electronics

radio, sound, industrial applications of electron tubes + + + design, engineering, manufacture

A patent pool for radio?

+

Permeability tuning

+

Sound-picture markets abroad

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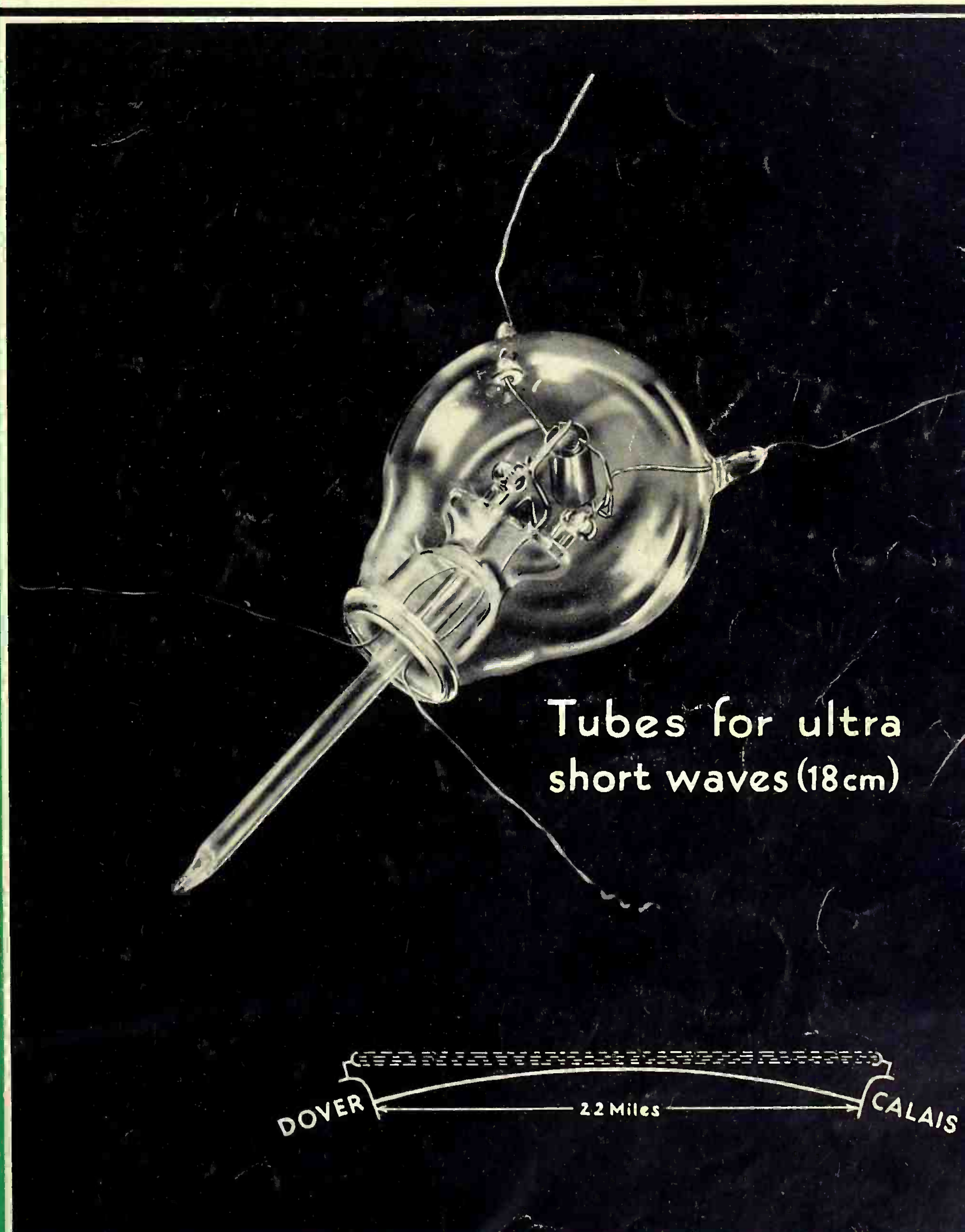
Electronic music

+

RMA Trade Show trends



Tubes for ultra short waves (18 cm)

A McGRAW-HILL PUBLICATION

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A McGRAW-HILL PUBLICATION

New York, July, 1931

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The blight of price

radio
sound pictures
telephony
broadcasting
telegraphy
counting
grading
carrier systems
beam transmission
photo cells
facsimile
electric recording
amplifiers
phonographs
measurements
receivers
therapeutics
traffic control
musical instruments
machine control
television
metering
analysis
aviation
metallurgy
beacons
compasses
automatic processing
crime detection
geophysics

RADIO now faces a new internal competition—the bitter wrangle of price whittling—which is bound to manifest itself as a blight on every part of the industry.

Former standards of quality are being abandoned in some quarters, in desperate efforts to get prices below competing low standards.

Conservative factors of safety in set design and set manufacture are being wiped out, and the market is being flooded with receivers which "just get by"—with prospects of troublesome breakdowns after a few months in the customer's hands.

Tone quality—a requirement all important, if broadcasting is to continue as a dominant musical medium—seems to have been forgotten, in the race to shave costs.

ALL along the line, this blight of price is being felt, throughout the trade and industry, and in the associated fields of broadcasting and parts manufacture.

Makers of components entering into radio sets find that their specifications and prices are being hammered down, until price paralysis penetrates even the outermost fringes of parts making.

Dealers and distributors protest that present low price units give them little on which to operate successful businesses. Broadcasters see the doom of their great new art, if poor radio reproduction is to be the standard,—rather than full fidelity of tone.

EVERY group concerned deplores the price situation in which radio finds itself today.

It is time the radio industry turned about and climbed out of this price morass. Every group is anxious to get back on good firm ground.

Strong leadership will find an army ready to follow.

IS A RADIO PATENT

Present economic situation points to importance of eliminating costly litigation between manufacturers

FOR months and years past, patent pooling has been proposed for the radio industry, along lines satisfactorily employed in the automobile field. Such pooling, it has been pointed out, would reduce or eliminate the costly litigation which has beset the radio industry during all its years of greatest growth and prosperity. A pooling plan, its advocates declare, would stabilize the industry and would secure the fullest measure of coöperation between manufacturers, while obtaining for inventors and patentees the greatest rewards for wide use of their patents.

The recent Supreme Court decision denying the validity of the Langmuir "high-vacuum" patent (generally regarded as one of the most important patents in radio), has called attention anew to the fact that few of the many radio patents have ever been adjudicated, and that the host of remaining patents might be better administered and evaluated by cooperating interests, rather than be made the basis of endless litigation by contending groups.

To obtain a cross-section of present industry opinion on the subject of patent pooling, the editors of *Electronics* telegraphed well-known figures in the manufacturing field, inviting expressions of opinion regarding the desirability of a patent pool at this time, and the economic need for such pooling of patents as a means of eliminating expensive litigation. Opinions were also invited regarding the desirability of frank interchange of patent information and constructive use of the radio industry's resources, for investigating the scope and validity of patents, as a step toward closer industry cooperation.

Otherwise Congress may act in ways detrimental to radio industry

By Morris Metcalf
United American Bosch Corporation, Springfield, Mass.
Past-president, Radio Manufacturers Association

Nearly every set manufacturer operates under continuous hazard of patent litigation, and royalties now paid do not give adequate protection. Our company has never denied the rights of owners of substantial patents, but I feel that the strong-arm and tactless methods used by some patent-holding groups plus the racketeering methods of others have aroused such antagonism and resentment that politicians will capitalize this situation and Congress may force a showdown.

I am strongly of the belief that the time has come for the industry to establish a patent pooling arrangement under the leadership of the RMA, and the more important holding groups or it will be done for us in ways that will be to the disadvantage of the radio industry.

"Now, if ever," is time to reduce burden of "untenable patent situation"

By H. B. Richmond
Treasurer, General Radio Company,
Past-president, RMA.

Radio has been a popular subject and thereby has attracted many workers. Many patents have resulted, no small number of which have been issued to persons not directly associated with the manufacture of radio receivers.

The industry has seen the development of several licensing groups built up around patents, only a microscopic number of which have been adjudicated by a court of appeals. Royalties to these groups are threatening the solvency of the radio industry.

In addition to these groups there are now a host of independent patent holders clamoring for royalties. Most of these patents have not been contested for validity. The cost of investigation of these patents to individual manufacturers, added to the royalties already being paid is an important factor in making it impossible for the radio industry to operate at a profit.

Now if ever, the time has arrived for the industry to pool its resources to reduce the burden imposed by the present untenable patent situation.

The Radio Manufacturers Association has for several years proposed a plan. This plan, free from individual domination, working for the good of the whole, could now be consummated to the mutual advantage of manufacturers, patent holders, and the purchasers of radio products.

