Radio Engineering

JULY, 1937

VOL. XVII NO. 7

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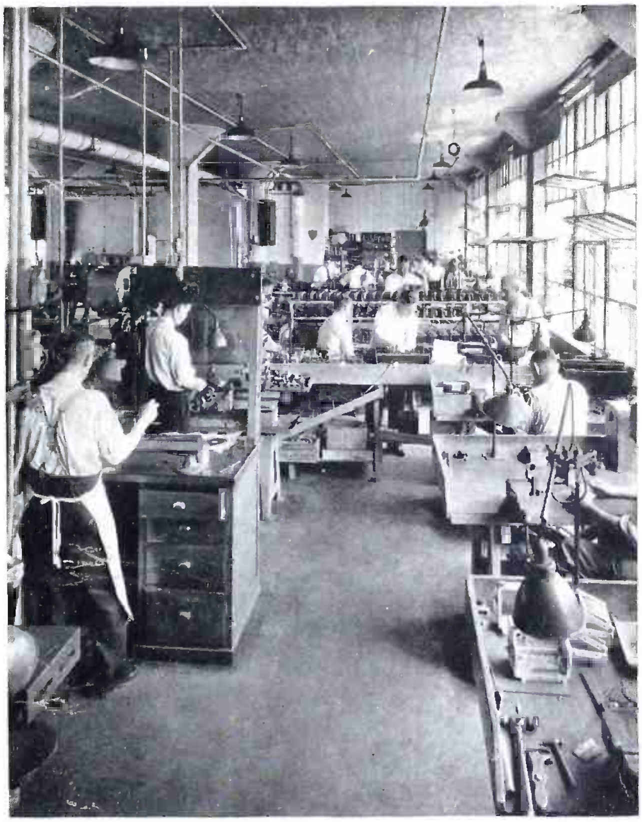

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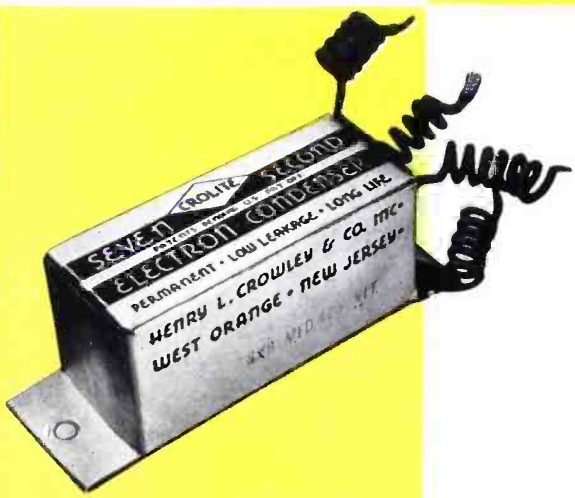

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RADIO ENGINEERING

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W. W. WALTZ • Editor

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FEATURES

DEPARTMENTS

VOL. XVII *Member Audit Bureau of Circulations* NO. 7

COVER ILLUSTRATION

VARIABLE CONDENSER ASSEMBLY AND WINDING DEPARTMENTS IN THE GENERAL RADIO COMPANY PLANT.

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Editorial

THIS MONTH

ENGINEERS GIVE PLENTY of thought to the Q's of the component parts of circuits, but how many times have you ever seen anything on the resultant of hanging a good coil across a fairly good condenser, then hooking the whole works to a "molded-mud" socket. Obviously, something happens to the otherwise excellent Q exhibited by the coil—by itself! Just what does happen can now be determined. The lead article tells how.

Every now and then we receive another article of the series which Paul Adorjan started about 1935; these have covered the mathematics of amplifiers in great detail. The latest, on class "B" tubes, appears further on.

In line with our idea of presenting comments on radio from outside the industry, we have this month some very pertinent remarks from a consumers' organization. The material was prepared from the reports of Consumers' Research, Inc., by an engineer who must, for obvious reasons, remain anonymous. Suffice it to say that our writer is well enough acquainted with radio to be considered an authority. The editor, as usual, will accept all of the bricks!

And, in addition, some more of the classic on Dynamic Symmetry in design. It's becoming involved, but stick around—they say that Einstein isn't so hard to read once you learn the language!

BY WAY OF SUGGESTION

WE ARE INCLINED to believe that if set manufacturers could, and would, persuade the broadcasters to clean up a few carrier waves, there might be less resistance to the sale of high-fidelity receivers.

We won't mention any names, but a few hours spent with a high-fidelity receiver, set for maximum sideband response, ought to surprise some of the broadcast people who apparently assume that they are putting out quiet carriers.

Modern receivers, with audio systems that for all practical purposes are good well below 100 cycles, certainly show up plenty of 60-cycle and other noise.

And it doesn't help the sale of a receiver to have to offer the lame excuse that the noise is coming from the station—it shouldn't come from there, at all.

FOREIGN TRADE

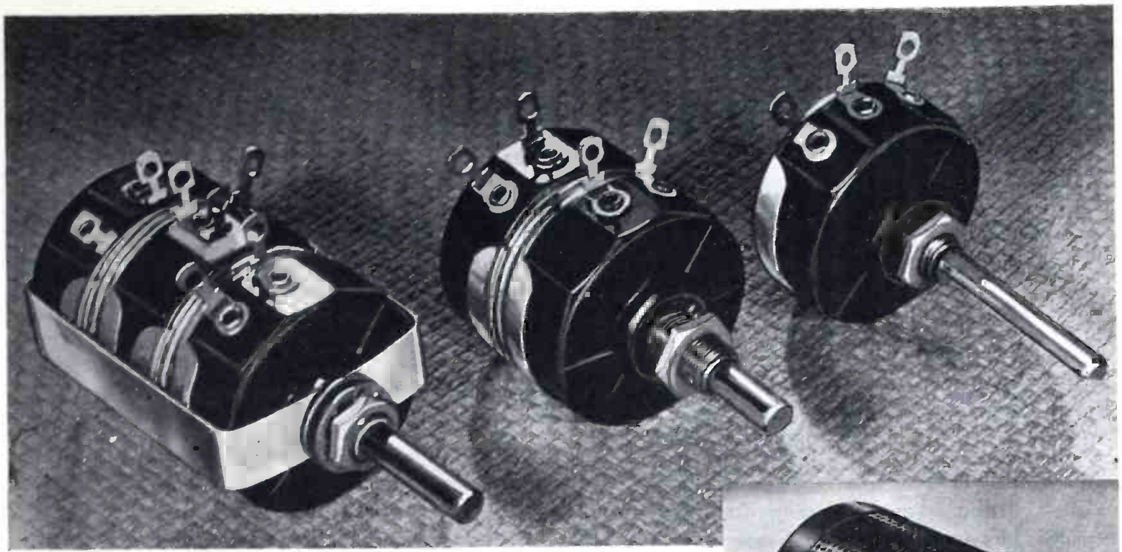
RECIPROCAL AGREEMENTS between the U. S. and foreign countries provide one way—and probably a very effectual way—to increase exports. But treaties of any kind are devices that require long-time maneuvering before they can be effected, and even then they don't necessarily cover all products.

According to John H. Payne, Chief of the Electrical Division, Bureau of Foreign and Domestic Commerce, one of the best ways to insure increased exports is for U. S. manufacturers to get behind the idea of providing certain foreign localities with *consistent* radio programs from this country. Consistent, in this case, refers to reception rather than to quality of program material; apparently, in some parts of the world the things which make us turn off our sets in disgust, can be taken with equanimity—perhaps because the glories of So-and-so's Remedy For What Have You may be construed simply as the title of the succeeding musical number.

The point is, our programs are popular —when they can be received! And it is being demonstrated convincingly that he who supplies entertainment gets the orders.

Here, then, is an opportunity for the RMA. That organization could, in collaboration with others (such as the U. S. Chamber of Commerce, the National Association of Manufacturers, etc.) start things rolling. What is needed, of course, is a group of high-frequency beam transmitters which can be on the air all of the time that the major networks are. The stunt is to shove beams into certain points in foreign countries, and keep hammering with programs.

This is already being done by certain other nations. Its effect upon our trade is tremendous. If something isn't done quickly, there may be just too much of a handicap to overcome. The situation calls for action—prompt and decisive.



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RADIO ENGINEERING

FOR JULY, 1937

THE RESULTANT Q OF TUNED CIRCUITS

by A. W. Barber
Consulting Engineer

A HIGH-Q COIL and a good condenser are prerequisite to a high-Q tuned circuit, but most practical circuits include other components which must be taken into consideration if accurate results are desired. The air portion of an air tuning condenser may be assumed to be without loss, but the condenser insulating supports, the coil, terminal strips, amplifier or detector tubes, tube bases and sockets may all introduce losses. The better the coil and condenser, the more noticeable will be the effect of the other components. Mathematically exact expressions for such a circuit are very involved and the true significance of the result is obscured. However, expressions for admittance or 1/Q may be greatly simplified by neglecting 1 as compared to Q^2 which is justified if Q is greater than 10.

The Q or ratio of reactance to resistance of a circuit is of great significance in many circuit applications. It is most useful in the consideration of parallel resonant circuits such as those used in radio or intermediate frequency selective amplifiers. The use of expressions in terms of Q permits a double simplification in circuit design since it may be easily measured directly and mathematical results are abbreviated by its use.

Briefly, circuits consisting of parallel connected imperfect inductances and capacities as found in any tuned circuit will be expressed as equivalent parallel resistances and perfect inductances and capacities in which form they may be easily combined even though the circuit be made up of a large number of such elements.

In Fig. 1a $Q_L = \frac{L\omega}{R_L}$ and in Fig. 1c $Q_C = \frac{1}{R_C C\omega}$. The impedance Z_L of the circuit of Fig. 1a is $Z_L = R_L + jL\omega$ and the admittance Y_L is $Y_L = \frac{R_L - jL\omega}{R_L^2 + L^2\omega^2}$. If Q is greater than 10, Q^2 will be greater than 100 and we may neglect 1 compared to Q^2. By employing this approximation Y_L becomes $Y_L = \frac{1}{Q_L L\omega} - j\frac{1}{L\omega}$ and Fig. 1a may be replaced by Fig. 1b in which the series inductance is replaced by an equal parallel inductance and the series resistance R_L is replaced by the parallel resistance $R_L' = Q_L L\omega$. In a similar manner Fig. 1c has an admittance $Y_C = \frac{C\omega}{Q_C} + jC\omega$ and it may be replaced by the parallel circuit of Fig. 1d where the parallel capacity is equal to the initial series capacity and the parallel resistance is equal to $R_C' = \frac{Q_C}{C\omega}$. If the circuits 1b and 1d are connected in parallel the susceptances cancel at the frequency $f = \frac{1}{2\pi\sqrt{LC}}$ and the resulting admittance is a conductance $\frac{1}{R''} = \frac{1}{Q_L L\omega} + \frac{C\omega}{Q_C} = \frac{1}{L\omega}\left(\frac{1}{Q_L} + \frac{1}{Q_C}\right)$.

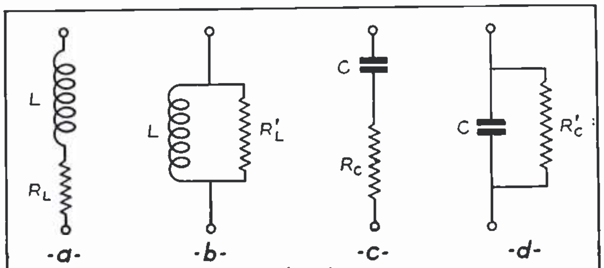


Fig. 1

While this simple case serves to illustrate the method employed more complicated circuits will be of greater interest and the simplification in computation will be more evident.

In Fig. 2a is shown a general circuit consisting of an imperfect inductance LR, a perfect air condenser C, imperfect condensers $C_1 R_1$, $C_2 R_2$ . . . . $C_n R_n$ and a shunt resistance R''' all connected in parallel. L R may be taken to represent the circuit inductance, C the air portion of a variable or fixed tuning condenser, $C_1 R_1$, $C_2 R_2$ . . . $C_n R_n$ the various imperfect or solid dielectric capacities in the tuning condenser and other parts of the circuit and R''' the sum of all shunt resistances such amplifier tube input and output resistance and the ohmic leakage in the circuit. In general the admittance of this circuit will be

$$Y = \frac{1}{R'''} + \frac{1}{Q_L L\omega} + \frac{C\omega}{Q_C} + \frac{C_1\omega}{Q_1} + \frac{C_2\omega}{Q_2} + \dots \frac{C_n\omega}{Q_n} - \frac{j}{L\omega} + j\,(C\omega + C_1\omega + C_2\omega + \dots C_n\omega) \dots (1)$$

but at resonance the susceptance is zero, $\frac{C\omega}{Q_C}$ is zero and the admittance becomes a pure conductance

$$\frac{1}{R''''} = \frac{1}{R'''} + \frac{1}{Q_L L\omega} + \omega \sum_{n=1}^{n=n} \frac{C_n}{Q_n} \quad \dots\dots\dots\dots (2)$$

If the total parallel circuit capacity is

$$C' = C + C_1 + C_2 + \dots C_n$$

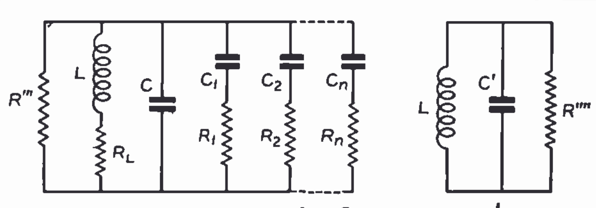
and Q_x is the effective Q of the entire circuit we have

$$\frac{1}{Q_x} = \frac{L\omega}{R''''} = \frac{L\omega}{R'''} + \frac{1}{Q_L} + L\omega^2 \sum \frac{C_n}{Q_n} =$$

$$\frac{L\omega}{R'''} + \frac{1}{Q_L} + \frac{1}{C'} \sum_{n=1}^{n=n} \frac{C_n}{Q_n} \quad \dots\dots\dots\dots (3)$$

From these last two equations the net Q or Y of a complex circuit may be determined from the constants of the various components. The effect of using a certain switch, terminal strip or socket on the total circuit performance may be easily computed. By expressing the circuit in terms of each of its elements the effect of each element may be seen at a glance. Synthetic circuit design becomes easy since the constants of various elements may be tabulated and the result of using various combinations quickly determined. Economic considerations are evident since the improvement in the entire circuit resulting from the improvement or substitution of a single element shows up at once.

In most cases the C_n/Q_n terms are constants over a range of frequencies and their value may be obtained at a single point. It will be noted that the effect of the last term of equation (3) is to reduce the net circuit Q and is proportional to the square of the frequency. The last term of the conductance equation (2) is proportional



-a- **Fig. 2** -b-

Table

f	ω	$L\omega$	Q_L	C'	$\frac{1}{C'}$
540×10^3	3.39×10^6	732	180	400×10^{-12}	2500×10^6
1000×10^3	6.28×10^6	1356	220	115×10^{-12}	8700×10^6
1700×10^3	10.6×10^6	2300	150	40×10^{-12}	$25{,}000 \times 10^6$

$\frac{L\omega}{R'''}$	$\frac{1}{Q_L}$	$\frac{1}{C'} \sum \frac{C_n}{Q_n}$	$\frac{1}{Q_x}$	Q_x
732×10^{-6}	5500×10^{-6}	343×10^{-6}	6575×10^{-6}	152
1356×10^{-6}	4500×10^{-6}	1190×10^{-6}	7046×10^{-6}	142
2300×10^{-6}	6700×10^{-6}	3430×10^{-6}	$12{,}430 \times 10^{-6}$	80.6

Coil inductance .... = 216 μh
Terminal strip C_1/Q_1 .... = 2×10^{-14}
Condenser supports C_2/Q_2 = 0.4×10^{-14}
Tube base C_3/Q_3 .... = 8×10^{-14}
Tube socket C_4/Q_4 .... = 3.3×10^{-14}

$\sum \frac{C_n}{Q_n} = 13.7 \times 10^{-14}$

to the first power of the frequency and increases the conductance of the circuit.

Let us consider the primary of a high-Q intermediate-frequency transformer as a first example of the method and results herein obtained. The coil is a dust cored 1.17 mh inductance having a Q of 300 at the intermediate frequency of 465 kc. The tuning condenser is an air condenser with high-Q insulating supports. The coil leads are connected to a terminal strip having a 1 mmf capacity through a solid dielectric having a Q of 50. The tuning condenser has a capacity of 2 mmf through the solid supports which have a Q of 500. The tube to feed this tuned circuit has an alternating-current plate resistance of 1 megohm, a base having a capacity of 2 mmf through material with a Q of 25 and a socket having a 1 mmf capacity through material with a Q of 30. The total circuit capacity is 100 mmf. Applying equation (3) and taking it term by term we have $L\omega/R'''$ due to the plate resistance equal to 0.00343, $1/Q_L$ due to the inductance equal to 0.00333, $C_n/C\,Q_n$ due to the terminal strip equal to 0.00020, due to the tuning condenser supports equal to 0.00004, due to the tube base equal to 0.00080 and due to the socket equal to 0.00033. The air portion of the tuning condenser of course does not contribute a C/Q term since Q is assumed to be infinite. Thus the sum of all the terms of the equation is $1/Q_x = 0.00813$ and Q_x is 123. Thus starting with a coil having a Q of 300 we find that a practical circuit can easily reduce the effective Q to 123. The selectivity of the circuit has also been reduced and its tuned impedance which equals $Q_x L\omega$ has been reduced from 1,030,000 ohms to 430,000 ohms, causing a corresponding reduction in gain.

As a second example let us consider a continuously tunable circuit suitable for the broadcast band. Let us consider a circuit with the same components as the circuit of the first example except that a broadcast band coil and a variable condenser with a maximum change of capacity of 360 mmf will be substituted for the coil and condenser used before. The application of equation (3) results in the values shown in the table. It should be understood that the values of $1/Q_L$ account for all coil losses such as those due to current through the distributed capacity, dielectric losses in the coil form, copper losses, etc., all of which might have been expressed separately as for instance in case of the design of a coil. The results given in the table show that the tube and circuit losses have reduced the circuit Q at 540 kc from 180 to 152, at 1000 kc from 220 to 142 and at 1700 kc from 150 to 80.6.

DYNAMIC SYMMETRY IN RADIO DESIGN

By W. C. Eddy, Lieut. U.S.N. (Retired)

PART II

THE FIRST ARTICLE of this series demonstrated the geometrical construction of the various root figures that form the basis of Dynamic Symmetry. In order to apply these shapes to practical usage it is necessary that we reconsider these rectangles from the standpoint of design importance. Just as one color will stand out among the more somber hues of a background, so one geometric shape will take precedence over another less attractive arrangement. In order to evaluate these root figures it is again necessary to refer to the sequential theory of plant growth and redevelop our groundwork in a more detailed manner.

