FEBRUARY, 1936

Radio Engineering

VOL. XVI NO. 2

DESIGN • PRODUCTION • ENGINEERING

- Broadcast Receivers
- Auto-Radio Receivers
- Electric Phonographs
- Sound Recorders
- Sound Projectors
- Audio Amplifiers
- P-A Equipment
- Electronic Control Devices
- Testing and Measuring Equipment
- Television Apparatus
- Loudspeakers
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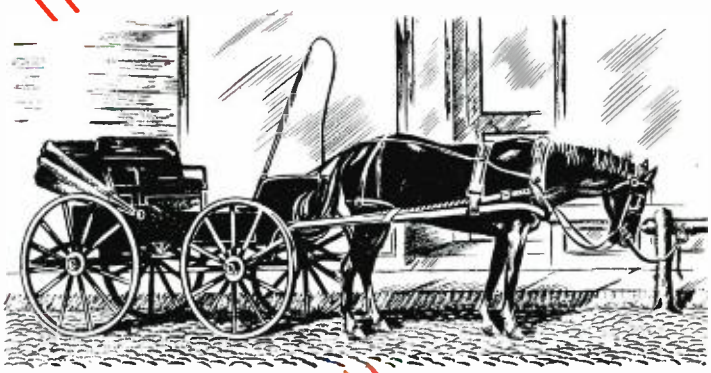
The Journal of the Radio and Allied Industries



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RADIO ENGINEERING

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LABORATORY ASSISTANT HOLDING TWO SHEETS OF POLAROID WITH THEIR POLARIZING AXES AT RIGHT ANGLES, BLOCKING OUT ALL THE LIGHT.

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DEPARTMENTS

VOL. XVI NO. 2

BRYAN S. DAVIS
President

JAS. A. WALKER
Secretary

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Editorial

LIGHT-POLARIZING GLASS

THERE IS SHOWN on the front cover of this issue a photograph of a laboratory assistant holding two sheets of a new type light-polarizing glass, known as Polaroid, with their light-polarizing axes at right angles and thus blocking out all light where the two sheets overlap. By simply turning one of the sheets of glass, the amount of light passing through may be varied.

Light-polarizing glass is by no means new, but this particular glass has a number of unique properties. It has already been employed for the production of color and three-dimensional motion pictures, and because of its capability of eliminating surface reflection, it will find many uses in the laboratory.

Light-polarizing glass may play an important part in television, and there is the possibility of it proving to be an effective and inexpensive form of light valve. There is also the possibility, for instance, that small plates of this glass could be effectively employed in new types of tuning indicators and for the dial scales of all-wave receivers.

A development of this sort goes to prove that with the rapid advancement in all fields of science, it is necessary that the radio engineer keep abreast with materials progress.

• • •

THE NOISE SILENCER

THE NOISE-SILENCING circuit described by James J. Lamb in the February issue of *QST* has interesting possibilities. The idea of replacing noise impulses with holes of silence is unique to say the least. Just as long as the noise impulses are well separated and of short duration, the interruptions in the signal continuity are not noticeable. As a result, many signals that would otherwise be lost in noise are clearly readable.

The effectiveness of the system is limited by the fact that all groups of noise impulses are not good enough to be widely separated and of short duration. Under such conditions the relief brought on by the partial or complete elimination of a train of noise impulses is replaced by a condition almost as bad as the noise itself, that is, excessive signal chopping.

Nevertheless, the system is of distinct value in the short-wave bands where auto ignition impulses, dial telephone clicks, etc., are prevalent, and where program quality is not an essential.

No doubt the original system will pass through a number of refinements, and it may be that in the near future it will be found practical for use in home radio receivers.

VOLUME EXPANSION

ONE OF THE new RCA Victor radio-phonograph combinations is equipped with a variable-gain dynamic amplifier which provides an expansion of the volume range of the phonograph record from around 45 db to as much as 65 db. And now comes Crosley Radio Corporation with a new receiver having a volume expander in the loudspeaker circuit.

The Crosley system consists of a bridge circuit, one leg of which contains the speaker and the other leg two small flashlight-type bulbs. The filaments of the bulbs increase in resistance with an increase in the a-f signal volume, with the result that the greater the volume of the signal the greater the amount of a-f diverted to the speaker circuit.

With this system, there is some sacrifice at low volume levels, but it is assumed that the system would be switched into use only in the event that the signal input to the receiver was large to begin with.

The fact that the system cannot be used effectively on all high-level signals, because of monitoring conditions at the transmitter, does not make the arrangement impractical. It *can* be used on many stations and this makes it a worthwhile feature, particularly since the system is inexpensive.

• • •

MISTUNING

THE EXPRESS PURPOSE of the tuning indicator is to safeguard against mistuning.

But, the effectiveness of the tuning indicator is made incomplete because of automatic volume control.

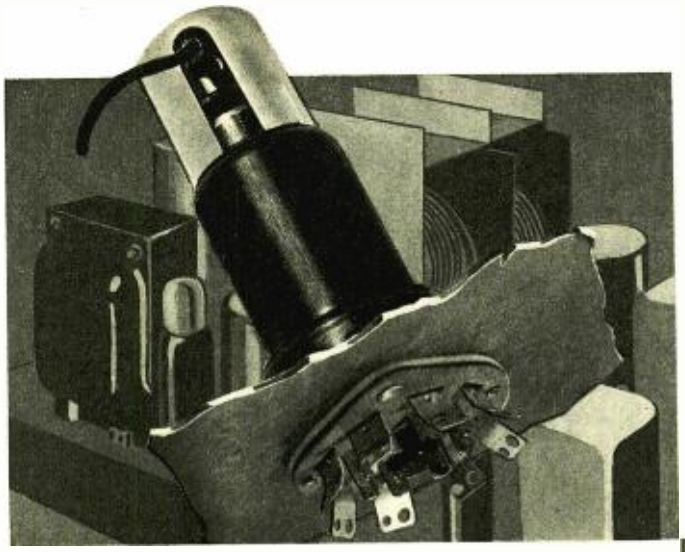
Possibly it never occurred to the engineer that a listener could be so all-fired careless in his tuning as to miss the desired station completely. In the absence of avc and chain programs, this form of mistuning would not occur, but it has become a common error on the part of the average listener to inadvertently tune his receiver to a distant station rather than to the desired local broadcaster.

Everything is fine, of course, until fading takes place and the avc raises the receiver gain. More often than not the listener is not aware of his mistake until station announcements are made.

The obvious cure is some mechanical arrangement similar to the one used by Stromberg-Carlson, whereby the tuning control clicks into a semi-locked position for each setting for a local station. An alternative arrangement could be a series of electrically controlled panel lights, one for each of the usual four or five "favorite" locals.

And think of the convenience.

"It's a 'Cinch'-



THAT MAKES IT PERFECT"

—TO QUOTE
A LEADING SET MANUFACTURER

and he speaks from experience. He, like many others, knows that with "CINCH" *parts and* "CINCH" *service, he gets complete satisfaction.*

Here is the "CINCH" shield, screen grid clip and socket. Designed for the ALL METAL TUBE, with exclusive features by "CINCH".

1 CAP SHIELD. "CINCH" designed steel shield; sets snugly on tube top over screen grid cap (as illustrated). The perfect function of the tube is assured; hovering electrical interferences, or extraneous disturbances are grounded. Sharp indentations at base of shield, a feature, assure contact when shield is applied.

2 SCREEN GRID CLIP. Designed especially for the metal tube in four styles, affording wide selection. "CINCH" solder coating or plain steel finish.

3 SOCKET. With exclusive "CINCH" features. Already the popular socket. Every socket need supplied; four, five, six, seven and eight prongs; all with eight holes open—simplifies testing when assembling sets. Original "CINCH" floating type low loss contacts—strong $^{1}/_{16}$" top plate, $^{3}/_{64}$" bottom plate—high voltage breakdown—key hole type.

Each part illustrated is in actual size. These parts contribute much to the efficiency of the ALL METAL TUBES. And to the profit on the set! Users know that when the part is a "CINCH" . . . so is the problem. That is the record! Ask us for names of set manufacturers who can tell you about "CINCH" parts or better still, tell us your problems.

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RADIO ENGINEERING

FOR FEBRUARY, 1936

THE 1936 RADIO MARKET

For the First Time in Radio History, the Industry Will Pass the Half-Billion Mark

A detailed and far-reaching survey conducted by RADIO ENGINEERING shows that for the year 1936 the radio industry will exceed the half-billion dollar mark for the first time in its history.

An analysis of the business of the radio and associated industries for this year indicates that the gradual but continuous increase in the total business during 1935, and the estimated total business to be handled in 1936, is due in a large measure to the development of new equipment and the improvement in raw materials that have both increased the scope of the radio field and brought about increased manufacturing efficiency.

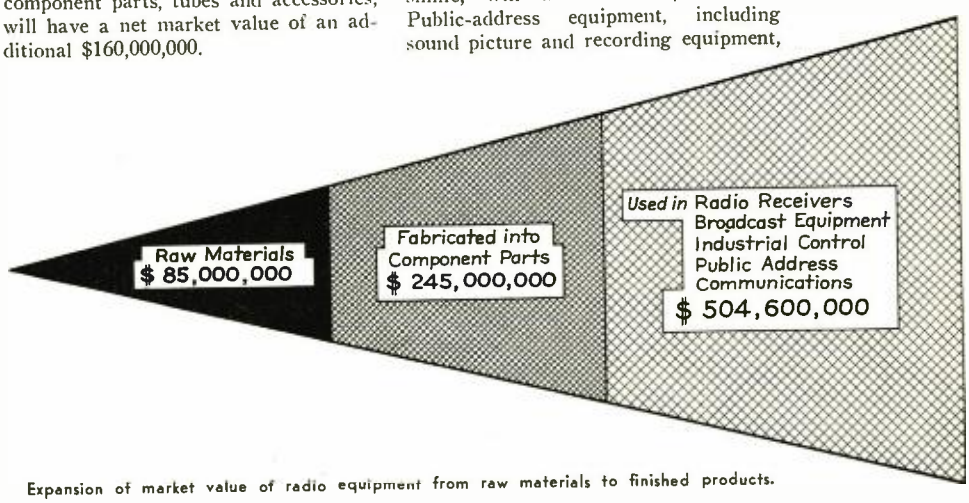
CONTRIBUTING FACTORS

Factors contributing to this large expanse of business are: the development of vacuum tubes having greater efficiency and more numerous applications, increased efficiency of all-wave receivers, fool-proof receivers of the battery-operated type, compact and efficient auto-radio receivers, a larger degree of engineering efficiency in all forms of radio design, and the advancements made in all forms of communications and radio control systems.

The radio business in 1936 will be given added impetus since this is a presidential election year. Moreover, a good portion of the money received by war veterans in the form of a bonus will go into the purchase of radio equipment. Federal Housing Loans, now extended on certain types of radio equipment will also serve to boost business in the fields of servicing, public-address, and residential radio control systems.

Nearly 1700 manufacturing companies will share in the 1936 radio business. These companies will purchase over $85,000,000 worth of raw materials and these materials, when fabricated into component parts, tubes and accessories, will have a net market value of an additional $160,000,000.

Of commercial equipment, the business in broadcast transmitting equipment, including amateur and marine installations, will amount to $28,000,000. Commercial communication equipment, including telephone, telegraph and facsimile, will amount to $35,000,000. Public-address equipment, including sound picture and recording equipment,



Expansion of market value of radio equipment from raw materials to finished products.

Over 5,100,000 radio receivers having a market value of $204,400,000 will be absorbed during the year. Manufacturers of broadcast and amateur transmitter equipment, public-address equipment, commercial communications equipment, and industrial control devices will chalk up a total net sales of over $88,000,000.

MARKET BREAKDOWN

A breakdown of this immense market is given in the accompanying charts. will run to $5,000,000. About $20,000,000 of business will be done in industrial-control equipment, this equipment including therapeutic and other electronic devices.

All companies connected with the manufacture of radio equipment of one type or another, will require approximately $90,000,000 worth of component parts and accessories, tubes not included. An additional $50,000,000 worth of components will be required during 1936 for replacement purposes. Approxi-

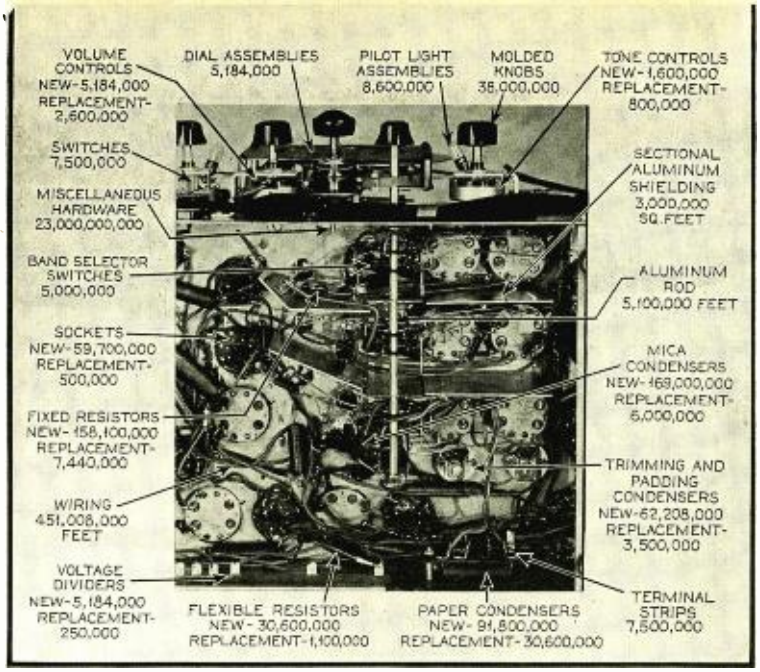


Photo courtesy RCA Manufacturing Co., Inc

Number of original and replacement components that will be used in radio receivers during 1936. Figures are based on an estimated production of 5,180,000 radio chassis for this year.

mately $35,200,000 worth of tubes will be required for new equipment and an additional $34,100,000 worth for replacement purposes.

The raw materials and the component parts used in the manufacture of radio and electronic equipment are identical in nature. Such items as molded plastics and ceramics, mica, wax, paper, aluminum, copper, etc., go into the manufacture of various types of condensers which are in turn supplied to the manufacturers of home and commercial radio receivers, broadcast and amateur radio transmitters, public-address equipment, electronic control devices, laboratory equipment, etc. Many of the same materials, such as molded plastics, ceramics, paper, aluminum, copper, etc., are also used in the fabrication of numerous other component parts that are used by the majority of the manufacturers in the field.