Could acquire patent rights of common interest

By B. J. Grigsby
President, Grigsby-Grunow Company, Chicago, Ill.

Patent threats, royalty demands, and litigation over patents have been a paramount factor in disturbing the industry and preventing cooperation on matters of vital common interest. These conditions have permitted owners of patents to harrass the industry, putting its members to millions of dollars of unnecessary litigation expense and extorting from them additional millions for royalties under patents which the courts have ultimately declared invalid. All of these factors have contributed to high cost of products to the public and to lack of profits to the members of the industry. It has been clearly demonstrated that these intolerable conditions can be remedied only by a pooling of patents along the line of the RMA plan patterned after that of the automobile industry. Under such a plan there is a free interchange of patent information and the resources of the industry are made available for joint defense against invalid patents and improper royalty demands, and for the acquisition of patent rights of common interest. Now is the time for adoption of the plant which has been approved several times by the industry as a whole and for closest cooperation on all matters of common interest.

In 1927, proposed pool with centralized engineering laboratory

By Edgar Rickard
President, Hazeltine Corporation, Jersey City, N. J.

Hazeltine Corporation has always been in favor of the broad principle of a patent pool for the radio industry. Its present attitude, although favorable, is conditional upon the safeguarding of its rights that have been established in expensive and bitterly contested litigation against infringers.

More than four years ago Hazeltine Corporation presented a definite, constructive plan to Radio Corporation of America. This plan proposed a pooling of *all* radio patents; a centralized engineering laboratory for the industry free from the control of any one manufacturing company; one all-comprehensive royalty; the elimination of patent litigation; and a centralized organization to promote the wider use of radio. This plan was rejected as visionary.

At that time no radio patent pool would have been practicable without the inclusion of Radio Corporation of America; consequently, Hazeltine Corporation, in order to protect its rights, was compelled to engage in extensive litigation against com-

POOL THE WAY OUT?

Interests of all parties, independents as well as RCA group, declared protected by open interchange

panies, including Radio Corporation, which Hazeltine Corporation considered to be infringers of its rights.

Although Hazeltine Corporation has, in the past, been in favor of a patent pool, the development of the industry has been such that we feel we now owe a prior obligation to our own loyal licensees and to our own stockholders. We intend to fulfill that duty.

We have no desire to block any constructive move to establish whatever desirable result an industry-wide patent pool might bring about; therefore we would be ready and willing to give serious consideration to any concrete plan that may be proposed. We will not, however, acquiesce in any plan that does not fully take into consideration our rights.

Pool's success must start at top

BY POWELL CROSLEY, JR.
President, Crosley Radio Corporation, Cincinnati, Ohio.

Attempts toward bringing about patent-pooling plan sound fine, but is it reasonable? Economic conditions in radio industry certainly require alleviation of present excessive royalties to make such a plan workable.

Start will have to be made at top, working down, rather than at bottom, working up, if you know what I mean.

Patent pool is today an economic necessity

BY C. C. COLBY
President, Samson Electric Company, Canton, Mass., Past-president, RMA.

For many years I have favored patent pooling in the radio industry as an economic necessity. Today the need is greater than ever. It would stimulate development, standardize equipment, improve products, result in cost reductions, and bring a united industry into a cooperative effort that will avoid unprofitable litigation and gain the good will of the American people. This is necessary today if radio is to consistently advance. The frank interchange of patent information would prevent the foisting of unsound and unwarranted patents upon the industry, as few patents can stand thorough investigation and analysis. Such close industry cooperation would result in untold benefit to obtain these benefits. However there must be an industry pooling of patents and not a mere paternal licensing arrangement such as the industry has had and is now suffering under.

Patent library a valuable adjunct of pool

BY HERBERT H. FROST
President, Frost-Minton Company, New York, Past-president, RMA.

The stabilization of the radio industry cannot be effected until patent pooling becomes a reality. Continuation under existing conditions means a continuation of litigation, uncertainty and artificial costs, which in themselves prevent stabilization of any industry. The RMA through its patent pooling plan is ready to undertake this major endeavor just as soon as the manufacturers are ready to come in. In addition to the patent pool it would be necessary to set up a complete patent library under competent legal personnel in order that members of the patent pool may at all times call on this agency for information. Patents, or patent applications offered to the radio industry could be passed upon by this agency and in case of attack by any patent-holder not willing to place his patents in the RMA pool, this agency would be in an admirable position to defend any member of the pool or group of members so attacked.

Most suits have shown patents invalid

BY ERNEST KAUER
President, CeCo Manufacturing Company, Providence, R. I.

The automotive industry has found it profitable, over a period of years, to pool their patents. In addition, the lack of patent litigation in the automotive industry, since the original pooling agreement, speaks for itself. We believe that the benefits derived from the pooling of patents in the radio industry will be proportionately as great as those derived in the automotive industry. Recent court decisions on radio patents have shown an unusually large percentage of these patents in suit to be invalid. The cost of this litigation to both parties in suit was considerable. With an organization set up along the lines of the Automotive Chamber of Commerce, by which radio manufacturers within the pool can obtain complete information on any patent, domestic or foreign, and this information available on short notice, it is doubtful whether the average organization or person would attempt suit knowing that complete information is available on the entire art.

The RCA-Government conferences on an "open patent pool"

Repeated efforts were made by the editors of *Electronics* to secure a statement from the executives of the Radio Corporation of America on the subject of patent pooling, before going to press with this issue, but without success.

It is known that during the weeks of June 22 and June 29, daily long conferences were being held on the subject, at 120 Broadway, New York City, but no statement of the RCA view was forthcoming.

Representatives of the Department of Justice were present at the conferences, and it was proposed that if the Radio Corporation would establish an "open patent pool" available to the industry generally, the government's suit against RCA might be terminated. Judge Warren Olney represented the Government during the conferences, and after the interim adjournment July 1, declared the suit would be pressed if the conferees failed to agree.

Statement by Department of Justice

"It developed at the conferences, however, that, regardless of the legality or illegality of their contracts, the principal defendants were ready to change them so as to make them unobjectionable in the view of the department. It also appeared that the principal defendants would, in addition, consider favorably creating an open patent pool, whereby the use of their patents in the radio and certain allied fields would be open to the public generally upon fair and reasonable terms to be fixed by independent trustees.

"Such a pool would, in the opinion of the department, if practicable, be of distinct advantage to the public both as opening the patents of the particular defendants to general use and also as serving as the beginning of an open patent pool into which all patents important in the radio field might be brought and their use made open to the public on terms fair and reasonable to patent owners on the one side and the industry on the other, and the industry be largely relieved of interminable and expensive disputes over patent rights."

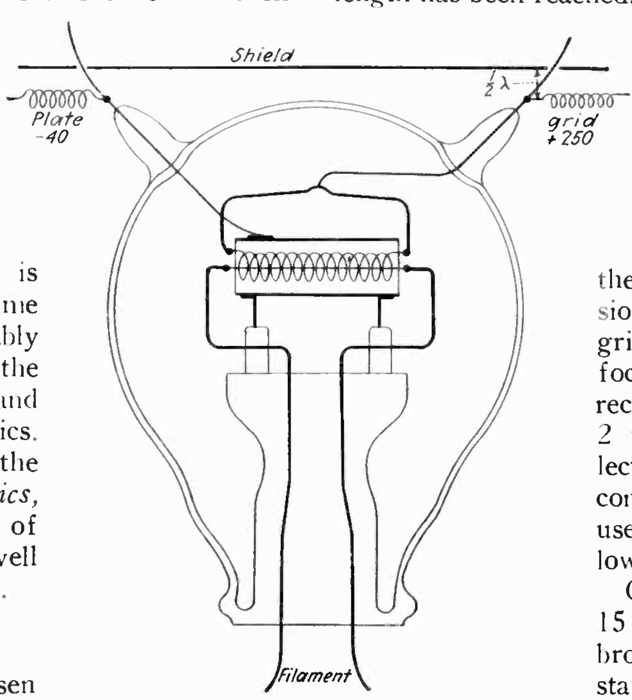
"There has been no definite commitment as yet either by the department or by the defendants" in regard to the pool, but that "the parties will genuinely endeavor to formulate an acceptable plan embodying it."

The conferences were adjourned July 1, until September, "when they are to be resumed and pursued without interruption, to a conclusion."

Tubes for generating 18 cm. waves

JUNE *Electronics* chronicled the transmission of radio phone communication across the English channel by means of a directive wave of the order of 18 centimeters, a wavelength far below those used commercially for communication up to this time. The experiment was performed by the International Telephone and Telegraph Company, transmission and reception taking place at historic Calais and Dover, over a distance of about 22 miles.

Through the courtesy of Dr. Irving J. Saxl, *Electronics* is enabled to publish for the first time in this country, and most probably in any country, a photograph of the tube used in this pioneer work and to describe briefly its characteristics. The photograph appears on the cover of this issue of *Electronics,* and an idea of the construction of the tube may be had from it as well as from the drawing given here.