We have already stated that nature had been found to design around a geometrical progression of whole numbers purported to be in the order of 1, 2, 3, 5, 8, 13, 21, 34, and 55. In so far as actual plant growth is concerned this may be assumed to be entirely correct, but we are more concerned with the possibility of reducing design to the common denominator of a true mathematical progression than taking the more lenient viewpoint of the botanist. Any geometrical progression can be reduced to a ratio which will represent the phenomenon by dividing one term into the next. A hasty analysis of the above series indicates that this summation is not a true progression from the standpoint of geometry, the resultant ratio ranging from 2.000 to 1.600. A much closer representation of an actual geometrical series would be contained in the progression of 118, 191, 309, 500, 809, and 1309. Here the ratio becomes 1.618, which we will later prove to be the index of all plant and animal growth as well as the foundations of Dynamic Symmetry. In addition to the fact that this substitute series produces an exact ratio, each term of the progression will reappear as a ratio of the more common dynamic areas used in design.

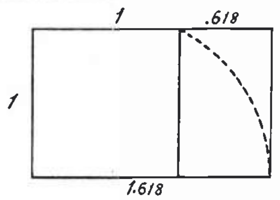


Fig. 1

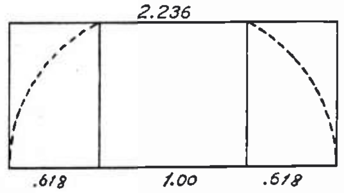


Fig. 1A

If we turn again to the whole number series demonstrated in plant growth we can develop some interesting relations that might help to clarify our later applications. As we know the interlocking seed spirals of the sun flower exist in the sequential series of 1, 2, 3, 5, 8, 13, 21, 34, and 55. This summation, while not true from the mathematical standpoint, is termed a normal series. Botanical research has determined that nature varies from this simple arrangement into the more complex where, as in the bi-jugate series, we find the original progression reading 2, 4, 6, 10 and 16; or in the tri-jugate series, 24, 39, and 63. This multi-jugate series does exist in plant life in conjunction with the normal arrangement and lends credence to the fact that multiple series are normal in nature and can therefore be applied to design practice.

Let us develop this theory a bit further and see what interesting properties will result from the manipulation.

Assuming a normal substitute series such as 809, 1309, 2118 and 3427, we multiply by three to obtain a tri-jugate substitute progression of 3927, 6354, 10,281, which when treated mathematically results in a curious accumulation of interrelations. We find that any two numbers added together equal a third—that every term divided into its successor is equal to 1.618—that every term divided into its third term equals 1.618^2 or into its fourth term equals 1.618^3. Powers of these numbers divided by two again equal the normal substitute series. The square of 1.618 equals itself plus unity or the square of 0.618 added to $.618^2$ again results in unity. These are a few of the many relations that exist in this substitute tri-jugate arrangement. Many more interesting interdependencies can be evolved from a study of this index of 1.618 and its various powers, but for the sake of brevity we must take these few and apply them to geometric construction.

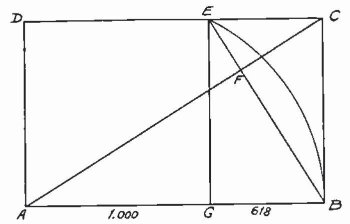


Fig. 2

If we construct a Whirling Square as in Fig. 1 we find the fundamental ratio appearing in the dimensions of the long side, or if we continue the arc through 180 degrees as in Fig. 1A we produce two overlapping whirling squares and an interesting accumulation of parent and related shapes. In this rectangle 0.618 appears twice, the unit square once and the length of the long side squared is equal to 2.236 or the $\sqrt{5}$, showing the close interrelation of the whirling square and the Root five enclosure. It is this inter-relation and the fact that the index of growth is more predominant in these two areas that makes them stand out in importance among the other dynamic shapes.

Two other functions of area must be developed before these or any rectangles can be applied to design practice, i.e., the reciprocal and the complement. The reciprocal of an area is defined as a rectangle similar in shape but smaller in size while the complement is obtained by dividing the number into unity to

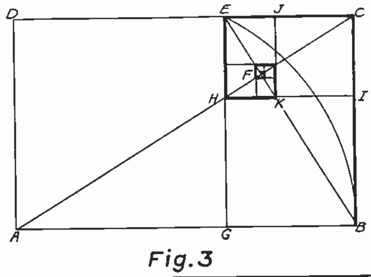


Fig. 3

find the reciprocal and subtracting that figure from unity. Dynamic Symmetry makes frequent use of both the reciprocal and complementary shapes to secure force and emphasis in the composition.

A geometric lay-out for the production of the reciprocal is demonstrated in Fig. 2. Draw the diagonal AC in the 1.618 rectangle ABCD. From B erect a perpendicular to AC such as EB. Draw EG parallel to CB. Area GBCE is now the reciprocal of ABCD being similar in shape and smaller in size. The length of the long side divided into unity equals 0.618 which is the measured length of the short side of the reciprocal. Another interesting relation is apparent from the diagram, expressed in the proportionate ratio of AF::FB::FC::EF. If we care to go further into the development of this 1.618 area the derivation of its name, the Whirling Square, can be shown.

In Fig. 3 we have constructed a 1.618 area ABCD and its reciprocal shape BCEG. Continuing the construction of reciprocal shapes we derive HICE as the reciprocal of the first and EHKJ as a further development of the second. Each of these rectangles maintains a proportionate ratio to the other as well as to the parent form. It will be noted that with each subdivision, the diagonal of the reciprocal rotates 90 degrees about the major shape. Using this phenomenon we can develop the Greek spiral about the intersection F as in Fig. 3. This particular spiral and its many modifications constitute an important fundamental design, the focal point F being one of the most important intersections within a rectangle. If we construct squares on the various diagonals of the reciprocals, the origin of the name of this particular shape, The Whirling Square, is apparent.

Before we make practical application of our theories, let us come to an understanding of just what we can expect from Dynamic design. First of all, we assume that we are able to produce rectangles of pleasing proportion. But these areas themselves are inert and are not capable of producing a complete design. Even these admittedly pleasing shapes can be grouped in such a manner that the result will resemble the riotous conglomeration of color on an artist's pallette. Here is where Dynamic Symmetry comes into play. It teaches us design coordination and makes us work in terms of area rather than the single dimension of length. We have a myriad of rectangles to choose from in which we can easily find an approximation of the area required for the design. This area may be the parent shapes such as Root 2, 3, or 5, their reciprocals, their complements or any commensurate subdivisions of these ratios. It will be noted that Root 1, the square, and Root 4, two squares, are not included in our classification of true dynamic shapes. These areas alone can be considered static in nature and only when used in conjunction with other dynamic forms do they become a factor in design.

Root 2	1.4142	Reciprocal 0.7071
Root 3	1.732	Reciprocal 0.5773
Root 4	2.000	Reciprocal 0.5000
Whirling Square	1.618	Reciprocal 0.618
Root 5	2.236	Reciprocal 0.4472
A Square $\frac{0.618}{2} = 0.309$		
A Square $\frac{\sqrt{5}}{2} = 1.118$		

Fig. 4

Some of the more important simple areas of Dynamic Symmetry are listed in the table of Fig. 4 as ratios of length to height. These ratios and their subdivisions will produce ample area themes to satisfy the requirements of the beginner in Dynamic Symmetry. Root 5 and its counterpart, the Whirling Square, appear to be the most widely used of all dynamic figures. Hambridge in his research on the sites of ancient Grecian temples has pointed out that the ratio of 1.618 with its multiples and sub-multiples appear in over 85 per cent of their work. Root 2 was next in favor with approximately 10 per cent, while Root 3 and the semi-static forms completed the history. From this we can assume that Root 5 and the Whirling Square represent our strongest themes and for this reason we should strive to make full use of this rectangle in our designs.

Now for some thumb rules of good design:

1. The diagonal of area is the most important single element from the design standpoint.

2. The diagonal of the reciprocal is second in importance to the diagonal of the whole.

3. The intersection of the diagonal of the whole with the diagonal of the reciprocal (F in Fig. 3) constitutes a position of strength and emphasis in design.

4. Do not mix root figures in a design. If the design is started in Root 2 keep it in this ratio and do not attempt to combine it with Root 3 or the Whirling Square.

5. Continue the same theme in a design. If the subdivision of the parent shape has been started with the construction of reciprocals, carry this division throughout the design. In other words, do not mix composition any more than a pianist would attempt "Hearts and Flowers" in swing time.

The easiest way to demonstrate a practical application of this art to radio would be the consideration of some particular design problem in this field. The standard 7" x 19" panel for a sound mixing rack on a television control board is a suitable example. On this panel we must locate four channel terminations, each unit consisting of a fader, one channel switch and two pilot lights.

The panel itself is the frame of the picture. If it is of dynamic proportions, our problem is simple for we merely carry out the existing theme. If it is not, as we find 7" x 19" is not, we are forced to establish an area for our design that will be dynamic.

Dividing length by breadth we find the ratio of the whole panel to be 2.714. By comparison with the table of Fig. 4 we find no exact divisor among any of the parent shapes, their reciprocals or their submultiples. Obviously this area can not be exactly divided into any group of dynamic shapes and we must necessarily look further for a starting theme. The opening of the rack which determines the usable area on the panel should next be investigated. This measure 17.5" and the rectangle projected on the panel equals $17.5 \div 7 = 2.500$ representing the area in which the ap-

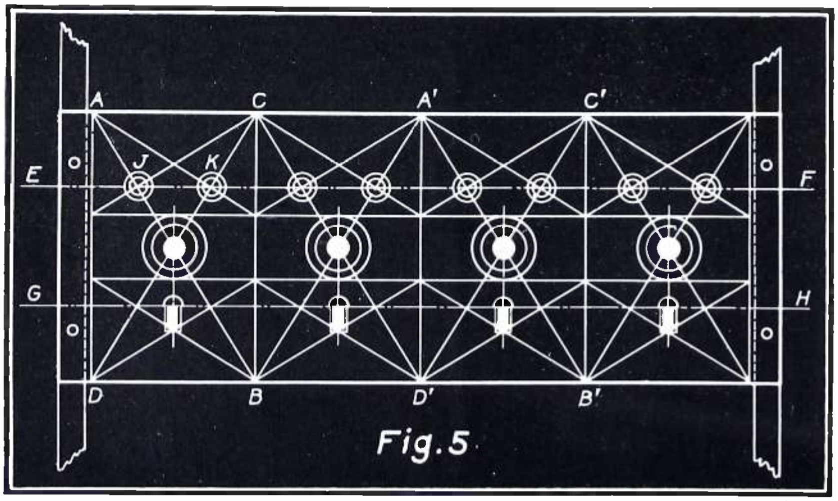


Fig. 5

paratus must be grouped. This ratio is exactly divisible by 0.5000 resulting in a lattice of ten squares measuring 3.5" on a side. Such a subdivision is static so we apply Root 2 (1.414) and find that this shape plus a unit square will leave a clearance between the usable area and the rack of

1.414+1.000=2.414
1.414 + 1.000 = 2.414
2.500 — 2.414 = .086 clearance
.086 × 7" = .602" clearance.

The subdivision of the usable area into Root 2 plus the unit square can be considered as one alternative, but such an arrangement does not lend itself to further subdivision to accommodate the four groups of controls. Dividing 2.500 by 4 we get 0.6250 which suggests the employment of four Whirling Squares on end. Mathematically we arrive at the dimensions of a single unit by multiplying the length of the side, 7", by the ratio of the reciprocal shape 0.618. This indicates that the dimensions will be 7" x 4.326" for each rectangle or 17.30" x 7" for the entire group leaving a clearance of 0.196" between the racks and the limits of the working rectangle, half of this being at either end.

A hasty review of other root figures indicates that the 0.618 ratio is most applicable, dividing, as it does, the usable area into four strong dynamic subdivisions. We can now construct Fig. 5 with the panel divided into four Whirling Squares on end.

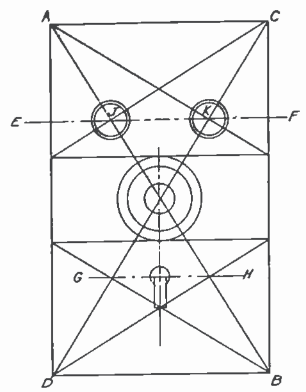


Fig. 6

Drawing in diagonals to the whole such as AB, CD, A'B', C'D' and A"B"-C"D" as well as perpendiculars to these diagonals we establish two lines of intersection EF and GH, which by reason of the fact that they continue the major intersections across the panel, represent lines of importance in the design.

If we construct Fig. 6 representing a single unit, we can proceed with the arrangements of the parts. At the intersection of the two main diagonals we center the fader knob itself. This intersection is the primary point of interest and the knob the outstanding feature of the lay-out. At the two intersections J and K we place the two pilot lights and on the lower line of intersections, directly beneath the knob we center the channel switch. Having decided on this particular arrangement we duplicate it in the other rectangles producing a completed design, pleasing in appearance, strong in design and practical in application. There are, of course, many other possible arrangements of these sixteen pieces of apparatus within the confines of the space allotted. Some will be unbalanced, crowded, or show no semblance of thought while other versions of Dynamic design will no doubt produce equivalent results to the 0.618 theme illustrated.

Dynamic Symmetery is a form of good composition, not a series of rules demanding strict adherence. It can be considered as a system of two dimensional co-ordination assisting the engineer or the artist in the production of designs that are pleasing to the eye.

(To be continued)

BOOK REVIEWS

Electrical Engineers' Handbook, edited by Harold Pender and Knox McIlwain. Published by John Wiley and Sons, Inc., New York. 1022 *pages, price* $5.00.

This particular volume (number 5 of the Wiley Engineering Handbook Series) deals with communication and electronics. There are seventeen sections in the book, each prepared by a group of specialists on the particular subjects to which the section is devoted. The various sections follow, more or less closely, the conventional subdivisions of the communication and electronic arts.

Selecting various topics at random, we find an all too brief discussion of quartz, Rochelle Salt and tourmaline crystals under the general heading of Properties of Materials; the practical application of crystals to the control of oscillators is covered some pages further on under the heading Circuit Elements. This last mentioned section (Circuit Elements) attempts in 161 pages to cover such matters as coupled circuits, iron-core transformers, antennas, radio receivers, amplifiers, oscillators, wave filters, power supply equipment, etc. The result is, to say the least, sketchy, although the contributors to this section have made Herculean efforts to fit their assignments into the allotted space. The fault, as this reviewer sees it, is in the attempt to crowd too much material into a relatively small space. It would seem that some of the sections might well be eliminated entirely by combining the material with others; "tighter" editing in places would also help.

The handbook, while it will probably be disappointing to many, as it was to this reviewer, will still be of service to the practicing engineer, although it probably will not be an indispensable "Bible" to the profession.

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Television Optics, by L. M. Myers. Published by Pitman Publishing Co., New York. 338 *pages, price* $8.50.

The optics of television systems, both past and present, are presented in great detail in this book which should prove of interest to all who are or may be engaged in this coming art.

Commencing with a long chapter on the theory of image formation, the book proceeds to studies of photometry, the Kerr effect, and mechanical scanning systems. To this point it might be called historical.

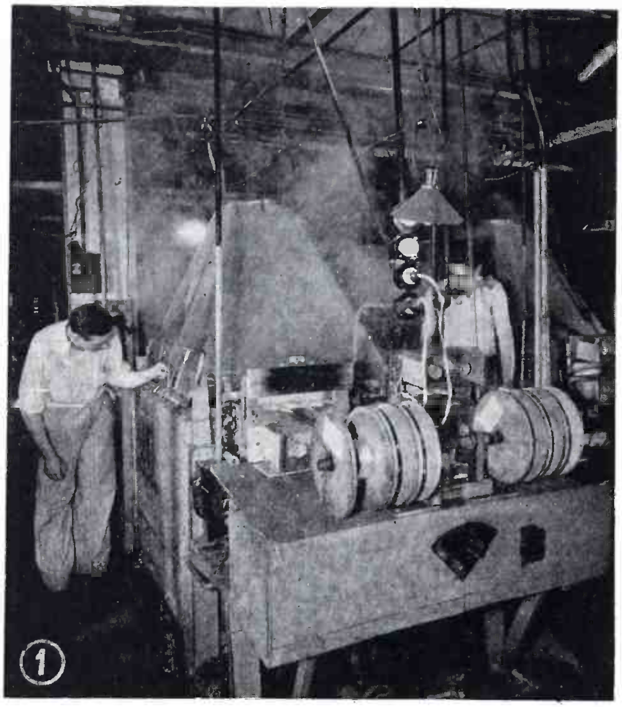
The last chapter, which fills nearly one hundred pages, is devoted to electron scanning. Such details as time bases, electrostatic lenses, etc., are discussed in sufficient detail (sufficient for the present, at least) to give the reader considerably more information than may be obtained from the more popular descriptions which have appeared from time to time. Mathematical expressions are used generously, but this need not deter anyone from this book; acquaintance with algebra, trigonometry and elementary calculus is all that is required. Several nomograms for the determination of various Kerr cell phenomena are included.

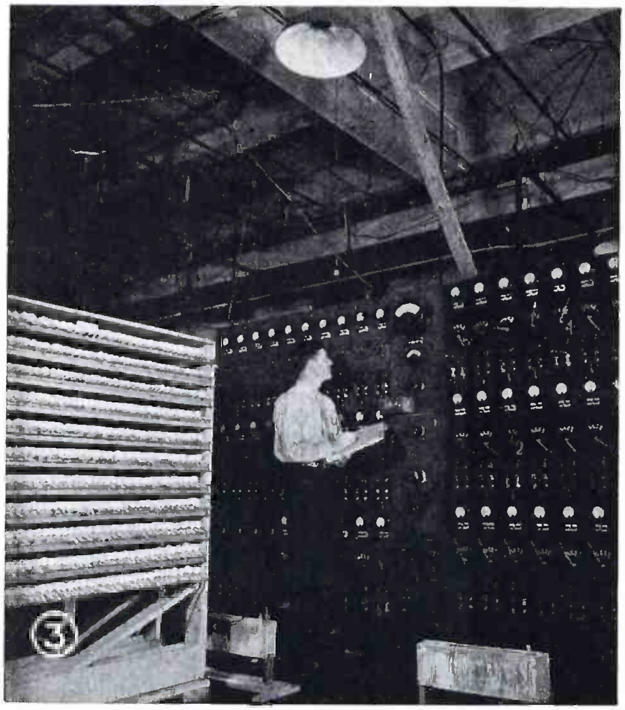
•

Television Technical Terms and Definitions, by E. J. G. Lewis. Published by Pitman Publishing Co., New York. 95 *pages plus space for additional notes, price* $1.75.

