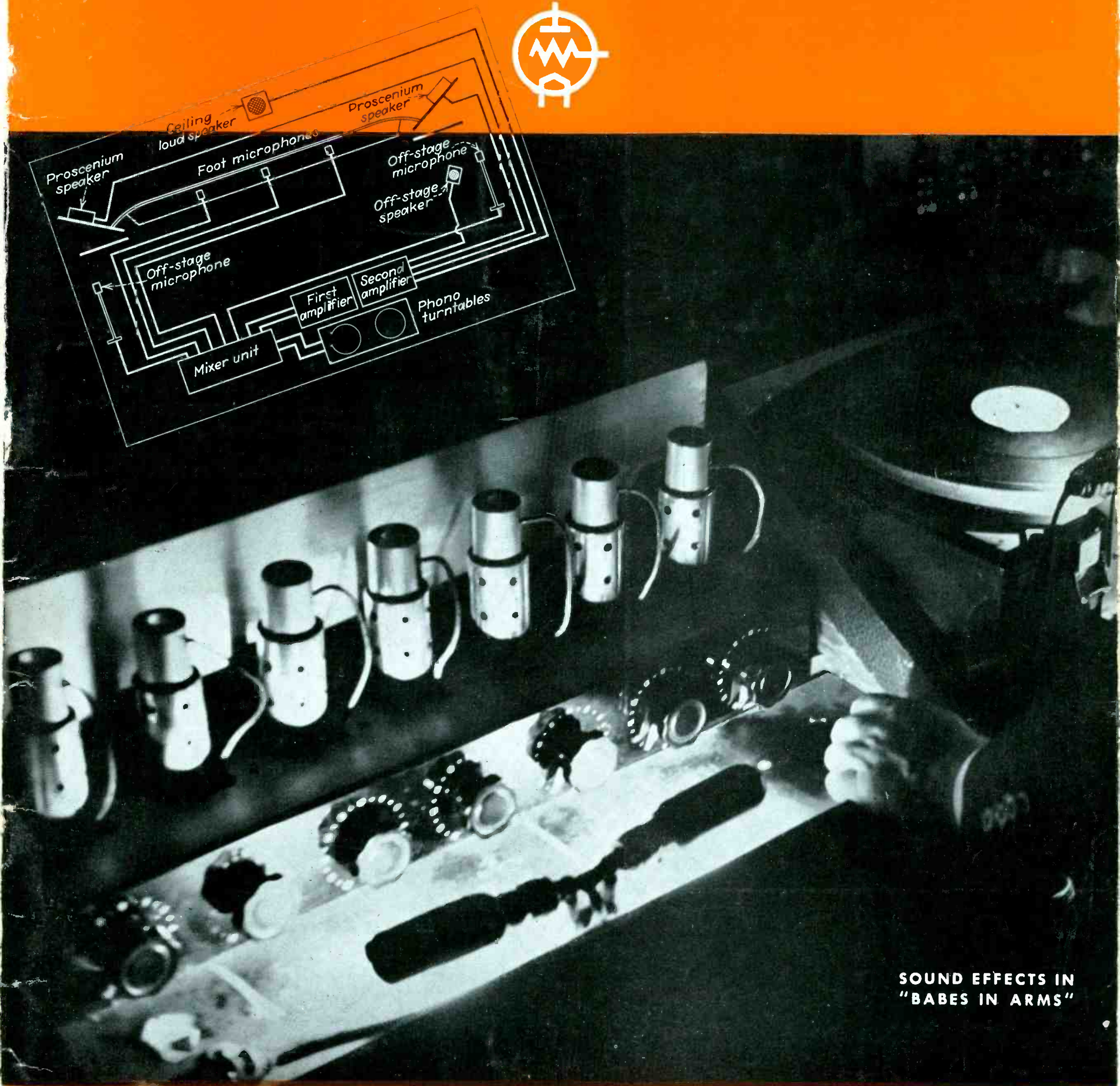
electronics

radio, communication, industrial applications of electron tubes . . . engineering and manufacture



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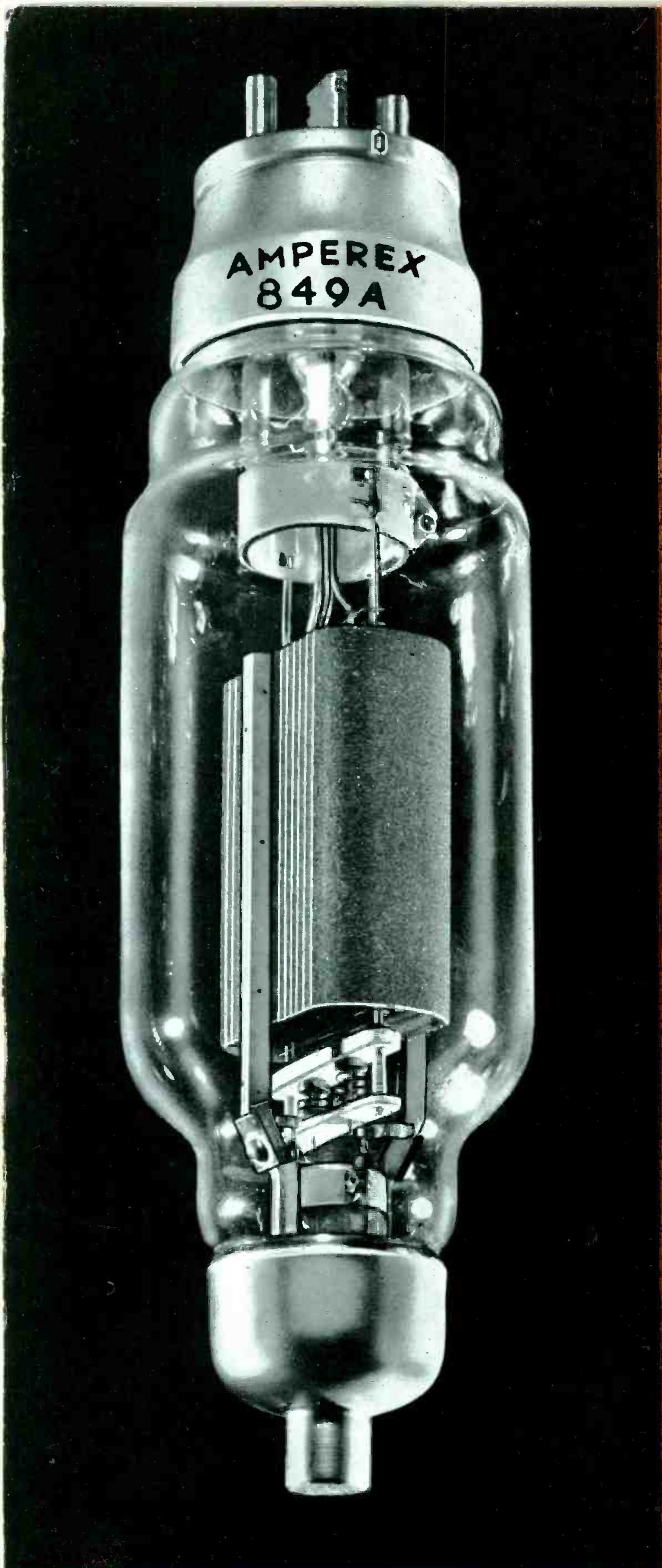

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electronics

RADIO . . . COMMUNICATION AND INDUSTRIAL APPLICATIONS OF ELECTRON TUBES . . . DESIGN . . . ENGINEERING . . . MANUFACTURE

CONTENTS, FEBRUARY, 1938

DEPARTMENTS

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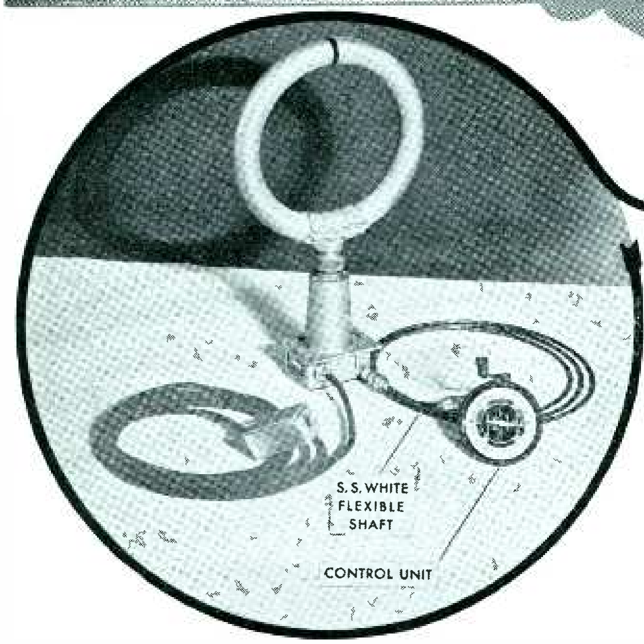

WESTERN ELECTRIC RADIO COMPASS ATTACHMENT. The shielded "anti-static" loop antenna is rotated for direction finding service by an S. S. WHITE Remote Control Flexible Shaft. A gear ratio of 264 to 1 between the control unit and the loop permits extremely accurate adjustment. Photo courtesy of Western Electric Co.

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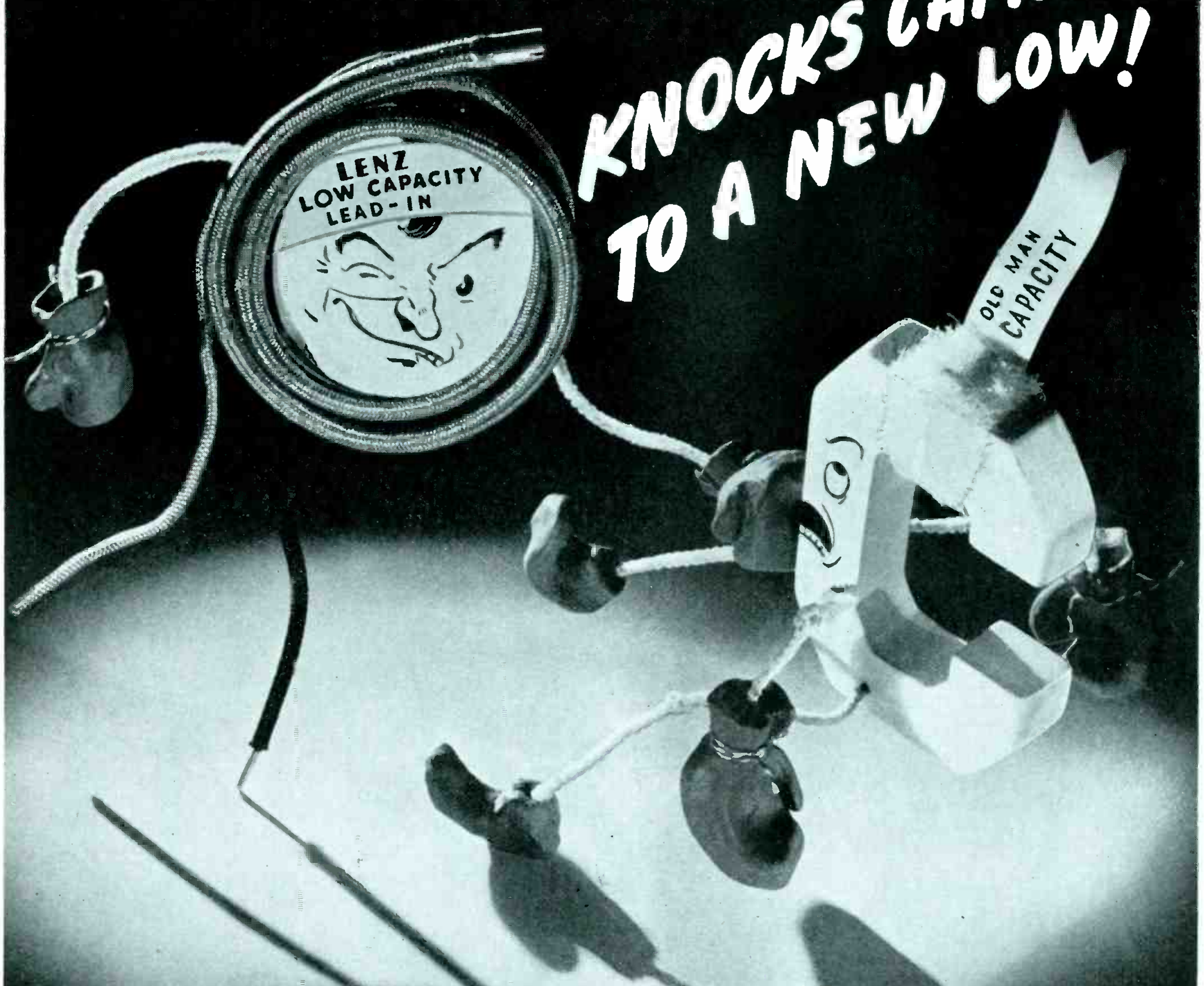

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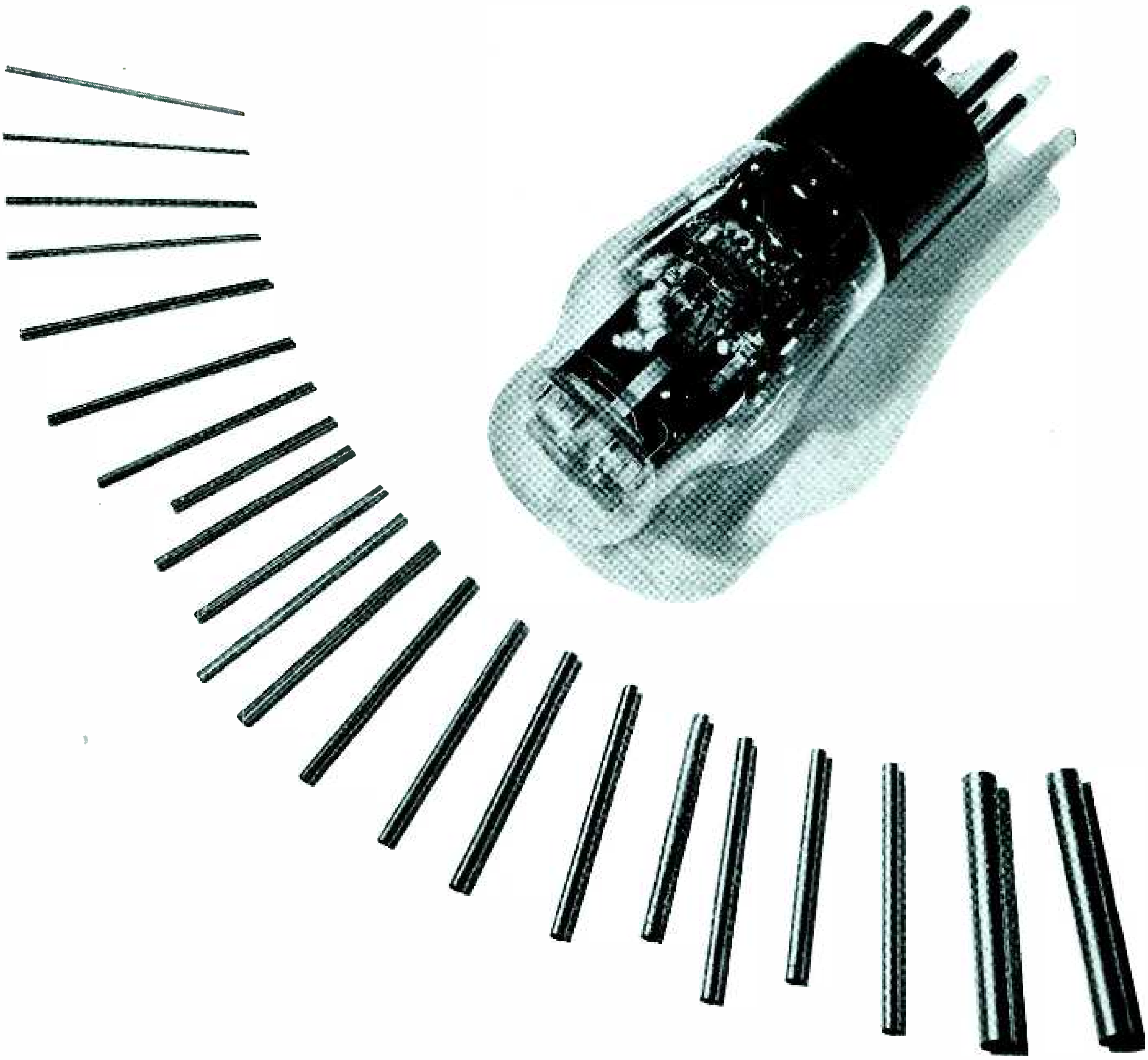

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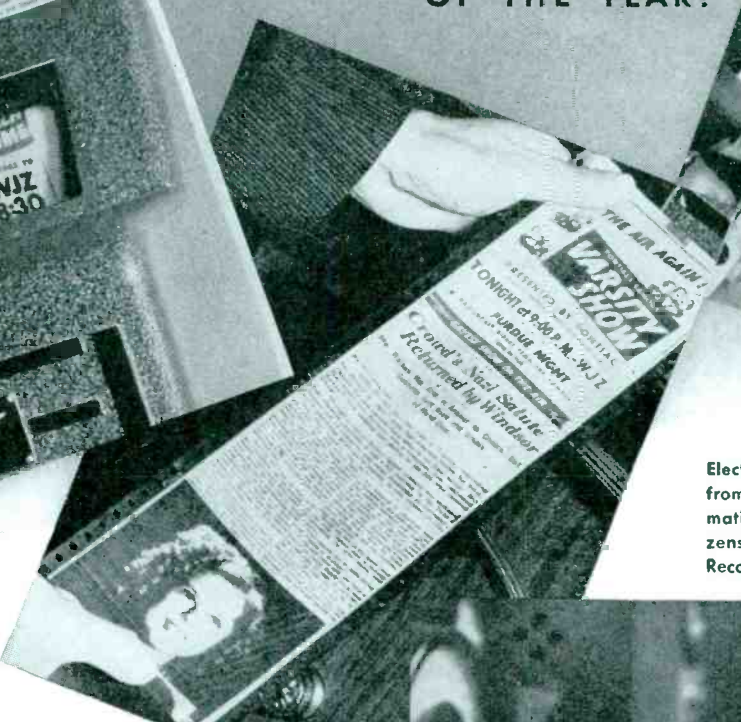

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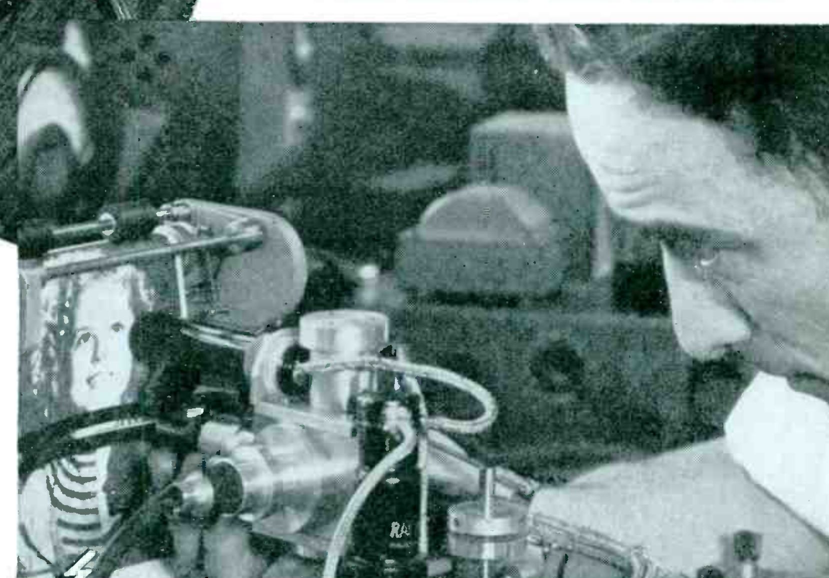

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ELECTRONICS

FEBRUARY
1938

KEITH HENNEY
Editor

Crosstalk

►**CENSORSHIP** . . . However little we may have liked the Mae West broadcast, we like the letter of censure from the FCC still less. The Commission states that it has no powers of censorship but that it will consider the circumstance of the broadcast when station license renewals come up. If this isn't censorship of the most insidious and yet most brazen sort, we don't know A from Z.

The reaction of the listener to this particular broadcast was immediate and perfectly certain as to its meaning. This is all the censorship that is needed. Any more would soon force broadcasting into a banality that would make utterly impossible the transmission of the many great programs now on the air. There simply would be no listeners, there would be no money for programs and broadcasting would degenerate into one gigantic flop serving merely as a free mouthpiece for the many who like to orate.

►**ENGINEERING** . . . It has been our opinion that there has been too little engineering applied to photography. As a beautiful science suitable for Ph.D.'s is has no equal; as a cut and try business or hobby for thousands of practitioners it is replete with inefficient wastage of materials, time and effort. There are two sheets of paper in the wastebasket for every good print.

Two articles by Clifton Tuttle of Kodak Park Research Laboratories, however, indicate that engineering is coming into photography. These appear in the *Journal of the Franklin Institute* in September and November, 1937, and relate to the proposition that an automatic means of printing negatives on contact or projection paper would save time and material and provide better prints for the amateur who turns his films into the drug store for printing.

Mr. Tuttle's engineering involves psychology, scientific sampling, population studies, theories of probability, mathematics, the engineering application of photoelectricity to a very practical and somewhat pressing commercial problem. The two papers describing this work should provide fascinating reading to any engineer who has a problem to solve and who wishes to know the most modern scientific way to do it.

►**QRM** . . . An amateur operating a half-kilowatt code-phone transmitter recently came to some grief at the hands of a new purchaser of a popular model of a popular broadcast receiver manufacturer. Everything the amateur said into his mike was heard on the BCL radio; key thumps disturbed him mightily. A service man discovered that the broadcast receiver was very much misaligned and that after this had been fixed up, no more QRM was heard. The particular model of radio involved seems very prone to cause trouble of this sort.

►**BAD NEWS** . . . There's a lot of ostrich-in-the-sand business about the present business depression, what with calling it by some other name than the depression it really is. The editorial offices of Electronics have never seen so many men, scientists, engineers, older men, younger men, who have been suddenly thrown out of jobs they have held, some of them for upwards of 10 or more years. Research and development men have not been spared. They have gone out along with production men.

That in our opinion is a depression, and a damned discouraging depression.

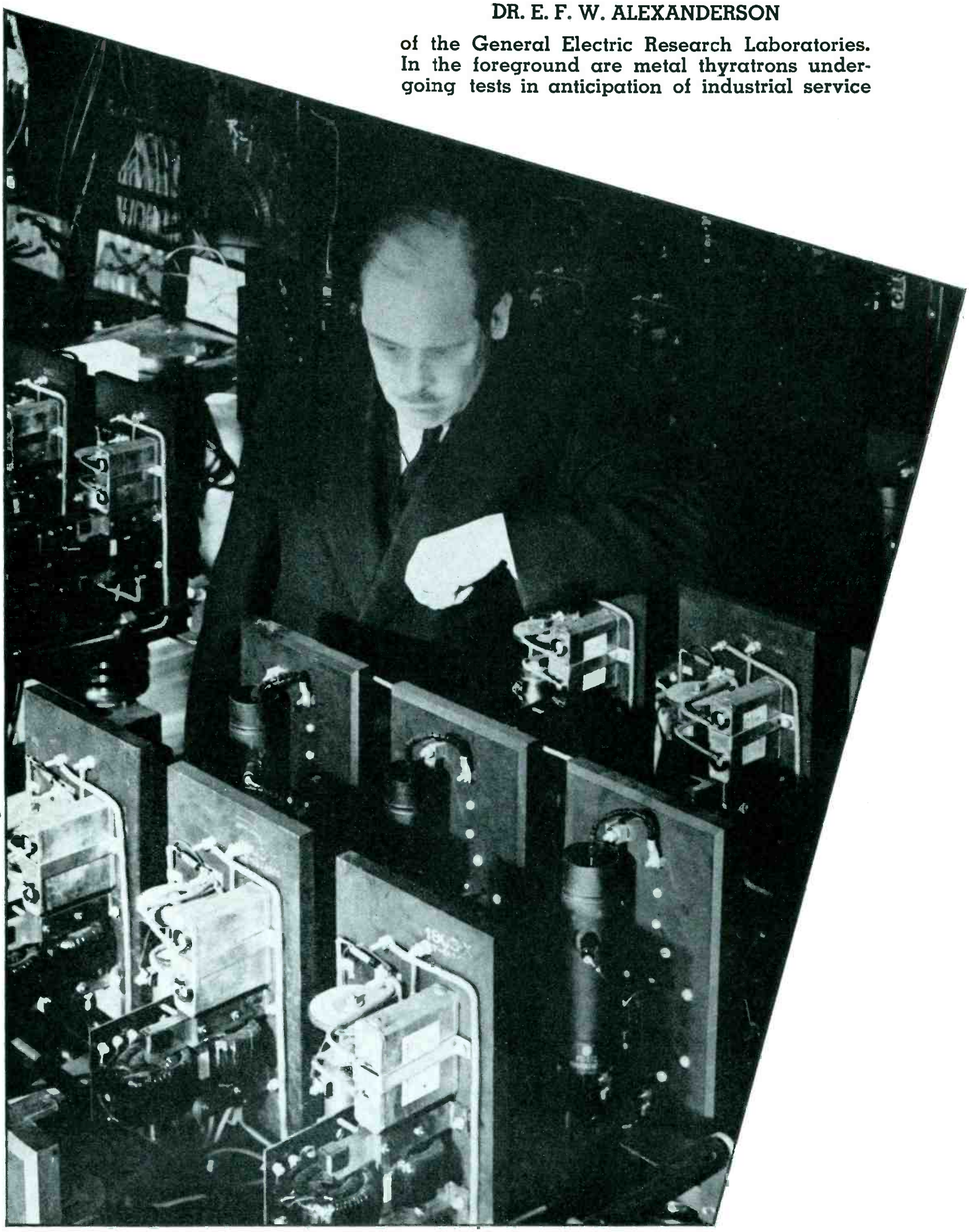
►**GOOD NEWS** . . . There are some bright spots in an otherwise drab sky at the present moment. For example Electrical Research Products (ERPI) has opened an engineering laboratory in New York City. Products of the Western Electric Company and the Bell Laboratories not primarily intended for the telephone industry will be commercialized by ERPI. Naturally much of ERPI's present activity is connected with film reproduction, but a solder pellet detector for use by companies which pack liquid products in tin cans is already in commercial use. Thus the many possible uses of electron tubes for non-communication purposes have a new avenue for seeing the light of day. Anyone who knows the work of the Bell Laboratories and of the personnel engaged there cannot help but see that ERPI should find many products for distribution and service to other industries than the telephone plant.

J. V. L. Hogan's station WQXR contributes a bright note, and one which should tend to counteract any ideas that the broadcast picture could be contracted, just a bit here and there to admit some new stations. Recent tests with high and low frequencies disclosed the fact that 4/5ths of the receivers reporting on these tone tests could hear frequencies as low as 60 cycles; that 89 per cent could hear frequencies up to 6,000 cycles. Even at 8,000 cycles 64 per cent of the people could hear the modulation.

All of this proves that high fidelity stations are worthwhile and that limiting broadcast stations to 5,000 cycle side-bands would play directly into the hands of those set designers who can't hear a thing above 3,000 cycles and don't believe the average radio listener can either.

DR. E. F. W. ALEXANDERSON

of the General Electric Research Laboratories. In the foreground are metal thyratrons undergoing tests in anticipation of industrial service



Thyratrons and their Uses

A paper, delivered before the United States Patent Office Society, on the applications of gaseous filled controlled rectifiers

By E. F. W. ALEXANDERSON
General Electric Company
Schenectady, N. Y.

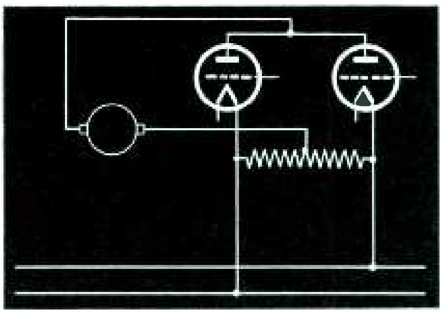


Fig. 1—Thyratron motor in simple terms

THYRATRON tubes and their uses is a subject which is at the present time uppermost in the minds of many of those connected with the laboratories of the electrical industry. Some years ago the same organizations interested themselves very largely in radio, but the radio industry has, in the meantime, attained its principal objectives, and it has exceeded all expectations in commercial importance.

The application of the electronic science to the power industry is, however, still in its infancy, and we are not yet able to predict what importance it will have in the commerce and finance of the future, but we can say with certainty that the electronic science, in one way or another, will be intimately interwoven with most of the branches of the electrical industry.

I believe we can classify inventions broadly in two groups:

The first is the one where there is an insistent public demand for a certain service, and scientists and inventors are thereby stimulated to find a practical solution. The automobile industry and the aircraft industry are examples of inventions of this type.

The second group of inventions is the one where a scientific discovery is the starting point and where a new technic gradually develops. The fundamental invention and many of its refinements are usually established before the public is conscious that it has an important new tool at its disposal. A period of years, often longer than the life of a patent, will therefore elapse before inventions of this type can be commercially exploited. Radio is an example of this. The development of the radio industry

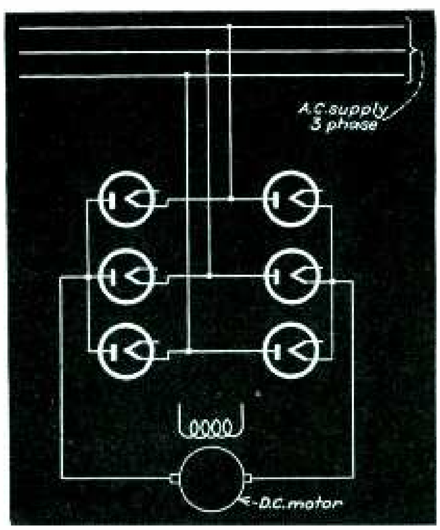


Fig. 2—A d-c thyratron motor operating from 3-phase a.c.

was remarkably fast and therefore some of the fundamental patents became important before they had expired, but those cases are, perhaps, more the exception than the rule for inventions which start from a scientific discovery. The use of electronics in the power industry is in this category, and while we may visualize a possible field of immense importance, we do not dare predict whether or when these expectations may be realized.

The branch of electronics that created the modern radio industry was based on the pure electronic discharge in a high vacuum, but the branch which holds out the greatest promise in the power industry is the ionized discharge in attenuated gas. An electric arc of this type has a very much higher conductivity than the pure electronic discharge and, therefore, is much more adaptable for carrying the currents of the magnitude used in power circuits.

The mercury vapor arc had been known and used for a long time, but with a limited application for rectification of alternating current into direct current, and it was not until

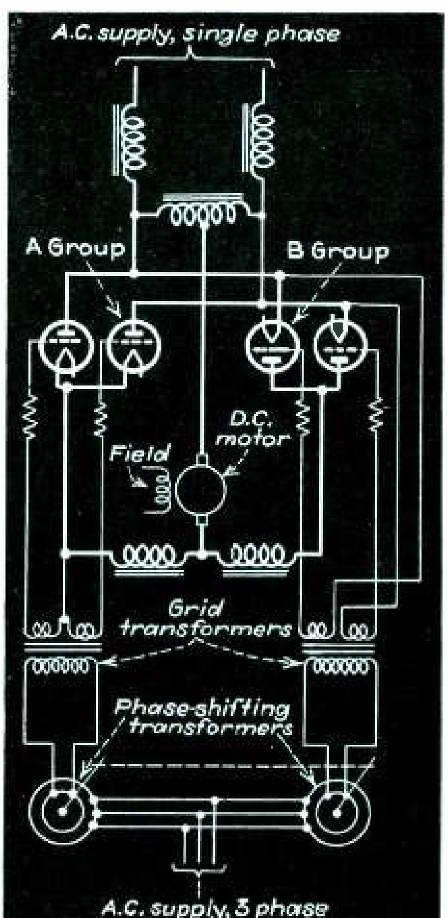


Fig. 3—Reversible thyratron d-c motor

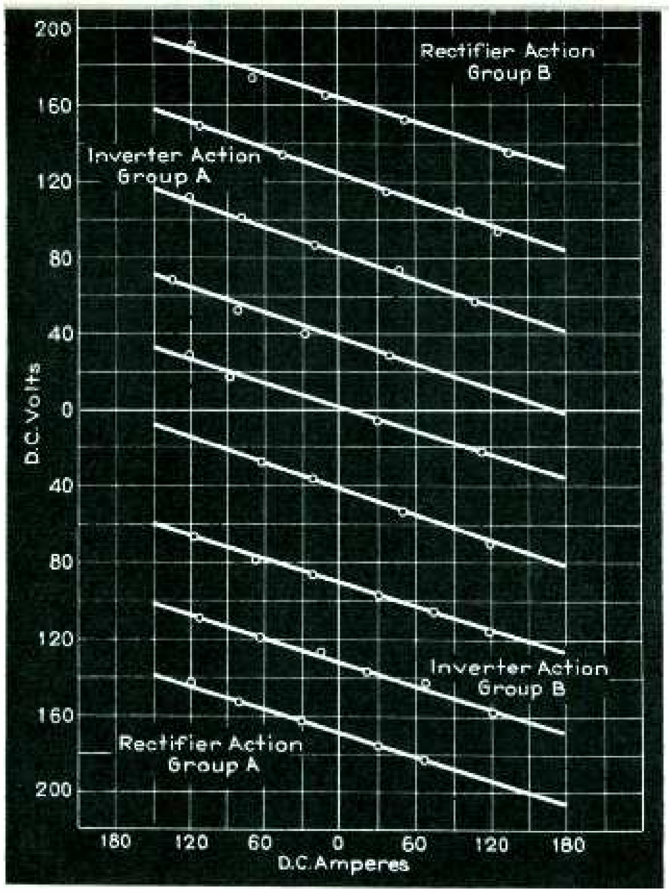


Fig. 4—Speed torque characteristics of motor of Fig. 3

the ability to control this mercury arc was discovered that the possibilities were opened up for broad usefulness in electronic power devices. The controllable gas discharge tube known as the thyratron can now be used not only for changing alternating current into direct current but also for the reversal of the process by changing direct current into alternating current, also for changing one frequency of alternating current into another frequency, for amplification of energy flow from a low level to a high power, etc. Thus, we have devices known as thyratron inverters, thyratron motors, thyratron frequency changers, and thyratron amplifiers, and I shall attempt to give you a brief review of the practical application of these devices.

The starting point of this development was the independent discoveries of Langmuir and Pierce that a mercury vapor arc can be controlled by the application of a negative electrostatic field which prevents the arc from starting. The basic Langmuir patent is already expired, but the art has been progressing at an accelerated rate in developments of new methods of operation and practical applications. The first thyratron was a mercury rectifier of the type used for arc lighting with a third electrode introduced in the corner of each side arm. This proved to be a very practical device. With this we were able to demonstrate the reversal of the process of rectification and it resulted in the device which is now known as the thyratron inverter. The first thyratron was operated quite reliably for laboratory purposes at 5000 volts direct current. The object of this test was to explore the possibilities of power transmission by direct current. We also set up one of those first thyratrons to operate a d-c motor at variable speed in the factory for operating a lathe. The next important step which covered a number of years of laboratory work was undertaken by A. W. Hull and resulted in the development of a practical hot cathode for high currents. These hot cathode thyratrons are used in power transmission by direct current at 30,000 volts which has been in successful operation for more than a year. The hot cathode thyratron is also used in a 400 hp variable speed motor which has been in service for a year and a half in one of the power stations of the American Gas and Electric Company.

