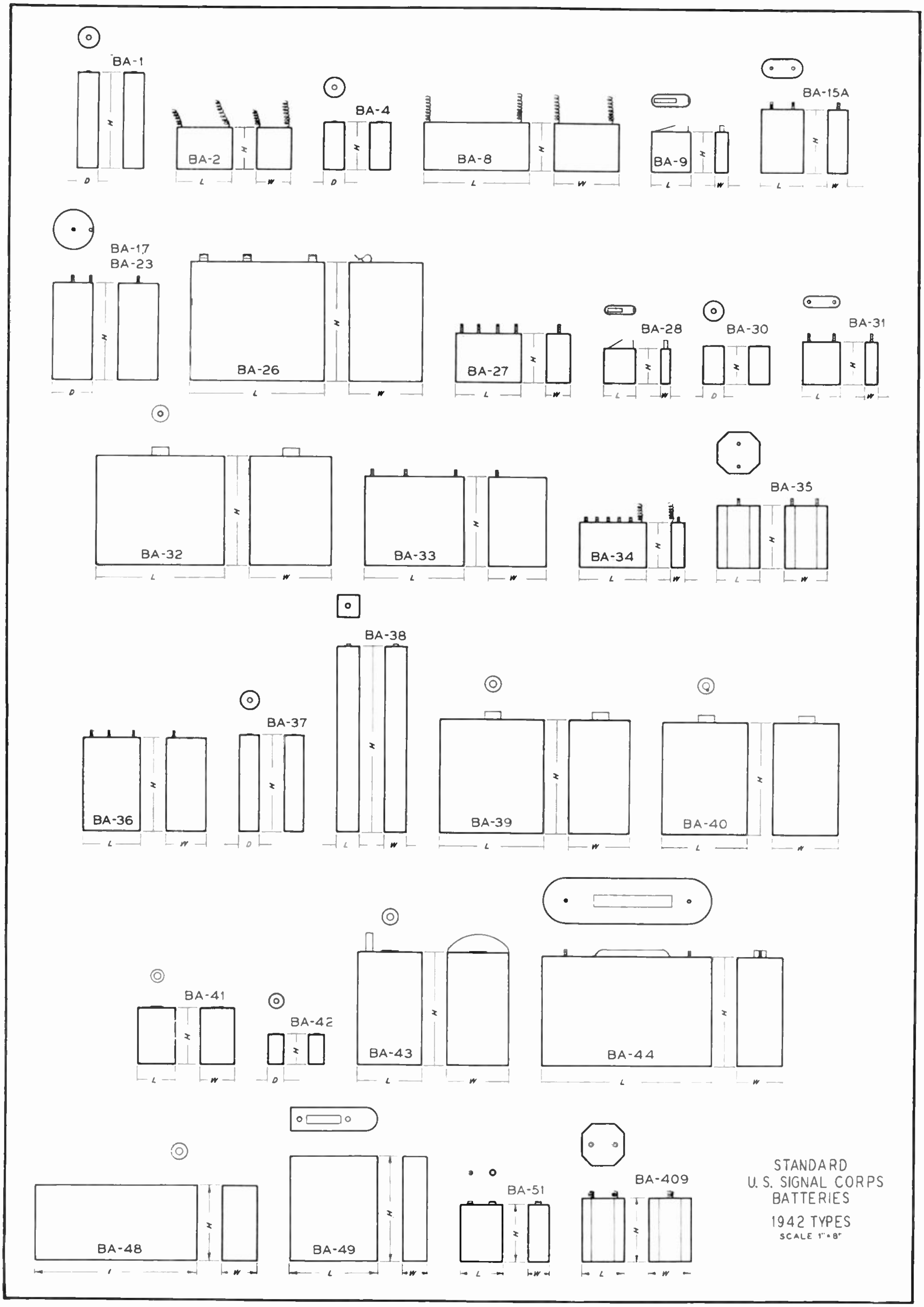
Battery type BA-51, which is interchangeable with the Navy type 19032, has snap fasteners for terminals. These snaps are different in size, so that connections cannot be reversed.

Designers of new military equipment must confine themselves to these accepted battery types, or to battery cases containing combinations of these types. This situation has been brought about by the extremely complex problem of keeping fresh stocks of every type at every depot and supply base maintained by the U. S. A. in all parts of the world.

Of the 30 different types, only 11 are interchangeable with Navy batteries. These are indicated in the second column of the Table, and should be favored for applications which might be used by both services.

ELECTRICAL AND MECHANICAL DIMENSIONS OF SIGNAL CORPS BATTERIES, 1942 TYPES

S.C. NO.	EQUIV. NAVY NO.	TYPE	TERMINAL VOLTAGE	NO. & TYPE OF CELL	TYPE OF TERMINAL	DIMENSIONS				WEIGHT LBS.
						L. OR D.	W.	H.	O.A.H.	
BA-1		Tube	3	2 No. 39	Flat cap	1 5/16		6 1/16	6 1/16	.5
BA-2	19033	Wax or paper top	22½	15 No. 4	Flex. leads	3 7/16	2 3/32	2 19/32	2 19/32	1.15
BA-4		Tube	1½	1 No. 39	Flat cap	1 5/16		3	3	.25
BA-8		Wax top	22½	15 No. 2	Flex. leads	6½	4	3	3	4.25
BA-9		Wax top	4½	3 No. 5	Flat spring	2 7/16	13/16	2 9/16	3	.4
BA-15A		Wax top	1½	2 No. 9	Screw	2⅝	1¼	4	4 7/16	.90
BA-17		Tube	1½	1 No. 6	Screw	2½		6	6 7/16	2.25
BA-23		Tube	1½	1 No. 6	Screw	2½		6	6½	2.25
BA-26		Wax top	22½ 45	30 No. 9	Spring clip	8¼	4½	7⅜	8 1/16	11.35
BA-27	19014	Wax top	4½	3 No. 2	Screw	4 1/16	1½	3⅛	3 9/16	.88
BA-28		Wax top	4½	3 No. 4	Flat Spring	1 31/32	21/32	2¼	2¾	.16
BA-30	19031	Tube	1½	1 2LP	Flat cap	1 5/16	2⅜	2⅜	2⅜	.21
BA-31	19013	Wax top	4½	3 No. 5	Screw	2⅜	13/16	2 11/16	3 3/16	.4
BA-32	19015	Metal can	A=3 B=144 C=4½ 13½	6 No. 8 96 No. 5 12 No. 5	Plug in	7 15/16	5	6 13/16	7⅜	12
BA-33		Wax top	45 135	90 No. 4	Screw	6⅛	3 9/16	5⅝	6 1/16	5.5
BA-34	19011	Wax top	7½	5 No. 5	5 screw 1 flex.	4⅛	⅞	2⅞	3 3/16	.75
BA-35	19010	Paper top	1½	4 No. 9	Screw	2⅝	2⅝	3 15/16	4⅜	1.35
BA-36	19005	Wax top	22½ 45	30 No. 5	Screw	3 9/16	2½	5¾	6 3/16	2.88
BA-37		Tube	1½	1 No. L	Flat cap	1¼	1¼	5 15/16	5 15/16	
BA-38	19038	Paper top	103½	69 No. 716	Flat cap	1 11/32	1 11/32	11½	11⅝	1.2
BA-39		Paper top	A=7½ B=150	5 No. 9 100 No. 4	Plug in	6 7/16	3¾	7 1/16	7½	7.25
BA-40		Paper top	A=1½ B=90	4 No. 8 60 No. 5	Plug in	5¼	4 1/16	6 15/16	7⅜	6.75
BA-41		Paper top	B=60 C=25½ C=4½	40 No. 716S 17 No. 716S 3 No. 716S	Plug in	2⅜	2⅛	3½	3½	.75
BA-42		Tube	1½	1 No. 1LP	Flat cap	1		1⅛	1⅞	.11
BA-43		Paper top	A=1½ B=90 C=45	4 No. 9 60 No. 7R 30 No. 716	Plug in	3 31/32	3 13/16	7⅙	7 1/16	4.25
BA-44		Metal can	6	4 No. 6	Screw	10½	2⅞	6⅞	7 5/16	10
BA-48		Paper top	A=1½ B=90	6 No. CD 60 No. 4	Plug in	10	2 3/16	4¾	4¾	4.75
BA-49		Metal can	A=1½ B=135	2 No. 39 90 No. 716	Plug in	5 7/16	1½	6 9/16	6 9/16	2.5
BA-51	19032	Paper top	67½	45 No. 716	Snap Fastener	2⅝	1 5/16	3 11/16	3⅞	.75
BA-409		Paper top	6	4 No. 9	Spiral Spring	2⅝	2⅝	4	4 7/16	1.37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BA-39
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BA-41
BA-42
BA-43
BA-44
BA-48
BA-49
BA-51
BA-409
STANDARD
U. S. SIGNAL CORPS
BATTERIES
1942 TYPES
SCALE 1" = 8"

PRODUCTION OF TRANSMITTER FRAMES

Describing Methods and Equipment Used to Manufacture Frames for High-Power Transmitters

BY FRANK A. GUNTHER*

FRAMES and mechanical construction have been the problem children of transmitter manufacturers ever since the requirements of modern design made it necessary to abandon the use of conventional telephone relay-racks. The prime requirement of the frames in which transmitters are assembled is that they be absolutely rigid, and capable of withstanding all strains during movement within the plant and in transit to the site of installation. Now, of course, military use introduces further hazards of overseas shipping.

Any design involving assembly with bolts and nuts is ruled out. Only arc welding and spot welding give the absolute rigidity required. This fixes the general plan of construction and manufacturing methods.

Movement of Materials ★ Confronted with the need of producing transmitter frames in substantial quantities, the Radio Engineering Laboratories were faced with the alternatives of 1) contracting for their production or 2) equipping a separate plant for this purpose, since no space was available in the property already occupied.

Upon analysis, the real problem was found to be that of movement of materials. That is, beyond the familiar question of paying a contractor his profit, we had to decide between moving materials to the contractor, and then moving the frames to our plant, or bringing sheet steel directly to the point where finished transmitters would be shipped out. Consideration of these factors, added to the advantages of having production schedules and the quality of the finished products under our own control, indicated the latter course beyond question.

Planning the Plant ★ Since a new plant was necessary, it was decided to provide additional, associated facilities, comprising:

1. Space for assembling the transmitters, with further allowance to handle completed frames awaiting components fabricated in the main plant, and finished transmitters awaiting shipment.
2. Power lines and heavy equipment required to put the transmitters through their final acceptance tests.
3. Packing and shipping facilities.
4. A special platform lift so that the heavy equipment could be raised and rolled onto trucks with ordinary dollies.

We were fortunate in finding a one-floor garage, of ample floor space, vacant because it had lost so many of its customers. It had the concrete floor required for our purposes, and it was no problem to sink piers wherever needed for heavy machinery.

Just how the plant was planned and equipped can be seen from the accompanying illustrations. The one important section not shown is the testing laboratory which, for obvious reasons, is not included in this description.

Power Squaring Shear ★ The first step in fabricating the transmitter frames, covers, doors, and panels is that of cutting up sheet stock into plates and strips of exact dimensions. This is done in a No. 68 Niagara power squaring shear, Fig. 2.

The shear, weighing 10,800 lbs., is capable of cutting up to 10-gauge mild steel, and takes stock up to 96 ins. wide. Built out at the front, as Fig. 2 shows, is an extension squaring gauge fitted with a scale and adjustable stop. In use, two men lift a large sheet into position. Then the one at the rear presses the sheet against the gauge while he pulls it back against the stop, while the other guides the sheet at the front and operates the long foot treadle.

There is also a self-measuring parallel back gauge, behind the shear, used principally for cutting strips. In that service, the shear can be operated automatically at a maximum of 65 strokes per minute.

Bending Brake ★ Ordinary bends and the more complicated shapes used at the corners of the frames are done on a Dreis & Krump type 6L8 steel press brake. The machine, as well as some of the special corner shapes, can be seen in Fig. 3. No. 10 gauge cold rolled steel in 6-ft. lengths or 16 gauge in 8-ft. lengths can be bent in this machine.

Standard forming dies of all kinds and shapes are available for this machine. Dies can be changed easily and quickly in accordance with the particular bend required. For pieces which can be fed continuously, the brake can be operated at speeds varying from 15 to 45 per minute. Adjustment can be made while the machine is running by turning a hand wheel at

FIG. 1. WELDED STEEL TRANSMITTER FRAME COMBINES MINIMUM WEIGHT WITH GREAT RIGIDITY REQUIRED FOR MODERN EQUIPMENT

*Vice president in charge of engineering, Radio Engineering Laboratories, Inc., Long Island City, New York.

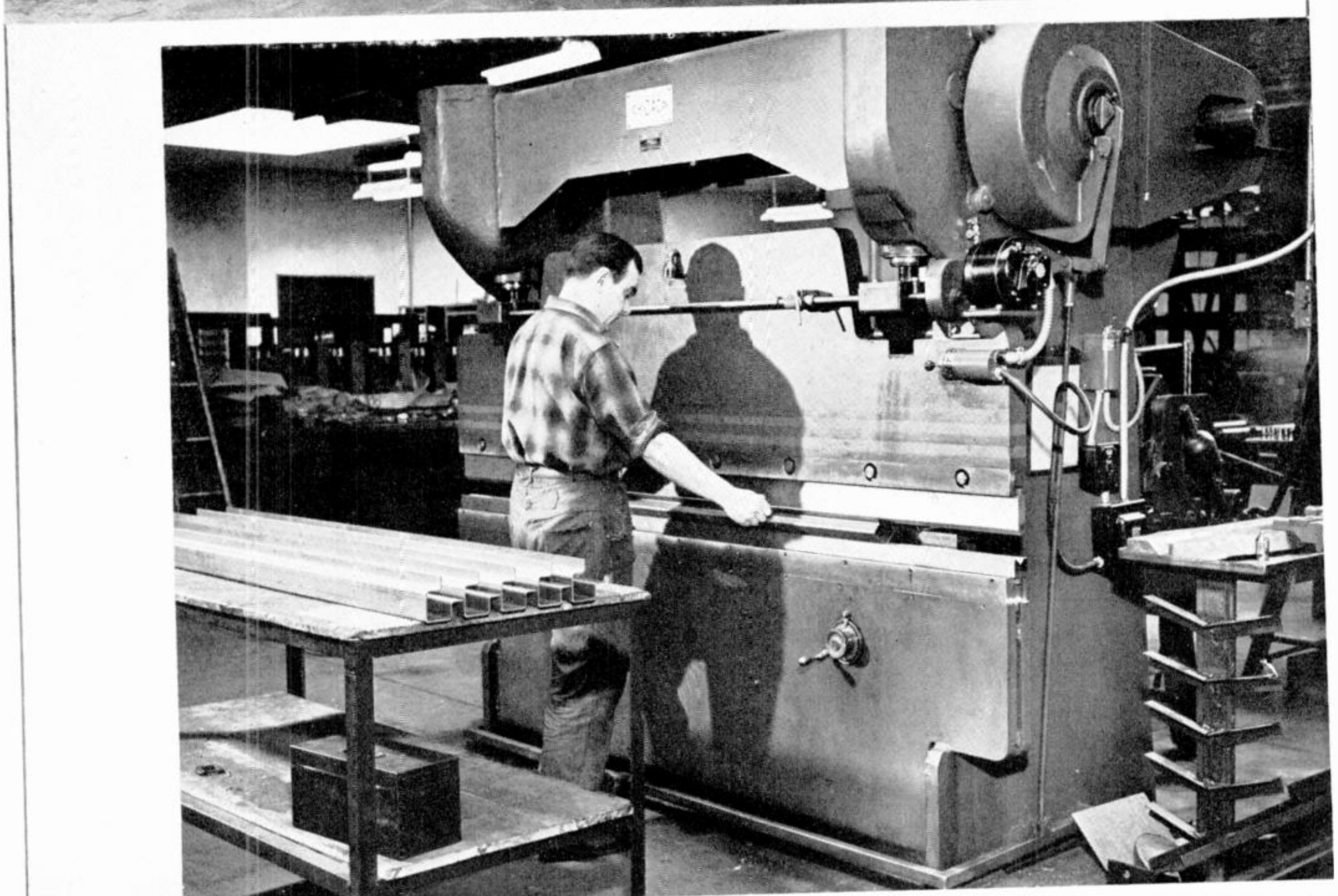


FIG. 2, ABOVE: PLATES AND STRIPS FOR PANELS AND FRAME MEMBERS ARE CUT FROM STEEL PLATES IN THE SQUARING SHEARS

FIG. 3, BELOW: SECTIONS BENT FROM STEEL SHEET GIVE GREATER STRENGTH WITH FAR LESS WEIGHT THAN SOLID MEMBERS the base of the motor. The total weight of the brake is 8,600 lbs.

