APRIL, 1936

Radio Engineering

VOL. XVI NO. 4

DESIGN • PRODUCTION • ENGINEERING

- Broadcast Receivers
- Auto-Radio Receivers
- Electric Phonographs
- Sound Recorders
- Sound Projectors
- Audio Amplifiers
- P-A Equipment
- Electronic Control Devices
- Testing and Measuring Equipment
- Television Apparatus
- Loudspeakers
- Components
- Tubes
- Photocells

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The Journal of the Radio and Allied Industries

Balanced Erie Resistors are the best INSURANCE against these SERVICE FAILURES

Distorts at high volume level . . . Usually due to open 4 mike electrolytic. Also check 400,000 ohm resistor from 47 grid to voltage divider for change in value or open circuit causing high pentode plate current. If 47 is weak, other tubes ok, this may be the cause.

Intermittent reception . . . Check primary of i.f. transformers. Trouble is usually in the second. Distortion at low volume settings of the volume control on locals . . . Usually caused by drop in value of 110,000 ohm unit on resistor strip.

Tone distorted, everything appears to check ok . . . Replace 200,000 ohm resistor in circuit of unshielded tube on rear of chassis if value is materially higher than this. Plate voltage will appear normal on an analyzer.

Sets play only when 27 a.v.c. tube is removed . . . Look for open resistor in a.v.c. return, also for high negative bias on r.f. and i.f. control grids. Oscillation . . . Usually caused by open circuit in .1 mike screen by-pass condenser. .1 by-pass . . . Look for open or leaky .1 by-pass across resistor in a.v.c. circuit, usually found in the power pack connected to the blue lead from the condenser block.

Poor volume or entirely inoperative . . . All models use a screen supply resistor of 14,000 ohms, 2 watts, followed by a 1/3 watt, 5,000 ohm unit in the case of the 24 oscillator and another 1/3 watt, 5,000 ohm resistor as a bleeder to ground. These resistors commonly become charred and their values drop to as little as 500 ohms, or they burn out entirely. Replace them with a 15,000 ohm, 2 watt and two 5,000 ohm, 1 watt units.

Weak reception . . . Check .1 mike condenser from 35 screen to ground. Replace 250,000 ohm, eighth watt resistor from 2nd detector 57 plate to 80 filament even if it tests ok. On load it sometimes drops plate volts from 180 to 100. Use a one-watt carbon replacement. (I.F. 262 kc.)

Audio frequency modulation of oscillator, audible all over dial . . . Replace 56 grid leak with proper size. It has probably increased in value.

Fading, after a few minutes of operation . . . Often caused by shorting of resistor located near volume control to one of control terminals.

Service Hints on how to correct various forms of receiver failures due to inferior resistors reproduced from a national radio servicemen's magazine.

Because Erie Resistors show exceedingly small changes from their nominal resistance values under all types of normal operating conditions, they can be depended on to give balanced trouble-free operation in standard receiver circuits.

The booklet "CHECK EVERYTHING" tells why Erie Resistors are the best insurance against operating failures similar to those reproduced above. Write for your copy today.

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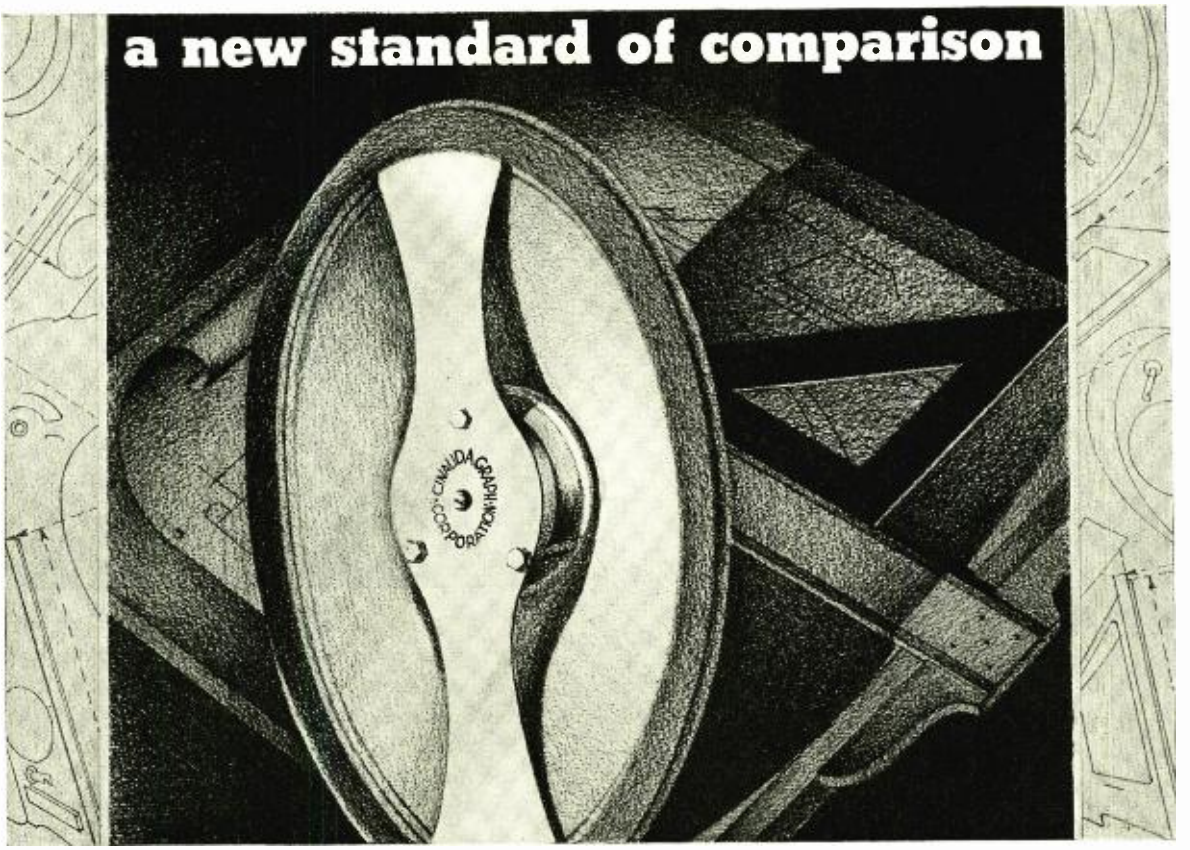
ERIE RESISTOR CORPORATION

AUTOMATIC INJECTION MOLDING

TORONTO ERIE, PENNSYLVANIA LONDON



Magic Magnet Speakers

A new design—a new construction. Old speaker concepts cast aside. Old standards of performance obsoleted. The Magic Magnet Speaker! Lay any yardstick on it that you will—many engineering laboratories have!—test it, compare it . . . prove to yourself that this new super-speaker line is the standard by which conventional speakers are henceforth to be measured. In high-fidelity reproduction . . . equal to electro-dynamics of comparable dimensions; in compact and sturdy assembly; in price range that is amazingly low — the Magic Magnet Speaker is new! Write today for complete technical data on the Cinaudagraph Magic Magnet Speaker Eight, Ten, Twelve and Eighteen Inch line.

CINAUDAGRAPH CORPORATION

Speaker Division — Dept. E.

STAMFORD, CONNECTICUT, U. S. A.

RADIO ENGINEERING

FOR APRIL, 1936

I. R. E. CONVENTION

The Statler Hotel in Cleveland, Ohio, is the scene of the eleventh annual convention of the Institute of Radio Engineers. During the convention, which is scheduled for May 11, 12 and 13, the following program will be presented:

SUNDAY, MAY 10

4:00 P.M.-6:00 P.M.:

Registration.

MONDAY, MAY 11

9:00 A.M.:

Registration and opening of exhibition.

10:30 A.M.-12:30 P.M.:

Official welcome and technical session. Addresses of welcome by Alan Hazeltine, President of the Institute; R. M. Pierce, Chairman of the Cleveland Section; and K. J. Banfer, Chairman of the Convention Committee.

Technical Session—Ballroom:

High Speed Motion Pictures of Mercury-Vapor Tube Operation, by O. W. Livingston, General Electric Company, Schenectady, N. Y.

Radio Transmission Anomalies, by J. H. Dellinger, S. S. Kirby, and N. Smith, National Bureau of Standards, Washington, D. C.

Recent Investigations of the Ionosphere, by S. S. Kirby and N. Smith, National Bureau of Standards, Washington, D. C.

10:30 A.M.-1:00 P.M.:

Ladies meet in Parlor 1.

12:30 P.M.-2:00 P.M.:

Luncheon and inspection of exhibits.

1:00 P.M.:

Trip No. 1. Ladies' luncheon and visit to the Higbee Department Store and WHK Studios.

2:00 P.M.-4:15 P.M.:

Technical Session—Ballroom

Ultra-High-Frequency High-Power Transmitter Using Short Transmission Lines, by John Evans, RCA Manufacturing Company, RCA Victor Division, Camden, N. J.

A Modern Two-Way Radio System, by Stewart Becker and L. M. Leeds, General Electric Company, Schenectady, N. Y.

A Multi-Tube Ultra-High-Frequency Oscillator, by P. D. Zottu, RCA Manufacturing Company, RCA Radiotron Division, Harrison, N. J.

6:00 P.M.:

Close of registration and exhibition.

TUESDAY, MAY 12

9:00 A.M.:

Registration and opening of exhibition.

10:00 A.M. - 12 NOON

Technical Session—Ballroom

The Effect of Automatic Volume Control Upon the Measurement of Selectivity of Radio Receivers, by D. S. Bond, RCA Manufacturing Company, RCA Victor Division, Camden, N. J.

Automatic Tuning—Simplified Circuits and Design Practice, by D. E. Foster and S. W. Seeley, RCA License Laboratory, New York, N. Y.

Aural Compensation, by C. M. Sinnett, RCA Manufacturing Company, RCA Victor Division, Camden, N. J.

12:30 P.M.-5:30 P.M.:

Trip No. 2. General Electric Lamp Development Laboratories.

5:00 P.M.:

Close of registration and exhibition.

7:00 P.M.:

Annual banquet and entertainment—Ballroom.

WEDNESDAY, MAY 13

9:00 A.M.:

Registration and opening of exhibition.

10:00 A.M.-12:30 P.M.:

Technical Session—Ballroom

A New High-Efficiency Power Amplifier for Modulated Waves, by W. H. Doherty, Bell Telephone Laboratories, New York, N. Y.

Simplified Methods for Computing Performance of Transmitting Tubes, by W. G. Wagener, RCA Manufacturing Company, RCA Radiotron Division, Harrison, N. J.

The "Shunt-Excited" Antenna, by J. F. Morrison and P. H. Smith, Bell Telephone Laboratories, New York, N. Y.

Some Notes on Amplifier Transients, by C. W. Carnahan, Hygrade Sylvania Corporation, Salem, Mass.

12:30 P.M.-2:00 P.M.:

Luncheon and inspection of exhibits.

2:00 P.M.-4:30 P.M.:

Technical Session—Ballroom

Electron Optics of Television Cathode-Ray Tubes, by D. W. Epstein, RCA Manufacturing Company, RCA Victor Division, Camden, N. J.

A Cathode Ray Time Axis for High Frequency, by L. M. Leeds, General Electric Company, Schenectady, N. Y.

Application of Conventional Vacuum Tubes in Unconventional Circuits, by F. H. Shepard, Jr., RCA Manufacturing Company, RCA Radiotron Division, Harrison, N. J.

A Study of Noise Characteristics, by V. D. Landon, RCA Manufacturing Company, RCA Victor Division, Camden, N. J.

Cathode Ray Oscillograph Applications Other than Radio, by H. J. Schrader, RCA Manufacturing Company, RCA Victor Division, Camden, N. J.

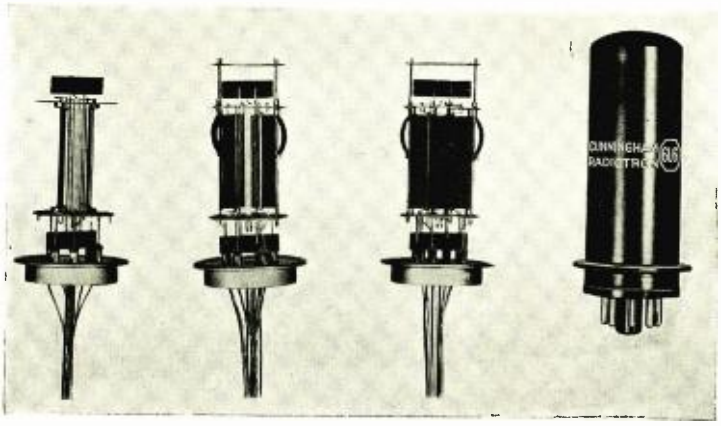
A Potentiometric Direct-Current Amplifier and Its Applications, by R. W. Gilbert, Western Electrical Instrument Corporation, Newark, N. J.

3:00 P.M.:

Close of registration and exhibition.

THE POWER

RCA 6L6



BEAM POWER AMPLIFIER
(Tentative Data)

Heater Voltage (A-C or D-C)	6.3 Volts
Heater Current	0.9 Ampere
Maximum Overall Length	4-5/16"
Maximum Diameter	1-5/8"
Base	Small Octal 7-Pin

Static and Dynamic Characteristics

Heater Voltage	6.3	Volts
Plate Voltage	250	Volts
Screen Voltage	250	Volts
Grid Voltage	—14	Volts
Amplification Factor	135	
Plate Resistance	22,500	Ohms
Mutual Conductance	6,000	Micromhos
Plate Current	72	Milliamperes
Screen Current	5	Milliamperes

Single-Tube Class A1 Amplifier
(Subscript 1 indicates that grid current does not flow during any part of input cycle)

Plate Voltage							375	Max Volts
Screen Voltage							250	Max Volts
Plate and Screen Dissipation (Total)‡							24	Max Watts
Typical Operation:								
Heater Volt.‡‡	6.3		6.3		6.3		6.3	Volts
Plate Volt.	375		250		300		375	Volts
Screen Volt.	125		250		200		250	Volts
	Fixed Bias	Self Bias*	Fixed Bias	Self Bias*	Fixed Bias	Self Bias*	Fixed Bias	
D-C Grid Volt.°	—9	—9	—14	—13.5	—12.5	—11.8	—17.5	Volts
Peak A-F Grid Voltage	8	8.5	14	14	12.5	12.5	17.5	Volts
Zero-Sig. D-C Plate Cur.	24	24	72	75	48	51	57	Milliamperes
Max.-Sig. D-C Plate Cur.	26	24.3	79	78	55	54.5	67	Milliamperes
Zero-Sig. D-C Screen Cur.	0.7	0.6	5	5.4	2.5	3	2.5	Milliamperes
Max.-Sig. D-C Screen Cur.	1.8	2	7.3	7.2	4.7	4.6	6	Milliamperes
Load Resistance	14,000		2,500		4,500		4,000	Ohms
Distortion:								
Total Harmonic	9		10		11		14.5	Percent
2nd Harmonic	8		9.7		10.7		11.5	Percent
3rd Harmonic	4		2.5		2.5		4.2	Percent
Max. Signal Power Output	4.2	4	6.5		6.5		11.5	Watts

‡Precautions should be taken to insure that dissipation rating is not exceeded with expected line-voltage variations, especially in the case of fixed-bias operation. Fixed-bias values up to 10% of each typical screen voltage can be used without increasing distortion.

‡‡The heater should be operated at 6.3 volts. Under no condition should the heater voltage ever fluctuate so that it exceeds 7.0 volts. The potential difference between heater and cathode should be kept as low as possible.

*With no signal.

°The type of input coupling used should not introduce too much resistance in the grid-circuit. Transformer- or impedance-coupling devices are recommended. When the grid circuit has a resistance not higher than 0.05 megohm, fixed bias may be used; for higher values, self-bias is required. With self-bias, the grid circuit may have a resistance as high as, but not greater than, 0.5 megohm provided the heater voltage is not allowed to rise more than 10% above rated value under any condition of operation.

The RCA-6L6 is a power-amplifier tube of the all-metal type for use in the output stage of radio receivers, especially those designed to have ample reserve of power-delivering ability. This new tube provides high power output with high power sensitivity and high efficiency. The power output at all levels has low third- and negligible higher-order harmonic distortion.