MANUFACTURING BRANCHES

There are seven principal manufacturing branches in the field and the equipment they manufacture is subdivided as follows:

(1) Manufacturers of Radio Receivers

(a). Complete Receivers
1. *Home Receivers*
2. *Broadcast Monitors*
3. *Police Car Receivers*
4. *Police Station Receivers*
5. *Direction Finders*
6. *Aircraft Receivers*
7. *Automatic Sounders*
8. *Press Transcribers*
9. *Time Signal Receivers*

(b) Short-wave Receivers
(c) Remote Control Devices
(d) Pickup Equipment
(e) Frequency Stabilizers
(f) Signal Amplifiers
(g) Filters or Suppressors
(h) Test Equipment

(2) Manufacturers of Broadcast Equipment

(a) Complete Transmitters
(b) Speech Amplifiers
(c) Remote Pickup Equipment
(d) Television Apparatus
(e) Production Testing Equipment
(f) Remote Control Equipment
(g) Automatic Level Controls
(h) Monitoring Equipment
(i) Tele-Control
1. *Police*
2. *Army-Navy*
3. *Municipal*
4. *Sound Picture*
5. *Commercial Transmission*
6. *Press*
7. *Broadcast Chain Circuits*

(j) Short- and Long-Wave Transmitters

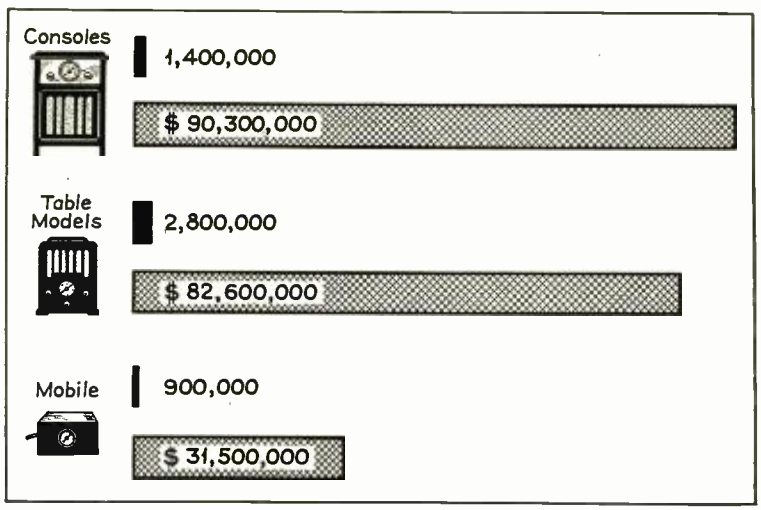
(3) Manufacturers of Wire and Wireless Communications Equipment

(a) A-F and D-C Amplifiers
(b) Multiplex Equipment
(c) Speech Inversion Equipment
(d) Automatic Senders
(e) Automatic Receivers
(f) Time Cut-Off Devices
(g) Translating Devices
(h) Teletype Equipment
(i) Facsimile Transmitters
(j) Navigation Aids
1. *Base Station Equipment*
2. *Directional Beams*
3. *Radio Beacons*
4. *Homing Devices*
5. *Radio Altimeters*
6. *Collisional Alarms*
7. *Automatic Field-Light Controls*
8. *Marker Light Controls*
9. *Blind Landing Devices*
10. *Radio Compasses*
11. *Photoelectric Communication Devices*
12. *Wind Direction and Velocity Measurement Devices*
13. *Automatic Tranmission*
14. *Visibility Measurement Devices*

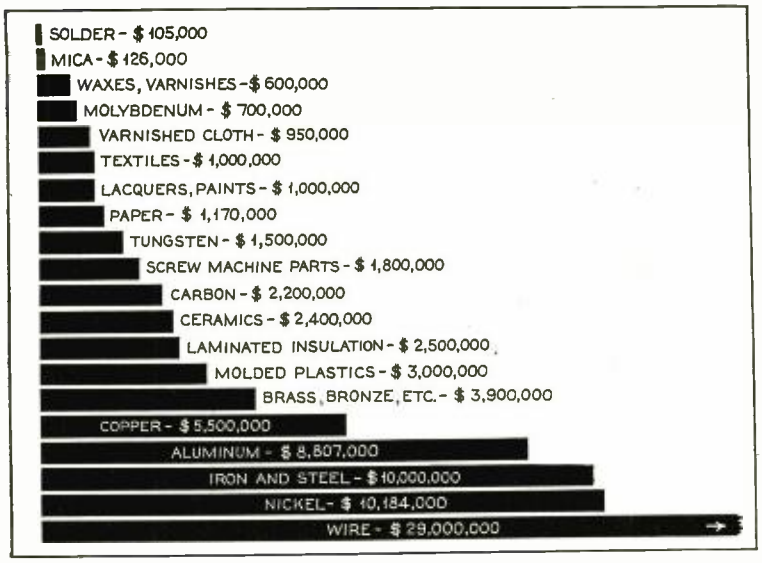
(4) Manufacturers of Amplifiers

(a) Sound Systems
1. *Airports*
2. *Educational Institutions*
3. *Industrial Instruction*
4. *Railway Stations*
5. *Sports Announcements*
6. *Traffic Direction*
7. *Outdoor Sound Advertising*
8. *Public Address*
9. *Calling Systems*
10. *Centralized Radio*
11. *Ship Installations*

(b) Sound Picture Equipment
(c) Electronic Industrial Control
(d) Industrial Communications Systems and Test Equipment
1. *Recording Equipment*
2. *Detector Systems*
3. *Illumination Control Devices*
4. *Carrier Current Systems*
5. *Criminology Devices*
6. *Metallurgical Test Equipment*



The number of radio receivers of each principal class that will be produced during 1936, and their total market values.



Comparative dollar values of the raw materials that will be purchased by the radio and allied industries during 1936, to be used in the fabrication of component parts and complete equipment.

7. *Intensity Control Devices*
8. *Chemical Measurement Devices*
9. *Electrical Testing Apparatus*
10. *X-Ray and Therapeutic Equipment*
11. *Protective Devices; Fire, Burglar, etc.*

(5) Manufacturers of Electrical Power Devices

1. *Starting Equipment*
2. *Rectifiers and Inverters*
3. *Circuit Breakers*
4. *Frequency Controls*
5. *Synchronizing Equipment*
6. *Current and Voltage Regulators*
7. *Relays, Vibrators, Switches*
8. *Generator Field Controls*
9. *Surge and Lightning Arrestors*
10. *Commutation Control*
11. *Elevator Leveling Controls*
12. *Frequency Indicators*
13. *High-Voltage Voltmeters*
14. *Sensitive Electrical Measuring Devices*
15. *High-Frequency Supply for High-Speed Motors*

(6) Manufacturers of Laboratory Measuring Devices

1. *Resistance, Capacity, Inductance*
2. *Sound Pressure*
3. *Micrometer Measurements*
4. *Photometric Determination*
5. *Moisture Determination*
6. *Densitometry*
7. *Tachometers*
8. *Stroboscopes*
9. *Chronographs*
10. *High Vacuum Measurements*
11. *Oscillographs*
12. *Integrating Ultra-Violet Meters*
13. *Frequency Measurements*
14. *Traction Dynamometers*
15. *Astronomical Measurements*
16. *Spectrophotometry*
17. *Telemetering*

(7) Manufacturers of Components Entering All Groups Above

Practically all of the various devices listed used quantities of the raw materials peculiar to the manufacture of radio and electronic equipment. These materials are used, first, in the manufacture of the components, and, second, in the fabrication of the complete equipment.

The total dollar value for each of the principal raw materials for the year 1936 is given in the accompanying chart. There follows a breakdown of each material which shows where it goes.

ALUMINUM:

In Sheet Form: Used as electrical shielding and as chassis material in radio receivers and transmitters, audio amplifiers, public-address equipment, electronic devices, as plates for variable condensers and, in stamped form, as coil and tube shields.

In Rod Form: For shafts of variable gang condensers, waveband selector switches, volume and tone controls and as mechanical supports.

In Foil Form: In the manufacture of high-capacity electrolytic condensers.

BRASS — BRONZE:

In Sheet Form: Used for the plates of variable and trimmer condensers, electrolytic condenser cans, terminals, socket contacts, lugs and washers, dial pointers, escutcheons and, in heavy gauge, for transmitting condenser plates.

In Tubing Form: Vacuum tube base pins, terminal connectors, conduits and water-cooled transmitter tubes.

In Rod Form: Drive shafts, subpanel bushings, supports, etc.

PHOSPHOR BRONZE:

Used for trimmer and padder condenser plates, selector switches, vibrators and relays, connectors, aerial wire and circuit breakers, dial cables, pilot-light assemblies, wiping contacts.

CARBON:

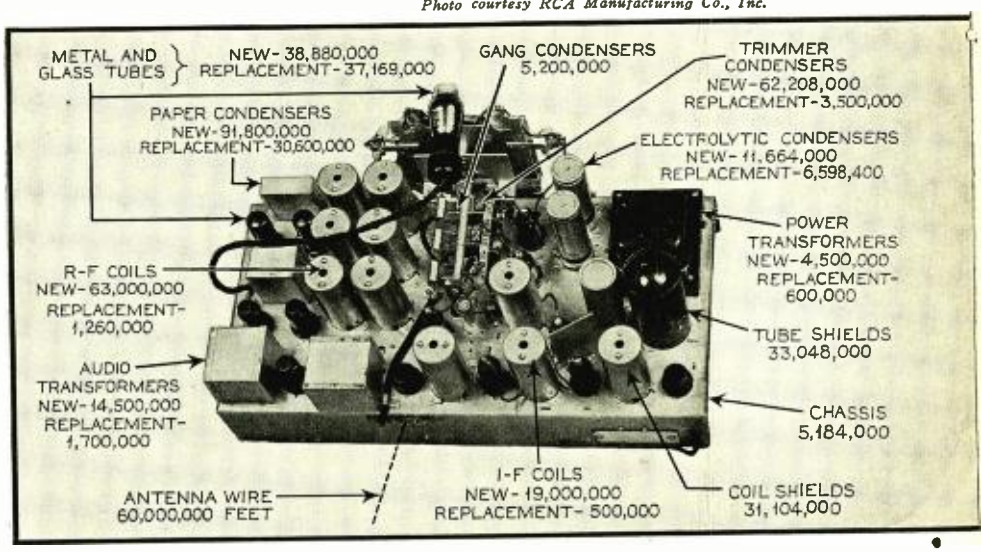
Carbon in its various forms, is used in the manufacture of dry-cell "A", "B" and "C" batteries, fixed resistors, variable resistors of the type used for tone and volume control, transmitter tube plates, microphone buttons, brushes and contacts, and as a lubricant.

CERAMICS:

Ceramics, such as Lava, Steatite, Porcelain, etc., are used principally as insulators in radio components and

(*Continued on page* 18)

Number of original and replacement components that will be used in radio receivers during 1936.
Photo courtesy RCA Manufacturing Co., Inc.



(*Courtesy Crosley Radio Corp.*)

By E. E. HORINE

The 1936 Battery-

This is a big country. It has a lot of people in it. To a far greater extent than in any other nation, the people of this country have taken to radio. Instead of being the passing fancy some predicted for it in the early 20's, radio has become an established American institution, one of the major industries.

And yet, within the United States is a vast neglected market for radio amounting to fully one-third of all the people living in this land of ours. From the beginning of broadcasting until only recently, the Radio Industry has catered to two-thirds of the people and neglected the one-third. This neglected third is radio's biggest immediate opportunity for the sale of receivers and of the equipment and services which go with it.

For purposes of analysis, the population can be divided into two broad groups; those who can use a-c sets and those who can't; those who live in homes with electricity and those who don't. Those who don't obviously must use battery-operated receivers or do without radio. No matter how good or how inexpensive an a-c set may be, those people can't use it; no matter how badly they want radio in their homes, as long as nothing but a-c sets are being made, they can't have it.

BATTERY SET MARKET

In round numbers there are 30,000,000 families in the United States. Of these, 20,000,000 live in homes with electricity and therefore can use a-c sets and wouldn't be interested in battery receivers; 10,000,000 live in homes without electricity, and by the same token *must* use battery-operated receivers and *can't* be interested in a-c sets.

Each of the 10,000,000 families living in homes without electricity is as much of a prospect for a receiver as each of those living in wired homes. More so, just at present, for the wired home market has been worked so hard that it is more nearly saturated than the battery set market, which has scarcely been worked at all.

The battery set market for the most part is rural. It is made up of people living beyond the power line. In this group, as in any other large population group, are wealthy people, well-to-do independent people and poor people. All but the poorest of the poor are good prospects for radio receivers. There is nothing in statistics or in history to indicate that the rural section of the population has a greater proportion of poor people than the urban. In fact, it most probably is the other way around. The rural market for radio undoubtedly can be saturated to the same extent as the urban market. That it has not reached this degree of saturation along with the city market is not due to an impoverished state, although this is a popular alibi, but largely to the fact that until recently the Radio Industry has not produced a really practical country home receiver.

Saturating the rural market to the same extent as the urban market would mean the production and sale of at least 7,500,000 battery-operated receivers. Nowhere else does there exist a ready, hungry, empty market for so many receivers. With the a-c field better than 75% saturated, it is predictable that radio's next marked expansion will be in the rural field. But this expansion can not take place and the unwired market be saturated with just any old kind of a battery receiver.

THE A-C RECEIVER

A modern console-type a-c operated all-wave receiver, including all the latest improvements.

The vast market beyond the power line will be tapped this year with the modern battery-operated receiver which has finally come into its own

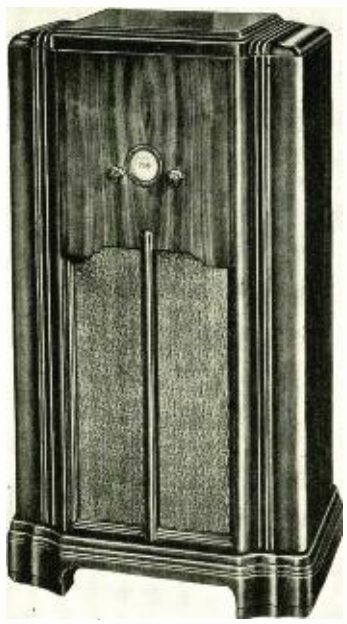
(Courtesy Crosley Radio Corp.)

Operated Receiver

RURAL NEED

Before the a-c set came out, all receivers were battery operated, and then, if ever, the rural dweller had his opportunity to obtain the benefits and pleasures of radio. Ever since broadcasting started it has been accepted as self-evident that radio had more to offer those living in the remoter regions than the city dweller. The distant, semi-isolated country home pulsing to the music of an orchestra in a distant city exerted and still exerts a powerful influence on the imagination; the farmer, miles from his market, receiving up-to-the-minute information on prices and day-by-day advice from farm experts on the conduct of his business has long been used as an example of the utilitarian value of radio. The main difference between the urban and rural markets is that the city dweller wants radio, but the rural dweller needs it.

THE BATTERY SET



A modern console-type "Air-Cell" operated receiver having the same advantages as the a-c set.

Yet, at the end of the battery set era, the receivers in use were divided about in the ratio of 9 in city homes to 1 in rural homes, in spite of population division of 2 to 1 and the added appeal radio naturally has for the rural dweller. Radio was then and is now a natural for the country home, yet, when nothing but battery receivers was being made, radio penetrated only skin deep into its natural field, the rural market. The reason was not inability to buy or lack of desire to buy, but that the receivers of those days, although battery operated, were not practical for use in country homes.

From the beginning of broadcasting clear up to the advent of the a-c set, the Radio Industry had not succeeded in producing a practical rural home receiver and the vast rural market went neglected because of this fact. The development of the a-c set and its ready acceptance by those living in wired homes so taxed the facilities of the set manufacturers that almost unanimously they dropped the battery set like a hot potato, thus abandoning even the pretense of catering to the needs of those who could benefit from the ownership of a receiver.

EVOLUTION OF BATTERY RECEIVER

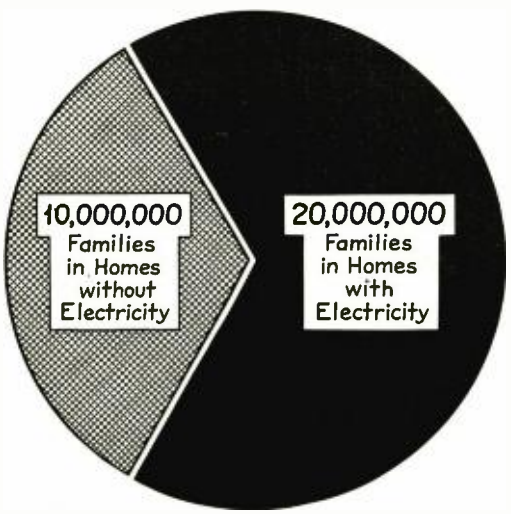
The knotty rural radio problem was solved in 1930 and it was solved, naturally enough, by a battery manufacturer. This manufacturer, sensing the threat at its business by the a-c receiver, and realizing the possibilities in the almost untouched rural field, set about in 1928 to find out how to make a truly practical country home receiver. By 1930, the answer was ready, requiring only that the set manufacturers begin making receivers according to the plan worked out to open up this long neglected and eager radio market.

A brief examination of the shortcomings of the pre-a-c battery receivers and of the reasons for their failure to meet the needs of the rural dweller will serve to reveal the nature of the problem and to make clear that today's battery receivers are just what the rural market has been waiting for.

The early receiving tubes (201-A) required so much filament power that only a storage battery could supply it. Each tube took 0.25 ampere at 5.0 volts, a total of 1.25 watts per tube, and even with 3-tube sets, which at one time were so popular, the total filament power required was 3.75 watts, well outside the economical or practical range of any form of low-voltage primary battery.