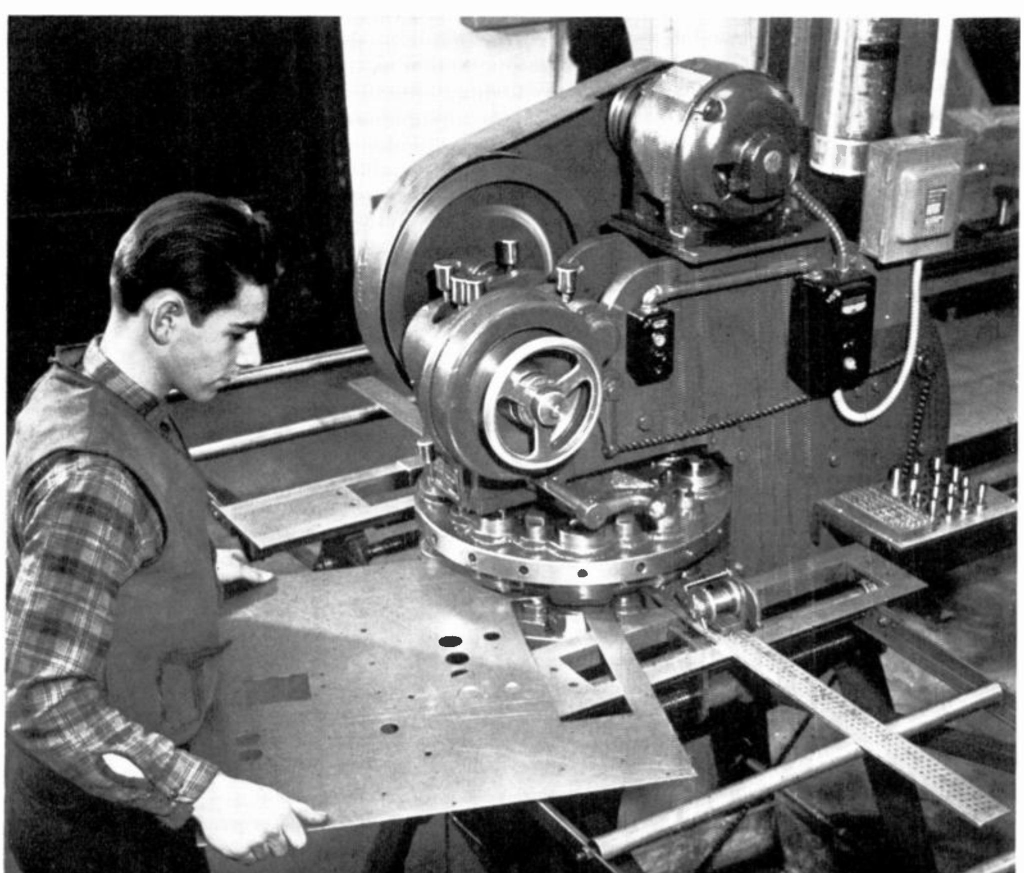
Turret Press ★ We solved the problem of punching the great variety of holes required by installing a battery of Wiedemann turret presses, one of which is illustrated in Fig. 4. The relatively small runs of transmitters do not justify making complete dies, and the large dimensions of many of the pieces would require enormous presses.

We save both time and tool costs by using turret presses. As Fig. 4 shows, each press carries up to 18 different, removable dies, any one of which can be selected in a matter of seconds. The usual practice is to set the stops and select the die for one hole to be punched in the run of pieces. Then the machine is adjusted for the next hole, and the pieces put through again. Experience shows a tremendous saving from the use of these presses in runs up to 800 or 1,000, as well as in making one or two pieces for experimental work.

The holes we use vary from ⅛ in. up to those for mounting meters. Rectangular holes of large dimensions are made by taking several bites with a small, square die. Operated by a foot-pedal, this press can take mild steel sheet as heavy as 10 gauge.

The lateral and longitudinal gauges can be set with great accuracy. The former is set with a pin stop in one of the holes in the strip which extends toward the lower right hand corner of the illustration. For distances which lie between the holes, pins are used with buttons of various diameters. The longitudinal gauge has a screw adjustment which can be set from the front.

FIG. 4, BELOW: PUNCHING HOLES IN A STEEL PANEL. FIG. 7, ABOVE: SPRAYING ZINC CHROMATE ON A COMPLETED TRANSMITTER FRAME



If several holes are to be punched along the same lateral center line, a corresponding number of pins can be set up in the gauge, and the stop moved accordingly.

Arc Welding ★ The frame sections are joined by arc welding. This work is done in a separate room so that the light cannot interfere with the other workers. Most welding is done by teams of two men, so that while one is welding, the other can set the clamps and gauges for the next weld. One of these teams is shown in action in Fig. 5, assembling the top deck of a frame.

The arc welding unit in use can be seen behind the man at the right. It is a portable Westinghouse 6 kw. unit, model WT 4.

Adequate ventilation for the welding department is provided by a separate blower system. This is necessary to carry off the fumes from the welding operations.

Finishing ★ The last stage of fabrication requires the smoothing of the welded

FIG. 5, BELOW: ARC WELDING IS USED TO JOIN THE FRAME MEMBERS. FIG. 6, ABOVE: WELDED JOINTS ARE SMOOTHED BY A SANDER

joints. Each unit of the frame, such as the top decks shown in Fig. 6, is smoothed before it is joined with other sections, because many of the joints then become inaccessible. This work is done with Stanley portable sanders.

Spraying ★ Fig. 7 shows a completed frame in one of the spray booths, getting its base coat of zinc chromate. The frame is set on a rotating stand so that the operator can direct the spray into the booth at all times. This section of the plant is separated by a brick wall, and is ventilated by huge exhaust fans.

Spray guns are the De Vilbiss type MBD, as shown in Fig. 7, and are used for both the primer and finishing coats.

Baking ★ From the spray booths, the frames are wheeled into a huge Gehnrich indirect gas-fired baking oven. Recirculation provides the distribution of heat throughout the oven, to assure even drying on all surfaces of the painted parts. An accurate control of the fresh air intake permits regulation in accordance with the type of finish used.

While the baking oven calls for elaborate construction to accommodate it, and to meet strict fire regulations, it is an essential part of the equipment, since air-drying methods are not adequate or satisfactory, nor are they suited to production requirements.

Spot Welding ★ Another important process in the fabrication of the finished frames is that of spot welding. This is used for sheet metal parts such as doors and side panels, as shown in Fig. 8.

The welder is a Rex 75 kva. model, air-operated from a foot treadle. The arms are reversible, and are drilled at one end to carry the tips vertically, and at the other, at an angle of 30°.

Timing is controlled by a Square D automatic timer, set up behind the operator standing at the right, in Fig. 8.

Notes ★ The information presented here may give rise to the remark: "That is a tremendous amount of equipment and installation just to make transmitter frames. Have the results fully justified the investment and the added responsibilities of operation?"

The answer is definitely "Yes." One reason is that the equipment was selected specifically for the work to be produced, yet it is flexible enough to meet any modifications in designs which may develop in the future. Most important, however, is the fact that in the production of heavy transmitting equipment, running up to 50 kw. output, we are now able to maintain a steady flow of movement

(CONTINUED ON PAGE 22)

SPOT NEWS NOTES

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

Dr. W. R. G. Baker: "Consumers should not be led to believe that the day after peace comes they will be able to buy television and FM radio sets for $9.95. It will take a long time to reduce new wartime knowledge to peacetime practice, and it won't take place overnight. If the War lasts until 1945, probably only 50% of the Nation's radio receivers will be in operation. This will mean a big demand for receivers when peace comes, and will keep workers employed while engineers are converting their new wartime knowledge to better peacetime products.

"When the electronics industry returns to making consumer peacetime products, it will start where it left off when it converted to War production. New wartime developments will be eventually incorporated in these products, but it won't be done overnight." — From a talk to the American Marketing Association, by G.E.'s vice president in charge of radio, television, and electronics.

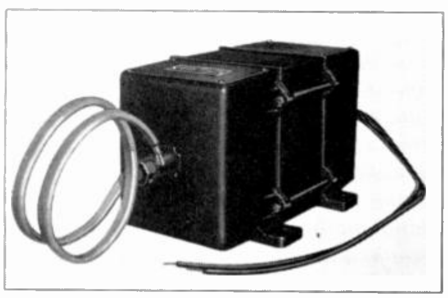
JAMES WATSON AND G. V. ROCKEY PRESENT CAPT. HENDERSON WITH 5,000,000TH COIL PRODUCED BY THE MEISSNER COMPANY SINCE DEC. 7, 1941, DURING "E" CEREMONY

Lubricant Color Code: American Standards Association is at work on color code to indicate grade of grease or oil for given machine part. Plan is to color-code part of lubricant container, thus showing correct grade for best service.

Vibration Insulators: When vibrations set up by manufacturing equipment interfere with laboratory work, insulated mountings for the machinery may be the answer. Various types for heavy loads, constructed of rubber bonded to steel supports, are available from B. F. Goodrich Company, Akron, O.

Packing Military Equipment: War Department has published an illustrated book showing preferred methods for packing delicate equipment to withstand moisture and vibration. Also illustrated are types of interior packing, bracing, and blocking in boxes and shooks which can be stowed on board ship to best advantage. Copies can be obtained from Office of the Quartermaster General, Washington, D. C.

Isolating Transformer: To reduce interference brought into shielded test rooms by AC power lines, a 2 kva. isolating transformer has been brought out by Acme Electric & Manufacturing Company, of Cuba, N. Y. With a 1% regulation at 1 kva., it can be used to operate lights, soldering irons, and AC-powered test equipment. Secondary is enclosed in a copper shield, grounded to a lead-shielded output lead.



ACME NOISE-ISOLATING TRANSFORMER

Leslie J. Woods: Named vice president and general manager of National Union Radio Corporation, according to an announcement by S. W. Muldowny, president. He was a lieutenant of the Royal Engineers, serving in the British Army from 1915 to 1918. He joined the Philco organization in 1923, when he came to the United States to make his home here permanently.

50 Kw. at Rio: New short-wave broadcasting station at Rio de Janeiro, built and installed by RCA, is now on the air. North America beam is on 26.5 meters.

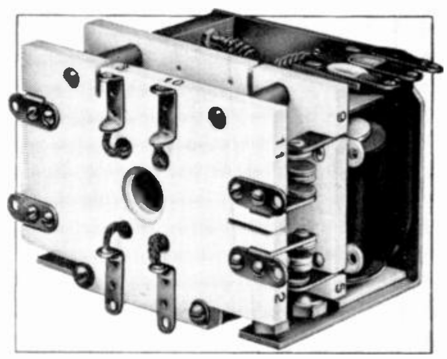
Quits Radio: Jack Ross, head of Detrola Corporation, has sold his interest in that Company, and has retired to a western ranch. Stock was purchased by Strong, Carlisle & Hammond Company, of Cleveland, which will operate Detrola as a subsidiary. New officers include J. S. Stephens, president; Roger M. Daugherty, vice president in charge of engineering; W. Keene Jackson, vice president in charge of sales.

5,000,000 Coils: As evidence of its outstanding accomplishments for which Meissner Manufacturing Company was awarded the Army-Navy "E", James Watson, left, president of Meissner Company, and G. V. Rockey, vice president, presented Capt. Robert Henderson with the 5,000,000th coil which their factory has produced since "Pearl Harbor."

Electronic Progress: Outlined in a beautifully illustrated 32-page booklet issued by General Electric Company. Illustrations show and explain applications in war, research, industry, radio and television, agriculture, and medicine. Copy can be obtained by writing to Schenectady, N. Y.

Aircraft Keying Relay: Four-pole, double-throw aircraft keying and break-in relay illustrated handles 1,000 volts at 20 mc. at 30,000 ft., and 10,000 volts at sea level. Contacts hold in either position against 20 G. Keying speed up to 20 cycles.

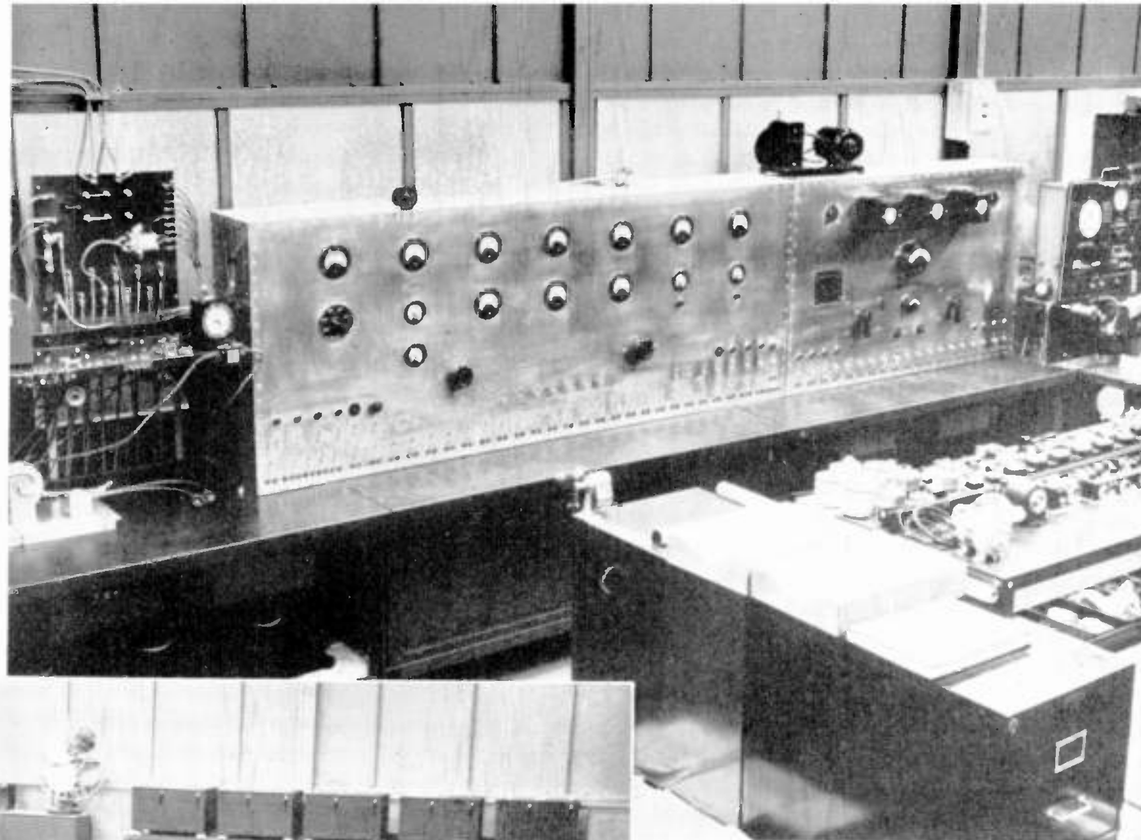
(CONTINUED ON PAGE 35)



ALLIED KEYING RELAY FOR AIRCRAFT USE

NEWS PICTURE

THESE photographs show the very elaborate setup of Republic Aviation's radio and electronic laboratory. Here all electrical equipment for use in the super-speed Republic Thunderbolt fighters is checked for ability to meet all the extraordinary conditions encountered under service conditions.