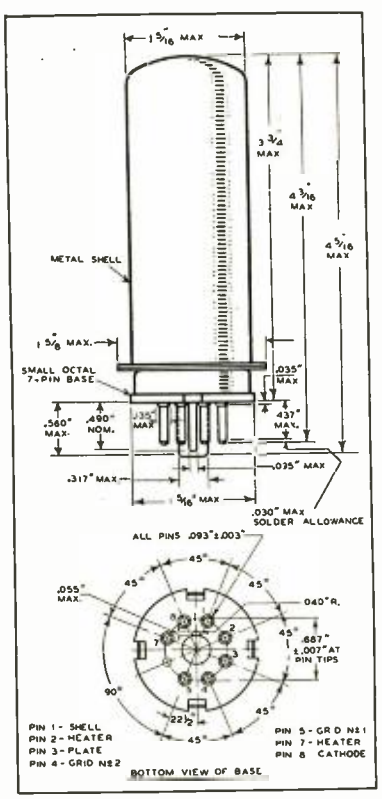
These distinctive features have been made possible by the application of fundamentally new design principles involving the use of directed electron beams. The beams of high electron density are produced by constraining the electrons with potential fields set up by the tube electrodes arranged to give the desired effects.

Primary features resulting from this arrangement are that the screen does not absorb appreciable power and that efficient suppressor action is supplied by space-charge effects produced between the screen and the plate. Secondary features are high power-handling ability, high efficiency, and high power sensitivity. Furthermore, large power output is obtainable without any grid current flowing in the input circuit.

In the design of the 6L6, the second-harmonic distortion is intentionally high in order to minimize third and higher-order harmonics. Experience has shown that second harmonics are far less objectionable in the audio-frequency output than harmonics of higher order. The second harmonics can easily be eliminated by the use of push-pull circuits. while in single-tube, resistance-coupled circuits, they can be made small by generating out-of-phase second harmonics in the pre-amplifier.

BEAM AMPLIFIER

Because of the high power sensitivity of the 6L6, it is practical to use circuits which avoid the troublesome effects of loud-speaker resonance and variable impedance. In such circuits, the 6L6 not only maintains its high efficiency, but also provides power sensitivity and stability equal to or better than that of a triode.



Push-Pull Class A₁ Amplifier

Plate Voltage	375 Max Volts
Screen Voltage	250 Max Volts
Plate and Screen Dissipation (Total)‡	24 Max Watts

Typical Operation—2 Tubes:

VALUES ARE FOR 2 TUBES.

	Fixed Bias	*Self Bias*
Heater Voltage‡‡	6.3	6.3 Volts
Plate Voltage	250	250 Volts
Screen Voltage	250	250 Volts
D-C Grid Voltage°	—16	—16* Volts
Peak A-F Grid-to-Grid Voltage	32	35.6 Volts
Zero-Signal D-C Plate Current	120	120 Milliamperes
Max.-Signal D-C Plate Current	140	130 Milliamperes
Zero-Signal D-C Screen Current	10	10 Milliamperes
Max.-Signal D-C Screen Current	16	15 Milliamperes
Load Resistance (Plate to Plate)	5,000	5,000 Ohms
Distortion:		
Total Harmonic	2	2 Percent
3rd Harmonic	2	2 Percent
Max.-Signal Power Output	14.5	13.8 Watts

Push-Pull Class AB₁ Amplifier

Plate Voltage	400 Max Volts
Screen Voltage	300 Max Volts
Plate and Screen Dissipation (Total)‡	24 Max Watts

Typical Operation—2 Tubes:

VALUES ARE FOR 2 TUBES.

Heater Voltage‡‡	6.3	6.3	6.3		6.3 Volts	
Plate Voltage	400	400	400		400 Volts	
Screen Voltage	250	250	300		300 Volts	

‡, ‡‡, °, *: See notes under Single-Tube Class A₁ Amplifier

	Fixed Bias	*Fixed Bias*	*Self Bias**	*Fixed Bias*	*Self Bias**	*Fixed Bias*	
D-C Grid Volt.°	—20	—20	—19	—25	—23.5	—25	Volts
Peak A-F Grid-to-Grid Voltage	40	40	43.8	50	57	50	Volts
Zero-Sig. D-C Plate Cur.	88	88	96	100	112	102	Milliamperes
Max.-Sig. D-C Plate Cur.	126	124	110	152	128	156	Milliamperes
Zero-Sig. D-C Screen Current	4	4	4.6	5	6	5	Milliamperes
Max.-Sig. D-C Screen Current	9	12	10.8	17	16	12	Milliamperes
Load Res. (Plate to Plate)	6,000	8,500		6,600		3,800	Ohms
Distortion:							
Total Harmonic	1	2		2		0.6	Percent
3rd Harmonic	1	2		2		0.6	Percent
Max.-Sig. Power Output	20	26.5	24	34	30	23	Watts

Push-Pull Class AB₂ Amplifier

Subscript 2 indicates that grid current flows during some part of input cycle.

Plate Voltage	400 Max Volts
Screen Voltage	300 Max Volts
Plate and Screen Dissipation (Total)‡	24 Max Watts

Typical Operation—2 Tubes:

VALUES ARE FOR 2 TUBES.

	Fixed Bias	*Fixed Bias*	
Heater Voltage‡‡	6.3	6.3	Volts
Plate Voltage	400	400	Volts
Screen Voltage	250	300	Volts
D-C Grid Voltage°	—20	—25	Volts
Peak A-F Grid-to-Grid Voltage	57	80	Volts
ZeroSignal D-C Plate Current	88	102	Milliamperes
Max.-Signal D-C Plate Current	168	230	Milliamperes
Zero-Signal D-C Screen Current	4	6	Milliamperes
Max.-Signal D-C Screen Current	13	20	Milliamperes
Load Resistance (Plate to Plate)	6,000	3,800	Ohms
Peak Grid-Input Power°°	180	350	Milliwatts
Distortion:			
Total Harmonic	**	**	Percent
3rd Harmonic	**	**	Percent
Max.-Signal Power Output	40	60	Watts

**With zero-impedance driver, plate-circuit distortion does not exceed 2%.
°°Driver stage should be capable of supplying the grids of the Class AB stage with the specified peak values at low distortion.
‡, ‡‡, °, *: See notes under Single-Tube Class A₁ Amplifier.

FLUXES AND SOLDERS

The First of Two Articles on a Subject of Great Importance to Production Departments

By E. R. WAGNER, Ph.D.

To the person who uses solder in his business, the meaning of the term is too often confined to the particular materials with which he is familiar, and to the specific process he has followed in the past. The wide range of materials available for use as solders and as fluxes, to produce "a good joint" and to enhance production efficiency is not generally appreciated.

To many minds the word "solder" conveys the impression of a metallic substance that will melt at low temperature and which can be used to join two metal surfaces. A flux, similarly, is all too often a mysterious something that is necessary for successful soldering.

This sketchy understanding of the true nature of soldering is revealed by published formulas, by much of the earlier literature of the subject, and by many patents. During the past thirty years, which have witnessed the increasing use of aluminum, there has been published and patented an especial wealth of material on aluminum soldering, which aptly illustrates the statement just made. Search of the patent literature of earlier years would yield a similar result with reference to solders and fluxes intended for use with the commoner metals. As a matter of fact, aluminum soldering, once the basic principles have been thoroughly understood, is little if any more difficult than any other soldering.

The impression received from a survey of these patents is that most of the inventors had no basic knowledge of what they were doing or trying to do, and that the results they obtained were chiefly the result of "puttering." Comparison of their prescriptions with more modern formulas, and analysis of them in the light of the principles now known to be fundamental, would indicate that the prime achievement of many of the inventors was a feeling of fellowship with Edison, a sense of satisfaction, and a firm conviction of having contributed to the progress of mankind. Many of these formulas are in no way better than those they were intended to supplant, and sometimes are worse. However, it can be said of all of them that they are different—or no patent could have been obtained.

Owing to the interest evolved by Mr. C. L. Barber's article entitled "How Shall We Solder the Radio Chassis?" in the February, 1936, issue of RADIO ENGINEERING, *it was felt desirable to offer a still lengthier and more detailed discussion of the same subject. —Editor.*

Many solder and flux formulas have been patented or published, which contain substances that defeat the purpose of the other ingredients. Some even include constituents that might work at higher temperatures if used alone, but which are either useless or harmful in the presence of the other materials with which they are mixed.

For example, a formula patented in 1918 calls for: stearic acid, 16 parts; borax, 2 parts; rosin, 2 parts, and powdered cinnamon bark, 5 parts. The stearic acid and rosin alone would be sufficient. The cinnamon forms a bit of charcoal, harmless, but also useless; and in the presence of the rosin and stearic acid the borax loses its identity at ordinary soldering temperatures. It combines with them chemically to form soaps which merely add to the ash residue and hinder rather than help soldering. The inclusion of borax in this formula is probably based on its known usefulness as a flux in brazing and welding operations, but its chemical action in those cases is entirely different, since it is then the sole fluxing agent. Its chemical action in welding and brazing is entirely different than that which it has when used with acids such as rosin and the others mentioned.

Another example of an improperly planned flux, that nevertheless will function to a certain extent under certain conditions, is the following: ammonium chloride (sal ammoniac), 22 parts; rosin, 6 parts; borax, 2 parts; copper sulphate, 1 part, and sodium bicarbonate, 1 part. These components are to be mixed dry, and one part of dry mix to three parts of water constitutes the flux. As in the preceding case, part of the formula is effective, the remainder useless or probably harmful. As soon as the mixture is moistened, and especially if permitted to stand for such short intervals as are inevitable in production work, the copper sulphate is entirely converted to insoluble copper carbonate and copper borate, which impede the fluxing action. There is more than enough borax alone, or sodium bicarbonate alone, to remove all of the copper from solution; and more than enough excess borax to form soap with all of the rosin, leaving only the ammonium chloride to act as a flux (if it can) in the presence of all these inert and useless materials.

Published or patented fluxes frequently contain substances that cause corrosion, and these will be discussed in further detail below, after the true nature of the fluxing action has been described.

However, a large number of published or patented formulas contain only compatible ingredients, of course claiming superior performance for particular proportions of ingredients. In fact, these proportions could be varied widely without affecting the value of the flux or solder to any appreciable extent.

Study of these formulas indicates the very wide choice of substances that can successfully be used as solders and as fluxes, provided only that proper selection is made to meet the requirements of the actual work to be done.

Patents and formulas for solders vary as greatly as those for fluxes. Many have similar compositions, and melting points that fall within a very narrow range. Others differ slightly in composition and very slightly in fluidity. In some cases the solder has been definitely formulated to meet definite requirements as to hardness, tensile strength, melting point, etc. In aluminum solders, zinc and tin seem to be favored ingredients, in proportions that appear to depend upon the individual experience of the inventor. The International Critical Tables state: "There are a host of aluminum solder patents, many of doubtful value."

However, aluminum soldering, as already stated, is not exceptionally difficult, and is not particularly dependent upon the type of solder used. Zinc, tin and lead, and alloys of those metals, alloy readily with aluminum, and ordinary tin-lead solder may be used quite

satisfactorily. The problem of aluminum soldering is one of choice of flux, rather than choice of solder.

Mere reading of published or patented formulas, without analysis of more fundamental considerations, demonstrates clearly that there is a very wide choice of materials which can be used for good soldering in any particular case, and that production is never dependent upon a limited selection. To the contrary, study of the basic action will indicate that production practices can often be improved in efficiency, and soldered bonds improved in permanence and reliability, by suitable choice of alloys, fluxes and technique, which perhaps have never been thought of as desirable for such work.

The True Nature of a Soldered Connection

Disregarding the action of the flux for the time being, the nature of the soldered connection as such may accurately be described as an alloy of several metals, produced at a temperature which is often lower than the melting points of the individual metals composing the solder, and perhaps much lower than the melting points of the metals that are joined.

The distinguishing characteristic of an alloy, as understood by the metallurgist, is the homogeneous mixture of metals. In some alloys, pure crystals of one metal are intimately mixed with pure crystals of another. These crystals are held together by a "cement" consisting of molecules of the same metals, in such proportions as to constitute a eutectoid mixture, or one having a lower melting point than the crystals. Alloys may also consist of, or include, definite chemical combinations of the metals, in which the crystals, or some crystals, contain more than one kind of molecule.

Alloys formed in the process of soldering apparently differ from the more common alloys, in that they are formed by the application of molten metal to solid metal, and not, as is more usual, with all the metals involved in liquid state. In the latter case, the solubility of the metals in each other brings about a homogeneous mixture, by diffusion, in a very short time. The difference between such alloys and those produced by soldering is more apparent than real, and is one of degree and not of kind. The wetting of solid metal by molten metal produces a limited degree of diffusion, or of penetration of molecules of molten metal among or into the crystals of solid metal. A true alloy is formed which penetrates to a limited depth below the surface of the solid member.

Not only does the molten metal penetrate or diffuse into the solid one, but to some extent the solid may diffuse or dissolve into the liquid. A very simple analogy would be that of pouring water on a surface of sugar and immediately freezing the water. Not only does some of the water, before it is frozen, penetrate into the sugar, but some of the sugar dissolves in the water, and when the process of freezing is completed the ice is joined to the sugar by an intermediate layer of vague boundaries, consisting of a solidified solution of both substances.

The extent to which penetration takes place, in soldering, depends upon the solubilities of the metals in each other at the temperature of the operation. Thus brass, which is composed of copper and zinc, is much more readily soldered than iron, for the reason that iron is far less soluble in common solder than copper or zinc are, particularly at the temperatures involved.

Solders used in all ordinary work are themselves always alloys, in proportions which vary according to the physical characteristics desired, and commonly range between 70-lead/30-tin and 30-lead/70-tin. Other metals are also alloyed in some solders; for example, copper or zinc may be added. The choice of a solder alloy, in any given case, will depend partly upon the metal to be soldered and partly upon the physical properties desired, such as high tensile strength, etc., a vital factor in the choice always being the mutual solubility of the solder and the metal to which it is applied.

Another important characteristic of any solder alloy is its fluidity at the temperature involved in the process. A high-tin solder is much more fluid than a high-lead solder. The high-lead solder also remains "mushy" in cooling for a longer period of time (as will be explained in greater detail hereafter)—a property that is advantageous in some work, for example, joining lead to lead, as in the sheaths of telephone cables; but a drawback in a radio receiver production line.

The Nature and Function of the Flux

It is obvious that an impenetrable, continuous layer, such as an oxide, upon the surface of the metal to be soldered, will prevent the desired penetration by diffusion, which is the essence of a soldered bond. Cruder forms of foreign matter, such as dirt, must of course be removed, and in the process of removing it the metal may be filed, presenting a clean surface that is apparently free from oxide. Such a surface could be soldered in an inert atmosphere such as hydrogen or nitrogen. In air, however, an invisible layer of oxide forms very rapidly, especially when the metal is heated. It becomes necessary that some agent be used which either prevents oxidation, or, if oxidation has occurred, which will dissolve the oxide film and permit the solder to come into contact with the clean metal.

This agent is the flux.

In the case of aluminum, upon which an oxide appears instantaneously at ordinary temperature and forms a very tough and adherent film, it may be said that the primary action of the flux is to dissolve this film in order that it may flow away under the heated solder and permit metal-to-metal contact. Of course, a secondary function of the flux is to protect the metal against further contact with air until the bond has been completed. In the case of copper, however, upon which oxidation takes place rather slowly at room temperatures, the prime purpose of the flux may be considered preventive, in keeping the metal out of contact with air when it is heated for soldering, and only secondarily to remove the slight trace of oxide that may have appeared since the metal was filed.

Surfaces that have been previously "tinned" for soldering, as is often done, for example, in the case of lugs used in radio work, have merely been soldered to a surplus of metal of low melting point. This metal oxidizes, but since it also melts readily, the oxide layer is easily broken up without use of a flux, and floats upon the molten surface as particles. Solder can be added to such a surface, or two such surfaces may be joined together, even though flux is not used at all.

For the sake of brevity, one action of the flux has been described as that of dissolving the oxide layer. In some cases this is precisely what happens, as, for example, when zinc chloride is used as a flux on aluminum. Usually, however, the chemical process involved is more complicated, and the oxide is first chemically attacked and converted to a reaction product, which is then dissolved by the flux and washed away.