A storage battery naturally presupposes the existence of near-by, convenient charging facilities, and charging

facilities do not grow on farms. The use of storage-battery receivers was restricted by the very nature of the battery to those who lived close enough to sources of power to make storage battery maintenance at least half-way feasible, and it was for this reason that radio did not penetrate very deeply into the rural areas. What was not realized then but what is perfectly obvious today is that the storage battery receiver is only one short step removed from the all-electric set, being dependent, in the last analysis, on the power supply line for its operating power, and naturally usable with greatest convenience only by those living in wired homes provided with a home charger.



There are twice the number of families in homes with electricity as there are in homes without electricity, but the former market is already 75 per cent saturated, whereas the latter is only 25 per cent saturated.

It took several years for the infant Radio Industry to awake to the realization that radio was not reaching out into the rural areas where it was most needed, but when it did wake up, it went at the problem hammer and tongs, determined to leave no stone unturned until every home in the country, rural and city alike, was overflowing with music. The energy and aggressiveness of the Industry in those days was just a little bit awesome, and inclined to be somewhat hit-or-miss, but it got things done.

FIRST DRY CELL TUBES

The past weakness to be overcome and the line of future action to be followed were plain. The storage battery was the stumbling block and had to be eliminated. What was needed was a set *completely* independent of the power line, and this inescapably meant a receiver obtaining all operating power, filament as well as plate, from primary batteries. But primary batteries can't deliver heavy currents economically. Therefore tubes with low-drain filaments were indicated.

The tube people rose to the situation manfully. They developed a tube (199) that would do as much on only 180 milliwatts as the big husky 201-A would do on 1250 milliwatts. Only 60 milliamperes at 3.0 volts per tube, a rational, economical load for the standard, widely distributed, universally used No. 6 dry cell.

With the development of the dry cell tube, rural radio took a new lease on life. Set manufacturers were swamped with orders. At last it looked as if radio was going to fulfill its destiny by penetrating to every nook and cranny of the country, but it didn't.

Those dry battery sets which went out with so much promise and with every surface indication of being the final solution of the rural radio problem soon began trooping back. They wouldn't stay sold. Within a year of its launching the dry cell set was practically dead. All manufacturers but one ceased its production, returning to the less salable but more dependable storage battery set, and a year later, the sole remaining manufacturer gave up.

The dry battery set was the worst commercial flop in radio history.

CAUSE OF FAILURE

The cause was obscure but not beyond discovery. Popular opinion blamed the tubes, because they were forever and eternally burning out, but the trouble was more deeply seated than the tube. The dry cell tube would last as long and serve as well as the storage battery tube *when burned at constant voltage*, but dry cells do not deliver their output at constant voltage. They start out at about 1.5 volts per cell and wind up at 1.0 volt per cell or less, usually less. To remove them from service before they get down to 1.0 volt or less is to throw away, unused, a large part of their electrical energy. The 199 tube filament was rated at 3.0 volts, which called for a battery of three dry cells connected in series, to enable it to be worked down to 3.0 volts, or 1.0 volt per cell.

The initial voltage of a 3-cell dry battery is 4.5 volts, and thus it was that every purchaser of a dry battery receiver had at his disposal 50% more voltage than the tube could stand with nothing between him and its destruction but a manually-operated rheostat which he was supposed to adjust from time to time to absorb the difference between 3.0 volts and the instantaneous voltage of the battery. And he just couldn't do it. The natural tendency was to over-voltage the tubes, since turning on more power made the set play louder, and the inevitable consequence of trying to hitch a variable-voltage battery to a constant-voltage tube was an epidemic of premature tube failures which brought about the total collapse of the dry battery set idea.

The Industry did not abandon the dry battery set without a struggle. All sorts of ideas were tried to make voltage regulation automatic. They ranged all the way from complicated self-adjusting rheostats requiring more power for operation than the set itself, filament voltmeters with a red line at 3 volts and dire warnings not to push the needle up into the danger zone, to thermo-electric regulators with no moving parts; but one and all failed to solve the problem. It was as though nature never intended the variable-voltage dry cell and the constant-voltage tube filament to trot in double harness, and all attempts to mate this incompatible pair met the usual consequences attendant upon attempts to thwart any natural law.

VARIABLE VOLTAGE TUBES UNSUCCESSFUL

Here were two major drives launched at the rural radio market, both of which failed because of the inherent nature of the "A" battery. Being primarily a battery problem, and since the a-c set came along shortly after the dry battery set's collapse, absorbing the entire attention of the Industry, it was once again taken up, this time by a battery manufacturer. One of two things obviously was required: a variable voltage tube or a constant voltage primary "A" battery.

The variable voltage tube idea was the more interesting from the battery

maker's viewpoint, as it would function without rheostats or other voltage control devices directly from an "A" battery made of dry cells. Being a staple item of production, the 6-inch cell would thus find another large field of usefulness through the medium of the variable voltage tube, and battery makers are always on the lookout for ways to make two dry cells grow where only one grew before.

A good deal of time was spent and, as it turned out, wasted, trying to develop a tube filament that would have sufficient emission at low, economical power inputs and which would suffer no damage when subjected to the full initial voltage of 1.5 volts per cell and undergo no appreciable reduction in operating characteristics when battery voltage fell to 1.0 volt per cell or less. But all efforts to make such a filament failed. The voltage range—50% or more—of the dry cell was too great.

NEW BATTERY DEVELOPED

Remained only the constant voltage primary battery idea. No such battery existed in practical form for radio applications, but a number of clues as to how to make one existed. Primary battery voltage declines with discharge primarily because of decreasing effectiveness of the depolarizer. The depolarizer is always oxygen, usually introduced into the battery at the time of manufacture in the form of various oxygen-bearing compounds, such as manganese dioxide. If some means could be provided whereby there always would be an ample supply of oxygen available right at the surface of the positive electrode, the voltage would remain practically constant throughout the battery's life.

The problem of imparting constant voltage to a primary battery was solved, not by using some new and different kind of oxygen-bearing compound, but by taking the oxygen as required directly out of the air. A unique form of gas absorbing carbon having a strong affinity for oxygen was used as the positive electrode, and the battery built around this air depolarizing electrode came up to all expectations. Because it "breathes" oxygen out of the air, the manufacturer called it the "Air Cell" battery.

While the main object to be achieved was the attainment of constant voltage in a primary battery, a number of incidental advantages came out of this development. Because atmospheric oxygen is free and chemical oxides are both costly and bulky, the "Air Cell" battery gives more ampere-hours per unit of volume, per unit of weight, and per unit of cost than any other form of primary battery. Compared with the most economical combination of dry cells designed for the same load, the "Air Cell" battery gives nearly twice as many ampere-hours per dollar of cost. But most important of all, from the standpoint of making radio available to rural dwellers, is the fact that it delivers its output at practically constant voltage. This solved the voltage regulation problem by eliminating it.

The constant voltage primary "A" battery of itself was not the complete solution of the rural radio problem. Its voltage differed from that of all previous types of batteries and as a consequence there were no tubes in existence with which it would co-function. It was necessary to develop a line of 2-volt tubes before receivers could be built.

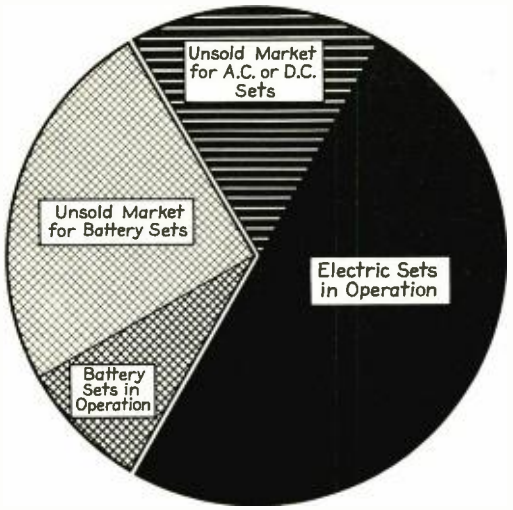
The "Air Cell" battery's voltage is approximately 2.5 volts. Tube filament voltage must be lower than "A" battery voltage to allow for the inescapable voltage drop caused by the resistance of the battery leads, switch and other elements of the filament circuit between the battery and the tubes. The voltage rating of the new tube was established at 2.0 volts, thus allowing 0.5 volt leeway which was considered enough to take care of the maximum lead and switch resistance liable to be embodied in the design of any receiver.

The "Air Cell" battery and the 2-volt tube provided the means whereby set manufacturers could produce a truly practical rural radio receiver. By the time they were ready for release, however, the a-c set was two years old and had established a standard of appearance and performance which by comparison would make a battery receiver designed along previous lines look sick and sound ridiculous. Gone was the external tin horn loudspeaker and in its place was the self-contained unit with the loudspeaker an integral part of the whole. The dynamic speaker had come in, revolutionizing all ideas of what a radio set should sound like. To be acceptable, modern battery receivers must look like as well as sound like a-c sets, and that meant starting from scratch in basic receiver design.

FIRST "AIR CELL" RECEIVER

The first "Air Cell" receiver was produced in 1930. Its introduction was not accomplished by any ballyhoo or fanfare of trumpets. Announced quietly and exploited cautiously, without any consumer advertising whatever, it was an immediate success. Although the price was ridiculously high in comparison with today's prices, and although 1930 probably marked an all-time low in the financial affairs of the farmer, those early sets were bought eagerly and, almost unique for battery sets in rural communities, they stayed sold. A check-up made about a year later, revealed the existence of some of those pioneer sets in such far-away places as Alaska and the Hawaiian Islands, where they were giving complete satisfaction.

The growth of the "Air Cell" receiver idea, while not spectacular, has been steady ever since it was launched in 1930. Improvements have come as a natural course of events, and 1935's receivers not only out-perform the early 1930 sets, but do it on even less battery power, and with it all, they cost much less. Each year has shown a substantial increase in sales over the preceding



Of 30,000,000 families, only 4,000,000 in electrified areas are still unsold, whereas 7,500,000 remain unsold in areas beoynd the power line.

year, and there have been steady additions to the list of set manufacturers making "Air Cell" receivers until today there are over twenty of them including practically all the well-known, leading prominent set makers. The "Air Cell" receiver is available today in a wide variety of makes, models and prices. It is a firmly established institution, well out of the experimental stage, with over five solid years of experience and development behind it.

The "Air Cell" receiver differs from battery sets of the pre-a-c days about as radically as the a-c set itself. Instead of a voltage regulating rheostat and a multiplicity of tuning dials requiring an engineer to operate them correctly, it has no voltage regulating devices of any sort, and it has the same single tuning control with calibrated dial found on the latest a-c sets. It snaps on and off with a switch, just like an a-c set, and with the constant voltage of the "A" battery, tube filament voltage is never too high or too low. Unlike early battery sets, it is fool proof, to use an inelegant expression. The user *can't* abuse his tubes.

The "Air Cell" receiver not only operates with all the simplicity and dependability of an a-c set, it looks like one, and best of all, perhaps, it sounds like one. Dynamic speakers, developed especially for "Air Cell" receivers, obtaining their field from powerful permanent magnets instead of from electromagnets, and therefore requiring no battery power whatever for excitation, reproduce the kind of tone quality established as the standard of comparison by the a-c set.

POWER CONSUMPTION

Alternating-current receiver practise has contributed much to battery set design. Many features, essential to a-c operation, have been applied to battery receiver design with highly beneficial results. One great difference exists, however, which confronts every a-c experienced designer who contemplates developing a satisfactory battery receiver. In a-c practise, the question of power consumption is relatively unimportant. It may be 60 watts or it may be 100. Alternating-current power is both plentiful and cheap. Not so with battery power. It is neither plentiful nor cheap. Every last little milliwatt delivered to the set must be made to give a good account of itself. A wasteful battery set can not compete. Other things being equal, the best set is the one which gets along on the least battery power, for the owner of that set will get longer battery life and lower operating expense than the owner of some other set which performs no better but is hard on batteries.

It is surprising what has been accomplished in the last few years in the conservation of battery power with, if anything, an improvement in receiver performance. It is not uncommon for an a-c receiver, adjusted to deliver two or three watts of undistorted power to the loudspeaker, to draw as much as 100 watts from the line. Some modern battery sets, capable of delivering two or three watts to the loudspeaker, do it on a total input of well under 5 watts total, "A", "B" and "C". Such efficiencies are essential for battery receivers, for while a-c power may cost only 8 or 9 cents per kilowatt-hour, battery power may cost as many dollars per kwh.

Aside from the filament circuit which, as a result of the constant voltage "A" battery, has now become simplicity itself, modern battery receivers differ from those of the pre-a-c days in a number of important respects, making for better performance and longer "B" battery life. These changes involve the grid and plate circuits of the receiver for the most part.

In the old days, receivers usually became inoperative when the "B" battery got down to about 17 volts per 22-1/2-volt section, requiring battery replacement at that point. Because of this, the impression was created—and it still exists in certain quarters—that a "B" battery is exhausted when it gets down to 17 volts. This is not so. At 17 volts, a "B" battery is far from exhausted; it still has a lot of unused capacity remaining in it. The old sets couldn't take it below 17 volts, so their owners, all unknowingly, were throwing away a lot of perfectly good, relatively expensive battery power which was unavailable to them.

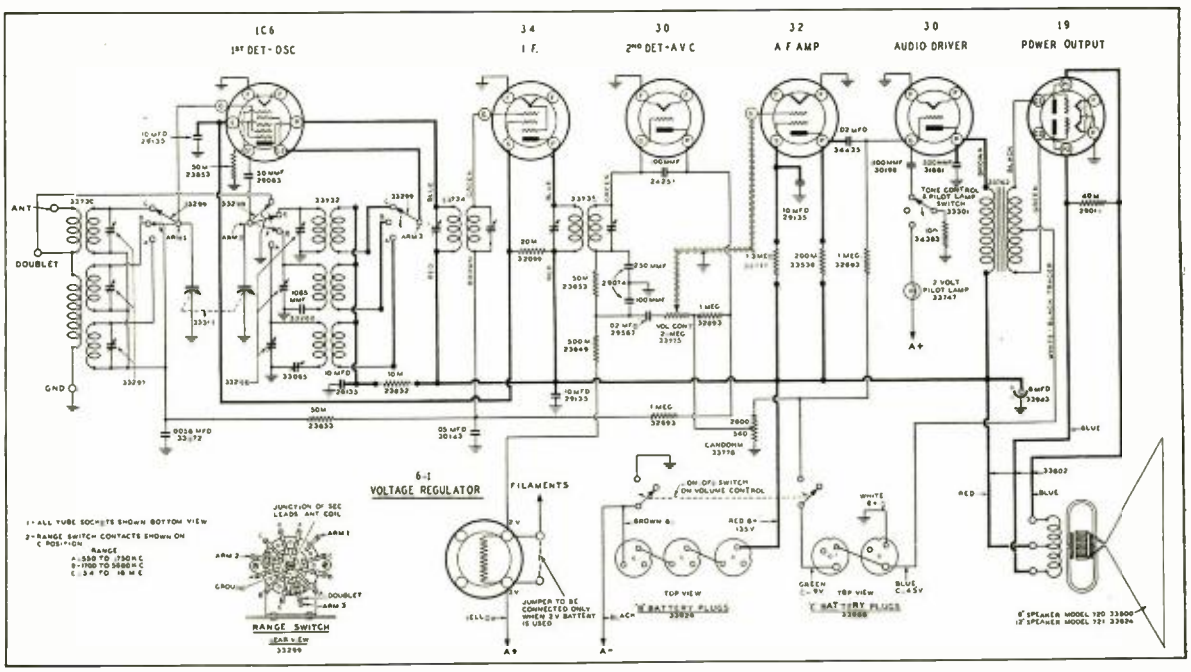
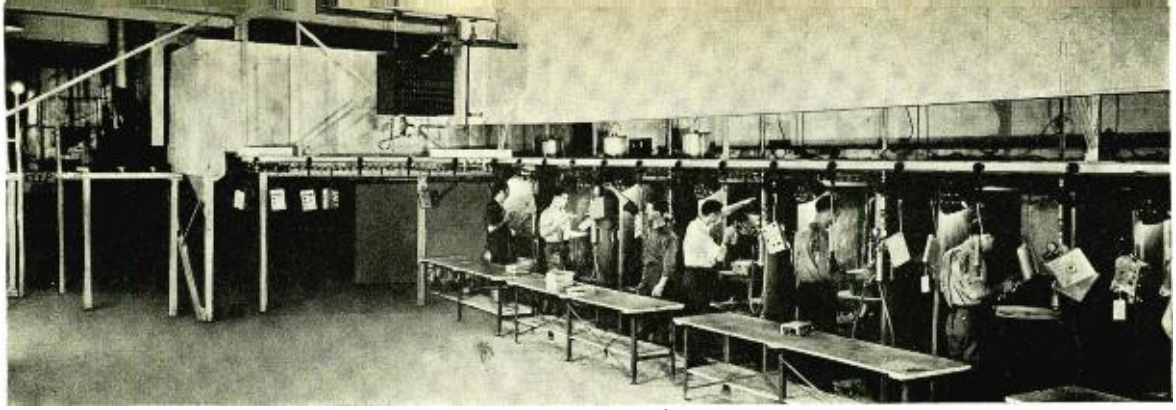


Diagram of a typical battery-operated receiver; the one shown is the Grunow Chassis 7DB. This receiver has everything the a-c set has—superheterodyne circuit, all-wave reception, automatic volume control, real power output, dynamic-type speaker and the same simple control systems. A "C" bias bleeder is also included.