A high-altitude chamber is built into the right-hand panel in the upper photograph. Above it is an exhaust pump connected to the chamber.

Aircraft radio engineers prefer to make all their own tests, feeling that radio manufacturers do not have a sufficient understanding of the unusual conditions met in flight service.

Electro-mechanical parts are tested to destruction. Motor-generators are given the works by the apparatus at the extreme left of the center picture. Complete circuits used in the planes can be set up on the panel shown above and below. Relays, switches, and control devices awaiting acceptance tests line the shelves.

Recorder shown at right is used to make records of conversations with pilots while they are on test flights.

James J. Kuffler is in charge of Republic's radio laboratory.

MICA-DIELECTRIC CONDENSERS

A.S.A. STANDARDS OF NOVEMBER 12, 1942

A. APPLICABLE SPECIFICATIONS AND DRAWINGS

A-1. The specifications and drawings listed below form a part of this specification. Unless modified in the order, the issue numbers given shall apply.

A-1a. *Specifications.* — (Not furnished with this specification):

American Standard for Screw Threads for Bolts, Nuts, Machine Screws and Threaded Parts (B1.1-1935).

Color Code — Standard Color Card of America (8th Edition, 1928). Textile Color Card Association of the United States, 200 Madison Avenue, New York, N. Y.

A-1b. *Drawings.*

CM20-1 Molded Mica Capacitors, CM20
CM25-1 Molded Mica Capacitors, CM25
CM30-1 Molded Mica Capacitors, CM30
CM35-1 Molded Mica Capacitors, CM35
CM40-1 Molded Mica Capacitors, CM40
CM45-1 Molded Mica Capacitors, CM45
CM50-1 Molded Mica Capacitors, CM50
CM55-1 Molded Mica Capacitors, CM55
CM56-1 Molded Mica Capacitors, CM56
CM60-1 Molded Mica Capacitors, CM60
CM61-1 Molded Mica Capacitors, CM61
CM65-1 Molded-Case, Potted Mica Capacitors, CM65
CM70-1 Molded-Case, Potted Mica Capacitors, CM70
CM75-1 Ceramic-Case, Potted Mica Capacitors, CM75
CM80-1 Ceramic-Case, Potted Mica Capacitors, CM80
CM85-1 Ceramic-Case, Potted Mica Capacitors, CM85
CM90-1 Ceramic-Case, Potted Mica Capacitors, CM90
CM95-1 Ceramic-Case, Potted Mica Capacitors, CM95

B. TYPES, GRADES, AND CLASSES

B-1. *Grade.* — This specification covers fixed mica-dielectric capacitors. Capacitors shall meet the requirements contained in this specification in all respects. They may be of a grade better than specified.

B-2. *Type Designation.* — The type designation assigned to a particular capacitor will be indicated on the drawing covering the capacitor and is formed as outlined in D-5 herein.

B-3. *Types.* — Capacitors of the following types are covered by this specification:

B-3a. *Molded Capacitors.* — Capacitors wherein the capacitor element or stack is molded in the case material.

B-3b. *Molded-Case Potted Capacitors.* — Capacitors wherein the capacitor element or stack is supported within a case of molded material and embedded in some potting compound.

B-3c. *Ceramic-Case Potted Capacitors.* — Capacitors wherein the capacitor element or stack is supported within a case of ceramic material and embedded in some potting compound.

C. MATERIAL AND WORKMANSHIP

C-1. The material for each part shall be as specified herein. An adequate material shall be used when a definite material is not designated. All parts shall be manufactured and processed in a careful and workmanlike manner, in accordance with the best design and practice for tropical and cold climates and must meet the design, performance, and test requirements of this specification and the applicable detail drawings.

C-2. *Substitution of Material.* — If the supplier desires to substitute for a specified or previously approved material or fabricated part, he shall submit to the purchasing agency with his bid or sample a statement to that effect, describing the proposed substitution, together with evidence to substantiate his claims that such substitute is adequate. At the discretion of the purchasing agency, test samples may be required to prove the suitability of the proposed substitute.

C-3. *Soldering.* — Only rosin or rosin and alcohol shall be used as a flux. Consideration will be given to the use of other soldering fluxes only where adequate evidence is presented to indicate that the proposed flux is equally suitable and noncorrosive.

C-4. *Machine Screws, Bolts, and Threads.* —

C-4a. *Standard Screw Threads.* — Where practicable, all bolts, machine screws, nuts, and tapped holes shall conform to the American Standard for Screw Threads (B1.1-1935). Except with specific approval, screws smaller than size 4 shall not be used other than for mounting nameplates. Screws of the self-tapping type having American Standard threads may be used for mounting nameplates only.

C-4b. *Locking of Screw-Thread Assemblies.* — All screw-thread assemblies shall be made vibration-proof. Where practicable, split-type lock-washers of bronze, stainless steel, or other approved material shall be provided under all nuts.

C-5. *Wood.* — Wood, suitably treated, may be used for wedges and spacers.

C-6. *Riveting.* — The riveting operation shall be carefully performed to assure that the rivet is tight and satisfactorily headed.

C-7. *Iron and Steel.* — Use of ferrous materials for current-carrying parts is prohibited.

D. GENERAL REQUIREMENTS

D-1. *Enclosure.* — All capacitors shall be potted or molded in cases as specified in the individual drawings. Capacitors shall be effectively sealed against the entry of atmospheric moisture and the elements shall be mounted so as to prevent injurious movement in their cases. The capacitor elements shall be completely enclosed in their cases on all sides except where terminals or leads project.

D-1a. *Molding Insulating Materials.* — The cases shall be molded of any one of the following materials or an approved substitute.

Bakelite	*Durez*
BM 262	11863
BM 120	2260

D-1b. *Color.* — The color of the case material is not specified and uniformity of color within a given lot will not be required.

D-2. *Insulating and Impregnating Compounds.* — All such compounds, including varnishes, waxes, and the like, shall be suitable for each particular application. Under all specified test conditions, a compound shall adequately preserve the electrical characteristics of the insulation to which it is applied by the ex-

[1] This standard is one of a number of standards for radio materials and parts which are being developed under the War Procedure of the American Standards Association at the request of the War Production Board and with the cooperation of the War and Navy Departments, the Institute of Radio Engineers, the prime contractors, and the capacitor manufacturers. The possibilities of stimulating increased production of radio equipment for the Armed Services through standardizing component parts was discussed at a meeting of interested groups on March 19, 1942. Formal organization of a War Committee on Radio resulted. This standard was developed under the direction of this committee, the personnel of which is as follows:

S. K. Wolf, War Production Board, *Chairman*
R. P. Bennett, Bendix Radio Corporation
Major Theodore Bishoff, Signal Corps General Development Branch, U. S. Army
(Lieutenant G. C. Anderson, *Alternate*)
H. C. Bonfig, RCA Manufacturing Company
Lieutenant Commander A. B. Chamberlain, Bureau of Ships, U. S. Navy
L. A. DuBridge, National Defense Research Council
(M. D. McFarlane, *Alternate*)
J. J. Farrell, General Electric Company
(R. J. Biele, *Alternate*)
(C. H. Crawford, *Alternate*)
Alfred N. Goldsmith, Institute of Radio Engineers
D. G. Little, Westinghouse Electric & Manufacturing Company
Colonel Tom C. Rives, Signal Corps Radar Division, U. S. Army
H. N. Willets, Western Electric Company
H. P. Westman, American Standards Association, *Secretary*

These standards cover physical dimensions, capacitance values, color coding, characteristics, and test procedures and requirements for a range of fixed mica-dielectric capacitors from the smallest sizes used in receivers to the large units for high-power transmitters. They are prepared in such form as to be directly used for the procurement of these components by the Armed Services.

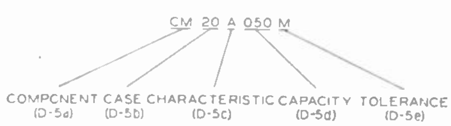
There are many additional sizes and shapes of capacitors which are not covered by these standards. It is not intended that their manufacture be discontinued. Existing designs under which equipment is being, and will continue to be, fabricated are such as not to permit complete substitution with capacitors included in this standard. Neither are these standards suitable in all cases for direct replacement of existing capacitors which may fail in service. However, they should be controlling in the preparation of new molds and other manufacturing facilities, and equipment designed after the promulgation of these standards should utilize them as extensively as possible in order that maximum production may be had with a minimum of waste of time and material.

clusion therefrom of moisture. A compound, either in the state of its original application or as the result of cracking or aging, shall not show any injurious effect upon any part of the capacitor with which it may come into contact, and shall not crack or leak when the capacitor is mounted in any position, under the most severe combination of conditions outlined herein.

D-3. *Connections.* — In no case shall electrical connections depend upon wires, lugs, terminals, and the like clamped between a metallic member and an insulating material. Such connections shall be soldered or be clamped between metal members, preferably such as an assembly of two nuts, two washers, and a machine screw. If such an assembly is not used, and the maintenance of a tight connection depends upon the resistance of an insulating material to compressive stress or shear, such connections shall be securely soldered. This restriction does not apply to capacitors where space and mechanical limitations preclude such design; however, in such cases, the connection between the lead or terminal and the capacitor electrode shall be designed so as to provide secure and permanent contact with the electrode.

D-4. *Finishes.* — All exposed metal surfaces, except aluminum, shall be finished as specified on the detail drawing except in the case of inserts molded into place, in which case unplated brass may be used. The plating shall be of sufficient thickness and permanence to provide protection for the base metal against corrosion. Cadmium shall not be used for plating.

D-5. *Type Designation.* — This is a comprehensive type-numbering system which identifies the component. The capacitor type designation shall be in the following form:



STANDARD METHOD OF TYPE-NUMBERING

D-5a. *Component Designation.* — Fixed mica-dielectric capacitors are identified by the symbol "CM."

D-5b. *Case Designation.* — The case designation is a 2-digit symbol which appears on the detailed drawings and identifies a particular combination of type and class.

D-5c. *Characteristic.* — The characteristic is indicated by a single letter in accordance with Table I.

D-5c (1). Figure of merit or *Q* for capacitors of characteristics other than A and for which current ratings are not listed, when measured at 1 megacycle, shall be not less than the values given in

TABLE 1

Characteristic	*Q*	Temperature Coefficient Parts Million/deg. C	Maximum Capacitance Drift (F-6)	Verification of Characteristics by Production Test
A	Not specified	Not specified	Not specified	Not required
B	[As specified	Not specified	Not specified	Not required
C	in D-5c (1)]	—200 to +200	0.5 per cent	Not required
D	"	—100 to +100	0.2 per cent	Not required
E	"	0 to +100	0.05 per cent	Not required
F	"	0 to + 50	0.025 per cent	Required
G	"	0 to — 50	0.025 per cent	Required

Figure 1. For capacitances larger than 500 micromicrofarads, the value of *Q* shall be greater than 1500.

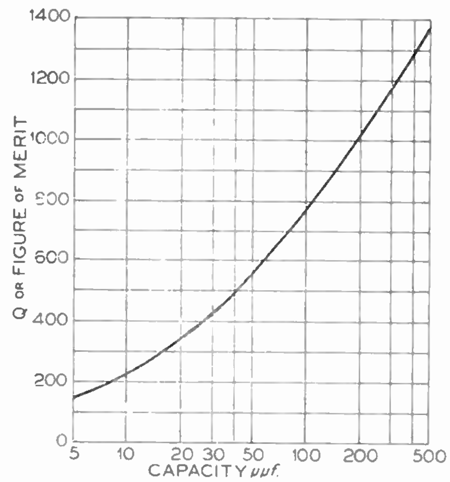


FIG. 1. REQUIRED Q FOR MICA CONDENSERS

D-5d. *Capacitance Value.* — The nominal capacitance value in micromicrofarads is indicated by a 3-digit number. The first 2 digits are the first 2 digits of the capacitance value in micromicrofarads. The final digit specifies the number of zeros which follow the first two digits. If more than 2 significant figures are required, additional digits may be used, the last digit always indicating the number of zeros.

D-5e. *Capacitance Tolerance.* — The symmetrical capacitance tolerances in per cent shall be designated by a letter as shown below.

Tolerance	Designation letter
± 2 per cent	G
± 5 per cent	J
± 10 per cent	K
± 20 per cent	M

In no case shall the tolerance be less than one micromicrofarad.

D-6. *Marking.* —

D-6a. Each capacitor shall be permanently marked with the manufacturer's name or symbol, type designation, capacitance, working voltage, and if specified on the drawing, the current ratings. Where space or existing molds do not permit the marking required above, the manufacturer's name or symbol and the type designation only may be permanently marked on the capacitor.

D-6b. *Color Coding.* — Where marking of the type designation is not permitted by space or existing molds, the capacitance, characteristic, and tolerance may be indicated by color coding as given on the applicable drawings and in Table II.

The colors specified in the table indicate the color shades as shown on the Standard Color Card of America, 8th Edition, 1928.

TABLE II

Cable No.	Color	Significant Figure	Decimal Multiplier	Tolerance	Characteristic
.....	Black	0	1		A
60113	Brown	1	10		B
60149	Red	2	100	2 per cent (G)	C
60041	Orange	3	1,000		D
60187	Yellow	4			E
60105	Green	5			F
60102	Blue	6			G
60010	Violet	7			
60034	Gray	8			
.....	White	9			
.....	Gold	..	0.1	5 per cent (J)	
.....	Silver	..	0.01	10 per cent (K)	
.....	Black			20 per cent (M)	

E. DETAIL REQUIREMENTS

E-1. All capacitors shall be in accordance with their applicable drawings and shall be capable of meeting the test requirements given in Section F.