Another important step has been discovered of a new method of controlling the mercury arc. The arc is started during each cycle of the alternating current by an ignitor immersed in the mercury pool. The power flow can be controlled by timing this ignition. This device has become known as the ignitron and should be included in this discussion because it can be used in many cases as an alternative to the thyratron and has found a particularly important application in electric welding. Unfortunately, we have no general name that includes both the thyratron and the ignitron except when an assembly of such tubes is called a mutator. This art is in such a rapid growth that the nomenclature cannot keep up with it. The 30,000 volt d-c power transmission and the 400 hp thyratron motor which I have mentioned are indications of the direction in which it is growing. One of the ultimate objectives which we hope may be realized is power transmission to whatever distances it may be economical to transmit electric power. Technically this appears possible. Whether it will be useful in the economics of power distribution must be answered by the future.

Motor applications on a large scale are nearer at hand. In the early years of the electrical industry there was no acceptable a-c motor. After the development of the induction motor and the synchronous motor, two machines were available which are unsurpassed in simplicity, reliability, and economy. These motors are, however, both inherently constant speed motors. In later years a variety of a-c motors have been developed and a number of these have had a variable speed characteristic. There

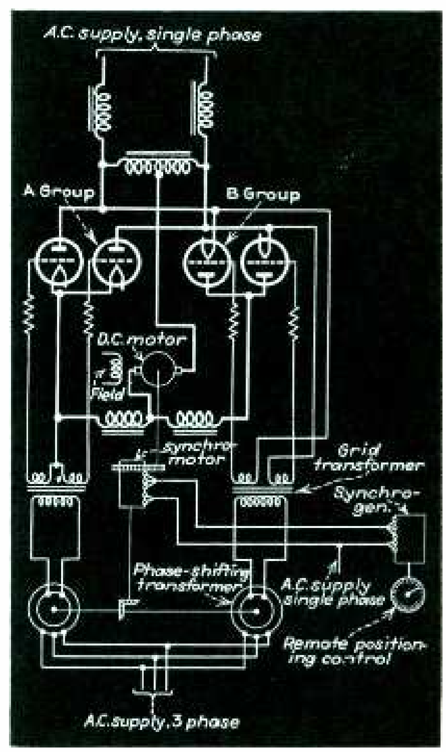


Fig. 5—Schematic of a torque amplifier

is as yet, however, no adjustable a-c motor as flexible as the Ward Leonard combination, and there is still room for much improvement on adjustable speed a-c motors. Electronics opens up new possibilities in this direction and a number of new motor types are possible. In the absence of any accepted terminology, I shall, for brevity, call them all thyratron motors and designate the specific type by further qualifications such as thyratron d-c motor, thyratron induction motor.

Thyratron D-C Motor

Figure 1 shows the thyratron d-c motor in its simplest form requiring only two tubes. The motor is controlled by the thyratron grids from standstill until full voltage has been applied to the armature. From this point, still higher speed can be attained by weakening the motor field. This motor can also be used for regenerative braking, in which case the tube functions as an inverter returning the power to the line. For this purpose, the motor field must be reversed because the current flow in the tube is unidirectional.

Figure 2 shows thyratron d-c motor with six tubes and a 3-phase power supply. This type has been worked out in commercial form as a 10 hp motor. Small hot cathode thyratrons are mounted on the front of the control box, which is not much larger than the starting box for a d-c motor of the same power. For large motors of this type we are reverting to the original pool type thyratron with certain improvements to make them commercially acceptable. Tubes with a continuous rating of 400 amperes and a momentary rating of several thousand amperes have been designed and appear thoroughly practical. Six such tubes may be used to draw power from a 440-volt 3-phase power circuit and drive 1200 amperes to a d-c motor at 550 volts. It should be noted that this motor combination requires no power transformer and that the motor is completely controlled by the thyratron grids.

Reversal and Regenerative Braking

Figure 3 shows a diagram for a reversible thyratron d-c motor, and Fig. 4 is the speed torque characteristics of that motor. As shown by these characteristics, it is possible to operate it as a motor in both directions, and it will also automatically shift over from motor operation to regenerative braking if it is connected to an overhauling load. This thyratron motor has the very desirable characteristics which so far have been associated exclusively with the Ward-Leonard motor generator control. It is expected that thyratron converters for this purpose will find applications for hoists and cranes and generally for applications where a high degree of control is required and the power supply is alternating current.

Torque Amplifier

A specific case where this motor has already been extensively used is the equipment which we call torque amplifier. The torque amplifier is not only a speed control but a position control where it is required to accurately reproduce mechanical motions with a greatly increased power. One such thyratron torque amplifier is being installed on a large boring mill in Schenectady, the object being to control the position of the tools which thereby can be set to an accuracy of a thousandth of an inch by adjusting the dials of the control mechanism. Such torque amplifiers with position control have so far not been available to the industry and we expect this to become an important advance in factory practice. A diagram of a torque amplifier is shown on Fig. 5. The controlling shaft is connected to a pair of phase shifting transformers which in their turn control the grids of the thyratron amplifier. The shaft of the machine driven by the motor is also connected to the phase shifting transformers so as to give a differential action on the motor control. Thus, whenever the primary shaft moves, it impresses a grid potential which sets the motor in motion and the motor continues to run until the differential action has neutralized the grid potential created by the remote control. Thus, the motor cannot

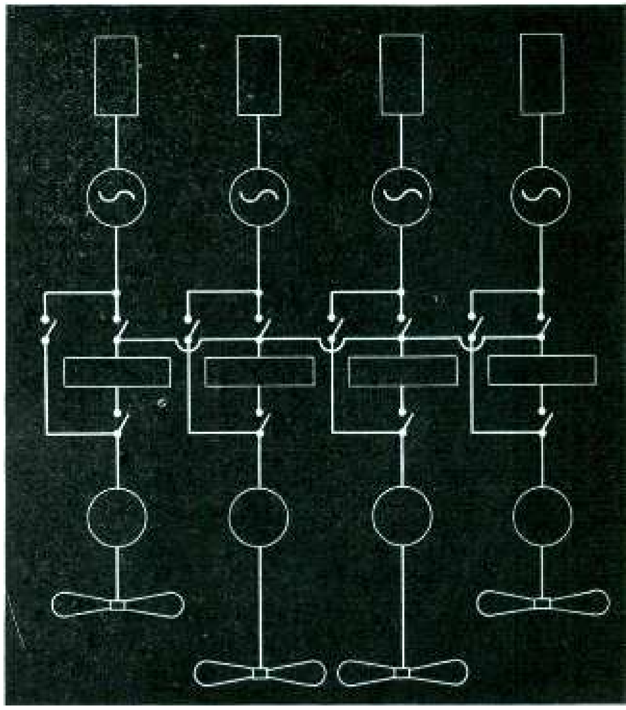
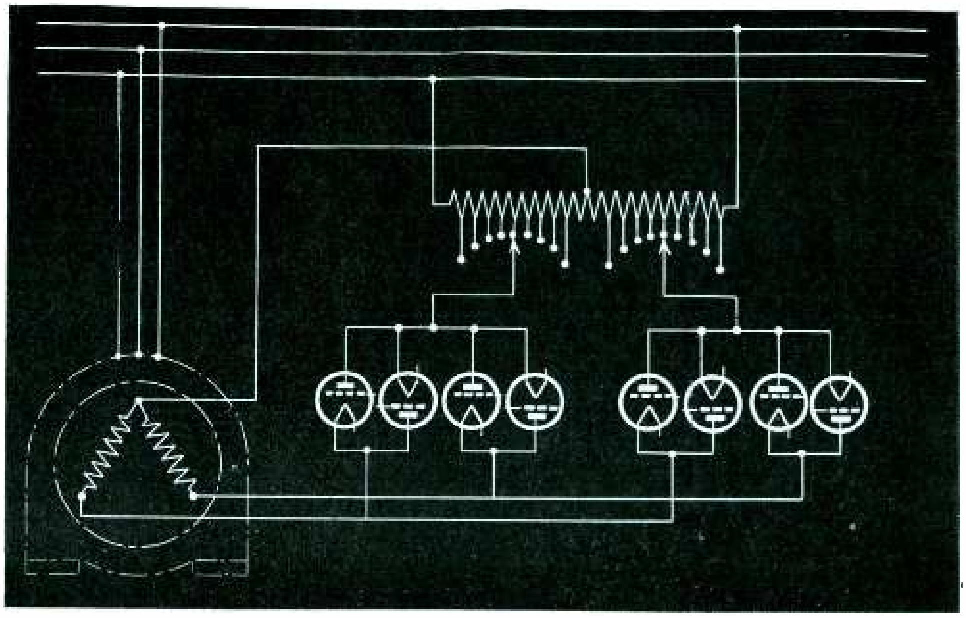


Fig. 7—Use of thyratrons in ship propulsion

Fig. 6—Schematic of a thyratron type of induction motor



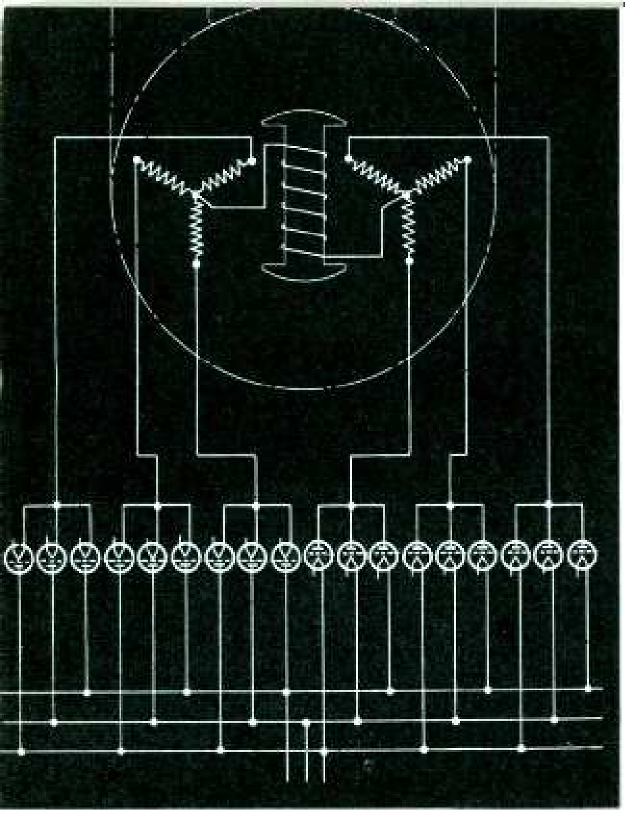


Fig. 8—Diagram of the first 400 hp. thyratron motor of variable speed

come to rest until there is an exact agreement in the position between the controlling shaft and the output shaft. If the controlling shaft is kept in continuous motion the output shaft is compelled to follow in a corresponding angular position, and the grid control is so sensitive that an extremely small lag of the output shaft behind the input shaft produces the necessary grid voltage to maintain the motion. The accuracy of position may thus be kept within a thousandth of an inch, or within a few arc minutes of angular motion.

Ship Propulsion

A promising application of electronics is electric ship propulsion. A turbo-generator can be built more economically for a relatively high frequency, whereas the slow speed motors driving the propeller shaft are favored by a low frequency. A thyratron frequency changer is therefore well adapted as a connecting link between the generator and the motors. On high speed ships it is necessary to have several turbo-generators. When the ship is operated below its maximum speed it is then possible to shut down some of the turbines and operate the remaining turbines at full speed and full economy, although the motors run at reduced speed.

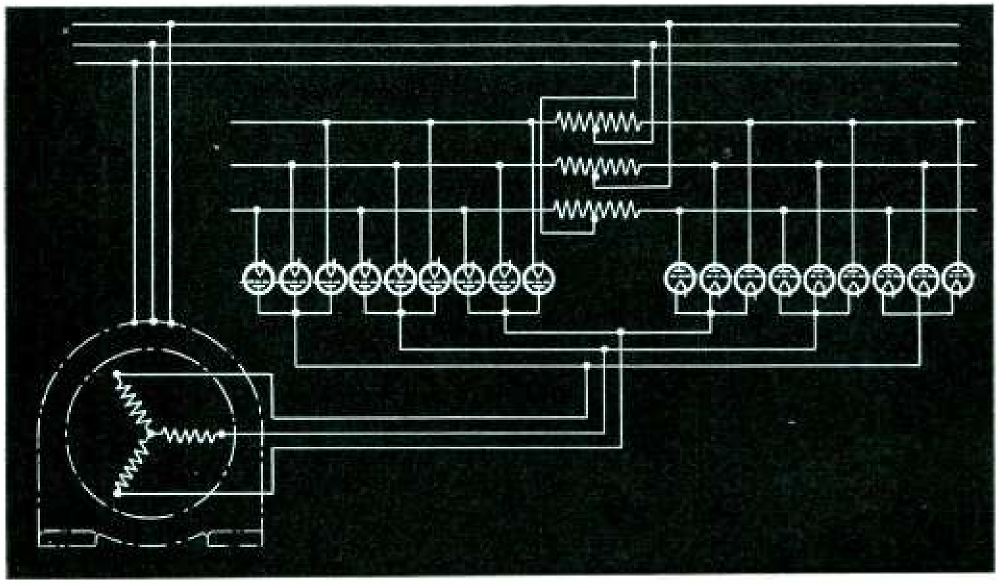
Thyratron Induction Motor

Figure 6 shows the diagram of a combination that we may call the thyratron induction motor. The tube set takes the place of the rheostat in the secondary of the induction motor, but returns the power to the line instead of wasting it. The speed is controlled by a tap changing transformer, but for fine adjustment it may also be controlled by the thyratron grids.

Thyratron Synchronous Motor

Figure 8 shows the diagram of the first 400 hp thyratron motor. The tube set functions as a frequency changer and the motor is structurally of the type of a synchronous motor. The motor speed is changed by varying the frequency supplied by the tube set. On the end of the motor shaft is a distributor which controls the grids so that the tube set functions as if it were a commutator for the full power. From the point of view of the distributor, the tube set is a thyratron amplifier; from the point of view of the motor armature it is a commutator; and from the point of view of the power supply it is a frequency changer. To distinguish from other types, we may call this the thyratron synchronous motor. We are thus utilizing the structure of a synchronous motor, which is cheap and sturdy. But instead of being able to use this motor effectively only at full speed, we give it the characteristics of a d-c motor with high torque in starting and acceleration and the ability to run at any speed.

Fig. 9—Exciter for a machine that may be used as generator or motor



Power Transmission

Figure 9 shows a thyratron exciter for a machine that may be used either as a motor or a generator and may be operated either above or below synchronism. Such a combination may be used as a connecting link between two power systems which are not operated in synchronization, or as a synchronous generator for an a-c transmission line of such a length that it is beyond the range of synchronous stability. Test developmental arrangements have shown that there is no technical limit to the length of a-c transmission lines that may be built in this way. In this there is a temptation to let our imaginations run away by saying that electronics is the solution to the problem of power transmission with alternating current as well as with direct current. We are then, however, confronted with the hard facts that even at present the limit of power transmission is not technical but economic. Whether this will be so in the future and in what distant future, we do not know.

For those of us who are interested in electronic engineering it is therefore better to be satisfied that this subject has fascinating possibilities even if the most ambitious dreams do not come true, and it is one of the steps in electrical engineering which are inevitable because of the course taken in the physical sciences since the beginning of this century.

Method of viewing the stroboscopic pattern drawn on the record

Turntable WOBBLE Indicator

By WILLIAM F. WICHART
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SEVERAL months ago this laboratory was faced with the problem of determining, with a considerable degree of accuracy, the existence of fluctuation in speed of rotation (wow) of various turntable equipments used for disc sound recording and reproduction purposes.

The most desirable qualities of a wobble indicator appeared to be the following:

1. A fair degree of accuracy and sensitivity.
2. A visual in preference to an auditory method.
3. Simplicity and portability.
4. Low initial cost.
5. If possible, the method used should accentuate or magnify the fluctuations.

The following device, we believe, fulfills these requirements to a remarkable degree.

A twelve inch uncut nitrate record blank was duplicated in bakelite, and clamped to the recording or playback turntable from the center pin in the usual manner for recording. A thin mixture of titanium dioxide in alcohol was applied to the surface of the disc with a soft paint brush, starting at the outside edge and extending toward the center one or two inches. The mixture dries rather rapidly and leaves a dense white ring of pigment on the outside of the disc.

Should the turntable be wowless, and an accurately driven vibrating stylus is pressed down for one revolution on the prepared surface of the bakelite disc, a sine wave pattern is then recorded as a black trace on white background. Driven directly from the 60 cycle light circuit a reed tuned to 120 vibrations a second is used for a vibrating stylus.

When this record is viewed intermittently at 120 times a second, it will stand out with a startling appearance of solidity. The stroboscopic viewing device consists of a small synchronous motor driven from the 60 cycle line, and a slotted six inch disc within a metal housing.

So far we have been discussing only a wowless turntable. If the speed of the turntable varies once per revolution and always at the same angular position the stroboscopic pattern stands perfectly stationary at the stylus, while 180° from this position the pattern will have a pronounced wobble back and forth. The point of greatest wobble merges gradually into the point of no wobble.

Turntables in which the speed of rotation varies in some irregular manner will have an irregular wobble. Therefore the stroboscopic pattern varies irregularly even at the point of application. This is often the case with belt driven turntables. In the use of this device it is not difficult to be able to recognize the characteristic pattern variations and ascertain immediately the cause of the difficulty.

It is worthwhile to mention another application in the rapid timing of high class belt driven turntables by allowing the stylus to record for about two revolutions before lifting it, and noting the character and amount of the overlap. In a few moments one can obtain data that otherwise would require hours of research with stop-watch and an electric revolution counter.

Turntable, recording stylus, and record upon which a black stroboscopic pattern is traced for checking wobble of turntables

Outside of the limited field of disc sound recording and sound-on-film recording, the principle described here has wide application to rotating machinery research.

The equipment described has been worked out with the co-operation of the engineers of the Universal Microphone Co., of Inglewood, Cal.

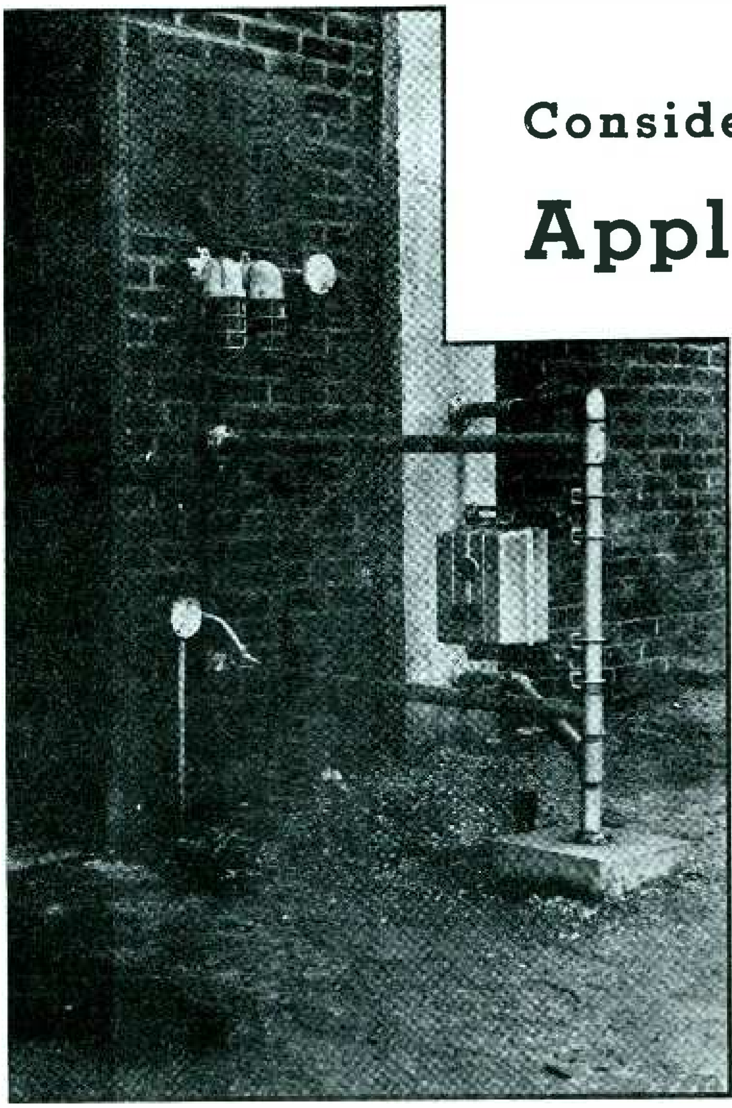

Fig. 1—Warehouse entrance time delay opening and closing control

Consider these things in Applying Electronic

By W. I. BENDZ
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Westinghouse Electric & Mfg. Co., Boston, Mass.

DOOR opening was one of the earliest applications of a phototube because it was novel and had popular appeal. Now it is used because it is practical, reliable, and often shows a profitable return.

The first point to consider in selecting the proper control is that there are four types of doors, requiring different types of mechanical apparatus to operate them. These are:

1. Swinging (hinged) doors
2. Horizontally rolling doors
3. Horizontally folding doors
4. Vertical roll-top metal doors

Devices for electrically operating each of these types of doors are available. Electrically controlled pneumatic operators are best suited to swinging doors; motor-operated devices are available for all types of doors; thruster-operated devices have been used for very heavy hinged or horizontally rolling doors.

In the control schemes that follow all references to "door operators" infer that an "operator" is a complete device, electrically controlled, for mechanically opening and closing a door and including limit switches for open and closed position limits of the door.

How is the Door to be Opened?

1. INSTANTANEOUS RESPONSE

is the simplest scheme. This method will begin to open the door the instant an object interrupts a beam of light shining across the entrance.

2. DELAYED OPENING.

A common objection to the instantaneous response scheme is that in some cases it is not desired to open the door for a vehicle or a person passing quickly through the beam, en route to some point other than the doorway. The easiest method of meeting this requirement is to introduce a time delay relay between the phototube relay and the door operator so that a person or vehicle must wait and keep the light beam interrupted for a period of several seconds before the door starts to open.

3. SIZE OF OBJECT.

Certain applications require that the door be opened for a vehicle but not for a person. This is accomplished by placing two light beams in front of the entrance and spaced several feet apart. The relays are so connected that the object must be large enough to intercept both light beams at the same time or else the door will not open. A further refinement of this scheme is to build the control so that the object must not only be large enough to span both beams but must also pass the beams moving in the proper direction, as toward the entrance and not away from it.

The choice of opening scheme depends entirely upon conditions encountered with each installation. In general, the instantaneous response scheme is usually preferred for service garages, in which case the purpose of an installation is to open the door as quickly as possible for the convenience of a customer. The delayed opening scheme is particularly useful where physical conditions necessitate that occasionally an object pass through the opening beam without entering the building. The scheme employing two beams to take into account the size

DOOR OPENERS

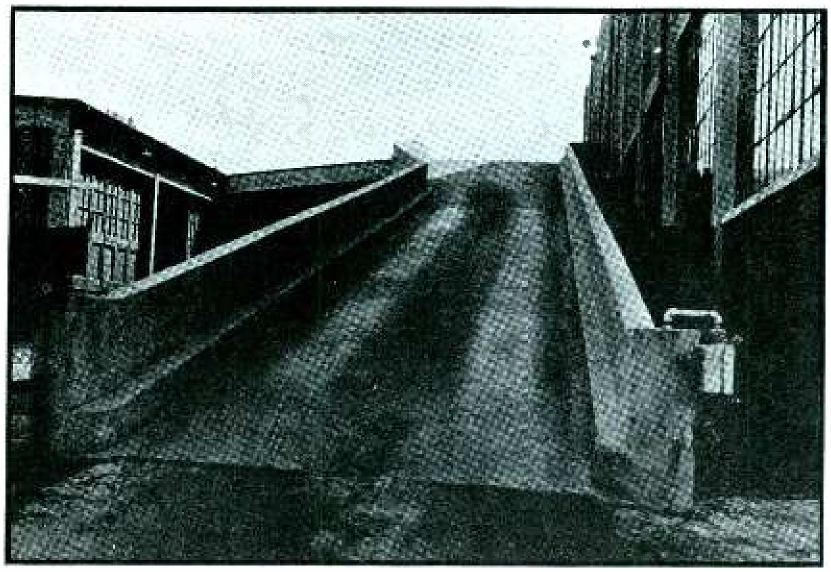

Fig. 2—Two-way control over warehouse entrance and exit ramp

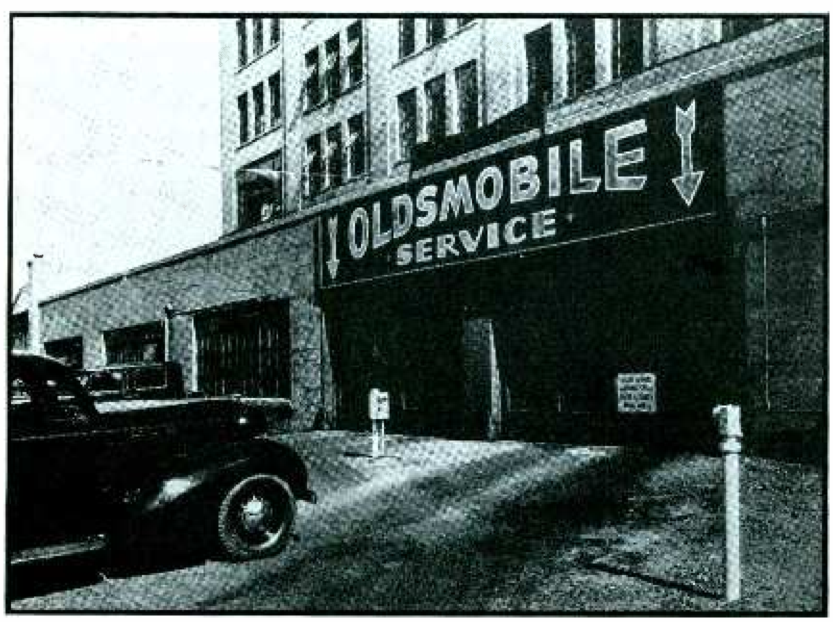

Fig. 3—Service garage entrance. Controls housed in water-tight case

and direction of travel of an object is advantageous where the entrance of a building is on a public street, and it is desirable to eliminate false operation caused by people, intercepting the beam.

How is the Door to be Closed?

1. BY PUSHBUTTON.

While there is no logical reason why a door should be closed by manually depressing a pushbutton, there are some who prefer this way.

2. INSTANTANEOUS CLOSING.

The most common method of closing is to start closing as soon as a vehicle has cleared the doorway. However, this method is not used for buildings of this type without one of the protective schemes discussed below.

3. TIME DELAY CLOSING.

A very simple method of control is to initiate the closing operation by a time delay relay a definite time after a vehicle has passed on through the light beam which it intercepted to cause the door to open. This scheme does not use any other form of protection to prevent closing the door upon a vehicle. For this reason it is applicable to installations such as a garage for a fleet of trucks, or like applications where a certain group of drivers who are familiar with the apparatus realize that they must continue through the doorway within a reasonable number of seconds, once they have started. It is not the scheme recommended for a service garage where an unfamiliar person might accidentally stall directly in the doorway after having passed through the opening light beam.

This method of control does possess an advantage for installations where there is a heavy flow of traffic at some particular time during the day because it causes less operation of the door since it will remain open during the peak periods of traffic and close automatically as soon as traffic is less frequent.

Protective Methods

1. DOORWAY BEAM.

The simplest protective scheme, and one that is entirely suitable for vehicular traffic, is to use a protective beam of light and phototube relay directly adjacent to the frame of the door and on the opposite side of the door from which the opening beam is placed. This relay is connected so that it is impossible for the door to start to close until a vehicle has cleared the doorway, or if the door has started to close, and the vehicle backs up, the protective relay will cause the door to re-open immediately, regardless of whether

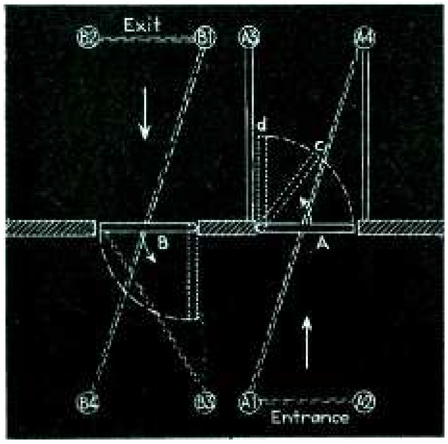

Fig. 4—Scheme for public building entrances

an instantaneous or time delay scheme is used to initially open the door.

2. DIAGONAL BEAM.

A scheme that affords complete protection employs a protective light beam projected diagonally through the doorway beginning at a point outside near the opening beam and terminating at a point inside a safe distance beyond the door. An object intercepting any part of the diagonal beam prevents the door from closing. Since the door cuts the beam when it is partially closed, a switch must be installed and wired so as to make the protective beam effective only while the door is fully open.

Two-way Traffic

While it is much preferred to arrange an installation for one-way traffic having vehicles enter by one door and leave by another, two-way schemes are practical. The installation shown in Fig. 2 is a ramp to the second floor of a warehouse by which traffic enters and leaves the upper floor. The control employs time-delayed opening and closing together with a protective beam in the doorway. Red and green traffic signals inside and outside at the top of the ramp automatically function in such a way that a vehicle travelling in one direction obtains the right-of-way and signals a red light to a vehicle that might approach the other end of the ramp. This installation incorporates many unusual features and represents what can be done with a complicated two-way traffic problem.

A typical installation of this type is illustrated in Figure 3. For inside installations, a standard light relay, and a light source with a small transformer to supply low voltage for the lamp filament is suitable. If the light beam is longer than fifteen feet, the phototube should be mounted in a special phototube housing and connected with a relay mounted nearby. For outdoor applications, the light relay enclosed in a watertight case is best, Fig. 3. Such applications will function for a separation up to a thirty-foot span.

an enclosure that harmonizes with a building style and adds to the appearance of an entrance. One of the well-known hardware manufacturers offers a complete line of electric door operators and hardware for enclosing light sources, and phototubes. The equipment consists of brass, bronze, or aluminum posts and rails, square or round, styled to meet any possible requirement.

Most satisfactory performance of such an installation is obtained when the traffic is one-way, that is, people enter by one door and leave

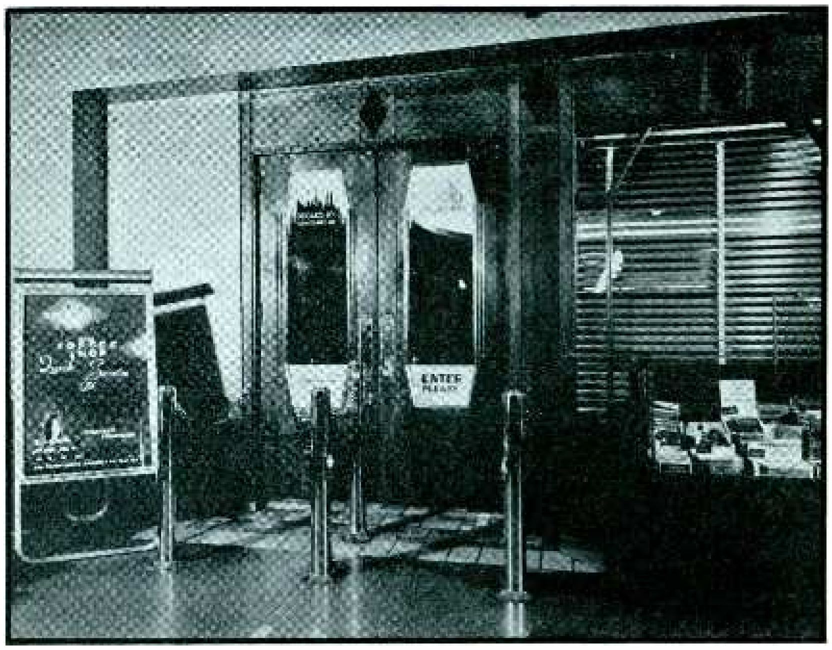

Fig. 5—Typical installation at entrance to public building

Control apparatus for these schemes are usually built of standard relays enclosed in metal cabinets and located wherever convenient inside the building.

The entrance doors to public buildings are hinged (swinging) doors for which pneumatic operators are excellently suited. They consist of a cylinder and piston together with an electrically controlled air valve, and because of their quickness of response, simplicity, and ability to stand frequent operation, they are applicable for such duty.

The control requirements for this service differ from commercial buildings considerably. First of all, the device must prevent a door from closing on a person in its path no matter what the person may do. Second, the apparatus must be in

by another. Furthermore, doors should open away from the direction in which a person is moving. Sometimes building laws prohibit an entrance door opening toward the inside of a building. A compromise can usually be reached by using an operator that is equipped with an "emergency release" which is a mechanical device that allows the door to be pushed outward, opposite to its normal direction of operation, when sufficient force is applied against the door.

How It's Done

The scheme of control frequently used for entrance doors is shown in Fig. 4. It will be noted that "A" is the entering door and "B" the exit door. The posts A-2 and A-4 (or B-2 and B-4) contain a light source and lens and project a beam of light focused on two photo-tubes enclosed in post A-1 (or B-1).

A person entering the building will walk between posts A-1 and A-2 and intercept this light beam, operating the photo-tube relay and tripping the electrically controlled air valve of the operator. The door immediately opens, and as the person steps forward, he also intercepts the diagonal beam A-4 to A-1 (B-4 to B-1). This diagonal beam is a safety beam and as long as it is intercepted, it is impossible for the door to reclose. By choosing the

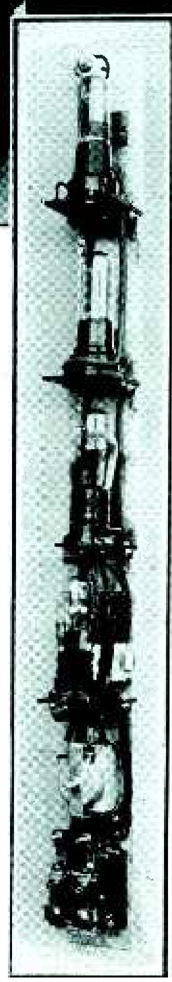

Fig. 6—Railroad station interior doors (courtesy The Stanley Works). At the right is a phototube unit to fit in posts

proper angle for this beam, it can be arranged so that a person will intercept some part of it whenever he is within the path of the door. Since the door can not reclose while either of beams A-1 to A-2 or A-1 to A-4 are intercepted, ample protection is afforded against closing the door on a person either in the doorway or ready to enter it.

Obviously the diagonal beam must be made inoperative while the door is closed or else the beam would be intercepted by the door itself and could never completely close. This is accomplished by a switch in the door-opening mechanism which makes contact only between positions "Ac" and "Ad". The diagonal beam relay is effective between these two positions but is switched out of the control circuit when the door closes further than position "Ac".

Several schemes are used to prevent a person from using the wrong doorway. Sometimes a rail or chain is run from posts on the far side of the door to the wall. Another very effective means is to connect a flexible chain or cord between the far side of the door and a post, such as B-3 to the door. When the door is closed, the chain stretches across its exit side, and a person instantly realizes he should not use that door. When the door opens properly, the chain loops behind it and is not an obstruction to the person passing in the right direction.