This book suffers from the same defects that handicap those from any foreign source which attempt to define technical terms. For the Englishman it is probably excellent, but we find too many inconsistencies and omissions to make it of any value to the engineer on this side of the Atlantic. Furthermore, many terms which properly are already part of an engineer's equipment, occupy space which otherwise might better have been devoted to more specific details of actual television terminology. Incidentally, the RMA will be interested to know how completely its recommendations have been ignored in the preparation of this work.

THE PRODUCTION OF





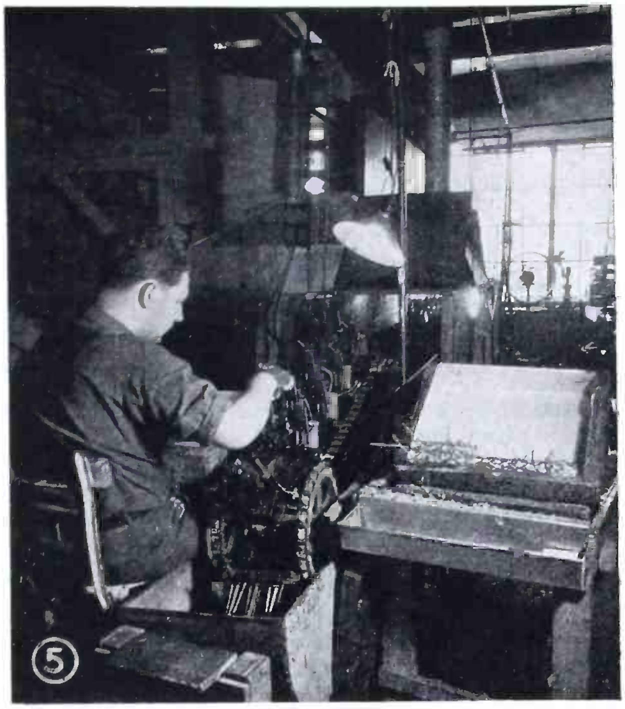
1. A typical view in the plate forming department. Spools of foil can be seen in the foreground with electric heaters directed on them to keep the foil at constant temperature. The forming tanks are in the background.

2. Winding machines for the manufacture of dry electrolytic condensers. The machines are constructed so that the foil plates and the gauze separators pass through a bath of paste electrolyte.

3. After forming the condensers are placed on aging racks and subjected to voltages higher than rated value for a definite period.

4. Trained operators put the finishing touches on the rolled sheets of foil and gauze, and slip the units into cardboard boxes or metal cans and seal the containers.

DRY ELECTROLYTICS



5. Machine for wax impregnating cardboard types of dry electrolytic condensers.

6. All dry electrolytic condensers must be hermetically sealed so that no moisture can enter or leave the units. Paraffin impregnation, shown in this view, does the trick.

7. One of the final steps in the manufacture of dry electrolytics—testing. The finished units move before the testers on a circular table.

8. Final electrical inspection. The trays shown have metal linings which make contact with all of the containers so that the inspector simply moves the test prod from one center terminal to the next while he watches the meters in front of him.

CONSUMERS' RESEARCH LOOKS AT RADIO

Remember "Your Money's Worth" and "100,000,000 Guinea Pigs"? Herein, the organization responsible for those books, Consumers' Research, turns its attention, through the medium of a disinterested writer, to radio.

IT IS BELIEVED that most of the objections to present day radios which are cited by Consumers' Research are those which any engineer who is at all honest with himself would find. Several of the points taken by Consumers' Research are, we believe, open to reasonable doubt; these will be given more attention in later paragraphs.

Some of the things to which Consumers' Research takes exception are not in the province of the engineer, and in some cases these objections can be charged almost exclusively to the sales and advertising policies of the retail dealers. It is unfortunate that in a good many cases the manufacturer's advertising lends itself to the extreme distortion which characterizes the claims made by none too ethical or even unscrupulous dealers. However, the problem of what to do about such dealers lies with organizations such as the Better Business Bureau rather than the manufacturer who builds the set.

Let us consider in detail some of the matters to which Consumers' Research takes exception, not only in the manner pursued by the manufacturer in his advertising, but in design and construction of receivers as well.

Some comment is made on the question of the number of tubes used in the receivers and especially with regard to the advertised number of tubes. It is pointed out that multi-purpose tubes while tending to reduce the actual number of tubes in the set, at the same time effect some saving in power consumption. There is some question in our mind if this latter point has any value whatever, as after all the only saving afforded by a dual-function tube is in the elimination of one heater, and this means probably only 0.3 amperes at 6.3 volts—a negligible amount of power. However, one real objection (in which we are again in agreement with Consumers' Research) to a multi-purpose tube which applies especially to the so-called pentagrid converter is, of course, the well-known inefficiency of these tubes at the higher frequencies, a point which is leading to a return to the old method employing physically separate tubes for oscillator and mixer. This latter point, strangely enough, ties in with another mentioned by Consumers' Research; it is said that where cost is an important factor in the selection of a radio receiver, due consideration should be given to the earlier models of manufacturers still in business. This, however, would mean going in for receivers of the vintage of about 1933, a matter of doubtful advantage (in the opinion of this writer) even where the manufacturer may still be in business.

There is one angle in connection with multi-purpose tubes which this writer does not feel has been given fair consideration by the report of Consumers' Research. The public demand for exceptionally low cost sets, and the wide interest in automobile receivers—which, to please the public, must be entirely hidden when installed in the car—led to the wide use of this type of tube for its low-cost associated circuits and its great saving of space. That this type of tube has found its way into larger sets is just one reason why prices have remained uniformly low.

While we are on the subject of costs it will be well to consider what Consumers' Research has to say. The report states in effect that prices greater than about $150 are not justified so far as fidelity, selectivity, or sensitivity are concerned. This writer finds himself in agreement with this contention, especially where it relates to needless refinements such as tone compensators, etc. However, where a large increase in price is obviously due to exceptionally massive or ornate cabinets, it is a matter entirely for the customer to decide; if he wants a glorified packing crate embellished with so-called "tasteful" carvings and what not, *caveat emptor*.

Speaking of cabinets, Consumers' Research finds that radio cabinets are designed as furniture (*sic*) rather than as efficient baffles for loud speakers; we suspect that most set makers will agree with this point. It is pertinent, however, to note further the comment to the effect that the deficiency in the low frequency response occasioned by this serious lack of baffle area is supposedly corrected by making the circuit response so poor over the rest of the audio range that the loss of the low frequencies is not too noticeable. Add to this the effects of cabinet resonance and we have the complete picture of what far too many sets sound like.

Advertising of the sort that some manufacturers indulge in comes in for plenty of criticism—and justly so. Here again, though, the retailer may be responsible for over-playing some of the catch words and phrases that the manufacturer's advertising staff have coined—without really knowing what it's all about—to attract the attention of the public.* But to this extent the

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*On submitting this material to Consumers' Research for their comment, the following remarks, among others, were appended to their previous comments:

"It is no excuse to say that the ideas are difficult to express—because advertising men pride themselves in getting across difficult ideas. Their sin is in the fact that they, for good business reasons, like to say things in unclear terms so that much of the real truth is hidden. It is often what they omit to say that is important, and what many people will think they meant. There is no possible question of lack of ability on their part to say what they please if they happen to wish to say that which is of use to the consumer. I need hardly tell you that by a nice choice of words an advertising man can avoid difficulty with the Federal Trade Commission and with the Better Business Bureau and other such agencies and still give the consumer just the shade of impression which helps to mislead him into an unwise or uneconomic purchase. Our objection is not to picturesque or popular statements, but to false statements and false impressions. It should be added that advertising men don't use "technical" terms out of ignorance. They have their own persuasion value to the man to whom they are mystical, and it is not uncommon for the advertising men to call in the engineers to "say some technical terms" in order that the former can pick out some good phrases for the next batch of copy (the accurate technical significance of which the advertising men will comprehend almost as poorly as will their lay audience)."

manufacturer is responsible; if his advertising, which is usually carried nation-wide in the popular magazines and in the daily papers, gives the retailer too much leeway then he must expect severe criticism.

But this argument of excesses in advertising is as old as advertising itself. It is really too much to believe that any rational person, even the father of the particular "brain-child" that is being touted, a la Hollywood, as the World-Wonder-Super-Colossal-Super, can make the set do all that is claimed for it. Luck, persistence, and common sense play so great a part in the results that can be achieved with any given set that it is pure assinity to advance some of the claims that we frequently see in print.

Along the same lines is the problem of yearly models. Any engineer knows that the refinements introduced this year will in all probability be common-place items on next year's sets—either that or they will be entirely discarded in favor of something about which more advertising blurbs can be created. Possibly Consumers' Research, and certainly this writer, feel that radio sets aren't ever going to be a replacement item in the sense that a car is. In the first place, how many sets are bought as musical instruments? Comparatively few, if the truth is told; and those that are bought for the musical entertainment (or education) which they may be able to supply *will not be replaced until something with a vastly improved quality of reproduction is attained in the new designs.* Even true music lovers—who, to judge by some rather pithy comments which appeared in RADIO ENGINEERING in March of this year—won't get excited over the addition of another third or half octave to the present frequency range of the set. And how many advertisements give a true picture of whatever improvements there may actually be? But, on the other hand, how is the public to be told? "Cycles" and "band width" mean less than nothing, although advertisements—some of them!—bristle with such terms. Here, we do not feel that the manufacturer is being misleading other than through a lack of appreciation of the fact that his prospective buyers just don't know what to make of all the "technical" terms. Some of them (the buyers) may even "fall" for this display of erudition and buy a set simply because they think that the manufacturer behind the advertisement must be good because his ads read so complicated and "technical."

What we have been driving at is that there is no sound reason for the mad rush to come on the market with "next year's models." The automobile industry learned an expensive lesson back in the days when a "new" model rattled itself apart before the draftsmen completed their preliminary drawings on the "newer" model. It might be well to give some thought to the idea of building a set to last for a couple of years at least. In connection with this, we can suggest that some recent issues of *The Wireless World* be consulted for some very relevant remarks on this angle.

The matter of combination long- and short-wave receivers comes in for its share of attention. Consumers' Research feels—as does this writer—that short-wave reception is, at best, so uncertain and unsatisfactory that the utmost consideration ought to be given to dropping this feature from many models. It is doubtful if few, other than the comparatively negligible number who become short-wave addicts, use the short-wave facilities once the initial thrill has evaporated. The network stations carry re-broadcasts of all important foreign events, and picked up by extremely sensitive receivers under technical control the programs as re-broadcast are almost certain to be far better than the same thing picked up on a home receiver which in all probability is bringing in at the same time, all of the power company's leaky insulators and assorted ignition, X-ray, and other noises.

It seems to many competent observers that the money spent by the set manufacturer on short-wave circuits could well be diverted to improving such matters as side-band trimming cabinet resonance, and detector distortion—just to mention a few. And, although Consumers' Research apparently hasn't suggested it, let us put in our little argument for a receiver that can be used in a vicinity like New York, Philadelphia, Boston—any area well covered by high-quality stations—and that will give truly high-fidelity reception from the local stations. We may be wrong, but it is our guess that some alert manufacturer could make himself some nice business with such a set; and it wouldn't have to cost a fortune, either. Introduced and advertised for what it is—a good local receiver—such a job would appeal to a great number of people with enough discrimination to want music rather than a lot of nearly unintelligible propaganda delivered in bad English and tossed about by three or four thousand miles of assorted thunder storms.

Circuit noise comes in for plenty of attention in the Consumers' Research report—and rightly so. Far too many receivers have such a terrific amount of 60- and 120 cycle hum that it seems almost as if there was no power supply filtering at all. It is the belief of this writer that much of this is due to the use of the field coil of the conventional dynamic speaker as the filter choke. Let it be stated here that we have never known an engineer—ourselves included—who had even a faint idea of how much inductance a speaker field would show under d-c load; rather, these fields are invariably specified as "so many ohms resistance." That, of course, gives some control of their regulation of the power supply, but that's about all. Little wonder, then, that we find filters using quantities and quantities of microfarads in an attempt to smooth out the ripple!

However, power supply noise isn't all. There is the noise supposedly inherent in mixer tubes, especially those of the pentagrid variety; there is noise generated in resistors, especially when they are worked just on the verge of overload; likewise with condensers. There is noise caused by thermal emf's; by chemical action—a prolific source of noise especially if the set is used in humid locations; and by a host of other causes, some of which, we suspect from personal experiences, may never occur to engineers until sad tales drift back from the field.

RADIO ENGINEERING had recently, in an introductory note to a certain article on automatic selectivity control, a very pointed observation to the effect that the fewer controls on the set, the less likely it will be for the user to jam things up. This point was later taken up by a writer in *The Wireless World*, and apparently it is tacitly concurred in by Consumers' Research. However, this latter's comment is directed more toward the variable selectivity idea; we wonder if there isn't a profitable suggestion contained in their thought? Suppose that a set's selectivity were to be adjusted on installation to meet local requirements; suppose that the manufacturer were to guarantee satisfactory local reception provided the selectivity adjustment remained untouched, once set; suppose further that the customer wanted satisfactory distant reception (if he knew what he meant by that!) then the selectivity could be sharpened but with the distinct understanding that local reception would be impaired—from a quality standpoint, that is.

Such an arrangement would be, to say the least, novel,

(Continued on page 16)

PLATE EFFICIENCY OF CLASS "B" AMPLIFIERS

by Paul Adorjan

Technical Director, Rediffusion, Ltd., London

THE PURPOSE of this paper is to deal with the question of average plate dissipation and plate efficiency of tubes used in Class "B" amplifiers.

The manufacturers' rating of plate dissipation is usually expressed as "watts averaged over any audio frequency cycle." It is left to the designer to calculate the watts dissipated in tubes under any condition of operation and to determine the optimum condition of operation.

Instantaneous plate dissipation characteristics of tubes have been dealt with by the author in a previous paper. (Power Amplifier Design, RADIO ENGINEERING, June 1936). It was shown that by using the test circuit of Fig. 1, a set of curves similar to those shown in Fig. 2 is obtained. No grid current characteristics are shown in Fig. 2 as the present paper deals with the question of plate dissipation only.

The following are the nomenclatures used below:

- I_a = instantaneous plate current
- V = plate voltage
- R = load resistance
- W_a = plate dissipation watts
- V_g = instantaneous signal grid voltage
- E_g = maximum value of V_g during any half cycle
- R_a = instantaneous plate resistance
- $\hat{R}_a$ = instantaneous value of d-c plate resistance when V_g reaches peak value during operative half cycle
- W_o = output watts
- $\hat{I}_a$ = maximum plate current during operative half cycle

It is obvious that the plate dissipation of a tube at any instant can be defined as the total power supplied to the plate circuit less the power dissipated in the load. Hence

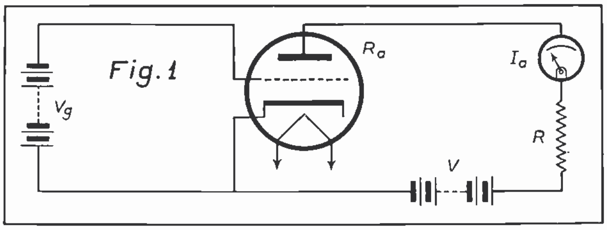
$$W_a = I_a V - I_a^2 R \qquad (1)$$

also

$$I_a = cV_g \qquad (2)$$

where c is a constant and the curvature due to the bottom bend is neglected, and $I_a = 0$ with no signal input.

$$\therefore\ W_a = cV_g \times V - c^2 V_g^2 R \qquad (3)$$



Consideration of the shape of the curve W_a allows us to plot plate dissipation against angle of operation for various peak values of applied sinusoidal grid voltage. It will be realized, of course, that the shape of the plate dissipation curve will vary for applied grid voltage curves of various amplitudes.

Fig. 3d shows the shape of the plate dissipation curve for the operative half cycle when $R_a = 0$ at the instant when V_g reaches its maximum value, i.e., $\hat{R}_a = 0$. This, of course, represents the upper limit to which any tube can be driven in a low frequency amplifier.

Fig. 3b shows the wave shape of the plate dissipation curve when V_g peak is so chosen that $R_a = R$ when V_g reaches its maximum value, i.e., $\hat{R}_a = R$, when R is the load resistance.

In the case of Fig. 3c, $R_a = \frac{1}{2}R$ when V_g reaches its peak value, i.e., $\hat{R}_a = \frac{1}{2}R$.

In the case of Fig. 3a, $R_a = 2R$ when V_g reaches its peak value, i.e., $\hat{R}_a = 2R$.

In plotting these curves it is assumed that two similar tubes are used in push-pull and biased to $I_a = 0$.

Consideration of the curves shown in Fig. 3 clearly shows that the wave shape of the plate dissipation curves varies considerably, and the maximum value of the averages can be determined mathematically.

The method of construction of the graphs on Fig. 3 is shown in detail in the case of Fig. 3a.

For a sinusoidal variation of the grid voltage

$$V_g = E_g \sin\theta \qquad (4)$$

Substituting (4) into (3), we get

$$W_a = cVE_g \sin\theta - c^2 RE_g^2 \sin^2\theta \qquad (5)$$

To find the area enclosed by graph W_a and the horizontal axis, it is necessary to integrate equation (5) with respect to θ and for the half cycle during which each valve is operative, the limits of θ are 0 and π. Therefore

$$\int_0^{\pi} W_a d\theta =$$

$$\left[-cVE_g \cos\theta - c^2 RE_g^2\left(\frac{\theta}{2} - \frac{1}{4}\sin 2\theta\right)\right]_0^{\pi} \qquad (6)$$

When $\theta = \pi$, $\sin\theta = 0$, $\cos\theta = -1$

When $\theta = 0$, $\sin\theta = 0$, $\cos\theta = +1$,

$$\therefore \int_0^{\pi} W_a d\theta = 2cVE_g - \frac{c^2 RE_g^2 \pi}{2} \quad \dots\dots\dots\dots (7)$$

Average dissipation per operative half cycle can be obtained by dividing equation (7) by π.

∴ Average dissipation per operative half cycle:

$$W_a \text{ average} = \frac{2c\,VE_g}{\pi} - \frac{c^2 RE_g^2}{2} \quad \dots\dots\dots\dots (8)$$

But $cE_g = \hat{I}_a$

$$= \frac{V}{R + \hat{R}_a} \quad \dots\dots\dots\dots (9)$$

where $\hat{R}_a$ is the value of the tube resistance when $V_g = E_g$, i.e., at crest of sine wave.