F. INSPECTION AND TESTS

F-1. *Test Equipment and Inspection Facilities.* — The contractor shall furnish all necessary facilities and equipment for making all tests (except qualification tests) and inspection required by this specification and shall carry out all tests under the supervision of the purchasing agency's inspector. The test equipment shall be adequate in quantity to enable the inspection to keep up with production. The inspector shall ascertain that the equipment meets all the requirements of this specification. The contractor shall correct all deviations from this specification pointed out by the inspector. Wherever practicable, the inspection of capacitors shall be at the plant of the capacitor manufacturer.

F-2. *Classification.* — The inspection and testing of mica capacitors shall be classified as follows:

F-2a. *Qualification Tests.* — Qualification tests are made on a sample quantity to insure that the basic design produces capacitors meeting all the performance requirements of this specification.

F-2b. *Production-Sampling Tests.* — Production-sampling tests are applied to a relatively small number of capacitors selected at random from production and, in general, are intended to check production quality with reasonable thoroughness.

F-2c. *Production Tests.* — Production tests are made on all capacitors to insure that they will meet the basic requirements.

F-3. *Qualification Tests.* — To supply capacitors under these specifications, an

We're experimenting so you won't have to

General Electric is operating today one of the world's most complete television stations, WRGB, at Schenectady. There, within the limitations of full-scale war production, G. E. is gaining practical knowledge on which to build a new industry.

For a clear television picture on a fluorescent screen is only the beginning of television. From there on out, problems still loom. What will television offer that movies, theater, concert hall,

approval of the design must be obtained. Application for such approval shall be made in duplicate to the purchasing agency. Unless specifically waived by the purchasing agency, samples for qualification tests shall be submitted in accordance with the following provisions and instructions from the purchasing agency.

F-3a. *Number of Samples.* — The number of samples shall be as follows:

- Molded capacitors: CM20, CM25, CM30, CM35, and CM40 — 48
- Molded capacitors: CM45, CM50, CM55, CM56, CM60, and CM61 — 24
- Molded-case, potted capacitors: CM65 and CM70 — 12
- Ceramic-case, potted capacitors: CM75, CM80, CM85, CM90, and CM95 — as required by purchasing agency

F-3b. *Test Routine and Failures Permitted.* — Qualification tests shall be conducted in the order in which they are listed in Table III. All samples are subjected to the tests of F-4 to F-10 inclusive. The samples shall then be divided into groups of the number specified, one of which groups shall be subjected to the thermal-cycle test (F-11), another to the vibration test (F-12) and the corrosion test (F-13), and the third group to the life test (F-14).

TABLE III

Test	Number of Samples Submitted to Each Test	Number of Failures Allowed for Each Test
Visual (F-4)	48	8
Capacitance (F-5)	48	8
Temperature Coefficient (F-6)	48	8
Capacitance Drift (F-6)	48	8
Q (F-7)	48	8
Current Rating (F-8)	48	8
Dielectric Strength (F-9)	48	8
Insulation Resistance (F-10)	48	8
Thermal Cycle (F-11)	12	2
Vibration (F-12)	12	2
Corrosion (F-13)	12	2
Life (F-14)	12	1
All Tests	—	12

If the number of failures exceeds that allowed, a second set of samples may be submitted which shall be accompanied by a description of the changes incorporated in the new samples to overcome the defects causing the failure of the preceding ones.

F-3b (1). Molded and molded-case capacitors shall be tested in accordance with F-3b.

F-3b (2). Ceramic-case capacitors shall be tested in accordance with F-3b except that no failures are permitted. Any failure shall require retesting in accordance with F-3b.

F-4. *Visual Inspection.* — Capacitors shall be inspected to verify that their physical dimensions are within the specified limits, that the workmanship is satisfactory, and that the quantity is correct.

F-5. *Capacitance.* — Capacitors shall be tested to insure that the capacitance is within the specified tolerance limits. When the allowed tolerance is ± 2 per cent, the capacitance shall be measured by a standard bridge at a frequency of 1,000 cycles per second or higher, or by some other method of equal accuracy. When tolerances wider than ± 2 per cent are allowed, a standard commercial capacitance meter accurate to within ± 2 per cent, or some other method satisfactory to the purchasing agency or its representative may be used.

F-6. *Capacitance Drift and Temperature Coefficient.* — The capacitor temperature shall be varied from room temperature to − 40 degrees Centigrade (− 40 degrees Fahrenheit) to + 75 degrees Centigrade (+ 167 degrees Fahrenheit) for potted units, or + 85 degrees Centigrade (+ 185 degrees Fahrenheit) for molded units, and back to room temperature. Each measurement shall be made after the capacitor has reached thermal stability. (See I-3.) Capacitance-change measurements shall be taken at a sufficient number of points over the temperature range to establish the slope of the capacitance-temperature curve from which the temperature coefficient will be calculated.

F-7. *Q.* — Measurement of the figure of merit or *Q* shall be made on a Boonton Radio Corporation Type 100A or 160A *Q* Meter or equivalent.

F-8. *Current Ratings of Potted Capacitors in Still Air.* — With the capacitor supported so as to have free air on all sides, rated current at 1,000 kilocycles flowing through the capacitor shall cause the temperature of no part of the external surface of the capacitor case to rise more than 15 degrees Centigrade (27 degrees Fahrenheit) above the ambient, which shall be between + 20 degrees Centigrade (+ 68 degrees Fahrenheit) and + 30 degrees Centigrade (+ 86 degrees Fahrenheit), and shall be held within ± 2 degrees Centigrade (± 3.6 degrees Fahrenheit) during the test, and at a barometric pressure of 28 to 32 inches of mercury. The test shall be continued to insure maximum case temperature.

F-9. *Dielectric Strength.* — Capacitors shall be tested as indicated below for compliance with the requirements of the applicable detail drawing.

F-9a. *Molded Capacitors.* — Molded capacitors shall have the rated direct-current working voltage specified on the detail drawing of the individual capacitor. Each capacitor shall withstand a direct-current test voltage equal to 200 per cent of the rated direct-current voltage. This voltage shall be applied for not less than 1 second, nor more than 5 seconds. The maximum charging current shall not exceed 50 milliamperes.

F-9b. *Potted Capacitors.* — Potted capacitors shall withstand for not less than 5 seconds the application of an alternating voltage having a root-mean-square value equal to the rated peak working voltage as shown on the detail drawing and a frequency of 100 cycles or less. The alternating-current test voltage shall be applied at not greater than 1/4 test value and then raised continuously to full test value or in steps not greater than 10 per cent of full test value.

F-9c. *Case Insulation.* — Where holes, studs, or any mounting means other than terminal connections are provided, the capacitor shall be capable of withstanding twice the rated direct-current working or peak voltage applied between the terminals connected together and a metal electrode touching the face or faces of the enclosure which the design indicates as a logical mounting surface.

F-10. *Insulation Resistance.* — The insulation resistance, measured in an ambient temperature of not less than + 20 degrees Centigrade (+ 68 degrees Fahrenheit) and a relative humidity between 10 per cent and 80 per cent, shall be greater than 7,500 megohms. The direct-current test voltage used shall be at least 100 volts. The electrification time shall not exceed 2 minutes.

F-11. *Thermal Cycle.*

F-11a. *Molded and Molded-Case Potted Capacitors.* — Each capacitor shall be exposed to at least 5 of the temperature cycles indicated in Table IV.

For molded-case potted capacitors, the maximum temperature shall be + 75 degrees Centigrade (+ 167 degrees Fahrenheit). The capacitor shall be held at the specified minimum and maximum temperatures long enough to reach equilibrium and in no case for less than 15 minutes. The rate of temperature change within the climate chamber may be not less than 2 degrees Centigrade per minute. The capacitors may be transferred from one chamber to another for these temperature changes, in which case they may be kept at room temperature for at least 15 minutes between exposures to the extreme temperatures. The temperature cycling shall be followed by 2 cycles of 15-minute immersions in tap water at + 65 degrees Centigrade (+ 149 degrees Fahrenheit) and + 20 degrees Centigrade (+ 68 degrees Fahrenheit) or lower. The elapsed time between the removal of the capacitors from the immersion tank and the measurements shall not exceed 30 minutes. Surface moisture may be removed. The capacitors shall then be tested for dielectric strength and insulation resistance in accordance with F-9 and F-10. The insulation resistance shall be greater than 3,000 megohms.

TABLE IV

	Degrees Centigrade	=	Degrees Fahrenheit
Start at	+ 20		+ 68
To	− 55		− 67
To	+ 20		+ 68
To	+ 85		+ 185
To	+ 20		+ 68

F-11b. *Ceramic-Case Potted Capacitors.* — Ceramic-case potted capacitors shall be subjected to the same conditioning and tests outlined in F-11a except that (1) the rate of temperature change shall be not less than 0.5 degree Centigrade (0.9 degree Fahrenheit) per minute; (2) the capacitor shall be removed from the climate chamber at + 75 degrees Centigrade (+ 167 degrees Fahrenheit) and placed in tap-water bath at + 65 degrees Centigrade (+ 149 degrees Fahrenheit) for 15 minutes and then cooled in air to room temperature; and (3) the insulation resistance, as measured by F-10, shall be greater than 4000 megohms.

F-12. *Vibration, Acceleration, and Shock.* — The capacitor shall be subjected to a simple harmonic motion having an amplitude not exceeding 0.03 inch (maximum total excursion of 0.06 inch), the frequency being varied uniformly between the approximate limits of 10 and 55 cycles per second. The entire range of frequencies shall be traversed in approximately 1 minute. This motion shall be applied for a total period of 5 hours.

For this test the capacitors shall be fastened by their mounting feet or lugs, if any, and shall be vibrated in any direction. Small capacitors which normally are supported by their wire leads shall be mounted and soldered to rigidly supported terminals so spaced that the length of each lead from the capacitor shall be approximately 5/8 inch when measured from the edge of the supporting terminal.

F-12a. *Failure.* — Failure shall be indicated by breaking or noticeable weakening of any part of the capacitor, or any serious or permanent degradation in performance.

F-13. *Corrosion.* — The capacitor shall be immersed in a saturated solution of sodium chloride for 24 hours at room temperature and shall then be dried in air for 24 hours. There shall be no deleterious effect on the operation of the capacitor.

F-14. *Life Test.* —

F-14a. *Molded Capacitors.* — Molded capacitors shall withstand, without short circuiting or open circuiting, a continuous accelerated life test of 1000 hours at room temperature and at 200 per cent of rated direct-current working voltage for all rated direct-current working voltages up to 500 volts, and at 175 per cent of rated direct-current working voltage for all rated direct-current working voltages above 500 volts.

F-14b. *Potted Capacitors.* — Potted capacitors shall withstand, without short circuiting or open circuiting, a continuous accelerated life test of 1000 hours at room temperature and with a 60-cycle voltage having a root-mean-square value equal to the peak working voltage.

F-15. *Production Sampling.* —

F-15a. *Selection.* — For production sampling, capacitors shall be selected by the inspector at random from a continuous production run of capacitors that have passed the production tests. These samples may be of the largest capacitance and highest voltage of those in production for that type. Capacitors which are within ± 25 per cent of the nominal values specified in the order and which are representative of the production processes being used, shall be acceptable for tests which result in the destruction of the capacitor.

F-15b. *Number of Samples and Failures Permitted.* —

F-15b (1). *Molded and Molded-Case Capacitors.* — The quantities of molded and molded-case capacitors shown in Table V shall be selected and not more than the number of failures specified shall result.

TABLE V

Quantity in Continuous Production	Number of Samples	Maximum Number of Failures
1 — 50	0	0
51 — 100	4	1
101 — 500	6	1
501 — 5000	12	3, not more than 2 for any one test
Additional 5000's	12	3, not more than 2 for any one test

In case the number of failures exceeds those permitted, an additional sample group shall be tested. If the number of failures again exceeds that specified above, the entire production lot will be rejected until the manufacturer can give the entire production lot a remedial treatment which will satisfy the purchasing agency that all capacitors in production are capable of passing these tests. Capacitors which have been subjected to the tests and conditioning procedures listed in F-15c shall not be delivered on any order unless specifically permitted by the purchasing agency.

F-15b (2). *Ceramic-Case Potted Capacitors.* — For production sampling of ceramic-case potted capacitors, a number of samples satisfactory to the manufacturer and the purchaser shall be subjected to the tests listed in F-15c. Any failure shall require remedial treatment meeting the approval of the manufacturer and the purchasing agency.

F-15c. *Test Routine.* — The selected samples shall be subjected to the tests in the order listed in Table VI.

TABLE VI

Test	Reference Paragraph	Remarks
Visual	F-4	
Capacitance	F-5	
Temperature Coefficient Capacitance Drift	F-6	Where specified. Approved abbreviated method may be used.
Q	F-7	Where specified in D-5c
Current Rating	F-8	Where specified. Approved abbreviated method may be used.
Dielectric Strength	F-9	
Insulation Resistance	F-10	
Thermal Cycle	F-11	

F-16. *Production Tests.* — Every capacitor shall be subjected to the tests listed in Table VII in the order given.

TABLE VII

Test	Reference Paragraph	Remarks
Visual	F-4	
Capacitance	F-5	
Temperature Coefficient Capacitance Drift	F-6	Where specified. Approved abbreviated method may be used.
Q	F-7	Where specified in D-5c
Current Rating	F-8	Where specified. Approved abbreviated method may be used.
Dielectric Strength	F-9	
Insulation Resistance	F-10	

G. PACKAGING

G-1. *Packaging.* — Capacitors delivered to the purchaser as separate articles shall be packaged in accordance with the manufacturer's standard practice unless otherwise specified. Each package shall be marked at both ends with the manufacturer's name, capacitor type designation, purchaser's stock number, quantity enclosed, the order number, date, gross weight, the name of the purchaser, and the name of the consignee.

I. NOTES

I-1. *Temperature Coefficient of Capacitance.* — The temperature coefficient of capacitance is the slope of the capacitance-temperature curve. In this specification, it is expressed in parts per million per degree Centigrade.

I-2. *Capacitance Drift.* — Capacitance drift is the change in capacitance, which results from a period of operation involving changes in temperature, divided by the original capacitance, expressed in per cent.

I-3. *Thermal Stability.* — Thermal stability has been reached for the tests specified in F-6 when no further change in capacitance is obtained between 2 successive measurements taken at 5-minute intervals. These capacitance changes are so small that special care shall be taken in the placement of the equipment and in the maintenance of relative positions of the capacitors under test and the test equipment.

I-4. *Current Ratings in Increased Ambient Temperatures at Sea Level.* — With all conditions except ambient temperature as specified in F-8, safe operation of potted units will be obtained with the percentage of normal rated current shown for the ambient temperatures given in Table VIII.

TABLE VIII

Ambient Temperature Degrees Centigrade	Per Cent Normal Rated Current
50	95
60	85
70 maximum	70

I-5. *Voltage Ratings.* — Voltage ratings given on the applicable drawings apply under the following conditions: temperature, + 20 degrees to + 30 degrees Centigrade (+ 68 degrees to + 86 degrees Fahrenheit); barometric pressure, 28 to 32 inches of mercury; relative humidity, 10 per cent to 80 per cent.

Section C-1.2 will appear in February.