Drawing of the 18 cm.-tube

Barkhausen oscillator

The tube is used as a Barkhausen oscillator, that is, a tube in which the physical dimensions control the frequency rather than the electrical dimensions of the circuit attached to the tube. In this circuit (see Loeber, November, 1930 *Electronics,* "Developments in ultra-high frequency generation") the grid is maintained positive, and the plate is negative. Electrons emitted by the cathode are attracted to the grid, many of them pass through it and come within the field of the plate. Since this is negative the electrons are repelled and again come to the grid field. Thus one oscillation takes place in the time required for an electron to make its circuit. In this particular case the plate had a negative voltage of 40 and a positive voltage of 250 was placed on the grid.

Voltages are applied to the tube through choke coils to protect the power supply apparatus from the high frequency currents and to prevent part of these supply leads forming an oscillating system at a frequency lower than that desired for radiation from the antenna proper.

Since the wavelength is a function only of the size and mutual position of the electrodes within the tube and the voltages thereon, the tube is designed in such a way that all parts which act as coupling devices are exact ratios (in size and spacing) of the desired wavelength. A shield about one inch square protects the radiating parts of the tube from the field of the antenna.

Development of the tube

Several different constructions have been made since the first work on the micro-ray tube began which culminated in the English channel transmission of Clavier, Darbord and Fournier March 31, 1931. Early tubes were similar to tubes used at much lower frequencies, i.e., with the usual stem construction and with leads coming out through the stem. Such construction limits the life of the tube due to the electric strain on the dielectric material and limits the lower wavelengths that can be reached. The type shown on the cover and drawn here is of much more recent construction.

The grid is self supporting. There are no connections between windings of the grid so that any short-circuiting within the oscillating system is avoided. The lead-in wire to the grid is made at the exact center of the grid. With such tubes a lower limit of 2.5 centimeters wavelength has been reached.

Radiating system

Antennas for such short-wave transmission are extremely simple. The English Channel experiment used two double reflectors at each end of the circuit, one for receiving from the other side and one for transmission. Bipoles going out from the grid and plate were carried to the focus point of the reflectors. At the receiving end wires on a frame about 2 feet long act as an antenna collecting the radiation whence it is conducted to a tube similar to that used for transmission except for lower voltages.

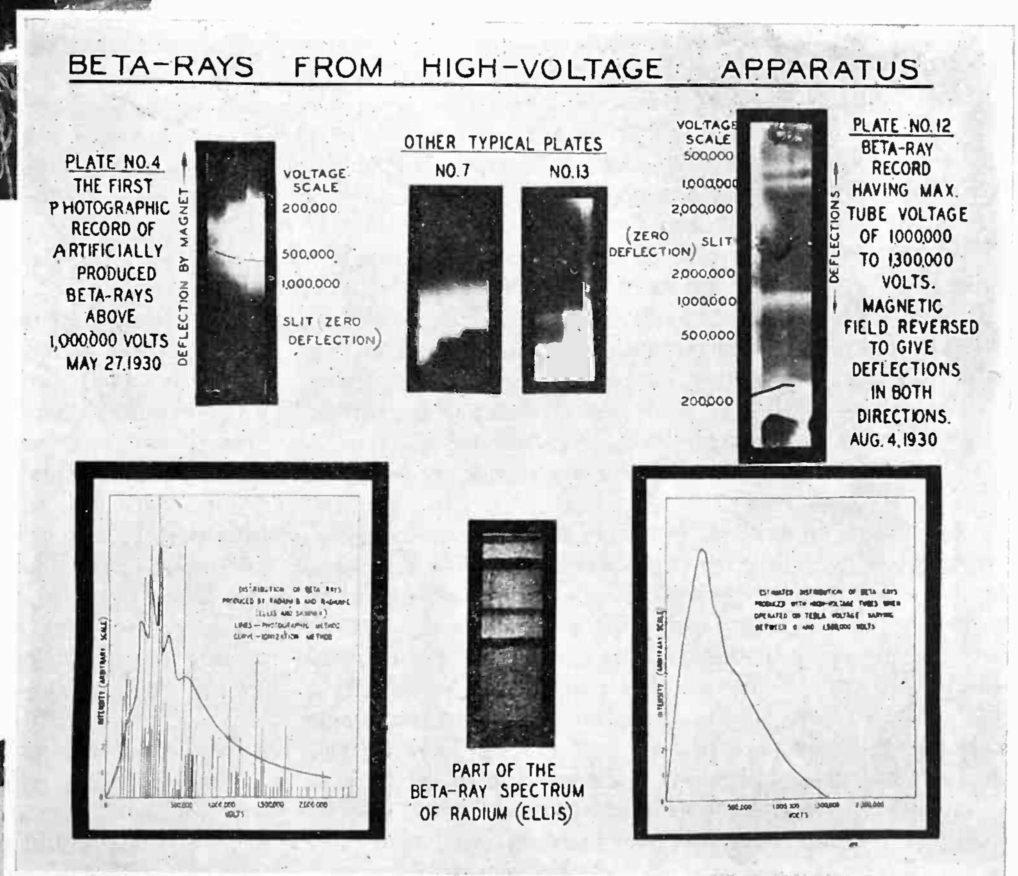
Considering that between 10 and 15 meters there is room for 1,000 broadcast stations or 100 television stations, and that this room becomes vastly greater as we progress toward the shorter and shorter waves—although the difficulties of transmission and reception increase, too—it is impossible to overlook the importance of this work in England and France. Such frequencies can be used only between points which are within the line of sight between them. A mountain intervening will reflect the radiation; but a mountain can be used to deflect radiation and in effect make it go around a corner. A reflector on a mountain side could turn through a fairly wide angle radiation directed at it from a transmitter and aim it toward a receiver out of sight of the transmitting end.

Short waves, the hope of television

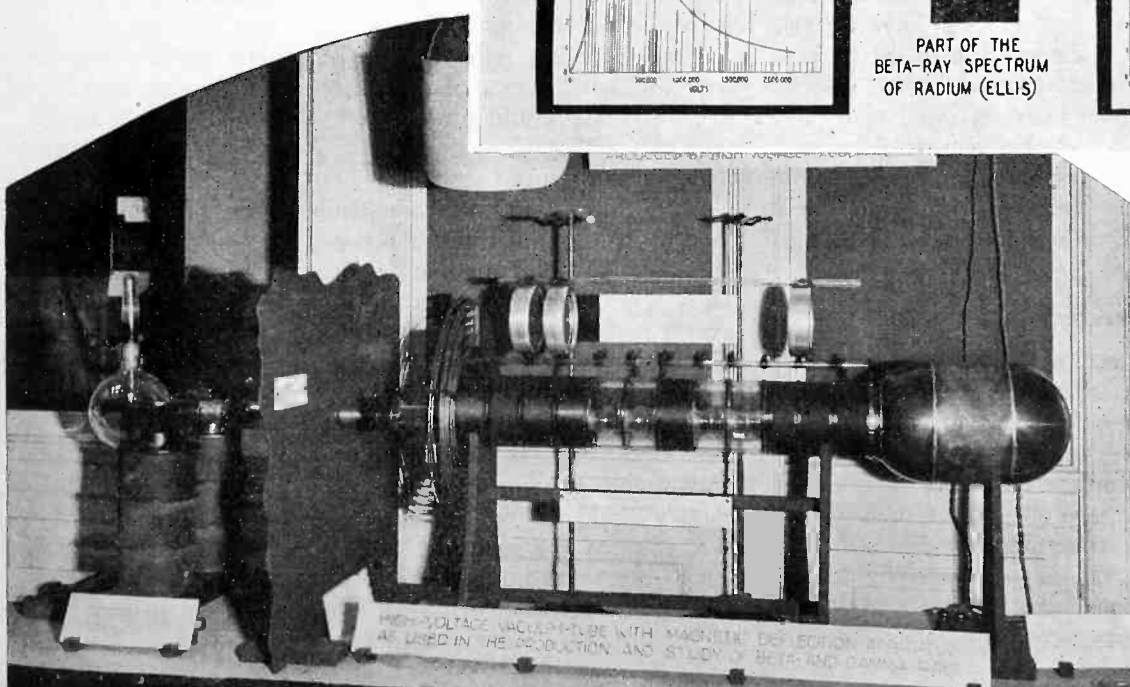
Work on such vastly higher frequencies than are now used is being watched with the greatest of interest by radio engineers here and abroad. Many of them pin whatever hopes for television they have on these ultra-high frequencies because of the impossibility of transmitting sufficient detail on limited bands available in the present radio spectrum.