The surface film on common metals is frequently a hydrated oxide and sometimes contains a carbonate, but for practical purposes it may be regarded simply as an oxide of the metal in question. As such, it is classed chemically as a base, and, being a base, it may be made to react with an acid to form a salt. In all cases where direct solution of the oxide is not practical, the flux must consist of acid ingredients or acid-forming ingredients, and must be one that will permit the necessary reaction to take place at the temperature to which the surface is raised by the soldering iron. *(To be concluded)*

COIL MANUFACTURING COSTS

A Complete Analysis of One of the Most Important Phases of Set Manufacture

Each year brings added refinements in radio transformer design, many seemingly traceable to stricter tolerances in coil inductances. Such restrictions require coil-winding machines of unquestionable accuracy in their performance. Lacking such equipment, coil manufacturers must adjust finished coils to required inductances manually, a tedious and expensive operation, and one which often throws anticipated production costs out of line. The latter method is hardly a desirable one to contemplate, and yet it is a fact that many coil producers are obliged to tolerate this condition, and in at least one known instance, at a labor cost totaling 25% of the weekly payroll.

Much of this adjustment is obtained through padder-condenser setting, but the resultant performance is not always as dependable as might be desired. The bulk of this coil correction is accomplished through removal of wire turns until the desired inductance is reached, a costly and unreliable procedure, but one unfortunately that cannot be avoided where inefficient and cheaply-constructed winding equipment is utilized.

Current receiver design calls for one type of intermediate-frequency transformer having rather a unique pattern, the primary and secondary coils being composed of a group of "pies" or thin disc-shaped sections, exactly spaced and containing absolute uniformity of wire turns. The various sections of each group, for production purposes, are generally wound with a continuous length of wire, stranded-Litz with enamel and silk covering.

The spacing between the primary and secondary groups is of the utmost importance, and as a relocation of the finished coils would prove impractical, succeeding coil windings must be uniformly placed in relation to one another. This uniformity can be obtained at no sacrifice to rate of output by using a rather ingenious coil-winding machine designed primarily for the production of i-f, r-f, and other coil types featuring a cross-wind construction.

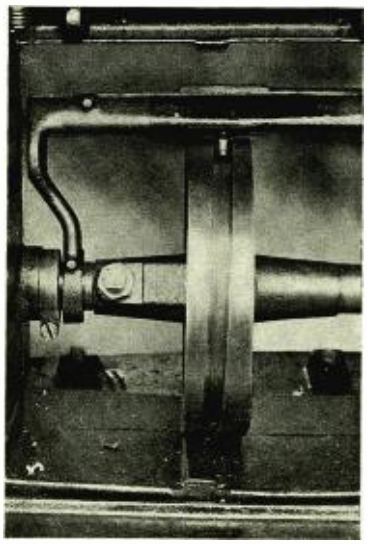
The key-point in any winding mechanism is its traversing device, and in the Universal Winding Company's No. 84 machine, therefore, particular attention has been given the traverse cam controlling the coil thickness. This part is machined to close limits, and using a cam roll drive, assures coils of equal widths at all times. In the operation of the cam and the winding arbor, the relation is such that a one-throw-per revolution is maintained, giving a uniformity of "knuckles" or wire cross-overs throughout the coil.

Special attention has also been given to the design of the wire spool unrollers, which are accurately synchronized to assure equalized tension on the wire whether the spool is full or almost empty. A new type of counting mechanism permits higher winding speeds, stopping the winding operation promptly at any desired number of wire turns, and resetting to zero by a single motion.

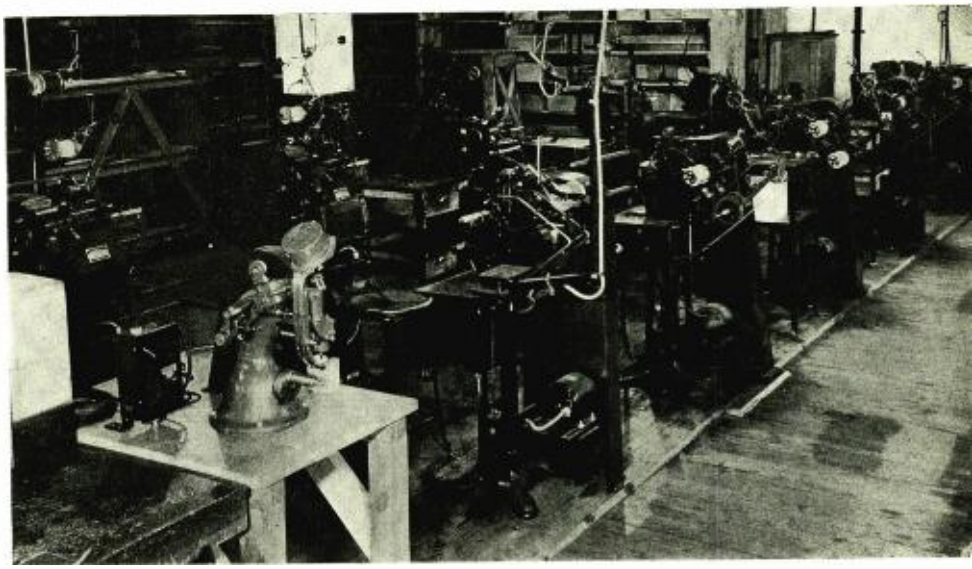
A new wire-guide construction featuring "off-set" wire slots permits producing coils within 1/64" of previously-wound coil sections, as required in "pie-winding," and a winding arbor of unique design permits quick and accurate shifting of these wire guides for the production of successive "pies." Incidentally, the guide settings are adjustable to accommodate changes in coil specifications. Further adjustments in the machine govern the number of wire crosses per revolution of the winding arbor, and also the spacing between adjacent wire turns, eliminating any possibility of the equipment becoming outmoded through changing coil requirements.

Installations of these versatile machines at two of the larger radio plants in this country have demonstrated interesting rates of output. One concern requires approximately 5000 i-f transformers of the pie-wound type per day, and using operators unfamiliar with automatic winders, was able to obtain 670 complete transformer assemblies per 8-hour day from each No. 84 machine utilized. The coil in question had a primary of two pies and a secondary of three pies, each containing approximately 100 turns of Litz wire. In spite of the fact that five distinct coils were required in each of these transformers, the output reported was maintained, due

COIL WINDER TRAVERSE MECHANISM.



By M. E. FAGAN †



TYPICAL BATTERY OF COIL-WINDING MACHINES.

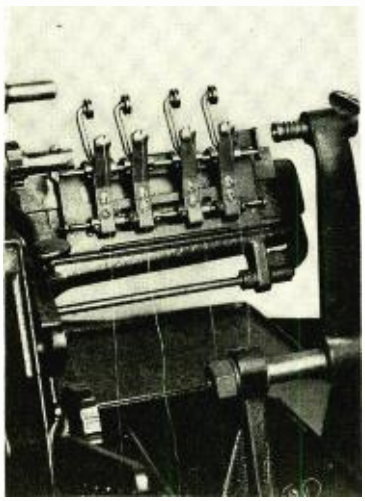
primarily to the ability of the machine to produce four sets of pies, or two complete transformer assemblies, at a time.

Using a bonus system of recompense, the labor cost per coil never exceeded $.005, and as the coil groups so produced did not require elaborate corrective operations after completion, attractive cost reductions were also effected in coil assembly. Equally interesting savings were also established at this plant on such coils as band-pass i-f transformers (having 2 single-section coils and 5 pies); receiver and transmitter chokes (composed of 5 pies of similar characteristics); r-f transformers (containing a single cross-wound coil section); i-f transformers (comprising 2 sections, one having 750 turns of No. 36 S. S. & E. wire, and the other, 250 turns of 7/41 Litz). Also antennae loading coils, r-f, choke coils (containing a single cross-wound section.) To illustrate the present costs on a complete i-f transformer, a detailed analysis is given below taken from this plant, and covering two coil sections composed of 325 turns each of 4-strand No. 41 Litz wire, silk and enamel covered:

Winding Machine Labor Cost:	
Install 2 laminated bakelite tubes or wood plugs on arbor, and transfer to winding machine	10 sec.
Anchor 4 ends of Litz wire, and thread 4 wires in guides	16 sec.
Set automatic counter at zero	2 sec.
Start machine, producing 4 coil sections of 325 turns each, at 750 rpm*	30 sec.
Anchor final wire turn on all four coil sections	12 sec.
Clip wires, and remove finished coils	4 sec.
Allowance per two pairs of coils, for wire spool renewals	5 sec.
Total machine time for 2 pairs of coils	79 sec.
Total machine time for 1 pair of coils	40 sec.
Output per 8-hour day, at 100% operative efficiency	720 pr. coils
Output per 8-hour day, at 85% operative efficiency	612 pr. coils
Output per hour, average	74 pr. coils
Winding labor, per pair of coils, at 40c per hour	$.005
Assembly labor cost, attaching leads, etc., at rate of 21 coils per hour, 40c per hour cost per coil	.013
Total labor	$.018
Materials:	
Wire, 116 grains of 4/No. 41 Litz, $3.00 per lb.	$.049
Leads, covered (4)	.006
Wood plug, or paper tube, and staple	.005
Metal housing, or aluminum can	.025
Padder Condenser	.092
Insulation for housing, yellow varnished cloth	.001
Total material	$.178
Total cost for complete i-f transformer.. (Which, of course, does not include overhead charges or allowance for wasted materials, as these items vary too greatly in different plants.)	$.196

*Higher winding rates are possible for certain types of coils, but invariably result in faulty winding regardless of the type of machine employed.

ADJUSTABLE GUIDE ARRANGEMENT.



Much has been said for and against manufacturers maintaining coil-winding departments, but the past radio season demonstrated rather forcibly the value of having means at hand for producing these i-f and r-f coils when and as needed. Dependent upon commercial winding organizations for their coil needs, several concerns experienced exasperating delays in obtaining delivery of complete transformers, and in at least two instances, were obliged to take cancellation on receiver contracts. Lost orders, regardless of the quantity or value of merchandise involved, are not pleasant to contemplate, and particularly when the predicament could have been averted through an installation of coil winders. A battery totaling but two machines for instance would have assured a daily output exceeding 1000 transformers of a single type, or 200 transformers embracing 5 different types. Obtainable for an investment not exceeding $1325, including motors, the amount could easily have been realized through the profits represented by these lost orders.

Another factor in favor of coil-winding equipment chiefly concerns the manufacturer with unused floor-space at his disposal. Idle shop area adds to the maintenance costs and general overhead of the active area, and hence to the entire manufacturing structure. Dedicating idle floor-space to a coil department relieves the burden on existing departments, and creates a general decrease in cost of parts produced by those departments.

†Universal Welding Co., Boston, Mass.

CRYSTAL FILTER DESIGN

Part 4 . . . Concluding the Series on the Application of Crystal Filters to High Fidelity Receivers

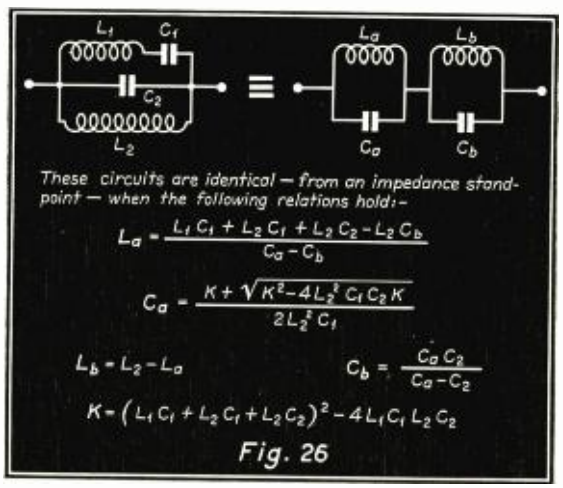
Thus far our discussion of the crystal filter has been, of necessity, of a general nature. We have investigated the possibilities of various structures employing quartz plates as circuit elements, and have arrived at the conclusion that the bridged-T type of structure gives evidence of the best solution to the problem of crystal filters for broad-band receiver circuits. We showed, in Figs. 20 and 22 of Part III, bridged-T sections using but one crystal each. These, of course, will probably be the most economical.

The circuit of Fig. 22 can be derived from that of Fig. 20 by replacing the mutual inductance, M, by the coil L_2. This is in agreement with the theory discussed in connection with Figs. 1 and 2 of Part I, wherein the equivalence between a two-winding transformer—with mutual inductance between the windings—and a T network of three inductances—between which there is *no* mutual inductance—was demonstrated. Obviously, the equivalent circuit, Fig. 21, can be applied to the examination of the circuit of Fig. 22. For the sake of completeness, we showed another form of the bridged-T network in Fig. 23, its equivalent circuit being that of Fig. 24. It will be seen that this circuit, like that of Fig. 18, Part II, employs two crystal plates, but otherwise the structure only remotely resembles the former.

To return to Fig. 20, we find that this network has a resistance, 2R, which is common to both sides of the circuit. On first thought it might be assumed that this resistance is a common coupling medium between the two portions into which the circuit of Fig. 20 is divided in order to derive the lattice-equivalent of Fig. 21. However, the mutual inductance, M, provides all of the coupling necessary. The resistance, R, has an entirely different function.

Bi-Section Theorem

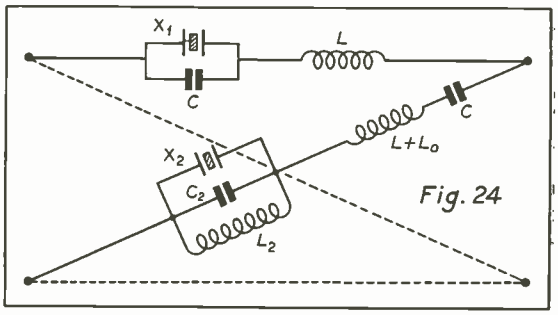
It will be remembered that in Part I we discussed the so-called Bi-section Theorem, and gave at least some hints regarding its usefulness in filter design calculations. We mentioned, among other things, that the Bi-section Theorem provided a means for annulling the inherent resistance of the coils which must be used to provide wide-band response. Obviously, to employ circuit elements—crystals—with exceptionally high Q's in combination with elements of comparatively low Q's—coils—would be to defeat the very purpose of using quartz plates as circuit elements.



The value of 2R is determined from equation (1) below, in which L is the inductance of one coil, M is the mutual inductance between the two coils, and r is the resistance of the two coils. Equation (1) is solved for R, and twice this is, obviously, the value of 2R.

$$\frac{R+r}{r} = \left(\frac{L+M}{L-M}\right)^2 \qquad (1)$$

In the case of the resistance, r, of the circuit of Fig. 22, the calculation is somewhat different. For instance, in the equivalent-lattice of Fig. 21 the resistance of L is r_1 and the resistance of L_2 is r_2. Then, the resistance of the coils of the line (series) branches of the lattice will be r_1, and that of the coils of the lattice (shunt) branches, $r_1 + 2(r_2 + r)$. These may be expressed in terms of the inductance and frequency, at certain frequencies; i. e., throughout the pass band and for some distance on either side. These expressions for r_1 and r_2 are:



$$\frac{r_1}{\omega^2 L^2} \text{ and } \frac{r_1 + 2(r_2+r)}{\omega^2(L+2L_2)^2} \text{ respectively.}$$

These are equal when

$$\frac{2(r_2+r)}{r_1} - 1 = \left(\frac{L+2L_2}{L}\right)^2 \qquad (2)$$

When r is determined in accordance with this procedure, the effect upon the circuit is exactly that which would obtain if equal high resistances were connected across the input and output terminals of a non-dissipative filter. That is, there would be a constant loss in-

By W. W. WALTZ

troduced, a loss entirely independent of frequency. Loss due to coil resistance in a filter not corrected by this means is not independent of frequency. Since the attenuation occasioned by the resistance r is not a function of frequency, the sharpness of cut-off—or selectivity—is unaffected. Fig. 7 of Part I gives the equivalence between several types of lattice structures and indicates the functioning of the Bi-section Theorem as in the equations above; Fig. 7D is the result sought under the procedure just discussed, while Fig. 7C is the dissipative case.