(Courtesy Crosley Radio Corp.)

INCREASED "B" BATTERY LIFE

Today's battery receiver imposes no such drain on its owner's pocketbook. It sails right through the old cut-off point of 17 volts without knowing it, and continues to function with entire satisfaction until the "B" battery has yielded up all the energy the purchaser paid for. The savings thus effected are remarkable, the least being to prolong "B" battery life by 40%, and in many cases resulting in actually doubling "B" battery life. The accomplishment of this is an example of how certain practises have been applied to battery set design with beneficial results.

The reason the old sets quit working in the neighborhood of 17 volts was the increased internal resistance of the "B" battery at that stage of its discharge. It is just as natural for the internal resistance of a battery of dry cells to increase with discharge as it is for its voltage to go down. It is one of the battery's inherent properties. This resistance, common to the plate circuits of all the tubes, eventually reached a stage where it set up excessive regenerative effects, causing the receiver to squeal, or motorboat or otherwise become unmanageable and inoperative. That it happened in the neighborhood of 17 volts was purely fortuitous; it might just as easily have been at some higher voltage.

The "B" power supply unit of an a-c set acts almost exactly like an old, rundown "B" battery. Its "internal resistance" is high and as a result, its voltage regulation is poor. Before the a-c receiver could even be made to operate, means of making it independent of "B" power supply unit resistance had to be evolved. In general, the desired result is obtained by some form of filtering, and this same idea, applied to the battery receiver, makes it just as independent of "B" battery resistance, thus enabling the battery to continue in service until it is completely used up. The amount and kind of filtering required differs with different designs and circuit arrangements so that no general rule for handling this phase of battery receiver design can be laid down. Each design has to be analyzed and treated separately.

Filtering alone, while helpful, will not accomplish all the "B" battery life prolongation that is possible. Another feature of set design, which in addition to filtering, makes it possible to go the whole way is the practise of bleeding the "C" battery during periods of receiver operation so that the grid bias voltage goes down in step with the declining plate voltage.

BLEEDING "C" BATTERY

Normally the "C" battery delivers no current and its voltage remains at its initial level for long periods. The "B" battery, on the other hand, delivers sizable currents and its voltage naturally goes down with use. Under the old conditions prevailing in the early days, the grid-bias voltage was right only once, usually during the first listening period after installing new batteries. Thereafter, the biased tubes became progressively over-biased, causing sensitivity and undistorted output to fall off rapidly with declining "B" voltage.

Bleeding the "C" battery correctly maintains the ideal relationship between plate and grid voltage throughout battery life. Thus the loss of sensitivity and undistorted output per volt drop in the "B" battery is greatly reduced, and with the avoidance of instability resulting from filtering, there is no pronounced diminution of set performance until the "B" battery is in the last stages of complete exhaustion.

"C" battery bleeding is usually accomplished by switching a resistor of suitable value across the battery terminals during periods of receiver operation. This calls for a separate contact on the "off-on" switch. The amount of resistance required depends largely on the receiver's plate current and the rate at which it changes with changing plate voltage. Since this rarely is the same for any two designs, accurate bleeder design can be accomplished only by an analysis of the characteristics of the receiver.

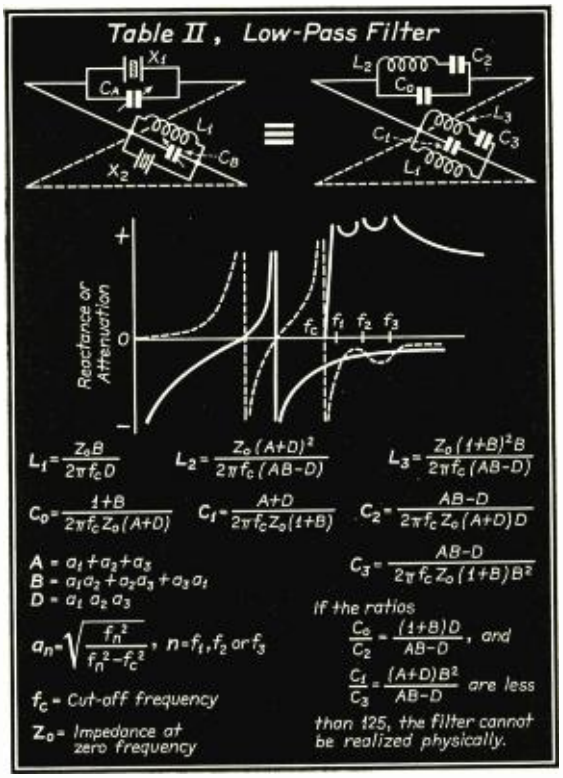
The practise of filtering and bleeding the "C" battery is almost universal today. Almost without exception, all battery receivers of current manufacture embody this important battery saving feature.

ELIMINATION OF LEAKAGE CURRENTS

Still another departure from early battery set design is the now universal practise of disconnecting the "B" battery from the receiver during periods of idleness. A separate point on the "off-on" switch takes care of this operation automatically. This practise has almost totally eliminated transformer and coil failure in humid countries due to electrolytic corrosion. Removing the "B" voltage from the receiver during the "off" periods also has been of material help from the battery viewpoint. Complaints of short "B" battery life, traceable to leakage currents within the receiver which, though small, flow continuously, 24 hours per day, have become a thing of the past.

These are just some of the ways in which today's battery receivers differ from those which, in the early days failed to meet the requirements of the rural population. The final proof of its ability to serve those living in unwired homes as well as the a-c set serves the city dweller lies in its ownership. With five years of growing popularity, the answer is plain; it is the solution of the rural radio problem. Not a makeshift adaptation of a set designed primarily to sell to the city dweller, but one designed from the ground up with the farmer's needs in mind.

1936 promises to be the biggest battery receiver year since the really practical rural receiver was evolved in 1930. It ought to be. It is Presidential election year, for one thing, and this year, if ever, the air will be full of things the farmer, of all people, shouldn't miss. Carrying the message to him is not just a matter of talking into a microphone; somebody has to get busy on a rural radio merchandising program, and from present indications, this market is going to receive in 1936 for the first time in history the full measure of attention of the Radio Industry it deserves.



Crystal Filter Design

PART 2

By W. W. WALTZ

THE theory of electric wave filters usually starts from the band-pass type of structure; low-pass and high-pass structures are derived from the band-pass by considering one of the cut-off frequencies to be (for the low-pass) zero or (for the high-pass) infinite. This is the method described by Campbell in his original patent application filed in 1915, although he presumably developed the low-pass structure first, as a result of his mathematical investigations of the loaded line.

Crystal filters of the low- and high-pass types are probably of academic interest only to the radio engineer; however, elsewhere in this article we are including a table of formulas for these types.

BAND WIDTH

As we pointed out in the first article of this series, there is no combination involving crystals alone which will give more than an 0.8% band, the percentage being of the mean band frequency. This means that, considering a crystal-coupled filter for an i-f amplifier, for a mean band frequency of 175 kc, the response curve would be only 1,400 cycles wide; the improvement for a 465-kc intermediate would, of course, be appreciable, although still not great enough—3,720 cycles—for quality reception. Condensers in combination with the crystal or crystals serve only to restrict further the band width which can be passed.

However, it was also demonstrated (see Figs. 10 and 11, Part I) that added inductance increased the bandwidth. We shall make use of this effect to design a band-pass filter for use with an i-f amplifier for a high-fidelity receiver circuit.

The circuit of Fig. 14 is that of an i-f amplifier, with the tubes connected push-pull, employing crystal coupling between the stages. The equivalent electrical circuit of one of the crystal coupling circuits is shown in Fig. 15, and the reactance curve is that of Fig. 16. In this latter figure, the solid line curve is the reactance of the line (series) branches of the lattice type structure, and the broken line curve is the reactance of the lattice (shunt) branches. Few if any present-day receivers use push-pull stages elsewhere than in the power amplifier, so that giving this circuit more than a cursory examination may appear to be another of those purely academic matters. However, it will be remembered that we devoted a considerable amount of space in the first article to the equivalence between various types of structures, and especially to the equivalence between the lattice network and the bridged-T type. It is convenient to obtain the crystal network in the lattice-equivalent form before converting into the bridged-T section.

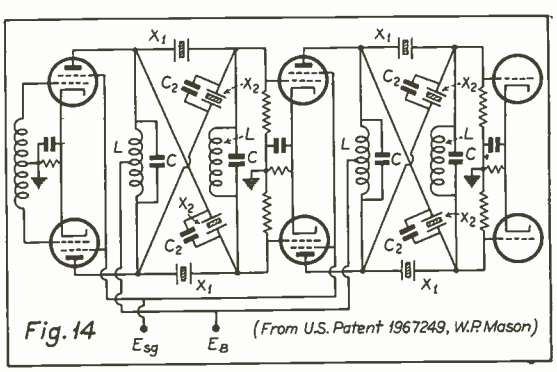
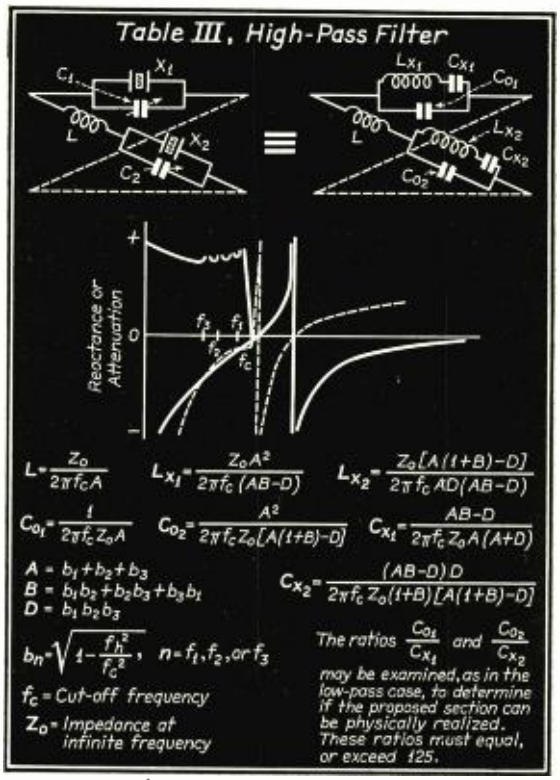


Fig. 14 (From U.S. Patent 1967249, W.P. Mason)

The Design of Special Crystal-Filter Circuits for Superheterodyne Receivers Requiring High-Fidelity Characterisitcs



IMPEDANCE MATCH

Returning to the circuit of Fig. 14, we find that its reactance curve shows the existence of a pass band, as between the points f_1 and f_4, the cut-off frequencies, the reactance of the line branch is at all times opposite in sign to that of the lattice branch. The impedance of this network is as shown in Fig. 17. It will be seen that the impedance rises to extremely high values at the marginal frequencies; even at mid-band this filter may have a sufficiently high impedance to insure a good match to the plate resistance of a screen-grid tube, a point of some value from the possibility of obtaining high gain from r-f tubes of the pentode variety—the best of high-Q electrical circuits at radio frequencies rarely present an effective impedance in excess of about 30,000 ohms, and this is far from being the optimum load for these tubes.

The elements of the equivalent circuit of Fig. 15 can be determined from the equations appearing below. These expressions are derived by means of the Campbell reactance theorem, the general equation of which was given in the first part of this series.

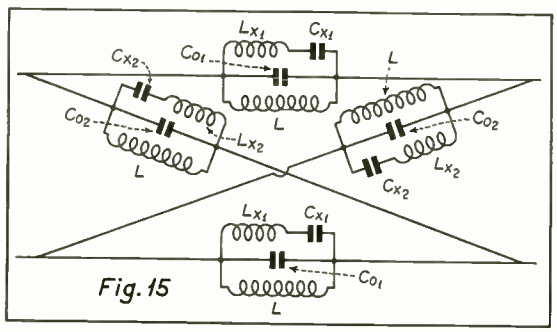


Fig. 15

$$\frac{1}{C_{o_1}} = L\frac{\omega_1^2\omega_3^2}{\omega_2^2} \quad (1)$$

$$\frac{1}{C_{x_1}} = L\frac{\omega_1^2\omega_2^2\omega_3^2}{(\omega_2^2-\omega_1^2)(\omega_3^2-\omega_2^2)} \quad (2)$$

$$L_{x_1} = L\frac{\omega_1^2\omega_3^2}{(\omega_2^2-\omega_1^2)(\omega_3^2-\omega_2^2)} \quad (3)$$

$$\frac{1}{C_{o_2}} = L\frac{\omega_2^2\omega_4^2}{\omega_3^2} \quad (4)$$

$$\frac{1}{C_{x_2}} = L\frac{\omega_2^2\omega_3^2\omega_4^2}{(\omega_3^2-\omega_2^2)(\omega_4^2-\omega_3^2)} \quad (5)$$

$$L_{x_2} = L\frac{\omega_2^2\omega_4^2}{(\omega_3^2-\omega_2^2)(\omega_4^2-\omega_3^2)} \quad (6)$$

ω_1 and ω_4 are the lower and upper cut-off frequencies, respectively; they are expressed here in angular measure, i.e., $2\pi \times f$. ω_2 and ω_3 are frequencies within the pass band; their location determines to a great extent the attenuation characteristics of the filter section. In general, if the frequencies ω_1, ω_2, ω_3, and ω_4 have a certain relationship, such that they are a geometric series, the attenuation will be high outside the pass band.

CHARACTERISTIC IMPEDANCE

The characteristic impedance of the filter may be found from any one of several expressions. Perhaps the most useful of these is given as equation (7) below. It will be seen that here the impedance is a function of,

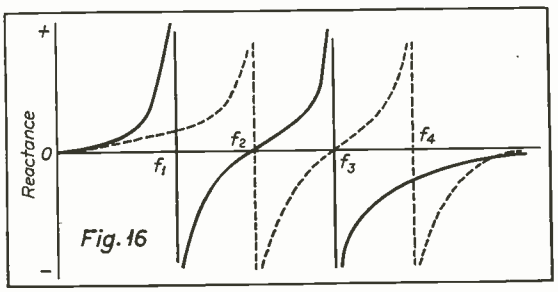


Fig. 16

among other things, the inductance L of the coils of the filter (see Fig. 14). Since the impedance of the filter is generally known—or, more properly, the impedance which the filter have to face is known—and since the cut-off frequencies are known, equation (7) provides a very convenient starting point for the design, i.e., from it we can find L, which in turn appears as a parameter in all of the equations from (1) to (6) inclusive.

$$Z = \frac{\omega_1 \omega_4 L}{\omega_4 - \omega_1} \qquad (7)$$

In connection with this matter of filter impedance it is important to note that, since the capacities—fictitious, to be sure, but none the less effective!—of the crystal are extremely small, and since by careful design the added capacities can be made small, the impedance of the network can be made sufficiently high to match the plate resistance of pentodes, as previously mentioned. It should be noted particularly that the effective capacity of the coils L is directly in shunt with the crystal, as is the grid-cathode and plate-cathode capacity of the tubes; each of these must be taken into consideration in the design[1].