Electron speeds reach 167,000 miles per second

Apparatus developed at Department of Terrestial Magnetism of the Carnegie Institution of Washington produces radiations more penetrating than those from radium; electron speeds within one per cent of the velocity of light are attained



Dr. M. A. Tuve, Dr. L. R. Hafstad, and O. Dahl with apparatus developed by them which produces gamma- and beta-rays rivalling those from radium



Apparatus for producing magnetic deflection of radiation produced from high-voltage apparatus. Results of the experiment are shown above

TECHNICAL TRENDS SEEN

HIGH POINTS—
Advent of home talkies
Early promise of television
Increased use of "a.v.c."
Tube testers to boost sales
Pentodes—variable-mu tubes

HOME talking pictures, television and tube testers vied for distributors' interest at the RMA Trade Show held at the Stevens Hotel, Chicago in June. Technical trends were conspicuous by their absence, price remains the sole factor of importance in the minds of the industrial leaders. Prices on receivers fixed, tentatively of course, before the show opened were hastily revised after the first half hour, lowered again as the show progressed, and at the end of the viewing, rumor had it that set manufacturers were returning to their respective factories determined to lower prices again.

A permanent magnet speaker (Jensen), thyratron equipment for operating a.c.-refrigerators and radios in d.c. districts (RCA Victor), a radio to sell to dealers at but slightly over $10 including tubes (Frost-Minton), a number of sets having but two tuned circuits, tone control which automatically varies the high-frequency response at various volume levels (Stromberg Carlson), a voltage doubler for power supply circuits and not using rectifier tubes (Elkon), neon lights for aid in tuning automatic voltage control sets (Duovac and Fada notably)—these seemed to be the outstanding technical points of interest.

Price alone controls the purchase and sale of component parts according to engineers responsible for making the majority of the 4,000,000 receivers estimated to be made and sold this year. This dangerous practice of cutting everything to the bone to compete solely in price will probably run its course this year. Those who take a long term interest in the industry fear that next year many of these ultra-low priced receivers will have warped panels, loose gadgets, burned resistors, and in many ways will inform their owners that they have indeed bought exactly what they paid for and such receivers will have to be replaced to the great glee of radio manufacturers. It it difficult to believe that the confidence of many radio purchasers will not suffer some inconvenience as a result of the mad race to undercut prices throwing factors of safety to the winds.

Tube testers

Tubes no longer sell by name, or by advertising, or by quality, or by reputation—but by fancy testers with large meters to mystify and reassure the prospective purchaser. Some of these meters test the tube's oscillating qualities —and according to some tube manufacturers cannot do a good job with screen-grid tubes, others in their desire to test everything have been forced to use a number of adjustments which probably will only confuse the dealer; who no doubt has already determined to sell the customer a new set of tubes regardless of what the meter says.

Some tube testers are sold on some such proposition like this—the dealer buys the meter paying about half list-price down and the rest on time. Then he agrees to take a consignment of tubes say ten times the list price of the meter. He takes his time about selling the tubes but when they are sold, he gets his meter money back and gets a bill of sale which says he owns the meter. The final result is that the dealer has secured an additional 10 per cent discount on his tubes, he owns a tube tester that impresses the customer, and there you are. For the first time a constructive sales plan for replacing old tubes with has been developed; a plan dealers can understand.

The chances are that this sales plan (which seems to be getting results) will spread; the dealers' initial ante will probably come down as well as the number of tubes that he must agree to take. When it comes down to the point where a tube manufacturer gives the dealer the tester free and does not force him to take any tubes, someone will invent a new scheme. How long it will take such a price reducing race to run its course cannot be guessed at—but it probably won't be long. Fortunately the testers have technical merit, seem able to move tubes, and when properly operated will give the customer honest information.

Shades of the past

A three or four tube radio was openly sniffed at, a year or so ago; it reminded one too much of the 1924 days. Similarly, at that time, the only way to control volume was to shunt down the audio amplifier or to detune. The present year sees such days returned, the simplest radio shown was a three-tube receiver selling (to dealers) around $10 with tubes and there were plenty with only four tubes. The only advantage of such receivers is their low price. They have poor sensitivity, selectivity, fidelity—some have poor appearance. No one seems game to produce a low sensitivity set of fair selectivity but high in fidelity. Many discriminating listeners want a *cheap* set not necessarily so small and so poor in quality that it is little better than a portable phonograph, designed for lovers' canoe parties.

Pentode tubes and variable-mu tubes were omnipresent, the advantages of the latter being so evident that even a dealer could understand; but the pentode advantage being somewhat more difficult to visualize, except in price and space reduction.

Bad quality and overloaded tube distortion floated from nearly all demonstration rooms. Amplifiers and loudspeakers designed for two or three watt output were gleefully loaded up with 10 or 15 watts from poor phonograph records. The more bass, the better the apparatus. Home talkies apparatus was not above the average radio in quality of reproduction.

Dealers and jobbers enticed to the show learned that prices had been so reduced they could make little money and many were openly resentful; realizing that little money could be made from selling midgets the distribution part of the industry (often spoken of as the backbone of the radio business) is asking when television, home talking pictures or some other higher priced piece of merchandise will be available for him.

Receivers still look amazingly alike. The majority of

AT RMA TRADE SHOW

the midgets are still three-cornered. One notable exception (Bosch) was rectangular, of pleasing proportions, dimensions, and simplicity of appearance. A virtual treat to jaded eyes was the display of cabinets made by Radio Master Corporation. Enterprising dealers may capitalize the low price of chasses by putting them in good examples of cabinet design and actually make their money not in radios but in cabinets. It would be pleasant if dealers (at least) could show some profits; the distribution set-up still hopes for profits in spite of price cutting by manufacturer.

The fidelity question

It must be admitted that the small cheap set sounds remarkably good. Loudspeaker design has so progressed that deficiencies in bass or high treble existing in other parts of the system can be made up by the speaker, partially at least. One manufacturer has no difficulty in making up an 8 db. set loss at 100 cycles so that the set with insufficient baffle area really does not sound so bad. But super selectivity in superheterodynes makes the best of them very poor indeed at higher audio frequencies. High quality in America means excessive bass, a fact often commented on by European writers. Perhaps the antisidebandists are correct—perhaps the American listener will permit stations to be put twice as close together, perhaps 2,500 cycles is as much as he desires.

Television-Stenode-permeability tuning

The outstanding feature of the Chicago visit was the several demonstrations of the Sanabria television system, marked as it was by intense illumination (due to the Taylor lamp) over a six-foot screen, and beautiful mechanical work (by Sanabria himself). What the demonstration lacked in showmanship it made up technically. The universally expressed opinion was that Sanabria's television was the best seen to date; that his 45-line picture had good detail and that Sanabria himself was a young man whose feet were squarely on the ground. The lamp of low cost, high intensity and reasonable life, the work of Taylor a young man of promise, is a most important part of the system.

Interest in television as evidenced by attendance at the Deforest-Jenkins booth is tremendous. If brought along at a good clip now, it may be the looked-for new industry to bring the army of the unemployed out of the trenches by another Christmas.

Several manufacturers of noted engineering skill and sagacity have now under demonstration or construction, examples of the English Stenode circuit which will undoubtedly eliminate an undesired "peanut whistle" caused by a station wandering from its assigned frequency and which gives the listener reception remarkably free from background noise—it is not yet demonstrated, however, whether this advantage is paid for in lack of high frequency response. Tests by these American manufacturers will soon determine the merits, be they technical, economical, or from a sales standpoint, of the Stenode. (An interesting and simple explanation of the use of quartz crystal bridge circuit, developed at *Electronics'* request, will appear soon.)

LOW POINTS—

Disregard of safety factors
Components sales below cost
Lack of technical originality
Craze for cheap prices
Widespread poor tone quality

Displayed at the IRE Annual Convention, preceding the RMA show was a permeability—tuning system made possible by the research of Polydoroff in iron dust coils. A more complete description of the system will be found in this issue of *Electronics*, the first to be published on the subject.

Cathode ray tube

Several exhibits attracted considerable attention. The new cathode ray tube of Von Ardenne (Germany) now imported and sold by General Radio was in continuous operation displaying all manner of wave pattens and of considerable brilliance.

Also at the IRE Convention was a demonstration of the use of Rochelle salts crystals as acoustic devices, picking up from a phonograph record sufficient energy to play a loudspeaker, also a crystal, with but little amplification and with fair quality. Whether these crystals become of industry importance depends upon their ability to stand up under varying temperature conditions existing in radio sets, and whether their use as a a motor element is less expensive than existing drivers. Eliminating the field coil of a modern dynamic speaker is of little benefit to a radio receiver—the filtering effect must be replaced by a 30-40 henry choke which costs good money to build and to ship.