Propagation Constant

In order to clarify further the determination of the electrical elements of the equivalent-lattice network of the crystal filter, we shall discuss certain other points, especially with regard to the bridged-T sections. The

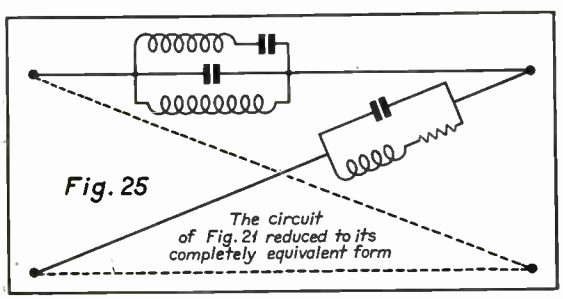


Fig. 25

The circuit of Fig. 21 reduced to its completely equivalent form

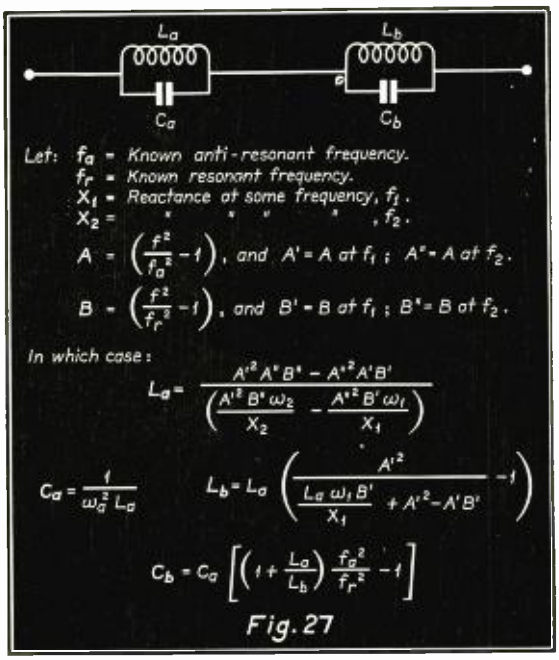
Propagation Constant of a filter[3] of this type is given by equation (3).

$$\text{Tanh}\ \frac{P}{2} = \sqrt{\frac{Z_1}{Z_2}} \qquad (3)$$

In (3), Z_1 is the impedance of the line branch of the equivalent lattice and Z_2 is the impedance of the lattice branch. From our previous examinations of the conditions for a pass band, we know that if Z_1 is equal—or nearly so—to Z_2, the attenuation to frequencies outside the band will be exceptionally high.

For the circuit of Fig. 20, Z_1 will be seen to be identical with Z_1 of Fig. 19, Part II. This means, of course, that the reactance-frequency characteristic will be the same. The impedance of the lattice branch, Z_2, is, however, simply an anti-resonant circuit made up of L, M, and C and so proportioned as to be anti-resonant at a frequency, f_2—this results in free transmission between frequencies f_1 and f_3. These frequencies—f_1 and f_3—are in turn determined by the circuit which constitutes Z_1.

[3]Defined rather broadly as one-half the natural logarithm of the complex ratio of the volt-amperes entering and leaving the network when it (the network) is terminated by its iterative impedances. The steady-state condition is assumed. The term "iterative impedance" is used synonymously with "characteristic impedance," and in the case of a symmetrical network, with "image impedance."



With these apparently unrelated points in mind we can now set up a more or less well defined design procedure for crystal filters of the bridged-T type. Let us refer again to Fig. 20; since this is evidently the simplest of the crystal filter structures—and, as it will satisfactorily meet the requirements for service in an i-f system—we can best confine our further remarks to this particular network.

R-F Band Response

First, we may examine the possibilities, mentioned early in this article, of obtaining a sufficient degree of wide-band response through the r-f system to warrant the inclusion of a crystal filter in the intermediate amplifier.[4] Under the present broadcast set-up, a high degree of selectivity is still greatly to be desired. It, then, our design starts with a radio-frequency amplifier of sufficient tuned stages to insure freedom from image interference, we are presumably justified in relegating to the i-f amplifier the job of maintaining suitable selectivity, and gain.

This latter point—gain—has, we believe, been adequately met in the crystal-filter coupling unit by reason of the high impedance which it presents to the associated vacuum-tube plate circuit.

The selectivity due to the crystal filter is largely a matter of design, not restricted by low Q's, or the limitations imposed by ordinary coupled circuits.[5] With this kind of selectivity available, and with the necessary r-f stages, there seems to be no feasible reason for considering variable bandwidth filters in the i-f stages.

We have been pre-supposing, up to this point, that

[4]As we mentioned, image-frequency considerations dictate the need for pre-detector r-f stages, especially so for high-fidelity receivers. In connection with this, we note the following addition to the bibliography of footnote 1: *Wireless World* (London), Vol. XXVII, No. 9. Pages 186-189, August 27, 1930.

[5]It will be recalled, at this point, that the limitations in bandwidth of the type of crystal structure which we are considering are such that we are chiefly concerned with *restricting* the bandwidth to a usable point—actually, a bandwith of *less* than 10 kc will be difficult to attain. This, of course, means an audio band of 5000 cycles.

the i-f amplifier with crystal filter will employ one, or at the most two, tubes, coupled by means of broadly tuned i-f transformers—perhaps of the metal-core variety—and with a crystal filter somewhere in the line-up. It is, of course, entirely feasible to use two crystal-coupling units, although the increase in cost would be appreciable. The selectivity of such an arrangement would be enormous, but the quality—within the limits imposed by the designer of the filter—would be unimpaired.

Actual Design

For the actual design of a filter of the type shown in Fig. 20 it will be necessary further to break down this circuit beyond the equivalence of Fig. 21. In this latter diagram we have a lattice network[6] in which there is a crystal. This must be replaced by its equivalent circuit; the result is as shown in Fig. 25. From this circuit, and our knowledge of the requirements of the impedances of the various line and lattice branches, we can, by application of the Campbell reactance thorem, arrive at the constants for the elements of the equivalent circuit. Those constants which are of the crystal equivalent circuit are then converted (see Part II, footnote 2) into terms of dimensions for the appropriate quartz plate.

Space will permit only a brief illustration of the use of the Campbell theorem, but the general lack of information on this important mathematical tool makes it seem advisable to devote at least a few words to its methods.

The general equation (equation (10) Part I) can be applied to practically any problem where one knows the impedance characteristics of a circuit and wishes to know how such a characteristic may be physically realized. There is little indeed in print on this method[7] considering its great usefulness.

As we mentioned, Fig. 25 gives the circuit in its completely equivalent form. Both the line and lattice networks are calculated from known impedances derived from considerations of transmitting and attenuating regions. The lattice arm network of Fig. 25 will present no particular difficulties to the circuit designer, but the problem of the line branch circuit is somewhat more complicated. The equivalence between the circuit representing the crystal in Fig. 25 and another form of this circuit is given in Fig. 26; in this latter diagram (b) is the circuit which we can most easily use to find the elements necessary to give our pre-assigned impedance characteristic. Fig. 27 gives all of the data necessary to make this determination.

Other circuits—such as those of Fig. 18, Part II; Figs. 21 and 23, Part III—can be handled in exactly the same manner, although the calculations will be necessarily more complicated.

[6]Conventional practice is to show only half of a lattice network; this makes for a clearer drawing. The broken lines represent elements identical with those shown.

[7]Appendices D(1-4) and F of "Transmission Circuits for Telephonic Communication" by K. S. Johnson, appear to be about the best—if not the only—available source of this material. Of course, the original paper by Campbell (*loc. cit.*) and that of Foster (*loc. cit.*) should be consulted for the fundamental principles.

BOOK REVIEWS

RADIO DATA CHARTS, Second Edition, by R. T. Beatty, M.A., B.E., D. Sc. Published by Iliffe & Sons, Ltd., Dorset House, Stamford St., London, S. E. 1., England. 4/6 net, by post 4/10.

This Second Edition is completely up to date, many new Abacs having been added in accordance with modern developments, and obsolete charts correspondingly deleted.

This handbook has been popular with experimenters and engineers for many years, providing as it does, means for instantly arriving at many technical results which would otherwise necessitate much laborious calculation. Accompanying each Abac, as before, are notes to enable the user to derive the maximum service from the book as a whole.

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PHENOMENA IN HIGH-FREQUENCY SYSTEMS, by August Hund, 642 pages, cloth covers. Published by McGraw-Hill Book Co., New York, N. Y. Price $6.00.

Mr. Hund's latest and most ambitious effort will be welcomed by all who work with high-frequency circuits. Practical material is subordinated in favor of mathematical analyses of the numerous subjects, but this should serve only to enhance the value of the book. This book is to be classified as a reference work rather than as a textbook or laboratory manual. However, students of high-frequency circuits will find it useful in supplementing their lecture notes; engineers and research workers likewise should find many occasions to use the volume, either to brush up on some obscure point or as a complete course of study in what may be, to many, a new field.

The book is another addition to the International Series in Physics.

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MEASUREMENTS IN RADIO ENGINEERING, by F. E. Terman, 400 pages, cloth covers. Published by McGraw-Hill Book Co., New York, N. Y. Price $4.00.

The author states that this book is in no sense an encyclopedia of measuring methods, but rather an engineering treatment of the subject. With certain reservations in mind, we agree. The subject is covered in sufficient detail, but the man who is looking for specific directions on how to make measurements will probably be disappointed. For this reason it is somewhat difficult to understand the reason for the book. Of course, anyone who wants to undertake high-frequency measurements presumably has at least a hazy idea of laboratory technique; Mr. Terman's book will help to clarify the idea, but in the end the prospective technician will probably be high and dry in so far as making the actual measurements is concerned.

We suspect that the book was written primarily for the benefit of the author's university classes. For this purpose the book should be of some value, but for the engineer it can serve best to "dress up" his book-shelf.

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RADIO MEDAL AWARDED G. A. CAMPBELL

THE INSTITUTE OF RADIO ENGINEERS has announced the award of its 1936 Medal of Honor to Dr. George A. Campbell for his contributions to the theory of electrical networks. Dr. Campbell, who recently retired from the Bell Telephone Laboratories in New York City, is the inventor of the electrical wave filter which has played an important part in the development of radio broadcasting and wire telephony.

The Medal will be presented to Dr. Campbell at the annual banquet of the Institute which will be held in Cleveland on May 12.

PRODUCTION LINE VENTILATION

By W. A. MURDOCH

The removal of unpleasant or unhealthy fumes, gases or dusts from various industrial operations often presents a difficult problem to manufacturers. More than that different industries have special problems of their own in this line, peculiar to their particular type of manufacturing.

A large Chicago radio set manufacturer was faced with the problem of removing resin dust and lead fumes present in soldering operations. In certain sections of the factory, where work was stationary, fume and gas removal was relatively a simple matter. But the assembly plant presented a number of difficult ventilating problems which took more than a year of experimentation to work out. However, after this experimental period the combined efforts of the plant engineer, local and state health officials, and a ventilating engineer all problems apparently have been solved.

The main assembly plant consists of five production lines. Set chassis move forward on intermittently moving belts in front of operators. There are 45 stations in each line and soldering is done at several of these. Because of the different size chassis passing through the assembly lines soldering is done at different points on different sizes of chassis. More than that, it is obvious that soldering is done at a point higher above the line on a large chassis than on a small one. In short, a ventilating system had to be devised which could remove resin dust and lead fumes from any one of the 45 stations in each of the five assembly lines and at the same time from points varying from six to eighteen inches above the line.

Another requirement of the system was that of economy. Production varies with the demands of the sales department. On some days all five assembly lines are in operation while on others perhaps only one is needed. This demanded of the system enough power to exhaust one line or all five, but so flexible that it might be partly shut down when two, three, or four lines were in operation.

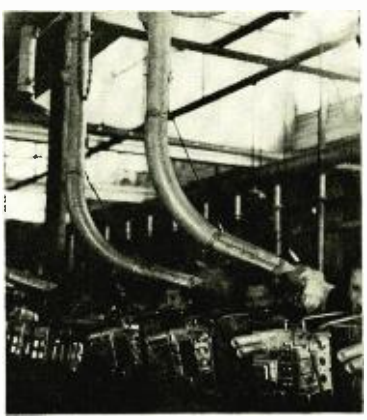
What was needed was something in the nature of a combination vacuum cleaner and a many tentacled octopus-like device whose arms could reach out to all parts of the assembly plant and draw off lead fumes and dust wherever soldering was being done. It must draw off fumes from a few points or many points as the production scheduled required. After several designs had been tested on a small scale, but under practical working conditions, the present system was decided upon.

As it now stands it consists of five main ducts, one above each of the assembly lines. At the middle of these are located two exhaust fans, one a 5 hp and the other a 7½ hp. The smaller can handle any two lines and the larger any three, while the two operating at once can handle all five lines. Through a system of dampers any combination of assembly lines can be exhausted of fumes.

Removing fumes from the soldering is accomplished by a separate pipe extending down from the main ducts—a separate pipe for every one of the 45 stations on each of the five production lines. The lower half of the pipe is slightly smaller than the upper and is adjustable with a sleeve arrangement, and held by a clamp once the operator has set its height above the table. Just above the assembly belt the pipe terminates in a flexible tube with a fan-shaped nozzle on the end. The operator can swing the nozzle to right or left to suit his convenience, but the effect is to gather in the fumes even though the nozzle is not directly above the chassis.

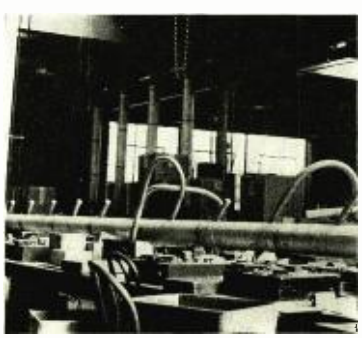
The system was designed to handle a maximum of 15 inlets on each assembly line at the same time. Those not in use are cut off by a damper or else the entire pipe is removed and the inlet to the main duct is capped. The system has now been in operation for about six months under all production conditions and has been fully approved by both state and local boards of health. From all appearances it has fulfilled all requirements and is so flexible as to be adaptable to any but the most radical changes in radio set manufacturing.

Removal of fumes from solder and glue pots.



Adjustable nozzles on assembly lines.

Fixed inlets for use where work is stationary.



PERMANENT MAGNET SPEAKERS

By IGOR B. SERGE*

SINCE the advent of the electro-dynamic loudspeaker, a great deal of research work has been done in an effort to find ways and means of producing a magnetic circuit using a permanent magnet which will be efficient and permanent enough to equal or better the electro-dynamic speakers of the same size.

It is conceded that the permanent magnet dynamic speaker is preferable for use in battery-operated sets. Heretofore an extremely heavy, inefficient, permanent magnet speaker has been used which required special reinforcement on panels. This speaker over a period of time showed a marked loss in efficiency. Magnetic type speakers have been used with some success, but these units were not generally satisfactory because of mechanical faults and inherently poor sound response characteristics.

* Continental Motors Corp., Detroit, Mich.

Field Considerations

Permanent magnet dynamic speakers produced to date have been handicapped by high production costs, lower sensitivity, and in many cases weight and size made them impracticable for numerous uses.

There is no advantage gained by using a weak field in the gap in the hope that the loss of signal strength would be compensated for by the use of a generous winding on the moving coil and the signal being increased with the output from several power tubes. The economy of design, which is a characteristic of today's radio receivers, excludes the possibility of inefficient sound reproducers. Also, if we increase the signal strength by using a larger power output, the performance of the loudspeaker cannot be uniform over entire frequency ranges due to excess inductance and limited current carrying capacity of the windings of the voice coil. The current consumed by the output stage in case of battery-operated receivers at the expense of the storage and dry-cell battery, is not a practical solution of the problem. In other words, the smallness of the gap and the large size of the coil necessarily imposes a limit beyond which one cannot go.

The development of Perm-O-Flux permanent magnet dynamic speakers by

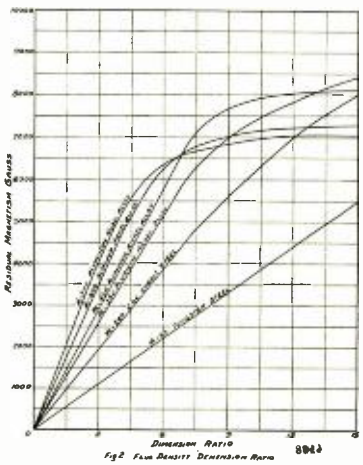


Fig. 2. Flux density dimension ratio.