FIG. 8. SPOT WELDING THE VENTILATING SCREEN ON A TRANSMITTER DOOR

(CONTINUED FROM PAGE 13)

from the assembly of the panel units to the wiring and installation of the component elements right through to the final acceptance tests.

This policy is working out advantageously now, when our primary concern is to serve the Armed Forces most effectively, and it is in line with our planning for peace time when, in order to meet competitive conditions which will exist then, we propose to meet the demand for FM equipment which will be required as soon as restrictions are lifted, and this field can forge ahead once more in the service of broadcast listeners.

IMPORTANT BOOKS

Communication Circuits: By Prof. Lawrence A. Ware and Prof. Henry R. Reed. 287 pages, illustrated, $9\frac{1}{4}$ by $6\frac{1}{4}$ ins., cloth bound. Published by John Wiley & Sons, Inc., 440 Fourth Avenue, New York City. Price $3.50.

As a text book on communications engineering, this volume presents splendidly organized first-course material. The basic principles of communication transmission lines and their associated networks are presented, covering the range from voice frequencies through the ultra-high frequencies.

There is a rather extensive treatment of ultra-high frequency transmission by means of coaxial cables and rectangular and cylindrical wave guides, together with the related equations of Maxwell. The elements of the theory are admirably tied in with practical applications to modern high-frequency transmission.

The authors assume a knowledge on the part of their readers of calculus and the elements of alternating-current theory. For parts of the text where more advanced mathematics is needed, suitable appendices have been included.

Many examples are introduced in the text to illustrate specific points and to serve as problem exercises.

The fifteen chapters cover transmission-line parameters; networks; network theorems; the correctly terminated line; infinite line; open- and short-circuited lines; reflection losses; power transmission line; constant-K filters; M-derived and composite filters; impedance transformation; UHF rectangular wave guides; UHF cylindrical guides; electromagnetic theory of coaxial lines; transmission-line experiments.

Professors Ware and Reed are respectively Associate Professor of Electrical Engineering and Professor of Electrical Engineering at the State University of Iowa.

The Electron Microscope: By Dr. E. F. Burton and Dr. W. H. Kohl. 233 pages, about 150 illustrations, $9\frac{1}{4}$ by $6\frac{1}{4}$ ins., cloth bound. Published by Reinhold Publishing Corporation, 330 West 42nd Street, New York City. Price $3.85.

The complete background of electron and light theory which this volume provides for the electron microscope makes it an excellent textbook for the great number of research workers and engineers who are becoming interested in this subject.

That the text has been so well prepared is not surprising, for Dr. Burton is head of the Department of Physics at the University of Toronto, while Dr. Kohl, his former associate, is now development engineer of Rogers Radio Tube Company, of Toronto.

The chapters devoted specifically to electron microscopes discuss both the electrostatic and magnetic types in detail, covering all the latest developments of this increasingly important tool of research and investigation.

Although it may not be generally known in the United States, some of the most significant work on electron microscopes has been done at the University of Toronto, where there is one of the largest and best-equipped physical laboratories in America. The first electron microscope was built in 1938 under the authors' supervision by two post-graduate students, James Hillier and A. Prebus. The former is now in charge of electron microscope development at RCA Laboratories.

Fundamentals of Electric Waves: by Dr. Hugh Hildreth Skilling. 186 pages, 65 illustrations, $9\frac{1}{4}$ by $6\frac{1}{4}$ ins., cloth bound. Published by John Wiley & Sons, Inc., 440 Fourth Avenue, New York City. Price $2.75.

Dr. Skilling's presentation of the material in this book reflects his familiarity with the subject of electric waves from his use of the original material in the form of lecture notes. He has handled the principles of wave action and the basic ideas of Maxwell's equations in such a way as to make them understandable to students, using simple examples in such a way as to make them thoroughly familiar.

The radio engineer will find this book helpful in acquiring a knowledge of antenna arrays, transmission lines, wave guides, reflectors, resonators, and electromagnetic horns, and the wave theory in the behavior of receiving antennas and vertical radiators for broadcast transmitters.

The material is arranged for those who do not have any previous knowledge of electromagnetic theory beyond general college physics and mathematics through calculus. Although vector analysis is introduced in this book, it is not necessary for the reader to have any previous knowledge of it.

Dr. Skilling, who is Professor of Electrical Engineering at Stanford University, has used a general method of presenting the material in this book somewhat similar to that of a course formerly given at the Massachusetts Institute of Technology by Dr. M. S. Vallarta.

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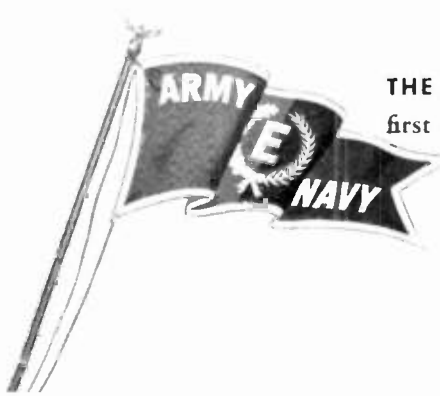

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The Radio Engineers' & Purchasing Agents' Guide to Essential Materials, Components, and Equipment

★ Indicates advertiser in this issue of Radio-Electronic Engineering

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Brach Mfg. Corp., L. S., Newark, N. J.
Camburn Elec. Co., 484 Broome St., N. Y. C.
Galvin Mfg. Corp., Chicago, Ill.
★ Link, F. M., 125 W. 17th St., N. Y. C.
Premax Products, 4214 Highland Ave., Niagara Falls, N. Y.
★ Radio Eng. Labs., Inc., L. I. City, N. Y.
★ Snyder Mfg. Co., Noble & Darien Sts., Phila.
Ward Products Corp., 1523 E. 45 St., Cleveland, O.

ANTENNAS, Transmitting
Blaw-Knox Co., Pittsburgh, Pa.
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

BEADS, Insulating
American Lava Corp., Chattanooga, Tenn.
Dunn, Inc., Struthers, 1321 Cherry, Phila., Pa.
Star Porcelain Co., Trenton, N. J.
Steward Mfg. Co., Chattanooga, Tenn.

BOLTS, NUTS & SCREWS, Machine
American Screw Co., Providence, R. I.
Bristol Co., The, Waterbury, Conn.
Central Screw Co., 3519 Shields Av., Chicago
Chandler Prods. Corp., Cleveland, O.
Continental Screw Co., New Bedford, Mass.
Corbin Screw Corp., New Britain, Conn.
Federal Screw Prod. Co., 224 W. Huron St., Chicago
Harper Co., H. M., 2609 Fletcher, Chicago
International Screw Co., Detroit
Lamson & Sessions Co., Cleveland, O.
National Screw & Mfg. Co., Cleveland
New England Screw Co., Keene, N. H.
Ohio Nut & Bolt Co., Berea, Ohio
Parker Co., Charles, Meriden, Conn.
Parker-Kalon Corp., 198 Varick, N. Y. C.
Pawtucket Screw Co., Pawtucket, R. I.
Progressive Mfg. Co., Torrington, Conn.
Republic Steel Corp., Cleveland, O.
Russell, Burdsall & Ward Bolt & Nut Co., Port Chester, N. Y.
Scovill Mfg. Co., Waterbury, Conn.
Shakeproof, Inc., 2501 N. Keeler, Chicago
Southington Hardware Mfg. Co., The, Southington, Conn.
Whitney Screw Corp., Nashua, N. H.

BOOKS on Radio & Electronics
MacMillan Co., 60 Fifth Ave., N. Y. C.
McGraw-Hill Book Co., 330 W. 42 St., N. Y. C.
Radio Technical 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.

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.
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.

CASTINGS, Die
Aluminum Co. of America, 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.
American Lava Corp., Chattanooga, Tenn.
Centralab, Div. of Globe-Union Inc., Milwaukee, Wis.
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.
Victor Insulator Co., Victor, N. Y.

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

CLIPS, Connector
Mueller Electric Co., Cleveland, O.

CLIPS & MOUNTINGS, Fuse
Alden Prods. Co., Brockton, Mass.
Dante Elec. Mfg. Co., Bantam, Conn.
Ilsco Copper Tube & Prods., Inc., Station M, Cincinnati
Jefferson Elec. Co., Bellwood, Ill.
Jones, Howard B., 2300 Wabansia, Chicago
Littelfuse, 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.

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

CONDENSERS, Fixed
Aerovox Corp., New Bedford, Mass.
American Condenser Corp., 2508 S. Michigan, Chicago
Art Radio Corp., 115 Liberty, N. Y. C.
Atlas Condenser Prods. Co., 548 Westchester Av., N. Y. C.
Automatic Winding Co., East Newark, N. J.
Bud Radio, Inc., Cleveland, O.
Cardwell Mfg. Corp., Allen D., Brooklyn, N. Y.
Centralab, Milwaukee, Wis.
Condenser Corp. of America, South Plainfield, N. J.
Condenser Prods. Co., 1375 N. Branch, Chicago
Cornell-Dubilier Elec. Corp., S. Plainfield, N. J.
Cosmic Radio Co., 699 E. 135th St., N. Y. C.
Crowley & Co., Henry L., W. Orange, N. J.
Deutschmann Corp., Tobe, Canton, Mass.
Dumont Elec. Co., 34 Hubert St., N. Y. C.
Electro-Motive Mfg. Co., Willimantic, Conn.
Erie Resistor Corp., Erie, Pa.
Fast & Co., John E., 3123 N. Crawford, Chicago
General Radio Co., Cambridge, Mass.
Girard-Hopkins, Oakland, Calif.
H. R. S. Prods., 5707 W. Lake St., Chicago
Illinois Cond. Co., 3252 W. North Av., 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
Mallory & Co., P. R., Indianapolis, Ind.
Micamold Radio Corp., Brooklyn, N. Y.
Muter Co., 1255 S. Michigan, Chicago
Potter Co., 1950 Sheridan Rd., N. Chicago
RCA Mfg. Co., Camden, N. J.
Sangamo Elec. Co., Springfield, Ill.
Solar Mfg. Corp., Bayonne, N. J.
Sprague Specialties Co., N. Adams, Mass.
Teleradio Engineering Corp., 484 Broome St., N. Y. C.

CONDENSERS, Gas-filled
Lapp Insulator Co., Inc., Leroy, N. Y.

CONDENSERS, High-Voltage Vacuum
Centralab, Milwaukee, Wis.
Erie Resistor Corp., Erie, Pa.
★ General Electric Co., Schenectady, N. Y.

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

CONDENSERS, Tubular Ceramic Transmitting
Cornell-Dubilier, S. Plainfield, N. J.
RCA Mfg. Co., Inc., Camden, N. J.
Sangamo Electric Co., Springfield, Ill.
Solar Mfg. Corp., Bayonne, N. J.

CONDENSERS, Variable Receiver Tuning
Alden Prods. Co., Brockton, Mass.
American Steel Package Co., Defiance, Ohio
Barker & Williamson, Ardmore, Pa.
Bud Radio, Inc., Cleveland, O.
Cardwell Mfg. Corp., Allen D., Brooklyn, N. Y.
General Instrument Corp., Elizabeth, N. J.
Hammarlund Mfg. Co., 424 W. 334d 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.
Radio Condenser Co., Camden, N. J.
Rauland Corp., Chicago, Ill.
Reliance Die & St'p'g Co., 1260 Clybourn Av., Chicago

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.

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

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

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

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

CRYSTAL GRINDING EQUIPMENT
Felker Mfg. Co., Torrance, Calif.

CRYSTALS, Quartz
Bausch & Lomb Optical Co., Rochester, N. Y.
Bellefonte Eng. Labs., Bellefonte, Penna.
Bliley Elec. Co., Erie, Penna
Burnett, Wm. W. L., San Diego, Cal
Collins Radio Co., Cedar Rapids, Iowa
Electronic Research Corp., 800 W. Washington Blvd., Chicago
General Electric Co., Schenectady, N. Y.
General Radio Co., Cambridge, Mass.
Harvey-Wells Communications, Southbridge, Mass.
Hipower Crystal Co., 2035 W. Charleston, Chicago
Hollister Crystal Co., Merriam, Kan.
Hunt & Sons, G. C., Carlisle, Pa.
Kaar Engineering Co., Palo Alto, Cal.
Meck Industries, John, Plymouth, Ind.
Miller, August E., North Bergen, N. J.
Peterson Radio, Council Bluffs, Iowa
Precision Crystal Labs., Springfield, Mass.
Precision Piezo Service, Baton Rouge, La.
Premier Crystal Labs., 63 Park Row, N. Y. C.
RCA Mfg. Co., Camden, N. J.
Scientific Radio Service, Hyattsville, Md.

ADDITIONS THIS MONTH

8 New Product Listings

62 New Names Have Been Added

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

Standard Piezo Co., Carlisle, Pa.
Valpey Crystals, Holliston, Mass.
Zeiss, Inc., Carl, 485 Fifth Av., N. Y. C.

DIALS, Instrument
Crowe Nameplate Co., 3701 Ravenswood Ave., Chicago
General Radio Co., Cambridge, Mass.
★ 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.

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

FELT
American Felt Co., Inc., Glenville, Conn.
Western Felt Works, 4031 Ogden Av., 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.
Taylor Fibre Co., Norristown, Pa.
Wilmington Fibre Specialty Co., Wilmington, Del.

FILTERS, Electrical Noise
Avia Products Co., 737 N. Highland Ave., Los Angeles
Mallory & Co., Inc., P. R., Indianapolis, Ind.
Tobe Deutschmann Corp., Canton, Mass.

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

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

FREQUENCY STANDARDS, Primary
General Radio Co., Cambridge, Mass.

FREQUENCY STANDARDS, Quartz Secondary
Millen Mfg. Co., Inc., Malden, Mass.

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

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

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

GENERATORS, Gas Engine Driven
Kato Engineering Co., Mankato, Minn.

GENERATORS, Hand Driven
Carter Motor Co., 1608 Milwaukee, Chicago

GENERATORS, Standard Signal
Boonton Radio Corp., Boonton, N. J.
Ferris Instrument Co., Boonton, N. J.
General Radio Co., Cambridge, Mass.
Measurements Corp., Boonton, N. J.

GENERATORS, Wind-Driven, Aircraft
General Armature Corp., Lock Haven, Pa.

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

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

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

INSULATORS: Ceramic Stand-off, Lead-in, Rod Types
American Lava Corp., Chattanooga, Tenn.
Corning Glass Works, Corning, N. Y.
Electronic Mechanics, Inc., Clifton, N. J.
Isolantite, Inc., Belleville, N. S.
Johnson Co., E. F., Waseca, Minn.
Lapp Insulator Co., Inc., Leroy, N. Y.
Locke Insulator Co., Baltimore, Md.
Millen Mfg. Co., Malden, Mass.
National Co., Inc., Malden, Mass.

IRON CORES, Powdered
Crowley & Co., Henry L., West Orange, N. J.
Gibson Elec. Co., Pittsburgh, Pa.
Mallory & Co., P. R., Indianapolis, Ind.
Stackpole Carbon Co., St. Marys, Pa.
Western Electric Co., 195 Broadway, N. Y. C.
Wilson Co., H. A., Newark, N. J.