Supers—variable-mu—pentodes

Of 185 models, 132, or 71 per cent, were superheterodynes; 73 per cent of all models used pentodes; complete acceptance of the variable-mu is evidenced by the fact that of the models shown 94.5 per cent used variable-mu tubes. Automobile sets, battery sets, combinations, high priced receivers all were evident but in small numbers. Remote control receivers apparently do not sell, the number on display was much smaller than at the show of last year. Tone control continues to be of sales appeal, automatic volume control sets increase in numbers as they should, visual tuning meters accompanied a few of the a.v.c. sets, one of them using a tricky neon sign.

All in all it was a show not devoid of technical interest or possibility. Occasional signs of ingenuity and originality stared one in the face but in general such evidences of free thinking were carefully kept from vulgar gaze. The permanent magnet speaker for multiple installations in schools, hotels, etc., the tube tester as a means of selling tubes, voltage-doubler apparatus, the $10-radio, the Sanabria television, the thyratron inverter for d.c.-district radios and refrigerators—such were encouraging signs of invention in engineering and salesmanship.

Tuning by permeability variation

By RALPH H. LANGLEY

"HE DIDN'T know it couldn't be done, and he did it." This familiar phrase is only true when the emphasis is placed on the right word. It is one thing to think something can't be done, and quite another thing to be certain about it. And it is those who are courageous enough to disagree with common beliefs that make the real forward steps in the application of science and the expansion of knowledge.

To attempt to entirely eliminate the variable air condensers which have come to be accepted as the one best method of tuning radio frequency circuits, was courageous in itself. But to suggest that they might be replaced by iron cores inserted gradually into the radio frequency transformers would have invited immediate denial. And so, in his small laboratory in Chicago, Mr. W. J. Polydoroff has labored for years, confiding only in those who shared his belief. The story of his experiments and of his gradual progress is a romance in itself, but the final result, with its wide range of possible applications, is of even greater interest.

Nobody knows what magnetism is, or why iron, and some other metals to a lesser degree, exhibit this strange property. Recent X-ray investigations have proved that neither the molecule or the atom changes its position under a magnetizing force. Polydoroff's investigations show that at very high frequencies in the neighborhood of 2 million cycles there are sudden changes in behavior, and this fact may pave the way for a new and much more adequate theory of magnetism.

This history of the use of iron at higher and higher

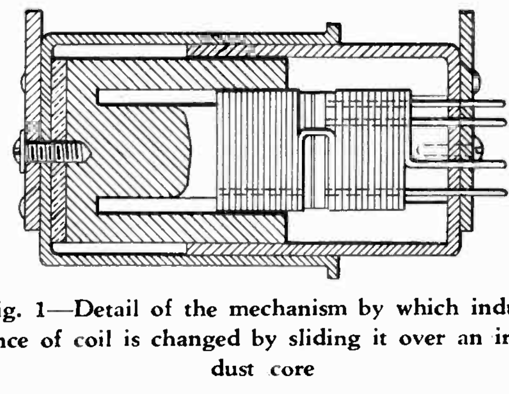


Fig. 1—Detail of the mechanism by which inductance of coil is changed by sliding it over an iron-dust core

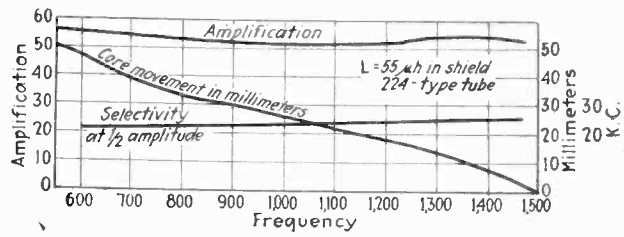


Fig. 2—Amplification and selectivity of screen-grid tube with iron core transformer

frequencies shows that it has been possible to reduce the losses due to eddy currents to a satisfactory value by shortening the paths which the eddy currents might take. This was accomplished first by lamination into thinner and thinner sheets. A thickness of 0.001 inch was used in the Alexanderson high frequency alternators with marked success, but only up to frequencies of from 30,000 to 40,000 cycles. This same thickness was used in early untuned radio frequency transformers, but here the high losses were desirable, to broaden the resonance over the range of frequencies used in broadcasting.

To still further reduce the length of the eddy current paths, iron wire and powdered iron has been used. As long ago as 1890, patents were issued on compressed iron dust cores, and cores of this type have been successfully used in telephone work, and at frequencies as high as 40,000 cycles. But the losses increased more rapidly than the square of the frequency, and such cores were useless above 200 kc. The secret of the Polydoroff cores lies not only in the fact that a method of producing a very much finer powder has been developed, but also lies in the method of completely insulating the particles. Beyond this is the physical design of the cores themselves, and of the transformers with which they are used Such designs, for use over the broadcast frequency range, are now available, and careful measurements indicate that the performance is even better than can be obtained with the conventional variable air condenser method of tuning.

Figure 1 is a cross-section of such a transformer. In this case the primary has been wound at the center of the form, and the secondary is disposed on either side of it. The core is arranged to go both outside and inside the coil, and telescoping shields guide the core as it is inserted into the windings. The shield around the coil is preferably of copper or aluminum, but the shield around the core may be of steel, or in some cases can be dispensed with entirely. The performance of a transformer of this type is shown in Fig. 2. It will be seen that the amplification, with a standard screen-grid tube, is quite constant, varying only between 52 and 60. But the more remarkable fact is the constant selectivity. The half-amplitude band width varies only between 21 and 26 kc. and this is very much better than can be accomplished in variable condenser tuned circuits. In fact, four circuits of this type will approach very closely to the selectivity of the superheterodyne system. Nor is the reason for this excellent performance difficult to explain.

Characteristics of permeability-tuned circuits

In designing a circuit that is to be tuned with a variable condenser, the inductance of the secondary must be such as to give the lowest frequency (550 kc.) with the maximum value of the condenser. Such a combination has very good selectivity at 550 kc. but becomes increasingly worse as the frequency is increased by decreasing the capacity, until at 1,500 kc., it is from 3 to 4 times as broad. The inductance remains constant, but the losses increase with frequency, and the ratio of inductance to resistance decreases. This has been accepted as unavoidable, and is the principal reason for the introduction of the superheterodyne method.

A transformer that is to be tuned by inserting an iron core is designed in an exactly opposite manner. The inductance of the coil and the size of the fixed capacity are chosen to give the desired performance at 1,500 kc. rather than at 550 kc. This is not a matter of great difficulty. The inductance will be much smaller than normally used and its resistance will be less. The condenser will be considerably higher than the minimum in a variable condenser tuned method, and the inductance-resistance ratio will be as good or better than it is in the normal case at 550 kc.

As the iron core is inserted to tune such a transformer to lower frequencies, both the inductance and the effecttive high frequency resistance are increased. But the inductance-resistance ratio is kept substantially constant by the fact that the increase due to the core is offset by the decreased high frequency resistance of the winding due to decreasing frequency. This result, of course, is not obtained without a very careful balancing of each of the factors involved, and it has taken years of careful experiment and measurement.

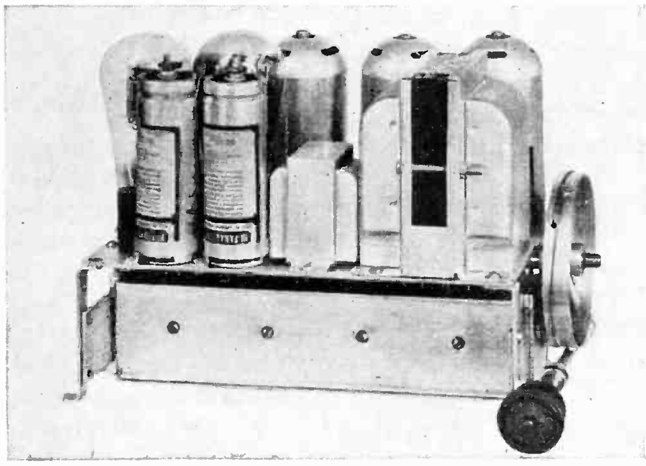


Fig. 3—Compact chassis made possible by the new tuning system

The powdered iron used in making the cores is too fine to be successfully produced by any mechanical process. It may be secured by condensing the vapor of iron carbonyl, $Fe(CO_5)$, or by reducing the sulphate, $Fe_2(SO_4)_3$, with hydrogen. By either of these methods grain sizes down to 1 micron can be obtained, but if the particles are too small, the powder is very "fluffy" and hard to compress, and the insulation of the particles becomes difficult. The grain size used has therefore been chosen at 10 microns. Over each grain there is placed a thin film, 1 micron thick, of a specially developed insulator. This prevents the powder from burning on contact with air, which it would otherwise do.

This insulated powder is mixed with phenol resin and moulded under heat and pressure into a bakelite core, in which, however, 90 per cent of the weight is pure iron. These cores are strong and chemically stable, and can be machined like any other metal, although this is not necessary. The specific density is 4.6 as against 7.2 for pure iron, and the initial permeability, in ring-shaped samples is 10, as against 50 for pure iron. Much more important and impressive, however, are the figures for specific resistivity, where the difference is enormously greater. The moulded core material measured 50 ohms per centimeter cube, whereas pure iron has a value of only 0.00001. Thus the new material has 5,000,000 times the resistance of pure iron.