The entire assembly consisting of all amplifier tubes, photo-electric cells, and control relay is complete and fits neatly into a post 36" high and 3" square or a post 4" in diameter. There are no parts of the photo-electric equipment outside of the post. Consequently, the installation of such a unit is reduced to a minimum. This type of relay is extremely compact which makes for an inconspicuous and neat installation as well as avoiding the necessity for providing wall boxes in which to house additional equipment. By making watertight joints in the post in which the relay is enclosed, the unit will function reliably out-of-doors.

Interior Doors

Interior doors of office buildings, restaurants, libraries, etc., present many useful applications. An example is a doorway between an office and a laboratory, where it is necessary to keep the office doors closed at all times, yet there is a considerable amount of traffic between the two rooms. Busy restaurants have installed operators on doors between the main dining room and kitchen. This is the scene of many accidents resulting in expensive breakage of dishes, and the benefits derived from automatic opening equipment are quite obvious. A very similar application is the doorway between a library desk and the book stock rooms.

Interior doorways are in most cases the same as public building entrances and use the same scheme and equipment previously described. In some cases it is not necessary to use special hardware in which to enclose the photo-electric apparatus, and the standard industrial type units are entirely acceptable. Then, too, the doors are usually used by the same group of persons who realize that they are expected to keep moving through the doorway. For this reason, the expense of using the diagonal protective beam may be eliminated since there is ample time to pass without being caught by the closing door provided one moves ahead at a normal pace.

Cathode Ray Wave Form Distortion

PREVIOUS work has been published which shows that the trace of an ultra high frequency signal on the screen of a cathode ray tube is unaffected by errors due to time of flight of the beam electrons through the deflecting field until frequencies of the order of 10^8 cycles per second are reached. The velocity of the electron beam and the length of the deflecting field both play a part in determining the frequency at which distortion becomes appreciable. Libby[1] has demonstrated both mathematically and experimentally that the amplitude of the response on the screen diminishes with increasing frequency until a frequency is reached at which the response is zero for any finite sinusoidal signal amplitude. At this frequency, the time of flight of an electron in the beam through the deflecting field is just equal to the period of the signal. His Fig. 2 shows clearly that, as the frequency is increased even further, the response becomes negative, passes through a minimum, and then increases to a second frequency at which the response is again zero.

It is desirable to go beyond the work of Libby and investigate the type of distortion which the trace of a non-sinusoidal signal will experience at very high frequencies. First, however, it will be desirable to derive a single equation which, with the aid of a table of trigonometric functions, will yield directly the response of a cathode ray tube as a function of frequency.

In Fig. 1 is shown a schematic diagram of a cathode ray tube in which the essential dimensions and voltages are indicated. Assume:

(1) the deflection plates to be short compared to the tube length. ($q >> a$)

(2) the deflecting field to be uniform between the plates and zero elsewhere.

(3) the average potential of the deflecting plates to be E_2.

(4) the screen to be flat and perpendicular to the gun axis.

Then by the laws of physics, the force acting sideways on a particular electron is eE_d/h and imparts a sideways acceleration to the electron as given below:

$$\frac{d^2y}{dt^2} = \frac{eE_d}{mh} \qquad (1)$$

where e/m is the charge to mass ratio of the electron E_d is the deflecting voltage and h is the separation between deflecting plates. By a single integration of Eq. (1), the sideways velocity imparted to the electron is determined.

$$\frac{dy}{dt} = \int_{\phi}^{\phi + a/\sqrt{2E_2 e/m}} \frac{eE_d}{mh}\, dt \qquad (2)$$

The time when the electron enters the deflecting field is denoted by ϕ, a is the distance the electron has traveled and $\sqrt{2E_2 e/m}$ is its velocity toward the screen due to the voltage E_2. As the first goal in an equation giving the response to a sinusoidal signal, assume:

$$E_d = V \sin \omega t \qquad (3)$$

When Eq. (3) is substituted into Eq. (2), the integration can be easily performed.

$$\frac{dy}{dt} = \frac{2eV}{mh\omega}\left[\sin\left(\omega\phi + \frac{\omega a}{2\sqrt{2E_2 e/m}}\right) \sin\left(\frac{\omega a}{2\sqrt{2E_2 e/m}}\right)\right] \qquad (4)$$

Eq. (4) gives only the sideways component of the velocity. Looking again at Fig. 1, we see from similar triangles that

$$\frac{b}{q} = \frac{dy}{dt} \Big/ \frac{dx}{dt} \qquad (5)$$

where dx/dt is the beam velocity as it leaves the gun and can be calculated from the second anode voltage E_2. Hence:

$$b = \frac{2Vq}{h\omega\sqrt{2E_2 m/e}} \sin(\omega T) \cdot \sin\left(\frac{\omega a}{2\sqrt{2E_2 e/m}}\right)$$

$$\text{where } T = \phi + a/2\sqrt{2E_2 e/m}. \qquad (6)$$

To find the ratio C of the response of a cathode ray tube at any ultra high frequency to that at low frequency, divide (6) by the well known expression:

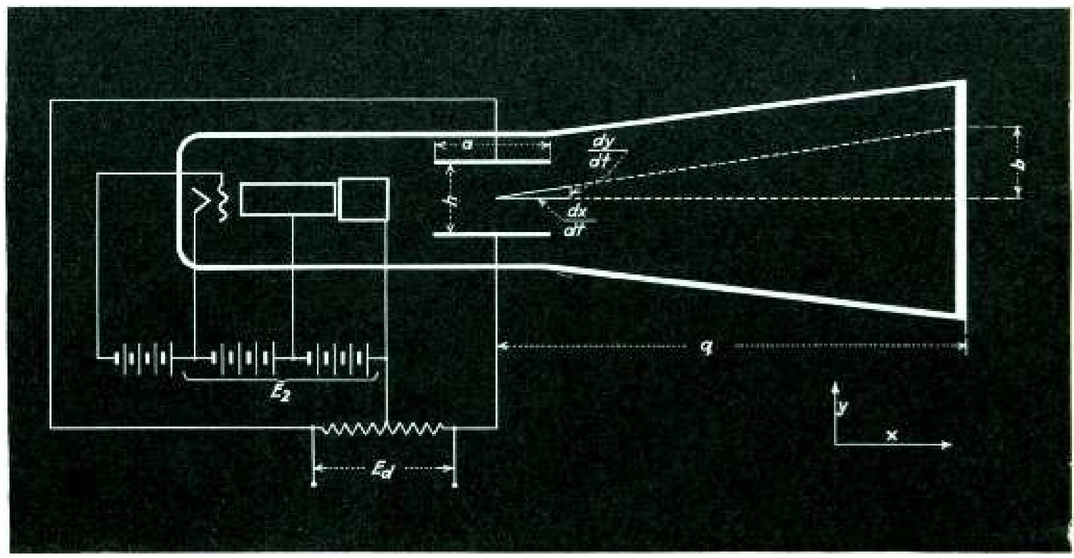

Fig. 1. Schematic diagram of electrostatically deflected cathode ray tube

$$b_{uncorrected} = \frac{qVa}{2hE_2} \sin \omega T \qquad (7)$$

for the deflection neglecting time of flight. The phase difference between b and E_d being irrelevant, T has been substituted for t. Then,

$$C = \frac{2\sqrt{2E_2 e/m}}{\omega a} \sin\left(\frac{\omega a}{2\sqrt{2E_2 e/m}}\right) \qquad (8)$$

$$= 1.89 \times 10^7 \sqrt{E_2}/fa \cdot \sin(3.03 \times 10^{-6} fa/\sqrt{E_2}) \qquad (9)$$

If E_2 is expressed in volts, f in cycles per second and a in cm. the angle in parenthesis is in degrees of arc. An ordinary table of trigonometric functions may be used in computing.

at Ultra High Frequencies

By R. M. Bowie

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St. Marys Works
St. Marys, Pa.

Equation (6) which gives the response of a cathode ray tube to a sinusoidal signal of any frequency contains only a sine term which is a function of T. Therefore, the trace on the screen is sinusoidal and suffers only from amplitude but not from wave shape distortion at ultra-high frequencies. Such, we shall see, is not the case with a periodic signal of any other shape.

It is well known that any periodic wave regardless of shape can be expressed as the sum of an infinite number of harmonic frequencies properly selected as to amplitudes and phases. Such a representation is known as a Fourier series and may be expressed as

$$E_d = V_o + \sum_{n=1}^{\infty} V_n \sin(n\omega t + \theta_n) \quad (10)$$

This expression for E_d can be substituted directly in Eq. (2) and the resulting expression integrated. By the same reasoning used in connection with (5), an expression analogous to (6) is obtained.

$$b = \frac{qV_o a}{2hE_2} + \sum_{n=1}^{\infty} \frac{2V_n q}{hn\omega\sqrt{2E_2 m/e}} \sin(n\omega T + \phi_n) \cdot \sin\left(\frac{n\omega a}{2\sqrt{2E_2 e/m}}\right) \quad (11)$$

Upon comparing the term $\sin(n\omega t + \theta_n)$ of (10) with the term $\sin(n\omega T + \theta_n)$ of (11), it is evident that the trace on the screen will be free of phase distortion between component frequencies. As $t \neq O$ when $T = O$, the position of the spot on the screen will not be in phase with the instantaneous signal value. This is a matter of no consequence. Assume:

$$C_n = \frac{2\sqrt{2E_2 e/m}}{n\omega a}\left(\sin\frac{n\omega a}{2\sqrt{2E_2 e/m}}\right) \quad (12)$$

then Eq. (11) becomes:

$$b = \frac{qV_o a}{2hE_2} + \sum_{n=1}^{\infty} C_n \frac{qV_n a}{2hE_2} \sin(n\omega T + \phi_n) \quad (13)$$

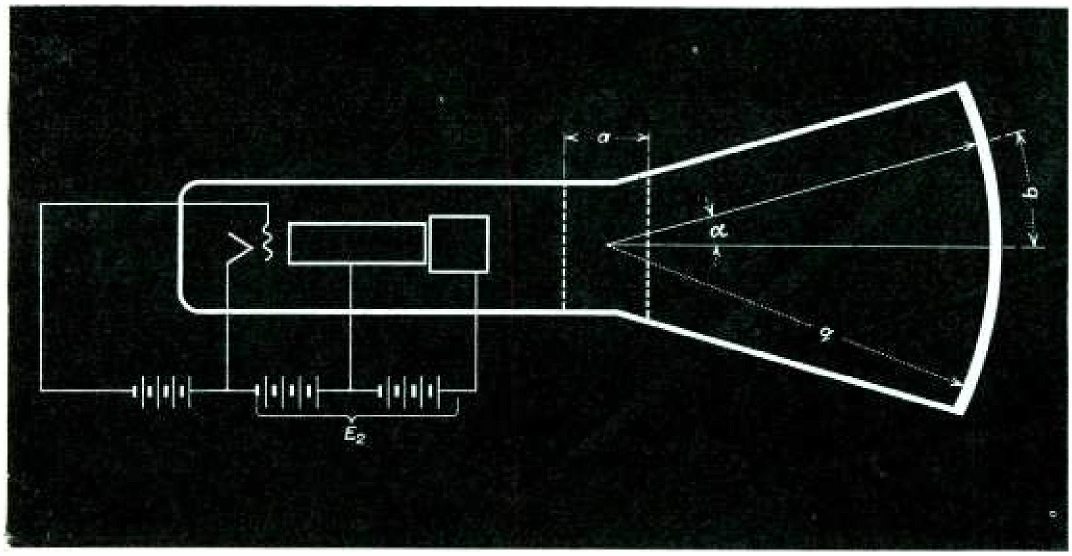


Fig. 2. Schematic diagram of magnetically deflected cathode ray tube

which, except for C_n, is the form of the equation which results if the time of flight is neglected. The amplitude of each component frequency is, therefore, diminished by the amount given by C_n. Under a particular condition of the voltage E_2 and signal frequency, it is possible to have a harmonic absent from the trace on the screen which is present in the signal. For instance, under proper conditions, the fifth harmonic might be absent although the third, fourth and sixth would be present with diminished amplitudes. In this case, $5\omega a/2\sqrt{2E_2 e/m} = \pi$ radians. It is to be noted, however, that, if $\omega a/2\sqrt{2E_2 e/m} = \pi$ (or some multiple thereof), $C_n = 0$ for all values of n. Hence, for this condition, only the d-c component of the signal appears on the screen. In other words, the frequencies at which the response passes through zero are independent of the periodic wave form of the signal.

The case of magnetic deflection can be dealt with very briefly. In Fig. (2), the following assumptions are made:

(1) H, the magnetic field, is perpendicular to the paper.

(2) H is confined to the space between the dotted lines separated a distance a apart.

(3) $q >> a$.

(4) The length of the electron path within the deflecting field is independent of the deflection.

It is well known that an electron traveling in a magnetic field perpendicular to its velocity tends to travel in a circular path of radius (r) where

$$\frac{1}{r} = \frac{H}{\sqrt{2E_2 m/e}} \quad (14)$$

If ds is an element of electron path within the field, the angular displacement of the electron is

$$d\alpha = \frac{ds}{r} = \frac{Hds}{\sqrt{2E_2 m/e}} \quad (15)$$

Since the electron velocity remains constant as determined by the second anode voltage

$$ds = \sqrt{2E_2 e/m}\, dt \quad (16)$$

The angle α can be determined by substituting (16) in (15) and integrating.

$$\alpha = \int_{\phi}^{\phi + a/\sqrt{2E_2 e/m}} H(e/m)dt \quad (17)$$

Again ϕ is the time when the electron enters the deflecting field. If it is remembered that $\alpha = b/q$, it can be seen that essentially Eq. (17) differs from Eq. (2) only in that H replaces $E_d h$.

(Continued on page 29)

Snow-static studies are carried out in this flying laboratory of the United Airlines. On the bench are automatic recorders for correlating static levels with weather conditions

Developments

FEW radio engineers outside the aircraft industry realize the extent to which the commercial air lines are now utilizing radio facilities for maintaining the regularity and safety of their services. Equipment in the planes and on the ground has been expanded to include such refinements as simultaneous transmission of voice and range signals, the voice reporting weather information, while the radio range provides beam signals for navigation. As adjuncts to the radio range system, newly developed ultra-high frequency services are now being installed. Among these are the "cone-of-silence" marker, which gives the pilot a positive indication of the location of the radio range transmitter, and the "fan-type" marker which acts as a location marker along the beam itself. Experimentation with "blind-landing" systems has reached a point where commercialization is not far off. The Army has been successful in taking an airplane off the ground, flying it over a pre-arranged course, and landing it again, all by radio control and without a person on board.

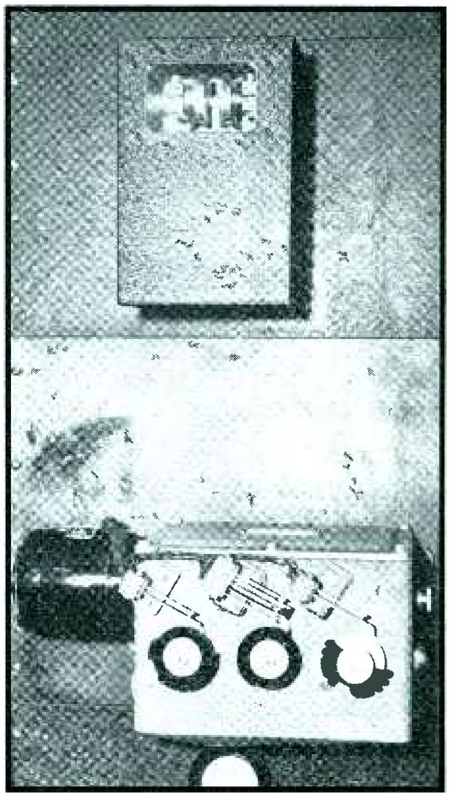
With this increase in available facilities have come corresponding improvements in the equipment used, and great progress in connection with such transmission problems as static, skip-effect, and other vagaries of transmission which make radio unreliable. Nor has this development been limited to the air lines alone. Equipment is available for the private flyer in a wide variety of shapes and sizes. To add to the effectiveness of this equipment, the Government is now establishing certain "watches" during which government radio stations will listen on the bands assigned to itinerant flyers, namely, 3,105, 3,120, and 6,210 kc. Frequency measuring services are now available so that the private flyer's transmitter can be properly lined up at appropriate intervals, and arrangements have been made so that the airline transmission facilities may be used by private flyers upon the payment of a standard fee.

The Snow-Static Problem

The most difficult obstacle in the way of radio reception under all weather conditions is "snow-static," a general term for static caused by charged particles, whether they be particles of dust, snow, sleet, rain or fog. Snow-static usually has a continuous hissing character, and may have a definite pitch which runs up and down the scale. It appears usually when conditions are otherwise difficult, and when the pilot is relying completely on his radio for navigation or communication. Its effects are particularly troublesome in the 200 to 300 kc. band in which the beam signals are sent. For this reason much effort has been expended by several of the leading airlines' radio laboratories (particularly those of the Transcontinental and Western Air and the United Air Lines) to track snow-static to its lair and to find means of minimizing it.

The first successful attack on the problem was made by means of the shielded anti-static loop, which has recently been listed by the Bureau of Air Commerce as required equipment on all commercial air lines. The loop is of circular shape, varying in size from 10 to 15 in. in diameter and is enclosed in a circular metal tube, the tube being continuous except for a short section which is made of insulating material. The presence of the insulation prevents the shielding from acting as a shorted secondary turn on the loop, and allows the electromagnetic component of radio reception to influence the loop, while effectively shielding it from electro-static disturbances. When the pilot runs into snow-static, he switches his receiver from the conventional straight-wire antenna to the loop.

Keying mechanism of the new Floyd Bennett radio range beacon. The black discs have cam outlines for the A and N signals and for the identification signal "FB"



in Aircraft Radio Area

New services for communication and navigation, on long as well as ultra-short waves, have permitted more regular schedules in airline operation without decreasing safety

The purpose of the loop is primarily that of improving signal-to-noise ratio, but the fact that it is a loop antenna, makes it available, in addition, for direction finding. Through the use of a rotating loop the pilot is able to take direction finding "sights" on stations within range, and by performing a triangulation problem can ascertain his position with a fair degree of approximation.

Unfortunately the anti-static shielded loop is not effective in all types of snow-static, and on occasions it fails to produce much improvement, especially when the static level is very high. In order to investigate further this effect, an engineering party composed of men from the United Air Lines, the Bell Telephone Laboratories, the Bendix Corporation, and physicists from Purdue, Reed College and Oregon State undertook last year a comprehensive static survey in the Pacific Northwest. One of the conclusions of this survey is that much of the static is caused by the discharge of electricity from the trailing surfaces of the ship, i.e., from the tail and from the after edges of the wings. These experiments also suggested a very novel means of improving the signal, relative to the noise caused by this component of the static. This method consists of trailing a fine wire from the tail of the ship, the wire being supported at the end of a heavier wire about 50 ft. long. Between the fine wire and the heavy wire is placed an ordinary suppressor resistor, of the kind used to reduce ignition static. Because the radius of curvature on the small wire is smaller than that of any part of the plane, including the larger support wire, the greater part of the discharge takes place from the fine wire. The oscillatory currents arising from the discharge are prevented from re-entering the plane by the presence of the suppressor resistor.

Advances in Communication Equipment

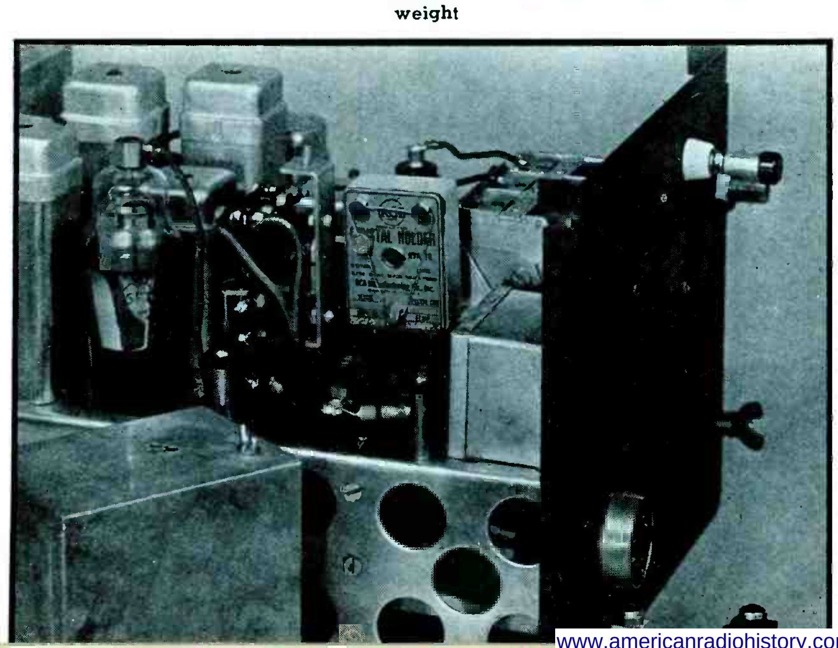
The transmission of messages to and from the plane, has been improved greatly in reliability. Part of this improvement is the result of increases in power, both in the plane transmitters and on the ground, which has effectively lowered the noise level. One manufacturer has offered a heating device equipped with a thermostat which maintains the interior of all radio cabinets at a constant temperature, thereby removing the cause of failure due to moisture collection. Very small and efficient transmitters, especially suitable for private planes, have been constructed with beam power tubes, acting as a crystal controlled oscillator and modulator.

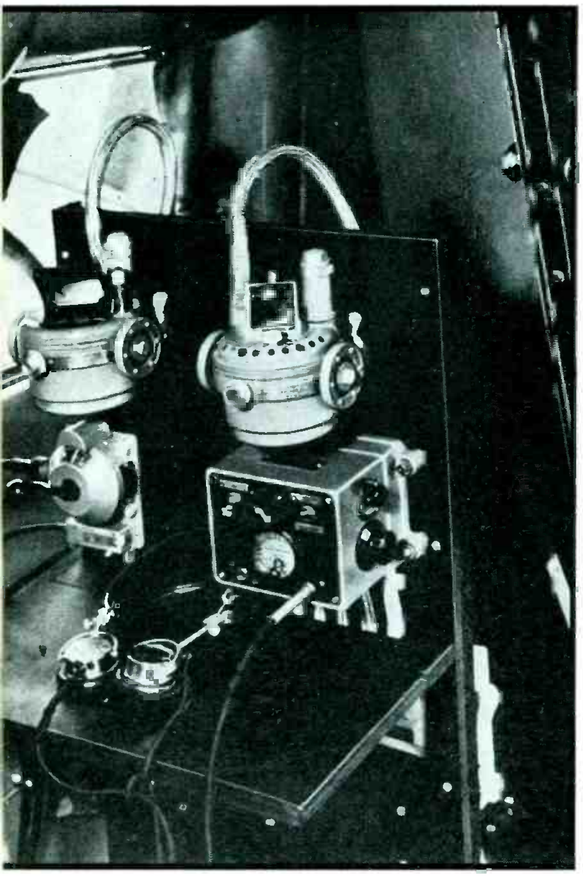
The shielded loop, now required equipment on all transport planes, reduces snow-static by allowing only the magnetic component of the incoming wave to affect the receiver. Note the insulation segment at the bottom of the loop housing

There is at present a division of opinion as to whether the rotating generator or the vibrator is the more desirable type of power supply. Most commercial transports also have an auxiliary battery supply, used for emergency purposes only.

Receivers are almost universally of the superheterodyne type, and many of the newer models have complete wavelength coverage from 150 kc. to 15,000 kc. While most all of the receivers provide a continuous tuning range from the lowest frequency to the highest, it is common to experience difficulty in setting the receiver directly on an assigned wave length above 2,000 kc. To aid in this adjustment, several manufacturers have offered receivers containing

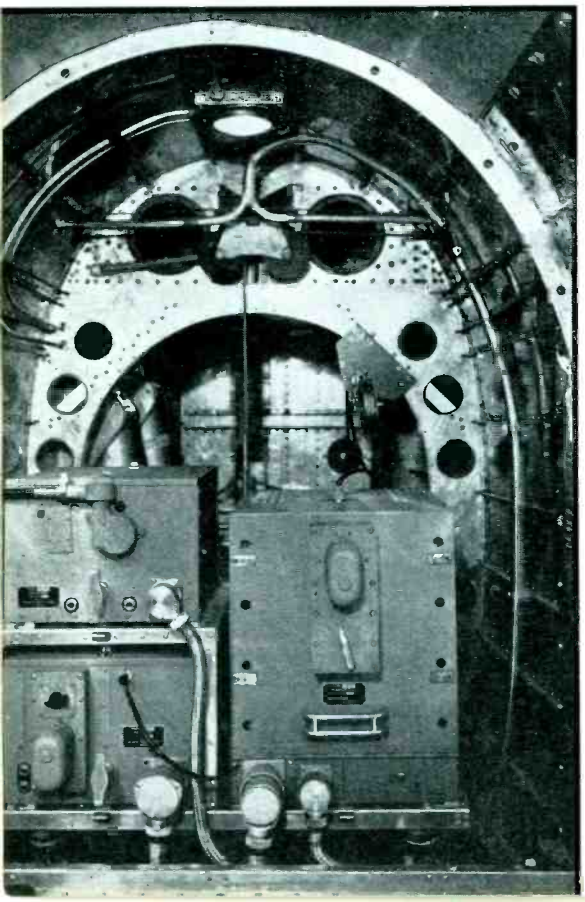
For easy tuning at high frequencies, aircraft receivers may be obtained with crystal controlled oscillators, one crystal being required for each desired frequency. Below is a typical RCA receiver chassis containing a crystal mounting. Note the holes cut from the chassis to reduce weight





Navigation position in American Airlines test plane, fitted with the L.M.T. rotating-loop compass. The motor-like objects are phase difference indicators which show the bearing of the incoming signal

Typical receiver and transmitting equipment. Bendix receivers (left) and transmitter installed in a Lockheed 14 plane



crystal controlled oscillators, which "lock-in" at certain pre-arranged frequencies, one crystal being necessary for each frequency desired.

On the border line between communication and the navigation radio service is the newly developed simultaneous radio-range and weather reporting stations which transmit beam signals and voice at the same time. Formerly it was customary to silence the radio range signals during the broadcast of weather reports, since the weather broadcast stations and radio range stations are assigned to the same frequency in any given locality. To enable the radio range system to operate continuously, the radio range carrier is modulated at 1,020 cycles. On the same carrier voice modulation frequencies from 50 to 4,000 cycles (except between 830 and 1,252 cycles which are suppressed by means of a filter) are transmitted. The removal of this band of frequencies from the voice does not seriously interfere with its intelligibility. In the plane's receiver filters are also required to separate the voice from the radio range. Filters for this purpose have been developed in exceedingly small size, weighing only 3¼ lb. and mounted in a box 2½ x 3¼ x 5 inches. With a switch having three positions, it is quite possible to direct the range signals to one pair of headphones and the weather signals to another, so that the co-pilot may keep tabs on the weather, while the pilot is following the beam.

The major airports of the country are now equipped with airport traffic control stations, operating on 278 kc., which contact each radio-equipped plane as it comes within the vicinity of the airport and directs its movements thereafter. Several ultra-high frequency channels have been reserved for this service, since it is essentially a local service in which ultra-high frequencies could be used with maximum freedom from interference effects. These channels are located in the range between 126 and 132 mc. Still other frequencies at 33.42, 35.8, 37.86 and 39.06 mc. have been reserved for local service in instructing student pilots during their first solo flights.

Radio Aids to Air Navigation

Foremost among the navigation facilities now in use in this country is the radio range beacon system operated by the Bureau of Air Commerce. Each radio range station transmits directional signals along four courses, two of which are along the regular airway, the other two being for cross airway flying, or in rare cases to mark intersecting airways. In two opposite quadrants the signal A is sent by a directional antenna system, while in the remaining quadrants the signal N is transmitted. At the boundaries between the quadrants the A and N signals synchronize to produce a continuous tone, which is used by the pilot as a guide.

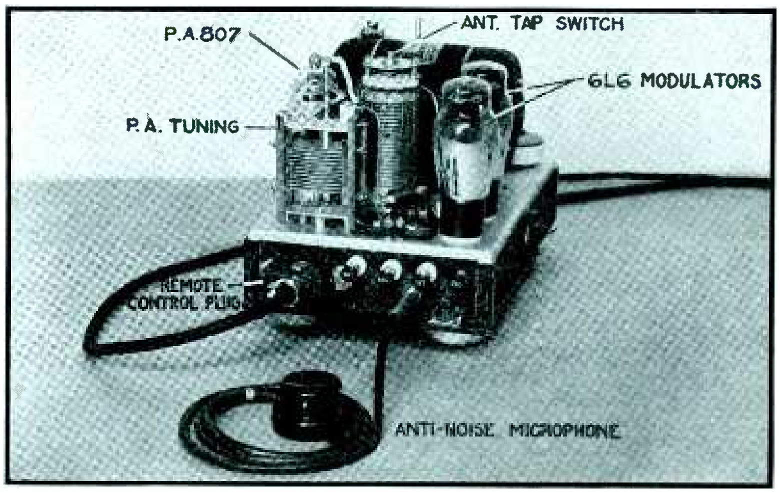
Following the beam, the pilot hears the continuous tone of the beacon until he is immediately over the towers of the station. At this point the signal suddenly ceases for a short interval, while the plane is traveling in the so-called "cone-of-silence" directly over the towers. This silent region is used to determine the exact position of the plane relative to the airport. One of the difficulties of this mode of operation is the fact that silence is a negative indication and may be occasioned by momentary failure in either transmitter or receiver, thus producing a false cone-of-silence indication. To guard against this, the Bureau of Air Commerce is installing a number of ultra-high frequency beacon stations called "cone-of-silence markers", which are intended to give a definite indication to the pilot when he passes over the towers of the radio range station. These marker transmitters operate on 75 megacycles with an output power of 5 watts and emit a continuous modulated signal of 3,000 cycles.

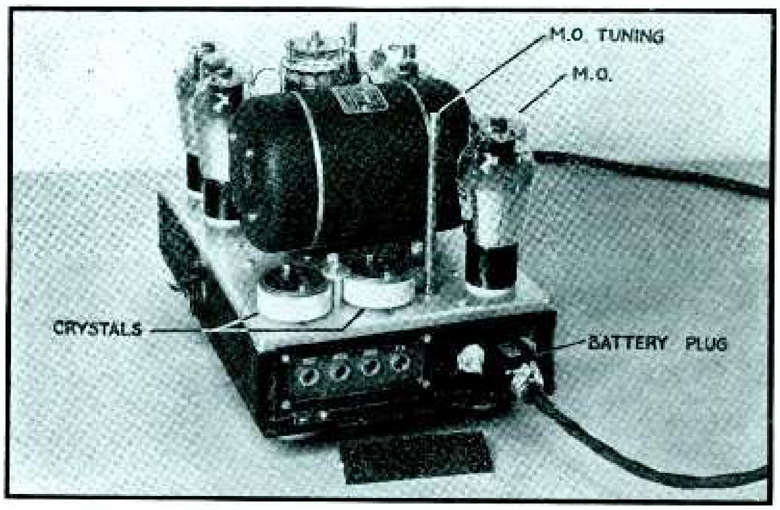
Another type of ultra-high frequency marker is used between radio range stations and at the edges of airports. This is a so-called "curtain" type operating like the cone-of-silence marker on 75 megacycles but with 100-watt power. The antenna of this type of marker consists of four half-wave radiators arranged horizontally end to end in the direction of the radio range course. All of these radiators are fed in phase, by the use of quarter-wave lines, producing a signal having a fan-like or curtain shape. The plane of the fan is at right angles to the radio range course, and extends about 12 miles wide at 3,000 ft. altitude and about 3 miles thick. The receiver produces both an oral and visual indication when the plane passes through the curtain.

In addition to these navigation radio facilities along the airways a considerable development is now under way to improve the navigational facilities directly at the airport. Since 1933 much effort has been directed toward the development of a fool-proof "blind-landing" system. A modification of the original Bureau of Standards system, developed by the Lorenz Co., in Germany, and demonstrated at the Indianapolis airport last summer, consists of a transmitter feeding a half-wave vertical radiator with 500 watts at 33.3 megacycles. On either side of this half-wave radiator are two unenergized di-poles with shorting relays, keyed with the A and N signals, at the center of each. The pilot picks up the main beam and proceeds toward the airport following the continuous signal. At 10,000 ft. from the airport a separate channel in the same receiver picks up a signal on 38 megacycles which is being directed vertically from the ground by a 5-watt transmitter modulated at 700 cycles. Through a rectifier and relay system, the signal actuates a lamp on the dashboard indicating to the pilot that he is on the beam and 2 miles from the edge of the airport. The pilot then begins to lose altitude at a fixed rate. By the time he reaches the edge of the airport he is about 50 ft. from the surface of the ground. At the edge of the airport another marker transmitter supplies him with a 38-megacycle signal but modulated at 1,700 cycles which operates through a filter rectifier relay to flash another lamp on the dashboard. The pilot then is ready to commence the glide to the surface of the airport proper. He may perform this glide in one of two fashions. In the first, he simply loses altitude, with the ship held in landing position, until the ground is visible or until the wheels strike ground. In the other, the pilot follows indications of a volume indicator on the receiver, which is set to indicate a definite level of signal strength. The beam transmitted by the 500-watt transmitter is so arranged that a locus of constant signal strength is set up along the beam, the locus coming close to the ground as the plane nears the transmitter. The pilot, by following this locus of constant signal strength on the volume indicator meter can perform a glide to the ground entirely without reference to ground itself. To guard against failure in the system, due to changes in transmitter power or receiver sensitivity, each transmitter is carefully monitored, and the signals are brought to a central monitoring panel in the control tower of the airport from which the radio control operator may inform the pilot if any part of the system fails to function.

Still more recent experiments in blind landing systems have been performed by the National Bureau of Standards. One such experiment is an ultra high frequency antenna operating underground in the center of the airport which is capable of establishing a satisfactory landing beam. One of the first installations of blind landing intended for commercial test purposes is that installed at the Pittsburgh Airport by the Washington Institute of Technology. The eventual aim of this development is the coupling of the receiver relays to the automatic gyro pilot, so that a landing can be made completely automatically, with no attention except the supervision by the pilot.