TYPICAL DESIGN

In the references just cited we may find a typical design for the type of structure which we have been discussing. Mason assumes a filter to work out of a tube having a plate resistance of 500,000 ohms; the filter is to pass a band of frequencies lying between 1,200 kc and 1,212 kc. In accordance with the method of spacing the frequencies, from f_1 to f_4, in a geometric series, these have been given the following values: 1,200,000 cps; 1,202,610 cps; 1,209,425 cps; and 1,212,000 cps. To secure a more equable impedance match over the entire pass band, the characteristic impedance—in this case 500,000 ohms—has been reduced by about 20%, giving the structure an actual impedance of 400,000 ohms. Substitution of these values in equation (1) to (7) gives the following values for the elements of the crystal-equivalent-circuit (Fig. 15):

$L = 0.52$ mh.
$C_{o1} = 32.9$ mmfd.
$C_{o2} = 33.35$ mmfd.
$C_{x1} = 0.001468$ mmfd.
$C_{x2} = 0.001459$ mmfd.
$L_{x1} = 11.91$ henrys
$L_{x2} = 11.90$ henrys

These values are then substituted in expressions similar to those given as equations (7) to (9) of Part I, and the crystal dimensions found by a simultaneous solution of these equations for the three unknowns—length, width and thickness[2]. Mason, however, has arbitrarily assumed a thickness of 0.05 cm. for all of the crystals of the circuit of Fig. 14; the remaining dimensions are then calculated to be, for X_1:

Length = 0.224 cm.
Width = 0.11 cm.

and, for X_2:

Length = 0.223 cm.
Width = 0.11 cm.

It is perfectly apparent that these crystals—in addition to being extremely small physically—are nearly of the same frequency characteristic. That is, since the length is the determining factor of the fundamental frequency, the difference in the fundamentals of these two plates is that represented by a length of only 0.001 cm. Calculation of the fundamentals of these plates bears out this observation. Furthermore, the theory of wave filters, which indicates that for a pass band to exist the frequencies of resonance of the lattice arms and anti-resonance of the line branches must be coincident; this occurs at points f_2 and f_3 of Fig. 16.

SINGLE-SIDED CIRCUIT

Turning now to the more conventional single-sided or straight cascade circuit, as exemplified by the present-day amplifiers, we find it necessary again to refer to the procedure for the derivation of equivalent circuits.

Fig. 18 shows the circuit of a bridged-T type of crystal filter, and Fig. 19 is the equivalent lattice structure. It is evident, from the relation shown in Figs. 12 and 13 of Part I, that this equivalent lattice is identical with that shown in Fig. 15. In other words, by dividing the circuit of Fig. 18 into two symmetrical parts[3] and determining, by inspection, the open and short-circuit impedances, we can easily find the equiv-

[1]Much of this material and that to follow has been selected from the specifications of the following U. S. Patents, issued to W. P. Mason: 1,967,249; 1,967,250; 1,921,035.

[2]Since the first part of this series was written it has been found that a somewhat different set of numerical constants for equations (7) to (9) of Part I will give more accurate results. The expressions as originally given are from the earlier of Mason's patents; a later patent gives the following, which will be used through the remaining discussions:

$$C_1 = \frac{40.2\ w\ l\ 10^{-14}}{t} \text{ Farads}$$

$$C_o = \frac{0.322\ w\ l\ 10^{-14}}{t} \text{ Farads}$$

$$L = \frac{106.1\ l\ t}{w} \text{ henrys}$$

As before, w, t, and ρ, are the width, thickness and length—all in centimeters—of the quartz plate.

[3]Exactly as was done with the T section of Figs. 4A and 4B of Part I.

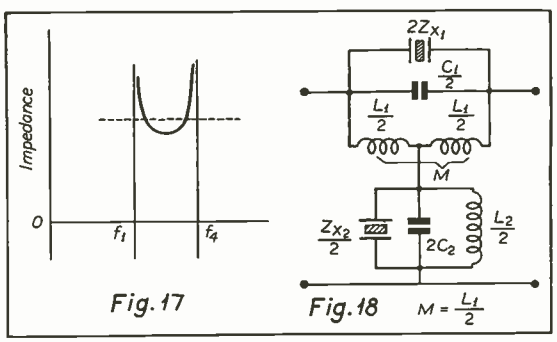


Fig. 17 Fig. 18

alent lattice structure of Fig. 19. Replacing the crystals of the lattice by *their* equivalent networks results, obviously, in the network of Fig. 15. The design procedure for a filter of this type is, then, simply that discussed above for the crystal filter of Fig. 14.

The reactance-frequency curve for the filter of Fig. 18 is identical with that of the structure of Fig. 14, this being shown in Fig. 16. It is perhaps pertinent again to point out that the condition for the existence of a pass band is that the reactance of the line branch of the equivalent lattice (solid line curve) is at all times opposite in sign to that of the lattice branch (broken line curve). With this statement in mind, it becomes evident that any number of sections of the bridged-T type can be devised. It is necessary simply to proportion the circuits that the reactance of the series arm is opposite in sign to that of the lattice between the limits f_1 and f_4. These frequencies, it will be remembered, are the band marginal frequencies and correspond, respectively, to the resonance and anti-resonance points of the series arm. Other frequencies—f_2 and f_3—within the band, and corresponding to the anti-resonance and resonance points of the lattice branch, are so related to f_1 and f_4 that $f_1 f_3 = f_2^2$ and $f_2 f_4 = f_3^2$, in which case $f_2/f_1 = f_3/f_2 = f_4/f_3 = \text{constant}$. It must, however, be kept in mind that we are concerned with the equivalent lattice structure in these remarks; i.e., first convert the proposed bridged-T structure to its equivalent lattice —by the methods discussed previously—then apply the principles above.

It follows that, to arrive at the constants of a network which will have the characteristics indicated above, we must have some means to determine circuit elements from a knowledge of nothing more than the reactances at various frequencies. The principles of Campbell's theorem were discussed briefly and the general equation was given in the final paragraphs of Part I. This reactance theorem is called upon for the derivation of the arms of the equivalent lattice structure, employing as parameters the assigned frequencies and reactances at these frequencies. From this we arrive at the elements of the lattice network, reconvert to the bridged-T and, finally, reduce the equivalent circuit of the crystal to terms of an actual plate.

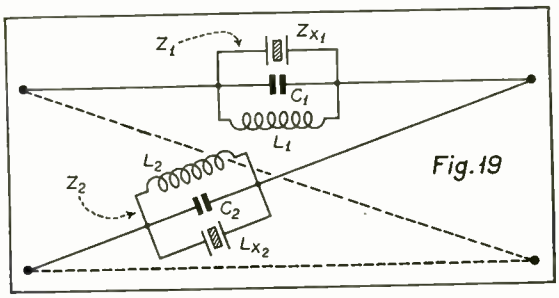


Fig. 19

APPENDIX

High- and Low-Pass Filters

The data in Table II give the design requirements for a crystal filter of the low-pass type; Table III being for the high-pass structure. This material, it is believed, is almost self-explanatory. The only confusing points are those involving the solutions for the functions a_n and b_n. It can be seen that these are simply functions of the various frequencies of infinite attenuation—f_1, f_2, and f_3. In general, these frequencies should be chosen so that they are within about two percent of the cutoff frequency. The design of either a low-pass or high-pass filter requires that the following should be specified, or arbitrarily assigned; from them the complete design is then readily determined:

f_c, the cut-off frequency
f_1, f_2, and f_3
Z_0, the impedance

The attenuation-reactance diagrams of Tables II and III show that for a low-pass filter the impedance of the lattice arms must be opposite in sign to that of the series arms at all frequencies below f_c; while in the high-pass case the impedance of the lattice arms is opposite in sign to that of the series arms above f_c. This, it may be of interest to point out, is a perfectly general statement: it may be condensed to: Opposite signs always indicate a transmission band; like signs an attenuation region.

(To be continued)

BOOK REVIEW

BLUEBOOK OF PROJECTION, Sixth Edition, 709 pages 6½ by 9½ inches. flexible imitation leather covers. Published by Quigley Publishing Co.. New York. N. Y. Price $5.00.

Containing over 700 pages of text and illustrations, and with its material so organized that both the highly trained projectionist and the student are equally served. the sixth edition of F. H. Richardson's "Bluebook of Projection," just published, reveals a painstaking effort to combine an exposition of underlying principles with detailed explanations of approved projection practice.

Throughout the book the fundamental sciences represented in the projectionist's craft, such as electricity and optics, receive theoretical attention as well as practical application to the every-day problems and processes of projection and sound reproduction. There are 32 chapters, and in addition, sections devoted to definitions of technical terms, mathematical quantities. etc.

Making the volume particularly handy for reference as well as for general study, is a system of paragraph identification designed to facilitate cross-reference and the finding of the answers to the study questions which precede each chapter.

This book has become through the years a standard work on projection. It is handsomely printed on coated paper and is profusely illustrated with diagrams and photographic reproductions.

In a foreword, Adolph Zukor, pioneer producer and chairman of the board of Paramount Pictures, Inc., gives glowing recognition to the part the skilled projectionist plays in the effectiveness of the motion picture as an amusement medium. Mr. Richardson has dedicated the book to the IATSE & MPMO, with the approval of George E. Browne, international president of the organization.

THE 1936 RADIO MARKET

(*Continued from page 7*)

equipment. As insulations, they are used in fixed condensers, trimmer and padder condensers, variable condensers, radio-frequency coils, coil-switching devices, antenna systems, rheostats, vacuum tube spacers, tube bases, tube sockets, coaxial conductor spacers; in fact, at any point where high-frequency insulation is required.

IRON AND STEEL:

Domestic: Used in the manufacture and fabrication of chassis frames, transformer laminations frames and end bells, filter choke laminations, speaker frames and magnets, metal vacuum tubes, powdered cores for r-f and i-f transformers, etc.

Swedish: Used for transformer laminations, vibrator reeds, etc.

Svea Metal, an ultra-pure Swedish iron is used for vacuum tube parts.

LACQUERS AND PAINTS:

Practically every radio and electronic device manufacturer uses some form of lacquer and paint, either to afford a finish to his completed product, or for insulation purposes.

MICA:

Used in vacuum tubes as spacers, in variable resistors, fixed condensers of both transmitting and receiving type, trimmer and padder condensers, dry rectifiers, meters, thermostatic controls, electric furnaces, soldering irons and relays. Powdered mica is also used as a base in some forms of insulating materials.

NICKEL AND NICKEL ALLOYS:

Pure nickel is used in the forms of rod, plate, tube, wire, sheet and extruded in the manufacture of all types of vacuum tubes, including transmitting tubes, cathode-ray tubes, neon tubes, etc. In 1936, receiver type tubes will contain approximately 17.2 pounds of metal per 1000 units.

In alloy form it is used principally in the manufacture of wire-wound resistors. Approximately 89 percent of all alloy resistance wire used by the radio industry each year is employed in the manufacture of resistors, both fixed and variable.

The resistance wire is used in the manufacture of power rheostats, potentiometers, voltage dividers, bleeders, bias resistors, voltage dropping resistors, meter shunts, etc.

PAPER, ALL TYPES:

Paper is used in the manufacture of fixed condensers, coil forms, wire spacers, in transformer assembly and as loudspeaker diaphragms. Paper tubing is also used for the cases of some types of fixed paper and electrolytic condensers.

PLASTICS:

Plastic materials, both laminated (in rod, tube and sheet), and molded, are considered prime insulation materials. Either or both forms enter into the manufacture of practically every type of radio or electronic device.

A few of the uses of laminated plastics are: tube sockets, radio-frequency coil forms, audio transformers, terminal strips, switches, loudspeaker diaphragm rings and spiders, fixed and variable condensers, volume, tone and sensitivity controls, resistor strips, flexible couplings, jacks, fuse mounts, meters, washers, bushings and separators.

In molded form, plastics are used for cases and bases for meters, volume, tone and sensitivity controls, vacuum tubes, electrolytic condensers, trimming and padding condensers, headphones, and in many other places where a material is required having both high insulation properties and mechanical strength.

Molded plastics are also used for radio knobs, dial escutcheons, complete radio cabinets, as a binder for small fixed condensers and resistors, and as terminal strips on apparatus such as electrolytic condensers, power and audio transformers.

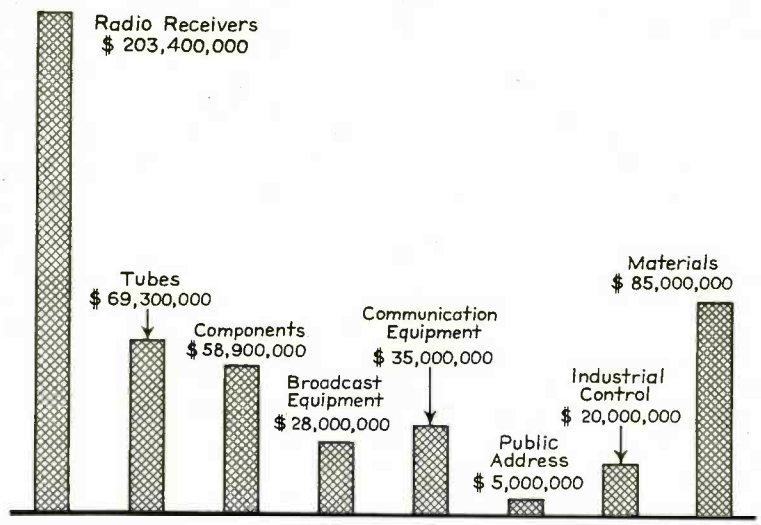
The total estimated business in plastics for 1936 is $5,500,000. Approximately $2,500,000 of this will be spent for laminated types and $3,000,000 for molded plastics.

MISCELLANEOUS HARDWARE:

This includes screws and screw machine parts. A single receiver requires in the neighborhood of 528 screws, 84 bolts of varying sizes, 179 nuts, 499 eyelets, 1,296 lugs, 181 washers, 768 self-tapping screws, 413 lock washers and 223 spring contacts.

TUBING AND VARNISHED FABRIC:

Materials of this nature are indespensible to the radio industry. Large quantities of "spaghetti" and varnished fabric are purchased each year for use in the manufacture of power and audio transformers, chokes, loudspeakers, and in the fabrication of radio receivers, public-address equipment, commercial and amateur radio transmitters and the various types of electronic devices.



Estimated market value of components and equipment that will be manufactured by the radio and allied industries during 1936.

TUNGSTEN:

The two major radio applications which require tungsten are: radio tubes in which it is used in the form of rod, wire and welds; and vibrators in which it is used in the form of contact points.

Over 500,000,000 tungsten welds will be used in tube production in 1936, and over 6,800,000 tungsten contacts will be used in vibrators. This will represent a total expenditure of over $1,500.000 for tungsten alone.

WAXES, VARNISHES AND COMPOUNDS:

Waxes and compounds are used primarily as impregnating, filler and insulation bodies in such components as transformers, condenser blocks, paper condensers, radio-frequency coils, radio-frequency chokes and audio transformer windings.

Varnishes are used as a substitute for paint and lacquer in some applications; in others, as a porosity, corrosion or oxidation preventative.

Dozens of radio components require one or more of a wide variety of waxes and compounds in their production. Over $540,000 will be spent for these materials during 1936.

How Shall We Solder the Radio Chassis?

(Photo courtesy RCA Manufacturing Co., Inc.)

An article dealing with soldering fluxes and chassis treatment that will prove of interest to production engineers

By CLIFFORD L. BARBER
Research Chemist
KESTER SOLDER CO.

A problem has recently come up which is vital to the welfare of the Radio Industry. Most major problems vitally affecting a large industry on a wide scale usually require months or even years for their successful solution. It is a significant fact that while Fiction travels like wildfire, Truth travels very slowly and the Radio Industry is no exception to the general rule that sound honest progress is accomplished only through long application, hard work and patient suffering.

SOLDERING FLUX

One experience which still rankles in the mind of the radio pioneer and which even yet fans the dying embers of wounds suffered in those early days is the experience which manufacturers had in the use of corrosive soldering fluxes. Gradually through the years, it has become impressed on the mind of the radio manufacturer that the only safe flux for radio assembly is rosin or one of its solutions, and that in spite of extravagant claims to the contrary, there is no other non-corrosive flux. There is no question that the present high state of development of the Radio Industry is partly due to the non-corrosive and dielectric features of Rosin.