Substitute (9) into (8)

$$W_a \text{ average} = \frac{2V^2}{\pi(R+\hat{R}_a)} - \frac{V^2 R}{2(R+\hat{R}_a)^2} \quad \dots\dots\dots (10)$$

Let

$$R + \hat{R}_a = bR \quad \dots\dots\dots\dots (11)$$

Substitute (11) into (10)

$$W_a \text{ average} = \frac{2V^2}{\pi bR} - \frac{V^2 R}{2b^2 R^2}$$

$$= \frac{V^2}{R}\left[\frac{2}{\pi b} - \frac{1}{2b^2}\right] \quad \dots\dots\dots\dots (12)$$

Equation (12) gives the general equation for average plate dissipation over an operative half-cycle in terms of plate voltage, load resistance and "b", and b has been defined in (11)

For maximum value of W_a average, differentiate equation (12) with respect to b and equate to 0

$$\frac{dW_a}{db} = \frac{V^2}{R}\left[-\frac{2}{\pi b^2} + \frac{1}{b^3}\right] = 0 \quad \dots\dots\dots\dots (13)$$

$$\therefore \quad b = \frac{\pi}{2} \quad \dots\dots\dots\dots (14)$$

Now substitute (14) into (12)

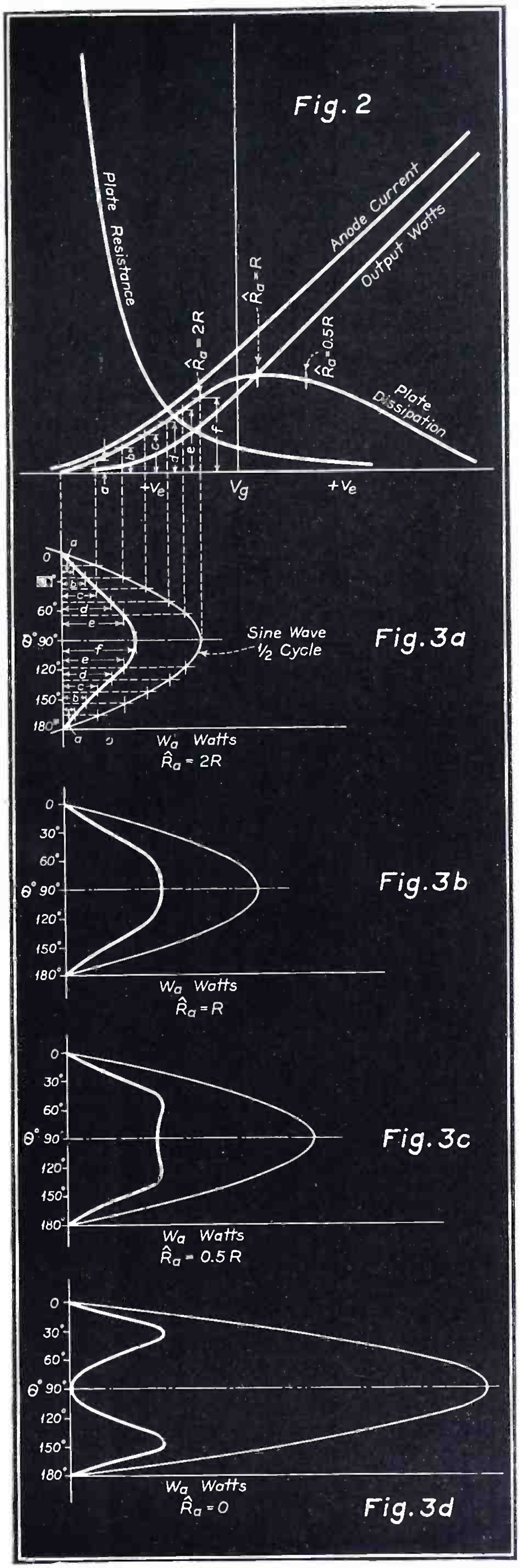
$$\text{Maximum value of } W_a \text{ average} = \frac{V^2}{R}\left[\frac{4}{\pi^2} - \frac{2}{\pi^2}\right]$$

$$= \frac{V^2}{R} \times \frac{2}{\pi^2} \quad \dots\dots\dots\dots (15)$$

It can be seen from the above that plate dissipation as averaged over the operative half cycle cannot exceed

$$\frac{2}{\pi^2} \times \frac{V^2}{R}$$

and the condition of maximum plate dissipation under which a tube will have to operate can, therefore, be determined from the known value of plate voltage and load resistance. Alternatively, the value of load resistance may be decided on by consideration of the maximum value of plate voltage and plate dissipation under which it is intended to use a particular type of tube.



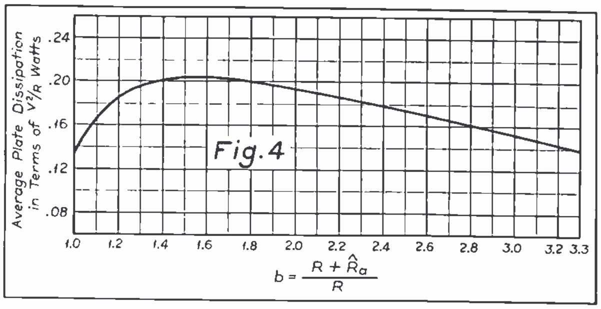


Fig. 4 shows a graph giving relation between b and plate dissipation in terms of $\frac{V^2}{R}$ (the values have been calculated from (12)). Inspection of this curve will show that if the tube is driven to its upper limit as referred to above, that is when $\hat{R}_a = 0$, the plate dissipation is $0.137 \times \frac{V^2}{R}$.

Having arrived at an expression in equation (12) for average plate dissipation, we can now derive a general expression for plate efficiency.

The output power of the amplifier is given by

$$W_o = \frac{\left(\frac{R}{R + \hat{R}_a}\right)^2 V^2}{2R} = \frac{V^2}{2\,b^2 R} \qquad \text{...............(16)}$$

Therefore efficiency E% =

$$\frac{\frac{V^2}{2\,b^2 R} \times 100}{\frac{V^2}{2\,b^2 R} + \frac{V^2}{R}\left(\frac{2}{\pi b} - \frac{1}{2\,b^2}\right)} = \frac{100\,\pi}{4b} \qquad \text{...............(17)}$$

When $\hat{R}_a = 0$
$b = 1$

$$\text{Efficiency} = \frac{\pi}{4} \times 100 = 78.5\%$$

which is the highest plate efficiency that can be obtained.

CONSUMERS' RESEARCH LOOKS AT RADIO

(*Continued from page* 13)

and undoubtedly worthy of a trial at least. It would remove the stigma of adding another gadget to increase the selling price; it should do away with both tone controls and variable selectivity controls. But it ought to keep everybody happy—the coil people would still sell their variable coupling coils (although the variable feature would be under lock and key in so far as the average used was concerned); the set manufacturer could claim, with a fair degree of truthfulness, that each of his sets would be individually adjusted to the requirements of the user.

In concluding this analysis of some of the faults which Consumers' Research finds with the present-day radio sets, we are impressed especially with one point—the discussion given in their report on the matter of safety from electrical shock. Speaking subjectively for a moment, this writer in a varied career has been closely associated with organizations and individuals intensely interested and concerned with safety in industry—and in the home. We can state unequivocally that many of these former associates felt so keenly the danger imminent in the average radio set that their families were, literally, forced to do without sets in their homes; and in those homes where they were grudgingly permitted, the sets were so hedged about with safeguards (*not* put there by the manufacturer) that they were almost reminiscent of a high-voltage switchboard.

Not so long ago the metropolitan press carried a story of the electrocution of a youth who, in attempting to remove a tube from the socket—with the set "on"—came into contact with the tube prongs and some grounded object at the same time. Presumably, the contact with the tube prongs was established before the prongs had entirely left the grip of the socket springs. Such an occurence ought to be impossible. In the first place, it should be made impossible to get at the chassis, *even for tube replacement purposes,* when the set is connected to the line. Service men, and others who appreciate the inherent danger, would not be seriously handicapped by this.

The question of ac-dc receivers, with their direct connection to the line, is of sufficient importance to warrant the most serious consideration. Chief among the points to be considered is that of providing a ground connection for these sets—which would probably mean doing away with the idea of using the chassis for a common return circuit; this would not be such a bad idea even for those sets which are isolated from the line by a transformer. The use of a high-conductivity ground bus might assist in the elimination of some of the miscellaneous noises that are due to the admixture of 60 cycle, direct, audio- and radio-frequency currents, all trying to get to ground through a conductor that, at best, may not be any too good electrically.

The matter of making radio sets safe is an urgent one and deserves immediate study. The problem is not insurmountable, nor is the cost of making a set safe anything to become alarmed about.

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INDUCTANCE OR CAPACITY TUNING?

by W. E. Bonham

Laboratory Instructor, Signal Corps School, Fort Monmouth, N. J.

PART I

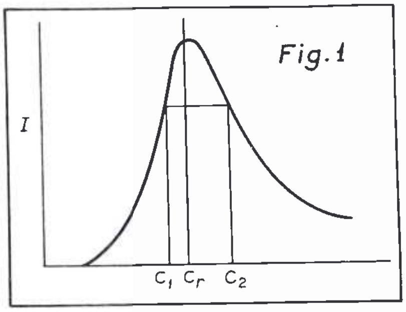


Fig. 1

THERE IS SELDOM a thorough distinction made on the difference of obtaining resonance by varying inductance and by varying capacity. It is not the object of this article to favor either variable, but instead to show in as simple a manner as possible some of the more practicable effects which are produced in the circuit by obtaining resonance with either variable.

Because of the importance of the parallel circuit in the role of tuning and filtering, and because of its greater complexity, more stress is placed upon this circuit.

The indication of resonance in the series circuit is a maximum of current at unity power factor. The parallel circuit shows two conditions of unity power factor resonance, except under conditions as indicated later; and one condition of minimum external current at which the impedance of the parallel combination becomes a maximum.

If a circuit containing inductance, resistance and capacity in series is excited at some frequency and the capacity is varied over a suitable range, a current-response curve of the type shown in Fig. 1 is obtained. This is the curve of

$$\frac{1}{\sqrt{R^2 + (\omega L - 1/\omega C)^2}}$$

where C is the variable. The non-uniformity of the curve is due to the inverse variation of the capacitive reactance with the capacity. It requires a greater amount of capacity above the optimum setting C_r than below to produce the same response. If several frequencies exist, about equally spaced and the capacity is varied to pass the circuit through resonance with each of them, the full response to each is obtained with a lesser change in the capacity on the approach to resonance from the minimum capacity upwards than from the maximum downward, giving the effect of quick tuning in and slow tuning out when the capacity is increased, and the reverse effect when the capacity is decreased.

If C_1 is the setting at which the predominating capacitive reactance is equal to the circuit resistance, and C_2 is the setting at which the predominating inductive reactance becomes equal to the resistance, these two settings can be used as a measure for the degree of selectivity of the circuit. Then,

$$\omega L - \frac{1}{\omega C_1} = \frac{1}{\omega C_2} - \omega L = R \quad \ldots . (1)$$

$$\omega = \sqrt{\frac{1}{L C_r}}$$

thus,

$$\frac{R}{\omega L} = \frac{1}{2}\left(\frac{C_2 - C_1}{C_2 C_1}\right) C_r \quad \ldots\ldots (2)$$

For each new frequency value assigned ω, there is a new value of C_r which gives resonance and this capacity will vary as $1/\omega^2$. For each new value of C_r, the settings C_1 and C_2 give new values to suit the equation (1). As C_r is varied, in equation (2), with R and L constant, the corresponding changes of ω, C_1, and C_2 maintain the equation at a constant value. Since the equation is a measure of the selectivity, it is seen that varying the capacity in the circuit tends to maintain a uniform degree of selectivity. The changing L/C ratio and the corresponding resonance frequency change so work together that the effects of each, in tending to change the selectivity, balance out.

A uniform degree of current response in the circuit may not be of any advantage, even though the response current remains at a constant value, if the reactance voltage drop across either the inductance or the capacity is to be used to excite the grid circuit of an amplifier, since the reactance voltage drop increases with the frequency. This means that the circuit gain factor varies inversely as the capacity is varied. But the resistance due to skin effect also increases with the frequency, which in turn lowers the response current to keep the circuit gain factor from increasing as fast as the increasing resonance frequency. The selection in the size of the circuit conductor can be such as will exactly compensate for the rising gain factor, but this in turn means a sacrifice in the selectivity as the resonance frequency increases. If a uniform degree of selectivity and gain factor is required over the entire tuning range of the capacity, the conductor must be selected of such size that the increase in the resistance with the frequency will not exceed a certain small percentage, and the exciting voltage must vary inversely with the frequency. The current response curve obtained as the inductance is varied and the frequency fixed, is symetrical on either side of the optimum setting as shown in Fig. 2. This curve is plotted from the same equation as that for the varying capacity. Its uniformity is due to the linear change of the inductive reactance with the inductance.

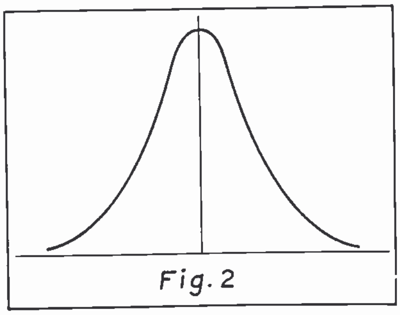


Fig. 2

By an elementary analysis of the series circuit it can be shown that a change in the L/C ratio which affects the circuit selectivity by a certain amount also produces the same change in the resonance frequency which would affect the selectivity by the same amount. The increase of the inductance increases the L/C ratio and decreases the resonance frequency; thus when the inductance is the variable, the selectivity of the circuit is affected by the amount of the product of the effects of both the changing L/C ratio and the changing frequency. Since the two effects are equal and since the frequency varies as $1/\sqrt{L}$, it follows that the selectivity varies inversely as the change of the inductance, if the resistance remains constant. Since the resistance decreases with the decrease of frequency it is seen that the tuning of a circuit by varying the inductance causes the selectivity of the circuit to change rapidly with the inductance.

The general case of the parallel circuit is that of Fig. 3 which contains resistance in both of the branches. The inductive reactance voltage drop and the drop across the resistance R_L must add vectorially to equal the applied voltage regardless of the value of each. All the possible combinations of the voltage drops in this branch cause a semi-circle to be traced as shown in Fig. 4a. Two possible combinations are shown in this figure. The greater the $\omega L/R_L$ ratio the greater becomes the inductive reactance voltage drop and the less the resistance voltage drop, and the greater becomes the phase angle ϕ_L. Likewise in Fig. 4b the greater the capacitive reactance voltage drop compared to the i_cR_c drop, the greater is the phase angle ϕ_c. The current in each branch is proportional to the IR drop, thus the IR vectors in Figs. 4a and 4b can represent the relative magnitude and the exact phase angle of the current in each branch. In Fig. 5 the upper half of the circle whose center is O′ represents the trace of the current in the capacitive branch and the lower half of the circle represents the trace of the current in the inductive branch. The currents of both branches trace within the same circle since the plotting of the figure is based upon the voltage drop across each branch being the same. In this figure let the current through the capacitive branch be fixed as indicated by the vector i_c; then as the inductance is varied, so that the current in the inductive branch passes through the values i_{L2}, i_{L3} and i_{L4}, the vector addition with the capacitive current i_c causes the external current to assume the values I_1, I_2, I_3, I_{min} and i_c along the trace of the projected semi-circle whose center is P. It is obvious that the external current reaches its maximum value at I_1, becomes in phase with the voltage at two values, I_2 and I_3, and reaches its minimum value at the particular point I_{min}. I_{min} is known as the minimum current resonance condition and is that adjustment of the circuit at which the impedance of the parallel combination becomes a maximum when the inductance is the variable. I_3 is the unity power factor resonance condition which enables the maximum of power to exist in the parallel combination. This unity power factor resonance condition and the minimum current resonance condition do not differ much when the resistance of both the branches is considered negligible. The unity power factor resonance condition I_2 has no value for tuning or filtering purposes, but offers unlimited advantages as an "in-phase shifting circuit" when the resistance of both branches is made equal and adjusted as follows:

When the inductance is adjusted so that the external current becomes I_2 (the current which would flow through the inductive branch when the inductance is decreased to zero) and the resistance R_c is made equal to R_L and the frequency is increased from zero, the current in the capacitive branch traces along the upper semi-circle $0 - i_c - I_2$ while the current in the inductive branch traces along the lower semi-circle in the reverse direction and at a rate such that the vectorial addition of the two currents at any value of the frequency always results in the same in-phase current I_2. This seems a strange circumstance, since regardless of the frequency applied to the circuit, the external current remains constant in value and in phase with the voltage, and its value is determined by the resistance of either branch. In the parallelogram $0 - i_c - I_2 - i_{L2}$, the vector i_c is proportional to the drop across the resistance R_c and the side "a" is proportional to the inductive reactance drop across L; thus $i_cR_c = i_L\omega L$ so that $\omega = \frac{i_cR_c}{i_LL}$, and in a similar manner i_{L2} is proportional to the voltage drop across R_L and the side "b" is proportional to the reactance drop across the condenser C. Thus also, $\omega = \frac{i_c}{i_L R_L C}$, so that $R_cR_L = L/C$. Since the resistance in both of the branches is the same, we may say that $R_cR_L = R^2$; then

$$R = \sqrt{L/C} \quad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

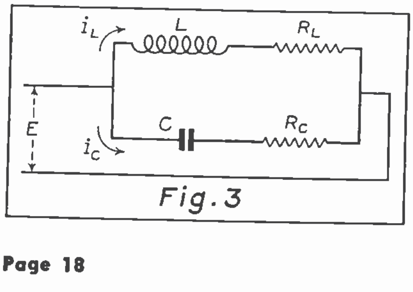


Fig. 3

Thus when the two resistances are equal and in turn equal to the square root of the L/C ratio, the circuit shows a constant value of impedance to all frequencies, and this impedance is equal to the resistance of one of the branches. The circuit thus has unity power factor for all frequencies. Also if the two resistances are unequal there is some setting of the inductance and frequency which the peculiar unity power factor condition obtains, but only for this one frequency and inductance setting.