The directional aspects of these facilities are controlled from the ground. It is also possible, of course, to install in the plane a direction-finding system which will allow the pilot to perform calculations based on triangulation taken with the aid of a loop antenna. This system has been widely used by the private flyer, and a considerable number of aircraft direction finders have been sold to this class of pilot. Receivers used tune not only to regulation aircraft frequencies, but also to the broadcast band so that with proper pre-

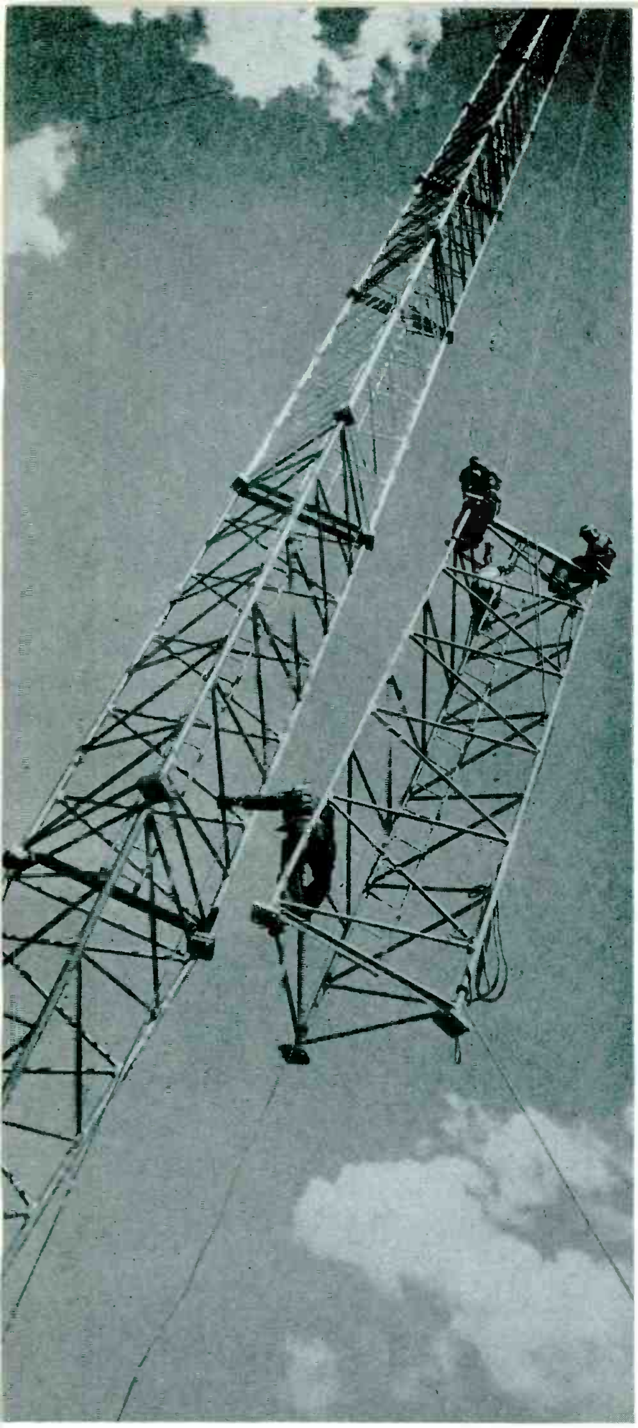


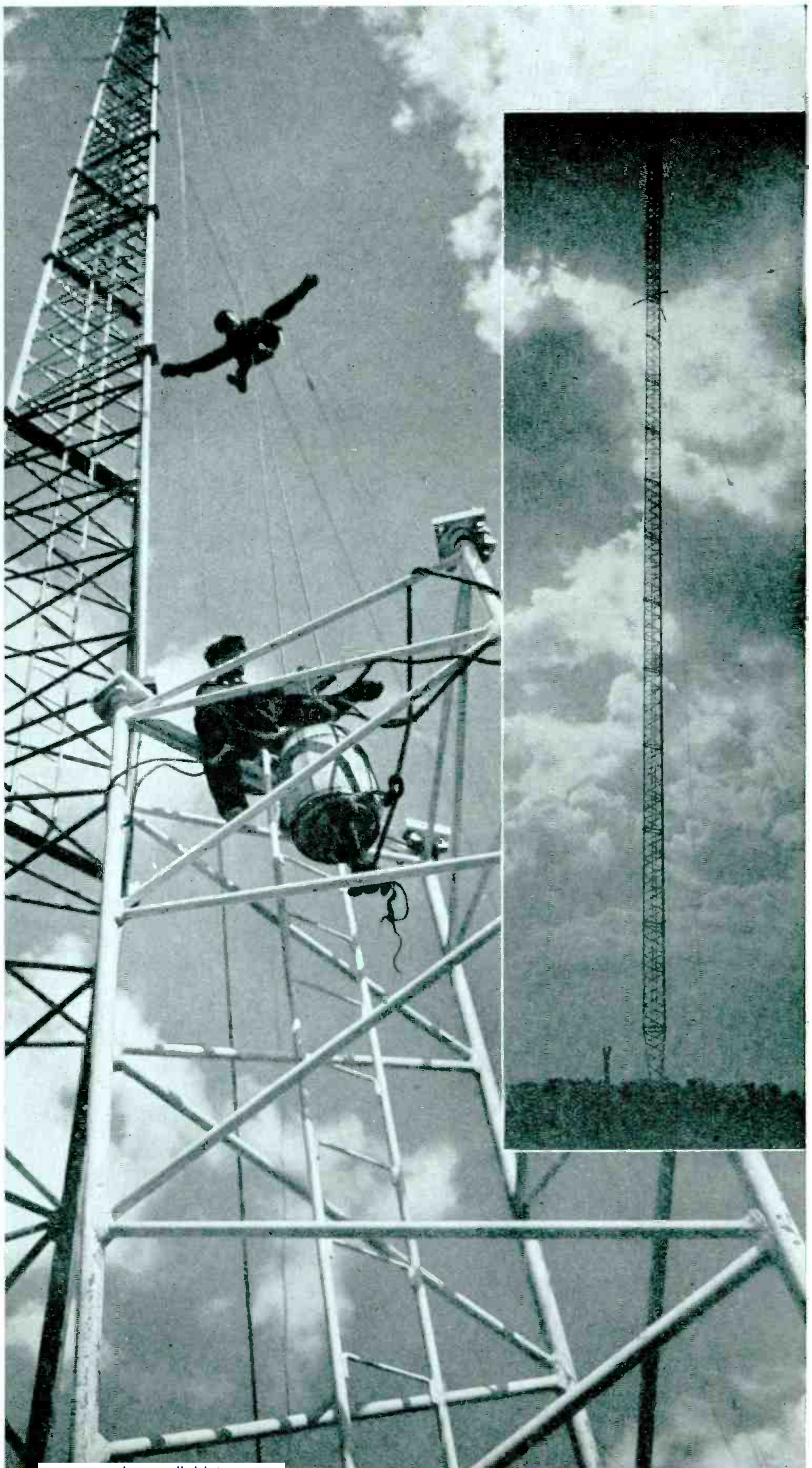


Compact and completely self-contained, this Lear transmitter employs beam power tubes throughout, has a generator type power supply unit mounted between the master oscillator and the modulator and amplifier tubes

(*Continued on page* 52)

KDKA's New Antenna Reaches





ABOVE

Section by section the tower rose in height. One of the steel sections on the way up guided, and rode, by riggers

RIGHT

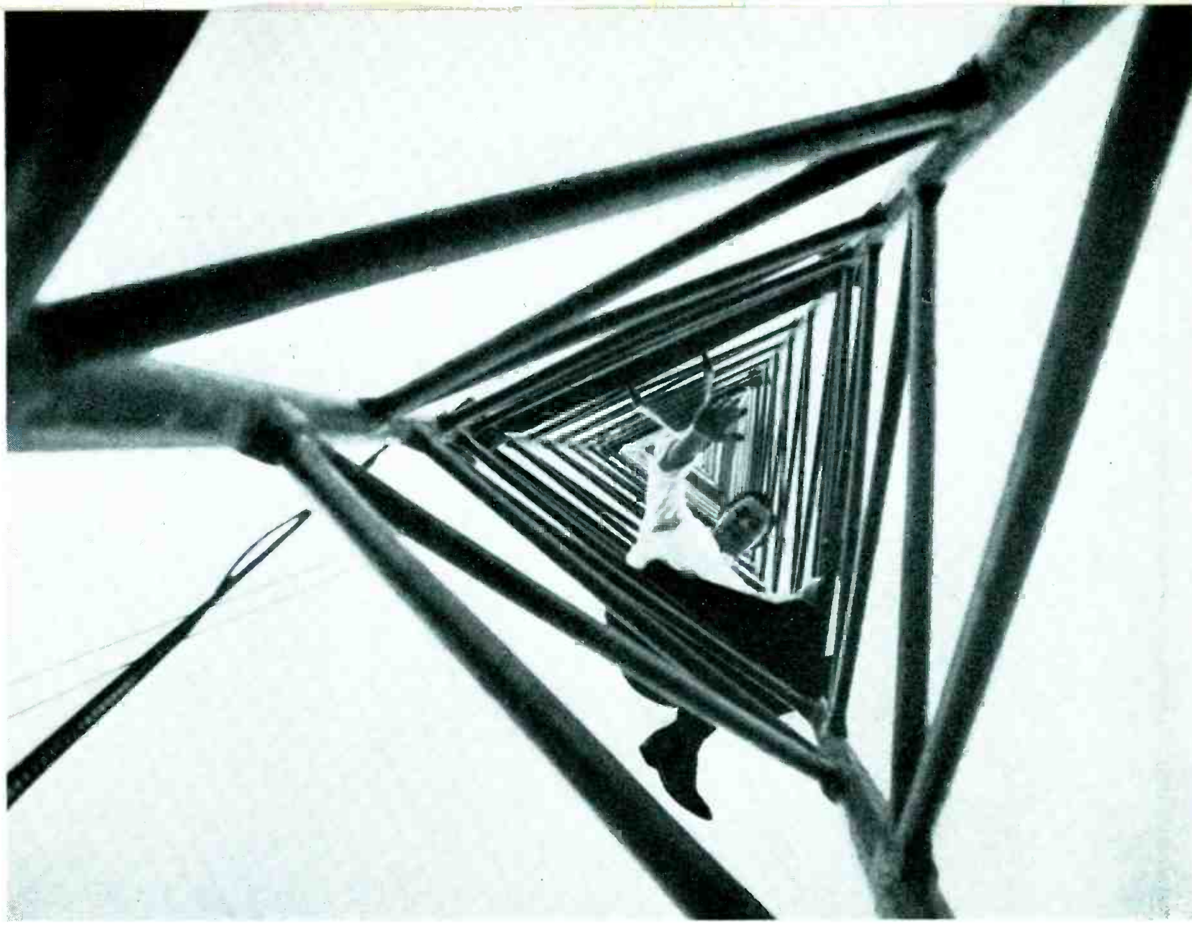
When the individual sections were raised, steel riggers rode with them, each day going higher until the tower reached 710 feet

INSERT

The antenna about one-third its finished height. At the top are the steel riggers and the wooden boom used to raise sections of the tower for

the

Clouds

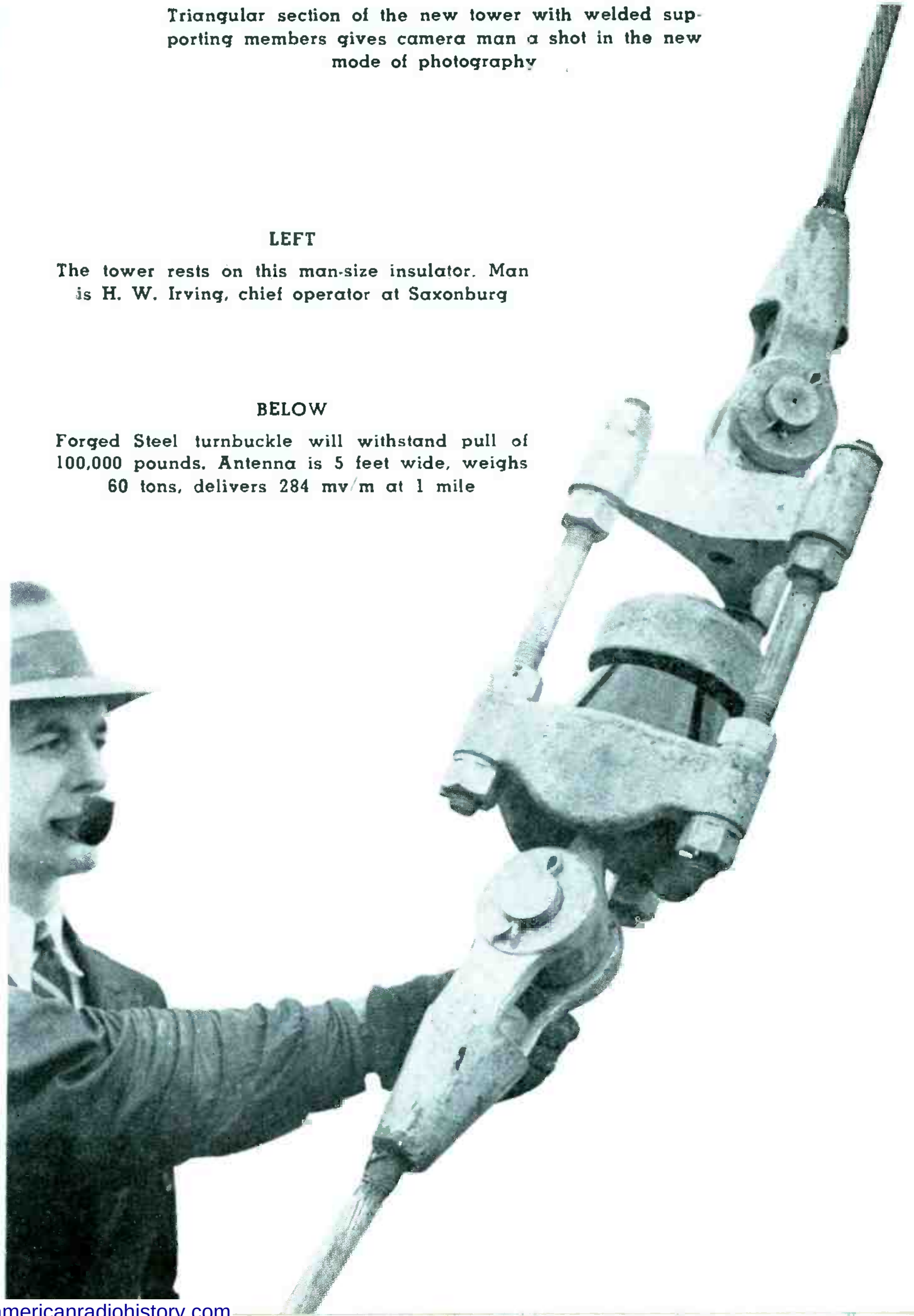


ABOVE

Triangular section of the new tower with welded supporting members gives camera man a shot in the new mode of photography

LEFT

The tower rests on this man-size insulator. Man is H. W. Irving, chief operator at Saxonburg



BELOW

Forged Steel turnbuckle will withstand pull of 100,000 pounds. Antenna is 5 feet wide, weighs 60 tons, delivers 284 mv/m at 1 mile

Time Delay in Resistance–Capacity Circuits

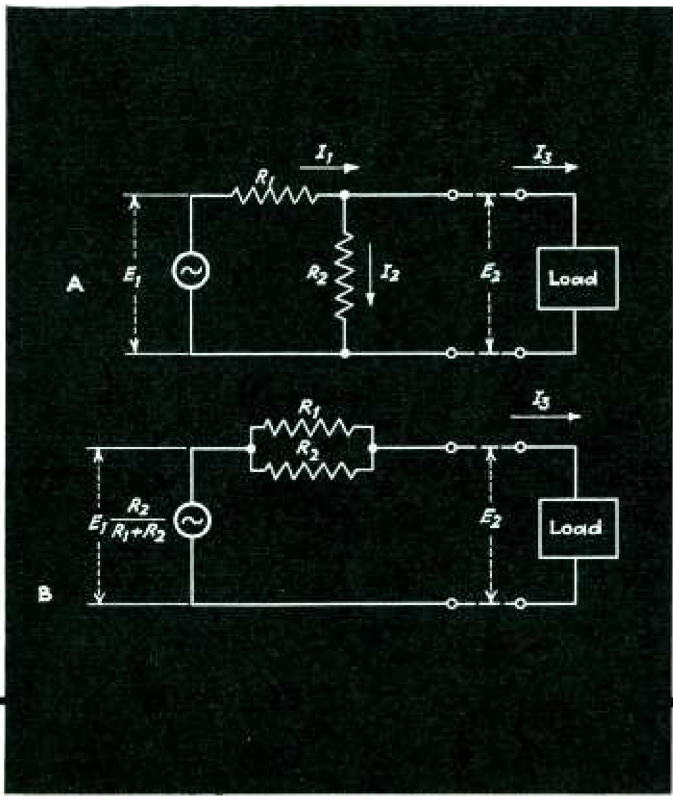


Fig. 7. Loaded supply circuit (A) and its equivalent (B)

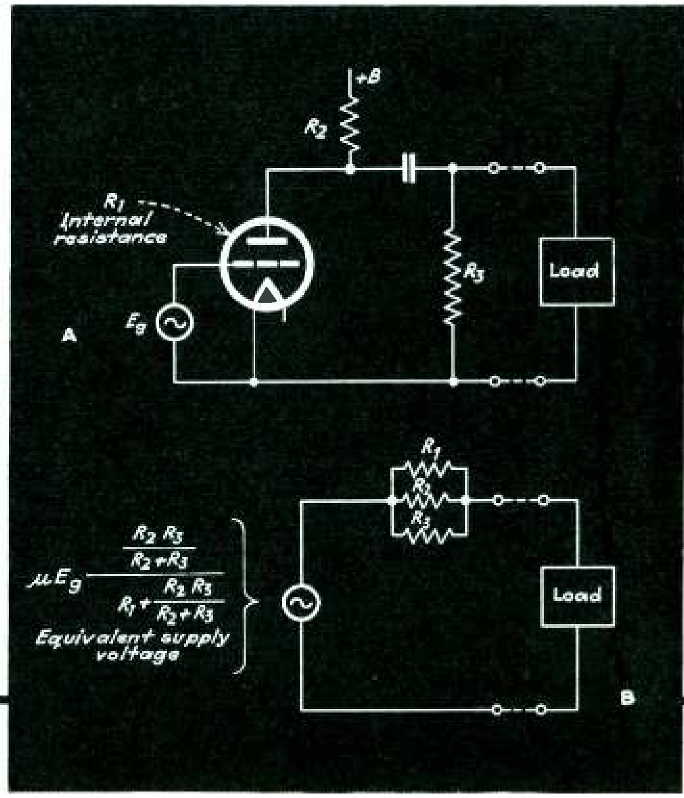


Fig. 8. Loaded tube circuit (A) and its equivalent (B)

By E. W. KELLOGG and W. D. PHELPS

Research Department RCA Manufacturing Co. Camden, N. J.

IN THE February 1937 issue of *Electronics*, the authors presented exact formulas and approximations for determining the net timing of circuits comprising two stages of resistance-capacity filtering. Curves were given showing the characteristic rise and fall of voltage at the output terminals in response to a sudden change at the input.

The principal application of such filters is in conjunction with rectifiers, where the purpose is to obtain a current proportional to the envelope or rectified value of a current of higher frequency. The most common case is the detection or demodulation of a radio frequency carrier, but in this instance the problem of filtering out the carrier without appreciably distorting the audio frequency waves is generally made comparatively easy by the large ratio of carrier to modulation frequency.

In practically all of these applications, the rectifier, with comparatively low conducting resistance, charges a condenser. When the modulation falls, the rectifier resistance is practically infinite for reverse current. Thus the speed of response of the system must be separately calculated for charge and discharge.

If the rectifier impedance may be assumed to be infinite during the discharge period, the circuit is simple and its timing easy to calculate. When the rectifier is conducting a number of circuit elements enter into the net charging resistance. For simplicity, the rectifier and its associated circuit may be represented by means of equivalent circuits. Before attempting to show the circuit equivalents for rectifiers, it will be well to establish some general relations in accordance with which some simplified equivalents may be drawn.

For estimating the time constant of a condenser which is being charged through some supply circuit, or for making calculations involving power transfer from one circuit to another, the impedance of both circuits as measured from the connecting terminals, must be known. This may call for arbitrarily separating the entire network into two parts, one of which is considered to be the load or receiving, and the other, the supply circuit. Frequently the supply circuit will then consist of the branch from which the power comes, plus one or more others which are loads across the actual supply branch. For example if a tube is supplying audio frequency power, it may be loaded by a plate resistor, or other impedance, but the entire combination constitutes the supply circuit furnishing power to the load. Under such conditions the impedance of the circuit is that of all of the branches in multiple, regardless of which are in fact supplying and which are absorbing power. This assumes that such passive branches have impressed across them the full voltage developed across the terminals of the active branch.

In Fig. 7-A the total current I_1 will be $I_3 + \frac{E_2}{R_2}$ and total supplied voltage

$$E_1 = E_2 + I_1R_1 = E_2 + \left(\frac{E_2}{R_2}\right) R + I_3R_1$$

whence $E_2\left(1 + \frac{R_1}{R_2}\right) = E_1 - I_3R_1$

or

$$E_2 = \frac{E_1}{1+\frac{R_1}{R_2}} - I_3\frac{R_1}{1+\frac{R_1}{R_2}} = \frac{E_1R_2}{R_2+R_1} - I_3\frac{R_2R_1}{R_2+R_1} \quad (1)$$

These equations indicate that the voltage E_2 across the terminals of the supply circuit is the same as would result from supplying a voltage $\frac{E_1R_2}{R_1+R_2}$ through a resistance $\frac{R_2R_1}{R_2+R_1}$ as shown in Fig. 7-B.

It is obvious that a third resistance can be added in similar manner, or that the same principle can be extended to as many branches as desired. Thus a vacuum tube with plate resistor and with a loading resistance such as shown in Fig. 8-A would have the impedance corresponding to all three resistances in multiple as indicated in Fig. 8-B.

Making use of the foregoing principle, the driving tube plate resistance R_p and plate supply resistance R_b may be combined with a single resistance R_1. With this simplification the resistance coupled rectifier in Fig. 9-A, may be represented by Fig. 9-B.

For an approximate analysis of the action of the circuit shown in Fig. 9-B, it seems simplest to assume that the impressed voltage and current are square waves. We shall make the further assumption that the reactance of the blocking condenser is zero, and the capacity C is so large as to have negligible reactance. For working out the voltage and current relations it is necessary to consider only what happens during one or two cycles, at any stage of the operation of charging the condenser. If, as is usually the case, a large number of cycles are required to charge the condenser, the back e.m.f. during such a small interval will be substantially constant. The voltage across the condenser at the time under consideration is designated by E_3.

Assuming a voltage E_3 across the condenser and a d.c. charging current

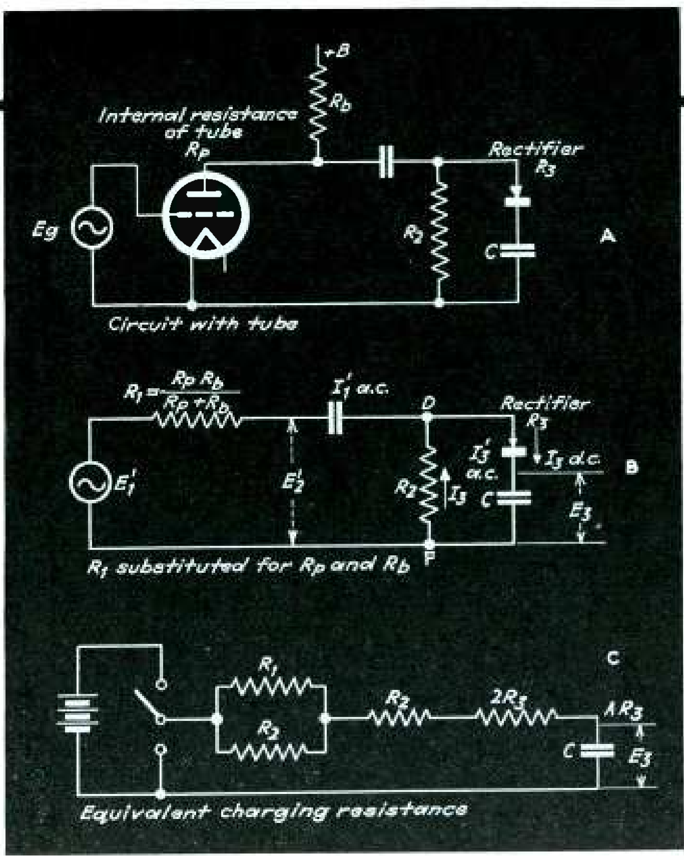


Fig. 9. Rectifier circuit and charging circuit of same impedance

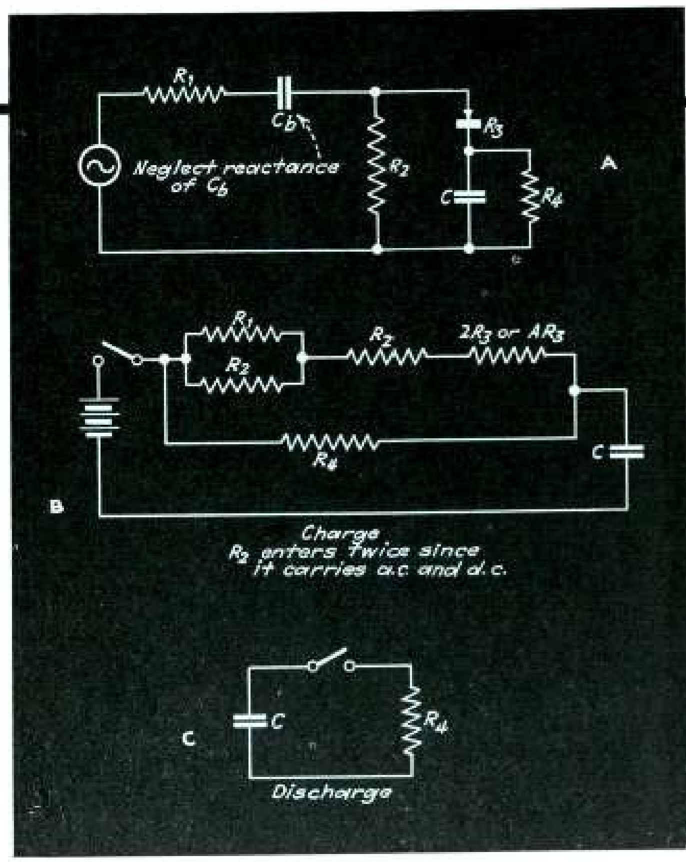


Fig. 10. Resistance-capacity coupled rectifier with condenser and discharge resistances

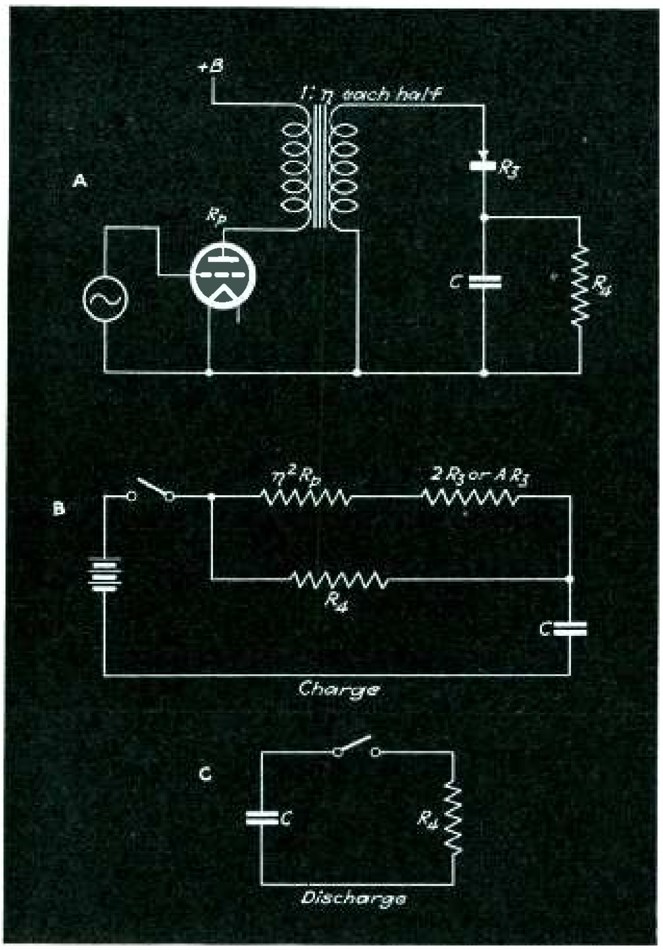


Fig. 12. Transformer coupled rectifier

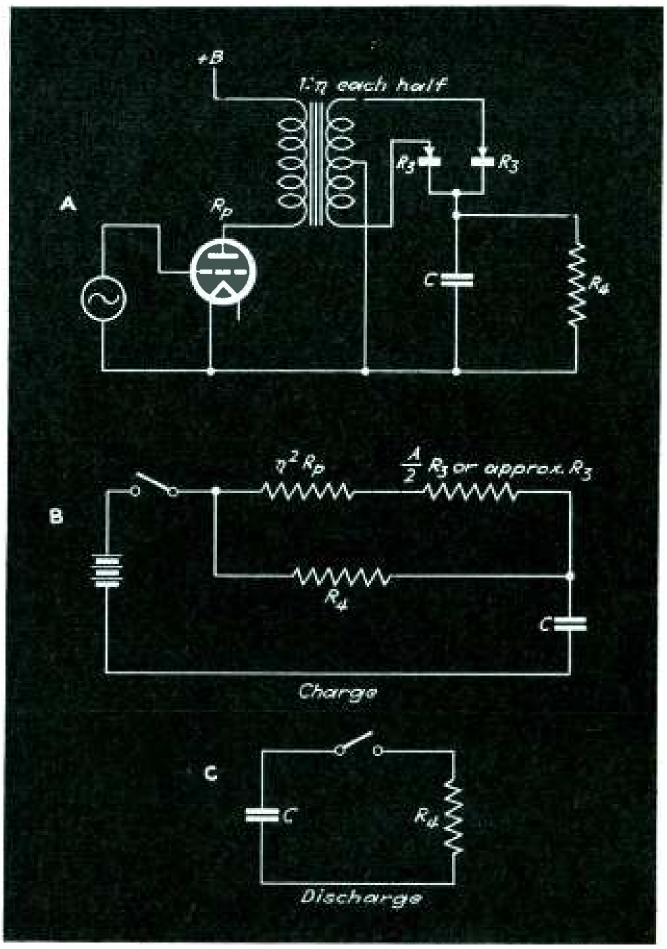


Fig. 13. Full wave rectifier

I_3 is being supplied, we can calculate the magnitude of the alternating voltage at the source, E_1, and the expression for the relationship between E_1, I_3 and E_3 will show the effective resistance of the circuit including the rectifier, through which the condenser is being charged.

The assumption of a square wave alternating current plus the condition that for a half cycle there is no current through the rectifier, means that the direct current I_3 and alternating current I_3 at this point are equal, giving a total current of $I_3 + I_3' = 2I_3$ for the positive half cycle, and $I_3 - I_3' = 0$ for the negative half cycle. While the current $2\,I_3$ is flowing through the rectifier the voltage across the rectifier and load C will be $E_3 + R_3 \times 2\,I_3$. The direct current, I_3, must return to the point D through the resistance R_2, and this requires that the point D be maintained at an average potential equal to I_3R_2 negative with respect to F, which voltage is built-up across the blocking condenser. The alternating voltage at the point D (referred to F) is determined from this average potential ($-I_3R_2$) and the maximum positive value $E_3 + 2\,I_3R_3$. The alternating voltage is therefore

$$E_2' = E_2 + 2I_3R_3 + I_3R_2 = E_3 + I_3\,(R_2 + 2R_3) \qquad (2)$$

In addition to the direct current I_3 which flows through R_2, the voltage E_2' will cause an alternating current E_2/R_2 through R_2. Then the total alternating current which the generator must supply will be

$$I_1' = I_3' + \frac{E_2'}{R_2} = I_3 + \frac{E_2'}{R_2} = I_3 + \frac{E_3 + I_3\,(R_2 + 2R_3)}{R_2} = \frac{E_3}{R_2} + I_3\left(1 + \frac{R_2 + 2R_3}{R_2}\right) \qquad (3)$$

The voltage which the generator must supply is

$$E_1' = E_2' + I_1'R_1 = E_3 + I_3(R_2 + 2R_3) + R_1\left\{\frac{E_3}{R_2} + I_3\left(1 + \frac{R_3 + 2R_3}{R_2}\right)\right\}$$
$$= E_3\left(1 + \frac{R_1}{R_2}\right) + I_3\left\{R_1 + \left(R_2 + 2R_3\right)\left(1 + \frac{R_1}{R_2}\right)\right\} \qquad (4)$$

or dividing by $1 + \frac{R_1}{R_2}$ and solving for E_3

$$E_3 = E_1'\frac{R_2}{R_1 + R_2} - I_3\left\{\frac{R_1R_2}{R_1 + R_2} + R_2 + 2R_3\right\} \qquad (5)$$

The effective supply circuit resistance is

$$\frac{R_1R_2}{R_1 + R_2} + R_2 + 2R_3$$

The equivalent circuit is shown in Fig. 9-C.

For determining the time constant of a condenser, charged through a resistor, it is usual to consider that the voltage applied to the resistor is suddenly changed from 0 to E_1 or vice versa. The equivalent assumption when a rectifier is included in the circuit is that the alternating voltage is suddenly changed from 0 to E_1 or vice versa. Since in circuit 9-B the rectifier does not appear as such, the condenser charging is to be calculated on the basis of a suddenly applied direct voltage, but it is evident from Fig. 9-A or B that the rectifier will prevent the condenser discharging through the same path. It is usual to provide a discharge resistance R_4 of Fig. 10.

The equivalent of Fig. 10-A is Fig. 10-B while the condenser is being charged. When the rectifier is inactive and the condenser is discharging the equivalent is simply the one discharge path R_4, indicated in Fig. 10-C.

Again for simplicity, assume a square wave of impressed voltage. During the positive half cycle the alternating and direct currents add, and since again they are equal, the current through the rectifier is $I_3 + I_3' = 2\,I_3$, and A is positive with respect to B by $E_3 + 2\,I_3R_3$. Since there can be no steady voltage difference between A and B, the negative swing of A must be the same as the positive swing, so that

$$E_2' = E_3 + 2I_3R_3 \ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

Since the choke takes no alternating current, the current through the blocking condenser is $I_1' = I_3' = I_3$. Then the generator must supply a voltage

$$E_1' = E_2' + I_1'R_1 = E_3 + 2\,I_3R_3 + I_1\,R_1$$
$$= E_3 + 2\,I_3R_3 + I_3R_1 = E_3 + I_3(R_1 + 2\,R_3) \ldots (7)$$

Again combining the discharge resistance R_4 with the net resistance during charge of the rectifier circuit, we have Fig. 11-B for the equivalent of Fig. 11-A during charge, while, as before, the discharge equivalent includes only R_4, as indicated in Fig. 11-C.

If the rectifier is fed through a transformer whose resistance to the flow of direct current in the secondary is negligible, the case is practically equivalent to that just considered, of a reactor and blocking condenser, except that if the transformer is of some ratio, instead of unity, the primary circuit resistance must be multiplied by n^2. The circuit and equivalents are illustrated in Fig. 12.

If a full wave rectifier is employed as indicated in Fig. 13, the factor 2 by which the rectifier resistance R_3 has been multiplied in the previous cases is omitted, since one or the other of the rectifiers is working for each half wave of the applied voltage.