The Radio Industry is now faced with a problem which threatens ill consequences. Due to a recent sharp rise in the cost of cadmium, radio chassis are now being zinc plated. It is unfortunate that zinc does not readily respond to the fluxing action of rosin. Confronted with this problem, manufacturers are contemplating the use of a more active flux. Manufacturers do not all realize that such a move is a step in a backward direction and that it only automatically relegates Radio to a status from which it once merged only after a hard and bitter struggle. Certainly it would be unwise to ignore the costly lesson which it has taken fifteen years to learn.

(Photo courtesy RCA Manufacturing Co., Inc.)

SOLDER APPLICATION

A somewhat more constructive analysis of the existing situation involves a basic knowledge of solder application. Obviously, soldering may be resolved into two distinct factors:

1. The role played by the solder metal.
2. The role played by the flux.

It is the function of the solder metal to form an intermediate alloy either through metal solubility or compound formation between the solder and the metal soldered. If the solder operation were confined to this factor alone, zinc would offer no obstacle to soldering because this element is easily and readily soluable in molten solder at low temperatures. Although it is true that the introduction of small amounts of zinc markedly decreases the mobility of solder, it is of relatively little consequence in the case of the zinc plated chassis where the demand for speed and for quantity production necessitate a "spot solder" operation. Any attempt to increase the solder receptiveness of the zinc plating by altering the solder alloy is therefore not based on sound principles.

It is with respect to the second factor, namely, the role played by the soldering flux, that zinc offers a real difficulty. Briefly, it is the function of the

(Continued on page 21)

Alnico magnet sustaining pull of 60 times its own weight.

ALNICO-

A New Magnet Material

Research in the field of permanent-magnet alloys has resulted in a new alloy, Alnico, so much more powerful than those commonly used hitherto as to open entirely new fields of application for permanent magnets. Small motors, dynamic loudspeakers, and various control devices hitherto operated by electromagnets can now use permanent magnet fields, at a considerable saving in cost and greater simplicity of construction; and Alnico already has been applied by General Electric in a variety of applications, including blow-outs for relays, holding-in magnets of large switches, in latching and special timing relays, and in different control devices. Alnico magnets will lift about 60 times their own weight, when designed for that purpose.

ALNICO USUALLY CAST

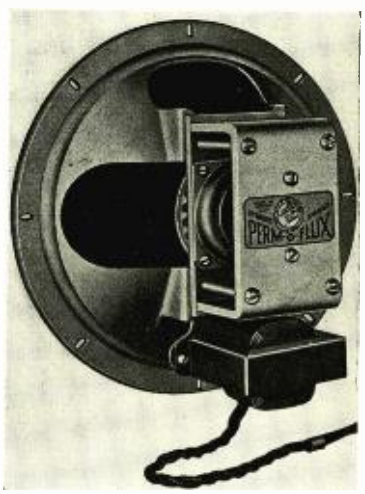
The new alloy is usually a cast material and is finished to shape by grinding. Alnico generally should be cast in quantities for commercial applications, and is not available in standard bars for individual fabrication. The Simonds Saw and Steel Company of Lockport, N. Y., has been licensed by the General Electric Company to manufacture and sell magnets of the new alloy.

An alloy consisting of the ingredients present in Alnico was originally developed by the General Electric Company as a heat-resisting alloy which resists scaling and deterioration at high temperatures. Some work on the magnetic properties of alloys of this type were later carried out by Professor T. Mishima of the Imperial University, Tokyo. General Electric has perfected a process of heat-treating of the alloy by which its magnetic properties are fully developed.

Marked improvements in permanent-magnet materials have been made in the past few years as the result of intensive metallurgical research covering both their composition and their heat treatment and preparation. Less than a quarter of a century ago the best magnets were hardened plain carbon steel, developed by cut-and-try methods. By metallurgical methods it was later found that the form of distribution of the iron-carbide in hardened steel was one factor that determined its quality as permanent-magnet material. Consideration was therefore given to the properties of alloy steels in which the alloying metal elements, other than iron, would form carbides. Thus the cromium and the tungsten magnetic steels were developed. The addition of cobalt to the tungsten-iron-carbon alloys resulted in another advance in the production of permanent-magnet steels.

Only a few years ago an alloy of iron, aluminum, and nickel was discovered to possess suitable permanent-magnet properties. This alloy contains no carbon and belongs to the precipitation-hardening type of alloys, quite distinct from the steels. The addition of cobalt was the next step; and thus was born Alnico. With the discovery that a precipitation-hardening alloy may pos-

(*Continued on page 21*)



Permanent-magnet dynamic speaker in which Alnico is used. Manufactured by Continental Motors

HOW SHALL WE SOLDER THE RADIO CHASSIS?

(*Continued from page* 19)

flux to reduce or prevent the formation of oxides during the solder operation in order that the respective metals may mutually make actual metallic contact. Unfortunately, the oxide of zinc is not readily reduced by rosin flux at rosin temperatures and there is therefore an oxide barrier between the zinc and the molten solder which prevents metallic contact. The molten solder, being unable to touch the zinc, cannot alloy with it, and unsatisfactory soldering results.

BASE MUST BE SOLDERED

A consideration of the practical as well as the purely theoretical aspects of solder is of particular importance as applied to the zinc plated chassis. It has been pointed out that the solder operation involves a solution action by solder on the metal which is soldered. If the metal is electroplated, the molten solder rapidly dissolves the thin plating at the point of application and then alloys with the base steel. In the final analysis, the soldering of electro-plated steel therefore involves the soldering of the base metal; the fact that it may be plated with another metal does not alter the fact that after all it is the steel which must finally be soldered. It is therefore important that steel must be clean and capable of being soldered before it is plated, since it is obvious that steel which will not solder before plating certainly will not solder afterward.

A second point of practical importance is the fact that electroplated coatings are very thin. Their attachment to the base metal is superficial in the sense that they are physically rather than chemically attached, and in their thin relatively porous state, they are extremely subject to oxidation. In particular, an electro-positive metal like zinc is quickly converted to the oxide or the carbonate or is otherwise subject to the attack of certain corroding atmospheres in plating plants. In order to reduce the burden imposed on the soldering flux, the plated article should be protected as far as possible from corroding agents. Furthermore, some phases of the plating process are not fully understood and platings are not always uniform either in composition or behavior.

TIN DIPPED STEEL

If one now turns to the "hot tin dipped" rather than the electro-plated steel, the problem of soldering is distinctly altered. One reason for this is the fact that the tinned steel is already soldered since the tinning process has automatically caused the necessary alloy formation to take place.

Manufacturers will, of course, contend that a tinned chassis is more expensive than a plated one. These manufacturers, however, should consider that the added speed of solder assembly will partly or completely compensate for the added cost of the tinned unit.

It is to be hoped that radio manufacturers may consider the adoption of a tinned steel chassis for radio assembly in view of the speed and readiness with which it may be soldered with rosin core solder. It is further hoped that manufacturers may not find it necessary to re-learn the tragic lesson of the corrosive soldering flux. It is said that history repeats itself; let us then hope that we may be granted a little longer interval before this particular experience is again inflicted on the manufacturer.

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ALNICO

(*Continued from page* 20)

sess excellent permanent-magnet properties, an entirely new field of alloys for magnets was opened for research.

PROPERTIES OF ALNICO

The coercive force is higher and the residual induction lower for Alnico than for other magnetic materials. The maximum available energy is higher for Alnico, and occurs at a lower flux density and a higher demagnetizing force. Alnico magnets may, therefore, be of smaller volume, but generally should be designed with greater cross-sectional area and shorter length to maintain a given magnetic field in an external air gap.

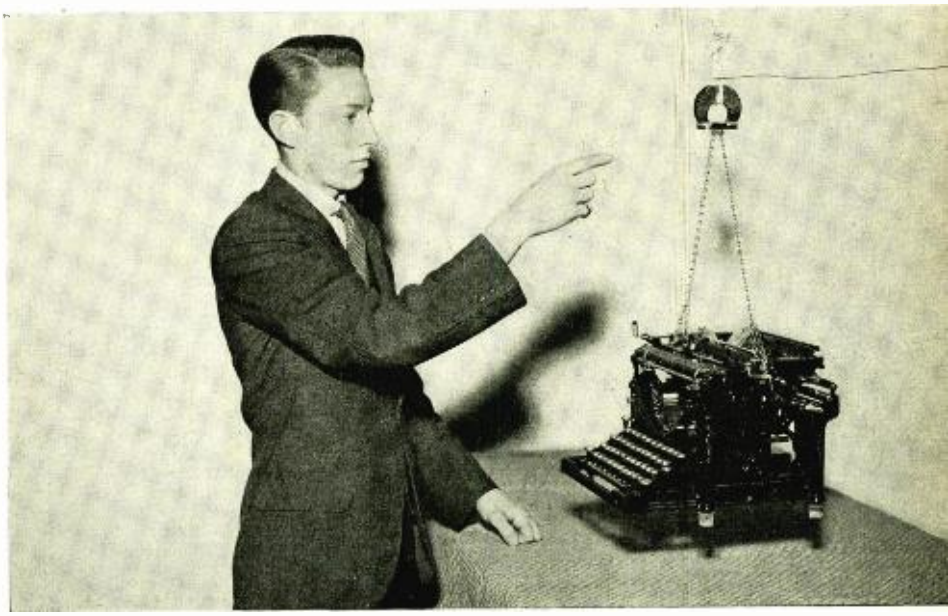
Alnico magnets are less subject to demagnetization by stray fields. Tests on Alnico bar magnets resulted in a decrease in total flux of less than one percent after being subjected for one minute to an alternating field of 100 ampere turns per inch and a decrease of approximately 10 percent after being subjected to an alternating field of 500 ampere turns per inch. No further decrease was observed when the alternating field was maintained constant for one-half hour.

Alnico magnets are less subject to demagnetization by high temperatures, and are less subject to demagnetization by mechanical vibration. Vibration tests on Alnico bar magnets resulted in a decrease of less than one percent in total flux after severe vibration at 120 cycles per second for one-half hour.

Alnico magnets require a considerably stronger magnetizing force to magnetize them completely than do other magnet materials. A magnetizing force of at least 2000 oersteds (4040 ampere turns per inch) should be applied.

The new magnet alloy has a relatively low specific gravity (6.9), is non-corrosive, and is brittle. It is cast in the proper design, and finished by grinding. Any necessary holes should be cored in the casting. Soft steel inserts may be cast in for fastening.

Alnico magnet sustaining pull of suspended typewriter.



RMA NEWS

BUSINESS OUTLOOK FOR 1936

Optimism over 1936 prospects for the radio industry is held by industry leaders composing the RMA Board of Directors. The Association's managing board, with President Leslie F. Muter presiding, met Wednesday, January 22, at the Stevens Hotel in Chicago, and the coincidental cold wave did not cool the estimates for 1936 sales.

In outlining constructive plans for industry promotion in 1936, the RMA directors look forward to another excellent year. Some industry leaders even feel that the record-breaking sales of 1935 will be exceeded in 1936.

The Presidential election campaign, in which radio is assured of special prominence and the many months of the unusual political battle, is regarded as an important factor. During past Presidential elections the sales curve in radio has always increased and the 1936 campaign promises to bring radio to the fore even more prominently. An advance indication was the public interest and also radio sales stimulus in January in the recent political addresses of President Roosevelt, former President Hoover, Al Smith and others.

Another important sales factor is the new soldier's bonus distribution, probably next June and July. Veterans' organizations estimate about $1,500,000,000 of the bonus will be spent immediately on consumer goods by the ex-soldier beneficiaries. A substantial part of a previous bonus distribution was invested in radio.

FRENCH TUBE QUOTAS

A meeting of the RMA Tube Division is planned soon for further consideration of improving conditions in the export of tubes to France. Chairman Ben Erskine of the Tube Division is recuperating in Florida but by long-distance has arranged for an early meeting of tube manufacturers who will be advised definitely later. Further requests have come to the RMA from the French administrative committee in charge of tube import quotas requesting data regarding American manufacturing which will assist them in more equitable allocation of tube imports. The complex question will be studied further by the Tube Division at the forthcoming meeting.

EMPLOYMENT INDICES FOR OCTOBER 1935

Increase of 25.3 percent during October 1935 in radio factory employment over October 1934, detailed in the latest report, for last October, by the U. S. Department of Labor, Bureau of Labor Statistics, coincided with the increased radio industry production and sales which contributed to the record-breaking year of 1935. This was an unusual seasonal increase. While the Department of Labor reports have apparently discontinued stating the number of radio companies contributing reports and the detailed number of employees, in October 1934, fifty-one radio factories reported employment of 39,335 employees, from which a comparison is possible. The Department of Labor also apparently has discontinued reporting wage increases or wage decreases.

The October 1935 increase in radio factory employment of 25 percent compares with an employment increase of only 2 percent nationally in manufacturing industries, but in the radio industry the average weekly working hours of employees per week were somewhat longer and their average hourly earnings and per capita weekly earnings were smaller than the national average of manufacturers of durable goods.

While the increase in radio factory employment over October 1934 was 25.3 percent, the federal report also stated that during October 1935 there was an increase of 9.5 percent in employment over September 1935. Radio factory employment during October 1935 was 179.1 percent over the official three-year average of 1923-25.

Radio factory payrolls during October 1935 increased 11.7 percent over September 1935, and 34.8 percent over October 1934. They were also 85.8 percent above the three-year official average of 1923-25.

Per capita weekly earnings in radio factories reported in October 1935 were $20.74, an increase of 2 percent over the previous month of September, and 7.6 percent above those of October 1934. The national average of all durable goods manufacturers in October 1935 was $23.97, and the all-industry average was $21.64.

Average hours worked per week in radio factories during October 1935 were 40.7 percent, as compared with 39.5 percent in September 1935, an increase of 2.8 percent in working hours over September 1935, and 15 percent over average hours worked per week in October 1934. In the durable goods manufacturing industry the national average during October 1935 was 39.4 hours, and the all-industry average 38.2 hours.

Average hourly earnings of radio factory employees during October 1935 were 51 cents, compared with 51.9 cents during the previous month of September, a decrease of one percent, and they were 6.6 percent below average hourly earnings in the radio industry in October 1934. The national average of durable goods manufacturers was 60.5 cents, and the all-industry average 56.4 cents during October 1935.

NOVEMBER EXPORTS REACH PEAK

A new peak record in American radio exports was reached last November, according to the latest reports of the U. S. Bureau of Foreign and Domestic Commerce. The November 1935 exports totaled $2,894,778, the highest in any month during the past two years and insured an increase in exports for 1935 which will surpass even the previous record of American radio exports made in 1934. For the eleven months of 1935 ending in November, the total American radio exports were $23,194,837, compared with $22,543,031 for the same period of 1934, and are comparable with the total 1934 radio exports of $24,856,592.

Sets accounted largely for the increased American exports. The exports in November of tubes, parts and accessories and speakers were under recent previous months but ahead of November 1934.

Exports of receiving sets during November 1935 numbered 74,982 valued at $1,959,569, compared with 77,844 sets valued at $1,906,271 in November 1934.

Tube exports during November 1935 numbered 614,595 tubes valued at $276,070, compared with 600,778 valued at $274,221 in November 1934.

Exports of receiving set components during November 1935 were $433,349 against $428,808 in November 1934.

Loudspeakers exported during November 1935 numbered 23,928 valued at $50,748, compared with 18,235 speakers valued at $35,171 in November 1934.

Other radio accessories to the value of $51,720 were exported in November 1935 against $49,647 in November 1934, and the value of exports of transmitting apparatus respectively were $121,322 against $86,451.

RADIO QUOTAS INCREASED 60% IN TREATY WITH SWITZERLAND

The market in Switzerland for American radio products is increased substantially by 60 percent, under the reciprocal trade agreement recently negotiated by the State Department with the Swiss Government. The Swiss trade agreement, the tenth concluded by the State Department and the fourth with a European nation, was signed January 9 and becomes effective February 15, 1936. It is operative until February 14, 1939. Among the Swiss concessions is a 40 percent increase in quotas on electrical refrigerating apparatus.

The Swiss tariff rate of 200 francs per quintal on radio apparatus remains unchanged in view of the increase in the American import quota. The present rates on electrical refrigerators also are unchanged.