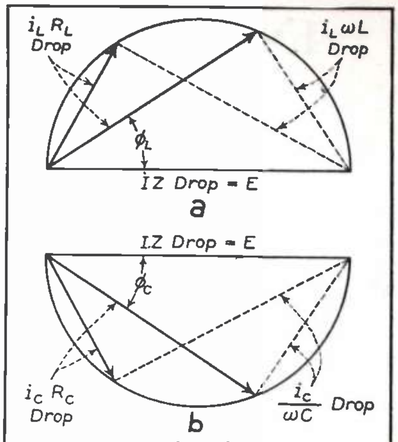


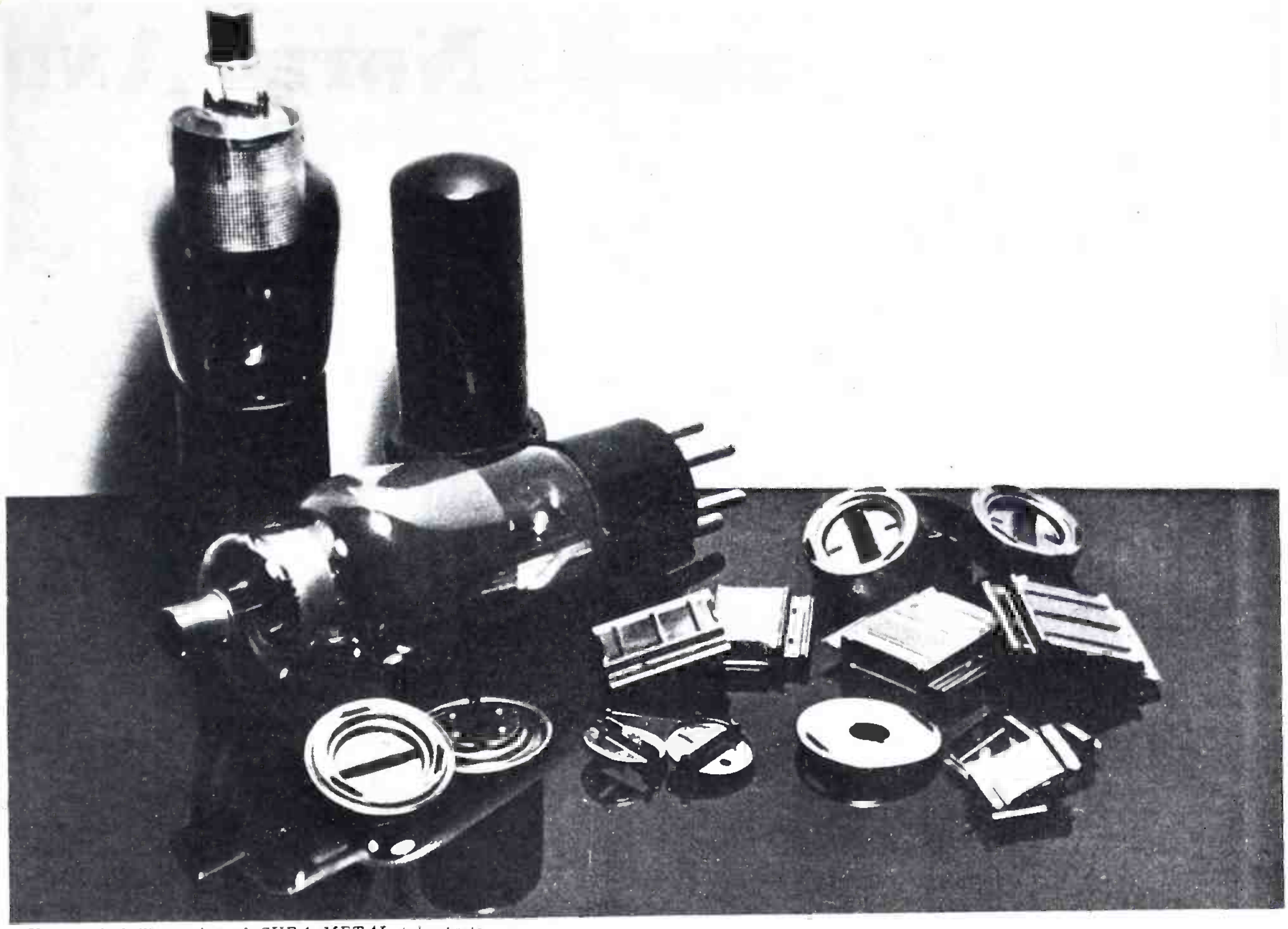
Fig. 4

By selecting low values of resistance and adjusting the L/C ratio to suit these low values of resistance, the current can be maintained constantly in phase with the voltage without causing appreciable loss or voltage drop.

The unity power factor resonance condition I_3 is that condition of resonance which must obtain when the maximum power is to be delivered into a circuit which may be coupled to it. This unity power factor resonance condition differs greatly from the peculiar unity power factor condition at I_2.

The current which flows through the inductive branch of the parallel circuit may be considered as comprising an active component which must be in phase with the voltage because of the resistance R_L, and a reactive component which must lag the voltage by 90 degrees because of the inductance. This reactive component of the current must be equal to $i_L \sin \phi_L$. Likewise, the current through the capacitive branch may be considered as comprising an active component in phase with the voltage because of the resistance R_c, and a reactive component which leads the voltage 90 degrees because of the capacity. This reactive component must be equal to $i_c \sin \phi_c$. Since the active components are in phase with the voltage, even in the external circuit, it follows that at unity power factor resonance the two reactive components must be equal in order to balance out in the external circuit. Thus, at the unity power factor resonance condition (resonance at I_3), $i_L \sin \phi_L = i_c \sin \phi_c$, in which i_L and i_c are equal to the reciprocal of the impedances of the inductive and the capacitive branches respectively. Thus,

(*Continued on page 31*)



Unretouched illustration of SVEA METAL tube parts.

SVEA METAL

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Swedish Iron & Steel Corporation

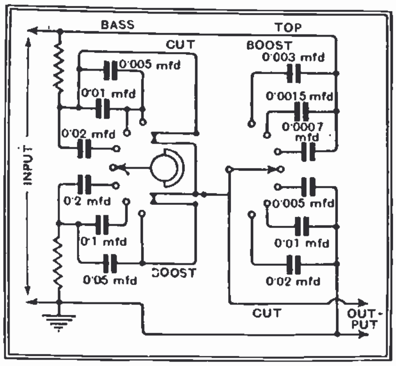
17 BATTERY PLACE NEW YORK CITY

A TONE-CONTROL CIRCUIT

A NOVEL METHOD of tone control or compensation was described in a recent issue of *The Wireless World**. Using as it does only resistances and condensers, this system should answer some of the objections advanced to the Barber system (RADIO ENGINEERING, June, 1936), which uses iron-core coils; inductive pickup, which has been experienced to some extent due to the proximity of the coils to parts of the circuit carrying 60-cycle current, is, in this later circuit avoided. However, it is to be borne in mind that any such arrangement must be carefully laid out since, presumably, the tone compensation should be effected at a low-level part of the circuit.

The accompanying circuit schematic indicates how the low- and high-frequency compensation are obtained. The input, from a preceding stage, is applied to a voltage divider having a ten to one ratio. In order to reduce the high-frequency response, a capacity is shunted across the "low" end of the divider network; this reduces the effective impedance and hence the voltage appearing across this part of the circuit. The capacity becomes effective only when its reactance is comparable with the resistance across which it is connected. At higher frequencies the reactance decreases until it becomes an effective short circuit. Variation of the capacity, in a manner as shown in the schematic, enables the point at which

*June 25, 1937.



The tone control circuit.

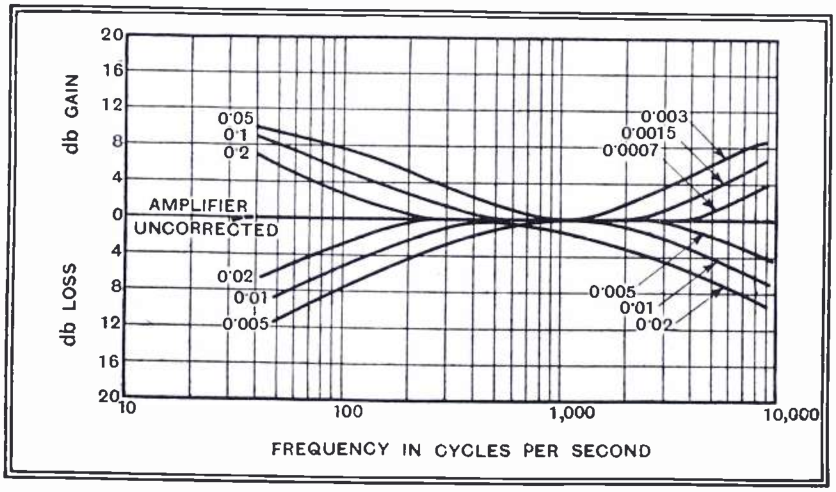
the reduction starts to be chosen by the user.

To increase the high-frequency gain, the condenser is shunted across the "high" side of the divider. When the reactance of this condenser becomes comparable with its shunting resistance, it causes more and more of the signal—again depending upon frequency—to be passed on to the following stages. At a frequency sufficiently high, the upper portion of the divider will be essentially short circuited, thus passing on practically all of the signal voltage.

Low-frequency control is effected by means of condensers in series with either portion of the voltage divider. For the reduction of low frequencies, the capacity is in series with the "high" side of the divider; here its action likewise depends upon frequency, the reactance increasing with decreasing frequency. Obviously, this has the effect of changing the location of the tap on the divider; as the low-frequency limit is approached, less and less of the voltage is made available for the following stages.

By introducing the condenser in series with the "low" side of the divider, exactly the opposite effect obtains, i. e., the location of the tap on the divider is in effect again changed, this time to increase the voltage passed on to the following stages.

It should be noted that extra points are provided on the tone-control switch, as shown in the schematic, to short the series condensers in whichever part of the voltage divider is not being used; if this is not done, the two effects—increase and reduction of the low frequencies—would be opposing each other.



Response characteristic of the tone control. Notice that the point at which control starts is varied rather than the slope of the curves.

SOME NOTES ON SOLDERS

THE SOLDERS that are made only of tin and lead in the various mixtures or alloys are known as soft solders. Those known as hard solders are composed of alloys of various metals—they, as a general rule, have high melting points.

Soft solders, depending on the alloy of tin and lead, have melting points ranging from 358° F. to approximately 500° F. Contrary to the general opinion, lead, which is a soft metal, has a higher melting point than tin, the latter metal, being comparatively speaking, a hard metal. The melting point of tin is approximately 450° F., the melting point of lead approximately 620° F. In alloying these two metals in making soft solders, strange and interesting melting points of the alloys result. As an illustration—equal parts of tin and lead, or a 50/50 solder, has a melting point of approximately 415° F. It will be noted that this is a melting point even lower than that of tin.

An alloy of 63 percent tin and 37 percent lead, which is known as the eutectic, or perfect combination, has a melting point of 358° F., almost 100° lower than the melting point of tin. This alloy unfortunately, for general work, is not practical. First of all, on account of the high cost and, secondly, it flows at too low a temperature for most purposes.

COMMENT . . *Production*

This alloy has, however, good tensile strength.

All solders start to melt at the same temperature, namely, 358° F. To turn them into a complete liquid means a greater amount of heat in accordance with the lead content. It makes no difference whether soft solders in various alloys are made in wire, bar, ingot or even a cored-solder form. They all have the same characteristics.

Fusible solders are generally of low melting points. They are made of various combinations of tin, lead, bismuth and cadmium. Some of these alloys melt as low as 120° F. One important use of this type of solder is in automatic sprinkling systems for fire protection.

James C. Shaw,
GARDINER METAL CO.

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THE MEASUREMENT OF NOISE LEVEL IN RECEIVERS

THE NOISE LEVEL—the point where the signal is overridden by noise is the limitation in the pickup ability of radio receivers. In household receivers, using comparatively large antennas, this limiting noise is generally that picked up in the antenna along with the signal. However, in other installations, particularly in auto radio, the effective height of the antenna is so low that the noise generated by the set itself may be greater than that coming in on the antenna. The importance of internal noise in this type of radio application has caused a considerable amount of work to be concentrated on reducing its effect.

As is well known, the limiting noise in receivers is due to tube and circuit noises arising chiefly from Schott effect or thermal agitation. Practically speaking, the only serious source of noise is the thermal agitation voltage due to the random motion of electrons. This noise is generally expressed as a certain number of equivalent microvolts corresponding to microvolts of signal that would have to be applied to produce the same output. The noise output will of course depend upon the bandwidth passed by the receiver, and the gain.

In rating receivers the measure of comparison has generally been the noise-to-signal ratio, obtained by taking the ratio of voltage output with and without modulation. This is obviously very unsatisfactory since the ratio depends entirely upon the gain in the receiver; any satisfactory factor should be independent of the receiver gain. Such a factor is very easily arrived at by multiplying the noise-signal ratio, as above defined, by the sensitivity of the receiver in microvolts. This may be conveniently christened the noise factor, and is more specifically defined by:

$$\text{Noise factor} = C \times \frac{E_n}{E_s} \times 100$$

C = Sensitivity in microvolts.

E_n = Volts of noise output without modulation.

E_s = Volts of signal output with 30% modulation.

This factor is independent of gain, if the noise arises at a single circuit point and the band width is constant with gain. This is easily seen since $\frac{E_s}{e}$ = gain of amplifier = G, and E_n is equal to a constant times GE_n. The noise factor is then proportional to E_n or the inherent noise voltage developed, which is independent of the subsequent gain.

The noise factor is very useful in design work, as it enables one to avoid the confusing effect of gain as affecting noise output. Some of its other applications are: interpreting noise decay curves, indicating regeneration, calibration of signal generators, etc. It may be interesting to note the value of the factor under some typical conditions. Applying signal to the grid of a 6D6 in an r-f stage, which is followed by an amplifier having average selectivity (6.0 kc wide at two times down), the noise factor is 276.* Substituting a 6F5 triode for the pentode reduces the nf to 60. These figures will, of course, vary with the voltages on the tube elements, but are relatively constant for any other variables in the receiver. In car radios the nf measured at the antenna varies, in commercial receivers, from ten to seventy. The theoretical limit that can be attained is fixed by the r-f resistance of the antenna and is of the order of two for the average under car antenna.

In plotting noise decay curves, it is customary to plot milliwatts noise versus applied microvolts, holding the signal output constant. Such a curve gives no readily seen measure of proper design. If instead of plotting milliwatts noise, we plot nf versus applied microvolts, it is evident immediately whether or not optimum performance is being obtained. In a set without regeneration, this factor will, under ideal conditions, be a constant independent of the microvolts being applied. If the nf increases with input it indicates that a secondary noise source is becoming equal to the primary noise source. This condition would be encountered for example if the avc voltage is improperly applied to an r-f stage succeeded by a modulator. The initial noise factor would be that due to the noise of the r-f tube alone, since the succeeding gain would swamp out the converter noise. However, if the r-f stage gain is reduced too rapidly by the avc the converter noise becomes effective and the noise factor increases. Having a proper measure of the decay curve is important since a receiver with an initial noise factor of fifty may very easily reach 300 with applied signals of the order of 100 μv. Obviously a low noise factor at the point where sensitivity is measured is meaningless, if under the higher signals encountered in actual use it rises to such absurdly high values.

A very interesting and useful application of the factor is the calibration of signal generators, where a standard generator is not available for comparison. Knowing the noise factor on a receiver, it can be used to calibrate a generator by taking "e" as the unknown in the equation for noise factor and solving for it in terms of E_n, E_s and nf. Instead of a receiver of known noise factor, the signal may equally well be applied to the first tube in a receiver; the noise factor at this point can easily be calculated from available data on equivalent grid noise microvolts for that particular tube. The foregoing necessarily assumes that the band width is either known, or assumed. Assuming an average band width of 6.0 kc at 2 times down will give results sufficiently accurate in most cases. For accurate measurements the method is inherently capable of a high degree of precision as it gives a comparison between a thermal agitation voltage (which can be accurately calculated for a tuned circuit by well known formulae), and the unknown signal in microvolts applied from the generator.

A. G. Tynan,
General Motors Corp.

* Dividing by 0.3 to take the percent modulation into account, this is equal to 0.92 μv of equivalent noise volts on the grid. This agrees fairly well with published data.

RMA NEWS

THIRTEENTH RMA CONVENTION LARGEST INDUSTRY GATHERING IN SEVEN YEARS

The largest industry conclave since 1930—in point of attendance, optimism and constructive action—developed at the thirteenth annual RMA convention, June 8 and 9, at the Stevens Hotel, Chicago. There were many committee and group meetings for promotion of radio interests, with several hundred RMA members in attendance and nearly 600 turned out at the "RMA Cabaret" and annual industry banquet, the biggest and most successful since 1930.

President Leslie F. Muter, who presided, was reelected for a fourth term, the first RMA president so honored. Other officers reelected were: Vice-President and Chairman of the Set Division, Arthur T. Murray of Springfield, Mass.; Vice-President and Chairman of the Tube Division, B. G. Erskine of Emporium, Penna.; Vice-President and Chairman of the Parts Division, Arthur Moss of New York City, N. Y.; Vice-President and Chairman of the Amplifier and Sound Division, Peter L. Jensen of Chicago, Ill.; Treasurer, Fred D. Williams of Philadelphia, Pa.; Executive Vice-President and Secretary, Bond Geddes of Washington, D. C.; General Counsel, John W. Van Allen of Buffalo, N. Y.

New services for RMA members and industry promotion were developed at meetings of the Set, Tube, Parts and Amplifier Divisions, and of the Association's Board of Directors, its export, credit, engineering, and other committees.

Sales promotion and employment problems were outstanding discussions of the convention. At the RMA membership luncheon meeting on June 8 the Wagner Act was discussed by Judge Van Allen, RMA general counsel, and sales promotion in cooperation between RMA and the Department of Commerce by John H. Payne, chief of the Electrical Division, U. S. Bureau of Foreign and Domestic Commerce, Washington, an official guest of the Association.

The Wagner Labor Act fails to protect both employers and employees, Judge Van Allen stated in his address. Control of labor unions and regulation of picketing was urged. While business and industry are strictly regulated, Judge Van Allen declared that the Wagner Act fails to similarly control union operations and subjects minority employees, as well as employers, to coercion and intimidation by "outside" pickets.

"Congress knows these defects exist and still does not remedy them," said Judge Van Allen. "If the law is admittedly defective, why wait for some catastrophe to happen before taking steps to prevent it? Today, freedom of men employed is menaced by unscrupulous practices of outsiders in seeking to procure by threats, intimidations, coercion and extravagant claims, the right to act as a bargaining agency for hire and by outside pickets never in the employ of those against whom they strike."

Many measures in behalf of the industry and to extend RMA activities were taken during the Chicago convention by the Association's Board of Directors and special Divisions. The Board authorized further exchange between Association members of employment data and expansion of RMA sales promotion work, both in the United States and abroad. Action in tube merchandising problems was authorized by the Tube Division, under the chairmanship of David T. Schultz of New York. The Parts and Amplifier Divisions also authorized numerous activities on behalf of these special groups, and arrangements were made for joint action by the Set and Tube Divisions to reduce the multiplicity of tubes in use.