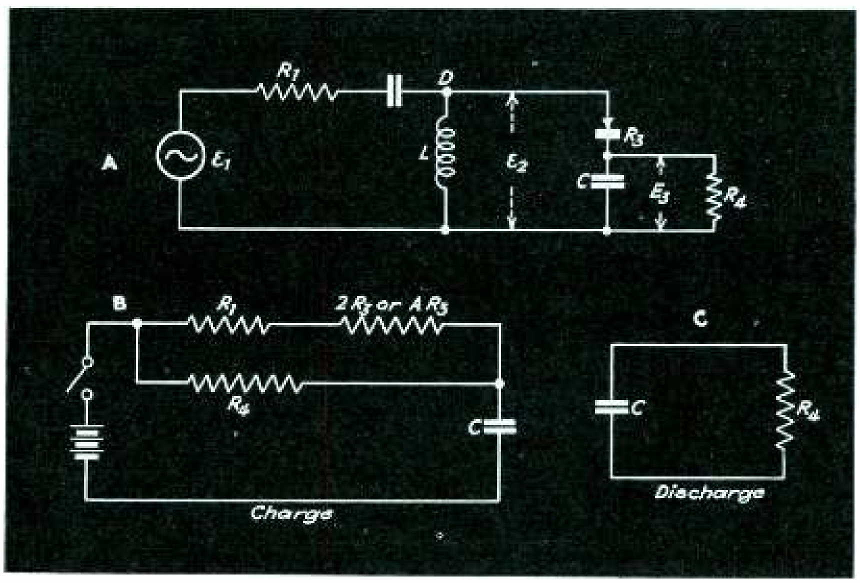


Fig. 11. Capacity coupled rectifier with inductance by-pass

In the foregoing, the assumption that the rectifier carries current half the time, resulted in the rectfier resistance being multiplied by 2 in the equivalent circuit. If the total rectified current must be passed in a smaller fraction of the time the momentary current must be higher and the voltage drop correspondingly greater. Therefore, as previously explained, the rectifier resistance is multiplied by a factor A which may be as low as 2 but is in general higher depending on what fraction of time conduction is taking place.

Correction

There is an error in sign in equation (11) of the article, "Time Lag in Resistance-Capacity Filters", by Kellogg and Phelps, in the February issue of Electronics. It should read

$$e_1 = 0.724E_\varepsilon^{-\frac{0.382\,t}{rc}} + 0.275E_\varepsilon^{-\frac{2.611}{rc}}$$

• • •

Cathode Ray Wave Form Distortion

[*Continued from page 19*]

As any periodic signal can be represented by a Fourier series of this type

$$H = A_o + \sum_{n=1}^{\infty} A_n \sin n\omega t \qquad (18)$$

any equation for the magnetic case can be obtained from the similar one for the electric case by merely replacing V_o/h by A_o and V_n/h by A_n.

The following general conclusions can be drawn regarding the response of a cathode ray tube at ultra high frequencies.

(1) The response of a cathode ray tube to a sinusoidal signal suffers only amplitude diminution as predicted by equation (9).

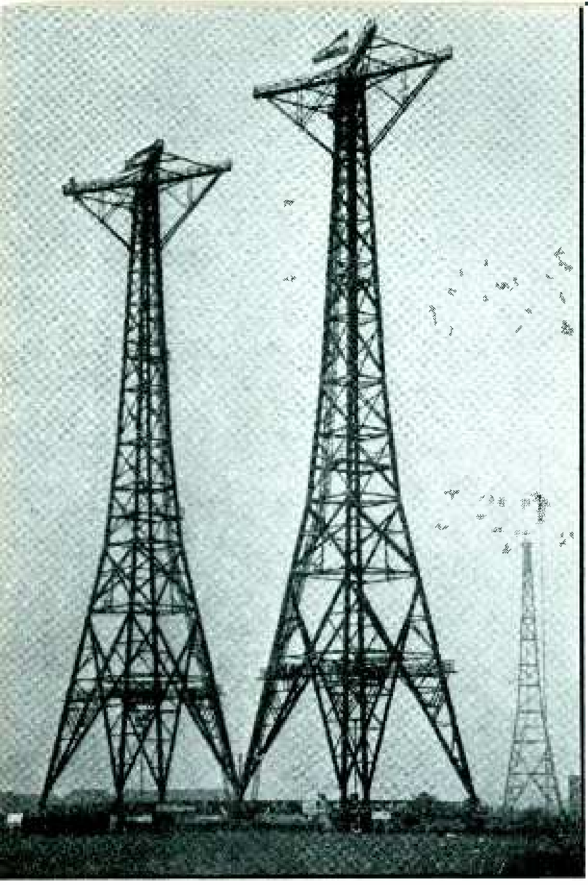
(2) The trace of a periodic signal containing harmonics of the fundamental suffers no phase distortion, although amplitude distortion exists.

(3) Each harmonic in a periodic signal suffer amplitude diminution as though it were sinusoidal signal of frequency $nf = n\omega 2\pi$.

(4) The response to a periodic signal of any wave form is zero provided $\omega a/2\sqrt{2E_2e/m} = \pi$ or some multiple thereof. The frequency of the fundamental is assumed to be $\omega/2\pi$.

(5) The response of a magnetically deflected cathode ray tube suffers the same amplitude diminutions of harmonic components of a periodic signal as does an electrically deflected one. Furthermore, the frequencies of zero responses are the same if the lengths of the deflecting fields and the beam velocities are the same.

[1] Libby, L. L.: Cathode Ray Tubes at Ultra High Frequencies; *Electronics* 15-17, Sept. 1936.



General view of the rotatable beam

Rotatable Antenna at PCJ

By D. J. FRUIN
Hilversum, Holland

RADIO Works, Eindhoven Holland, started the first short-wave broadcast. The 30 meter transmissions were specially intended for the Dutch Indies. The transmitter was an experimental device in the Philips Laboratory. It was shown that a reasonable reception was possible. In the beginning there were only occasional transmissions, but gradually the transmissions of PCJ grew into a regular service.

In the Indies special troubles were encountered, caused by exceptionally bad atmospheric conditions. So an increase in power of the transmitter was planned. The limits of possible power were rather narrow however. The bigger transmitter was moved from the Philips Laboratories to Huizen at the coast of the Zuiderzee. Soon the want of more power was felt again. The possibility of a beam aerial directed to the Indies was contemplated. But, then, it was found necessary to give transmissions for other Dutch speaking countries in the West Indies and South Africa. So the construction of a beam became the question of a great number of beams. A possibility was the construction of a moderate number of beams with rather wide angle of radiation thereby losing a great part of the effectiveness—or construction of a large number of beams with very narrow angle of radiation. The last solution was the best, but was found impossible on account of the enormous cost of the beams and the very large area necessary.

So a daring plan was contemplated—the erection of one very narrow rotatable beam. The entire mast structure had to be self-supporting and had to be mounted on a kind of turntable. An additional difficulty was the fact that the mast had to be constructed of wood so as not to spoil the directivity.

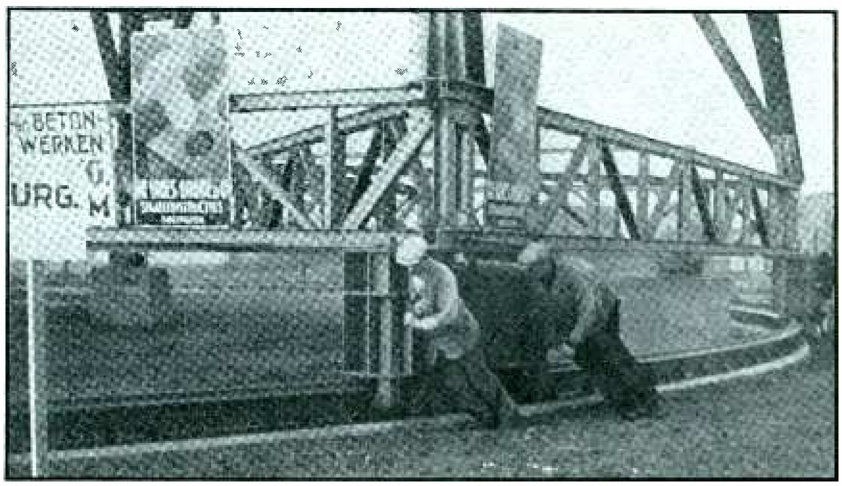
At last the constructional troubles were overcome and the antenna was erected. First a big circular foundation of concrete was laid, to a depth of 2.5 meters. In the foundation two circular rails were mounted with diameters of respectively 45 and 18 meters. In the center of the circle a very heavy vertical spindle was put into a concrete block of 20 cubic meters. This spindle is the center around which the structure rotates. The rails and the center can be seen in the illustration. Now a steel bridge weighing 95,000 kg. was laid across the rails and resting on 8 wheelcases. On each side of the bridge there are four wheelcases, two on the inner and two on the outer rail. On the bridge two square self supporting wood masts were erected. The distance of the feet is about 14 meters. The height is more than 60 meters. On the top of the masts is a cross with four arms consisting of four platforms on which a man can walk. From the tips of the platforms the antenna wires are suspended. Four antennae on one side are the transmitting wires and the other four are the reflectors. Strictly there are no antenna and reflector wires. To secure a very sharp directivity it was found desirable to feed the reflectors as well as the antenna wires. Thus there are 8 vertical antenna wires, each divided into three parts, each of which is a dipole and, therefore, there are 24 dipoles.

Beam is rotated until it aims radiation in the desired direction

The weight of the masts is 18,000 kg. each so the entire structure has a weight of 130,000 kg. It is calculated that in a storm the pressure on one foot of the tower can be 48,000 kg. To prevent the possibility of the wind blowing the structure down each wheelcase has two heavy steel clampings grasping the rails. In practice the antenna will be turned by a motor.

The beam has an angle of radiation of only 15 degrees giving an effective increase in power of 24 times or the equivalent of a non-directive aerial radiating a power of 1500 kw. The wave length is 16.88 meters.

Manpower will be replaced by a motor for moving the antenna



Single-unit Video Converter

A signal-to-sight transducer, incorporating all cathode ray tube circuits, ready to operate directly from the video output of a second detector. Unit separates sync signals, generates sweep voltages, amplifies them for electrostatic deflection, modulates grid, and provides power supply

By G. ROBERT MEZGER
Allen B. Dumont Laboratories, Inc. Upper Montclair, N. J.

DEVELOPMENTS of the past few years in television have gradually crystallized the design of television receiving equipment into a logical order which divides the unit into a number of chasses with a minimum of wires, particularly signal leads, running from one chassis to another. The demodulated video signal, coming from the low impedance output of the second detector, is in an ideal condition to be transferred from one chassis unit of the receiver to another. Transfer of the signal previous to detection is obviously impractical from an electrical standpoint and would mass a great amount of equipment on the final chassis. If the video signal were delivered to the cathode ray tube and sweep circuits subsequent to amplitude and frequency separation, separate leads to these circuits would be necessary for each synchronizing signal and for grid modulation.

The unit described here has been designed to operate in conjunction with video receivers in much the same manner that some type of electro-acoustic transducer, such as a loud speaker, is used in the development of audio receivers to accomplish the final translation from electrical to acoustic energy. With this view in mind, it has been designed to operate directly from the output of the second detector of the video receiver. The video signal then undergoes amplitude and frequency separation for synchronization and is at the same time carried to the grid modulating circuit of the cathode ray tube.

Amplifier Design

A complete circuit diagram of the video chassis is shown in Fig. 1. In the interest of simplicity the gas discharge type of sweep circuit is utilized. It has been found that this circuit synchronizes much more easily than a hard tube sweep circuit and it has the advantage that no wave form distorting circuits or transformers are necessary in order to obtain a sawtooth waveform. Linearity is preserved by charging the condenser C_1 from a high voltage source at essentially constant current through a high resistance consisting of R_4 and R_5. Only a small portion of the first part of the charging characteristic of the condenser, which is practically linear, is utilized by keeping the bias and therefore the output of the discharge tube small. Synchronizing is effected by applying a positive synchronizing pulse to the grid of the discharge tube. This pulse momentarily drops the bias of the tube and causes it to discharge slightly earlier than it would if it were running free. The effect of synchronization, then, is to slightly lower the bias on the discharge tube and thus reduce its output. This effect becomes immediately apparent when a synchronizing signal arrives at the grid of the discharge tube by causing a slight reduction in the pattern size on the cathode ray tube. The input circuit to the grid consists of a low resistance potentiometer R_1 and the resistance R_2 in series with the grid of the tube. The high resistance of R_2 serves to limit the peak positive signals which may be applied to the low impedance grid circuit of the discharge tube. The effect of this resistance is to cause high positive surges to be developed across itself rather than across the grid of the discharge tube which would drive the grid positive and reduce the output of the tube to zero.

The high impedance output of the discharge tube, which is essential to preserve linearity, imposes certain requirements upon the input circuit of the first amplifier stage in order that satisfactory linearity may be obtained. The time constant of C_2 and R_6 should be at least ten times the period of the signal which the amplifier is carrying. This requirement becomes most important in the low frequency sweep circuit where the period of the signal being amplified is relatively long. At the same time, the value of R_6 must not be too small in comparison with the value of the series combination of R_4 and R_5. If R_6 be too small in value, the feed current to the charging condenser C_1 will divide between C_1 and the shunt circuit to ground of C_2 and R_6 in series, which will cause the sawtooth wave to round off at the top. This will be evident on the screen of the cathode ray tube as a bright line on the right or bottom sides of the raster (line-pattern), which is due to the delay of the beam in slowly following the rounded top of the sawtooth wave. Distortion will also be caused at the input to the first amplifier tube by excessive capacitance to ground. Due to the high impedance of this circuit, it is not possible to use a capacitive voltage dividing network in shunt with the potentiometer R_6, since the impedance of such a network would place an excessive load upon the plate circuit of the discharge tube. Therefore, in order to reduce frequency discrimination with voltage division along this high resistance potentiometer, the shunt capacitance of the circuit must be at an absolute minimum. It was found that one source of such trouble was the capacity of the potentiometer element to its case. Removal of the front plate on the unit disconnected the shell from ground and intro-

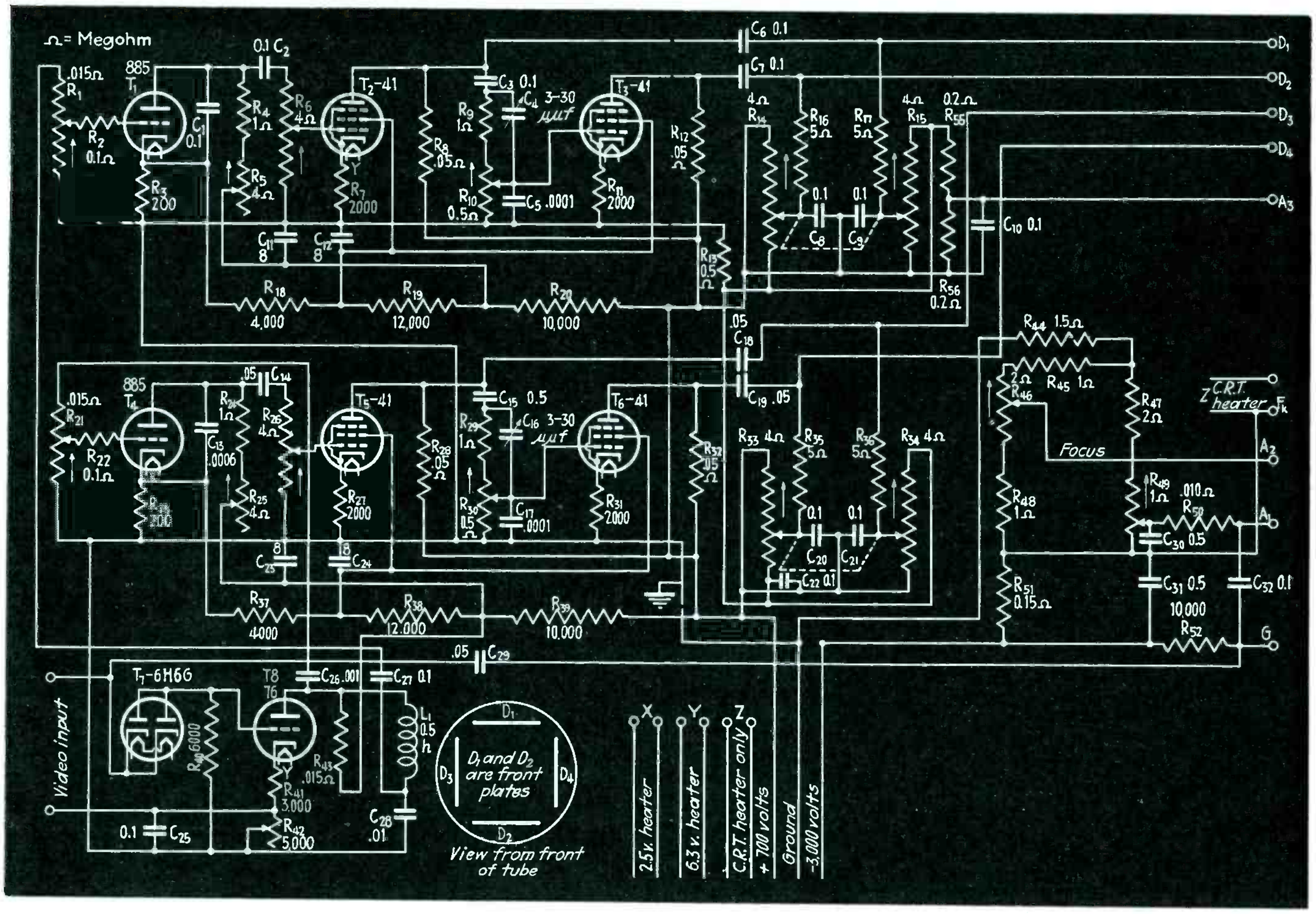


Fig. 1—Complete circuit diagram of the converter, except power supply

duced comparatively small series capacitance to ground which aided materially in reducing the return trace time of the sweep circuit.

Up to the grid of the first amplifier tube, stray circuit elements are most important in preserving a true sawtooth wave, due to the required high impedance of the circuits. The first amplifier tube offers the first place to change to a low impedance circuit to minimize these difficulties, and for this reason a comparatively small plate resistor is used in this and the following stage.

Push-pull deflection of the cathode ray tube, at the high second-anode voltages used on cathode ray tubes for television work, is imperative for two reasons. As the second anode voltage of the cathode ray tube is increased, the "stiffness" of the beam increases so that a higher voltage must be applied to the deflection plates to obtain full scale deflection. Since low impedance amplifier circuits must be used for linear amplification of the sawtooth wave, it is desirable to use the lowest possible plate supply voltage in order that tube life may be maintained and power supply cost kept at a minimum. Push-pull amplification will permit twice the deflection voltage obtainable from single-ended amplification at a given plate supply voltage. In addition, both deflection plates of the cathode ray tube will vary reciprocally in potential, which will cause both plates to be at a constant average voltage with respect to the final anode. When using single-ended amplification with one deflection plate tied to ground, and when the high voltages necessary for full-scale deflection with high final anode voltages are applied, the free deflection plate must vary so far in potential from the fixed one to obtain the necessary deflection that it begins to operate as part of the electron gun. As the beam then approaches the end of its sweep it becomes more and more defocused. With push-pull amplification it is possible to retain satisfactory focus over the entire screen area at even the highest second anode voltages.

The push-pull circuit, as shown in Fig. 1, obtains its signal 180 deg. out of phase, at the grid of the second push-pull amplifier, from a voltage dividing network across the output of the first stage. Tubes T_1 and T_3 thus supply push-pull voltage to the deflecting plates. The network between tubes uses the resistance divider R_9, R_{10} for division of the low frequency, "forward" portion of the sweep, and the capacitance divider C_4, C_5 for division of the high-frequency portion of the signal, which is composed mainly of the return trace. R_9 and R_{10} are designed to total to a high resistance in order to reduce the loading of the plate circuit of the first stage, and they are proportioned to deliver $1/\mu$ of the plate signal of the first stage to the grid of the identically designed second stage. For proper division of the high frequencies across this high resistance combination, the capacitance C_4 is chosen in value to be just enough larger than stray circuit values that the condenser may gain control of the voltage division. C_5 is then made μ times the middle-range value of C_4. When these circuit elements are all properly proportioned, a signal of exactly the same amplitude and wave shape but 180 deg. in phase from that on the grid of the first stage (T_2) should appear on the grid of the second stage (T_3).

Electrostatic Deflection

The amplifiers are connected to the cathode ray tube in the manner found in all electrostatic deflection type oscillographs. The only precaution necessary is that the deflection plate decoupling resistors, R_{16} and R_{17} be large enough that the time constant of the deflection plate coupling circuit will not be too short for the signal applied. Electrostatic deflection of the cathode ray tube was chosen here in the interests of simplicity. It has been found simpler to generate and amplify a pure sawtooth wave for electrostatic deflection than to provide the distorted wave necessary for magnetic deflecting coils.

Separation of Synchronizing Pulses

The synchronizing signal separator, as shown in Fig. 1, consists of a diode T_7 which is biased to pick off the synchronizing peaks and a triode T_8 to provide phase reversal of these peaks for positive signal synchronization of the discharge tubes. In addition the triode provides a small amount of amplification which may be useful in synchronizing the sweep circuits at low signal levels. In order that this unit may be used with any phase of synchronizing pulse which may be transmitted, the input to the synchronizing signal separator is taken from the same signal that is applied to the grid of the cathode ray tube. Since in all instances the synchronizing signal must be negative at this point in order to blank out the return trace, a signal of this phase will always be available to operate upon for synchronization signal selection regardless of the particular type of transmission in use.

The operation of the synchronizing signal separator directly from the diode detector as used in this unit has resulted from an attempt to eliminate all coupling condensers between the demodulated video signal source and the amplitude separator. Previous experiments with separators such as the positive grid triode type have all resulted in the coupling condenser between the video signal source and the amplitude separator assuming a charge in direct proportion to the average picture modulation. This slowly varying charge caused the amplitude separation level to shift with picture content and introduced video frequency synchronization into the high frequency synchronizing circuit causing the vertical sides of the picture to vary in shape with the transmitted signal. The direct coupling method used in this circuit together with the diode amplitude separator eliminates this trouble and permits separation entirely independent of the average picture content of the video signal.

The bias for the diode amplitude separator is obtained from the drop across R_{42} caused by the cathode current of the triode amplifier and phase inverter. This bias puts the plate of the diode negative with respect to the cathode so that no signal is passed until the cathode reaches a minimum negative peak corresponding to the amplitude of the synchronizing pulse. Voltages above this negative peak are amplified, changed in phase by the triode stage, and then fed to the frequency discriminating network which separates the high from the low frequency pulses. A small inductance L_1 blocks the high frequency pulses to the synchronizing circuit of the low frequency sweep. Condenser C_{28} is provided to by-pass and high frequency surges from the grid circuit. A small condenser, C_{26}, couples the high frequency synchronizing pulses into the grid circuit of the high frequency discharge tube.

It is to be noted that the video signal must be supplied to this unit from a source of low impedance and that the source must be continuous for d.c. in order that a return path be provided for the diode plate current. Such a source is found in the diode second detector of a video receiver, and with the cathode ray tubes available at the present time it is possible to obtain sufficient modulating voltage from the second detector to fully modulate the cathode ray tube.

Modulation of Cathode Ray Tube

It might seem at first thought that the problem of modulating the cathode ray tube directly from the second detector is a definite limitation to this unit. The only real reason for this requirement is that a d-c return path must be provided for the diode plate current. Should it be necessary to supply the video signal from some other type of signal circuit, such as the plate circuit of a video amplifier, a return path may be provided for the diode by adding a resistor across the video input. This has the disadvantage that it introduces capacitive coupling and places an additional load upon the video signal supply. Should it become necessary to supply more modulating

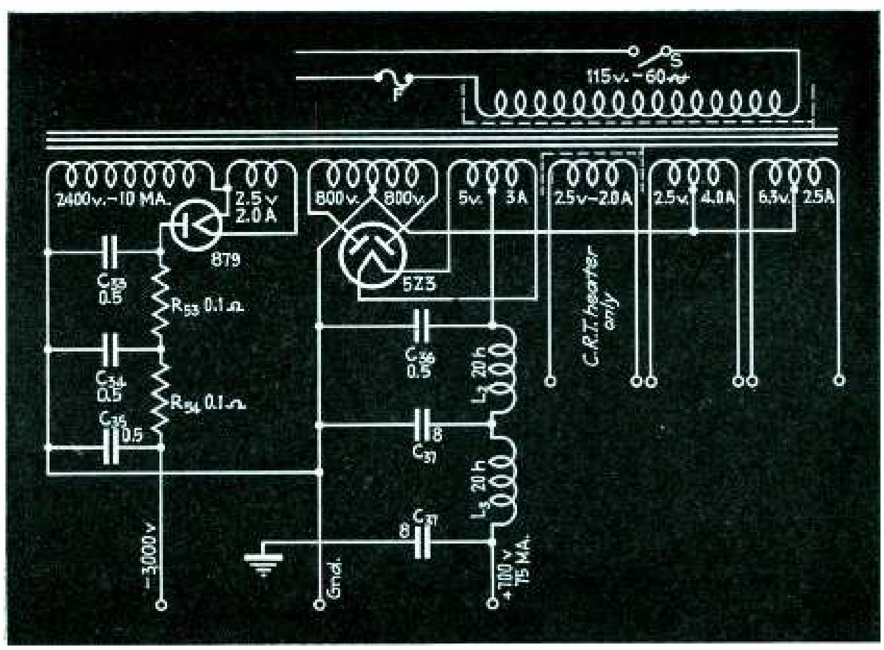


Fig. 2—High and low voltage power supply

voltage, a stage of video amplification may be inserted between the second detector and the video input to this unit.

The modulating signal for the cathode ray tube is taken from the same point that feeds the diode synchronizing signal separator as discussed above. The condenser C_{29} must have a voltage rating sufficient to withstand the full high voltage power supply voltage, for the positive of this power supply is grounded in order that four expensive high voltage coupling condensers will not be necessary to provide connection between the deflection plates and the deflection amplifiers. It will be noted that both the grid and the first anode of the cathode ray tube are modulated. This modulating method, together with proper cathode ray tube design, tends to keep the spot in focus over large changes in modulating voltage.

Positioning and Power Supply Circuits

For the same reason that push-pull deflection of the cathode ray tube was employed to eliminate defocusing at the edges of the raster, a balanced positioning arrangement has been used for centering the pattern on the screen. The dual potentiometer, R_{14}, R_{15}, applies positioning voltage simultaneously to the two deflection plates, driving one positive while the other becomes more negative. As a result, only half the voltage difference between the final anode and the two deflection plates is necessary for a given deflection as would be required for positioning by varying only one plate with the other fixed at the d-c final anode potential. The final anode of the cathode ray tube is kept at the mean d-c potential of the reflection plates by the voltage dividing network R_{55} and R_{56}. Positioning voltage will be required to compensate only for the earth's magnetic field and for slight misalignment of the gun in the blank of the cathode ray tube. For this reason, the deflection plates must deviate only slightly at d-c from the final anode voltage, and it will be satisfactory to supply only a small range of positioning voltage of the order of two to three hundred volts. The small deviation from the final anode voltage and the balanced positioning used in this unit, together with the symmetrical deflection employed, all tend to retain the electron beam in uniform focus over the entire screen area of the cathode ray tube.

The high voltage power supply bleeder and voltage divider for the cathode ray tube employs two parallel circuits to properly maintain the electrode voltages on the cathode ray tube independent of the variations in current drawn by the various electrodes. When using a high resistance bleeder across a power supply to obtain peak voltage output from the rectifier, it has been found that the use of a single combined high resistance bleeder and voltage divider for all electrodes of the cathode ray tube results in serious unbalances of the voltage division with only slight variations in electrode currents. The high voltage power supply bleeder and voltage divider for the cathode ray tube, as shown in Fig. 1, employs two parallel circuits, one to feed the first anode of the cathode ray tube, and the other to supply the second anode. The two separate circuits for the focus and intensity controls aid materially in reducing interaction between these two circuits.

A schematic diagram of the power supply for the unit is shown in Fig. 2. It will be noted that the power supply is conventional in most respects with the exception of special precautions to prevent excessive a-c modulation on the grid of the cathode ray tube. These precautions must be observed much more closely than is necessary in ordinary cathode ray oscillograph design. In the greatest number of oscillograph applications in the past, the presence of a slight amount of a-c modulation on the grid was of very little consequence. The two stage resistance-capacitance filter on the high voltage power supply serves to adequately reduce the ripple in the output of this circuit. This ripple must be at a very low value since the positive or insensitive end of the cathode ray tube is tied at ground and the sensitive elements of the tube are forced to follow the ripple of the power supply. The modulation resulting from this ripple has been reduced by tying the first anode, the cathode, and the grid together at this modulation voltage through condensers C_{30} and C_{31} shown in Fig. 1. This forces these three elements to "pump" together at ripple frequency and the resulting modulation on the beam is greatly lessened.

The electrostatic shield around the primary of the power transformer effectively ties the chassis of the unit to ground through the power line. This prevents the chassis from "pumping" with respect to ground due to the stray capacity of the ungrounded end of the primary to the core and chassis. A large amount of spurious signal is thereby eliminated from the sweep amplifications and modulating circuits.

The stray capacity of the cathode ray tube heater winding to other windings on the transformer has been found to couple the heater to the high voltage end of some one of the high voltage windings and therefore cause the cathode to follow the voltage variations of this winding. Such variation of the cathode voltage introduces serious a-c modulation of the beam. It can be reduced by either by-passing the cathode to ground through a large high voltage condenser or by the use of the electrostatic shield around the heater winding as shown in Fig. 2.

The design of the cathode ray tube equipment of television receivers has been affected, up to the present time, so much by cathode ray oscillograph design that many of the simplifications permissible for television service have been overlooked. In oscillograph design it is customary to ground the positive of the cathode ray tube power supply in order that the final anode and the deflection plates may be at d-c ground potential. This was necessary to insure safety to the operator when using the equipment with the unknown circuit directly connected to the deflection plates. In television receiving equipment, however, there is no excuse for the operator touching the cathode ray tube. For this reason, the cathode ray tube power supply and the sweep circuit plate supply have been connected in series. This connection has a number of advantages. For a desired high voltage on the cathode ray tube, the potential of the high voltage power supply may be reduced by the sweep amplifier plate supply voltage, thereby effecting a saving in high voltage condenser and transformer cost. Conversely, with existing equipment the brilliance of the pattern may be materially increased by an amount proportional to the sweep amplifier power supply voltage.

(*Continued on page 74*)

TUBES AT WORK

Overloads in broadcast transmitters may be by-passed around the plate meter by an ingenious fuse mechanism. Police radio monitoring equipment.

Protecting the High Voltage Plate Ammeter

WILLICE E. GROVES
Staff Engineer KSL, St. Louis

AS IS WELL KNOWN by radio engineers whose job it is to operate and maintain high powered radio equipment, the weakest link in the plate circuit chain of such equipment is the plate current ammeter. This instrument is in a circuit which is subject to frequent overloads, especially during the "bug elimination" phases of development. Flashovers during tube testing, during the last stages of tube life, overloads due to line pops, modulation surges, power line surges, lightning, and "bugs" of frequently unknown nature all contribute to the large number of plate circuit overloads which occur in the best of transmission equipment.

When we had lost our share of plate ammeters at KSL, it was decided that something should be done about it. With the permission of Mr. E. G. Pack, Chief Engineer, the writer proceeded to search for a solution of the problem. Fuses were definitely out, because they merely weakened the plate circuit further, and while protecting the meter, would increase the probability of shut-downs. In the broadcasting business, a one or two minute shut-down may cost more than several meters. Then too, a 17,000 volt fuse is no small item.

Several possible solutions to the problem, using relays and thermo-electric mechanisms were investigated, but the arrangement to be described excels them all in simplicity and effectiveness. Figure 1 is a schematic of the final solution.

Referring to Fig. 1, the operation of the device may be described as follows: (1) and (2) are phosphor-bronze strips bearing tungsten contacts, (3). (4) is a heavy strip. The strips (1), (2) and (4) are isolated electrically from each other by a group of insulating wafers (5). The whole assembly is mounted on a strap-iron angle (6) by means of the round-head machine screws (7), the mounting screws being insulated from the strips by means of insulating sleeves (8). Through two small holes (9) in the strip (1) is fastened a piece of standard fuse wire of appropriate rating. This wire is pulled upward with sufficient tension to cause the contacts (3) to separate slightly, and is then fastened in this condition by the binding post (11).

The device is mounted on the same or similar insulators as those supporting the meter to be protected, since it must be at the same general potential as the instrument. The electrical connections are made as shown in the sketch. The terminals (13) and (14)

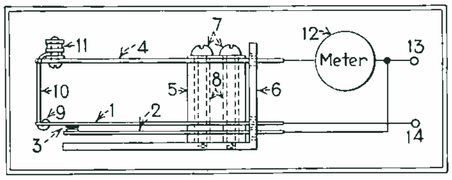


Fig. 1 Assembly of ammeter protector

are then used in lieu of the regular instrument terminals in connecting the instrument into a circuit.

Current normally flows from terminal (13) through the meter, through strip (4), the fuse wire (10) and thence through strip (1) to terminal (14). Should a current of magnitude greater than a predetermined value attempt to pass through the instrument, the fuse wire will melt, opening the circuit between strips (1) and (4). The melting of the fuse wire will also allow the contacts (3) to close because of the elasticity of strip (1). The current then cannot flow through the instrument, but is provided with another path from terminal (13) through strip (2), contacts (3) and strip (1) back to terminal (14). The instrument has thus been isolated and protected, and the circuit has been restored automatically through contacts (3) without interruption. When time or convenience permits, the fuse wire may be replaced and the instrument restored to normal service.

• • •

Crystal Monitor for Checking Police Radio

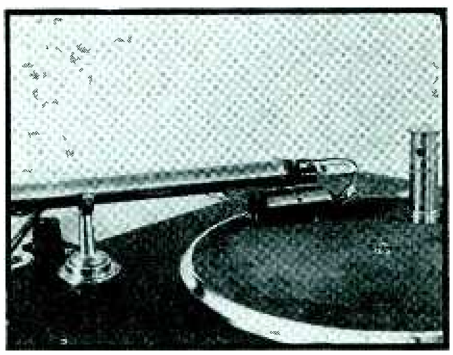
BY LESLIE E. KULBERG
Radio Division
Westinghouse Elec. & Mfg. Co.,
Chicopee Falls, Mass.

ULTRA HIGH FREQUENCY police radio installations require not only initial frequency adjustments but subsequent periodic checking because of constant operation and the vibration which the cruiser receivers and transmitters receive. Also, the frequency setting must be checked during any replacement of parts, or immediately upon return of the set to the car. These adjustments consist in setting the transmitter to the assigned frequency if it employs a self-excited oscillator, and alignment of the receiver intermediate frequency, as well as oscillator, radio frequency, and detector stages in superheterodynes employing a self-excited oscillator.