The losses due to the use of an iron core at high frequencies may be divided into three groups, hysteresis losses, eddy-current losses, and losses due to increased capacity. The hysteresis losses depend on the structure of the material itself and are small for pure iron, becoming important only in steel laminations. The eddy-current losses are due to currents flowing in the surfaces of the magnetic particles, or between particles. They are reduced to values satisfactory at radio frequencies, first by using very small particles, and second, by insulating the particles from one another. The losses due to increased distributed capacity of the coil in the presence of a metal core, are reduced by insulating the core from the coil, and from ground and the associated circuits, and by designing the core so that it has sufficient clearance from the coil. All these problems have been successfully solved in the designs now available.

Variation in inductance due to core

If the loose iron powder is inserted into a coil, an inductance increase of from two to three times can be obtained at 1,000 kc. In order to tune through the broadcast band a change of 8 times is necessary. This apparent permeability is secured by moulding the particles into compressed cores with bakelite as a binder. The insulation of the particles also greatly decreases the losses below what would occur with the loose iron powder.

The well-known formula for the resonant frequency of a tuned circuit,

$$f = \frac{1}{2\pi\sqrt{LC}}$$

must be rewritten, when an iron core is used, to include permeability;

$$f = \frac{1}{2\pi\sqrt{LC\mu}}$$

The initial, or highest frequency to which the circuit will tune, is obtained with the core withdrawn, and permeability equal to 1 for air. When the near ends of the coil and core are $\frac{1}{4}$ in. apart, the effect of the core is negligible. As the core is inserted into the coil, the flux paths lie increasingly in iron, and the result is an increase in the effective average permeability of the medium surrounding the coil, with a corresponding increase in inductance. When the core is all the way in, the coil is almost completely surrounded by the core, and the maximum value of its permeability is secured. The permeability factor enters under the radical sign, as a new and independent factor. This has important results which will be pointed out later.

The inductance-resistance ratio for a circuit tuned with an iron core must also be rewritten to include permeability, and, if the properties of the circuit are to remain constant at all frequencies, this ratio must remain constant.

$$\frac{\mu L}{R} = \text{constant}$$

We can determine the value of μ in terms of frequency:

$$\mu = \frac{K}{f^2} \; (K = 2{,}250{,}000) \; \frac{KL}{f^2R} = \text{constant}$$

But since the numerator of this fraction is a constant, the denominator must also be constant. This means that the total effective high frequency resistance of the system must be inversely proportional to the square of the frequency. The resistance of the coil and circuit will increase roughly as the square of the frequency, and the effective resistance caused by the presence of the core must therefore *decrease* roughly as the fourth power of the frequency. As is indicated in Fig. 2 this result has been closely approximated in the present designs. The circuit arrangement was for parallel resonance with a '24 type tube on the input side.

Antenna circuits—an important application

The fact that the permeability enters the equation for frequency as an independent variable, has an important bearing on the tuning of antenna circuits. This is a case of series resonance, and the capacity of the antenna itself must be taken into account. But by choosing the proper value of inductance to make the circuit resonant to 1,500 kc. with the core all the way out, it may be tuned through the range by the insertion of the core, and will remain in step with the interstage circuits, regardless of the fact that the inductance value is different. The only precaution is that the antenna inductance and the interstage inductances must be geometrically identical, so that the same values of permeability are produced by the insertion of the cores. This is a result which cannot be secured in capacity tuning, and the tuning of the antenna system gives an important increase in sensitivity, and in signal-to-static ratio.

In such a series resonant circuit, the current will be

$$I = \frac{E}{R}$$

and the voltage across the coil will be

$$V = E\,\frac{L}{R}\,2\pi f$$

If we assume E to be constant, the voltage will be proportional to the frequency, and may be applied to succeeding radio-frequency amplifiers. If, as is probably the case, the voltage E generated in the antenna by the signals is inversely proportional to frequency, then the voltage across the inductance will be constant throughout the range.

In the present designs, the coils are of the "low-loss" single layer type, and are wound on 1-in. diameter bakelite tubing. A larger diameter would give lower losses, but would materially increase the weight and cost of the core. Also, in order to obtain the necessary maximum permeability (approximately 8) the length of the coil should be at least $1\frac{1}{2}$ times the diameter, which would still further increase the weights and costs. With the 1-in. diameter form, the winding is $1\frac{1}{2}$ in. long, and the core has corresponding dimensions. Because of the very small amount of wire used, and the improvement secured, Litzendraht, wire has been employed for the secondary, and is recommended. It gives an increase in the initial selectivity (at high frequencies).

Questions of economics

For interstage coupling, using '24 or '35 type tubes, the primary consists of No. 38 enameled wire wound between the turns of the secondary, so that the transformer has substantially a one-to-one ratio. The secondary consists of 70 turns of 10 by 38 Litzendraht, closely wound. The primary winding does not change the electrical properties of the coil.

Measured in a copper shield $1\frac{5}{16}$ in. in diameter, and $2\frac{1}{2}$ in. long, at 1,500 kc. this transformer has a gain of 55 and a half-amplitude band width of 26 kc.

It was not until a definite figure for the cost of the core material and the complete cores could be obtained, that any comparison of the cost of complete receivers could be attempted. It is obvious that the windings themselves, even if Litzendraht is used, will be less than in conventional designs. The windirg itself is extremely simple and the amount of wire is very small. Shields for the coils will cost the same. The variable air condenser gang is completely eliminated. The coils are initially tuned by small fixed condensers, preferably of the air dielectric type, to keep the losses low. These may be designed to go directly under the coils, and will occupy very little space. Thus not only the cost of the condenser gang, but also the very considerable space which it occupies, is saved. The overall dimensions of the complete chassis can therefore be materially reduced. The shape of the coils and cores is such, that with the core all the way out, the volume occupied is closely the same as the associated tube, and they may therefore be placed side by side on the top of the chassis, the core requiring no additional space. A very compact design, with no exposed delicate parts, is the result (Fig. 3). The total cost is well below conventional designs, and the performance, as has already been noted, is materially better.

Construction of the cores

The cores are moulded in hardened steel moulds, and the exact proportions of the mixture carefully maintained. They are therefore very closely identical, but can be graded or adjusted after completion if necessary. The coils will naturally be wound so that they are physically alike within very close limits. In the assembled receiver, the value of the fixed capacity is adjusted, with the cores out, to produce resonance at 1,500 kc. The fact that the inductance values of the secondaries do not have to be identical to produce accurate tracking of several circuits (pointed out above in connection with antenna circuits) gives an important advantage in producing alignment.

It is obvious that this new method of tuning is not limited in its application to broadcast receivers of the tuned radio-frequency type. It may be used with great advantage, for example, in the superheterodyne method, and in the case of the oscillator is easily arranged so as to give substantially constant output. When tuned with a variable condenser, the output of an oscillator varies as much as 8 to 1. With permeability tuning, the total change is not more than 15 per cent.

Advantages of system

Another factor of great importance is the lack of any delicate mechanical parts. Variable air condensers frequently go out of alignment, and are difficult to adjust both in the factory and subsequently in the field. No such condition exists with the iron cores. They have a mechanical ruggedness and permanence which makes them easy to handle in the factory, and capable of withstanding severe shocks in shipment, and in later use, without any change whatever. Changes of temperature, which have played havoc with condenser gangs, do not affect the cores. Although the development of this radically new method has now reached a point of completion where public announcement is justified, the efforts in the laboratories looking toward further improvement and refinement have by no means been decreased. It is felt that the best method of making the inventions available will be to have one source of the complete moulded cores which can supply them to all users. Plans for such a plant are now being perfected, and the technique of the processes studied and developed.

Sound equipment sales abroad

By C. J. NORTH and N. D. GOLDEN

Chief and Assistant Chief, Motion Picture Division, Bureau of Foreign and Domestic Commerce

WORLD wide depressions are not nearly so common as local ones and while we may be uncomfortably close to that unenviable state at the moment it provides only one more reason for trying to seek out business everywhere and anywhere without considering such obstacles as imaginary lines on the map. All of which, contains the implication that foreign trade is not mysterious, that it merely involves greater distances which at their worst bring up certain definite annoyances in the shape of exchange transactions, duties, consular invoices, special packing and the like. Even so, manufacturers of sound devices should employ fundamentally the same methods in seeking sales in Buenos Aires as in Boston.

It is important to know, first, where equipment can be sold, and second, what does the market offer in quantity. Tables presented with this article endeavor to provide an answer.