The "RMA Cabaret" and annual industry banquet on Wednesday evening, June 9, in the Grand Ball Room of the Stevens Hotel, was the largest industry turnout since 1930. Nearly 600 Association membership guests enjoyed the cabaret program arranged by Chairman A. S. Wells and the Convention Committee. During the evening the associates of President Muter on the RMA Board presented him with a gold watch in appreciation of his work during the past year. Chairman Wells presented Paul V. Galvin of Chicago who made the gift presentation to Mr. Muter.

Enlargement of the RMA Board of Directors, to make it more representative, was proposed during the Chicago convention. Increase of the RMA Board from eighteen to twenty-five members by addition of three more set manufacturers and four more parts manufacturers as directors was proposed through the suggested change in the Association's By-Laws which will be submitted to the RMA membership. Two new directors were elected immediately, David T. Schultz of New York by the Tube Division, and Philip C. Lenz of Chicago by the Parts Division. Directors Paul V. Galvin of Chicago, Arthur T. Murray of Springfield, Mass., David Sarnoff of New York and James M. Skinner of Philadelphia were reelected by the Set Division for terms of three years. Arthur Moss of New York from the Parts Division, and Peter L. Jensen of Chicago from the Amplifier and Sound Division also were reelected directors.

In the plan to enlarge the RMA Board, which will become effective July 31, the Set Division chose P. S. Billings of Chicago, S. T. Thompson of Long Island City, and Ernest Alschuler of Chicago for new directors, while the Parts Division chose H. E. Osmun of Milwaukee, Ray F. Sparrow of Indianapolis, J. J. Kahn of Chicago, and S. I. Cole of New York as the four new directors upon enlargement of the governing Board.

CONVENTION REPORTS

Detailed reports of the Chicago convention of RMA, including those of President Muter, Treasurer Williams, all Division and Committee chairmen, and the address of Judge Van Allen of Buffalo are being prepared and will be forward to all RMA members.

MARCH LABOR INDICES

Increased working hours and a slight decrease in employment in the radio manufacturing industry were detailed in the latest report, for March 1937, of the U. S. Bureau of Labor Statistics. Smaller radio employment in March was said in the government report to be seasonal.

Radio factory employment in March decreased 4.5 percent but was 6 percent higher than March 1936. The March 1937 radio employment index figure was 163 percent, compared with February index figure of 170.6 percent.

Radio factory payrolls last March increased 2.3 percent over the previous month and were 21.2 percent above March 1936. The March index figure on payrolls was 127.1 compared with 124.2 during the previous month of February.

Average weekly earnings last March of radio factory employees were reported at $20.36, an increase of 7.1 percent over the February average earnings of $19.11, and the March earnings were 14.2 percent above March 1936. The March 1937 national average weekly earnings of all manufacturing industries was $25.54, while the national average of all durable goods manfacturing establishments was $28.78, both increased a small percentage above February.

Average hours worked per week in radio factories last March were 36.5 hours, an increase of 7.5 percent over the February average of 34.1 hours, and the March average was 10.8 percent above that of March 1936. The national average work hours of all manufacturing industries during March was 41.0 hours, while the national average work hours of all durable goods manufacturing industries was 42.4 hours, both increased slightly over one percent as compared with February.

Average hourly earnings last March of radio factory employees was 56 cents, the same as the previous month of February, and they were 3.5 percent above average hourly earnings during March 1936. The National average hourly earnings of all manufacturing industries in March 1937 was 61.3 cents, while the national average of all durable goods manufacturing industries was 67 cents, the former increased 2.1 percent and the latter 3 percent over the previous month of February.

BROADCASTERS CONVENTION

The annual convention of the National Association of Broadcasters was held June 20-22, at the Sherman Hotel, Chicago. The RMA was represented at the broadcasters' convention by Bond Geddes, executive vice president of RMA.

(Continued on page 30)

NOTICE!

RADIO ENGINEERING SUBSCRIBERS

1. Effective August 1, 1937, and thereafter until further notice, no subscription salesmen, solicitors, agents or field men will be employed by RADIO ENGINEERING. All subscriptions, both new and renewals, must be mailed directly to the publisher, Bryan Davis Publishing Co., Inc., or to RADIO ENGINEERING Magazine, 19 East 47th Street, New York, N. Y.

2. We have been compelled to adopt this policy in order to protect our subscribers against unathorized persons, who have in some cases imposed upon prospective subscribers.

3. After August 1, 1937, *no one* is authorized to solicit subscriptions or collect money for subscriptions to RADIO ENGINEERING.

4. Mail all new and renewal subscriptions direct to the publisher.

RADIO ENGINEERING
BRYAN DAVIS PUBLISHING CO., INC.
19 East Forty-seventh Street
New York, N. Y.

NEWS OF THE INDUSTRY

STURDEVANT APPOINTED CONSULTANT

United States Rubber Products, Inc., 1790 Broadway, New York City, has appointed Dr. Earl G. Sturdevant as Consulting Engineer of its Electrical Wire and Cable Department.

Since 1920, when he took his doctorate at the University of Michigan, Dr. Sturdevant has been connected with many important scientific developments in the rubber field. After a two-year interval of teaching at the University of Western Ontario, he joined the technical staff of Western Electric. While there he developed a method of continuous cure for rubber-covered wire.

Dr. Sturdevant joined United States Rubber Products, Inc., in 1929, coming directly from Western Electric. His work in cooperation with the development staff at their General Laboratories in Pasaaic was outstanding. He contributed in the work of commercially applying the process of the Hopkinson and Gibbons patent for forming a rubber thread directly from latex. This process is used in making the elastic core of "Lastex," the miracle yarn used so extensively in various types of elastic fabrics.

In 1931 Dr. Sturdevant was appointed Development Manager of the Electrical Wire and Cable Department, where he contributed to the successful development of "Laytex."

— RE —

GENERAL CABLE APPOINTEE

General Cable Corporation announces the appointment of R. S. Hopkins as Manager of the New York Sales Office, 205 East 42nd Street.

— RE —

ELSBERT CO. FORMED

B. J. Grigsby, president, announces the organization of Elsbert Manufacturing Co., Inc., with offices and factory at 353 West Grand Avenue, Chicago.

Mr. Grigsby organized and was president of the former Grigsby-Grunow Company. Other officers of the new company are: Raymond J. Grigsby, vice-president, O. E. Grigsby, secretary, and H. E. Kranz, chief engineer.

The company is developing and will shortly begin manufacture of a new type of slow speed high torque fractional horsepower electric motor; also, ignition devices and systems for greater efficiency in internal combustion engines, particularly with low-grade fuel.

— RE —

KUNKLER JOINS NATIONAL UNION

S. W. Muldowny, National Union Board Chairman announced this week that Homer H. Kunkler has been appointed General Sales Manager of National Union Radio Corporation.

Mr. Kunkler is well known to the radio trade; he was Manager of Distribution for the U. S. Radio & Television, Assistant General Sales Manager of General Household Utilities and held a similar position with Stewart Warner.

National Union has recently opened a Chicago office, located at 540 North Michigan Avenue and Mr. Kunkler will divide his time between National Union's Chicago office and the New York headquarters.

ARCTURUS PUBLISHES REVISED TUBE INDEX

An up-to-date index of all broadcast receiving tubes has just been published by the Arcturus Radio Tube Company, Newark, N. J. The index serves as a quick reference source for ascertaining the purpose of any specific tube. Every tube is identified by filament voltage, filament current, whether filamentary or cathode type, description of its function and the number of useful elements.

Three hundred and thirty tubes are listed in this index which is a ten-page letterhead size pamphlet. Space is provided in the directory so that any new tubes which may be placed on the market for years to come can be readily entered in proper numerical order.

— RE —

SHURE 1938 CATALOG

A new, completely revised six-page catalog of Microphones and Acoustic Devices has just been published by Shure Brothers, 225 W. Huron Street, Chicago.

Among the new items described in the catalog are the "Tri-Polar" Controlled-Direction Crystal Microphone, providing switch-controlled uni-directional, bi-directional and non-directional response in one unit, "Military-Type" hand microphones, designed to fit in the hand, improved "Communications-Type" microphones, "Transcription" Record Reproducers, and Vibration Pickups.

Copies of the catalog are available on request.

— RE —

ESTABLISHES NEW YORK OFFICE

Designers for Industry, Inc., of Cleveland, Ohio, industrial designers and product stylists have established New York quarters in International Building, Rockefeller Center, according to announcement by Chas. H. Oppenheimer. A designing staff will be maintained in the New York office which is in charge of H. C. Gooding who was transferred from the Chicago office to become business manager for the Eastern district. George E. Henry, formerly associated with the business paper field, has been appointed sales promotion manager with headquarters in the New York office.

— RE —

FLAT SPRING DESIGN

The Beryllium Corporation of Penna., Reading, Pa., has issued bulletin "D" on the subject, How to Design Flat Springs to Meet Definite Requirements. This bulletin should be of interest to manufacturers having flat spring design problems. Copies will be supplied upon request to the company.

— RE —

SPRAGUE CATALOG

The 1937 catalog of Sprague condensers has been issued by the Sprague Products Company, North Adams, Mass. Copies will be furnished to those requesting them.

HOLYOKE CHANGES NAME

It has been announced that the Holyoke Co., Inc., of Holyoke, Mass., will be known in the future as the Holyoke Wire and Cable Corporation.

— RE —

DU PONT BOOKLET

A booklet describing Neoprene, Du Pont's artificial rubber, has been published by that company. Copies may be obtained by writing to E. I. Du Pont de Nemours & Company, Wilmington, Del.

— RE —

SYLVANIA TRANSFERS FAIRBANKS

Hygrade Sylvania Corporation announces the transfer of Howard J. Fairbanks, Sylvania tube sales representative, from the Baltimore to the Pittsburgh sales division, where he will be in charge of tube sales. He replaces B. J. Erskine, who has joined the administrative department in the Emporium, Pa. offices of the company.

— RE —

AIR EXPRESS SHIPMENTS UP 35 PER CENT

Nation-wide air express shipments for May increased 35 percent over May a year ago, according to announcement by the Air Express Division of Railway Express Agency. May shipments totaled 49,383.

Outbound shipments from New York City for May showed an increase of 50 percent compared with the corresponding month in 1936. Combined outbound and inbound at New York for the month, totaling 22,237, increased 37 percent, it was said.

— RE —

OGLE JOINS MALLORY

C. R. Ogle, recently Secretary and Sales Manager of the B-L Electric Manufacturing Company, has joined the sales organization of P. R. Mallory & Co., Inc., manufacturers of rectifiers, battery chargers, radio, electrical and metallurgy products.

Mr. Ogle, whose activities in the electrical field covers a period of over twenty years, will be associated with the rectifier sales activities of the Mallory Company.

— RE —

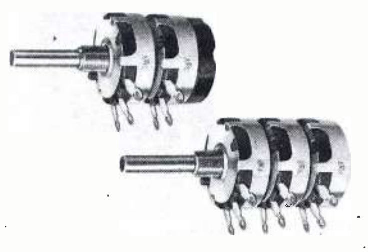
WASHER DATA CHART AVAILABLE

The Wrought Washer Mfg. Co. of Milwaukee, Wis., producer of washers, expansion plugs, stampings, tools and dies, serving the radio industry, has announced the publication of a special washer data chart available to manufacturers upon request.

This new specification table, printed on heavy index bristol and suitable for hanging in stock room, warehouse, engineering department, production department, etc., contains complete size and dimension data of the entire range of standard wrought washers, including outside diameter, inside diameter, gauge and fractional equivalent, and pieces per pound. The more frequently used washers are actually illustrated in exact size, thus enabling easy identification of a washer of unknown size by merely holding it against the printed illustration.

Requests for this chart should be submitted on firm letter-head and sent direct to the Wrought Washer Mfg. Co., Milwaukee, Wis.

New Products



IRC MULTI-UNIT GANG METALLIZED TYPE CONTROLS

Dual, triple and other gang controls, using as many units as desired and made up of IRC Type "C" Metallized Volume Controls with completely shielded individual sections controlled by one shaft, are being featured by the International Resistance Company, 401 North Broad Street, Philadelphia, Pa.

Each of the individual sections can be furnished in all curves and variations of standard and special Type C Controls and can be ganged up with or without switch.

— RE —

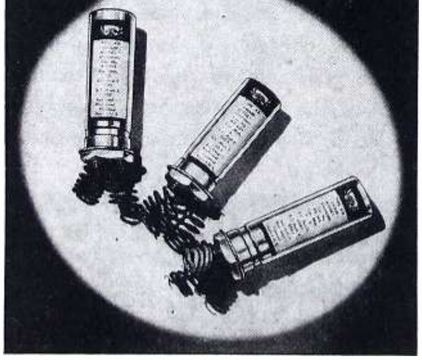
UTC AIRCRAFT FILTER

United Transformer Corp., 72 Spring Street, New York, N. Y. announces the release of their model BA-189 filter for commercial aircraft service. This filter is the culmination of an extensive development by UTC; it consists of a combination band pass and band rejection unit, which permit simultaneous voice and beam reception on aircraft receivers.

— RE —

ETCHED FOIL ELECTROLYTICS

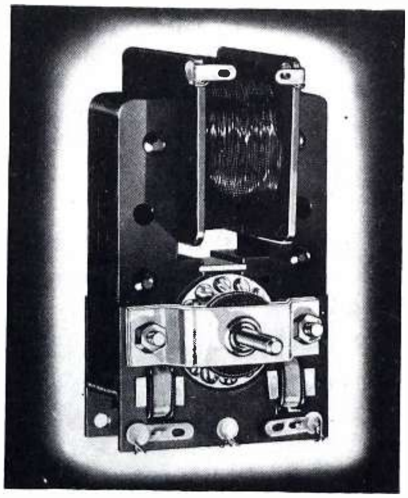
A recent development is the new etched foil dry electrolytic series of the Cornell-Dubilier Corporation. Engineers in the development laboratories of the South Plainfield, New Jersey, condenser plant announced that they have applied their hi-formation process to the manufacture of the KR and JR series, etched foil dry electrolytics of the Cornell-Dubilier Corporation, resulting in power factors on par with equivalent plain foil types.



COMPACT ROUND-CAN OIL-FILLED CAPACITORS

Handy high-voltage oil-filled capacitors in compact round cans, arranged for inverted mounting in limited space, are now offered by Aerovox Corporation, 70 Washington St., Brooklyn, N. Y. These units are similar in general appearance and size to the usual electrolytic condensers. The section of selected linen paper and foil, oil impregnated and bathed in oil, is hermetically sealed in the aluminum can. There is an insulated center terminal and grounded can. Fittings supplied with each unit permit insulating the can from the chassis and providing a second insulated terminal. Units are available in 600, 1,000 and 1,500 volts D. C. working, and in capacities of from 0.5 to 4 mfd.

— RE —



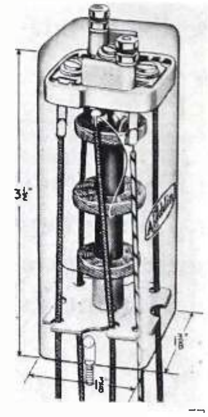
MINIATURE MOTOR

The Alliance Manufacturing Co., Alliance, Ohio, has announced a small motor for use in applications such as electrical tuning of radio receivers, etc. The full size of the motor is 1¾" x 2" x 3⅛". It is available in all a-c voltages, and for frequencies of 40, 50 and 60 cycles.

— RE —

GENERAL ELECTRIC ANNOUNCES NEW RADIO OUTLET

A convenient and attractive outlet for noise-reducing or "doublet" antennas, which eliminates the usually unsightly wiring connections characteristic of most radio receivers installed in the home, has been announced by the Appliance and Merchandise Department of the General Electric Company, Bridgeport, Conn. The outlet affords a compact means of separable attachment for ground, antenna (two-wire), and power leads for a radio set. Lead-in wires are thereby eliminated and replaced by neat, short lengths of cord.



ALADDIN TRANSFORMER

A triple-tuned i-f transformer, which is claimed to afford an unusual degree of adjacent-channel selectivity along with a flat topped response about 8 kc wide, has been announced by Aladdin Radio Industries, Inc., 466 West Superior Street, Chicago, Ill.

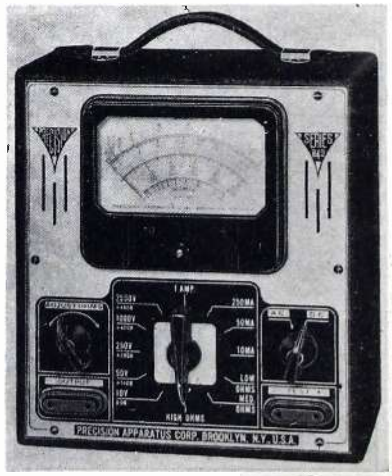
— RE —

PRECISION MULTIMETER

The Precision Apparatus Corp., 821 E. New York Ave., Brooklyn, N. Y., have recently announced their Series 840 Multimeter, shown in the accompanying illustration. The range specifications of this meter are as follows: a-c volts, 0-10, 0-50, 0-250, 0-1000, 0-2500 volts, at 1000 ohms per volt; d-c volts, 0-10, 0-50, 0-250, 0-1000, 0-2500 volts, at 1000 ohms per volt; direct current, 0-10, 0-50, 0-250, 0-1000 ma; resistance, 0-400 ohms, 0-1 megohm, 0-10 megohms; decibel, —10 to +15, +4 to +29, +18 to +43, +30 to +55, +38 to +63; output, 0-10, 0-50, 0-250, 0-1000 volts. The meter is housed in a bakelite square case 4 inches by 4½ inches. It has a d'Arsonval movement with a 2 percent accuracy.

Complete information may be secured from the manufacturer.

(*Continued on page* 30)



— For Higher Fidelity

The problems encountered in high fidelity equipment are strongly related to the transformers used. Some of the merits of UTC transformers for such service are indicated below.

HUM

Hum pickup on low level audio equipment is one of the bugaboos of communications equipment. In a large number of cases it can be traced definitely to low level audio transformers. To eliminate this difficulty the UTC Engineering Staff originated the hum balanced coil structure which, combined with a high permeability cast case, results in extremely low hum pickup. Going a step further, tri-alloy shielding was developed and is now available in a large number of input mixing and matching transformers. We feel the commendable reports which were received regarding these units have justified the extensive development involved. Tri-alloy shielded units are now used by practically every large communications organization in the country.

FREQUENCY RESPONSE

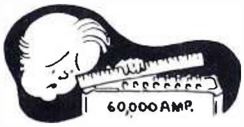
The gradual expansion in the frequency range required for true high fidelity has been most marked during the last few years. UTC leads the field in this respect with a guaranteed uniform frequency response from 30 to 20,000 cycles on all linear standard components. High level driver and output transformers are designed to effect a minimum of frequency discrimination and small increase in distortion at the two ends of the audio frequency band. This latter effect is one which has been considerably overlooked by many contemporary organizations. Some of the transformers checked in our laboratory have shown harmonic distortions as high as 25% at 30 and 10,000 cycles, as compared to 3 or 4% at 400 cycles. The judicious use of materials and proper interleaving of windings has reduced this effect to an absolute minimum in UTC transformers.