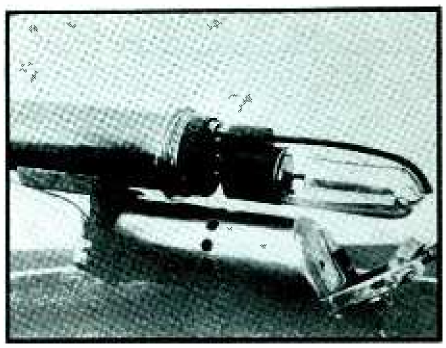
To perform these operations easily, quickly, and accurately, the use of a suitable oscillator and precision wave-meter, or of a signal generator, are two possibilities. Both suffer from lack

(*Continued on page* 40)

PHOTOTUBE RECORD PICKUP



A moving vane is fixed to the needle of this pickup, interrupting light reflected from a lamp to a phototube. The vibrations of the needle are thereby translated to variations the phototube current, which is amplified. The delicate needle suspension thus made possible is said to reduce scratch and improve response



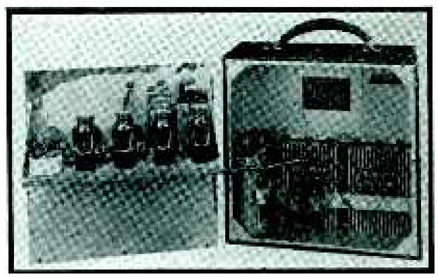
Detailed view, showing lamp in housing (below), needle and vane, reflecting mirror and phototube (above)

Tubes At Work

(*Continued from page* 38)

of accuracy, and to approximately the same extent. In addition, the first method requires too much equipment for ease of operation when "on location" at the cruiser. The second one requires a costly unit, if the setting is to be at all indicative of the actual frequency, and such laboratory equipment was never meant to endure the rigors of the usage it would receive.

When accuracy of frequency is the paramount concern, the crystal controlled oscillator immediately offers possibilities. The crystal frequency monitor gives this immediate and decided advantage over other methods, in combination with greater ease of operation. For example, one design is capable of supplying a 30 to 42 Mc. or 4100 kc. signal, either of which can be modulated or not as desired, for the adjustments previously mentioned. The low frequency is for intermediate frequency use and although normally supplied for 4100 kc. can be obtained for other frequencies if desired. In addition, it serves as a transmitter frequency monitor, to ensure the maintenance of the FCC 0.05 per cent maximum frequency deviation requirement, a task in itself. It will also permit aural monitoring of the transmitter's quality and act as a secondary frequency standard.



The monitor is portable and completely self-contained

The method of setting a cruiser transmitter on frequency is as follows. Using the unmodulated h-f output as determined by the calibration chart, and with the proper crystal holder in its socket, a piece of insulated wire is attached to the detector antenna post. This should be long enough to give a good signal in the phones when the transmitter is modulated. Next a two-foot piece of wire is connected to the h-f antenna post and moved about with respect to the first wire, for best mixing. The transmitter frequency is adjusted to zero beat with the monitor, as indicated in the monitor phones.

An evident advantage arises from this type of adjustment against a crystal standard. Every cruiser transmitter can be set at the monitor frequency instead of varying among each

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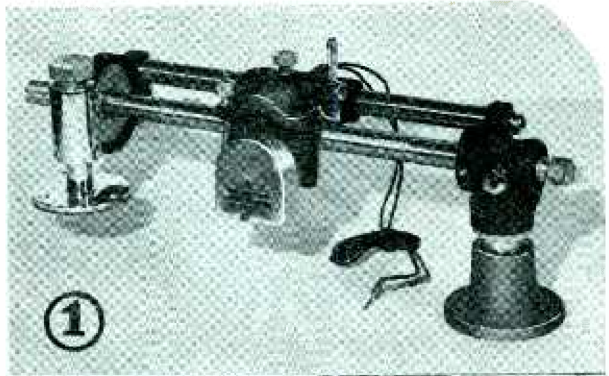

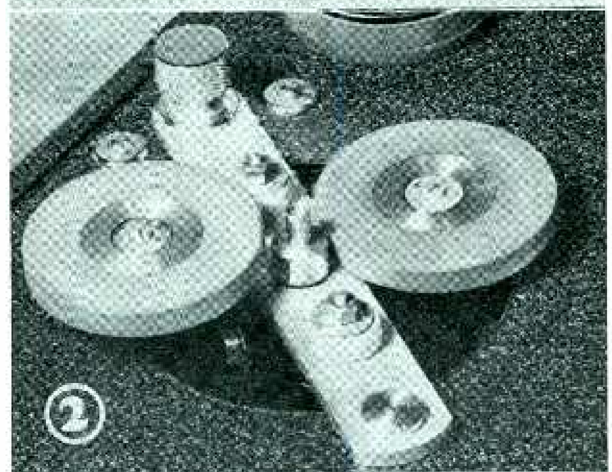

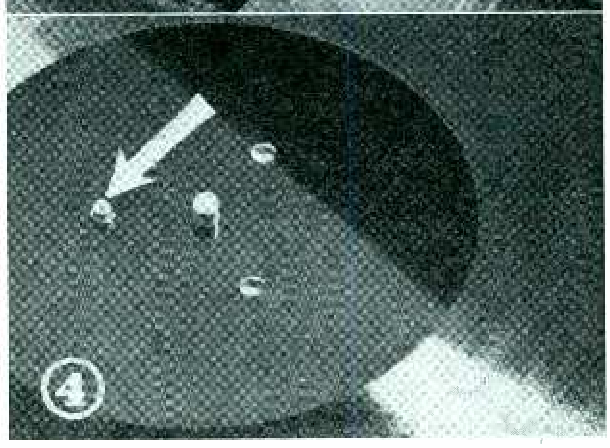

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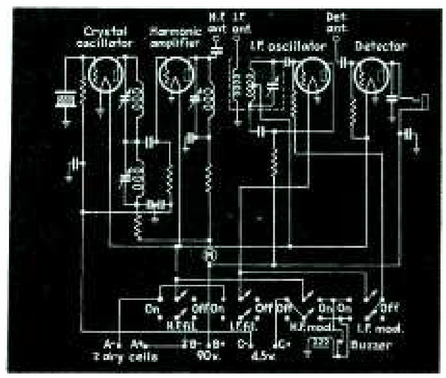
CABLE ADDRESS: *Allrecord*

other. The headquarters receiver is then in constant tune with all of them, instead of requiring shifting to catch each separate car's frequency.

While on the subject of the use of the monitor with transmitters, there is that use for which the development was named, i.e., for monitoring the output of a transmitter as regards to quality, ripple and noise. Suitable for checking these factors either in mobile or station house installations, it can be set up permanently in the latter case. To operate, a wire coupled to the transmitter output is connected to the detector post, the headphones plugged in, and the unmodulated h-f circuits turned on. By adjusting the three tuning condenser controls the beat note is prevented from appearing, while the signal can be heard. By tuning to zero beat as well, frequency and aural monitoring can be performed simultaneously.

Receivers of the fixed-tuned type, with perhaps only a vernier tuning control available externally, must have all circuits aligned. To adjust the high frequency circuits, the required



Schematic circuit diagram of connections

h-f output is connected to the receiver input or coupled to its antenna, and using modulated h-f output (and of course the proper crystal) the receiver main controls are tuned for minimum reading of the monitor plate meter. Spare receivers can be set on frequency at the service bench, ready for immediate installation and use. The same is true of receivers brought in for repairs. This avoids the necessity of driving the car to a point remote from the station house transmitter, in order to tune up the receiver.

To align the i-f amplifier, modulated i-f output is switched on, the i-f antenna connected to the grid of the receiver first detector, and the i-f stages adusted for maximum loudspeaker volume or minimum receiver tuning meter deflection.

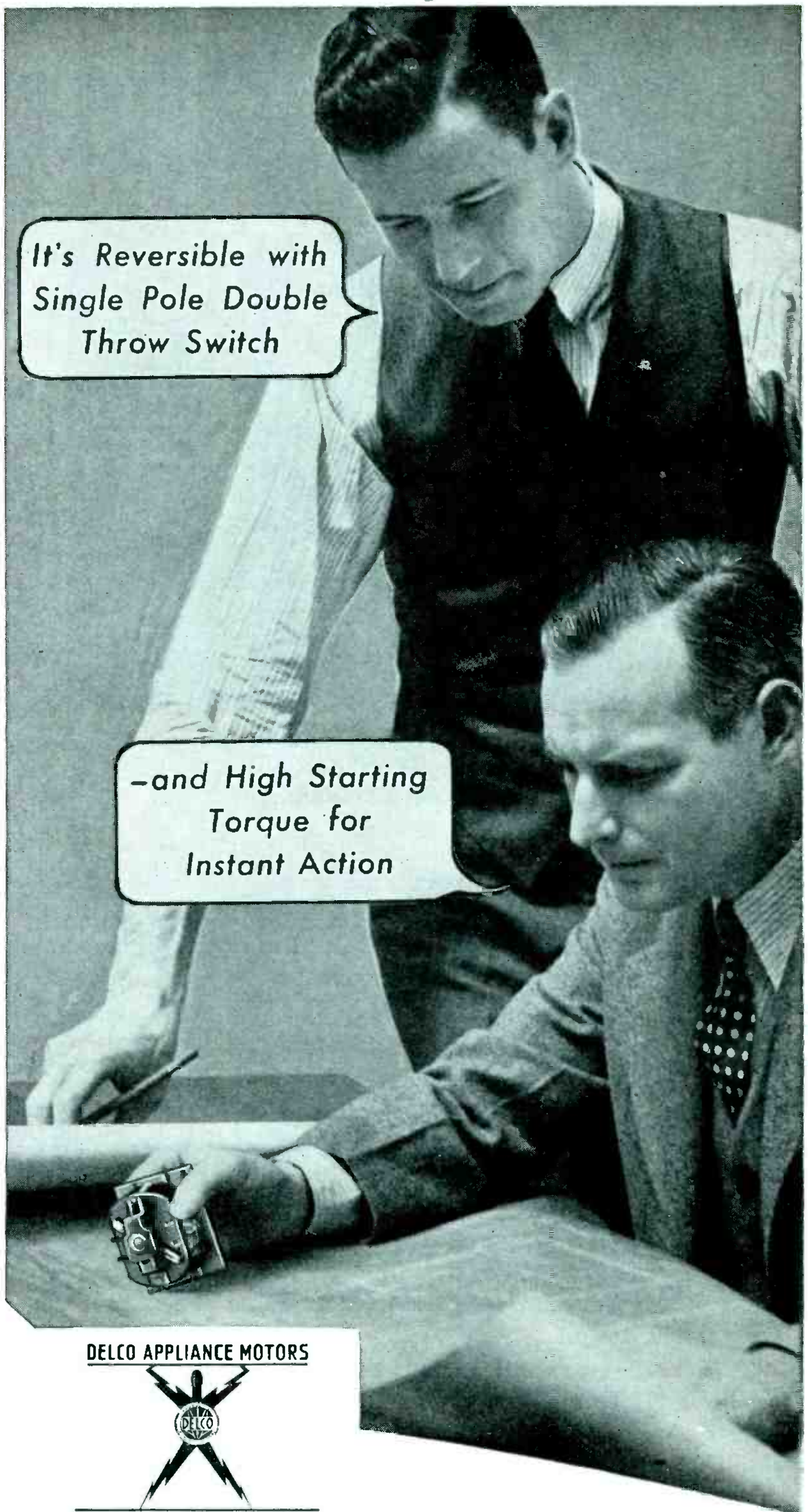
The photograph shows a typical monitor. It is complete with battery power supply within its metal shielding case. The circuit consists of a crystal oscillator with fundamental and tripler tank circuits, a harmonic amplifier (doubler), a 4100 kc. i-f self-excited oscillator, and a mixer or de-

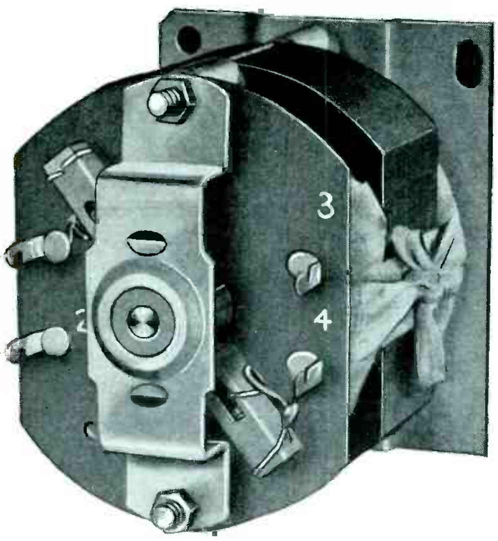
DELCO APPLIANCE SCORES *Again*

THIS NEW AUTO RADIO TUNING MOTOR jumps into high speed the instant the switch is touched, is reversible, extremely smooth and quiet and has ample power.

The illustration below gives an idea of the sturdy flange or bracket mounting, the well taped coils, the simple connections and the self aligning bearings; but to appreciate the many quality features of this inexpensive motor you should have a sample in your hands.

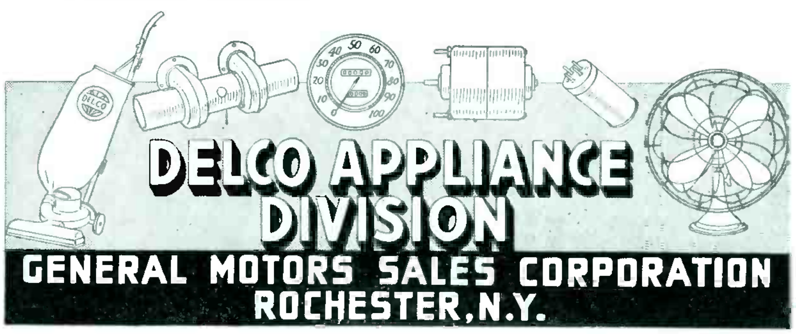
If you will send data showing your requirements, our engineers will be glad to meet these requirements promptly and expertly.





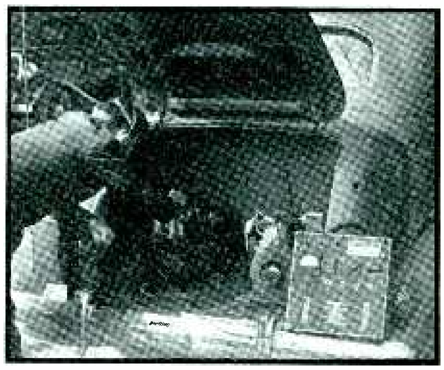
DELCO APPLIANCE MOTORS

PRODUCT OF GENERAL MOTORS



tector. Type 30 tubes are utilized throughout. All switching is accomplished by means of the four toggles, "H.F.Filament", "I.F.Filament", "H.F.-Modulation", and "I.F.Modulation". The use of either filament switch alone provides the designated frequency output, unmodulated. Turning on the modulation switch for the frequency range desired impresses a tone of approximately 1000 cycles upon the output, by means of the buzzer. The detector is automatically on whenever the instrument is set for h-f output. One crystal is plugged into the circuit and a spare one carried in the socket attached to the small door (seen inside the case in the figure). By merely removing the two thumbscrews by which the door is held in place, it is a simple matter to reach inside and exchange crystal holders. Only two are required for any given installation, and are, of course, of one sixth the output frequency.

A constantly available calibration chart appears on the front panel, designating the settings of the three controls for the four police frequencies—30.1, 33.1, 37.1, and 40.1 Mc., each of which uses its own crystal. The controls are set at the necessary positions for the frequency wished, and then returned in the order A, B, C for maximum reading of the milliammeter in the plate circuits of the two h-f tubes.



Setting a police cruiser's tranmitter on frequency with a crystal frequency monitor

Two antenna posts on the front panel serve for coupling the outputs of the two oscillators, and when either is used in conjunction with the third post, it serves to mix the monitor frequency against that of the equipment being checked, by tuning the latter for a beat note in the phones. This last post by itself, serves for coupling to a signal to be detected or demodulated only.

The convenience resulting from the use of a device of this type can readily be appreciated. At the service bench it displaces slower, more complicated equipment. No output meter is required in tuning up receivers. As a result, greater speed and ease of operation and greater accuracy is obtained.

From INVENTOR'S SHOP to MODERN FACTORY

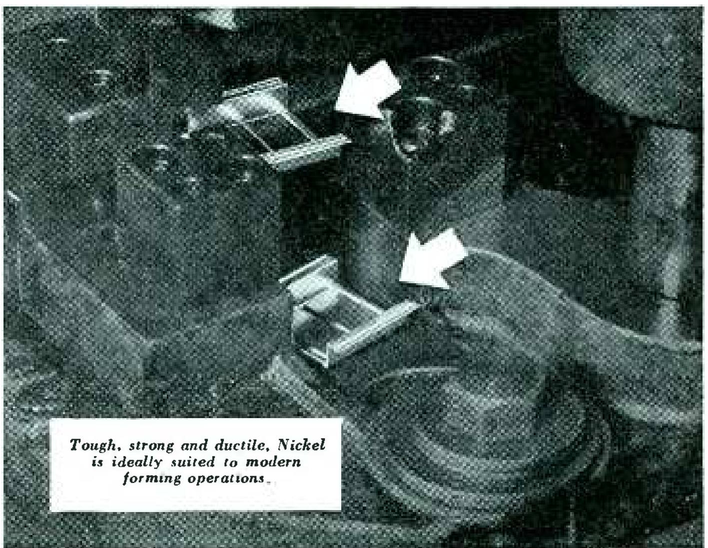
Nickel, first chosen for crude tubes of early days, meets exacting demands of modern production

INTRICATE PARTS made of Nickel strip, wire and tubing—formed, drawn, bent, notched, peened, spot welded—are turned out by the million—*and each part precision made.* No wonder Radio relies upon Nickel: For just as this amazing metal answered the requirements of early pioneers, so today, in various forms and alloys, it meets the complex demands of modern tube production.

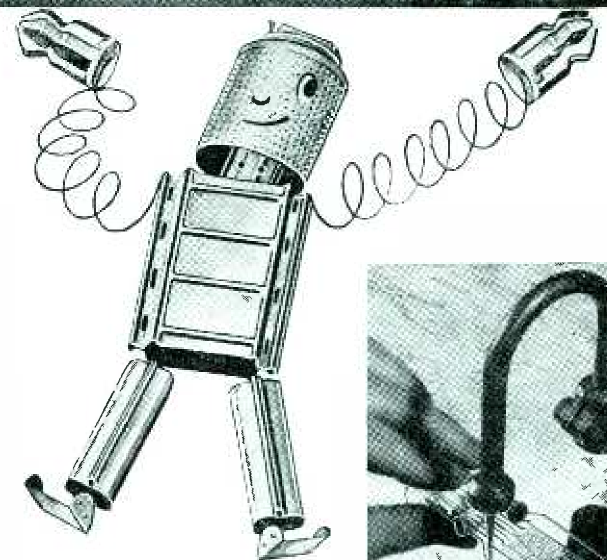
Strong and tough, yet ductile, Nickel has excellent fabricating qualities. It forms readily—avoids breakage under the rigors of the most intricate forming. It spot welds readily to Nickel and carbonized Nickel, and also to many other metals—producing a strong joint with little oxidation.

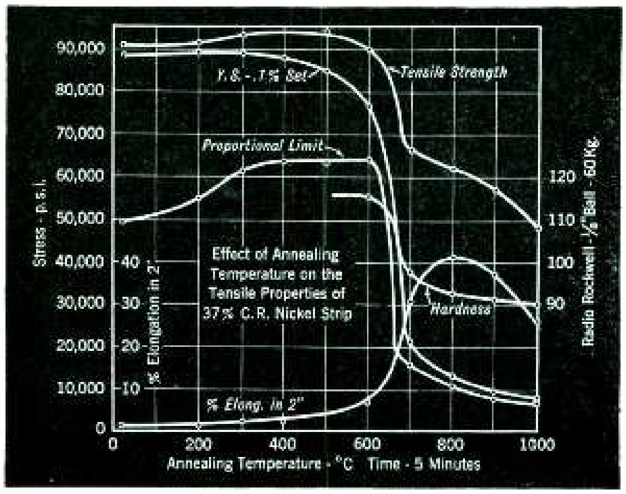
And despite the demand for smaller and smaller parts, closer and closer spacing and precision, all have been possible because of the superior fabricating qualities of Nickel. Not alone in tube factories, but in numerous plants making special wire, tubing and strip for radio parts, the excellent fabricating qualities of Nickel have simplified the job, increased yields, cut costs.

Perhaps they can do the same for you. We'll be glad to discuss your needs—and to mail your copy of "Nickel in the Radio Industry." Address "Electrical Research."

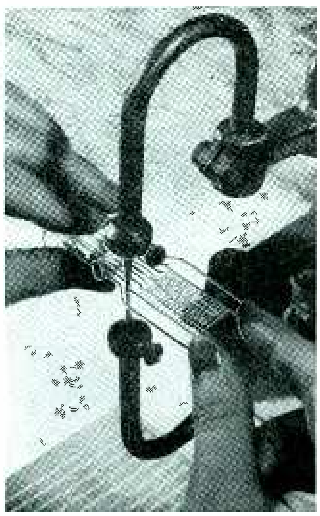


Tough, strong and ductile, Nickel is ideally suited to modern forming operations.





NICKEL



Nickel spot welds readily to many metals, producing a strong joint with little oxidation.

THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL ST., NEW YORK, N. Y.

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JACK VAUGHAN
Service Department Mgr.
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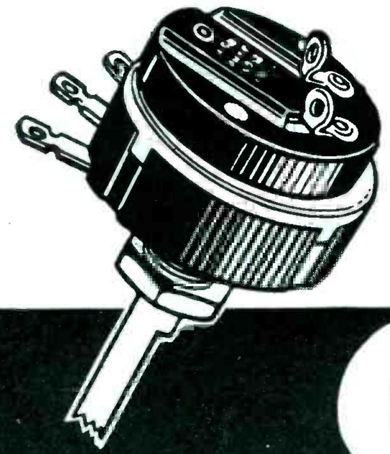
Our West Coast friend is but one of the thousands of Centralab enthusiasts. Their testimonials from the tropics to the frozen places of the globe speak volumes for Centralab performance.

Servicemen or set builders . . . experimenters, and amateurs all voice their approval; for they unanimously "SPECIFY CENTRALAB".



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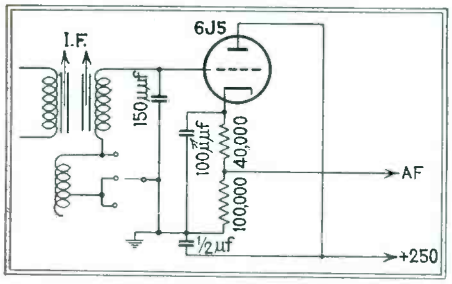
Variable-Selectivity Superhet

COMMENTING ON THE FACT that present day receivers still lack selectivity sufficient for modern requirements, especially variable selectivity, McMurdo Silver analyses the situation as follows. The basic trouble seems to be that coils of sufficiently high Q are not obtainable, and if obtained are not used properly. Shielding with small cans lowers the effective Q. Shunting a high Q coil with a low resistance diode detector further destroys the benefits of



Second-detector circuit

having good coils. With these considerations in mind he has produced a receiver with the characteristics shown in the graph, on page 48.

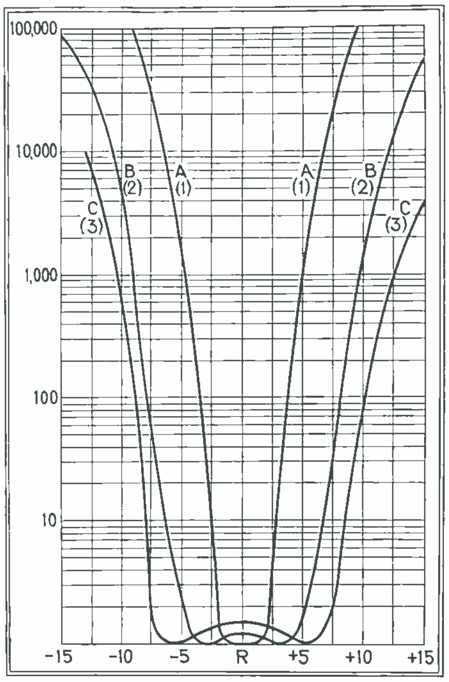
"This system has been produced through development of a new type of powdered r-f iron coil core (Ferrocart), new types of Litz coils, and the incorporation of the whole, including tuning condensers of Q equaling that of good Isolantite insulated laboratory air condensers, in shield cans large enough *not* to impair hard-bought circuit Q. The use of popular small 1½" to 2" square i-f transformer cans is one reason for poor selectivity, for such small cans quite definitely lower Q which is already too low. The first remedy is to use shield cans so large as not to measurably reduce coil Q when coils first measured in open air are inserted in

• • •

PHOTOELECTRIC FLOUR TESTER

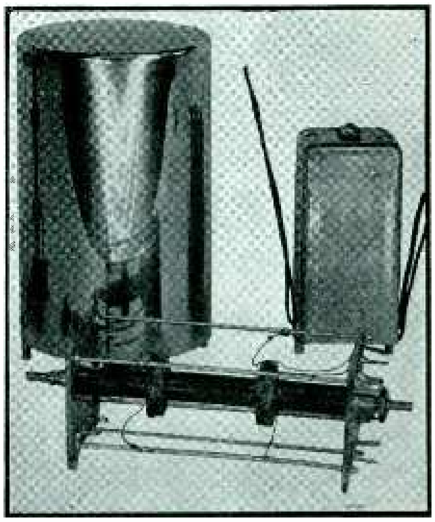
G. B. Puzrin, chief engineer of the Ukrania Research Institute, with a photoelectric device used to determine the percentage of bran in flour, to an accuracy of 0.2 per cent them. In practice this means a can of 2½" to 3" in diameter for i-f coils of customary size.

Coil and core development involved



Response curves of variable selectivity circuit

rigorous investigation of coil sizes, shapes, number of "Pi's", wire size, number of strands, insulation and the correlation of all these factors. The fortunate answer was the dependable production of coils measuring Q = 205, an improvement of more than 50% over the coils customarily found in amateur, commercial or broadcast receiver i-f



Large can (left) contributes to high performance

transformers. Using better powdered r-f iron cores, variable i-f tuning condensers could be replaced by inductance tuning obtainable by micrometric screw-thread movement of these cores inside their coils to vary inductance instead of capacity. Conventional moulded mica, and even the "tooth-pick" types of small capacitators, however, proved to

Paragraphs on Television Synchronizing

By J. R. Duncan
Midland Television, Inc., Kansas City

A TELEVISION PICTURE may contain 441 lines, the scanned pattern may be perfect, the spot size and focus uniformly excellent, and the resolution maximum, but if there be any failure in the synchronizing signal all is lost. Conversely, other imperfections can be tolerated so long as the picture appears to be "glued" on the end of the picture tube. The adoption of the interlaced pattern while offering what seems to be the only practical solution for flicker elimination at the same time added another worry to our synchronizing problem. Many times what is supposed to be a 345 or 441 line picture turns out to have just half that many lines, if something happens to the vertical synchronizing impulse. The general trend of opinion seems to be that we need more synchronizing signal amplitude, but there is such a thing as too much synchronizing signal, notwithstanding popular belief to the contrary.

Suppose we examine an oscillator of the type most commonly used in this country and see what happens when there is too much synchronizing signal amplitude. First, consider the horizontal sweep. Figure 1 shows the form of the voltage wave on the grid of the oscillator. In this discussion on synchronizing, it is important that we understand that there are two separate and distinct parts to the oscillation cycle, viz: the time during which the oscillator is active (*abc*) and the transient and discharge period (*cdef*). This active or impulse period determines, among other things, the *amplitude of the sweep* in the output circuit, while the discharge period determines the *frequency of the sweep.* Changes in the impulse wave will therefore affect the edges of the scanned pattern, while a change in the discharge waveform influences the effectiveness of the synchronizing. A positive synchronizing impulse introduced into the grid circuit at any time during the period (*ef*) will cause the oscillator to initiate a new cycle provided the amplitude of the impulse is sufficiently great to raise the circuit voltage at that time to cut-off. But, any amount it raises it beyond cut-off is *added to the oscillator impulse.* It is, therefore, extremely important that the ratio of oscillator impulse to this additional synchronizing impulse be sufficiently great that slight changes in synchronizing amplitude will not be reflected noticeably in the edges of the horizontal scanning. No harm would result if the amplitude of all horizontal synchronizing impulses were the same, or if the position of the synchronizing impulses on their pedestals (the blanking out) were moved in more from the leading edge. But, since neither condition obtains in actual practice, it is well to consider the ragged pattern edges that might result from the use of too robust a synchronizing signal, particularly if this signal is modulated with interference during the course of its transmission and reception.

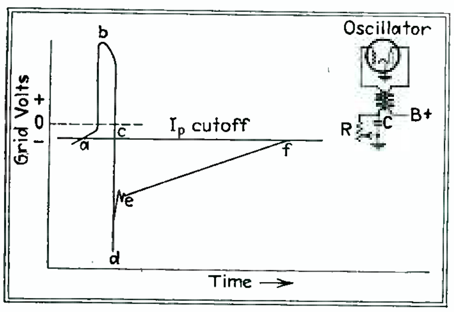


Fig. 1.—Synchronizing voltage wave-form

When the synchronizing signals are modulated with interference, some of the amplitudes are increased and some are decreased; in one case we have the sweep circuit being driven and, in the other, falling out of step. Both conditions, of course, are objectionable. Interference suppression circuits, when used in connection with the circuits handling only the synchronizing, offer a partial solution of the problem.

The amplitude of synchronizing required for the satisfactory operation of a given oscillator depends in part upon how far from below frequency we wish to "pull" the oscillator into step, and the waveform of the discharge curve at that particular point. Ordinarily, oscillators are operated sufficiently below normal synchronizing frequency to provide certain tolerances for slight circuit changes that may occur during the course of operation or the replacement of the oscillator tube. It is the writer's belief, based on many tests under actual working conditions in the field, that most satisfactory synchronizing is to be had when the oscillator tube and circuit require a minimum tolerance and may be operated at very near the scanning frequency. It follows from this that the type tube used as oscillator should have very definite and uniform characteristics. Such a tube, as far as I know is not available on the market at this time.

The waveform of the discharge curve may be varied to resemble either that at (*a*) or (*b*) in Fig. 2. Synchronization at time *t* with the waveform of (*a*) is much more critical and subject to failure than that of (*b*).

So much for the problems of synchronizing the horizontal sweep circuit. It is important now to understand what occurs when we synchronize the vertical oscillator. A synchronizing failure in this circuit during the showing of an interlaced pattern may result in poor interlacing (badly paired lines), loss of half the pattern lines (a reduction in detail), or complete frame failure. A perfectly interlaced pattern is possible if consecutive vertical synchronizing impulses are identical both in waveform and spacing and there is no extraneous signal pickup in the vertical sweep circuit, particularly crosstalk from the horizontal sweep circuit.

As in the case of the horizontal oscillator, optimum results are obtained when the ratio of oscillator impulse to synchronizing impulse is a constant. In the case of the vertical, this constant should be large, and any method for obtaining this objective will be found helpful from the standpoint of interlacing. One method suggested by the author early in the history of interlacing, viz: *the use of a narrow vertical synchronizing impulse;* such an impulse has the added advantage over the broad type impulse of having a steeper wavefront and, therefore, capable of more accurate timing action.

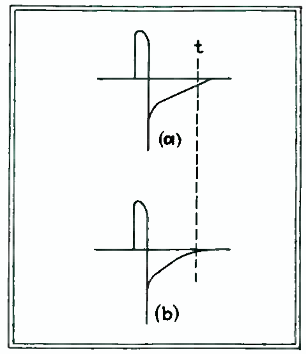


Fig 2—Effect of transient wave-form

There seems to be some misunderstanding as to the character of the narrow type vertical impulse. *It is not of the same time duration as a horizontal synchronizing impulse,* but usually lasts approximately one-half the time of one scanned line. Hence, the necessity of serrating the vertical synchronizing impulse is eliminated and along with it the use of additional complicated circuits in the synchronizing signal generator. Synchronization is possible when both horizontal and vertical synchronizing amplitudes are the same, but it is preferable that the vertical be slightly greater in amplitude—say 5 per cent.

In addition to the use of a narrow vertical synchronizing impulse, the ratio of vertical oscillator impulse to synchronizing impulse may be further increased by making the oscillator impulse broader. Since the matter of return time (ratio of scanning time to return time) in the vertical sweep is open to wide tolerances, it is easy enough to broaden the oscillator impulse by increasing the capacity of *C* in Fig. 1. A poorly interlaced pattern may often be improved by this one change.

Under the conditions outlined for good synchronizing, pictures have been received over the air when the field strength was around 500 microvolts (ratio of picture to synchronizing approximately 4:1) that were entirely satisfactory from the standpoint of both interlacing and synchronizing. Of course, the picture was pretty well "snowed under" by the noise, as would be expected with a field strength of one-tenth of that recommended for good reception.

Aircraft Radio

(Continued from page 23)

cautions broadcast stations may be made a part of the navigation system.

An entirely new principle in aircraft direction finders was demonstrated recently by the laboratories of Le Materiel Telephonique. In this compass, the loop antenna is rotated at a rate of 5 r.p.s. by a motor in the plane. The loop, acting as the armature of the generator and seeping through the line support in the incoming field of the radio wave, generates an alternating current of 10 cycles per second. On the same shaft with the driving motor and driven by the same motor is an a-c generator whose output at 10 cycles per second has a definitely fixed phase with respect to the axis of the ship. The phase angle between the voltage generated in this generator and the voltage generated by the loop, is an indication of the difference in phase between the axis of the ship and the axis of the incoming wave. The phase difference is used to actuate a visual indicator which then gives the direction of the plane with respect to the incoming wave directly in degrees.—D.G.F.

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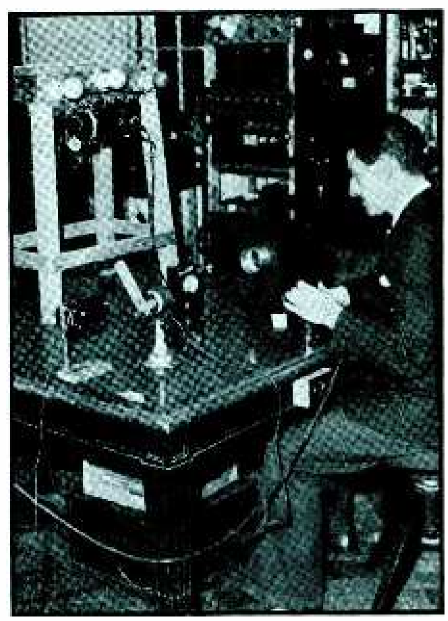
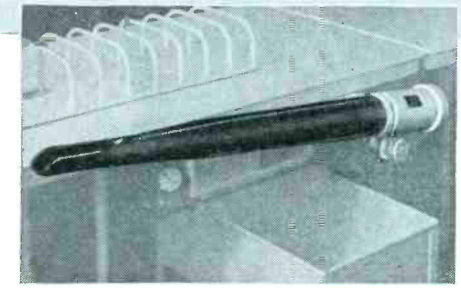
SPEEDER WARNING



Thomas McCaleb of Harvard with his traffic checking device. A phototube registers the speed of each passing car and actuates a warning sign by the road if the speed limit is exceeded. Infra-red light is used to control the phototube

1,202,240 STITCHES PER STOCKING



SYNTHANE makes it possible for the manufacturer to scan the 1,202,240 stitches of a sheer silk stocking in the twinkling of an eye. . . . *Synthane* Bakelite-laminated is used in stocking examiners because it has three desirable properties in *combination*—smoothness, solid color, and wear resistance. . . . You can get this same combination of properties or almost any other combination you desire in *Synthane*, for *Synthane* has an unusually broad *combination* of physical, electrical, chemical and mechanical properties. *Synthane* is a dense, solid material, tough, strong and light in weight—an excellent electric insulator—with a low power factor, low moisture absorption, high dielectric strength and low dielectric constant. It's chemically inert and corrosion resistant. It machines easily. *Synthane* is often the most *economical* material to use through lowered production costs, better product performance, dependable adherence to standards. Why not write for data on *Synthane*, giving us your requirements?