IRONS, Soldering
Acme Electric Heating Co., 1217 Washington St., Boston
Amer. Electrical Heater Co., 6110 Cass Ave., Detroit
Electric Soldering Iron Co., Deep River, Conn.
General Electric Co., Schenectady, N. Y.
Hexacon Electric Co., Roselle Park, N. J.
Vasco Electrical Mfg. Co., 4116 Avalon Blvd., Los Angeles
Vulcan Electric Co., Lynn, Mass.

JACKS, Telephone
Alden Prods. Co., Brockton, Mass.
Amer. Molded Prods. Co., 1753 N. Honore St., Chicago
Chicago Tel. Supply Co., Elkhart, Inc.
Guardian Elec. Mfg. Co., 1627 W. Walnut St., Chicago
Insuline Corp. of Amer., Long Island City, N. Y.
Johnson, E. F., Waseca, Minn.
Jones, Howard B., 2300 Wabansia Ave. Chicago
Mallory & Co., Inc., P. R., Indianapolis, Ind.
Mangold Radio Pts. & Stamping Co., 6300 Shelbourne St., Philadelphia
Molded Insulation Co., Germantown, Pa.

KEYS, Telegraph
Amer. Radio Hardware Co., Inc., 476 Broadway, N. Y. C.
Bunnell & Co., J. H., 215 Fulton St., N. Y. C.
Signal Electric Mfg. Co., Menominee, Mich.

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

LABELS, Removable
Avery Adhesives, 451 3rd St., Los Angeles

LABELS, Stick-to-Metal
Ever Ready Label Corp., E. 25th St., N. Y. C.

LABORATORIES, Electronic Research
★ Browning Labs., Inc., Winchester, Mass.

LUGS, Soldering
Burndy Engineering Co., 459 E. 133rd St., N. Y. C.
Cinch Mfg. Corp., W. Van Buren St., Chicago
Dante Elec. Mfg. Co., Bantam, Conn.
Ideal Commutator Dresser Co., Sycamore, Ill.
Ilsco Copper Tube & Prods., Inc., Station M, Cincinnati
Krueger & Hudepohl, Third & Vine, Cincinnati, O.
Patton-MacGuyer Co., 17 Virginia Av., Providence, R. I.
Sherman Mfg. Co., Battle Creek, Mich.
Thomas & Betts Co., Elizabeth, N. J.

LUGS, Solderless
Aircraft Marine Prod., Inc., Elizabeth, N. J.

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

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

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

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

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

MARKERS, Wire Identification
Brand & Co., Wm., 276 4th Ave., N. Y. C.

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

METERS, Ammeters, Voltmeters, Small Panel
Cambridge Inst. Co., Grand Central Terminal, N. Y. C.
De Jur-Amsco Corp., Shelton, Conn.
★ General Electric Co., Bridgeport, Conn.
Hickok Elec. Inst. Co., Cleveland, O.
Hoyt Elec. Inst. Works, Boston, Mass.
Readrite Meter Works, Bluffton, O.
Roller-Smith Co., Bethlehem, Pa.
★ Simpson Elec. Co., 5218 W. Kinzie, Chicago
Triplett Elec. Inst. Co., Bluffton, O.
Westinghouse Elec. & Mfg. Co., E. Pittsburgh, Pa.
Weston Elec. Inst. Corp., Newark, N. J.

METERS, Q
Boonton Radio Corp., Boonton, N. J.

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

METERS, Vibrating Reed
Biddle, James G., 1211 Arch St., Philadelphia
Triplett Elec. Inst. Co., Bluffton, O.

MICA
Brand & Co., Wm., 276 Fourth Av., N. Y. C.
Insulation Mfgrs. Corp., 565 W. Wash. Blvd., Chicago
Macallen Co., Boston, Mass.
Mica Insulator Corp., 196 Varick, N. Y. C.
New England Mica Co., Waltham, Mass.
Richardson Co., Melrose Park, Chicago

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

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

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

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

MYCALEX
★ General Electric Co., Schenectady, N. Y.
Mycalex Corp. of Amer., 7 E. 42 St., N. Y. C.

NICKEL, Sheet, Rod, Tubes
Whitehead Metal Prod. Co., 303 W. 10th St., N. Y. C.

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

OSCILLOSCOPES, Cathode Ray
Du Mont Laboratories, Inc., Allen B., Passaic, N. J.
General Electric Co., Schenectady, N. Y.
General Radio Co., Cambridge, Mass
Millen Mfg. Co., Malden, Mass.
RCA Mfg. Co., Inc., Camden, N. J.

OVENS, Industrial & Laboratory
★ General Elec. Co., Schenectady, N. Y.
Trent Co., Harold E., Philadelphia

PILOT LIGHTS
Alden Prods. Co., Brockton, Mass.
Amer. Radio Hardware Co., Inc., 167 B'way, N. Y. C.
Dial Light Co. of America, 90 West, N. Y. C.
Drake Mfg. Co., 1713 W. Hubbard Chicago
General Control Co., Cambridge, Mass.
★ General Elec. Co., Lamp Dept., Nela Specialty Div., Hoboken, N. J.
Herzog Miniature Lamp Works, 12-19 Jackson Av., Long Island City, N. Y.
Kirkland Co., H. R., Morristown, N. J.
Mallory & Co., P. R., Indianapolis, Ind.
Rothard Mfg. Co., N. 9th Ave., Springfield, Ill.
Signal Indicator Corp., 140 Cedar St., N. Y. C.
Sylvania Elec. Prod. Co., Emporium, Pa

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

PLASTICS, Extruded
Blum & Co., Inc., Julius, 532 W. 22 St. N. Y. C.
Brand & Co., Wm., 276 Fourth Ave., N. Y. C.
Extruded Plastics, Inc., Norwalk, Conn.
Irvington Varnish & Insulator Co., Irvington, N. J.

PLASTIC, Sheet for Name Plates
Mica Insulator Co., 200 Varick St., N. Y. C.

PLASTICS, Laminated or Molded
Acadia Synthetic Prods., 4031 Ogden Av., Chicago
Alden Prods. Co., Brockton, Mass.
American Cyanamid Co., 30 Rockefeller Plaza, N. Y. C.
American Insulator Corp., New Freedom, Pa.
American Molded Prods. Co., 1753 N. Honore, Chicago
Auburn Button Works, Auburn, N. Y.
Barber-Colman Co., Rockford, Ill
Brandywine Fibre Prods. Co., Wilmington, Del.
Catalin Corp., 1 Park Av., N. Y. C.
Celanese Celluloid Corp., 180 Madison Av., N. Y. C.
Chicago Molded Prods. Corp., 1024 N. Kolmar, Chicago

Translation: — "*When you know a thing, to hold that you know it; and when you do not know a thing, to allow that you do not know it; this is knowledge.*" — Confucius

"This is Knowledge" *said the Sage . . .*

Through the ages, the most learned have always been the most aware of their limitations.

Why is milk white? . . . Scientists admit that they do not know. They say, as did the late great Thomas Edison, that the total of man's knowledge is pitifully small.

In the vast field of Electronics, IRC certainly does not profess total knowledge. But in one small part of that field — the construction and application of Fixed and Variable Resistors — we do know many of the answers.

Because of our specialized research, we have succeeded in developing a line of resistance devices "Preferred for Performance" throughout the Electronic industries. Today IRC Resistors are so vitally essential for war equipment that we must concentrate our production efforts on caring for the needs of the Armed Services.

Though we may not be able right now to supply you with the Resistors you need for other than war uses, our Engineers and Executives are at your service for counsel, without obligation, to help you in the solution of Resistor problems. Please feel free to consult them in your search for the best obtainable resistance devices under existing conditions.

You will find a source of complete Resistor information here.

IRC

FIXED & VARIABLE RESISTORS

Preferred for Performance

INTERNATIONAL RESISTANCE COMPANY

429 NORTH BROAD ST., PHILADELPHIA, PA.

Continental-Diamond Fibre Co., Newark, Del.
Dow Chemical Co., Midland, Mich.
Durez Plastics & Chemicals, Inc., N. Tonawanda, N. Y.
Extruded Plastics, Inc., Norwalk, Conn.
Formica Insulation Co., Cincinnati, O.
★ General Electric Co., Plastics Dept., Pittsfield, Mass.
General Industries Co., Elyria, O.
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.
★ Radio City Products Co., 127 W. 26 St., N. Y. C.
Richardson Co., Melrose Park, Chicago
Rogan Bros., 180 N. Wacker Dr., Chicago
Rohm & Haas Co., Philadelphia
Stokes Rubber Co., Joseph, Trenton, N. J.
Surprenant Elec. Ins. Co., Boston
Synthane Corp., Oaks, Pa.
Taylor Fibre Co., Norristown, Pa.
Westinghouse Elec. & Mfg. Co., E. Pittsburgh, Pa.
Wilmington Fibre Specialty Co., Wilmington, Del.

PLASTICS, Transparent
Celanese Celluloid Corp., 180 Madison Ave., N. Y. C.
du Pont de Nemours & Co., E. I., Arlington, N. J.
Rohm & Haas Co., Washington Sq., Philadelphia

PLUGS (Banana), Spring Type
Eastman Kodak Co., Rochester, N. Y.

PLUGS & JACKS, Spring Type
Eby, Inc., Hugh H., Philadelphia, Pa.
Mallory & Co., Inc., P. R., Indianapolis, Ind.
Ucinite Co., Newtonville, Mass.

PLUGS, Telephone Type
Alden Prods. Co., Brockton, Mass.
American Molded Prods. Co., 1753 N. Honore, Chicago
Chicago Tel. Supply Co., Elkhart, Ind.
Guardian Elec. Mfg. Co., 1627 W. Walnut, Chicago
Insuline Corp. of Amer., Long Island City, N. Y.
Johnson Co., E. F., Waseca, Minn.
Jones, Howard B., 2300 Wabansia Av., Chicago
Mallory & Co., Inc., P. R., Indianapolis, Ind.

PLYWOOD, Metal Faced
Haskelite Mfg. Corp., 208 W. Washington St., Chicago

PRESSES, Plastic Molding
Kux Machine Co., 3930 W. Harrison, Chicago

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

RECTIFIERS, Current
Benwood Linze Co., St. Louis, Mo.
Continental Elec. Co., 903 Merchandise Mart, Chicago
Electronics Labs., Indianapolis, Ind.
Fansteel Metallurgical Corp., N. Chicago, Ill.
★ General Electric Co., Bridgeport, Conn.
International Tel. & Radio Mfg. Corp., E. Newark, N. J.
Mallory & Co., P. R., Indianapolis, Ind.
Nothelfer Winding Labs., Trenton, N. J.
United Cinephone Corp., Torrington, Conn.
Westinghouse Elec. & Mfg. Co., E. Pittsburgh, Pa.

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

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

RELAYS, Small Switching
Allied Control Co., Inc., 223 Fulton St., N. Y. C.
Amperite Co., 561 Broadway, N. Y. C.
G-M Laboratories, Inc., 1313 N. Knox Ave., Chicago
Guardian Electric, W. Walnut St., Chicago
Potter & Brumfield Co., Princeton, Ind.
Sigma Instruments, Inc., 76 Freeport St. Boston, Mass.
Struthers Dunn, Inc., 1326 Cherry St., Philadelphia
Ward Leonard Elec. Co., Mt. Vernon, N. Y.

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

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

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

RESISTORS, Fixed
Acme Elec. Heating Co., Boston, Mass.
★ Aerovox Corp., New Bedford, Mass.
Allen-Bradley Co., Milwaukee, Wis.
Atlas Resistor Co., 423 Broome St., N. Y. C.
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
Precision Resistor Co., Newark, N. J.
Sensitive Research Inst. Corp., 4545 Bronx Blvd., N. Y. C.
Shallcross Mfg. Co., Collingdale, Pa.
Sprague Specialties Co., N. Adams, Mass.
Stackpole Carbon Co., St. Marys, Pa.
Ward Leonard Elec. Co., Mt. Vernon, N. Y.
White Dental Mfg. Co., 10 E. 40th St., N. Y. C.
Wirt Co., Germantown, Pa.

RESISTORS, Fixed Precision
Instrument Resistors, Inc., Little Falls, N. J.
Intern'l Resistance Co., Philadelphia
Ohmite Mfg. Co., 4835 Flournoy St., Chicago

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

RESISTORS, Variable
★ Aerovox Corp., New Bedford, Mass.
Allen-Bradley Co., Milwaukee, Wis.
Amer. Instrument Co., Silver Spring, Md.
Atlas Resistor Co., N. Y. C.
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
Mallory & Co., P. R., Indianapolis, Ind.
Ohio Carbon Co., Cleveland, Ohio
Ohmite Mfg. Co., 4835 W. Flournoy St., Chicago
Precision Resistor Co., Newark, N. J.
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.
Ohmite Mfg. Co., 4835 Flournoy St., Chicago

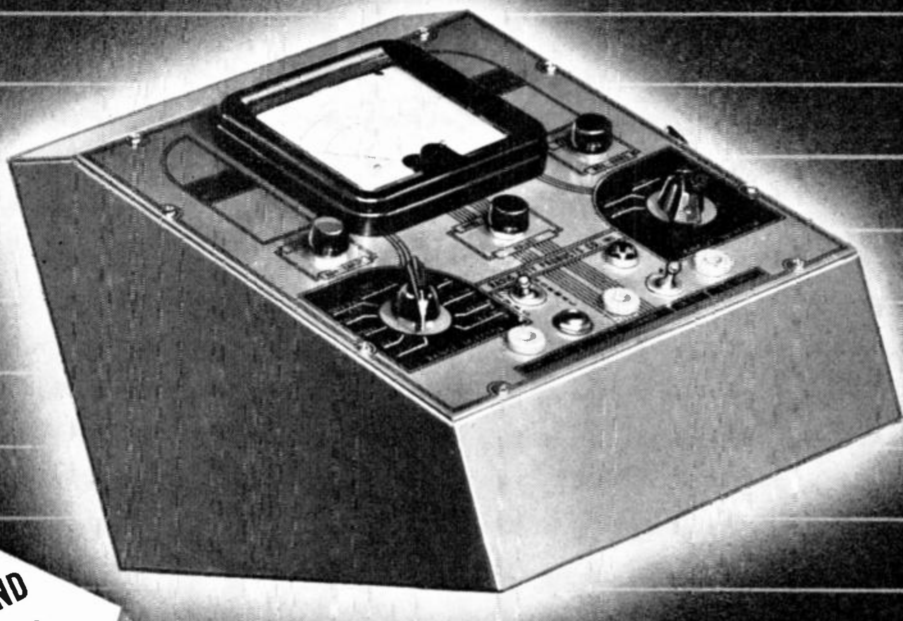
RIVETS, Plain
Central Screw Co., 3519 Shields Av., Chicago
Progressive Mfg. Co., Torrington, Conn.
Republic Steel Corp., Cleveland, O.

SCREW MACHINE PARTS, Non-Metallic
Continental-Diamond Fibre Co., Newark, Del.