EQUALIZATION

In keeping with the increasing fidelity of speech input and transmitter equipment, telephone lines and pickup equipment should be equalized. UTC has done a considerable amount of pioneering in this field. The model 3-A universal equalizer is being used extensively by a large number of the broadcast stations in American and foreign countries for service of this type.

In addition to equalization, attenuation is frequently required for dialogue equalization, reduction of scratch, etc. UTC has developed the 3-D universal attenuator for service of this type. Akin with the use of equalizers we may mention the rapid adoption of UTC model 4-B sound effects filter for studio use. Practically all sound effects such as distance, telephone, bass exaggeration, etc., can be produced with this unit.

SPECIAL UNITS



Due to its leadership in transformer design, UTC is frequently called upon to design special units for such organizations as RCA, GE, Bell Telephone Laboratories, CBS, and other organizations of similar nature. Prices on units of this type are reasonable and deliveries are prompt. Write to the UTC Engineering Staff if you have a specific problem.

UNITED TRANSFORMER CORP.

72 SPRING STREET • NEW YORK, N. Y.

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

RADIO ENGINEERING BUYER's GUIDE

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

Materials—Component Parts

BASES, VACUUM TUBE

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

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.
Caswell-Runyan Co.
GUTHMAN & CO., INC., 1036 W. Van Buren St., Chicago, Ill.
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.

CERAMICS

AMERICAN LAVA CORP., Chattanooga, Tenn.
CROWLEY & CO., INC., H. L., W. Orange, N. J.
ISOLANTITE, INC., 233 Broadway, N. Y. C.
Kirchberger & Co., Inc., M.
Mycalex Corp. of Amer.
STUPAKOFF LABORATORIES, INC., 6627 Hamilton Ave., Pittsburgh, Pa.
Tennessee-Eastman Co.

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 TRANS. CORP., 72-74 Spring St., N. Y. C.

COIL MACHINERY

UNIVERSAL WINDING CO., Providence, R. I.

COILS—POWER

ACME WIRE COMPANY, 1255 Dixwell Avenue, New Haven, Conn.
ANACONDA WIRE & CABLE CO., 20 N. Wacker Dr., Chi., Ill.
American Enameled Magnet Wire Co.
Belden Manufacturing Co.

COILS—RADIO RECEIVER

ALADDIN RADIO INDUSTRIES, INC., 466 W. Superior St., Chicago, Ill.
Alden Products Co.
Automatic Winding Co.
General Mfg. Co.
GUTHMAN & CO., INC., Edwin I., 1036 W. Van Buren St., Chicago, Ill.
HAMMARLUND MFG. CO., 424 W. 33rd St., N. Y. C.
MEISSNER MFG. CO., Mt. Carmel, Ill.
Norwalk Engineering Corp.
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., 502 S. Throop St., Chicago, Ill.
HALLDORSON COMPANY, 4500 Ravenswood Ave., Chicago, Ill.
JEFFERSON ELECTRIC COMPANY, Bellwood, Ill.
RCA MANUFACTURING CO., INC., Camden, N. J.
STANDARD TRANSFORMER CORP., 854 Blackhawk Street, Chicago, Ill.
THORDARSON ELEC. MFG. CO., 500 W. Huron St., Chicago, Ill.
UNITED TRANS. CORP., 72-74 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., S. Plainfield, N. J.
CURTIS CONDS. CORP., 3088 W. 106th St., Cleve., O.
DUMONT ELECTRIC CO., 514 Bway, New York.
ELECTRONIC LABORATORIES, INC., Indianapolis, Ind.
Magnavox Co., Ltd.
MALLORY & CO., P. R., Indianapolis, Indiana
MICAMOLD RADIO CORP., Brooklyn, N. Y.
SOLAR MFG. CORP., 599-601 Broadway, N. Y. C.
SPRAGUE SPECIALTIES CO., North Adams, Mass.
TOBE DEUTSCHMANN CORP., Canton, Mass.

CONDENSERS, FIXED ELECTROLYTIC

AEROVOX CORP., 90 Washington St., Brooklyn, N. Y.
CORNELL-DUBILIER CORP., S. Plainfield, N. J.
CROWLEY & CO., INC., H. L., W. Orange, N. J.
CURTIS CONDENSER CORP., 3088 W. 106th St., Cleveland, Ohio
DUMONT ELECTRIC CO., 514 Bway, New York.
Magnavox Co., Ltd.
MALLORY & CO., P. R., Indianapolis, Indiana
MICAMOLD RADIO CORP., Brooklyn, N. Y.
SOLAR MFG. CORP., 599-601 Broadway, N. Y. C.
SPRAGUE SPECIALTIES CO., North Adams, Mass.

CONDENSERS, ADJUSTABLE

HAMMARLUND MFG. CO., 424 W. 33rd St., N. Y. C.
MEISSNER MFG. CO., Mt. Carmel, Ill.
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.
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.

CONTACTS, METAL

Baker & Co., Inc.
CALLITE PRODUCTS CO., 542 39th St., Union City, N. J.
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.
CROWLEY & CO., INC., H. L., W. Orange, N. J.
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.
BRUSH DEVELOPMENT CO., E. 40th St. & Perkins Ave., Cleveland, Ohio
RCA MANUFACTURING CO., INC., Camden, N. J.
SCIENTIFIC RADIO SERVICE, University Pk., Hyattsville, Md.

DIALS, ESCUTCHEONS

CROWE NAMEPLATE CO., Chicago, Ill.
GENERAL RADIO CO., Cambridge, Mass.
Magnavox Company, The

ELECTRODES, NEON

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

EYELETS

STUPAKOFF LABS., INC., 6627 Hamilton Ave., Psgh., Pa.
United Shoe Mach. Co.
WATERBURY BRASS GOODS BR., Waterbury, Conn.

FIBRE (See Insulation, Laminated)

FLEXIBLE SHAFTING

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

FUSES

LITTELFUSE LABS., 4244 Lincoln Ave., Chicago, Ill.

GENERATORS

Carter Motor Company
ELECTRONIC LABORATORIES, INC., 122 W. New York St., Indianapolis, Ind.
MALLORY & CO., P. R., Indianapolis, Indiana
Onan & Sons, D. W.

GETTERS (See Nickel Tube Parts)

GRAPHITE

Acheson Colloids Corp.

HORNS

Atlas Sound Corp.
CINAUDAGRAPH CORP., Stamford, Conn.
FOX SOUND EQUIP. CORP., 3120 Monroe St., Toledo, Ohio
RACON ELEC. MFG. CO., 52 E. 19th St., N. Y. C.
WRIGHT-DECOSTER, INC., 2253 University Ave., St. Paul, Minn.

INSTRUMENTS—TEST EQUIPMENT

BOONTON RADIO CORP., Boonton, N. J.
Burton-Rogers Co.
CLOUGH-BRENGLE CO., 2817 W. 19th St., Chi., Ill.
DUMONT LABORATORIES, ALLEN B., 542 Valley Rd., Upper Montclair, N. J.
FERRANTI ELECTRIC, INC., 30 Rockefeller Plaza, N. Y. C.
FERRIS INSTR. CORP., Boonton, N. J.
GENERAL RADIO COMPANY, Cambridge, Mass.
HICKOK ELEC. INSTRU. CO., Cleveland, O.
RCA MFG. CO., INC., Camden, N. J.
READRITE METER WORKS, Bluffton, Ohio
SIMPSON ELEC. CO., 5218 W. Kinzie St., Chicago, Ill.
SOLAR MFG. CO., 599 B'way, N. Y. C.
SUPREME INSTRUMENT CORP., Greenwood, Miss.
TRIPLETT ELEC. INSTRU. CO., Bluffton, Ohio
TRIUMPH MFG. CO., 4017 W. Lake St., Chicago, Ill.
WESTERN ELECTRIC CO., 195 Broadway, N. Y. C.
WESTON ELEC. INSTRU. CORP., Newark, N. J.

INSULATION, CERAMICS (See Ceramics)

INSULATION COMPOUNDS

MAAS & WALDSTEIN, 438 Riverside Ave., Newark, N. J.
MICA INSULATOR CO., 200 Varick St., N. Y. C.
STUPAKOFF LABS., INC., 6627 Hamilton Ave., Psgh., Pa.
ZOPHAR MILLS, INC., 120 26th St., Brooklyn, N. Y.

INSULATION, FABRIC TUBING

ACME WIRE CO., 1255 Dixwell Ave., New Haven, Conn.
Bentley Harris Mfg. Co.
BRAND & CO., WM., 276 Fourth Ave., N. Y. C.
Glenn & Co., J. J.
MICA INSULATOR CO., 200 Varick St., N. Y. C.

INSULATION, LAMINATED BAKELITE VULCANIZED OR PHENOL FIBRE

American Mica Works Corp.
BAKELITE CORP., 247 Park Ave., N. Y. C.
Brandywine Fibre Products Co.
Continental-Diamond Fibre Co.
Formica Insulation Co.
Franklin Fibre-Lamitex Corp.
General Electric Co.
GENERAL PLASTICS, INC., N. Tonawanda, N. Y.
MICA INSULATOR CO., 200 Varick St., N. Y. C.
National Vulcanized Fibre Co.
Resinox Corporation
Richardson Company, The
SYNTHANE CORPORATION, Oaks, Penna.
TAYLOR & CO., INC., Norristown, Pa.
Westinghouse Elec. & Mfg. Co.
Wilmington Fibre Co.

INSULATION, MOLDED

American Insulator Corp.
AMERICAN LAVA CORP., Chattanooga, Tenn.
American Phenolic Corp.
BAKELITE CORP., 247 Park Ave., N. Y. C.
Chicago Molded Prods. Corp.
CROWLEY & CO., INC., H. L., W. Orange, N. J.
GENERAL PLASTICS, INC., No. Tonawanda, N. Y.
ISOLANTITE, INC., 233 Broadway, N. Y. C.
Kurz-Kasch Co.
Richardson Company, The
Stupakoff Labs., Inc.

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.
Irvington Paint and Varnish Co.
MAAS & WALDSTEIN, 438 Riverside Ave., Newark, N. J.
ZOPHAR MILLS, INC., 120 26th St., Brooklyn, N. Y

LAMPS, GLOW

LITTELFUSE LABS., 4244 Lincoln Ave., Chicago, Ill.
Sundt Co., E. V.

LUGS

CINCH MFG. CORP., 2335 W. Van Buren St., Chicago, Ill.
Jones Co., Howard B.
Thompson-Bremer Corp.
Micarta Fabricators, Inc.
WATERBURY BRASS GOODS BR., Waterbury, Con.

MAGNETS

TAYLOR-WHARTON IRON & STEEL CO., Highbridge, N. J.
THOMAS & SKINNER STEEL PRODS. CO., 1100-1120 E. 23rd St., Indianapolis, Indiana.

MELTING POTS

STA-WARM ELECTRIC CO., Ravenna, Ohio
Trent Co., Harold E.

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BURTON-ROGERS CO., 755 Boylston St., Boston, Mass.
CLOUGH-BRENGLE CO., 2817 W. 19th St., Chi., Ill.
HICKOK ELEC. INSTRU. CO., Cleveland, Ohio
RCA MFG. CO., INC., Camden, N. J.
READRITE METER WORKS, Bluffton, Ohio
SIMPSON ELEC. CO., 5218 W. Kinzie St., Chi., Ill.
SUPREME INSTRUMENT CORP., Greenwood, Miss.
TRIPLETT ELEC. INSTRU. CO., Bluffton, Ohio
TRIUMPH MFG. CO., 4017 W. Lake St., Chicago, Ill.
WESTERN ELECTRIC CO., 195 Broadway, N. Y. C.
WESTON ELEC. INSTRU. CORP., 612 Frelinghuysen Ave., Newark, N. J.

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American Mica Works Corp.
BRAND & CO., WM., 276 Fourth Ave., N. Y. C.
Macellen Co.
MICA INSULATOR CO., 200 Varick St., N. Y. C.
New England Mica Co.

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AMERICAN MICROPHONE CO., Los Angeles, Cal.
AMPERITE CORP., 561 Broadway, N. Y. C.
ASTATIC MICROPHONE LAB., INC., Youngstown, O.
Bruno Labs., Inc.
BRUSH DEVELOPMENT CO., Cleveland, Ohio
ELECTRO-VOICE MFG. CO., INC., South Bend, Indiana
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TURNER COMPANY, Cedar Rapids, Ia.
UNIVERSAL MICROPHONE CO., LTD., Inglewood, Calif.
WESTERN ELECTRIC CO., 195 Broadway, N. Y. C.

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CALLITE PRODS. CO., 542 39th St., Union City, N. J
ELECTRO-METALS, INC., 1880 E. 40 St., Cleveland, O.
Fansteel Metallurgical Labs.

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(plates, grids, wire cloth, cathodes, getters, hooks, heaters, base-pins, welds)
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American Electro Metal Corp.
CALLITE PRODS. CO., 542 39th St., Union City, N. J.
Cleveland Wire Cloth & Mfg. Co.
DRIVER CO., WILBUR B., 150 Riverside Ave., Newark, N. J.
General Plate Co.
Goat Radio Tube Parts, Inc.
King Laboratories, Inc.
NEWARK WIRE CLOTH CO., Newark, N. J.
SUMMERILL TUBING COMPANY, Bridgeport, Penna.
SUPERIOR TUBE COMPANY, Norristown, Penna.

PAPER TUBES

PARAMOUNT PAPER TUBE CO., 2035 Charleston St., Chicago, Ill.

PHOSPHOR BRONZE

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Riverside Metal Company
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Seymour Mfg. Company
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Eby Mfg. Co., H. H.
General Electric Co.
RCA MANUFACTURING CO., INC., Camden, N. J.
Westinghouse Elec. & Mfg. Co.
WESTON ELECTRICAL INSTRUMENTS CORP., 612 Frelinghuysen Ave., Newark, N. J.

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AUDAK COMPANY, THE, 500 Fifth Ave., N. Y. C.
FAIRCHILD AERIAL CAMERA CORP., Woodside, L. I.
RCA MFG. COMPANY, INC., Camden, N. J.
SHURE BROS., 225 W. Huron, Chicago, Ill.
SOUND APPARATUS CO., 150 W. 46th St., N. Y. C.
Webster Electric Co.

PLASTICS (See Insulation, Molded)

PLUGS

Alden Products Co.
American Phenolic Corp.
Cannon Elec. Development Co.
CINCH MFG. CORP., 2335 W. Van Buren St., Chicago, Ill.
Eby Mfg. Co., H. H.
MALLORY & CO., INC., P. R., Indianapolis, Indiana
REMLER CO. LTD., 2101 Bryant, San Francisco, Cal.

POINTS, CONTACT

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Fansteel Metallurgical Corp.
MALLORY & CO., INC., P. R., Indianapolis, Ind.

RECTIFIERS

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GENERAL ELECTRIC CO., Bridgeport, Conn.
MALLORY & CO., INC., P. R., Indianapolis, Indiana
UNITED TRANS. CORP., 72-74 Spring St., N. Y. C.
WARD LEONARD ELEC. CO., Mt. Vernon, N. Y.

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Dunn, Inc., Struthers
ELECTRONIC LABORATORIES, INC., Indianapolis, Ind.
GENERAL ELECTRIC COMPANY, Schenectady, N. Y.
Guardian Electric Co.
Heinemann Electric Co., Trenton, N. J.
Leach Relay Co., Los Angeles, Cal.
Sigma Instruments, Inc., Belmont, Mass.
WARD LEONARD ELEC. CO., Mt. Vernon, N. Y.
WESTON ELEC. INSTRU. CORP., 612 Frelinghuysen Ave., Newark, N. J.

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Chicago Tel. Supply Co.
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CROWLEY & CO., INC., H. L., W. Orange, N. J.
CONTINENTAL CARBON, INC., 13902 Lorain Ave., Cleveland, Ohio.
ELECTRAD, INC., 175 Varick St., N. Y. C.
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INTERNATIONAL RESISTANCE CO., 401 N. Broad St., Phila., Pa.
MALLORY & CO., INC., P. R., Indianapolis, Indiana
MICAMOLD RADIO CORP., Brooklyn, N. Y.
Ohio Carbon Co.
OHMITE MFG. CO., 4835 Flournoy St., Chicago, Ill.
STACKPOLE CARBON CO., St. Marys, Pa.
SOLAR MFG. CO., 599-601 Broadway, N. Y. C.
UTAH RADIO PRODS. CO., Chicago, Ill.
WARD LEONARD ELEC. CO., 33 South St., Mt. Vernon, N. Y.
White Dental Mfg. Co., S. S.

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CLAROSTAT MFG. CO., INC., 287 N. 6th St., Brooklyn, N. Y.
ELECTRAD, INC., 175 Varick St., N. Y. C.
INTERNATIONAL RESISTANCE CO., 401 N. Broad St., Phila., Pa.
MALLORY & CO., INC., P. R., Indianapolis, Indiana
MUTER CO., THE, 1255 S. Michigan Ave., Chicago, Ill.
OHMITE MFG. COMPANY, 4835 Flournoy St., Chicago
SHALLCROSS MFG. CO., Collingsdale, Pa.
WARD LEONARD ELEC. CO., Mt. Vernon, N. Y.

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SHAKEPROOF LOCK WASHER CO., 2501 N. Keeler Ave., Chicago, Ill.

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CINCH MFG. CORP., 2335 W. Van Buren St., Chi., Ill.
FRANKLIN MFG. CORP., ALBERT W., 160 Varick St., N. Y. C.

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RUBY CHEMICAL CO., 56 McDowell St., Columbus, Ohio.

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JENSEN RADIO CORP., 6601 S. Laramie Ave., Chicago
Magnavox Co., Ltd.
OPERADIO MFG. CO., 13th and Indiana Sts., St. Charles, Ill.
OXFORD-TARTAK RADIO CORP., 915 W. Van Buren St., Chicago.
RCA MFG. COMPANY, INC., Camden, N. J.
RACON ELEC. CO., INC., 52 E. 19th St., N. Y. C.
UTAH RADIO PRODUCTS CO., 820 Orleans St., Chicago, Ill.
WESTERN ELECTRIC CO., 195 Broadway, N. Y. C.
WRIGHT-DE COSTER, INC., 2253 University St., St. Paul, Minn.

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

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BRAND CO., WILLIAM, 276 Fourth Ave., N. Y. C.
CRESCENT INSULATED WIRE & CABLE CO., Trenton, N. J.