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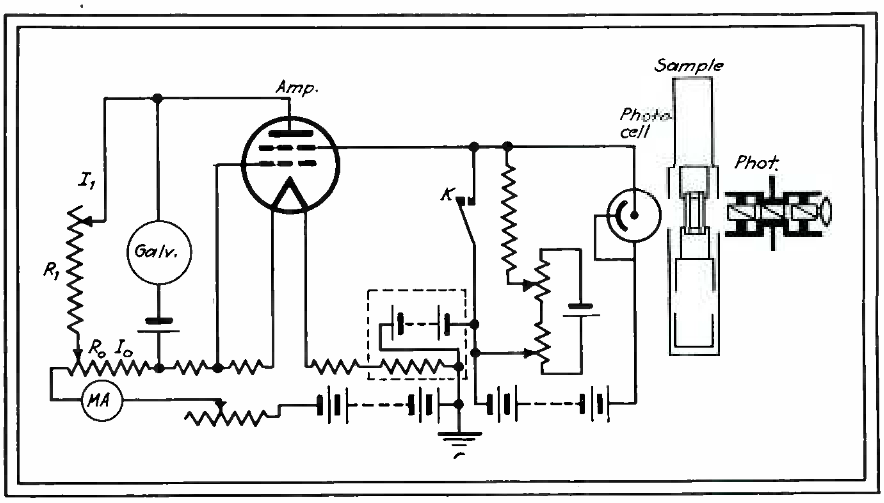
THE ELECTRON ART

EACH month the world's technical literature is scanned to see what physicists and engineers are doing with tubes, for presentation in tabloid form to Electronics' readers.

A Phototube Spectrophotometer

A SPECTROPHOTOMETER which is capable of measuring a transmission down to 1 per cent with a precision of about 1 per cent is described by Simon Shlaer in his article, "A Photoelectric Transmission Spectrophotometer for the Measurement of Photosensitive Solution," appearing in the January issue of the *Journal of the Optical Society of America*.

The accompanying schematic wiring diagram will indicate the method of operation. Monochromatic light, after passing through the sample to be measured, falls on the cathode of a photoelectric cell, whose current, passing through a high resistance, establishes grid voltage for the amplifier tube. The amplifier uses a four-element type FP-54 tube, operated at low voltages to eliminate ionization and constructed with extremely high insulation resistance. The voltage drop across the grid resistor is balanced out by means of an uncalibrated potentiometer until the galvanometer in the plate circuit of the tube reads zero. The sample is then removed from the light beam and balance is again restored so that the galvanometer current reads zero. The second balanced condition is established by the rotation of a polarizing prism. The angle through which this prism has to be rotated in order to restore balance can be used to determine the percentage of transmission of the sample.



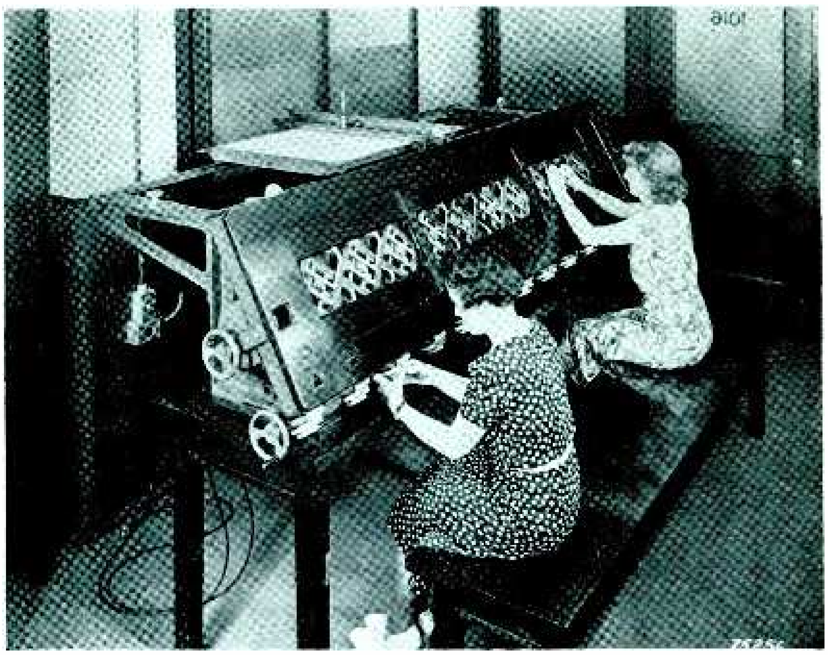
Schematic wiring diagram of spectrophotometer. The polarizing prisms in the photometer head are used to determine balance conditions

Mechanical Aids to Mathematics

FOR MANY YEARS slide rules, calculating machines, and similar pieces of equipment have been used as an aid for mechanical computation. In the realm of higher mathematics, the differential analyzer, the network analyzer, the cinema integraph, and a machine for solving simultaneous algebraic equations have been developed by the Massachusetts Institute of Technology and are finding daily application in the solution of problems in engineering and physics which would not be economical if solved in the usual manner.

One of the newest mechanical aids in the solution of mathematical problems is the isograph, recently developed by the Bell Telephone Laboratories for the solution of complex polynomials of as high as the tenth degree. The application of the isograph to certain problems in electrical engineering, as well as the mechanism of the isograph are described in two articles in the *Bell Laboratories Record* for December, 1937.

With the help of this device the roots of polynomials may be located quickly and easily irrespective of whether they are real or complex. The presence of multiple roots is no barrier to the solution of such problems. Since the process employed in the solution of these problems is one of successive and independent approximation, an error made at any point is automatically corrected by the next step.



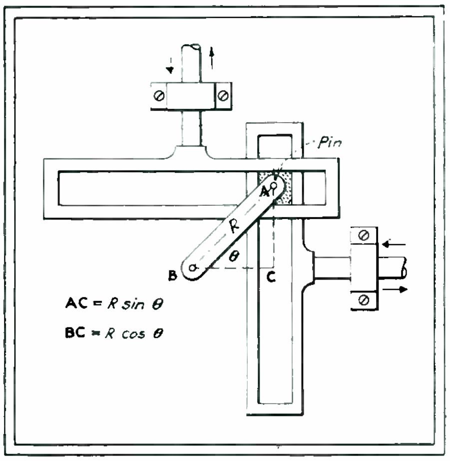
Two operators adjusting the isograph

According to one of the *Record* articles, the complex variable may be expressed in the form $r\ (\cos\theta + i\sin\theta)$, where r represents its magnitude and θ the angle that r makes with the axis of reference. Higher polynomials may be expanded in terms of the above equation, in which θ is the independent variable.

Since the independent variable in plotting the curve is an angle, what is required for the isograph is a rotating unit that provides two linear motions—one proportional to the sine and the other to the cosine of the angle. There would have to be ten of these units to provide for the ten terms of the equation, and while the first unit

moves through an angle θ, the second unit must move through an angle 2θ, the third through an angle 3θ, and so on. Then, by providing a means of summing the sine and cosine motions separately, and allowing these motions to control two perpendicular motions of a pencil and drawing board, a closed curve will be described as θ increases from 0° to 360°.

To secure motions proportional to the sine and cosine of the angle of rotation, the isograph utilizes the pin and slot mechanism, shown in the drawing. An arm rotating about a fixed point, causes a pin arrangement to slide, by means of a rectangular block, in rectangular slot cut in two slide bars, each of which is slid back and forth in one direction only, the two motions being at right angles to each other. These motions are equal to the length R times the sine and cosine of the angle of rotation. By making the length of the arms adjustable so that they may be thus equal to the constant of the equation, the displacement of the sine and cosine on the figure are always proportional to one pair of turns. Ten such units are provided and geared together to a common driving motor, but the gearing is so designed that when the arm of the first unit moves through an angle θ, that of the second unit will move through an angle of 2θ, etc.



To provide for summing up all of the sine terms and all of the cosine terms, the ends of all the slide bars carry pulleys so that a single wire may be carried around all of the sine pulleys and another around all of the cosine pulleys. These wires control the relative motion of a pencil and drawing board to plot a curve as the angle is varied from 0° to 360°. The resulting curve which is drawn by the pencil on the drawing board may be used to determine the real and quadarature roots of the equation.

Although the mechanism involved in the construction of the device is not inherently complicated, the construction of a satisfactory isograph is difficult because of the extreme precision with which all parts must be made and assembled. Backlash must be eliminated and gears must be fitted with an accuracy of 0.0001 in. for play.

Trustworthy

. . . For Every Test Requirement

MODEL 310 LINE

Precision portables (electrodynamometer type accurate within ¼ of 1%) for critical test work, available for AC and DC, in voltmeters (single, double and triple range), ammeters, milliammeters, wattmeters, etc. Scale length, 5¼ inches.

MODEL 430 LINE

Rugged portables for maintenance work. A full line of *DC instruments* (Permanent Magnet Moving Coil type—accurate to ½ of 1%). *AC instruments* (Movable Iron Type—accurate to within ¾ of 1%). Also *wattmeters* for DC and AC (accurate within ½ of 1%). Scale length, 4 inches (approx.).

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Single and multi-range *ultra-sensitive DC instruments* for measurement of minute currents in radio, telephony, thermocouple work, electro-chemistry, and the like. Shielded, double-pivoted instruments (Permanent Magnet Movable Coil type—accurate within ½ of 1%). Scale length, 6 inches.

For maintenance work, for industrial or school laboratories — wherever portable test instruments are employed — the name WESTON is recognized as a symbol of trustworthy electrical measurement.

WESTON "Portables" are designed in several types, with specifications and ranges to meet the particular requirements of all varieties of test work. Behind all the specifications, however, is the same "engineering-from-bedrock" — a consistent application of the design factors that make for rugged dependability as well as rated accuracy.

After all, when you buy a WESTON—whatever the type or specifications—you get an extra increment of experience which stems from a half-century of instrument building. Why not check with the WESTON representative as to the type of meter best suited to your needs?

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WESTON *Instruments*

Contribution to Electric Circuit Theory

THE SCIENTIFIC ADVANCES of any technical subject are made throughout the years by a series of advances, each of which may be regarded as an elaboration upon the proceeding or as another step in a series of successive approximations. For the electrical engineer engaged in power work, circuit analysis on the basis of a single frequency is sufficiently adequate. The communication engineer, on the other hand, is forced to extend his mathematical analyses so that current and voltages covering a wide range of frequencies may be dealt with. Practically all of the power and communication circuit theories which have been developed up to the present time are a complex exponential function of time as given by $e^{j\omega t}$, where ω represents a constant frequency.

Recent advances in communication engineering, in which frequency modulation, as developed for practical operation by Major E. H. Armstrong, makes necessary another step in the series of successive approximation in developing electric circuit theory. The theoretical analysis of circuits in which the frequency varies continuously, is dealt with by John R. Carson and Thornton C. Fry in a paper, "Variable Frequency Electric Circuit Theory with Applications to the Theory of Frequency Modulation," which has been published in the October, 1937 issue of the *Bell System Technical Journal.*

The variable frequency electric circuit theory of Carson and Fry is developed by replacing the usual cisoidal oscillation, represented by $e^{j\omega t}$, by the more general time function

represented by $\exp\left(i \int_0^t \Omega(t)\, dt \right)$,

where $\Omega(t)$ is the instantaneous frequency, and may be considered to be made up of two parts. Thus, the total instantaneous frequency may be considered to be composed of a constant frequency ω, plus a term $\mu(t)$ which represents the deviation from this constant frequency. The instantaneous frequency may therefore be expressed as:

$$\Omega(t) = \omega + \mu(t)$$

Using this expression for the instantaneous frequency, and making rather thorough use of the method of operational calculus, expressions are derived for the admittance and the current for a voltage of variable frequency. The results of the more general electric circuit theory of Carson and Fry naturally degenerate into the usual constant frequency electric circuit theory when $\mu(t)$ in this last equation reduces to zero.

The variable frequency electric circuit theory is applied to the case of frequency modulation. It is shown, that in frequency modulating communication systems, the low frequency signal which is ultimately wanted in the receiver may be detected by direct and

CINCH NEW DESIGN SOCKETS

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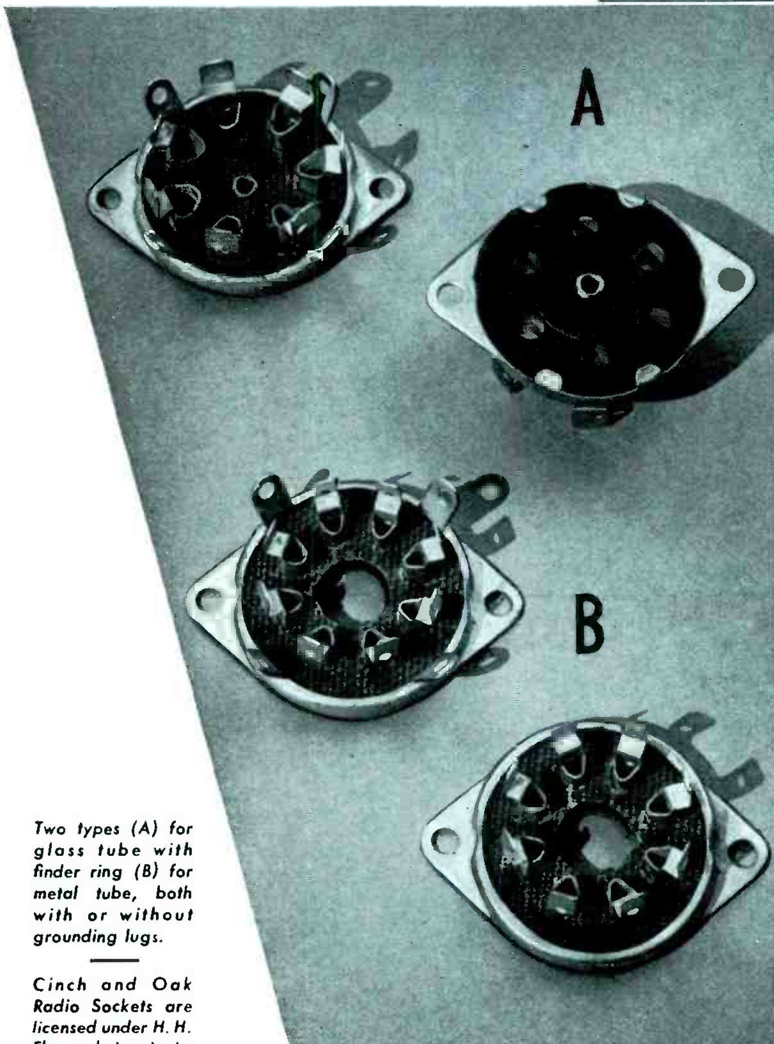

Two types (A) for glass tube with finder ring (B) for metal tube, both with or without grounding lugs.

Cinch and Oak Radio Sockets are licensed under H. H. Eby socket patents.

...FOR GREATER EFFICIENCY

"50% increase in point of breakdown" is the findings of tests to date. Note increased distance between contacts. And of course compact, trim sockets—more than 30% smaller. These metal saddle sockets eliminate riveting trouble—no breakage or damage. Rigid, this most durable, newest socket, is *streamlined* for greater efficiency! Ucinite laminated insulation used exclusively in all Cinch products. Get samples and prices, it pays.

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simple means. For the case of pure frequency modulation, the signal cannot be obtained simply and directly from the frequency modulated wave.

The mathematics, however, show that the expression for the signal can be obtained by differentiating the frequency modulated wave. From this it is inferred that the detection of a pure frequency modulated wave involves, in effect, its differentiation. The process of rendering explicit the low frequency signal has been termed "frequency detection." Actually frequency detection converts the pure frequency modulated wave into a hybrid modulated wave containing both frequency and amplitude modulated components. Thus, the detection of a frequency modulated wave involves conversion into amplitude modulation after which detection may be accomplished on the basis of amplitude modulation. From the fact that the frequency modulated wave must be differentiated in order to convert it into amplitude modulation, it can be shown that frequency detection can be effected by means of an electric network.

It is shown that for the detection of frequency modulated waves, by straight rectification, the modulation frequency must be less than the carrier frequency, and that the frequency detecting network should be as nearly as possible a pure reactance. The condition is also derived for the minimization of both linear and non-linear distortion. Reduction of noise may be accomplished through the use of a balanced rectifier, consisting of two frequency detectors in parallel, the rectified outputs of which are then differentially combined in a common low-frequency circuit.

While the Carson-Fry article will undoubtedly appeal to mathematically-minded engineers and physicists because of its application to a subject which, at the present time, is very much alive (that is frequency modulation), its greatest contribution is perhaps in the extension of electric circuit theory to take into account with mathematical rigor, the analysis of circuits having variable frequency.

• • •

Graphical Solution of Impedances in Parallel

COINCIDENTALLY WITH the publication of the article "Graphical Determination of Impedances in Parallel," in the Electron Art Department for January, there was published in the January issue of *Electrical Engineering* a letter from John L. Clark on "Graphical Solution of Impedances in Parallel." In his communication, Mr. Clark illustrates and proves a method for determining the net impedance of any two impedances in parallel.

They won't let you down

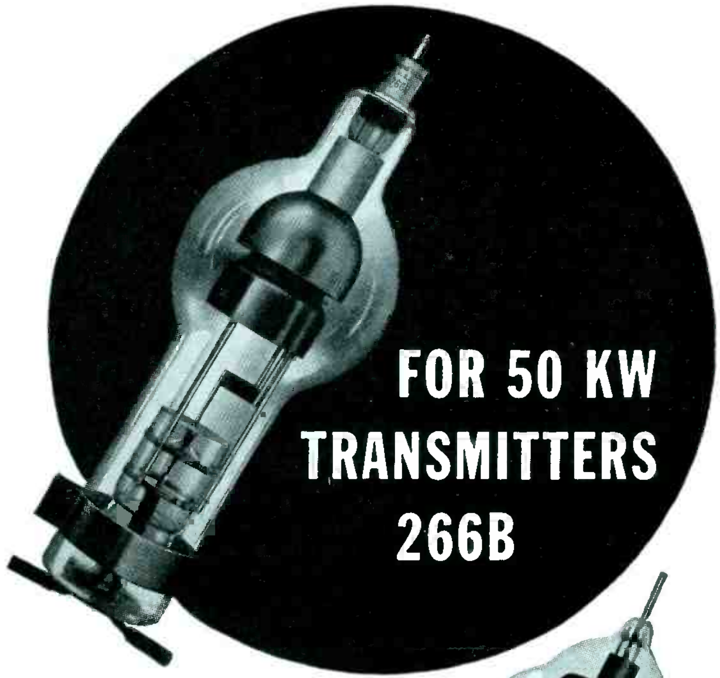
. . . these Mercury Vapor Rectifiers! Broadcasting stations all over the country have found these five tubes remarkable for their long life, reliability and freedom from arcback.

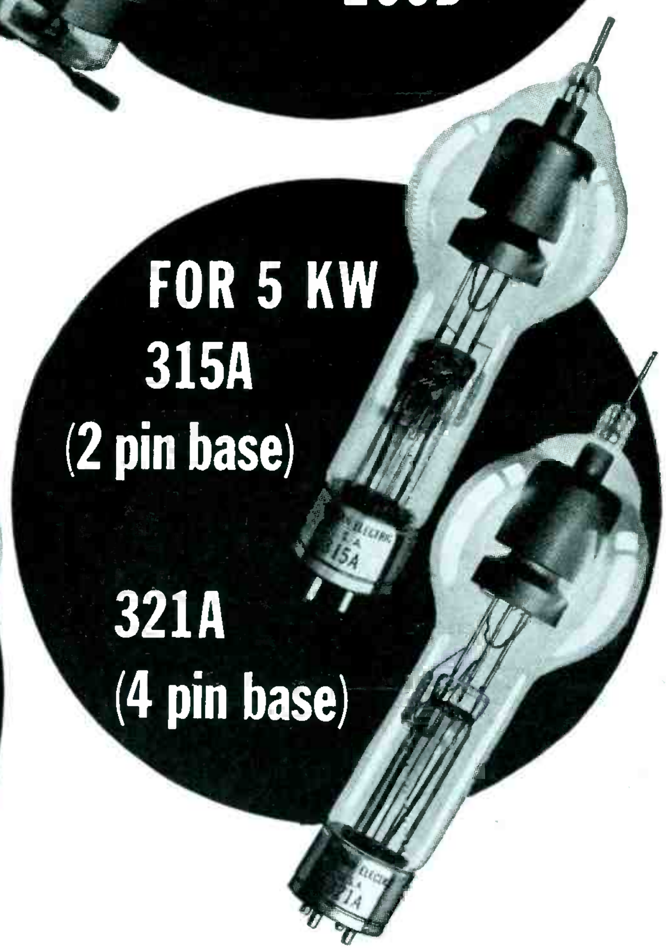
Important features are:

1. *Enclosed field structure:* the anode surrounds the cathode shield and limits ionization to a small volume.

2. *Rugged filament design.*

3. *Reliable glass construction:* careful control of manufacturing processes minimizes glass strains.





CHARACTERISTICS

	266 B	315 A 321 A	267 B 319 A
Filament voltage	5 volts	5 volts	5 volts
Filament current	42 amperes	10 amperes	6.75 amperes
Maximum peak plate current	20 amperes	2.5 amperes	2.5 amperes
Maximum peak inverse potential	20,000 volts	12,500 volts	7,500 volts

Western Electric

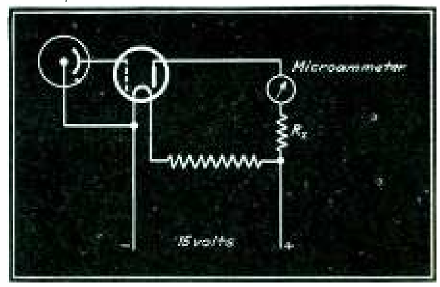
Distributed by GraybaR

Distributed by GRAYBAR Electric Co. In Canada: Northern Electric Co., Ltd.

RADIO TELEPHONE BROADCASTING EQUIPMENT

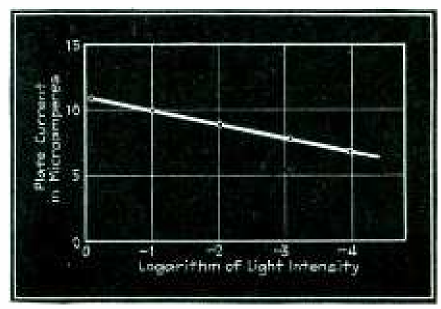
Logarithmic Phototube Circuit

A SIMPLE TYPE of phototube circuit having a response which is a logarithmic function of light flux stimulus is described by John Russell in the December issue of the *Review of Scientific Instruments* under the title "A Photoelectric Cell Circuit with a Logarithmic Response." As shown in the accompanying illustration, the circuit



Schematic wiring diagram of phototube circuit

consists essentially of a phototube, a three-element amplifying tube containing a microammeter from a plate circuit, a power supply, and the necessary voltage dropping resistor. The plate current response of the triode is proportional to the logarithm of the light intensity for a range of 10,000 to 1, according to a chart shown by the author.



Response of the circuit shown above

From the fact that the electrode current is a power function of the electrode voltage, the author shows that (for the circuit shown) the following relation exists:

$$\log i_g = K_1 + K_2 E_g,$$

where, i_g is the current to the grid, in E_g is the potential of the grid with respect to the electron emitting filament. For the equilibrium condition to be established, the current in the phototube and the grid current of the triode must be equal, for, if i_{pe} is the current in the phototube, the relation at equilibrium is

$$i_{pe} = i_g.$$

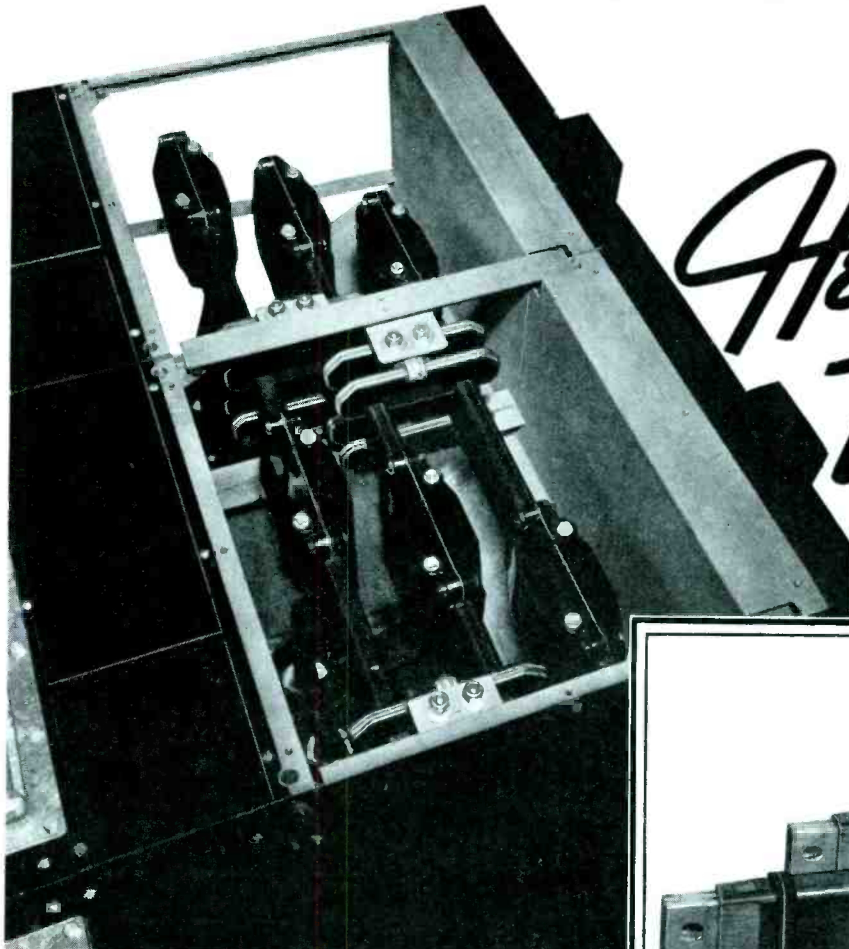
For a vacuum type of phototube, the current flowing through it is directly proportional to the incident light influx so that if F is the value of the incident light flux, the photoelectric current is

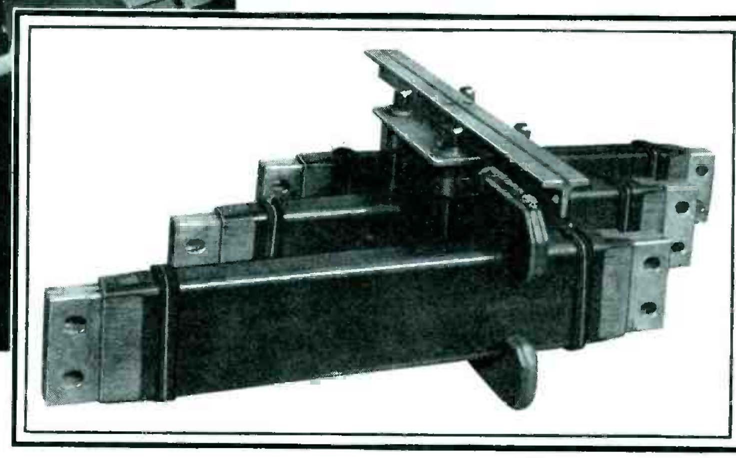
$$i_{pe} = K_3 F$$

This equation can be put into the logarithmic form,

$$\log i_{pe} = \log K_3 + \log F$$

FORMICA INSULATION for *Heavy Duty Bus Bars*





These insulators made from Formica rectangular tubing provide sturdy and efficient protection for heavy duty bus bars as produced by the Delta Star Electric Company, Chicago, Ill. . . . Formica has been used in light and heavy equipment by leading American electrical manufacturers for nearly 25 years—ever since such materials have been widely used in the electrical industry . . . A large producing and machining equipment makes it possible to give prompt service. Send us your blue prints for quotations.

THE FORMICA INSULATION CO., 4638 SPRING GROVE AVE., CINCINNATI, OHIO

FORMICA

From these equations it can be shown that the relation between the incident light flux and the grid voltage is

$$\log F + \log K_3 = K_1 + K_2 E_g,$$

which shows that the grid potential is a logarithmic function of the incident light intensity.

It now remains to produce linearity between the plate current of the triode and the grid voltage, and this is accomplished by the usual method of inserting the high resistance in series with the plate circuit.

• • •

Electron Theory

FOR THE INTELLIGENT reader who is not necessarily a specialist in theoretical physics, the article "Electron Theory," by R. G. Kloeffer in the January issue of *Electrical Engineering* gives a brief and simple picture of modern electron theory. The electron is shown to be a part of the atom, and to be the means by which electricity flows. Its function in electron tubes is explained, and the operation of amplifiers, rectifiers, and photoelectric devices of various types is discussed.

To our editorial co-workers who frequently bombard us with the question, "Say, just what is electronics all about anyway?" we can now point to Mr. Kloeffer's article as providing a basis for answering at least a part of this question.

• • •

HONORED FOR WORK WITH ARTIFICIAL TRANSMUTATION

Prof. E. O. Lawrence, of the University of California, has received the Comstock Award for his discoveries with cyclotron. Here he is inspecting the cyclotron at the University of Rochester with Prof. Lee duBridge (right)

MANUFACTURING REVIEW

News

✦ According to Gerard Swope, orders in every major department of the General Electric Co. were greater in 1937 than in 1936. Nothwithstanding the reduction in the last few months, the number of employees during 1937 was greater than a year ago. Orders received for the fourth quarter amounted to $73,997,063 compared with $84,857,181 for the same period of 1936, a decrease of almost 13%. However, for the nine month period, the total for 1937 was $305,276,556, compared with $211,891,038, representing an increase of 44%.

✦ Handy and Harmon, 82 Fulton St., New York, fabricators of precious metals, announce the formation of a Metal Powder Products Division, which will engage in the development and manufacture of products fabricated from metallic powders.

✦ With the expectation ultimately of doubling its present production and greatly increasing the number of employees, the Spencer Lens Co., 19 Doat St., Buffalo, N. Y., recently completed negotiations for the purchase of 25 acres at Cheetowaga where a new plant will be constructed.

✦ E. K. Cohan, C.B.S. director of engineering, sailed on January 15 for Cairo, Egypt, where he will represent Columbia at the World Telecommunication Conference to be held this month. Accompanying him on his journey is Haraden Pratt, vice-president and chief engineer of the Mackay Radio and Telegraph Co. and president of the Institute of Radio Engineers for 1938.

✦ Ralph J. Cordiner has been appointed manager of the appliance and merchandise department of the General Electric Co. according to an announcement by Charles E. Wilson, executive vice-president of the company.

✦ The order for 42 aviational combination radiotelephone and radio range beacon signal transmitters at 36 stations of the Bureau of Air Commerce of the Department of Commerce is in manufacture at the plant of the Federal Telegraph Co., Newark, N. J. According to Admiral Luke McNamee, president of the company, this equipment will replace and modernize beacon equipment along principal air routes.

✦ Myron T. Smith, formerly sales engineer for the New York Office of the General Radio Co., has recently opened a new office in Los Angeles where he will be available for consultation concerning the application of G-R instruments. In addition to engineering service, a stock of laboratory instruments and parts will be maintained in order to facilitate the prompt handling of orders on the West Coast. The New York office has been taken over by Frederick Ireland, after having spent several years in the factory and laboratories at Cambridge, Mass.

✦ To facilitate service to Canadian radio set manufacturers, Jensen Radio Mfg. Co. has recently concluded arrangements with the Canada Wire & Cable Co., of Toronto, Ontario, for the manufacture of Jensen products in Canada. Mr. C. A. Savage will be in charge of the new Toronto office.

✦ Five post-doctorate scholarships for research in modern physics at the Westinghouse Research Laboratories in East Pittsburgh are to be awarded to young scientific workers this spring, according to Dr. L. W. Chubb, director of the Westinghouse Research Laboratories. Appointment will be for one year and the fellows will be eligible for one reappointment. Five or more fellows will be appointed the following year under a plan which provides ultimately an opportunity for ten physicists to continue research using the facilities of one of the nation's leading industrial laboratories.

✦ John F. Cunningham, supervisor of production for the General Electric Co. since September, 1931, has been appointed assistant to the vice-president in charge of manufacture, according to W. R. Burrows, vice-president in charge of manufacturing. Mr. Cunningham succeeds Myron F. Simmons, who is retiring from the company.

✦ At a recent meeting of the Board of Directors of the Ferris Instrument Corp., of Boonton, N. J., it was decided that the business policies of the company should be continued with as little change as possible, in line with activities under the late Malcolm Ferris. C. J. Franks has recently been elected president and chief engineer of the company and John H. Redington has become treasurer and sales manager.

✦ According to Walter C. Evans, manager, the Radio Division of the Westinghouse Electric & Manufacturing Co., will be moved from its present location at Chicopee Falls, Mass., to Baltimore, Md. Construction of the new factory at Wilkins Ave. and Catherine St., has been begun and it is expected that the transfer of the employees and their families, together with equipment, will be completed within the next six months.

✦ The Wilbur B. Driver Co., of Newark, N. J., paid its stockholders a dividend of 40 cents per share on Dec. 20, and reported a successful year of business together with further expansion of its plant's capacity.

✦ Audio Production, Inc., producers of industrial films, has acquired the Easton Studios of General Service Studios, Inc., the organization operating the former Paramount Studios in Astoria, L. I.

✦ According to an announcement by J. B. Kleckner, president, H. B. Rickards has joined Motiograph, Inc., as advertising and publicity chief. Mr. Rickards comes to Motiograph after a varied experience in both newspaper and theatrical fields. His connection with the theatre dates from the inception of sound pictures when he left the radio promotion department of the Chicago Herald-Examiner to become associated with Paramount Famous Lasky in Hollywood.

New Products

Thermionic Amplifier

A NEW amplifier made by Leeds & Northrup, 4901 Stenton Ave., Philadelphia, makes it possible to adapt existing potentiometers to glass electrode measurements. It will measure ± 0.1 millivolt. Can also be used for measuring potentials encountered in polarization studies.

Power Amplifier

A THREE-STAGE power amplifier having a rated power output of 19 watts with a peak power of 25 watts, an overall gain of 110 db. and a frequency response sensibly flat from 40 to 10,000 cycles has been announced by the Amplifier Co. of America, 37 W. 20th St., New York City.

Field Intensity Meter

A SUPERHETERODYNE RECEIVER, loop antenna, and calibrating oscillator forms a field strength meter developed by Doolittle & Falknor, Inc., Chicago. With batteries the device weighs 43 lbs. The indicator is a microammeter in series with the diode load of the second detector.

Catalog & Literature Service

Manufacturers' literature constitutes a useful source of information. To make it easy to keep up to date, "Electronics" will request manufacturers to send readers literature in which they are interested.

1. Vapor Lamps. A folder on high efficiency mercury vapor lamps is available from the Spanner Vapor Lamp Co., Inc., 781 E. 142nd St., New York City.

2. Protectoid. A folder on a transparent packaging material known as Protectoid is available from the Celluloid Corp., 10 E. 40th St., New York City.

3. Electrometer Tube. Information Bulletin No. 15, issued by the Lamp Division of the Westinghouse Electric & Mfg. Co., Bloomfield, N. J., gives technical data on the type RH-507 electrometer tube, as well as on the type WL-756 carbon resistor tubes.

4. Automatic Control Equipment. Bulletins are available from the Zenith Electric Co., 607 So. Dearborn St., Chicago, covering magnetic contactors, remote control switches, turn switches, interval timers and other automatic electrical control equipment.