SCREWS, Recessed Head
American Screw Co., Providence, R. I.
Bristol Co., The, Waterbury, Conn.
Chandler Prods. Co., Cleveland, O.
Continental Screw Co., New Bedford, Mass.
Corbin Screw Corp., New Britain, Conn.
Federal Screw Prod. Co., 224 W. Huron St., Chicago
International Screw Co., Detroit, Mich.
Lamson & Sessions, Cleveland, O.
National Screw & Mfg. Co., Cleveland, O.
New England Screw Co., Keene, N. H.
Parker Co., Charles, The, Meriden, Conn.
Parker-Kalon Corp., 198 Varick, N. Y. C.
Pawtucket Screw Co., Pawtucket, R. I.

MAXIMUM TESTING RANGE

WITH R. C. P.'s
NEW ELECTRONIC A. C.-D. C.
VACUUM TUBE VOLTMETER
OHMMETER AND
CAPACITYMETER



SPEEDS PRODUCTION TESTING AND SAVES VALUABLE ENGINEERING TIME IN LABORATORY

The new Radio City Product's Electronic Multitester Model 662 combines sensitivity with maximum utility and flexibility. Simple to read—simple to use, this instrument is suitable for either production line or accurate laboratory test purposes; in extensive use by U.S. Signal Corps.

• Here are a few of the outstanding features of this unusual instrument:

A genuine vacuum tube voltmeter on A.C. • A.C. Voltmeter measures signal and output voltages • Comprehensive capacity meter reads directly in microfarads—40,000,000 to 1 ratio • No danger of shock on low capacity measurements—no test leads to short—no resetting when changing ranges • Meter cannot be damaged by checking live resistors or by using a low range scale on high voltages • Voltmeter readings taken without affecting constants of circuit being checked • Matched pair multiplier resistors 1% accurate • Regulator tube and associated circuits control line voltage fluctuations • 2% accurate 4½" microammeter.

RANGES:

D. C. VACUUM TUBE VOLTMETER-DIRECT READING.
Sensitivity: Input Resistance — 160 megohms (high ranges); 16 megohms (low ranges).
Range: 0-6-30-150-600-1,500-6,000 volts.

A. C. VACUUM TUBE VOLTMETER-DIRECT READING.
Input capacity only .00005 mfd. Input resistance 160 megohms (high) and 16 megohms (low).
Range: 0-3-6-30-150-600-1,500-6,000 volts.

VACUUM TUBE OHMMETER-DIRECT READING.
From the lowest scale division 1 ohm to 1,000 megohms.
Range: 0-1,000-10,000-100,000-1 megohm-10 megohms-100 megohms-1,000 megohms.

VACUUM TUBE CAPACITY METER-DIRECT READING.
Accurate measurements from .00005 to 2,000 mfd.
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Cinaudagraph Speakers, Inc., 3929 S. Michigan, Chicago
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INDEX OF LISTINGS

ANTENNAS, Mobile Whip and Collapsible
ANTENNAS, Transmitting
BEADS, Insulating
BOLTS, NUTS & SCREWS
BOOKS on Radio & Electronics
CABLE, Coaxial
CABLE, Coaxial, Solid Dielectric
CABLE, Microphone, Speaker and Battery
CASTINGS, Die
CERAMICS, Bushings, Washers, Special Shapes
CHOKES, RF
CLIPS, Connector
CLIPS & MOUNTINGS, Fuse
CLOTH, Insulating
CONDENSERS, Fixed
CONDENSERS, Gas-Filled
CONDENSERS, Small Ceramic Tubular
CONDENSERS, Transmitting, Ceramic Case
CONDENSERS, Variable Receiver Tuning
CONDENSERS, Variable Transmitter Tuning
CONDENSERS, Trimmer
CONNECTORS, Cable
CONTACT POINTS
COUPLINGS, Flexible
CRYSTAL GRINDING EQUIPMENT
CRYSTALS, Quartz
DIALS, Instrument
DISCS, Recording
FASTENERS, Separable
FELT
FIBRE, Vulcanized
FILTERS, Electrical Noise
FINISHES, Metal
FREQUENCY METERS
FREQUENCY STANDARDS, Primary
FREQUENCY STANDARDS, Secondary
FUSES, Enclosed
GEARS & PINIONS, Metal
GEARS & PINIONS, Non-Metallic
GENERATORS, Gas Engine Driven
GENERATORS, Hand-Driven
GENERATORS, Standard Signal
GENERATORS, Wind-Driven, Aircraft
HEADPHONES
HORNS, Outdoor
INSTRUMENTS, Radio Laboratory
INSULATORS, Ceramic Stand-off, Lead-in, Rod Types
IRON CORES, Powdered
IRONS, Soldering
JACKS, Telephone
KEYS, Telegraph
KNOBS, Radio & Instrument
LABELS, Removable
LABELS, Stick-to-Metal
LABORATORIES, Electronic Research
LUGS, Soldering
LUGS, Solderless
MACHINES, Impregnating
MACHINES, Numbering
MACHINES, Riveting
MACHINES, Screwdriving
MAGNETS, Permanent
MARKERS, Wire Identification
METAL, Thermostatic
METERS, Ammeters, Voltmeters, Small Panel
METERS, Vibrating Reed
MICA
MICROPHONES
MONITORS, Frequency
MOTOR GENERATORS, Dynamotors, Rotary Converters
MOUNTINGS, Shock Absorbing
MYCALEX
NICKEL, Sheet, Rod, Tubes
NUTS, Self-Locking
OSCILLOSCOPES, Cathode Ray
OVENS, Industrial & Laboratory
PILOT LIGHTS
PHOSPHOR BRONZE
PLASTICS, Extruded
PLASTIC SHEET, for Name Plates
PLASTICS, Laminated or Molded
PLASTICS, Transparent
PLUGS (Banana), Spring Type
PLUGS, Telephone Type
PLYWOOD, Metal Faced
PRESSES, Plastic Molding
PRESSES, Stamping
Q METERS
RECTIFIERS, Current
REGULATORS, Temperature
REGULATORS, Voltage
RELAYS, Small Switching
RELAYS, Small Telephone Type
RELAYS, Time Delay
RELAY TESTERS, Vibration
RESISTORS, Fixed
RESISTORS, Fixed Precision
RESISTORS, Flexible
RESISTORS, Variable
RESISTORS, Variable, Ceramic Base
RIVETS, Plain
SCREW MACHINE PARTS
SCREWS, Recessed Head
SCREWS, Self-Tapping
SCREWS, Set and Cap
SCREWS, Hollow & Socket Head
SELENIUM
SHAFTING, Flexible
SHEETS, Electrical
SHIELDS, Tube
SOCKETS, Tube, Phenolic Base
SOCKETS, Tube, Ceramic Base
SOLDER, Self-Fluxing
SOLDER POTS
SPEAKERS, Cabinet Mounting
SPEAKERS, Outdoor Type
SPRINGS
STAMPINGS, Metal
SUPPRESSORS, Parasitic
SWITCHES, Aircraft Push
SWITCHES, Key
SWITCHES, Micro
SWITCHES, Rotary Gang, Bakelite Wafer
SWITCHES, Rotary Gang, Ceramic Wafer
SWITCHES, Time Delay
TERMINAL STRIPS
TEST CHAMBERS, Temperature, Humidity, Altitude
TRANSFORMERS, Constant Voltage
TRANSFORMERS, IF, RF
TRANSFORMERS, Receiver Audio & Power
TUBE MANUFACTURING MACHINES
TUBES, Cathode Ray
TUBES, Current Regulating
TUBES, Photo-Electric
TUBES, Receiving
TUBES, Transmitting
TUBES, Voltage Regulating
TUBING, Laminated Phenolic
TUBING & SLEEVING, Varnished Cambric, Glass-Fibre, Spaghetti
VARNISHES, Insulating, Air Drying
VARNISHES, Insulating, Baking
VIBRATION TEST EQUIPMENT
VIBRATORS, Power Supply
VOLTMETERS, Vacuum Tube
WAXES & COMPOUNDS, Insulating
WIRE, Bare
WIRE, Hookup
WIRE, Magnet
WOOD, Laminated & Impregnated

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New York Transformer Co., 51 W. 3rd, N. Y. C.
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Eisler Eng. Co., 7518 13th St., Newark, N. J

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Farnsworth Tele. & Radio Corp., Ft. Wayne, Ind.
★ General Elec. Co., Schenectady, N. Y.
Nat'l Union Radio Corp., Newark, N. J
RCA Mfg. Co., Camden, N. J.

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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

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Bradley Labs., New Haven, Conn.
Cont'l Elec. Co., Geneva, Ill.
De Jur-Amsco Corp., Shelton, Conn.
De Vry, Herman A., 1111 W. Center, Chicago
Electronic Laboratory, Los Angeles, Cal
Emby Prods. Co., Los Angeles, Cal.
★ General Elec. Co., Schenectady, N. Y
General Scientific Corp., 4829 S. Kedzie Av., Chicago
G-M Labs., 4313 N. Knox Av., Chicago
Leeds & Northrup Co., Philadelphia
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Photobell Corp., 123 Liberty St., N. Y. C.
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Tung-Sol Lamp Works, Newark, N. J.

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Taylor Tubes, Inc., 2341 Wabansia, Chicago
United Electronics Co., Newark, N. J.
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Hytron Corp., Salem, Mass.
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Electronic Labs., Indianapolis, Ind.
Mallory & Co., Inc., P. R., Indianapolis, Ind
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Ballantine Laboratories, Inc., Boonton, N. J
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Measurements Corp. Boonton, N. J.

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

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Anaconda Wire & Cable Co., 25 Broadway, N. Y. C.
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Lenz Electrical Mfg. Co., 1751 N. Western Ave., Chicago
Rockbestos Prod. Corp., New Haven, Conn.

WIRE, Magnet

Acme Wire Co., New Haven, Conn.
American Steel & Wire Co., Cleveland, O
Anaconda Wire & Cable Co., 25 Broadway, N. Y. C.
Ansonia Elec. Co., Ansonia, Conn.
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Wheeler Insulated Wire Co., Bridgeport, Conn

WOOD, Laminated & Impregnated

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SPOT NEWS NOTES

Harold Westman: Secretary of the Institute of Radio Engineers has resigned to join American Standards Association, where he will serve on War Committee on Radio. I.R.E. members will be sorry to have him leave, for he has done a splendid job for the Institute during the last 14 years.

New Switch Designs: Wide variety of switches for 12- and 24-volt service are shown in new data book entitled "Aircraft Control Devices," issued by Square D Company, N. Richards Street, Milwaukee, Wis. Many uses for the new types illustrated will suggest themselves to radio engineers.

Patent License Change: T. K. Stevenson, vice president of Western Electric Company, has announced that notice of license termination, two years hence, has been given to motion picture producers using W.E. sound system. A new contract, a draft of which will be presented shortly to licensees, running to end of 1954, will provide lower recording fees.

New Plant: The Langevin Company, manufacturers of sound equipment, have completed a new plant at 37 West 65th Street, New York City. Space of 16,000 square feet will be used to manufacture transformers and parts which have been purchased from outside sources.

Battery Jars sans Rubber: Philco Storage Battery Division, located at Trenton, N. J., center of the ceramic industry, has developed a vitrified ceramic case for storage batteries used in telephone, industrial, and public utility service. Known as Vitrabloc, it does not absorb moisture, is unaffected by acid, and is pure white in color. Case can be heated to 212° and plunged into ice water without ill effects.

TUNING BY INDUCTANCE VARIATION

(CONTINUED FROM PAGE 7)

wire employed, at every point of each turn. At the left of Fig. 1 is seen a single-point spring supporting each end of the trolley rod, whereas in the two right hand inductors the rod is affixed to springs permanently fastened to the end plate at the bottom, and retained at the top by tension-adjusting screws.

Indicator Designs ★ The dials illustrated in Fig. 1 serve only to measure the amount of each individual turn in use, and may be supplemented by a secondary turn counter. In operation, the turn counter would indicate the number of total turns in use, and the dial would indicate the percentage of the last turn in use.

A simple turn counter-mechanism is visible on the left-hand inductor of Fig. 1. It consists of a dial numbered from 0 up to the total number of turns involved, affixed to a spur gear which floats on the inductor shaft. This gear is engaged with a pinion freely borne upon a pin secured to the front of the inductor end plate. The pinion is prevented from rotating by the pressure of a flat spring in contact with the teeth. However, it is turned one tooth at a time by an arm secured to the inductor shaft. Thus, through the pinion, the spur gear is advanced one tooth for each revolution of the coil. Fig. 3 shows a cross-section of the mechanism.

The reference numbers indicate: 1, coil form; 2, tie-rod; 3, end plate; 4, panel mounting support; 5, fractional-turn indicating dial; 6, dial spacer; 7, coil shaft; 8, kicker; 9, pinion; 10, bushing for pinion; 11, pinion retaining screw and washer; 12, kicker retaining washer; 13, pinion.

This is one of the simplest forms of turn-counting mechanisms and is quite satisfactory. If the indicator becomes misaligned, it can be restored by turning the coil all the way to one end or the other.

The relationship of the turn-counting indicator to the indicator shaft can be rendered positive by modification of the arm affixed to the indicator shaft. This may be accomplished by using a spur gear with the periphery, except for one tooth, of such diameter that it falls between two adjacent teeth on the pinion, thus preventing the pinion from rotating except when it is actuated by the single tooth on the spur gear. Thus, in the manner familiar in Veeder counters, the pinion would be locked except for a few degrees of inductor shaft rotation where the periphery of the spur is cut in on each side of the single tooth.

Another simple method of handling the turn-counting problem is to mount the inductor axis parallel to the panel, in which a window permits observation of the trolley. The position of the trolley roller can be read directly against a suitable scale graduated in turns of inductor rotation.

The curve of Fig. 2 illustrates typical performance of turns and Q versus frequency in kilocycles for the small inductor at the left of Fig. 1. This is intended for low-power transmitters of 10 to 50 watts carrier output. It operates efficiently, with diminished values of shunt tuning capacity, up to 30 mc.

The center inductor in Fig. 1, wound with No. 14 wire on a 2-in. diameter form is suitable for 100-watt transmitters. It is shown, as in the inductor at the right, without the turn counter mechanism, in order to illustrate the cantilever type of trolley rod spring support, the inductor shaft bearing, and more particularly the projections on the bottom end-plate tie-rods which serve to carry the detent spring for the turn-counter pinion gear.

Accuracy of Adjustment ★ The inductor at the right is a special form, as will be evident from scrutiny of the curve of Fig. 4. It is intended for use in a heterodyne frequency meter. It consists of 102 turns of No. 18 silver-plated zero temperature-coefficient wire on a 2-in. diameter form with a winding length of $7\frac{1}{4}$ ins. Using a total value of 200-mmfd. shunt tuning capacity, the frequency range of 1,000 to 2,000 kc. is spread over a fraction more than 70 turns of inductor rotation. This, coupled with a 4-in. dial of 200 divisions and a 0-10 division decimal indicator, provides a readability and resetability of 1 part in 2,000 for each inductor turn, or 1 part in 140,000 of the total frequency range of 1,000 kcs. This is a much finer order of readability and resetability than is possible or practical with commercial gear trains as applied to 180 degrees variable capacitors, and affords a much less expensive method of obtaining a superior end result. Peripheral variations in the fired ceramic inductor form do not affect resetability.

The single factor of error is the point at which the trolley rotor contacts each inductor turn. This is held within extremely fine limits by the cantilever type of trolley rod spring construction. The overall result is an accuracy of frequency control far superior to that which can be obtained with a variable condenser.