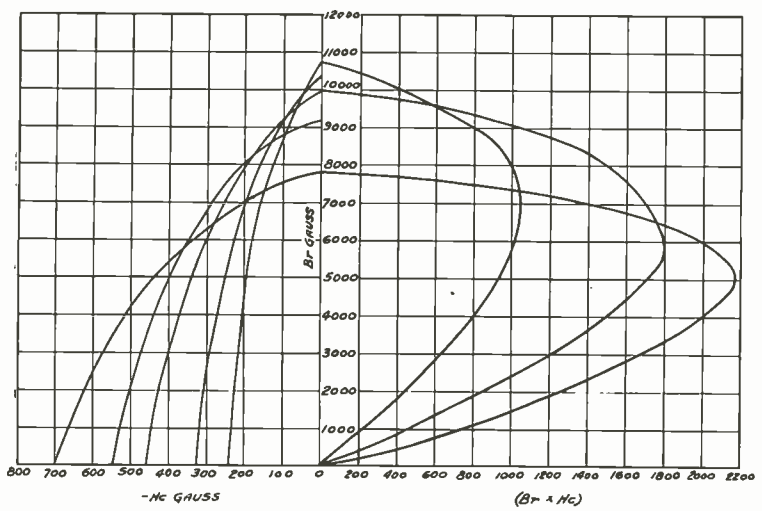


Fig. 1. Demagnetization and energy curves.

Continental Motors Corporation provides one solution of this problem. The solution was due to the development of a new magnetic material and the design of a novel magnetic circuit which allows economical use of this material.

Magnetic Alloys

This new magnetic alloy, which is composed of aluminum, nickel, cobalt and iron, has proved to be among the most powerful known to metallurgical science for commercial application and at the same time is practical for use in other applications. The use of this material in permanent magnet dynamic speakers has permitted lighter construction, using only a small portion of the magnetic material, permitting increased efficiency and superior tone quality.

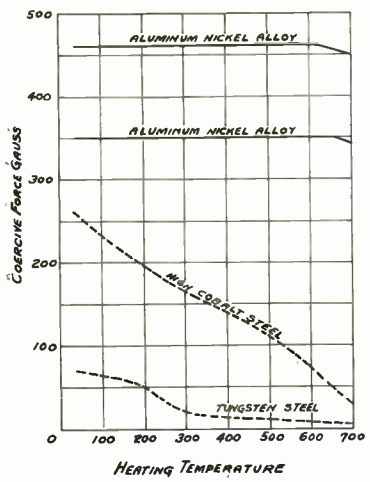


Fig. 5. Variation of coercive force by heating.

In the electro-dynamic type of speaker, a minimum flux density of 10,000 lines per square centimeter has been considered necessary for proper operation to meet present-day requirements of the trade. Flux density of the speakers being discussed varies from 10,000 to 14,000 lines per square centimeter.

Tungsten chromium and chromium tungsten steels have been widely acclaimed as high grade magnetic steels, but their coercive force (H_c) is small; its value is from 50 to 60 gauss. With the introduction of cobalt magnet steel, the value of the coercive force (H_c) was increased to 240 gauss.

Fig. 1 shows demagnetization and energy curves of magnet materials ranging from 250 to 700 gauss.

Increased values of coercive force (H_c) and residual magnetism (B_R) result in improved permanency and greater efficiency. Above all, the great coercive force is very important as it has a direct relation to the permanency of the magnet. The superiority of magnetic steel is generally compared with the energy product (B_R to H_c). It will be noted from Fig. 1 that the magnetic property of the steel can be widely varied by changing the proportions of nickel and aluminum and other elements forming the composition.

Fig. 2 shows the relation of the dimension ratio and residual magnetism for different types of magnetic material. The dimension ratio is represented by the ratio of length and diameter. This magnetic steel, having greater coercive forces (H_c), makes possible the use of smaller and lighter magnets.

The permanency of the new magnetic alloy is quite unusual due to the microstructure. This steel structure is stable and there is no magnetic variation even though the structure is subjected to temperatures up to approximately 600° C. It is noted that the magnet steels heretofore used are unstable and have a magnetic variation when subjected to higher temperatures as in the boiling water test. Ordinary magnet steel will lose some magnetization. Thereafter, the residual magnetism will gradually decrease.

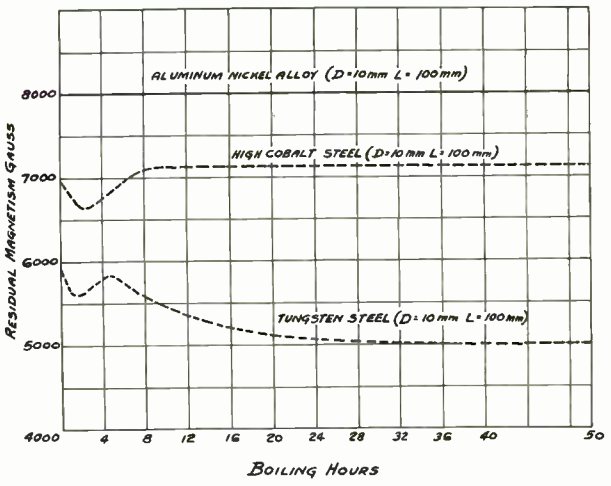


Fig. 3. Variation of residual magnetism in boiling water for fifty hours.

Fig. 3 shows comparative curves indicating variations of residual magnetism of various magnet steels.

This new permanent magnet alloy is not sensitive to mechanical vibration or impact.

Fig. 4 shows comparative curves indicating the variation in residual magnetism of various magnet steels when subjected to the falling test.

Fig. 5 shows curves indicating variation in residual magnetism (B_R) of various magnet steels when subjected to temperatures up to 700° C. It will be noted that the residual magnetism of the aluminum nickel alloy is not affected by temperatures up to approximately 600° C. Vibration tests conducted also indicate that this new magnet alloy is stable.

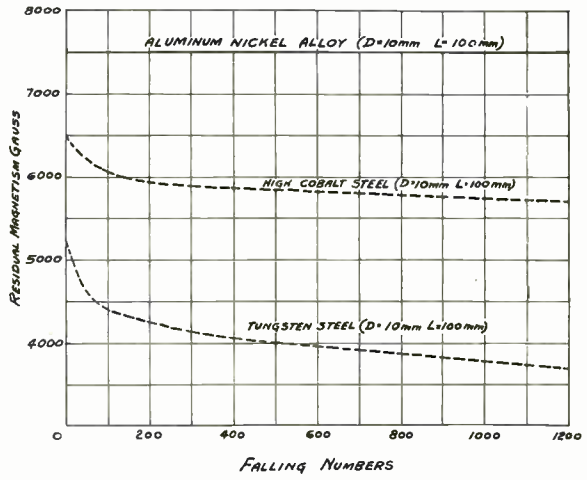


Fig. 4. Falling test.

Design . . NOTES AND

STROMBERG-CARLSON A-C, D-C RECEIVERS

IN THE PAST Stromberg-Carlson has provided certain of its models designed for operation on d-c circuits, but until this year no so-called a-c, d-c receiver has been produced. With the introduction of tubes especially designed for a-c, d-c service, it is now possible to design a receiver which will work interchangeably on a-c and d-c circuits and give a creditable performance.

There has been a steady call on the Stromberg-Carlson engineering department from metropolitan dealers to supply this combination a-c, d-c type of receiver, and one of the reasons for bringing out this instrument at the present time is that standard a-c type receivers were being converted for a-c, d-c operation by service men and usually without regard to the requirements set up by the Underwriters' Laboratories. The converted type of receiver obviously does not permit of obtaining the maximum efficiency which can be provided when a complete new design is undertaken. Thus, in addition to meeting Underwriters' Laboratories requirements in these receivers, it has been possible to obtain much better performance than is usually incorporated in the a-c, d-c types of instruments. For example, these receivers are designed with a radio-frequency amplifier stage operative on all-wave bands, insuring:

(a) Good signal-to-noise ratio.

(b) Freedom from cross-talk and "birdies" on broadcast reception.

(c) More reliable short-wave performance.

(d) Immunity from radiotelegraph code interference.

Also, by using a double-power rectifier system, separate supplies to the loudspeaker and to the radio set circuits, are provided. This gives higher voltages than would be available with the usual single rectifier system with consequent lower audio distortion for a given loudspeaker volume. In addition, the speaker field is provided with a generous power supply which serves further to minimize the audio distortion for a given speaker volume. Means also are provided for reducing the hum to a very minimum for a-c, d-c types of receivers.

Suitable illumination for the tuning dial, a difficult problem on a-c, d-c receivers, is obtained by using a separate branch circuit for this purpose, thereby doing away with flaring dial lights during the period when the receiver is warming up after being turned on. This arrangement also minimizes servicing difficulties.

From the standpoint of the dealer and purchaser this improved type of a-c, d-c receiver offers the following advantages:

1. It provides very good operating characteristics when connected to d-c power supply and in case the owner moves to an a-c territory or the d-c supply system is changed to an a-c supply system, the receiver is not made obsolete as is the case when a receiver is designed solely for d-c operation.

2. The receiver is designed to meet the exacting requirements of the Underwriters' Laboratories and, therefore, is built to meet safety and fire hazards which are usually not incorporateod in "unlisted" receivers.

3. The weight of the a-c, d-c receiver is slightly less than the straight a-c receiver for designs of similar performance. This is of advantage for portability in table type models.

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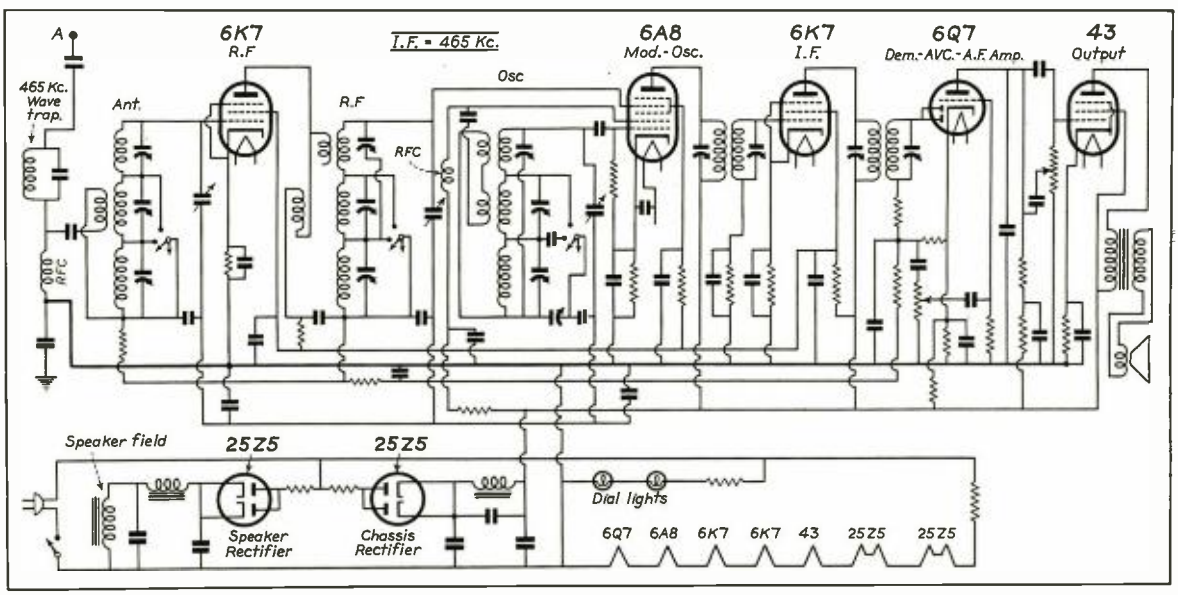
UNIQUE DESIGN FEATURES OF 6L6

RAYTHEON TYPE 6L6 is an all-metal power-amplifier tube of new design. It is intended for service in receivers of wide volume range and in power amplifiers where power output requirements are large. The design has made possible large output without loss of power sensitivity and with low distortion from third and higher order harmonics.

Type 6L6 is a tetrode. The arrangement of grids provides efficient suppressor action through compression of the electron stream into beams. The



Schematic Diagram of the Stromberg-Carlson AC-DC Receiver.

spread of these beams after leaving the screen-grid structure results in electron concentration at a position between screen and plate which would be occupied by a suppressor grid in the conventional pentode. The effect is normal suppression of secondary emission from the plate just as would be obtained with a suppressor grid.

The control-grid and screen-grid wires of the 6L6 are mounted so that they are directly in line or so that the screen-grid wires are in the shadow of the control-grid wires viewed from the cathode. This produces two effects which give the 6L6 its unusual characteristics. First, the current drawn by the screen is only a fraction of the current taken by the screen grid in an ordinary pentode. Second, the electrons passing from cathode to plate are compressed into beams, greatly increasing the total number of electrons available to the plate and producing the suppressor action mentioned above. In addition to special mounting of the grids, deflector plates parallel to the grid side rods restrict electron flow to the sectors on either side of the cathode where grid control is most effective.

In the design of the 6L6, second-harmonic distortion is made high in order to minimize third and higher order harmonics. Second harmonic distortion is eliminated in push-pull arrangements and can be reduced in single tube systems by generating out-of-phase second harmonic distortion in the preceding amplifier.

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PIEZO-ELECTRIC OSCILLOSCOPES

THREE OSCILLOSCOPE UNITS employing piezo-electric elements for the vibrating member have just appeared on the market. As is shown by the accompanying curves, two of the models are adapted to certain frequency ranges while the third is what might be called a high-fidelity type as it is said to exhibit a uniform response to 10,000 cycles.

The oscilloscope unit consists of a very thin, narrow, twister bimorph element (0.030" by 0.125") which is cemented in bakelite at one end; the other end is free to vibrate torsionally and to it is attached a small, plane mirror about ⅛" square. Leads are brought out through pins inserted in the bakelite base.

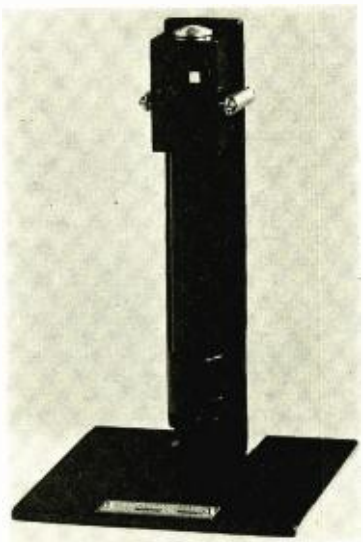
This element is enclosed in an oil-tight brass housing consisting of a length of tube surmounted by a head of square stock. A window in the head, sealed by a lens, affords access to the mirror. The lens is plano-convex and has a focal length of 10 inches. This enables the light from the mirror to be brought to a focus without any additional optical part. Lenses of different focal lengths or plane windows can be supplied if desired. The lens or window is tilted slightly downward so that any light reflected from its surface will not interfere with the light reflected from the mirror. The units are filled with oil which serves as a damping agent and also protects the crystal against physical shocks due to rough handling.

These oscilloscope units are voltage-operated devices of high impedance. They are designed to cover frequency ranges of 1,000, 5,000 and 10,000 cycles. Over the specified frequency range the response is essentially constant for a fixed impressed voltage.

The units are designed so that their lowest impedance in the frequency range covered is about 30,000 ohms so that when operated by an amplifier an ordinary general purpose triode may be used as a driver.

Type OS-1 has been designed to give uniform response to frequencies up to 1,000 cycles per second. The sensitivity of this instrument is of the order of 0.001 radian per peak volt, which will produce a bandwidth of two inches at ten inches radius for an applied alternating-current potential difference of 100 peak volts. Deflections are proportional to applied voltages and with this type unit 30 to 50 volts rms will generally produce sufficient response.

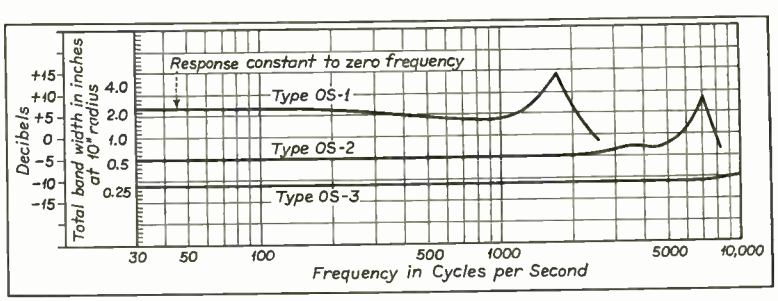
The sensitivity figure given is for an average room temperature. Temperature changes will cause variations in degree of sensitivity, but these deviations may be kept within 2 or 3 decibels over a wide range by inserting in series with the unit a capacity whose impedance is approximately equal to that of the crystal element. A 0.004 mfd condenser would be suitable for use with Type 0S-1. It must be kept in mind that this procedure will result in a lessened response per volt due to the voltage drop in the series condenser.