The old Swiss quota on American radio imports was 500 quintals, on a basis of 220 pounds per quintal. The new reciprocal trade agreement provides for an import quota of 800 quintals, to correspond to 5,600 sets with or without cabinets. The Swiss agreement provides that separately imported American parts and accessories, including tubes, will be charged against the quota in the proportion of 100 kilos equals seven sets.

For several years the RMA has endeavored to secure more liberal treatment for American radio in Switzerland. The RMA secured valuable aid from the U. S. Department of Commerce and especially from Andrew W. Cruse, Chief of the Bureau of Electrical Equipment, in connection with the Swiss concessions.

SPANISH PATENT POOL

A radio patent pool has been formed in Spain, according to advices to the Depart-

(*Continued on page 23*)

News Of The Industry

DETROIT REX INCREASES FORCES

W. W. Davidson, vice-president and sales manager of Detroit Rex Products Company, 13006 Hillview Avenue, Detroit, Michigan, has announced the opening of a new branch office at 201 North Wells Street, Chicago, Illinois, to cover the states of Wisconsin, Illinois and Missouri. The representatives placed in charge of this territory are G. P. Anstiss, S. B. Crooks and C. L. Jung.

Frank P. Cox, an outstanding authority in the metal cleaning industry, has been placed in charge of Alkali cleaners and strippers. Mr. Cox, from his headquarters in the Detroit office, will supervise the sale and service of Alkali cleaners throughout the country.

George W. Walter, formerly editor of "Metal Cleaning and Finishing," has been appointed advertising manager for the company.

During the past year, Detroit Rex Products Company, formerly known as Rex Products and Manufacturing Company, has vastly increased their sales and engineering forces. They have also expanded their lines of cleaning equipment and extended their service in the metal industries. This company produces Detrex degreasers and solvent machines, Triad and Perm-A-Clor non-inflammable solvents, and Triad alkali cleaning compounds.

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RCA 1935 INCOME

David Sarnoff, President of the Radio Corporation of America, released for publication on February 1 a statement of the estimated income of the Radio Corporation of America and subsidiaries for the calendar year 1935.

The estimate shows a net income of $5,100,000 for the year, representing an increase of approximately $850,000 over 1934.

The estimated figures are subject to the determination of final figures on completion of examination by the company's auditors. Arthur Young & Company.

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KAY PRODUCTS MOVES

Kay Products of America, Inc., manufacturers of auto-radio remote control units for installation in all makes and models of cars, have moved to their own building located at 560 DeKalb Ave., Brooklyn, N. Y.

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CORNELL-DUBILIER BUSINESS UP

Business must be good! In a recent letter released to their Sales Offices, The Cornell-Dubilier Corp., 4377 Bronx Boulevard, New York, made public some very interesting statistics. In 1933, the Cornell-Dubilier Corporation tripled its volume over 1932. In 1934 they doubled their business and once again in 1935 they doubled their output. Not bad!

The Cornell-Dubilier sales force is certainly to be congratulated.

President Octave Blake looks forward in 1936 to doing the largest volume of business, during the twenty-six years of operation of the company.

W. R. G. BAKER NAMED MANAGING ENGINEER OF G-E RADIO RECEIVER SECTION

W. R. G. Baker has been appointed managing engineer of the General Electric Company's radio receiver section, with responsibility for both the engineering and the manufacture of its products, according to an announcement by W. Stewart Clark, manager of the company's Bridgeport Works. Although closely associated with General Electric's initial radio-development activities, Mr. Baker for the past few years has been connected with the RCA-Victor Company, Camden, N. J.

A graduate of Union College, from which he received B.E., M.E.E. and D.Sc. degrees, Mr. Baker started his career in

MR. W. R. G. BAKER

1917 in the laboratories of the General Electric Company in Schenectady. In 1918, his work with new vacuum-tube transmitters and receivers to meet the requirements of the Army and Navy took him into the air, on the water and under the water, for it included development and testing of radio apparatus for aircraft, submarines, captive balloons, torpedo boats, destroyers and battleships. As the work of the General Electric Company in this field increased, a separate radio department was established and Mr. Baker was made designing engineer in charge of transmitters. In 1924, this responsibility was enlarged to include the design of all radio products and, in 1926, he was given complete charge of radio development, design and production. Under his supervision, the broadcast transmitters of WGY, KGO and KOA were designed, and the South Schenectady developmental laboratory was planned and built. He was also responsible for an intensive investigation of short-wave propagation.

On the formation of the RCA-Victor Corporation in November, 1929, Mr. Baker went to Camden to head the radio-engineering activities of the new organization. Within the year he was also placed in charge of production and later became general manager of the RCA-Victor plant. In May, 1935, General Electric transferred its radio-receiver production activities to Bridgeport and there, in December, Mr. Baker resumed his association with the General Electric Company.

A leading authority on television, Mr. Baker was, until recently, chairman of the television committee of RCA, formed to plan and carry out extensive tests of high-definition television. He is a commander in the U. S. Naval Reserve, chairman of the engineering committee of the Radio Manufacturers' Association, and a member of a number of other societies and associations connected with his profession.

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SEELEY ADDRESSES EMPORIUM I. R. E.

Mr. S. W. Seeley of the RCA License Laboratory in New York City addressed the Emporium Section of the Institute of Radio Engineers January 15. Mr. Seeley discussed the new circuit development known as Automatic Frequency Control which is applied to superheterodyne circuits to hold the oscillator system exactly in tune.

This arrangement makes possible refinements in receiver construction not heretofore possible and eliminates unpleasant noises when "tuning-in" stations. The circuits described bid fair to be useful for other purposes and some of these were discussed briefly.

The paper was discussed by Mr. Nelson P. Case of the Hazeltine Service Corporation, who was also a guest of the Section, as well as by a number of the members. The meeting was conducted by the Chairman, R. R. Hoffman of the Hygrade Sylvania Engineering Department. The attendance was sixty-five.

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R M A NEWS

(Continued from page 22)

ment of Commerce, Bureau of Foreign and Domestic Commerce, from Assistant Trade Commissioner Miles Hammond at Madrid. The announced object is to protect the Spanish market from reconstructed and assembled sets and eradication of cut-throat competition. Interests composing the "Spanish Consortium of Radio Patent Exploiters" include:

S. I. C. E., Sociedad Iberica de Construcciones Electricas. (American and French owned patents).

A. E. G., Iberica de Electricidad, S. A. (German owned patents).

Philips Iberica, S. A. E. (Dutch owned patents).

Standard Electrica, S. A. (American owned patents).

Talleres Electromecanicos Talmer. (British owned patents).

Some importers are opposing the Consortium and threatening legal opposition. They especially oppose proposed establishment of quotas limiting imports of radio sets, for which the Consortium proposes a fee of 25 pesetas per set. A copy of the Department of Commerce Bulletin regarding the Spanish patent pool will be forwarded upon request to RMA headquarters.

NEW PRODUCTS

NEW WELDING TIMERS

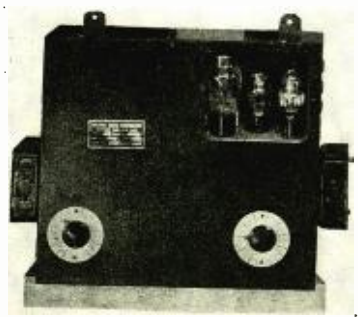
The Welding Timer Corporation, 251 Ogden Street, Newark, N. J., announces a line of electro-mechanical timers for spot welding machines.

The device consists of an electronic timing element and a set of balanced contactors specially designed to handle the high overloads encountered in spot welding.

Welco Timers permit spot welding at times as low as one cycle. Timing accuracy of less than ¼ cycle, plus or minus, is guaranteed at one cycle operation. At slower speeds, for example, between 20 and 30 cycles, any reasonable accuracy can be assured, even up to 2% plus or minus. Timers for longer times may be had on special order.

Standard settings cover a range of from one cycle minimum to 30 cycles maximum. Dial settings permit infinite variation of times between maximum and minimum.

Accurate timing at between one and two cycles, easily accomplished with Welco Timers, opens a vast new field for spot welding. Aluminum, brass, copper, stainless steel, chromium and nickel plated parts



and many other materials may be successfully welded provided a correct combination of low welding time, pressure and power is used.

Welco Timers are made in standard sizes for 30, 50, 150, 250 and 600 amperes. This range covers practically all spot welding requirements, but larger sizes can be had on special order. Literature available on request.

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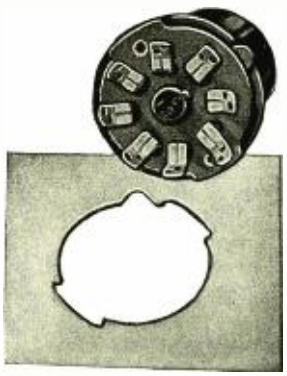
FRANKLIN SELF-LOCKING SOCKET

This type socket was designed at the request of radio set manufacturers who were interested in mounting sockets in the smallest possible space and who also wished to eliminate the riveting of sockets on to the chassis, it is said.

This socket is made to conform to the trend as indicated by the development of the new metal tubes, and although the contacts are included in the smallest possible diameter, the design is such that it does not sacrifice any efficiency as compared to the Franklin standard rivet type No. 39 socket. As a matter of fact, this socket has a higher breakdown voltage between contacts and from contacts to ground, than any other wafer-type socket on the market at the present time, it is stated.

The self-locking feature is such that a ¼ turn to the right locks the socket securely to the chassis and although the



socket can be readily removed with a tool, there is no danger of it becoming loose during usage.

A simple blanking die is all that is necessary for blanking out the chassis for receiving these sockets.

It is apparent from the above, that considerable time would be saved by this new method of assembling sockets into the chassis and that it will eliminate entirely, the breakage caused by riveting.

This socket is so constructed that it can be inserted into the chassis only in one position, thereby insuring that the contacts come in the same relative position for wiring, at all times. This saves the time spent in removing sockets which in some cases are riveted on to the chassis in the wrong position.

All of the standard features found in our type No. 39 socket are included in this new type, self-locking socket.

Further technical data and sample metal chassis plates will be forwarded to recognized set manufacturers, upon request to Albert W. Franklin Mfg. Corp., 137-141 Varick Street, New York, N. Y.

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LINE VOLTAGE DROPPING RESISTOR IN METAL-TUBE FORM

Employing a standard metal-tube casing and 8-prong octal base, the Clarostat Series "MT" line voltage dropping resistor not only provides a fortunate solution of the a-c, d-c series-filament supply problem, but also blends in with the modern set chassis and metal tubes.

Identical in size, shape and finish to metal-tube 25Z6 rectifier and 25A6 power tube. the new resistor is installed by providing another octal socket. It meets the Underwriters' requirements regarding "hot" terminals and high leakage resistance to ground, since "live" parts are thoroughly insulated and metal covered. It keeps the dissipated heat above the chassis, where it belongs, and eliminates fire hazard.

The new line voltage dropping resistor is available in any total voltage drop and for practically all pilot lamp and tube combinations. Ballast action in pilot lamp resistor section can be provided. The resistor is coded and wired in accordance with proposed R.M.A. standards covering such devices. There are three standard types available, covering the pilot lamp and filament requirements of 4, 5 and 6 tube sets, in each case allowing for two 25-

volt filaments and the balance of 6.3 volt filaments, all connected in series. dropping the voltage from a 117-volt line. Any other line voltage and filament load can be handled by special types made to order.

The new resistor is the latest product of the Clarostat Mfg. Co., Inc., 285 N. 6th St., Brooklyn, N. Y.

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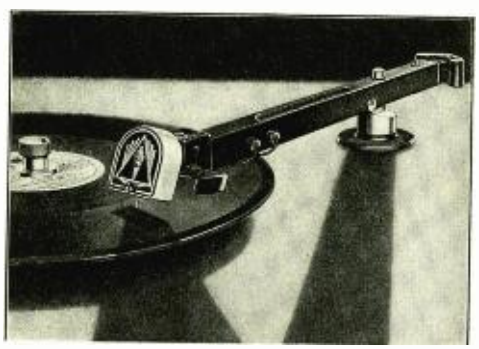
NEW AUDAK PICKUP

The Higher Range Professional Electric Pickup, shown in the accompanying illustration, is used in many leading radio stations. The arm is of special length to accommodate records up to 18 inches in diameter. It is counter balanced by dead weight. The arm is made of heavy gauge aluminum.

This instrument is designed for use with higher range recordings and works with low needle pressure. It is said to be immune to humidity and temperature changes.

For further information write to The Audak Company, 500 Fifth Avenue, New York City, N. Y.



The New Audak Higher Range Professional Electric Pickup.

NEW DIELECTRIC TESTER

The new dielectric or breakdown tester manufactured by The Acme Electric & Mfg. Co. of Cleveland, Ohio, not only indicates shorts, opens, or grounds—but actually checks circuits at approved standard testing voltages. The manufacturer states that this unit is entirely different in principle from the common insulation testers in present-day use — in that the Acme Dielectric Tester will permit actual application of the standard testing voltage of double the rated voltage plus 1,000 to the appliance device or equipment under test and thus prove the dielectric strength of the insulation to meet standard safety limits. Any windings with rotted, old or defective insulation, below minimum safety standards would break down under test necessitating proper rewinding or repairing and thus preventing the usage of unsafe, electrical equipment.

The Acme Dielectric Tester is a compact complete unit. A 6 ft. primary cord is plugged into a 110 volt, 60 cycle convenience outlet. Secondary connections are supplied with four foot high voltage cable leads each equipped with test prong. The secondary test voltage is manually controlled by a tap-switch that provides any voltage; 500, 1,000, 1,250, 1,500, 1,750, 2,000, or 2,500 volts, simply by rotating the indicator. The short circuit current is 1 amp. at 500 volts and 200 ma at 2,500 volts. The 100% leakage type transformer used in this device permits short circuit for a period of time without any damage. This current limitation also eliminates burning of materials at point of breakdown of apparatus under test.

Acme engineers point out particularly the use of a second secondary winding on the same common core, but shielded from the high voltage secondary. This second secondary supplies 110 volts to a small indicating ruby lamp. Lamp is inset and shielded by metal mask. This lamp glows when Dielectric Tester is turned on—thus warning operator of live secondary leads. On partial breakdown the lamp dims and on complete breakdown goes out.

Off and on toggle-switch conveniently mounted on the face of the device permits complete control of primary current. Equipped with a sturdy metal handle, this unit lends itself to portability by electrical equipment inspectors or maintenance men.

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THE BAGGE TALKING SCROLL

The object is to obtain a better medium for recording and reproducing the sounds of speech and music. The aim is to record in sound the world's literature; its speeches, its music, and its news topics and to make them available in an inexpensive form.

The apparatus is similar to a radio set. With portable accessories for recording and reproduction, it measures about 12 x 12 x 40". The record is a wide ribbon or scroll and contains a greater quantity of text on a given area than is found on talking film. The cost is therefore less and the applications correspondingly enlarged. A printed book can be replaced by a scroll, bringing the intellectual work directly to the ear; eliminating the reading and the book too.

Comparisons are illuminating. A book that can be read in five hours can be heard in the same amount of time. However, the scroll consists of about twenty-five feet of photographic paper, while the book—in addition to paper and cover—includes the cost of typesetting, printing, etc. The economic advantage is evident.

The exploitation of the T L P system has a wide range. It can perform excellent service to large organizations and institutions. For collective and individual education in schools and homes; for libraries; for the sightless, etc., and as a commercial medium for publicity, lectures, sermons, original discourses, etc., its field is unlimited; the author, in his own home, can produce the master scroll which is duplicated for lease or sale.

A "Salon de Music & Muse" where the public at a moderate subscription can listen in undisturbed comfort to selections of work in music and literature is within the realm of possibility and this activity alone will produce excellent revenue. Stories, travel, operas, symphonies, concerts, news, and special topics would be placed at their disposal.

Unparalleled activity may be developed for the use of the T L P system for instruction in many branches of the government service. This medium would replace the printed book.

The Bagge Talking Scroll is being handled by the Alpha-Omega Co., 6611 Euclid Ave., Cleveland, Ohio.

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NEW ELECTRAD ATTENUATORS

Electrad Inc., 173-175 Varick Street, New York City, have just announced their new type BN attenuators. These units replace the Electrad Types TN, LN and U attenuators, and they are said to have the advantages of greater attenuation, true logarithmic attenuation and lower noise level.