Taken together they cover virtually every important territory in the world. True, certain island areas and interior sections of Africa do not appear, but the amount of potential business contained therein is so small that their omission seems warranted. We find that the markets covered embrace a total of approximately 36,955 theaters. Of these, approximately 11,610 contain some type of sound equipment, thus leaving 25,345 houses as yet unwired.

It will be well worthwhile to study these tables with care, country by country, with particular observation of the widely differing proportions of wired to unwired theaters. This proportion is based on the average size of the theaters in each country in question. In other words, those countries which have the largest number of houses with seating capacities of 500 or more show the greatest number equipped for sound. As an instance of this the United Kingdom, Australia and New Zealand taken together have only 18 per cent of the motion picture houses as given in the tables and yet show just over 40 per cent of the total wired.

▼

POTENTIAL sales exist for approximately 5,000 sound equipments abroad. So far American companies have obtained 33 per cent of the total foreign business. Competing low prices of certain local apparatus can be met by credits and better quality American equipment.

▲

The point raised above is to dispose of any possible thought that because there are 25,345 unequipped theaters throughout the world that this number represents potential wiring business. Europe, Latin America, and the Far East with exceptions such as England, Australia and New Zealand as aforesaid—are dotted with film houses which ceased operating due to the introduction of sound-pictures, lack of films and competition with larger houses. The general set-up in most foreign countries is a few large capacity theaters up-to-date in appointments located in the capital and large commercial centers, a somewhat larger number of relatively small capacity theaters (500-750 seats) which act as neighborhood houses in the large cities and first runs in the small towns and after that, holes in the wall seating perhaps 200 people and run for the most part on the proverbial shoestring. To consider these units as prospects for any recognized make of sound devices is untenable.

Department of Commerce survey on markets

In defense, then, of this last statement a column giving "possibilities for further wiring" is added to the tables just discussed. It endeavors to provide an approximate guide of the number of motion picture houses yet unwired which can logically be considered as potentially able to purchase sound equipment. It shows that 4,025 theaters stand in this category, which amounts to a little over 15 per cent of the total unequipped houses. This figure is based on a world wide survey made through the more than 59 foreign offices of the Department of Commerce, but naturally it must be presented without responsibility.

In this survey all essential factors such as the economic condition of the country, the seating capacity of the theaters and so on were taken into consideration, so the resulting figures can be safely taken as a rough guide. Germany is given as a "negligible" market due to the fact that patent litigation has so far prevented the wiring of any theaters with American apparatus, and so far as can be ascertained, will continue to do so. The one conclusion, finally which should not be drawn from the figures on wiring possibilities is that the potential business represented here will fall entirely to American equipment manufacturers. The percentage of business obtained depends partly on the effort they make and on certain natural obstacles which have to be overcome.

American exports of sound equipment for the year 1930 totaled approximately $8,000,000 and while no definite standards of comparison exist with the year 1929, there is no doubt that the 1930 figures are at least $3,000,000 higher than for the previous year. (For instance only 1,670 theaters in Europe were wired at the end of 1929 as against nearly 8,000 at the end of 1930.) Even so, past performances are no guarantee of the future which may be borne out here by the significant fact that exports of sound equipment for the first three months of 1931 were about $1,200,000 less than for the first 3 months of 1930. But lest too pessimistic conclusions be drawn from this decline it should be remembered that it does not necessarily reflect less business in the number of units sold but rather the fact that those theaters overseas which can afford the most expensive equipment have now been wired and the equipment now being sent abroad costs much less per unit.

Foreign competition in sales

To return now to the obstacles. The first which naturally comes to mind is foreign competition. Perhaps the most graphic way of illustrating just what this amounts to lies in the following table which shows approximately the number of American makes against foreign units installed. Approximately 33 per cent of installations have been made with American apparatus and 67 per cent foreign.

Proportionately speaking, American sound equipment has done better in Latin America and the Far East than in Europe, where competing makes are more in evidence, but the fact remains that foreign manufacturers are now better organized and are rapidly going out to meet us in neutral fields. There has also been a tremendous increase in the number of locally made units which satisfy the needs of many small theaters in the territories in which these are manufactured. Even though the value of exports of American sound equipment were much greater in 1930 than in 1929, we did proportionately less wiring business. At the end of 1929 well over 50 per cent of all the theaters abroad had American sound apparatus. The answer lies in the fact that certain large American companies offering an expensive but highly satisfactory equipment, wired the large bulk of the houses whose seating capacity were such that they could afford installations of this type. This business is now largely a thing of the past, though even as late as April 1, 1931, not far from 2,800 of the 3,700 American installations abroad had been made by the companies referred to.

It is not enough to give percentage references only to these foreign sound devices which are creating such competition. The American manufacturer should know details of prices of individual equipments and number of units installed (space does not permit giving this data here but those interested should write the authors). However, the large number of devices now on the market are pointed out in providing price comparisons and illustrate the amount and widespread character of the business which a few of them have secured. The most formidable perhaps from a competitive standpoint are the Tobis-Klangfilm, Gaumont, British Thompson-Huston, Nordisk, Tonifilm, Aga-Baltic and two or three others, which have built up relatively powerful organizations with widespread agency connections. Even so, the competitive strength of the locally assembled unit, which does business only in that country in which it is made, should not be overlooked.

The second obstacle is one which is peculiarly apparent at present but which in the nature of things is bound to pass away. I refer of course, to the economic depression. This is uncomfortably close to being world wide and it has closed to us more than one market, Australia for example, which would under ordinary circumstances be decidedly promising. What the depression has done primarily is to lower purchasing power, and while motion picture theaters have not been as much affected as other sales channels vast numbers of exhibitors abroad have felt the pinch sufficiently to keep them from investing in sound equipment.

Sales American vs. foreign apparatus

	Theaters Wired	American Makes	Foreign Makes	Per Cent American	Per Cent Foreign
Europe	**9,120**	**2,451**	**6,669**	**26.8**	**73.2**
Latin America	**872**	**469**	**403**	**53.8**	**46.2**
Far East, etc.	**1,618**	**780**	**838**	**48.2**	**51.8**
Total	**11,610**	**3,700**	**7,910**	**33.0**	**67.0**

Tariffs, credits and patents

Another effect of the depression is in its influence on exchange particularly prevalent in Central Europe, parts of Latin America, Australia and other countries in the Far East. Theater owners in these localities cannot afford to make dollar payments for American sound apparatus in their own depreciated currencies and hence turn to local sound devices of inferior quality, but unaffected by exchange conditions. Other results corollary to the depression are disturbed political conditions always bad for business and the imposition of high taxes in an effort to balance government budgets. This latter feature in the shape of entertainment taxes has cut tremendously into theater receipts in many countries abroad.

A third obstacle lies in the duty on American sound equipment into a large number of foreign countries. It had been the original intention of the writer to furnish a table showing a full list of the tariffs on American sound apparatus into all important markets abroad. It was speedily discovered that the basis on which the duty is assessed is in many cases so complicated and differs so widely as between sound on disk, sound on film, type of sound head and other parts used, that it was impossible to work a satisfactory list.

In practically every foreign country the duty on American sound apparatus is sufficient to raise its cost to the consumer and in such countries as Australia and Japan a duty of 100 per cent virtually prohibits its entrance. The best plan is for such equipment manufacturers as contemplate foreign business, to procure from the Division of Foreign Tariffs of the Bureau a schedule of tariff on sound equipments into those countries with which they are doing business. In most cases as indicated above, a fairly complete description of the component parts of their apparatus will be necessary.

Finally, there is the question of patents to be considered. As is well known, considerable patent litigation has taken place between manufacturers of German and American sound equipment. This culminated in a patent agreement arrived at last July between Tobis-Klangfilm on the one hand and certain American sound interests. By its terms Germany, Austria, Hungary, Switzerland, Czechoslovakia, Netherlands, Denmark, Norway, Sweden, Finland, Yugoslavia, Rumania and Bulgaria are henceforth to be regarded as exclusive German territory so far as the American companies in question are concerned. This presumably means that American companies not signatory to this agreement, while they can go after business in these countries, will have to take the risk of suits for patent infringements. Of course, whether they are actually guilty of infringement or not is something which they alone can determine.

So far this paper has confined itself to a consideration of the general state of the foreign field for sound apparatus. The points outlined below are suggested to

Sound-picture markets abroad

EUROPE

Country	Number theaters	Number wired	Possibilities for further wiring
Germany	5,087	2,200	*Negligible
United Kingdom	5,079	3,395	400
France	3,236	747	300
Spain	2,600	205	200
Italy	2,500	405	200
Czecho-Slovakia	1,250	242	300
Norway	245	52	50
Sweden	1,190	411	200
Poland	861	103	100
Austria	745	165	150
Belgium	710	121	300
Hungary	524	171	50
Denmark	367	135	100
Portugal	398	26	25
Yugoslavia	362	107	100
Switzerland	320	107	100
Finland	230	70	50
Rumania	279	96	100
Netherlands	241	177	25
Greece	185	43	50
Turkey	167	38	10
Bulgaria	138	29	10
Latvia	70	26	20
Lithuania	70	26	10
Estonia	67	23	20
TOTAL	26,921	9,120	2,870

*Due to the special conditions mentioned in the text.