The Brush Crystal Oscilloscope.

Type 0S-2 may be used where the frequency range is to extend to 5,000 cycles per second. The bandwidth due to a fixed impressed voltage is essentially constant throughout the entire frequency range, and the sensitivity of this unit is approximately one quarter that of Type OS-1. A series capacity of 0.001-mfd will generally be found satisfactory for minimizing temperature variations.

Type OS-3 is designed for use in cases where high fidelity is the most important consideration involved. It gives a uniform bandwidth up to 10,000 cycles per second, and its sensitivity is about half that of the 0S-2.



Response Curves of the Three Oscilloscope Units.

RMA NEWS

RMA DIRECTORS MEET FOR TRADE COMMISSION HEARING

The RMA Board of Directors, under call issued by President Leslie F. Muter of Chicago, held a meeting at 3 p.m., Monday, April 6, at the Mayflower Hotel in Washington, D. C., to make arrangements for a public hearing ordered Tuesday, April 7, by the Federal Trade Commission on the proposed trade practice rules for the radio set manufacturing industry which has been submitted by the RMA.

The proposed trade practice agreement, which would apply to all set manufacturers but not to tube, parts or accessory makers, includes advertising and merchandising provisions regarded in the interests of the set industry and the purchasing public. The matter has been in negotiation with the Trade Commission since last July and the proposed trade practice agreement, which will not include any labor provisions, after final approval by the Commission will be submitted to all set manufacturing companies.

The RMA special committee in charge of the procedure before the Trade Commission consists of Mr. James M. Skinner of Philadelphia, chairman, and Messrs. James L. Schwank of Philadelphia, E. F. McDonald, Jr., and A. S. Wells of Chicago, and George A. Scoville of Rochester, N. Y.

In addition to the Trade Commission matter and other business, the RMA Board will fix a time and place for the Twelfth Annual Convention and membership meeting of the Association and annual election of officers.

The proposed trade practice rules for the radio set manufacturing industry as submitted to the Federal Trade Commission by the RMA follow:

Rule 1. (a) The making or causing or permitting to be made or published any false, untrue, or deceptive statement by way of advertisement or otherwise concerning the grade, quality, quantity, substance, character, nature, origin, size, or preparation of any product of the industry having the tendency and capacity to mislead or deceive purchasers or prospective purchasers, and the tendency to injuriously affect the business of competitors, is an unfair trade practice.

(b) The use of the term "Standard Broadcast" in description in advertising or otherwise of radio receiving sets, unless the "Standard Broadcast" sets so described and advertised in the American market shall cover a continuous spectrum of frequencies from 540 kilocycles to at least 1600 kilocycles, is an unfair trade practice. This definition and rule shall apply in the present state of the art, subject only to possible change or modification in the interest of the public and the industry.

(c) The use of the term "All Wave" in description in advertising or otherwise of radio receiving sets, unless the "All Wave" sets so described and advertised in the American market shall cover a continuous spectrum of frequencies from 540 kilocycles to at least 18,000 kilocycles (16.65 meters), is an unfair trade practice. This definition and rule shall apply in the present state of the art, subject only to possible future change or modification in the interest of the public and the industry.

(d) In the advertising and merchandising of all other radio receiving sets having less than continuous coverage from 540 kilocycles to 18,000 kilocycles, failure to detail specifically, either in kilocycle bands covered or in description of broadcast services covered by such receiving sets in accordance with below-detailed definitions recognized by the Federal Communications Commission, shall be an unfair trade practice.

These services represent the exact wavelengths referred to or continuous coverage between the two wavelengths noted.

All Wave	540 to 18000 kc.
Standard Broadcast (American, Standard or Domestic	540 to 1600
Nighttime Foreign: At least 2 of the following 3 bands...	6020 to 6140 9510 to 9590 11710 to 11890
Daytime Foreign: At least 2 of the following 3 bands...	11710 to 11880 15110 to 15330 17760 to 17800
Foreign (Unqualified) Must include nighttime and daytime as defined.	
State Police	1608 to 1712
Municipal Police	2308 to 2492
Police (Unqualified) Must include both State and Municipal as defined	
Night Aviation: At least 2 of the following bands	2612 to 2648 2732 to 2748 3082 4110 4785
Day Aviation: At least 2 of the following bands	5375 6510 to 6600 8015 16240
Aviation (Unqualified): Must include Night and Day Aviation as defined.	
Second-class Amateur	1800 to 2000
First-class Amateur, Night	3900 to 4000
First-class Amateur, Day	14150 to 14250
Amateur (Unqualified): Must include 2 of the above Amateur Bands.	

Rule 2. Commercial bribery is immoral, against public interest, and is an unfair trade practice.

Rule 3. The imitation of the trade marks, slogans, or other marks of identification of competitors, having the tendency and capacity to mislead or deceive purchasers or prospective purchasers and the tendency to injuriously affect the business of such competitors, is an unfair trade practice.

Rule 4. The false marking or branding of products of the industry, with the effect of misleading or deceiving purchasers with respect to the quantity, quality, size or measurements, grade or substance of the goods purchased, and the tendency to injuriously affect the business of competitors, is an unfair trade practice.

Rule 5. The use of a label, brand or trade name on a receiving set or cabinet which is similar, akin, or closely related to that of another manufacturer that tends to mislead or deceive purchasers or prospective purchasers of such radio sets is an unfair trade practice.

Rule 6. The distribution and sale of radio receiving sets from which the name plate, serial number, or other identifying mark of the original manufacturer has been altered, effaced or removed with the purpose and effect of deceiving purchasers or prospective purchasers, is an unfair trade practice.

REVISION OF STANDARDS

An Industry Conference of the RMA Safety Section under the chairmanship of Mr. L. F. Curtis and the representatives of the Underwriters' Laboratories was held on March 6. The following topics were discussed and agreements reached. This information was sent to RMA members in bulletin form for their use prior to the issuance of formal revision of the Standards by the Underwriters' Laboratories.

A letter from a radio manufacturer was read with an excerpt from a report by Consumers' Research commenting upon radio receivers which they had investigated. Apparently their contention is that the user of a radio set should not be able to come in contact with any live or current-carrying parts capable of delivering a current greater than 0.2 milliampere.

This led to a discussion of what limiting values should be given in the Laboratories' Standard for the capacity of line condensers, and the following values were agreed upon tentatively:

Not more than 0.25 microfarad from either side of the line to the chassis of an a-c, d-c receiver.

Not more than 0.1 microfarad from either side of the line to the antenna and/or ground connection in an a-c, d-c receiver.

Not more than 0.1 microfarad from either side of the line to the chassis, antenna, or ground connection in the case of an a-c receiver.

After a discussion of the subject of inclosure of motor windings, it was agreed to edit Paragraph 13 of the Standard to permit the omission of the inclosure mentioned in Paragraph 12 for motor windings and other coil windings which are not affected electrically (overloaded) by the failure of other parts.

After a discussion of permissible operating temperatures of electrolytic capacitors

it was agreed that not enough data were available to recommend any additions to the Standard. Accordingly, it was agreed that the Underwriters' Laboratories would continue with tests and that the RMA Safety Section would collect data from the manufacturers of electrolytic capacitors.

After a brief discussion of the subject of panel lights on receivers, it was agreed that live terminals of panel or pilot lamp receptacles shall be protected or fixed so that the possibility of grounding in use or in service is remote. This may not be the exact wording to be used in the Standard, but if any changes are made it will be only editorial. It is understood that such requirement will not be enforced until January 1, 1937.

The performance of connectors was considered and it was agreed that a separable connector in dynamic speaker circuit should be subjected to a number of cycles of make and break at full primary input voltage. By "separable" is meant a connector which is not held in place by a screw or clamp, and which would require the use of a tool in order to accomplish the separation. Ten cycles conducted within a period of one minute were considered to be sufficient in lieu of the 50 cycles proposed originally.

The statement of scope of the Standard on Power-Operated Radio Receiving Appliances will be clarified by the insertion of the following statement after Paragraph 1:

These requirements, in so far as they apply, cover features of non-commercial or domestic sound equipment similar to the features of radio appliances mentioned herein.

These proposed changes will be bulletined to the industry in the usual manner by the Underwriters' Laboratories, but in view of advance work on design of radio receivers it was felt that they should be brought to the attention of the members of RMA immediately.

LARGE FEBRUARY EXCISE TAXES

Collection in February, 1936, of the 5 percent radio and phonograph Federal excise taxes were $423,673.38, according to the latest official report of the U. S. Internal Revenue Bureau. This is an increase of 119 percent over the collections of $193,467.30 in February, 1935, and constitutes the largest monthly increase on record, but may be due in part to deferred accounts finally paid in February.

The excise tax collections on mechanical refrigerators for the month of February, 1936, were $572,594.87, as compared with $367,408.29 in February, 1935.

RADIO UNIONS MERGE

A merger of radio unions, combining the Electrical and Radio Workers Union and the National Radio and Allied Trades, was effected at a large meeting March 22 at Buffalo, according to current press reports. The new industrial union will be known as the Electrical and Radio Workers of America and will seek a charter from the American Federation of Labor which had been previously held by the National Radio and Allied Trades.

James B. Carey, young head of a Philadelphia local of the former National Radio and Allied Trades, was elected president of the new organization which announced an intensive membership campaign. Each of the merged unions claimed to have 16,000 active members. The new union will have headquarters in New York. Reported election of officers include the following vice-presidents: August Hein of Tonawanda, N. Y., Albert Newcomb of Philadelphia, Matthew Campbell of Springfield, Mass., Steve Rubicki of Newark, N. J., William Turnbull of Schenectady, N. Y., Walter K. Miller of Sandusky, Ohio, E. G. Bunting of Fort Wayne, Ind., William Jeager of Indianapolis, Ind., James Lewis of New York City and K. M. Kirkendall of Dayton, Ohio. The secretary and treasurer is Julius Emspak of Schenactady, N. Y.

JANUARY 1936 EXPORTS

Radio exports increased slightly in January, 1936, over those of January, 1935, but were somewhat smaller than last December, according to the latest report, for January, of the U. S. Department of Commerce, Bureau of Foreign and Domestic Commerce. Total exports in January, 1936, were $2,039,522, compared with $1,989,429 in January, 1935, and compared with $2,261,351 during the previous month of December, 1935.

There were 46,951 receiving sets, valued at $1,243,672 exported in January, 1936, compared with 43,898 sets valued at $1,172,129 during January, 1935.

Tube exports in January, 1936, were 491,354 units, valued at $227,822, compared with 481,668 units valued at $219,237 in January, 1935.

Exports of receiving set components in January, 1936, were $280,027, slightly less than the parts exports of $292,903 in January, 1935.

There were 12,382 loudspeakers valued at $29,801 exported in January, 1936, against 11,047 speakers valued at $25,522 in January, 1935.

Exports of other miscellaneous radio apparatus in January, 1936, were $35,037 compared with $33,371 in January, 1935, and transmitting apparatus worth $223,163 compared with $246,267 in January, 1935.

LABOR INDICES FOR DECEMBER 1935

In December, 1935, the usual seasonal decrease in radio factory employment occurred, according to the December report of the U. S. Department of Labor, Bureau of Labor Statistics. The decline in radio and phonograph factory employment was 15.3 percent and there was a seasonal decrease also of 20.1 percent in payrolls, but average hourly earnings increased slightly.

The national decrease in factory employment in December was 0.4 percent. Although radio factory employment dropped 15.3 percent in December compared with the previous month, it was 10.6 percent above December, 1934, and stood at 230 percent compared with the official three-year average of 1923-25. Despite the decrease of 20.1 percent in radio factory payrolls in December, 1935, they were 8.9 percent above December, 1934, and stood at 143.7 percent compared with the three-year average of 1923-25.

Average weekly earnings in radio factories in December, 1935, were $19.37, a decrease of 5.7 percent from the previous November, and 1.5 percent less than December, 1934. The average weekly earnings in all durable goods factories during December were $24.91.

Average hours worked per week in radio factories during December, 1935, were 35.3 hours, a decrease of 9.5 percent from November, 1935, but 1.1 percent above December, 1934. The average weekly hours for all durable goods factories was 40.1 hours.

Average hourly earnings of radio factory employees during December, 1935, were 55 cents, an increase of 4.4 percent over average hourly earnings in November, 1935, but 2.3 percent less than December, 1934. This compares with average hourly earnings of 57.1 cents for all manufacturing industries and 61.4 cents per hour for all durable goods manufacturers during December.

RMA SENDS TUBE DATA TO FRENCH GOVERNMENT

Official data regarding American manufacture of radio tubes, requested of RMA by the French Government Committee in charge of French tube imports, was forwarded from RMA headquarters on March 27. The confidential data was requested by the French Comite Interprofessionnel de l'Industrie Electrique which has jurisdiction over allocations of French import quotas. The French request to RMA came originally through the French Embassy to the U. S. and cooperation with the French Government was authorized at a recent meeting in New York City of the RMA Tube Division, of which B. G. Erskine of Emporium, Pa., is chairman.

RMA-SAE COMMITTEES ON AUTOMOBILE RADIO

The RMA and SAE Committees on Automotive Radio met in Detroit on March 13 under the chairmanship of J. H. Pressley of Philadelphia. The present standard on tuning range of automobile receivers (540 kc-1500 kc) was left unchanged for the present, but it was decided to review the subject again next fall. A sub-committee was appointed to consider methods of measurement of automobile receivers and to prepare a report for the next meeting of the committee during the fall.

A resolution was adopted condemning the use of the present commercial types of tuning indicators in automobile receiver installation. This action was taken on the basis that the use of such indicators causes distraction of the attention of the driver so as to be a serious menace to safety.

After a discussion of car antennas and loads on the electrical systems of cars, the meeting adjourned.

RMA JOINS ASTM

The Engineering Division of the RMA has taken the necessary steps to become a corporate member of the American Society for Testing Materials. The latter group has been requested by RMA to undertake the development of testing specifications for laminated phenolic materials. Naturally, it is desirable that RMA be officially represented and support such work. It is expected that this contact and membership in the ASTM will be useful in other matters in the future. Such activity is of direct benefit to RMA members and is one of the services rendered by the Engineering Division.

CANADIAN SALES

Canadian manufacturers in January, 1936, sold 10,475 sets with a list value of $1,020,725, according to a report to RMA through cooperation of the Canadian RMA. Of the January sales, 7,362 were a-c sets with a list value of $799,958; battery sets numbered 2,550 valued at $184,742, and automobile sets sold were 563 valued at $36,025.

Canadian manufacturers' sales in February were 12,021 sets with a list value of $1,082,327, including 10,041 kc sets with a list value of $945,099; battery sets numbering 978 valued at $77,269, and automobile units of 1,002 valued at $59,959.

(*Continued on page* 24)

News Of The Industry

JOINT I.R.E.-URSI MEETING

A joint meeting of the American Section of the International Scientific Radio Union and the Institute of Radio Engineers will be held on May 1, 1936. There will be two sessions at the building of the National Academy of Sciences, 2101 Constitution Ave., N.W., Washington, D. C., beginning at 10 a.m. and 2 p.m. Papers will be limited to fifteen minutes each to allow time for discussion.

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SEARS APPOINTED G-E RADIO FIELD SPECIALIST

E. W. Sears, who for fifteen years has been identified with advertising and sales promotion, has joined the General Electric Company's Detroit district office as a radio field specialist.

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PEMCO REPRESENTATIVE

The Porcelain Enamel and Manufacturing Company of Baltimore, Maryland, has recently appointed Harry Ingersoll to be their Pacific Coast representative. Mr. Ingersoll's residence is located at 4514 S. Van Ness Avenue, Los Angeles, California.

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DETROIT REX PRODUCTS FOLDER

A four-page folder just issued by Detroit Rex Products Co., 13002 Hillview Ave., Detroit, Mich., describes applications of "Triad" alkali cleaning compounds. It also points out production economies effected through the use of Detroit-Rex specialized cleaning service.

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REMOTE CONTROL BULLETIN

A bulletin describing a line of remote controls for auto radio has been made available by the Crowe Name Plate & Manufacturing Co., 1749 Grace St., Chicago, Ill.