5. Microphones. A comparison of the various types of microphones made by the Transducer Corp., 30 Rockefeller Plaza, New York, together with the characteristics of the microphones is available for distribution.

6. Testing Equipment. Test equipment for industry, school and laboratory, is described in a new bulletin issued by the Weston Electrical Instrument Corp., Newark, N. J.

7. Tube Charts. A revised edition of their tube characteristics sheet containing data on all types of tubes available in the Sylvania line is available from the Hygrade-Sylvania Corp., Emporium, Pa.

8. Photoelectric Colorimeter. Bulletin No. 460 describes a photoelectric colorimeter suitable for the quantitative determination of the concentration of solutions possessing inherent color. The bulletin is available from the Rubicon Co., 29 No. 6th St., Philadelphia.

9. Rectifier Power Unit. A 4-page bulletin describing heavy duty rectifiers is available from the B-L Electric & Mfg. Co., St. Louis, Mo.

10. Radio Transmitter. Catalog No. 52 from the Harvey Radio Laboratories, 25 Thorndike St., Cambridge, Mass., describes a number of high-frequency transmitters with output ratings up to ½ of a kilowatt.

11. Fluorescent Paint. An ultraviolet lamp, together with a number of colored fluorescent paints is described in a bulletin issued by the Eisler Electric Corp., 540 39th St., Union City, N. J.

12. Pyrometers. Catalog No. 1101-D of the C. J. Tagliabue Mfg. Co., Park & Nostrand Ave., Brooklyn, provides data on their high speed photoelectric pyrometer.

13. Wire-wound Resistors. A loose-leaf catalog giving technical data on a wide variety of precision wire-wound fixed and variable resistors has been issued by the Precision Resistor Co., 334 Badger Ave., Newark, N. J.

14. Coupling Shaft. Flexible coupling shafts and casings, especially suitable for automobile radio control work, are described in Bulletins No. 1137 and 3093, which are available from the S. S. White Dental Mfg. Co., 10 E. 40th St., New York, N. Y.

15. Amplifier Data. A wide variety of amplifying equipment together with their component parts and technical and other circuit information is given in the third edition of the Amplimanual, issued by the Standard Transformer Corp., 850 Blackhawk St., Chicago. Form No. 101 describes Stancor power supply equipment.

16. Transmitter Manual. Technical data on sixteen radio transmitters up to 1 kw. rating are given in the third edition of the Hamanual published by the Standard Transformer Corp., 850 Blackhawk St., Chicago, Ill.

17. Temperature and Pressure Control. Temperature and pressure control equipment is described in bulletin No. 1172 and catalog No. 1136 A of the C. J. Tagliabue Mfg. Co., Park & Nostrand Ave., Brooklyn, N. Y.

18. Record Price List. A new price list on records and recording equipment is available from the Mirror Recording Corp., 38 W. 25th St., New York.

19. Volume Control Replacement. Copies of the 9-page bulletin which indicate at a glance the make and type of sets served as well as the function of more than 1,200 exact duplicate controls is available from the Clarostat Mfg. Co., 285 No. 6th St., Brooklyn.

20. Relay Equipment. Relays, plugs, switches, and other accessories for communication work are listed in Catalog CC1 released by C. P. Clare Co., 4541 Ravenswood Ave., Chicago.

21. Communicating System. An 8-page catalog describing their communicating systems is available from the David Bogen Co., 663 Broadway, New York.

22. Public Address System. A 16-page catalog describing amplifiers, microphones, and other public address equipment may be obtained by writing to the David Bogen Co., 663 Broadway, New York.

23. Radio Hardware. A 16-page bulletin on radio hardware and manufacturers' supplies is available from the Federal Sales Co., 26 So. Jefferson St., Chicago.

(*Continued on page 67*)

ELECTRONICS **February**
330 W. 42nd Street, New York, N. Y.

Please request manufacturers to send me, without obligation, literature identified by numbers circled below.

1	2	3	4	5	6	7	8	9	10	11	12	13	14
15	16	17	18	19	20	21	22	23	24	25	26	27	28
29	30	31	32	33	34	35	36	37	38	39	40	41	42
43	44												

NAME ....TITLE...............

COMPANY ....

ADDRESS ....

CITY ....STATE...............

24. **Microphone.** A single page leaflet describes the velocity microphone made by the Lifetime Corp., 1010 Madison Ave., Toledo, O.

25. **Voltage Regulators.** Bulletins No. 136 and No. 137-E issued by the Acme Electric and Mfg. Co., 1444 Hamilton Ave., Cleveland, O., describe voltage regulating devices made by this company. A voltage breakdown tester is described in Bulletin 140.

26. **Lighting Transformers.** Transformers for mercury vapor lamps, as well as luminous tube transformers are listed in Bulletins 142 and 141, respectively, of the Acme Electric and Mfg. Co., 1444 Hamilton Ave., Cleveland, O.

27. **Selector Switches.** Multiple point switches, suitable for wave changing and similar applications, are listed in Form 674 of Centralab, 900 Keefe Ave., Milwaukee, Wisc.

28. **Frequency Converter.** A technical bulletin on the 6J8G triode-heptode frequency converter has been released by the Raytheon Production Corp., 55 Chapel St., Newton, Mass.

29. **Bolts and Screws.** A folder issued by the American Screw Co., Providence, R. I., describes wood screws, machine screws, stove bolts, and sheet metal screws, all with a new type of slotted head designed for ease and speed in assembly.

30. **Selector Switches.** A new type of selector switch which is available in many combinations of switch point contacts, is listed in form 674 of Centralab, 900 E. Keefe Ave., Milwaukee, Wis.

31. **Lathes.** Catalog No. 46 of the South Bend Lathe Works, 520 Niles Ave., lists lathe and accessory equipment for metal and wood turning.

32. **Phonograph Equipment.** Spring and electrically-operated motors as well as complete turntables are described in a bulletin issued by the Garrard Sales Corp., 17 Warren Street, New York.

33. **Radio Hardware.** Catalog 37 of the American Radio Hardware Co., 476 Broadway, New York, lists a complete line of small radio hardware and miscellaneous radio parts.

34. **Safety Seals.** The Acro Tool and Die Works, 1401 Wilson Ave., Chicago, has issued a bulletin describing their safety seals for protecting radio receivers.

35. **Transformers.** A four page folder issued by Ferranti Electric, Inc., 30 Rockefeller Plaza, New York, announces a complete line of transformers for aircraft and portable work where space and weight are important factors.

36. Pilot Lamp Equipment. Bulletins PL-P1 and PL-P2, of the Alden Products Co., 715 Centre St., Brockton, Mass., list detachable pilot lamp sockets and related parts.

37. Capacitor Bulletin. The Magnavox Company, Fort Wayne, Ind., has recently established their Capacitor Bulletin dealing with radio service problems. It is expected that this bulletin will be issued monthly.

38. Insulating Varnish. A 32-page catalog on insulating varnishes and compounds has been issued by the John C. Dolph Co., 168E Emmet St., Newark, N. J.

39. Extension Cable. A single leaf bulletin outlining the advantages of their "flat-wove" extension cable has been released by the Alden Products Co., 715 Centre St., Brockton, Mass.

40. Molded Direx. A 12-page well illustrated booklet recording the important part that plastics are playing in radio manufacture has been issued by General Plastics, Inc., North Tonawanda, N. Y.

41. Service Equipment. A bulletin on service radio equipment is available from the Hickok Electrical Instrument Co., 10514 DuPont Ave., Cleveland, Ohio.

42. Transcription Reproducer. The type 26B transcription reproducer made by the Radio Engineering and Manufacturing Co., 26 Journal Square, Jersey City, N. J., is described in a bulletin issued by this firm.

43. Electric Eye Equipment. Phototube control equipment is described in an eight page bulletin of the Photobell Corp., 96 Warren St., New York, N. Y.

44. Neoprene Data. Vol. 1, No. 1 of "The Neoprene Notebook" appeared in January. This publication of E. I. du Pont de Nemours & Co., Wilmington, Del., is intended to supply the designer and manufacturer with technical data on neoprene.

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New Products

Radio Slide Rule

DESIGNED BY W. M. Perkins, the National Union Radio Corp. is making available a new radio slide rule for engineers. The purpose of the slide rule is to permit the rapid determination of (1) capacitive reactance when capacitance and frequency are known, (2) inductive reactance when inductance and frequency are known, and (3) resonant frequency when both capacitance and inductance are known.

Ten New Tubes

Ten new radio tubes intended for use in radio receiving sets and other apparatus designed for their characteristics are announced by the RCA Mfg. Co. Deliveries on order for the new tubes have already been made to the wholesale trade. The ten new types are listed and briefly described as follows:

Type	*Description*
1G5-G	Power Amplifier Pentode
6AC5-G	High-Mu Power Amplifier Triode
6C8-G	Twin Triode Amplifier
6F8-G	Twin Triode Amplifier
6G6-G	Power Amplifier Pentode
6U7-G	Triple-Grid Super-Control Amplifier
6Z7-G	Twin Triode Power Amplifier
6ZY5-G	Full-Wave High-Vacuum Rectifier
25A7-G	Pentode-Rectifier
6V6	Beam Power Amplifier

Power Condensers

A new line of condensers, types TX and TZ, for radio transmitters and high power amplifier applications is available from P. R. Mallory & Co., Inc., Indianapolis, Ind. They are

housed in metal cans, finished with black crackle enamel to match standard transmitter components. The condensers are protected by the special compound which has a high dielectric constant and a high resistance to heat, have a good power factor and stable d-c resistance.

Amateur Receiver

Howard Radio Co., Chicago, has announced a new communication receiver. It uses a 4 channel i-f unit which gives increased band-width and image ratio in the 5 and 10 meter bands, as well as crystal selectivity when desired.

High Frequency Tube

A NEW GAMMATRON known as type 54 is to sell at $6.75. It is a 50 watt triode with an amplification factor of 27, and can be used in the final stage of a broadcast transmitter plate modulator. Made by Heintz & Kaufman, So. San Francisco.

Miniature Transformers

To BE KNOWN as the "Aero Series," Ferranti Electric, Inc., announces a new line of miniature transformers of particular interest to communications and electronic fields. Light in weight,

moisture proof, and extremely small in size, these transformers are very useful for aircraft or portable and compact installations of all types. Frequency range runs from 20 to 20,000 cycles per second. Operating levels from —80 db. to +22 db.

Photocell

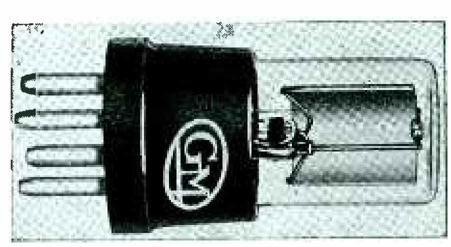
A DRY DISC self-generating photocell of the blocking-layer type has been developed by Hickok Electrical Instrument Co., Cleveland. It has a sensitivity of 6 microamperes per foot candle and can be used in all kinds of light measuring apparatus.

Tube Metal

A NEW rust-resisting metal for internal vacuum tube use, and known as Sveacote has recently been offered by the Swedish Iron & Steel Corp., 17 Battery Pl., New York City.

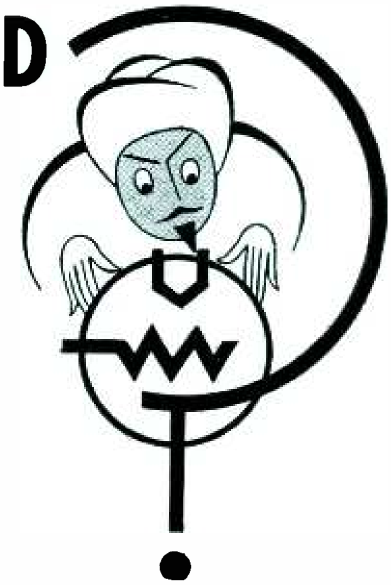
Miniature Photo Tube

HAVING ALL the performance characteristics of larger phototubes, but especially designed for small size apparatus, the latest addition to the G-M



line of phototubes is their type 62-A tubes having an overall lengh of 2 in. The phototube is manufactured by the G-M Laboratories of Chicago.

WHAT'S AHEAD



Read "Thyratrons and Their Uses" by Dr. E. F. W. Alexanderson in the February issue of ELECTRONICS. This famous engineer of the G-E research staff gives you a conservative view of the amazing prospects for exploration in just one branch of the electronics industry.

On page 22 of the January issue of RADIO RETAILING, Beverly Dudley, (Associate Editor of ELECTRONICS) tells the retailers that **another** sales opportunity is on the way, in his article "and What About Facsimile?"

National and Columbia Broadcasting are building studios, buying components and portable field equipment for television.

Broadcasting stations are putting up new radiators, modernizing studios, swinging over to high fidelity.

The concensus of hard-headed radio manufacturers is that the recession has presaged a **bigger** year for 1938-39 because it has created a holdover market to **add** to a general boom by summer.

Six NEW advertisers started in the January issue of ELECTRONICS. Older advertisers are increasing space. More new ones in February.

Business is GOOD for those who look ahead. This is no time to get fractious. One may be left at the post.

ADD ELECTRONICS TO YOUR SALES ORGANIZATION

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Covering through 13,000 Subscribers and more than 35,000 pass-on readers —

The radio industry—Broadcasting and Communications—Television and Facsimile—the Sound Industry—Industrial Manufacturers — Electrical and Testing Laboratories.

electronics

radio.sound.communications.industrial applications of electron tubes....design.engineering.manufacture

330 WEST 42ND STREET
NEW YORK, N.Y.

Acoustic Reproducer

INTERNALLY FOLDED so as to reduce its length by more than one-half the model PR telescope acoustic reproducer of the University Laboratories, 191 Canal St., New York City, is a 3½-ft. exponential air column horn. The speaker employs a permanent magnet dynamic unit which has a continuous rating of 25 watts. The horn is constructed entirely of aluminum and weighs 4 lb.

P. A. System

A 25-WATT power amplifier system using beam power tubes, and including two 12-in. permanent magnet speakers has been released by the Operadio Mfg. Co., St. Charles, Ill. This equipment is known as the Model 132-BAC public address system.

Record Changer

A NEW RECORD changer playing either eight 10-in. or eight 12-in. records, available for any current and also

with crystal pick-up, has recently been introduced by the Garrard Sales Corp., 17 Warren St., New York City.

Voltage Regulator

THE NEW H SERIES of a.c.-d.c. replacement regulators are equipped with starting resistor which prevents overloading a pilot light when the radio set is first turned on. The units are made by the Amperite Company, 561 Broadway, New York.

Metal Detector

DETECTING EQUIPMENT for determining the presence of iron, steel, or other magnetic metal, is now being offered for industrial use by the Industrial Testing Laboratories, Inc., of Chicago, Ill. The detector consists of three distinct parts; the detector, the amplifier and the supervisory signals which indicate the presence of magnetic material. Amplifier and signal indicator may be made an integral part of the call system, or they may be remotely located.

Video Unit

(Continued from page 34)

With the negative of the sweep circuit power supply grounded, the final anode and deflection plates of the cathode ray tube are at nearly the same voltage as the plates of the amplifier tubes. Condensers of comparatively low voltage rating and small physical size may therefore be used to couple the deflection amplifier output to the plates of the cathode ray tube. Positioning voltage for this circuit is obtained, as shown in Fig. 1, from the bleeder consisting of all the position control potentiometers in shunt with R_{55} and R_{56} and in series with R_{13}. This circuit is sufficient to provide the small range of positioning voltage necessary for keeping the raster centered on the screen under all conditions.

The results of the design precautions discussed above have been immediately apparent when carried into practice. The sweep circuit and power supply shown in Figs. 1 and 2 have been constructed and found to be entirely satisfactory for the class of work for which it was designed. The design of the unit has followed the present tentative R.M.A. standards of 441 lines per frame, interlaced, and 30 frames per second. The linearity of the sweep circuits is comparable with that found in good cathode ray oscillograph design. Return trace time for the sweep circuits is considerably shorter than the time alloted to blanking pulses in the tentative R.M.A. television standards. A synchronizing signal of one tenth of a volt is entirely adequate for synchronizing the sweep circuit. Uniform focus over the entire screen area of the cathode ray tube is as much a problem in tube design as in circuit design. Assymetric deflection was investigated, however, by tieing one of the deflection plates to the final anode. The results showed that a definite improvement in focus is obtainable by using symmetric deflection and positioning. The a-c modulation of the beam from the power supply output is entirely invisible when the tube is operated at normal beam intensities and the raster is synchronized in the normal manner to the incoming television signal.

NEW BOOKS

Modern Plastics

Annual Catalog and Directory Issue. Breskin and Charlton Publishing Company, New York. Price $2.00.

A PHENOMENAL growth in the production and use of plastics has occurred within the last several years: Today plastics have a recognized place in the national economy. The number of new materials now available to industry, grouped under the general name of "plastics" has become very large indeed.

For the second year, Modern Plastics has produced a catalog and directory issue; a book of some 340 pages which, in modern and beautiful format, includes sections on materials, molding and fabricating, machinery and equipment, product development, a bibliography and a directory of machinery equipment and supplies.

Anyone interested in plastics, and it seems that nearly everyone in any industry must be, can get a very good picture of the new materials and how to use them by perusing this annual directory issue.

Questions and Answers Handbook

Allied Radio Corporation, Chicago, 1937, price 95 cents.

SOME 3,000 questions on all phases of radio engineering, design and service have been compiled by the Institute of Radio Service Men and assembled in a handy looseleaf folder.

The questions and their answers are arranged in chapters as follows: basic theory, radio frequency, batteries, tubes, superheterodynes, audio frequency, public address, power supply, protective measures etc.

• • •

TELESCOPIC ANTENNA

This radio-equipped German Coast cutter has solved the antenna problem with a collapsible vertical mast, surmounted by a "capacity top" plate which raises its effective height. When extended the mast is fifteen feet high

Motion Picture Sound Engineering

A symposium of papers on recording and reproduction equipment and practice. Published by the Research Council of the Academy of Motion Picture Arts and Sciences, Hollywood. 525 pages, price $4.00.

THIS BOOK of 39 chapters deals with the mechanical and electrical circuits, apparatus, technique of the sound motion picture industry. It was made up of individual papers and sections written by outstanding experts in the several studios and in manufacturing companies. Lectures given to students in sound and conducted by the Research Council are included.

Such matters as film recording, noise reduction, film drive, phase distortion, equalizers, attenuators, filters, tubes and amplifiers, rectifiers, level indicators are only a few of the subjects covered and picked at random from the complete list of chapters.

Fundamentals of Radio

By F. E. TERMAN, *McGraw-Hill Book Company, 460 pages, $3.75.*

PROFESSOR TERMAN has cut down his large Radio Engineering to make a text for a one year preliminary course in the principles of radio communication. He has been aided by Lieutenant F. W. MacDonald of the Naval Academy and by Lieutenant Colonel C. L. Fenton of the Military Academy.

Problems differing from those in the larger text are included in this smaller book. They require no complex algebra for their solution. The author has cited no extensive references to the literature; the text picks out a straight course and sticks to it. Digressions are limited; the student is given the fundamental facts and must get his more complete information later in a more advanced text and course.

The advantages of such a book to the elementary student are obvious. He is not dismayed by the quantity of material there is to learn. He is taken over the field quickly and without too much confusion.

The simplification process can be overdone of course. The book states that condensers do not return all the energy put into them; that the power factor is a characteristic of the dielectric, and that the power factor is of the order of 0.042 for celluloid. One assumes that power factor is a measure of the loss in a condenser but the book does not say so; nor does it state what the actual losses might be if the power factor is 0.042.

The individual chapters and sections are exactly what one might think, and what one would want in an elementary text. Fundamentals, receivers, tubes, transmitters, antennas, acoustics, television and other pertinent subjects are covered in their turn.

Questions and Answers

Answers to questions posed by *Electronics* readers are due to Mr. Samuel Wein and others.

12. Bombay, India—*I have tried several methods for preparing a cuprous oxide photo-electric cell but not with much success. I would therefore feel obliged to know of a method which would be simple and yet show good results. The photo-cell should give a moderately high output to work into a sensitive relay.*

[A] There is no simple method of making a "good" copper-oxide photocell. However, it is not too difficult to make an electrolytic cell which has high output.

Cut a piece of pure copper to desired dimensions. Clean it brightly by alternate dips in concentrated nitric acid and water. Support edgewise in a furnace and allow the copper to oxidize for 15 minutes at 1000° C. Remove and cool in air until just below red heat and then plunge into water.

Scratch a contact area on one side and flatten the piece. Remove black oxide film by a three-minute etch in a two-per cent solution of sulphuric acid at 80° C. Brighten by alternate brief dips into concentrated nitric acid and water.

Coat the exposed edges of copper with a pigmented lacquer for insulation purposes. With a low-melting solder, connect a wire to the scratched area on the back of the piece. Frame the front surface of red oxide with a ribbon of lead to which a terminal wire has been attached. Mount the assembly into some suitable container in such a manner that the front surface of the oxide is exposed while the back side is hermetically sealed with, say, beeswax. With the lead frame in place, pour onto the oxide an eighth-inch layer of two-percent solution of lead nitrate in agar-agar gel. (I suppose any clear gel will serve.) Press on a window of glass and hermetically seal the container. The two terminal wires may be brought out through any convenient sealed openings in the container.

The resultant cell should deliver milliamperes in bright light and should be capable of operating a d'Arsonval type of relay. In time electrolytic action will deteriorate the cell.

13. Johnstown, Pa.—*I understand that it is possible to use a source of E. M. F. with the "barrier" or dry self generating light sensitive cell, the purpose being to increase the output and so make it possible to use an inexpensive or comparatively insensitive relay.*

[A] The use of potentials not exceeding 6 volts can be used with such cells. The voltage is a function of the active area of the cell. For instance,

the small areas use 1.5 volts and the larger sizes up to 2 inches in diameter will permit the use of 6 volts in its circuit.

When a source of E. M. F. is used in connection with these types of cells, the action is no longer "electronic" per se, but rather is "photo conduction", i.e.: in which the internal resistance of the circuit varies with the light it is subjected to.

14. Brooklyn—*We are interested in opening and closing a circuit through the medium of a slow acting relay, the cost of which is of paramount importance because of the large number to be used.*

[A] Thermal types of relays should not be overlooked. This type of relay makes use of a "bi-metal" which when heated bends and makes contact, or breaks a contact. Two methods of heating the bi-metal are in common use, they are (1) the current actually passing through it, and (2) by winding a heater coil around the bi-metal. Because of the thermal lag of the bi-metal, the action is slow.

15. New York, N. Y.—*Can a barrier type cell be cut, and what is the result of this cutting upon the output?*

[A] This type of cell can be cut without any appreciable reduction of the output as long as provisions have been taken not to over-heat the disc.

The best way to proceed is to recess a piece of wood so as to fit the cell (disc). Now, a sawcut ought to be taken through the wood in the direction of the intended cut of the cell (disc). The actual cutting of the cell should be done with the finest jeweler's saw available and without exerting too much pressure to avoid overheat.

16. Cleveland—*I want to form a film of metallic caesium on the inner wall of a glass bulb previously evacuated. The caesium film is intended to serve as a photo electric film in an inexpensive cell. Can you give me some material help in this direction?*

[A] A mixture is made of zirconium and caesium dichromate and formed into a "getter pill" by placing it in a nickel cup, and fixed into glass bulb subsequently evacuated. If the pill is now subjected to heat from an induction furnace, the zirconium will "flash" reducing the caesium dichromate and distilling the metallic caesium on the wall of the glass bulb where it forms a film on it.

For practical and inexpensive photo cells, it is suggested that the caesium film be deposited on a film of metallic magnesium which serves as the conducting film. This is done by first distilling metallic magnesium on the inner wall of the glass bulb and subsequently distilling the caesium thereon.

Cells made in this fashion were found to have a low light sensitivity with respect to the modern caesium oxide on silver oxide, but, if an inexpensive cell construction is desired, this is the most efficient method to use.

PROFESSIONAL SERVICES

20. Boston—*Will you give us the name and address of the firm making lenses from plastic compounds?*

[A] The plastic compound referred to is that made by Rohm & Haas. The lens itself is made from the material by

Unbreakable Lens Co. of America
401 No. Maple Drive
Beverly Hills, Calif.

These do not break so easy as by dropping on the stone pavement, etc. Will not discolor with the heat of the light source. Can be fixed into a metal mount much in the same fashion as metal to metal, or can be glued in with a suitable glue furnished by the makers.

They serve excellently for light sources in connection with photocell devices.

21. New York City—*I understand that the barrier cell is now being experimentally used in reproducing sound from talking motion picture films.*

[A] We have witnessed a demonstration of a device called a "film phonograph" in which a sound record on a film was reproduced using a barrier cell which was cut to the exact dimensions of the sound slit itself. This did two things, i.e.: (1) obviated the need for an optical slit, and (2) reduced to a minimum the internal capacity of the cell, and so made it possible with a 45 type tube to amplify the sound with excellent results. The "cell" so formed was mounted in a suitable holder and connected directly to the grid of the vacuum tube. Another circuit was to use the cell with an input transformer. A third circuit was the use of 4 to 6 volts in series with the cell.

VENDING RADIO PROGRAMS

Mr. H. Narding of Ebbw Vale, South Wales, who supplies 500 subscribers with programs, picked up on this receiver, and fed to his neighbors over wires. The system has been is successful operation for four years

Patent Suits

1,507,016, L. de Forest, Radiosignaling system; 1,507,017, same, Wireless telegraph and telephone system, C. C. A., 2d Cir., Doc. 15,333, *RCA et al.* v. *F. A. Andrea et al.* Decree modified (notice June 7, 1937).

1,403,475, H. D. Arnold; 1,403,932, R. H. Wilson; 1,507,016, L. de Forest; 1,507,017, L. de Forest; 1,618,017, F. Lowenstein; 1,702,833, W. S. Lemmon; 1,811,095, H. J. Round, D. C., N. D. Calif., Doc. 4166-R, Eq., *RCA et al.* v. *Cavalcade Radio Corp. et al.* Default decree holding patents valid as to certain claims and infringed, injunction, July 3, 1937.

1,573,374, P. A. Chamberlain; 1,707,-617, E. W. Kellogg; 1,728,879, C. W. Rice et al.; 1,795,214, E. W. Kellogg; 1,894,197, C. W. Rice et al.; 2,052,316, R. E. Sagle, D. C., N. D. Calif., Doc. 4167-R, Eq., *RCA et al.* v. *Cavalcade Radio Corp. et al.* Default decree holding patents valid as to certain claims and infringed, injunction, July 3, 1937.

1,889,758, T. H. Nakken, Means for transforming light impulses into current impulses; 2,039,182, same, Reproducing system; Re. 16,870, same, Means for transforming light impulses into electric current impulses, filed July 8, 1937, D. C., Dist. of Col., Doc. E-64-893, *Nakken Patents Corp.* v. *Crescent Amusement Corp.*

• • •

A.V.C. FOR AUTO RADIO

R. M. Smith and Irving Wolff of RCA Victor with their volume control device which operates to increase volume as the speed, and noise, of the car increases

SEARCHLIGHT SECTION

EMPLOYMENT : BUSINESS : OPPORTUNITIES : EQUIPMENT—USED or RESALE

UNDISPLAYED RATE:

10 cents a word, minimum charge $2.00.

Position Wanted, (full or part-time salaried employment only), ½ the above rates, payable in advance.

Proposals, 40 cents a line an insertion.

INFORMATION:

Box Numbers in care of our New York, Chicago or San Francisco offices count 10 words additional in undisplayed ads. Replies forwarded without extra charge.

Discount of 10% if full payment is made in advance for four consecutive insertions of undisplayed ads (not including proposals).

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1 inch.......................$6.00
2 to 3 inches.................. 5.75 an inch
4 to 7 inches.................. 5.50 an inch

An advertising inch is measured vertically on one column, 3 columns—30 inches—to a page. *Contract rates on request.*

(New advertisements must be received by February 23rd for the March issue)

POSITIONS WANTED

EXPERIENCED LICENSED FIRST CLASS radio telephone operator desires permanent position. PW-139, Electronics, 330 West 42nd Street, New York City.

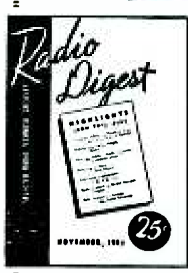
MECHANICAL ENGINEER, young. Experienced in coil winding and threading desires position. Particulars on request. PW-140, Electronics, 330 West 42nd St., New York City.

LICENSED RADIO TELEPHONE Operator, first class. Single, free to travel. One year of college, year of experience in Cathode-Ray Development Department, amateur operating and radio servicing experience. Desires contact progressive station that can place new man. PW-141, Electronics, 330 West 42nd Street, New York City.

RADIO-ELECTRICAL ENGINEER, M.A.Sc. degree, American, 28, single. Fully experienced in all phases of radio, including design and installation of broadcasting equipment. Past 4 years chief engineer CJOR Vancouver. PW-143, Electronics, 883 Mission Street, San Francisco, Calif.

WANTED

WANTED: Volumes of Proceedings I. R. E. from 1918. Must be cheap. W-142, Electronics, 330 West 42nd St., New York City.



Sensation OF THE RADIO FIELD!

- It's the ONLY magazine with the best from ALL branches of radio (except business and entertainment)
- Digests, extracts, reprints from QST, Radio, All Wave Radio, Radio News, Electronics, Service, Communications, Bell System and R C A papers, house organs and other journals
- Twelve issues for $2.50 in U.S.A., Canada, and Pan American countries. Elsewhere, $3.00 or 12s 6d. Sample copy, 25¢

RADIO DIGEST
7460 Beverly Blvd. Los Angeles

GLASSBLOWERS

Manufacturers of rare gas production items. High vacuum glass apparatus. Special apparatus to blueprints.

Hudson Brothers Mfg. Co., Inc.
539-41 Forty-Second Street Union City, N. J.

New "SEARCHLIGHT" Advertisements

must be received by the 23rd of the month to appear in the issue out the following month.

Address copy to the Department Advertising Staff
Electronics
330 West 42d St., New York City

QUARTZ

Quartz or Glass Apparatus—Gaseous Discharge Tubes of all descriptions.

Built to your specifications. We number among our customers America's largest manufacturers of Ultra Violet Equipment.

HYDE TECHNICAL LABORATORIES
1140 Venice Blvd., Los Angeles, Calif.

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NATIONALLY ADVERTISED **RADIO** PRODUCTS

WRITE FOR OUR 1938 CATALOG

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963 LIBERTY AVE. PITTSBURGH, PA. • 30 TWELFTH ST. WHEELING, W. VA.

Established 1919

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Electronic Devices	Lead to Pyrex Seals
Cathode Ray	X-Ray Assemblies
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TECHNICAL GLASS LABORATORY
200 Pennsylvania Avenue Hillside, N. J.
WAverly 6-0253

Meters repaired, made more serviceable. Conversion to higher sensitivity as high as 10 microamperes for Weston type I or 24-57.
Sensitive vacuum thermo-couples
For Sale used Weston panel meters, Rawson microammeters, Brown pyrometers. *Reasonable Prices*
Precision Electrical Instrument Co.
561 Broadway, N. Y. C.

DEPENDABLE

New and Used
ELECTRONIC TUBE EQUIPMENT

A complete line of equipment for the manufacture of Radio Tubes, Neon Tubes, Incandescent Lamps, etc.
Write for Bulletin showing savings from 25 to 75%

EISLER ELECTRIC CORP.
534 39th Street, Union City, N. J.

E. H. RIETZKE PRES. OF CREI

INSURE YOUR FUTURE!

Start Training Now in

PRACTICAL RADIO ENGINEERING

Do you ever sit down and "look your job in the face"? Are you satisfied with your present position, or anxious to get ahead? Today, you can't be satisfied, because rapid new developments mean Radio wants only men who are TECHNICALLY TRAINED.

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Right now is the time to start training—so you won't be left behind when others go ahead. CREI offers you home-training that will equip you to keep pace with, and get ahead in Radio.

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New booklet describes CREI home-study and residence courses. Fully illustrated —crammed with interesting information. Gladly sent on your request.

CAPITOL RADIO ENGINEERING INSTITUTE
Dept. E-2
Washington, D. C.—14th & Park Road
New York City—29 Broadway

SOLENOID COUNTERS

New four wheel counters in horizontal position 1300 ohm 24-48 volts, d.c.

Used particularly in photo-electric cell applications. Original cost $6.50; while limited stock lasts, **$2.00 each; 3 for $5.00.** C.O.D. only, parcel post prepaid anywhere in U. S. A. Perfect condition guaranteed or money refunded.

FEDERAL SALES COMPANY
26 S. Jefferson St. CHICAGO, Ill.

HIGH GRADE NEW AND USED

ELECTRON TUBE EQUIPMENT

Huge Stock of Equipment of Every Type and Variety

KAHLE ENGINEERING CORPORATION
Specialists in Equipment and Methods for the Manufacture of Neon Tubes, Radio Tubes, Incandescent Lamps, Photo Cells, X-ray Tubes, etc.
941 DeMott St., North Bergen, N. J.

CHAS. EISLER'S

Equipment Has Produced

MILLIONS

FOREMOST IN THE ELECTRONICS FIELD FOR OVER 20 YEARS!

Charles Eisler's equipment for the production of radio and electronic tubes, incandescent lamps, X-ray and cathode ray tubes, photo-electric cells, and neon signs has met the severest demands of industry in operating at the lowest cost and the highest efficiency. If you are in the market for any of this or allied equipment including electric spot welders up to 250 KVA, butt, and arc welders, get in touch with us. Write for our "college and glass working laboratory units" catalog if interested in equipment for instruction purposes.

750 S. 13th St. (Near Avon Ave.) ***EISLER ENGINEERING CO.*** ***Newark, N. J.***

VACUUM THERMOCOUPLES

Separate Heater and Contact Types, Mounted and Unmounted
Ranges from 1 Milliamp and up
Write for Bulletin "A"

American Electrical Sales Co. Inc.
65-67 E. 8th St., New York, N. Y.

INDEX TO ADVERTISERS

PIONEER OF THE AIR

FOUNDED IN 1919, the Radio Corporation of America has completed 18 years of pioneering effort to develop and improve the uses of radio.

Starting "from scratch," RCA has created a world-wide communications system with direct circuits between the United States and 42 foreign countries, and with ships at sea. It has created a nation-wide broadcasting system of endless cultural possibilities, now rapidly expanding its services by short-wave to all the world. It has created essential instruments for the radio transmission and reception of sound, of code messages, and of facsimile reproductions, and for the recording and reproduction of sound on records and on motion picture film. It has created countless radio devices indispensable to modern science, industry, medicine, telephony, and public safety. It has created the basis for a system of electronic television, forecasting the day when radio sight, added to sound, will perform a useful public service.

Today the Radio Corporation of America is owned by nearly a quarter of a million stockholders in 48 states. No one person owns as much as ½ of 1% of its stock. Achievements of the past 18 years are a tribute to the American tradition of service in the public interest through private initiative and ownership.

RCA presents the "Magic Key" every Sunday, 2 to 3 P.M., E.S.T., on NBC Blue Network.

RADIO CORPORATION OF AMERICA

RADIO CITY • NEW YORK, U. S. A.

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RCA COMMUNICATIONS, INC. • RCA INSTITUTES, INC. • RADIOMARINE CORP. OF AMERICA