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AMERICAN TRANS. CO., 175 Emmet St., Newark, N. J.
Chicago Transformer Co.
FERRANTI ELECTRIC, INC., 30 Rockefeller Plaza, N. Y. C.
GENERAL TRANS. CORP., 502 S. Throop St., Chi., Ill.
HALLDORSON COMPANY, THE, 4500 Ravenswood Ave., Chicago, Ill.
JEFFERSON ELECTRIC CO., Bellwood, Illinois
RCA MFG. COMPANY, INC., Camden, N. J.
STANDARD TRANS. CORP., 866 Blackhawk St., Chi., Ill
THORDARSON ELEC. MFG. CO., 500 W. Huron St., Chicago, Ill.
UNITED TRANS. CORP., 72-74 Spring St., N. Y. C.

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ECCO HIGH FREQUENCY LABS., 120 West 20th St., N. Y. C.
EISLER ENGINEERING CO., 740 S. 13th St., Newark, N. J.
ELECTRONICS MACHINE CO., 742 S. 13th St., Newark, N. J.
KAHLE ENGINEERING CORP., 941 De Motte St., N. Bergen, N. J.
LEPEL HIGH FREQUENCY LABS., 39 W. 60th St., N. Y. C.

TUBING, SEAMLESS CATHODE

General Plate Company
SUMMERILL TUBING COMPANY, Bridgeport, Pa.
SUPERIOR TUBE COMPANY, Norristown, Pa.

TUNGSTEN—MOLYBDENUM

CALLITE PRODS. CO., 542 39th St., Union City, N. J.
Cleveland Tungsten Mfg. Co., Inc.
Fansteel Metalurgical Labs.

VIBRATORS (See Relays)

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Reliance Mfg. Co.
SHAKEPROOF LOCK WASHER CO., 2501 N. Keeler Ave., Chicago, Ill.
Thompson-Bremer Corp.
WROUGHT WASHER MANUFACTURING CO., 2203 S. Bay St., Milwaukee, Wis.

WAXES (See Insulation, Compounds)

WIRE, BARE

ANACONDA WIRE & CABLE CO., 25 Bway., N. Y. C.
Belden Mfg. Co.
CALLITE PRODS. CO., 542 39th St., Union City, N. J.
CORNISH WIRE COMPANY, 30 Church St., N. Y. C.
CRESCENT INSULATED WIRE & CABLE CO., Trenton, N. J.
General Cable Corp.
HOLYOKE COMPANY, INC., THE, Holyoke, Mass.
Hoskins Mfg. Co.
LENZ ELEC. MFG. CO., 1751 N. Western Ave., Chi., Ill.
Roebling's Sons Co., John A.

WIRE, BRAIDED

American Braiding Co.
CORNISH WIRE COMPANY, 30 Church St., N. Y. C.
General Cable Corp.
Roebling's Sons Co., John A.

WIRE, FILAMENT and GRID

AMERICAN ELECTRO METAL CORP., Lewiston, Maine
CALLITE PRODS. CO., 542 39th St., Union City, N. J.
DRIVER CO., WILBUR B., 150 Riverside Ave., Newark, N. J.
Driver-Harris Co.
NEWARK WIRE CLOTH CO., Newark, N. J.
Prentiss & Co., Geo. W.
SWEDISH IRON & STEEL CORP., 17 Battery Pl., N. Y. C.

WIRE, INSULATED

ACME WIRE COMPANY, 1255 Dixwell Ave., New Haven, Conn.
American Braiding Company
American Enameled Magnet Wire Co.
American Steel & Wire Co.
ANACONDA WIRE & CABLE CO., 25 Bway., N. Y. C.
Belden Mfg. Co.
CORNISH WIRE COMPANY, 30 Church St., N. Y. C.
CRESCENT INSULATED WIRE & CABLE CO., Trenton, N. J.
General Cable Corp.
GENERAL ELECTRIC COMPANY, Schenectady, N. Y.
HOLYOKE COMPANY, INC., THE, Holyoke, Mass.
LENZ ELEC. MFG. CO., 1751 N. Western Ave., Chi., Ill.
Rockbestos Products Corp.
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ACME WIRE COMPANY, 1255 Dixwell Ave., New Haven, Conn.
American Braiding Co.
American Enameled Magnet Wire Co.
American Steel & Wire Co.
ANACONDA WIRE & CABLE CO., 20 N. Wacker Dr., Chi., Ill.
Belden Mfg. Co.
CRESCENT INSULATED WIRE & CABLE CO., Trenton, N. J.
General Cable Corp.
GENERAL ELECTRIC COMPANY, Schenectady, N. Y.
HOLYOKE COMPANY, INC., THE, Holyoke, Mass.
Roebling's Sons Co., John A.

WIRE, RESISTANCE

AMERICAN ELECTRO METAL CORP., Lewiston, Maine
CALLITE PRODS. CO., 542 39th St., Union City, N. J.
Cleveland Wire Cloth & Mfg. Co.
DRIVER CO., WILBUR B., 150 Riverside Ave., Newark, N. J.
Driver-Harris Company
Fansteel Metallurgical Labs.
HOLYOKE COMPANY, INC., THE, Holyoke, Mass.
Hoskins Mfg. Co.

WIRE ROPE

CRESCENT INSULATED WIRE & CABLE CO., Trenton, N. J.
WILLIAMSPORT WIRE ROPE CO., 122 S. Michigan Ave., Chi., Ill.

NEW PRODUCTS

(*Continued from page 26*)

PERI-DYNAMIC REPRODUCERS

Jensen has just announced a line of Peri-Dynamic Reproducers available in kits; these consist of speaker and knock-down enclosure. All necessary screws, bolts, grilles, brackets, etc., are furnished for assembling. Enclosures in all cases are cut to size, drilled and all necessary parts for assembling are enclosed. Hardwood is used throughout and outside surfaces are finished with two coats of French gray, sanded and smoothed.

There are two models, Model KM and Model KV. Model KM uses both Peri-dynamic and Bass Reflex Principles and is recommended for general uses and where reproduction of music is chiefly desired.

Model KV employs the Peri-dynamic Principle and is recommended where reproduction of speech is of paramount importance and music reproduction is secondary.

Complete information on models, prices and sizes available on request to Jensen Radio Mfg. Co., 6601 S. Laramie Ave., Chicago, Ill.

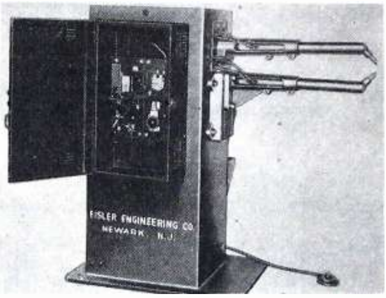
RESISTANCE WELDER

Welds on this new air-operated spot welder are controlled by means of a solenoid starter. By depressing the starter, the solenoid actuates the air cylinder which in turn closes the electrodes upon the work. The duration of the welding period is regulated by the automatic timer and contactor, assembled on the side of the fabricated frame. The timer is adjustable to regulate current from 2 to 60 cycles in 110 divisions. An air pressure valve on the machine is used to regulate the proper air pressure; this welder operates on an air pressure of 35 to 60 lbs. depending on the nature of the work.

Variation in type of work is facilitated by the interchangeable arms available on this welder. Arms shaped for welding different types of work can be substituted for the arms illustrated; the lower arm can be also be raised or lowered to conform to the depth of work required. This welder is especially equipped with strong arm supports. These supports make possible the long arms, and, at the same time, permit the arms to slide in or out of the supports to suit the type of work being welded. A water cooling arrangement passes water through the arms, electrode holders, and electrodes; water is circulated very close to the end of the electrodes. The arms on this welder are 36 inches long; arms can be supplied from 36 to 48 inches in length.

This welder is capable of making up to 100 spots per minute. It is equipped with an 8-point hand wheel for heat regulation and has an air-cooled transformer.

Further details may be obtained from the Eisler Engineering Co., Inc., Newark, N. J.



SCREWDRIVER LOCKS INTO SCREW-SLOT

Designed to be of great assistance to electricians, mechanics and repairmen in anchoring screws in hard-to-get-at places, the new Stromberg Grip-Point Screwdriver has just been placed on the market.

This screwdriver has a grip-point which, when released by a lever, ejects and revolves, gripping the screw-slot firmly. This permits the insertion of screws in formerly inaccessible places, since the screw may be "set" on the point and the screwdriver operated with one hand. When desired to use as an ordinary screwdriver, the lever is simply pushed back into a slot and the grip-point disappears.

It is claimed that there are just three parts in the Grip-Point Screw Driver not found in the ordinary screwdriver; further details can be obtained by writing to the Stromberg Motoscope Corp., 2701-11 Belmont Ave., Chicago, Ill.

— RE —

FIVE NEW "BULLETS" IN TRANSDUCER MIKE LINE

J. T. Kane, Sales Manager of Transducer Corporation, announced this week that the complete line of Bullet microphones has been redesigned and improved to provide higher fidelity, sensitivity and better all round performance.

The new models are: TR-5, an all purpose mike with sensitivity of 42 db high or low impedance. Available in standard black telephone bakelite. TR-6, substantially the same as TR-5 but adapted for use with exceedingly long lines. Sensitivity —40 db. available in standard black telephone bakelite. TR-7, a non-directional, vertical type. Sensitivity—40 db. available in standard black telephone bakelite. TR-8, custom built mike to satisfy any line or amplifier requirement. Sensitivity—38 db. This job may be had in black or choice of colors and in impedances of 10, 50, 200, 500, 2,500, 50,000, 500,000 ohms. TR-9, a custom built mike furnished with individual laboratory drawn curve. Sensitivity—38 db. available in black or choice of colors and any of the following impedances—10, 50, 200, 500, 2,500, 50,000, 500,000 ohms.

Complete information is available from the manufacturer; address, Radio City, N. Y.

RMA NEWS

(*Continued from page 22*)

RADIO GOLF TOURNAMENT

The Radio Industries Golf Club of Chicago got off to a big start for the season with its usual tournament during the RMA convention and with over one hundred members signed up. The opening tournament was held at the Calumet Country Club, Thursday, June 10, following the annual RMA convention, and was won, as usual, by Bill Tewksbury, with a gross 75. Nearly 200 players participated and each won a prize through the superlative activities of Fred Aylesworth, chairman of the prize committee. Paul B. Klugh presided, at considerable personal expense, over the heads and tails competition. The newly elected president of the Chicago Radio Golfers' organization is Phil C. Lenz, with Oscar M. Holen, past president, as secretary, and L. P. Norlie, treasurer. Charles H. Caine is chairman of the Membership Committee, and Peter L. Jensen, chairman of the Tennis Committee. A big season is anticipated during the several tournaments scheduled.

CREDIT COMMITTEE MEETING

A joint meeting of RMA credit managers was arranged during the annual Association convention at Chicago. A luncheon meeting of both eastern and western committee members was held at 12:30 Wednesday, June 9. Following the luncheon there was an exchange of credit information under the auspices of the National Credit Office, the official credit information agency of the RMA. The eastern credit group held a meeting May 26 at the Hotel New Yorker in New York, and the western committee followed with a meeting at Chicago.

INTERFERENCE PAMPHLET DISTRIBUTION

Over 50,000 copies of "Good Radio Reception," the consumer pamphlet prepared by the Joint Coordination Committee of RMA, EEI and NEMA have been distributed. At the suggestion of the RMA Board of Directors, the committee now is working on another pamphlet designed especially for radio service men, to include technical information especially suitable for their use.

EXPORT PROMOTION

Plans for developing export trade were considered at length during the Chicago convention of RMA by the Association's Export Committee. S. T. Thompson of Long Island City will continue for another year as chairman of the committee, but during his absence in Europe the Export Committee meeting at Chicago on June 8 was conducted by J. F. Weldon of Chicago. There was a large attendance in view of the presence of John H. Payne, chief of the Electrical Division, U. S. Bureau of Foreign and Domestic Commerce at Washington, who has charge of radio export promotion for the Department of Commerce. Quotas, tariffs, embargoes, and many foreign competitive situations were discussed by the Committee and arrangements made for proper action. It is expected that new reciprocal trade agreements will be negotiated by the State Department and it is hoped to continue the record of securing concessions in these treaties. A large attendance turned out for the Chicago meeting of the committee, and there was much interest manifested, as well as definite export promotion action.

INDUCTANCE OR CAPACITY TUNING

(*Continued from page* 18)

$$\frac{1}{Z_L} \cdot \frac{\omega L}{Z_L} = \frac{1}{Z_c} \cdot \frac{1}{\omega C Z_c} \quad \ldots\ldots\ldots\ldots (4)$$

$$\frac{\omega L}{(R_L^2 + \omega^2 L^2)} = \frac{1}{\omega C \left(R_c^2 + \frac{1}{\omega^2 C^2}\right)} \quad \ldots\ldots\ldots (5)$$

Simplifying,

$$\omega^2 = \frac{C R_L^2 - L}{L C^2 R_c^2 - L^2 C} \quad \ldots\ldots\ldots\ldots (6)$$

thus,

$$\omega = \sqrt{\frac{L - C R_L^2}{L^2 C - L C^2 R_c^2}} \quad \ldots\ldots\ldots\ldots (7)$$

which is the simplest form for the unity power factor resonance condition of the parallel circuit containing resistance in both of the branches.

At the resonance condition the two reactive components of the current balance out in the external circuit so that the current in the external circuit is the sum of the two active components. The active component of current in the inductive branch must be equal to $i_L \cos \phi_L$ and that of the capacitive branch must be equal to $i_c \cos \phi_c$. The impedance of the parallel combination then must be equal to the reciprocal of the sum of these two active components of current. That is, the impedance at unity power factor resonance becomes,

$$Z_r = \frac{1}{i_L \cos \phi_L + i_c \cos \phi_c} \quad \ldots\ldots\ldots (8)$$

or,

$$Z_r = \frac{1}{\frac{R_L}{R_L^2 + \omega^2 L^2} + \frac{R_c}{R_c^2 + \frac{1}{\omega^2 C^2}}} \quad \ldots (9)$$

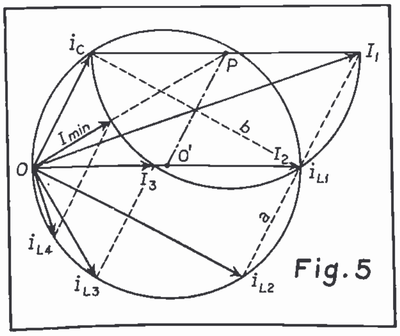


Fig. 5

The condition of minimum external current is that which makes the impedance of the parallel combination a maximum. From Fig. 5 it is seen that the condition of minimum current when the inductance is the variable always results in a leading external current, causing the combination to act as a capacitor. The condition of minimum current resonance finds its most value for filtering purposes and for building up a certain impedance value at a particular frequency or band of frequencies. It is always observed that when the plate tank circuit of an amplifier is tuned by variable inductance, the maximum power is not obtained at the setting of the inductance which gives the minimum external current in the plate circuit. This often gives the impression that the plate tank circuit must be detuned in order to obtain the maximum output. The fact is that the circuit is adjusted from the minimum current resonance condition to the unity power factor resonance condition.

From Fig. 5 it is evident that the minimum current resonance condition occurs at a point on the projected semi-circle which is on the line drawn from the origin 0 to the center P of the projected semi-circle. Since the inductance is the variable, the diameter of the circle whose center is O′ is equal to $1/R_L$. In the parallelogram $0 - O' - P - i_c$, the side $0 - 0'$ is equal to $1/2R_L$; thus the long diagonal $P - 0$ equals $I_{min} + 1/2R_L$, and from the relations of the parallelogram,

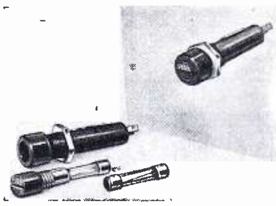
$$I_{min} = \sqrt{i_c^2 + \left(\frac{1}{2 R_L}\right)^2 + \frac{i_c}{R_L} \cdot \cos \phi_c} - \frac{1}{2 R_L} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (10)$$

Thus in general form, the maximum impedance, when the inductance is the variable, becomes,

$$Z_{max} = \frac{1}{\sqrt{\frac{1}{R_c^2 + \frac{1}{\omega^2 C^2}} + \frac{1}{4 R_L^2} + \frac{R_c}{R_L \left(R_c^2 + \frac{1}{\omega^2 C^2}\right)}} - \frac{1}{2 R_L}} \quad \ldots (11)$$

From the modification of this equation, a predetermined value of circuit impedance at a desired frequency may be obtained in the parallel circuit when the inductance adjusts the circuit to minimum current resonance.

(*To be continued*)



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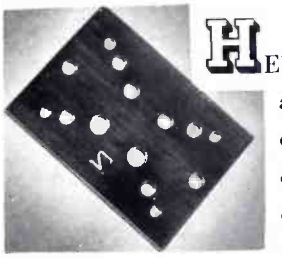
THE FLIGHT OF THE WATERBUG



HERE she comes... and goes...wide open!...a sliver of white tearing over a rippled mirror—she's over, winner by three lengths. Next time your eye tries to catch a "water-bug", remember outboard racing is more than a sport... it's a gruelling test of reliability. That's why you'll find SYNTHANE used for insulating the ignition system.... SYNTHANE laminated bakelite is a uniformly dense, solid material possessing a *combination* of useful physical and electrical characteristics. It is tough, strong and light in weight; one of the most effective dielectric materials; chemically inert and corrosion resistant; easy to machine. Uses for SYNTHANE are too numerous to total . . . SYNTHANE'S ability "to take it" in outboard motors suggests its possibilities of *material* assistance in the manufacture of your product. Write for "SYNTHANE laminated bakelite for Mechanical Applications". (Please indicate your requirements in your request.) . . . SYNTHANE gives you MATERIAL SATISFACTION.

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LAMINATED BAKELIT

a change in name— but not in policy!

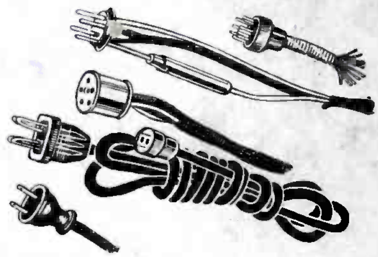
effective June 21, 1937, the name of

The Holyoke Company, Inc.

was changed to

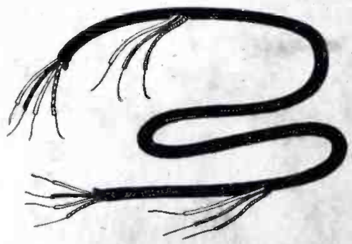
HOLYOKE WIRE & CABLE CORPORATION

"HOLYOKE makes a wire, cable, cord-set or harness assembly for every radio and electrical application."



Despite our change in corporate name, there has been no change in executive or engineering personnel.

The addition of a new production plant and $50,000 invested in modern wire covering machinery enhances our position in the field.



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