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OPERADIO CATALOG

A new catalog, No. 10, has been published by the Operadio Manufacturing Co., St. Charles, Ill. Public-address equipment and replacement speakers are listed.

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AIR EXPRESS GAINS 57 PERCENT IN FEBRUARY SHIPMENTS

There was 57% gain in Air Express shipments for February, 1936, over February, 1935, while in poundage shipments of Railway Express showed an enormous increase. The month marked the beginning of the expanded service made possible by the consolidation of 23 domestic airlines with the Air Express Division of Railway Express Agency, and by special arrangement with Pan American Airways. Today, directly or indirectly, every city and town in both Americas is served.

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SALES REACHING UPWARD FROM HIGH OF 1935

While the radio industry doubtless had the best year in its history in 1935, the insatiable demand for its products has headed both production and distribution toward new peaks in 1936. Retailers in practically all parts of the country have been encouraged by the progress thus far this year and in some quarters wholesale houses expect to double their 1935 volume. All of the stimulants necessary for broadening distribution, will be provided by the Presidential election, the payment of the bonus, the Olympic games, and the growing need for highly-perfected radio receivers.

Practically all makers have commented upon the increase in radio consciousness on the part of the general public. Metal tubes and the short-wave reception facilities of the modern instrument have engendered more avid interest, as overseas programs, including speakers of eminence, could be enjoyed. The absence of excess stocks has lessened unfair competition, and the more stable price level has allowed a reasonable profit to be realized by all divisions, according to a survey of the radio industry, which has just been completed by Dun & Broadstreet, Inc.

After turning out the largest number of sets in 1935 in the history of the radio industry, manufacturers have set schedules ahead to eclipse that record in 1936. In some divisions, operations were 15 to 20 percent more than in January and February a year ago, with further advances planned for the second quarter. Most of the output has consisted of consoles in the medium and higher priced ranges, in both short and combination wavelengths. Stocks are being accumulated, wherever possible, in order to avoid the delivery delays which curtailed sales last fall.

In spite of the new record that was made in sales of radio sets in 1935, distribution thus far this year has been at a constantly-widening rate. While percentage gains in 1936 are expected to be smaller than those set down for 1935, sales in January were 15 to 20 percent larger than a year earlier, and in February 25 to 30 percent. Demand has been stimulated by the introduction of metal tubes, the better broadcast entertainment, and the general desire to replace obsolete sets with modern all-wave units.

Fully 75 percent of the sales made were in all-wave or combination long- and short-wave sets. Demand has held closely to the national-advertised receivers, with but small interest accorded the off-brand units. Replacements in some districts have run as high as 50 percent of the total sales, with a marked increase in the number of purchases for cash. About 60 percent of the all-wave floor models sold were to families that had been using a table set for three years or more.

The shift to the more expensive larger sets with quality performance, which started last summer, has become increasingly evident. While some of these sales have involved trade-ins, consoles ranging from $125 to $350 have accounted for as much as 40 percent of the sales thus far this year.

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BRITISH GOVERNMENT PROVIDES TESTS FOR SPEAKERS

The results of a test by the National Physical Laboratory, London, made on the Magnavox speaker, are shown in the latest catalog of the manufacturer, The Benjamin Electric Ltd., Tariff Road, Tottenham, London, N. 17, England. The catalog also lists filters, transformers, and other parts.

BALLAST TUBE ARTICLE

In response to many inquiries, we take pleasure in announcing that the article entitled "Ballast Tubes," which appeared on page 10 of our March issue, was prepared by George Mucher and the engineering staff of the Clarostat Manufacturing Co., 285 North Sixth St., Brooklyn. N. Y.

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WHOLESALE RADIO CATALOG

A new 64-page catalog featuring a large assortment of radio receivers, public-address amplifiers and systems, radio service replacement parts, electrical appliances and electrical refrigerators, has been brought out by Wholesale Radio Service Co., Inc., of New York. Copies are obtainable from Wholesale Radio's main office at 100 Sixth Avenue, New York City, or from any of the company's branches.

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ARCTURUS TUBE CHART

The Arcturus Radio Tube Company, Newark, N. J., just published and released to its distributors a complete broadcast receiving tube list. Every tube is identified by showing filament voltage, filament current, whether filamentary or cathode type, description and number of useful elements.

The chart is made up in a 10-page booklet, letterhead size to fit into a standard binder. The addition of new tube types has been anticipated for years to come, and space is provided in the chart so that such new tubes readily can be entered in proper numerical order. Periodic notices of additions and changes to the chart will be sent automatically to subscribers whose names will be registered with the main office.

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GOAT APPOINTEE

Goat Radio Tube Parts, Inc., Brooklyn, New York, manufacturers of tube parts and form-fitting tube shields, announce the appointment of Clarence B. Place to their sales department.

Mr. Place, who has been actively engaged in radio for the past ten years, and who was last connected with the International Resistance Corporation, will handle the sale of tube parts to the receiving tube manufacturers as well as to the rapidly growing number of manufacturers of special electronic devices.

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CALLITE APPOINTMENTS

Announcement is made by Callite Products Company, 549 39th St., Union City, N. J., of the appointment of Dr. C. S. Brainin as manager of its newly formed department for the manufacture of a complete line of "Calliflex" Thermostatic Bimetals. Callite also reports the appointment of Mr. Mark Lincoln as factory superintendent of all bimetal production.

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AERIAL NEWS ISSUED

Copies of a folder, Aerial News, describing various automobile antenna systems manufactured by Ward Products Corp., 2135 Superior Ave., Cleveland, Ohio, may be obtained by writing to the company at that address.

SHERWIN-WILLIAMS ISSUES SAVE-LITE CATALOG

Prepared with the cooperation of the Better Vision Institute and Better Light-Better Sight Council, the new Sherwin-Williams Save-Lite Catalog is a factual presentation of painting as a part of lighting and "plant conditioning." In a concise manner it tells what a wall and ceiling paint should be, and its importance as an aid to better and more economical production as well as for beauty and protection.

Other interesting features of the new Sherwin-Williams Catalog are the inclusion of illustrated laboratory studies and various industrial applications—including before and after Sight-Meter readings. Case histories, simple charts on lighting standards and plant interior paint uses and applications constitute reference information of interest and value to all plant operators.

By writing the Sherwin-Williams Company, Cleveland, Ohio, copies of this catalog will be forwarded free of charge to all plant men and consultants interested.

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W. R. S. CO. APPOINTMENTS

Wholesale Radio Service Co., Inc., 100 Sixth Avenue, New York, N. Y., announces the following additions to its forces:

Wilson N. Durham, in the capacity of manager of public-address sales for the metropolitan New York area.

Aaron Nadell, author of several standard textbooks on public-address and sound motion-picture technique, as special engineering consultant and correspondent on p-a. problems.

Leonard Fischer, as design engineer in the high-frequency development laboratory.

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KOVAR METAL

Additional information on Kovar Metal, described in the article, "Advances in Metal-Glass Seals," in our March number, may be obtained from the Stupakoff Laboratories, Inc., 6629 Hamilton Ave., Pittsburgh, Pa. Mr. H. S. Stupakoff is the author of the article.

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WARD LEONARD BULLETINS

The following bulletins have been received from the Ward Leonard Electric Co., Mount Vernon, N. Y.: Bulletin 68 covers motor field rheostats of the enclosed type; bulletin 1105, the Vitrohm ring type rheostat; bulletin 5701 an a-c to a-c constant voltage load regulator; bulletins 8602, 8603, 8851 are on controlled rectifiers. Copies may be obtained from the company at the address given.

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RCA ELECTS DIRECTORS

At the Annual Meeting of Stockholders of the Radio Corporation of America held April 7, the following directors were re-elected for a term of three years: Newton D. Baker, Cornelius N. Bliss, Bertram Cutler, James G. Harbord.

The other directors of the corporation are: Arthur E. Braun, John Hays Hammond, Jr., Edward W. Harden, De Witt Millhauser, Edward J. Nally, David Sarnoff, James R. Sheffield, Frederick Strauss.

YARDSTICKS

Yardsticks, a 2-color folder issued by the Ohio Carbon Co., 12508 Berea Rd., Lakewood, Ohio, gives specifications, etc., of Ohio resistors. Test data indicating resistance to deterioration due to humidity, temperature variations, aging, etc.

Two new information sheets giving interesting test-data, dimensions, prices and hookups for the Ohiohm series of automobile-radio interference suppressors manufactured by this company are now available on request. A considerable improvement has been made in the construction of those RB suppressor brushes; this improvement being in the enclosing of the brush itself in a "pressed fit" laminated bakelite tube. The overall outside diameter of the tube is exactly the same as that of the original brush replaced; thus facilitating the change-over. This improved type is known as Model 2-RB, and is designed for use in the new Ford V-8 combined coil distributor unit. The test-data given indicate that the suppressors of this series will stand up for long periods under unusually severe operating conditions of heat and moisture.

Copies may be obtained from the manufacturer.

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"TREATISE ON ELECTROLYTIC CONDENSERS"

A very interesting and valuable 58-page "Treatise on Electrolytic Condensers" has just been made available. This treatise, which was written by Paul MacKnight Deeley, Chief Engineer, Electrolytic Division, Cornell-Dubilier Corporation of New York City, should be of interest to engineers in general and to those who use electrolytic capacitors.

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TRANSFORMER BULLETIN

Bulletin 1002 on "Transformers for Audio Amplification and Transmission" has just been issued by The American Transformer Company, 178 Emmet Street, Newark, New Jersey. This 32-page booklet contains a great deal of technical information.

VACUUM TUBES AND TELEPHONE CONVERSATIONS

When President Walter S. Gifford of the American Telephone and Telegraph Company and T. G. Miller, Head of that company's Long Lines Department, made history a few months ago by talking around the world to each other by telephone, the vacuum tube played an important part in the conversation. How important, a few figures will make clear.

The two men were in adjoining offices, scarcely 50 feet apart, as Mr. Gifford's voice traveled west and reached Mr. Miller's ear from the east, while the latter's words journeyed in the opposite direction and arrived from the west. In each round-the-world circuit, 490 vacuum tubes were employed, a total of 980 for the two-way conversation.

Many of the vacuum tubes were in telephone repeaters along the wire lines stretching between New York and San Francisco. Still others were in radio-telephone transmitters and receivers which sent the electric waves across vast distances of ocean and received the enfeebled radiations after their long voyages. About 85 percent of the distance around the world was covered by the radiotelephone links, the remaining 15 percent being in telephone wires.

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GARDINER ACQUIRES MONARCH METAL CO.

The Gardiner Metal Company, Chicago, Illinois, well known manufacturer of Flux-Filled Solders, Babbitts and White Metal Alloys, announces that it has taken over the manufacture and exclusive selling rights of Monarch Ball Metal, called "The Steel Process Babbitt." This patented metal was formerly made by the Monarch Metal Company, Chicago. As in the past the product will be sold through jobbers exclusively.

A. W. Hoffman, 2540 Derbyshire Road, Cleveland, Ohio, has been assigned to cover the western parts of New York and Pennsylvania, while the H. E. Russell Sales Co., Iola, Kansas, will cover the state of Kansas as sales representatives for this company.

RMA NEWS

(*Continued from page* 21)

REPORT OF SUB-COMMITTEE ON ULTRA HIGH FREQUENCY BROADCASTING

At a meeting of the subject Sub-committe held at the Hotel New Yorker on January 16th, the following points were agreed to as the consensus of opinion of those present:

1. It is felt to be highly desirable that the use of the ultra high frequency band between 42 and 86 megacycles be restricted to use for visual or audio-visual transmissions.

2. In view of the present incomplete general knowledge of the possibilities of the ultra high frequency bands for various types of transmissions, continuation of the policy of the Federal Communications Commission with regard to further experimentation in sound broadcasting transmissions in the ultra high frequency spectrum outside of the 42 and 86 megacycle band is felt to be desirable.

3. For the information of the manufacturers of radio receiving sets, the frequencies and bands available at the present time for experimental audio transmissions in the ultra high frequency spectrum are outlined below:

25,600 to 26,600 kc.

This is a band allocated internationally at the Madrid Conference for commercial sound broadcasting. As far as is known, no stations have been allocated to this band so far in the United States.

One possible reason for the lack of application for these bands up to the present time is probably the present sun spot cycle and the fact that if used for long distance transmissions they would be practical only for a short time in the daylight period in the summertime. This would not prevent the band from being useful for local broadcasting however.

The following single frequencies are also available:

31,600 kc.
35,600 kc.
38,600 kc.
41,000 kc.

It is understood that more than thirty stations in this country have been licensed to broadcast sound programs experimentally on these frequencies.

NEW PRODUCTS

VIBRATION PICKUP

A vibration pickup, by means of which any mechanical motion or vibration may be converted into electrical currents of

identical characteristics, has been announced by the RCA Manufacturing Co., Camden, N. J. The output of this device is said to be sufficiently high to permit its direct connection to the input circuits of a cathode-ray oscillograph.

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D-C, A-C INVERTERS

The American Television & Radio Company of St. Paul, Minn., in presenting their new 1936 line of ATR d-c, a-c inverters announces the following features: interference-free all-wave radio operation, long-life vibrators, and four-point voltage regulators.

ATR d-c, a-c inverters are manufactured in sixteen different types, each equipped with or without built-in filter and are used on d-c input voltages ranging from 6 to 220 volts d-c and supply a-c output voltages of both 110 and 220 volts for the operation of standard 110 and 220 volts a-c radios, public-address systems, electrical testing equipment and appliances.

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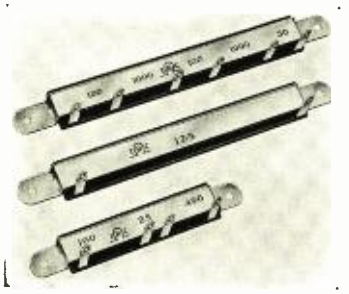
LEVEL INDICATOR

A new sound level indicator has been announced by the Industrial Apparatus Co., of 720 N. Wabash Ave.. Chicago, Ill.

The model 300 Sound Level Indicator consists of a calibrated crystal type microphone, an audio-frequency amplifier with the new all-metal tubes, a calibrated attenuator, an ear weighing network, a decibel meter and a crystal type headset. The range is from thirty to ninety decibels A.S.A. standard. Although designed for a-c operation, batteries may be used.



IRC ANNOUNCES HEAVY-DUTY INSULATED RESISTOR

The type "MW" resistor, just announced by the International Resistance Company, Philadelphia, Pa., is wound of flat strip enclosed in a phenol compound casing capable of withstanding temperatures of 170° C. It is said that prolonged overloads of 150 percent can be sustained. The insulation is rated at 1,000 volts (rms, 60 cycle).

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CABINET STRIPER

A striping device which is said to find applications in cabinet manufacture, has been announced by the Lewis Manufacturing Co., Decatur, Ill.

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FERRANTI TRANSFORMERS

Ferranti Electric, Inc., 130 West 42nd Street, New York, N. Y., announces a complete line of High-Fidelity Audio Transformers and Reactors to be known as Super High Fidelity—Series A.

The transformers are said to have a response, from 30 to 12,000 cycles, which is flat within 1 db. The transformers are furnished in reversible cases; they are self-shielding.

A four-page folder describing this line may be obtained by writing to the manufacturer.

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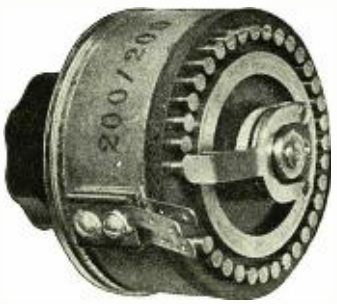
TECH ATTENUATOR

A new attenuator of improved design is announced by the Tech Laboratories, 703 Newark Avenue, Jersey City, N. J. This new unit is said to be especially designed for broadcast and high grade sound recording purposes. It has a larger number of steps, lower noise level, better frequency characteristics, better terminals, easier wiring and smoother operation.



CONTROL WHEEL

A molded bakelite control wheel for transmitters and laboratory equipment has been made available by the Coto-Coil Company, Inc., 2 Broadway, New York, N. Y.

As shown in the illustration, a dial scale may be used with the wheel, eight dial phases being available.

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ARCTURUS ADDS TWO TYPES

To the thirteen types of Coronet Metal Tubes for replacing glass types, the Arcturus Radio Tube Company, Newark, N. J., has added the types 25A6 Coronet and 25Z6 Coronet. These replace the types 43 and 25Z5, respectively.