These attenuators involve a new principle in design which makes it possible to obtain a substantially constant-impedance unit whose attenuation is linear in db and continuously variable over the entire range.

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UNIVERSAL RIBBON MICROPHONE

The first new product of 1936 to be brought out by the Universal Microphone Co., Inglewood, Cal., is a ribbon microphone housed in a new-style, futuristic jet black enamel and chrome polished casing.

The microphone case is hinged on swivel joints for greater ease in handling and is noiseless in adjustment and operation.

The new Universal ribbon microphone line has been designed for general all-'round radio use, including broadcast studios, remote control points, p-a work, amateur activities and other purposes in this field.

The new ribbon microphone and casing will be put on the market in conjunction with Universal's new adjustable stand which can be folded up when not in actual use, or may be adjusted to fit a small or awkward-sized space. Option of the standard Universal solid chrome base will also be given.

The compactness of the instrument makes for extreme ease in handling or transportation. It weighs a pound and a half, while the dimensions are 2¾" x 4¾" and is only one inch in thickness.

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9-INCH "WORKSHOP" LATHE

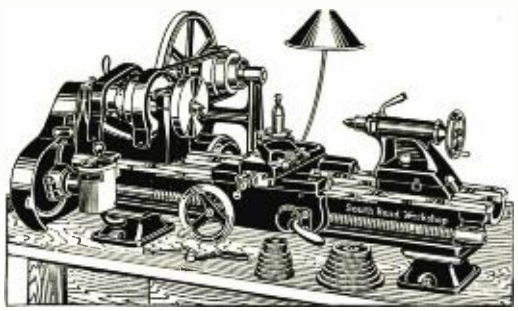
Announcement is made of the 1936 model 9-inch "Workshop" precision lathe by the South Bend Lathe Works, South Bend, Indiana. Besides being offered at a new low price. the lathe features ten new improvements, amongst which are: a simplified twin gear reverse for cutting right- and left-hand screw threads of 4 to 40 per inch, a countershaft of either the double friction type or the horizontal type with either the plain or adjustable belt tension, a newly improved back-geared headstock with larger spindle bearings and a new ball-bearing thrust collar on the spindle, a new and heavier designed saddle, and a simplified gearing for threads and speeds. The lathe has a strong, rigid bed of a one piece casting with 50% steel and 50% nickel-iron composition, and comes in four different lengths of 3-ft., 3½-ft., 4-ft., and 4½-ft., with distances between centers of 17", 23", 29" and 35" respectively.

Metals of all kinds can be machined as: cast iron, steel, cast steel, steel forgings, wrought iron, brass, bronze, copper, babbitt, aluminum, and the various alloy steels and metals.

Six spindle speeds ranging from 39 to 630 rpm are available on the standard headstock, three obtained on the open belt and three in back gear, the later with a ratio of 5 to 1, thus permitting a great amount of power to take the heaviest of cuts. Optional is the four-step cone headstock for V-Belt drive providing 8 spindle speeds, the two-step double V-Belt drive cone providing four spindle speeds, and the single step triple V-Belt drive furnishing two spindle speeds, all three types designed for extra power.

This lathe is particularly attractive for use in groups or production of small duplicate parts in the manufacturing plant, for the tool room, machine shop, laboratory, and for modern shops of all kinds engaged in light, accurate machine work.

The company is issuing a new catalogue containing descriptions of this lathe with accompanying illustrations giving valuable instructions as to methods of performing many jobs. Any reader interested in securing a free copy may write the Technical Service Department, South Bend Lathe Works, South Bend, Indiana, mentioning this publication.



New "South Bend" 9-inch Lathe for Laboratory and Workshop.

TRIUMPH MODEL 800 OSCILLOGRAPH

The Triumph Manufacturing Company, 4017-19 West Lake Street, Chicago, Illinois, have announced their Model 800 Oscillograph. This unit, which has been designed for laboratory and industrial use, features "top deck" controls which makes the instrument easy to see and set. Also featured is the special viewing screen which is said to permit the figures and patterns to be viewed continuously, whether the operator is standing, sitting or to either side of the instrument.

By careful design of the sweep circuit and proper application of bias to the 885 gaseous, grid-controlled rectifier, perfect linearity on multiple wave patterns has been secured, it is stated. The Model 800 has a linear sweep frequency range of 20 to 50,000 cycles. It is possible to synchronize and lock 2 cycles of a 100-kc wave and photograph it, it is further stated.

Amplification on both horizontal and vertical axes is provided through two 6C6 tubes. Intensity and focussing controls are located to the rear of the instrument, beside the adjustment for beam centering, where they are least disturbed.

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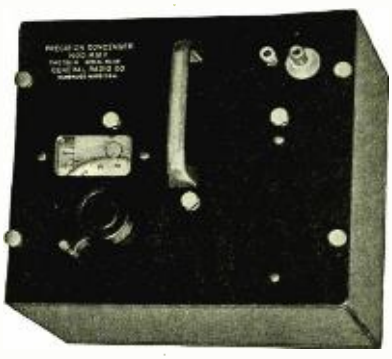
NEW PRECISION CONDENSER

Worm-drive air condensers have for many years been widely used as continuously-adjustable standards of capacitance. It has long been recognized that these condensers are subject to small variations from their desired characteristics caused by such factors as temperature, aging, worm, eccentricity, backlash, and various strains. In the General Radio Type 222 Precision Condenser these variations were known and allowance could be made for them when necessary.

The availability of new materials and methods of construction, however, made it possible to replace this condenser with one of completely new design, the Type 722, shown in the accompanying illustration, in which these factors are markedly reduced.

In designing the new condenser, the chief requirement was stability of capacitance. The whole condenser assembly is mounted in a cast frame. This frame, the stator rods and spacers, and the roter shaft are made of an alloy of copper and aluminum. Since the condenser plates are of aluminum, all parts have the same temperature coefficient of linear expansion, resulting in a low temperature coefficient of capacitance.



Connection to the rotor is made by means of a phosphor bronze brush running on a brass drum.

Since it is difficult to mount a worm gear on a shaft without some slight eccentricity, the worm in the Type 722 is cut directly on the shaft. The dial end of the worm shaft runs in ball bearings; the other end is supported by an adjustable spring mounting.

This arrangement of bearings and drive mechanism results in a backlash of less than ½ worm division and a low worm correction.

The worm drives a 50-tooth gear, so that 25 revolutions of the worm rotate the main shaft through 180 degrees. One-half revolution (100 divisions) of the worm advances the main scale one division. Since the main scale carries 50 divisions, the 180-degree rotation is divided into 5000 worm divisions, each half of the worm dial being engraved 0 to 100.

The capacitance per worm division on the 1400-mmfd model is approximately 0.28 mmfd and on the 500-mmfd model is 0.11 mmfd. Since the scale can be set to about 1/5 of a worm division, the precision of setting for these two models is 0.06 mmfd and 0.02 mmfd respectively.

Complete information may be obtained from the General Radio Company, 30 State St., Cambridge, Mass.

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DUCO MICA CONDENSERS

New mica condensers, surrounded by a low-loss ceramic housing, are being manufactured by the Dumont Electric Company, Inc., 514-516 Broadway, New York City. These condensers are said to be ideal for short-wave use. Due to the low-

loss housing, these units are said to have a very high power factor.

These new Duco condensers measure ¾-inch by ¾-inch by ¼-inch. They are made in capacities ranging from .000025 to .006 mfd. Higher capacities are available.

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PROGRAM SOUND SYSTEM

A new Program Sound System, embodying unique advantages for sizeable buildings, such as, schools, hotels, department stores and hospitals, has been introduced by the Western Electric Company, 195 Broadway, New York City. This system is completely described in an attractive bulletin, entitled "Program Sound System," just released.

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PAINT IN STICK FORM

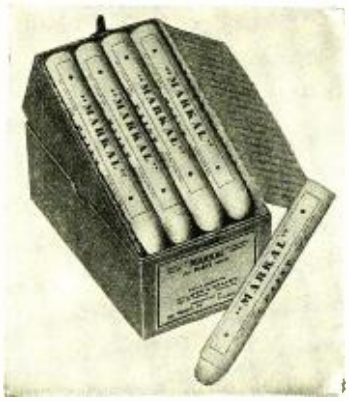
Real paint in stick form which is easily applied to any wet or dry surface, and which will not run when applied to hot metals, is the newest development for marking products and materials. Markal is the name of this new stick paint.

It is made in two types—one for cold marking, the other for hot marking.

Markal for cold marking is used for marking all metals (including structural steel, steel sheets, galvanized iron, etc.), Glass, Cardboard, Boxes, Crates, Lumber, Building Stones and Blocks, etc.

This new stick paint dries and remains as permanent as any other high quality paint. There is no messiness or waste as with paint and brush marking.

Markal for hot marking is used with signal success on Steel Shapes, Forgings, Castings, Pipes, Billets, etc. It marks



clearly and permanently at any temperature from 300-1,200° F. It does not run or flow while hot, or peel off after cooling.

Markal for cold marking is furnished in Black, White, Red, Yellow and Blue sticks, and for hot marking in White and Yellow.

Markal is marketed by Helmer & Staley, 2354 So. Parkway, Chicago, Illinois.

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NEW R-F CIRCUIT HOOK-UP WIRE

The Lenz Electric Manufacturing Company have announced their new r-f circuit hook-up wire. This wire, which was developed by Mr. Raymond G. Zender, is said to have extremely low losses at high frequencies, and has been designed especially for the r-f circuit. Conductors are supplied in several sizes, either solid or stranded. The insulation pushes back freely without adhering to the conductor and is mechanically strong enough to resist abrasion. It is said to be a fine production wire with insulation impregnated in a high-resistant, low-loss, moisture-resisting compound, with the following dielectric characteristics:

At 70° F, 50% RH

Power Factor—½ of 1% at 25 meters, completely immersed in mercury.
Phase angle—18° 7′.
Insulation resistance—83,000 megs/ft at 400 volts d-c, completely immersed in mercury.
Capacity (to ground)—22 mmfd/ft at 25 meters.
Voltage breakdown (a-c)—1600 volts/ft, completely immersed in mercury.

At 120° F, 90% RH

Power factor—1% at 25 meters, completely immersed in mercury.
Capacity (to ground)—28 mmfd/ft at 25 meters.
Moisture absorption—less than 1% by weight.

Address the above organization at 1751 North Western Ave., Chicago, Illinois.

RADIO ENGINEERING BUYER's GUIDE

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

Materials—Component Parts

ALLOYS, RESISTANCE

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

ARRESTORS, LIGHTNING

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

BASES, VACUUM TUBE

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

BINDING POSTS

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

BRASS—COPPER

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

CABINETS—WOOD

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

CATHODES (See Tubing, Seamless Cathode)

CATHODE RAY—TUBES

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

CATHODE RAY—OSCILLOGRAPHS

DUMONT LABORATORIES, ALLEN B., 542 Valley Rd., Upper Montclair, N. J.
General Electric Co.
RCA MANUFACTURING CO., INC., Camden, N. J.
RADIO INSTRUMENTS CO., 22 Wooster St., N. Y. C.
WESTERN ELEC. CO., 195 Broadway, N. Y. C.
Westinghouse Elec. & Mfg. Co.

CERAMICS

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

CHOKES

ACME ELECTRIC & MFG. CO., 1440 Hamilton Ave., Cleveland, Ohio
ALLOY TRANSFORMER CO., 135 Liberty St., N. Y. C.
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., 840 Barry St., N. Y. C.
UNITED TRANSFORMER CORP., 72-74 Spring St., N. Y. C.

COIL MACHINERY

UNIVERSAL WINDING CO., Elmwood Ave., Providence, R. I.

COILS—POWER

ANACONDA WIRE & CABLE CO., Muskegon, Mich.
ACME WIRE COMPANY, 1255 Dixwell Avenue, New Haven, Conn.
American Enameled Magnet Wire Co.
Belden Manufacturing Co.
Coils, Incorporated
Electrical Winding Company
GENERAL ELECTRIC COMPANY, Schenectady, N. Y.
Roebling's Sons, John
Westinghouse Elec. & Mfg. Co.

COILS—RADIO RECEIVER

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

COILS—SPEAKER

ACME ELECTRIC & MFG. CO., 1440 Hamilton Ave., Cleveland, Ohio
ALLOY TRANSFORMER CO., 135 Liberty St., N. Y. C.
AMERICAN TRANSFORMER CO., 175 Emmet St., Newark, N. J.
ANACONDA WIRE & CABLE CO., Muskegon, Mich.
Chicago Transformer Corp.
Dongan Electric Mfg. Co.
GENERAL TRANSFORMER CORP., 500 S. Throop St., Chicago, Ill.
Halldorson Company
JEFFERSON ELECTRIC COMPANY, Bellwood, Ill.
KENYON TRANSFORMER CORP., 840 Barry St., N. Y. C.
RCA MANUFACTURING CO., INC., Camden, N. J.
STANDARD TRANSFORMER CORP., 854 Blackhawk Street, Chicago, Ill.
Thordarson Elec. Mfg. Co.
UNITED TRANSFORMER CORP., 72-78 Spring St., N. Y. C.

CONDENSERS, FIXED PAPER

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

CONDENSERS, FIXED ELECTROLYTIC

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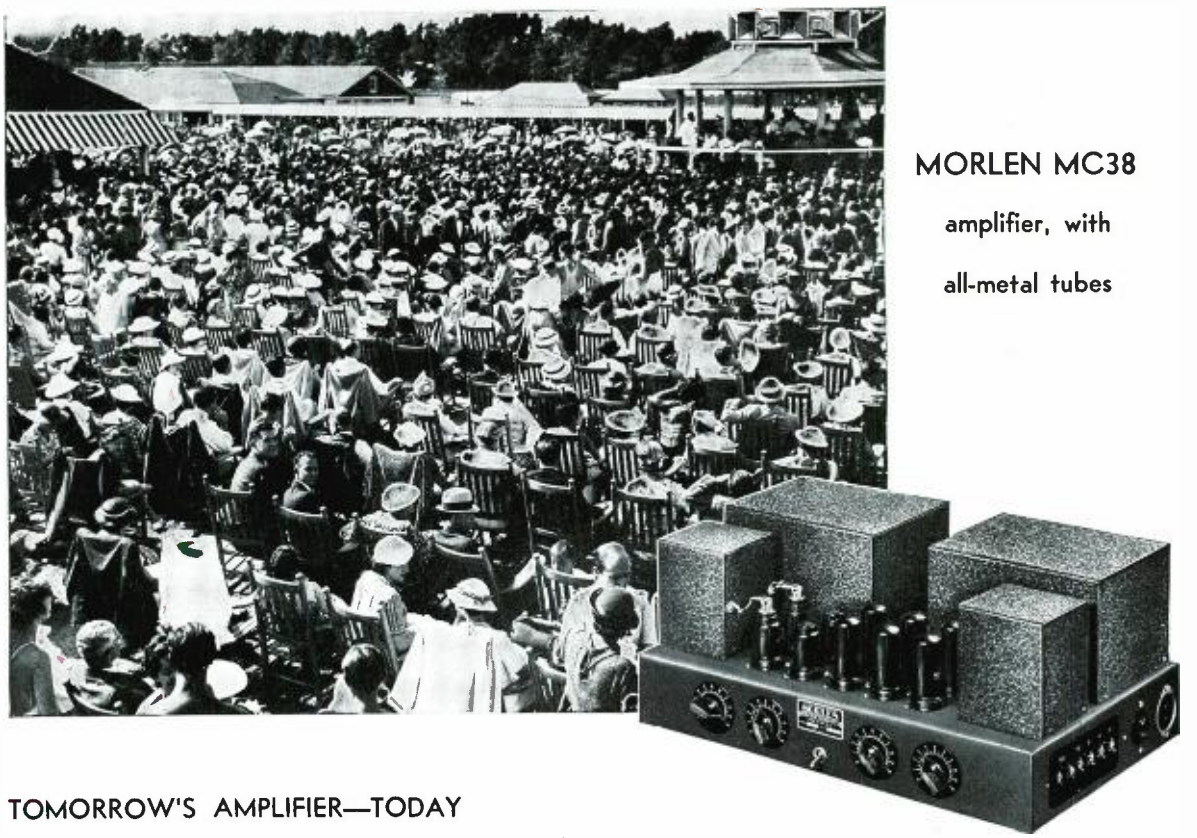

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