Still another method of insuring a definite relationship between number of turns in use and the indication thereof is to employ a spring carried on a threaded rod, the rod itself being geared back to the inductor shaft. The particular advantage of this arrangement is that it becomes difficult for an operator in servicing the equipment to alter the relationship between number of turns actually in use and the number of turns indicated by the turn-counter dial.

Any engineer who keeps in mind the advantages offered by inductance tuning will be surprised to find the number of instances in which it can be used to advantage in place of capacity tuning.

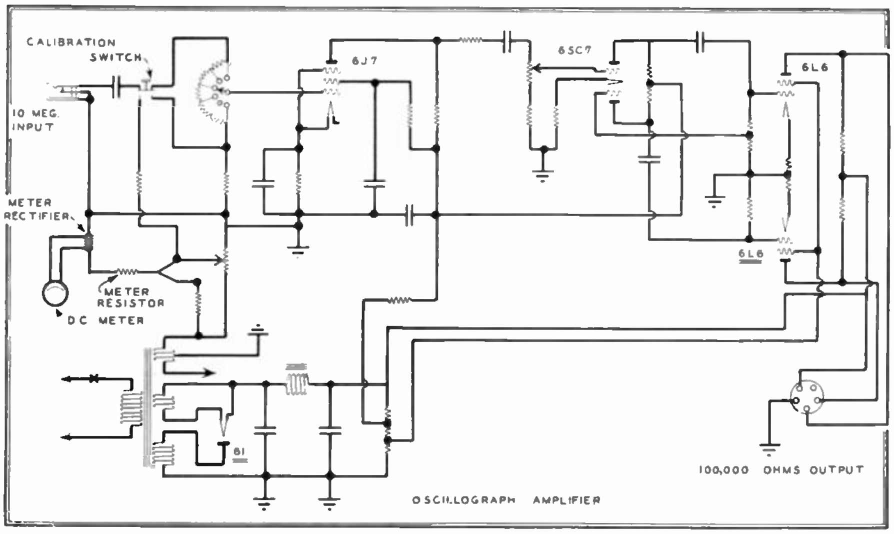

FIG. 4. CIRCUIT OF AMPLIFIER FOR FREQUENCIES FROM 1 TO 120 CYCLES PER SECOND

CRYSTAL-ACTUATED MECHANISMS

(CONTINUED FROM PAGE 5)

tached to the fourth corner. The spindle is carried on a soft plastic damping strip. Two washers on the damping strip cause the assembly to resonate near the free resonance of the oscillograph, giving increased damping effect. Thus the inking pen is given a uniform frequency characteristic up to 60 or 120 cycles per second.

In the oscillograph shown at Fig. 3, two pens are used with their respective drivers to record two different voltages simultaneously.

The crystal shown in Fig. 2 is 2½ ins. square by ¼ in. thick. Under an applied voltage of 500 volts R.M.S., a maximum peak to peak amplitude of .007 ins. is obtained. The lever system amplifies this 200 times, so that a total movement of 1.4 ins. is registered by the pen.

The sensitivity and damping of the crystal driving units is stabilized by automatically maintaining them at a temperature of 32° C.

Amplifier ★ The amplifier designed for the oscillograph is equally suited for other crystal-driven devices. The gain is about 100,000, delivering 500 volts R.M.S. from 1 to 120 cycles per second. Extra filtering is provided in the first two stages to minimize disturbances resulting from line voltage fluctuations.

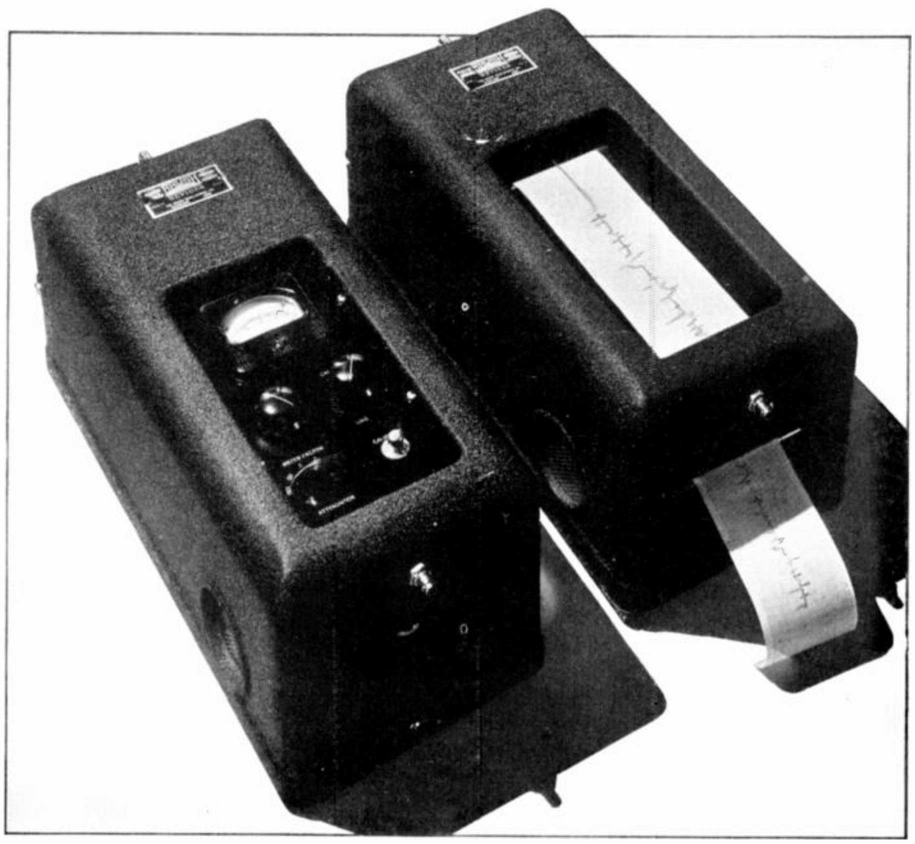

FIG. 3. SINGLE-PEN OSCILLOGRAPH WITH THE ASSOCIATED VACUUM TUBE AMPLIFIER

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(CONTINUED FROM PAGE 14)

Push-pull design uses 2 poles. First has 2 windings, one of which is a holding coil across the battery supply. The other is connected in series with a single winding on the second pole, and polarized so that, when the circuit is completed through the transmitting key, it neutralizes the flux of the holding coil, and the armature is attracted to the second pole. Either 12- or 24-volt types draw 5.5 watts at normal receiving position, 17 watts in transmitting position.

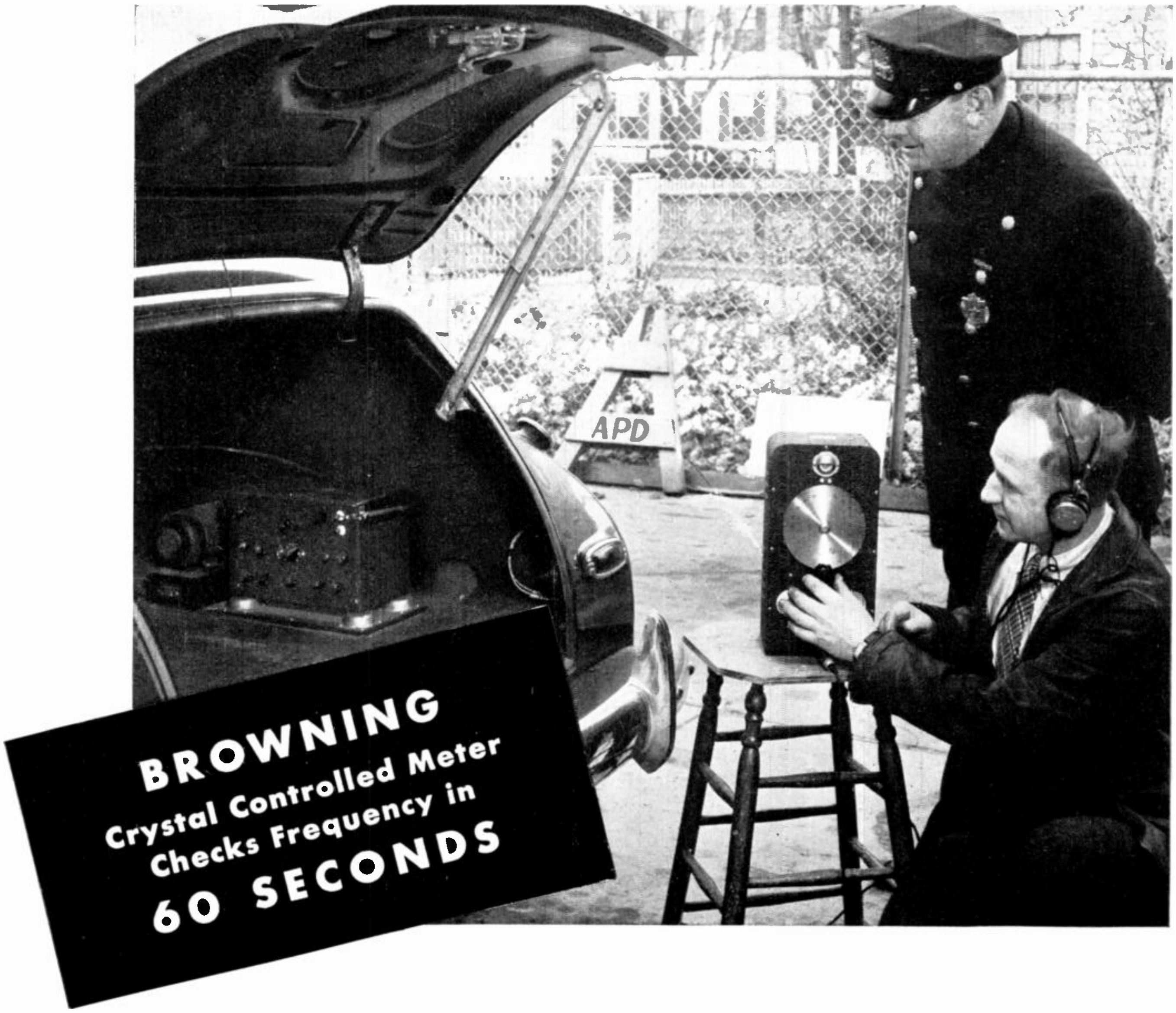
Insulation is Steatite, total weight 17 oz., mounted with elastic stop nuts, dimensions 2 7/16 by 3 1/2 by 2 1/4 ins. Manufactured by Allied Control Company, 223 Fulton Street, New York City.

Safety Cap: Lilly Daché has made a contribution to the safety of women workers, in the form of a newly designed cap of transparent Lumarith, combined with soft net. Cap serves double purpose of restraining hair from contact with moving machinery, and affording protection from dust and oil. It is, of course, non-inflammable. Charming design overcomes objections from women who are more concerned about their appearance than their safety. Manufactured by M. B. Price Associates, 350 Fifth Avenue, New York City.

LUMARITH CAP FOR WOMEN WORKERS

Roger M. Wise: Former chief engineer of Sylvania Electric Products, Inc., has been advanced to post of director of engineering of that Company.

Sealed Variable Resistors: New types from Stackpole Carbon Company, St. Marys, Pa., are designed to meet salt-spray test. Sealed construction, with extra spacing of current-carrying parts and increased surface insulation increase the leakage resistance. Type LP has dust-proof cover sealed with compound as extra protection. Engineering data is now available.



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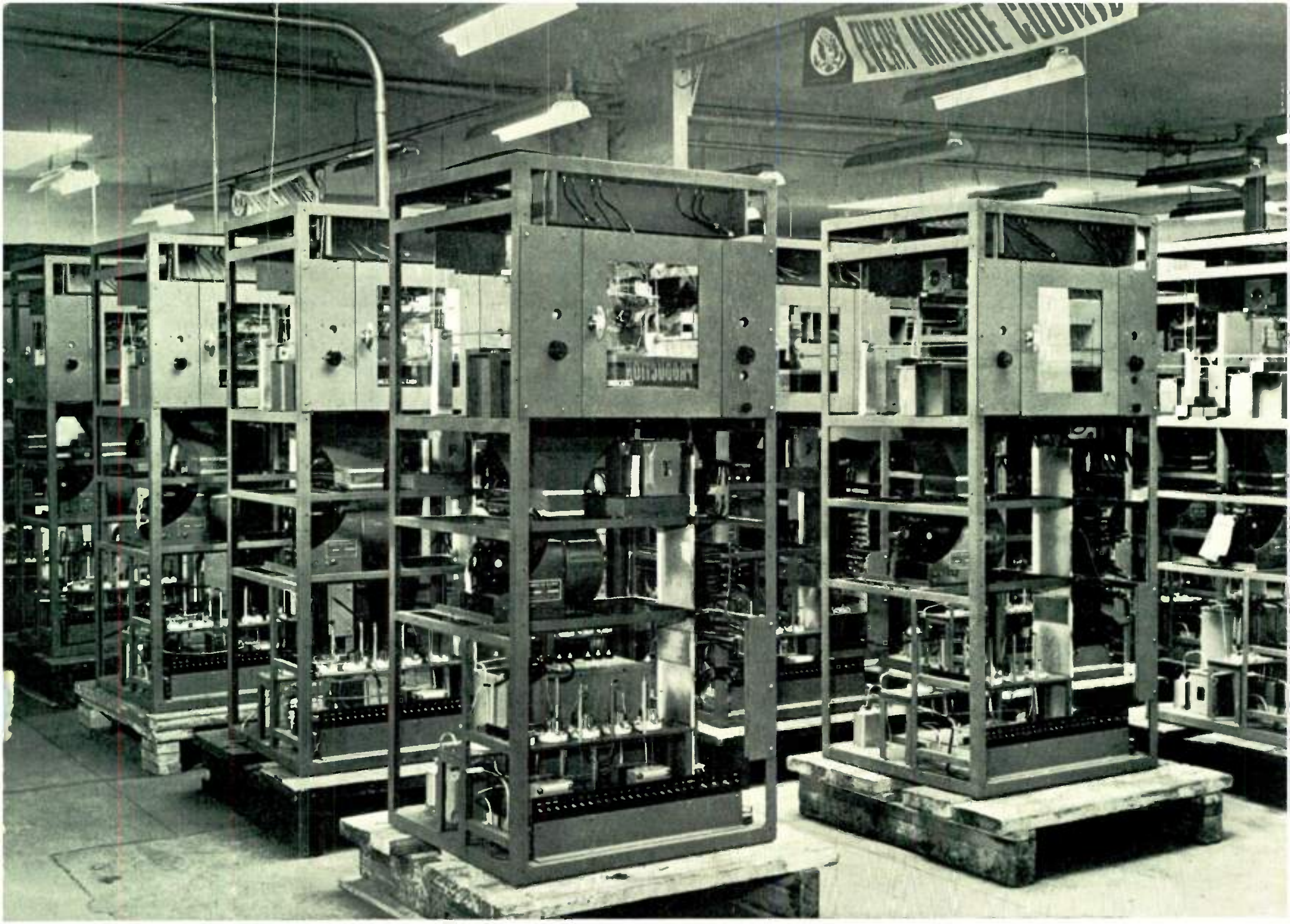

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