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AUDAX CUTTING HEAD

The Model 7B cutting head for instantaneous recording is the latest addition to various other models manufacured by the Audak Company, 500-S Fifth Avenue, New York, N. Y.

RADIO ENGINEERING BUYER's GUIDE

A continuous, indexed recording of the reliable sources of supply of

Materials—Component Parts

ALLOYS, RESISTANCE

AMERICAN ELECTRO METAL CORP., Lewiston, Maine
CALLITE PRODUCTS CO., 542 39th St., Union City, N. J.
Cleveland Wire Cloth & Mfg. Co.
Driver Company, Wilbur B.
Driver-Harris Company
Fansteel Metallurgical Labs.
Hoskins Mfg. Co.
Jelliffe Company, C. O.
Prentiss & Company, Geo.
NEWARK WIRE CLOTH CO., Newark, N. J.

ARRESTORS, LIGHTNING

Birnbach Radio Corp.
Knox Porcelain Co.
Johnson, E. F., Co.

BASES, VACUUM TUBE

AMERICAN LAVA CORP., Chattanooga, Tenn.
American Phenolic Corp.
American Record Corp.
ISOLANTITE, INC., 233 Broadway, N. Y. C.
Kurz-Kasch Co.
RCA MFG. COMPANY, INC., Camden, N. J.
Westinghouse Lamp Co.

BINDING POSTS

BANKS INTER-AIR PRODS., Woodside, N. Y.
Eby, H. H., & Co.

BRASS—COPPER

AMERICAN BRASS CO., THE, Waterbury, Conn.
ANACONDA COPPER CO., 25 Broadway, N. Y. C.
Baltimore Brass Co.
Bristol Brass Corp.
Ryerson & Son, Inc.
Scoville Mfg. Co.
WATERBURY BRASS GOODS BR., Waterbury, Conn.

CABINETS—WOOD

Adler Mfg. Co.
Alden Corp.
EXCEL WOODCRAFT CORP., THE, Columbus Rd. at Leonard St., Cleveland, Ohio
Peerless Cabinet Co.
Superior Cabinet Corp.

CATHODES (See Tubing, Seamless Cathode)

CATHODE RAY—TUBES

DUMONT LABORATORIES, ALLEN B., 542 Valley Rd., Upper Montclair, N. J.
General Electric Co.
HYGRADE-SYLVANIA CORP., Clifton, N. J.
RCA MANUFACTURING CO., INC., Camden, N. J.
WESTERN ELEC. CO., 195 Broadway, N. Y. C.
Westinghouse Elec. & Mfg. Co.

CATHODE RAY—OSCILLOGRAPHS

CLOUGH-BRENGLE CO., 1134 W. Austin St., Chicago, Ill.
DUMONT LABORATORIES, ALLEN B., 542 Valley Rd., Upper Montclair, N. J.
RCA MANUFACTURING CO., INC., Camden, N. J.
WESTERN ELEC. CO., 195 Broadway, N. Y. C.

CERAMICS

AMERICAN LAVA CORP., Chattanooga, Tenn.
American Phenolic Corp.
Colonial Insulator Co.
Crowley & Co., Henry L.
Dielectric Products Co.
ISOLANTITE, INC., 233 Broadway, N. Y. C.
Kirchberger & Co., Inc., M.
Mycalex Corp. of Amer.
STUPAKOFF LABORATORIES, INC., 6627 Hamilton Ave., Pittsburgh, Pa.

CHOKES

ACME ELECTRIC & MFG. CO., 1440 Hamilton Ave., Cleveland, Ohio
AMERICAN TRANSFORMER CO., 175 Emmet St., Newark, N. J.
General Transformer Co.
HAMMARLUND MFG. CO., 424 W. 33rd St., N. Y. C.
Kenyon Transformer Co., Inc.
UNITED TRANSFORMER CORP., 72-74 Spring St., N. Y. C.

COIL MACHINERY

UNIVERSAL WIND CO., Providence, Rhode Island

COILS—POWER

ANACONDA WIRE & CABLE CO., Muskegon, Mich.
ACME WIRE COMPANY, 1255 Dixwell Avenue, New Haven, Conn.
American Enameled Magnet Wire Co.
Belden Manufacturing Co.
COTO-COIL CO., INC., Providence, Rhode Island
GENERAL ELECTRIC COMPANY, Schenectady, N. Y.
Roebling's Sons, John
Westinghouse Elec. & Mfg. Co.

COILS—RADIO RECEIVER

ALADDIN RADIO INDUSTRIES, INC., 466 W. Superior St., Chicago, Ill.
ALDEN MANUFACTURING CO., Brockton, Mass.
Automatic Winding Co.
COTO-COIL CO., INC., Providence, Rhode Island
ELECTRICAL WINDING CORP., 22-26 Wooster St., N. Y. C.
General Mfg. Co.
GUTHMAN & CO., INC., Edwin I., 1306 W. Van Buren St., Chicago, Ill.
HAMMARLUND MFG. CO., 424 W. 33rd St., N. Y. C.
Meissner Mfg. Co.
National Company
Sickles Company

COILS—SPEAKER

ACME ELECTRIC & MFG. CO., 1440 Hamilton Ave., Cleveland, Ohio
AMERICAN TRANSFORMER CO., 175 Emmet St., Newark, N. J.
ANACONDA WIRE & CABLE CO., Muskegon, Mich.
Chicago Transformer Corp.
Dongan Electric Mfg. Co.
GENERAL TRANSFORMER CORP., 500 S. Throop St., Chicago, Ill.
Halldorson Company
JEFFERSON ELECTRIC COMPANY, Bellwood, Ill.
Kenyon Trans Co., Inc.
RCA MANUFACTURING CO., INC., Camden, N. J.
STANDARD TRANSFORMER CORP., 854 Blackhawk Street, Chicago, Ill.
Thordarson Elec. Mfg. Co.
UNITED TRANSFORMER CORP., 72-78 Spring St., N. Y. C.

CONDENSERS, FIXED PAPER

ACME WIRE COMPANY, 1255 Dixwell Ave., New Haven, Conn.
AEROVOX CORP., 90 Washington St., Brooklyn, N. Y.
CORNELL-DUBILIER CORP., 4388 Bronx Blvd., N. Y. C.
CURTIS CONDS. CORP., 3088 W. 106th St., Cleve., O.
ELECTRONIC LABORATORIES, INC., Indianapolis, Ind.
Flechtheim & Co., A. M.
Girard-Hopkins, Inc.
Magnavox Co., Ltd.
MALLORY & CO., P. R., Indianapolis, Indiana
Micamold Radio Corp.
Polymet Mfg. Co., Inc.
SOLAR MFG. CORP., 599-601 Broadway, N. Y. C.
Sprague Specialties Co.
TOBE-DEUTSCHMANN CORP., Canton, Mass.

CONDENSERS, FIXED ELECTROLYTIC

AEROVOX CORP., 90 Washington St., Brooklyn, N. Y.
Condenser Corp. of America
CORNELL-DUBILIER CORP., 4388 Bronx Blvd., N. Y. C.
CURTIS CONDENSER CORP., 3088 W. 106th St., Cleveland, Ohio
Magnavox Co., Ltd.
MALLORY & CO., P. R., Indianapolis, Indiana
Micamold Radio Corp.
Polymet Mfg. Co., Inc.
SOLAR MFG. CORP., 599-601 Broadway, N. Y. C.
Sprague Specialties Co.

CONDENSERS, ADJUSTABLE

DeJur-Amsco Corp.
HAMMARLUND MFG. CO., 424 W. 33rd St., N. Y. C.
Meissner Mfg. Co.
SOLAR MFG. CORP., 599-601 Broadway, N. Y. C.
TOBE-DEUTSCHMANN CORP., Canton, Mass.

CONDENSERS, VARIABLE

CARDWELL MFG. CO., ALLEN B., 81 Prospect St., Brooklyn, N. Y.
DeJur-Amsco Corp.
General Instrument Co.
GENERAL RADIO CO., 30 State St., Cambridge, Mass.
HAMMARLUND MFG. CO., 424 W. 33rd St., N. Y. C.
OAK MFG. CO., 711 W. Lake Street, Chicago, Ill.
Precise Mfg. Co.
Radio Condenser Co.
Reliance Die & Stamping Co.

CONTACTS, METAL

Baker & Co., Inc.
CALLITE PRODUCTS DIV., 542 39th St., Union City, N. J.
General Plate Co.
General Tungsten Mfg. Co.
MALLORY & CO., P. R., Indianapolis, Indiana
Wilson Co., H. A.

CORES, RESISTANCE COIL

AMERICAN LAVA CORP., Chattanooga, Tenn.
Colonial Insulator Co.
ISOLANTITE, INC., 233 Broadway, N. Y. C.
Steward Mfg. Co.

CORES, TRANSFORMER

THOMAS & SKINNER STEEL PRODS. CO., 1100-1120 E. 23rd St., Indianapolis, Indiana

CRYSTALS, QUARTZ and ROCHELLE SALT

BLILEY ELECTRIC CO., 237 Union Station Bldg., Erie, Pa.
Boonton Research Labs.
PREMIER CRYSTAL LAB., 55 Park Row, N. Y.
RCA MANUFACTURING CO., INC., Camden, N. J.
BRUSH DEVELOPMENT CO., E. 40th St. & Perkins Ave., Cleveland, Ohio
SCIENTIFIC RADIO SERVICE, University Pk., Hyattsville, Md.

DIALS, ESCUTCHEONS

Crowe Nameplate Co.
KAY PRODUCTS OF AMER., INC., 560 DeKalb Ave., Brooklyn, N. Y.
Magnavox Company, The

DIAPHRAGMS, SPEAKER

Hawley Products Co.
Masland Mfg. Corp.
UNITED PRESSED PRODUCTS CO., 407 S. Aberdeen St., Chicago, Ill.

ELECTRODES, NEON

EISLER ELECTRIC CORP., Union City, N. J.
EISLER ENGINEERING CO., INC., 747 So. 13th St., Newark, N. J.
SWEDISH IRON & STEEL CORP., 17 Battery Pl., N. Y. C.

EYELETS

Platt Bros. & Co.
STUPAKOFF LABS., INC., 6627 Hamilton Ave., Pgh., Pa.
United Shoe Mach. Co.
WATERBURY BRASS GOODS BR., Waterbury, Conn.

FIBRE, PHENOL and VULCANIZED

Bakelite Corp.
Brandywine Fibre Products Co.
Continental-Diamond Fibre Co.
Formica Insulation Co.
Franklin Fibre-Lamitex Corp.
General Electric Co.
National Vulcanized Fibre Co.
Resinox Corporation
SYNTHANE CORPORATION, Oaks, Penna.
Westinghouse Elec. & Mfg. Co.
Wilmington Fibre Co.

FLEXIBLE SHAFTING

Fischer Spring Company, Chas.
White Dental Mfg. Co., S. S.

FUSES

LITTELFUSE LABS., 4238 Lincoln Ave., Chicago, Ill.

GENERATORS

CARTER MOTOR COMPANY, 373 W. Superior St., Chicago.
ELECTRONIC LABORATORIES, INC., 122 W. New York St., Indianapolis, Ind.
MALLORY & CO., P. R., Indianapolis, Indiana
ONAN & SONS, D. W., Minneapolis, Minn.
PIONEER GENE-MOTOR CORP., 466 W. Superior St., Chicago, Ill.

GETTERS (See Nickel Tube Parts)

GRAPHITE

ACHESON COLLOIDS CORP., Port Huron, Mich.

HORNS

ATLAS SOUND CORP., 1449—39th St., B'klyn, N. Y.
FOX SOUND EQUIP. CORP., 3120 Monroe St., Toledo, Ohio
HOPE MFG. CO., 401 Broadway, N. Y. C.
RACON ELEC. MFG. CO., 52 E. 19th St., N. Y. C.
WRIGHT-DECOSTER, INC., 2258 University Ave., St. Paul, Minn.

INSTRUMENTS (See Meters or Cathode Ray)

INSULATION, BEADS

AMERICAN LAVA CORP., Chattanooga, Tenn.
ISOLANTITE, INC., 233 Broadway, N. Y. C.
Kirchberger & Co., Inc., M.
Steward Mfg. Co.
STUPAKOFF LABORATORIES, INC., 6627 Hamilton Ave., Pitts. Pa.

INSULATION, CERAMICS (See Ceramics)

INSULATION COMPOUNDS

Candy & Co., Inc.
Dolph Co., John C.
Glenn & Co., J. J.
Mica Insulator Co.
STUPAKOFF LABS., INC., 6627 Hamilton Ave., Pgh., Pa.
ZOPHAR MILLS, INC., Court, Lorraine and Creamer St., Brooklyn, N. Y.

INSULATION, LAMINATED BAKELITE

Franklin Fibre-Lamitex Corp.
SYNTHANE CORPORATION, Oaks, Penna.

INSULATION, MOLDED

American Insulator Corp.
AMERICAN LAVA CORP., Chattanooga, Tenn.
American Phenolic Corp.
American Record Corp.
Chicago Molded Prods. Corp.
Formica Insulation Co.
Kurz-Kasch Co.
Macallen Co.
STUPAKOFF LABS., INC., 6627 Hamilton Ave., Pgh., Pa.

INSULATION, FABRIC TUBING

BENTLEY HARRIS MFG. CO., Conshohocken, Pa.
BRAND & CO., WM., 276 Fourth Ave., N. Y. C.
Glenn & Co., J. J.
Mica Insulator Co.

IRON, SWEDISH (Tube Parts)

SWEDISH IRON & STEEL CORP., 17 Battery Pl., N. Y. C.

LACQUER, PAINT, VARNISH

ACME WIRE COMPANY, 1255 Dixwell Ave., New Haven, Conn.
Dolph & Co., John C.
Irvington Varnish Co.
Maas & Wallstein
ZAPON COMPANY, 60 E. 42nd St., N. Y. C.
ZOPHAR MILLS, Court, Lorraine and Creamer Sts., Brooklyn, N. Y.

LAMPS, GLOW

LITTELFUSE LABS., 4238 Lincoln Ave., Chicago, Ill.

LUGS

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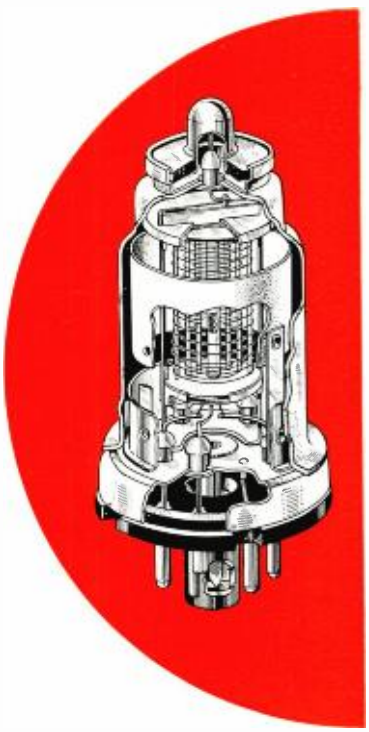

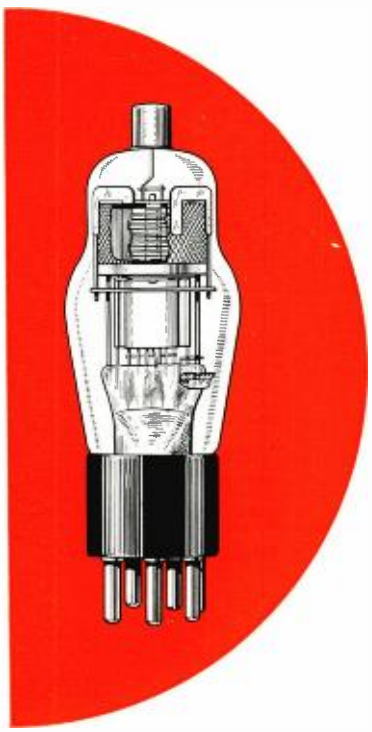

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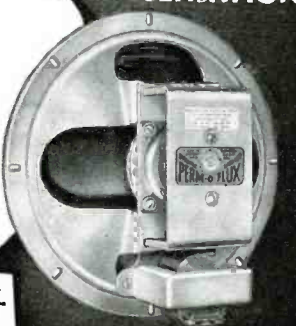

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