LATIN AMERICA

Country	Number theaters	Number wired	Possibilities for further wiring
Brazil	1,600	185	200
Argentina	1,360	256	100
Mexico	701	175	50
Cuba	457	36	50
Chile	235	78	15
Colombia	218	19	25
Uruguay	125	21	25
Venezuela	123	9	10
Porto Rico	113	56	20
Peru	70	13	25
Salvador	47	1	5
Guatemala	39	4	5
Panama	38	12	5
Honduras	27	1	5
Ecuador	25	....	5
Nicaragua	24	2	5
Costa Rica	21	4	5
Bolivia	20	....	5
TOTAL	5,243	872	560

FAR EAST, NEAR EAST AND AFRICA

Country	Number theaters	Number wired	Possibilities for further wiring
Japan	1,327	25	100
Australia	1,276	864	250
New Zealand	475	400	25
India	355	53	50
Philippine Islands	282	60	50
China	233	50	25
Netherland East Indies	214	54	25
Siam	42	1	5
British Malaya	42	19	10
South Africa	480	56	50
Egypt	65	36	5
TOTAL	4,791	1,618	595

manufacturers considering the foreign field. Undoubtedly, the ideal type of foreign set up is the branch office of the parent company with its own staff of salesmen, technicians, and so on. Unfortunately this is too expensive for the manufacturer of moderate priced equipment operating on a relatively small scale. The next best system therefore is to appoint a foreign agent. Such an agent should roughly have the same qualifications as a manufacturer would expect to find in his agents in this country. As in the United States, he should not expect the agent to cover too much territory. Most foreign countries naturally divide themselves into definite sales areas each of which merits separate representation unless one agent has branches which will insure adequate coverage. Each agent should naturally be given exclusive jurisdiction in his own territory.

Establishing foreign contacts

The Commercial Intelligence Division of the Bureau has the names of agents in all countries with data on their financial standing and character, which would be well qualified to represent sound apparatus manufacturers in various countries abroad. Experience has shown that distributors of motion picture equipment, electrical supplies, radio apparatus and the like make excellent representatives for sound devices. Importers of films and owners of theater chains have also been successful.

The exact type of agency agreement to be entered into is of course a matter for the principal and his agent to decide. But roughly speaking it would follow along the general lines of similar agreements in this country. One of the great troubles with American exporters is, that having secured representation abroad, they do not see the advantage of helping their foreign representatives to promote their equipment actively. In the sound equipment field such help might well lie along the following lines:

1. Periodical supplies of catalogues and advertising literature in the language of the appropriate country. Such literature should not only set forth the merits of the product but contain clear and simple operating instructions.

2. Service helps. The servicing of sound apparatus is a most important feature. In fact the success of one of our largest companies rests in considerable degree on this factor. Foreign projectionists are notoriously hard on apparatus and a break down with no service facilities at hand is a serious matter. The American equipment manufacturer should therefore be prepared to send a factory representative (or more than one depending on the territory covered) to work with his agents, particularly in the matter of servicing. A supply of spare parts should be arranged for.

The question of price quotations and credits is a knotty one. Under present economic conditions not very much business can be secured on quotations f.o.b. factory or demanding cash at port of exportation. In other words, credits must be extended though due care and caution must be exercised in this regard. The fact remains that contrary to popular belief credit losses in the foreign field average lower than in this country, perhaps for the reason that exporters make more searching investigation before granting it.

Do not appoint agents and allow them to book orders until you can deliver the goods in good condition and on time. There are obviously other problems in connection with selling sound equipment abroad which call for solution. What has been said contains merely a few general principles which would apply in nearly all cases. The Motion Picture Division will be only too glad to offer its limited facilities to aid any exporter of sound apparatus or any manufacturer contemplating the sale of his product abroad.

High level automatic or self-bias detection

By JAMES R. NELSON

Raytheon Production Corporation

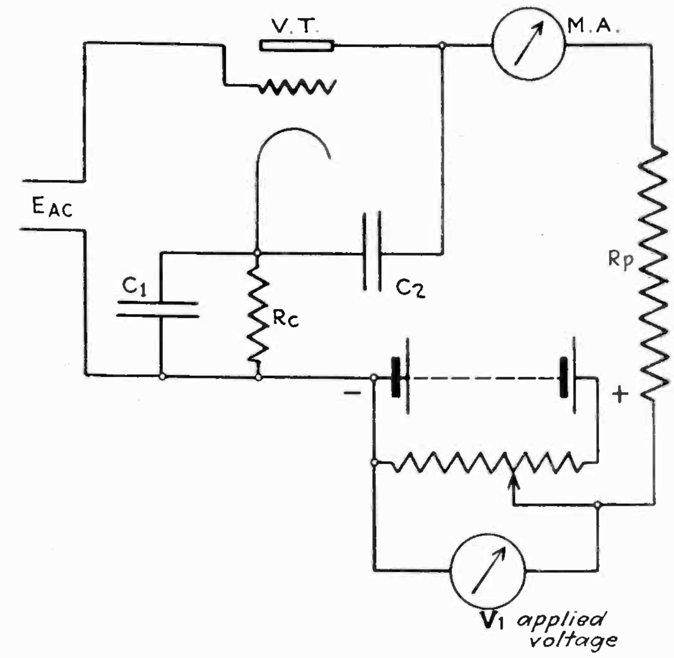


Fig. 1—Circuit used for experimental determination of self-bias detection characteristics

SELF or automatic bias detectors are used quite extensively in the present day electric receivers. The bias voltage is obtained from the drop across the resistor R_c shown in the schematic circuit diagram of Fig. 1. Both the *C* bias and the plate voltages vary with the amplitude of the a.c. input voltage as the rectified current which affects both of the above voltages varies with the a.c. input voltage.

The problem of measuring the rectified plate current with various a.c. input voltages is as simple as it is in the case of a fixed *C* bias detector which was considered in a prior article[1] so that anyone with measurable a.c. voltages and a fairly accurate d.c. milliammeter and voltmeter may take his own rectification data for a given type of tube with a certain voltage for *B* and *C* voltages. For example, the experimental data required for a general study of rectification using some particular type of tube may be found by taking the I_p-E_p curves for various values of R_c using a tube connected as shown in Fig. 1 with R_p omitted.

The interpretation of the data obtained, however, is not so simple as it is in the case where the bias is obtained from a *C* battery in place of the voltage drop across R_c. Under the usual operating conditions there will be three frequencies present in the detector output, the carrier frequency, the desired audio frequency, and the direct current which includes the normal d.c. and the rectified d.c. The network shown in Fig. 1 offers a different impedance to each frequency. The condenser C_2, which includes the output capacity of the tube, by-passes the carrier frequency but should not be low enough in impedance to by-pass the audio frequency while the condenser C_1 is usually of low enough impedance to effectively by-pass the audio frequencies. The external direct current impedance will of course consist of the sum of the resistance of R_p and R_c.

The impedance of C_1 should be small compared to that of R_c for the frequency of the a.c. supply used in the experimental set-up. The external resistance of the plate circuit consisting only of the resistances of the milliammeter and part of the potentiometer across the B supply should be small compared to the resistance R_c. If the above conditions are fulfilled, the experimental set-up will represent actual operating conditions fairly closely.

The drop across R_c is the C bias on the tube and the voltage E_b corresponding to the voltage E_b in the case using a fixed C bias is the voltage V_1 minus the drop across R_c. If the value of V_1-$I_p \times R_p$ or E_b is plotted versus the direct current I_p for various input voltages, we will have a series of curves which correspond somewhat to the series of curves obtained for the case of a fixed C bias detector. It is to be noted, however, that the slope of these curves gives us the internal output resistance of the tube plus the resistance of the resistor R_c instead of the internal resistance of the tube alone as is the case with the usual I_p-E_p curves. The rectified output voltage, however, may be easily found from these curves for the case of a resistance load as will be shown below.

Calculation of rectified output

Fig. 2 shows the I_p-E_b curves taken using an ER-227 tube with a 35,000 ohm cathode resistor. The value of E_b used was the actual B voltage available for the plate voltage so that the effect of the I_p R_c drop will not have to be further considered in the plate circuit. The curves differ from the usual I_p-E_b curves for this type of tube as they do not cut off until zero plate voltage is reached due to the C bias voltage decreasing with decreasing values of plate current.

The intersection of the external resistor load line with the I_p-E_b curve for any input voltage will give the operating conditions for that carrier. This means that the curves may be used in the usual manner to find the rectified output. In other words, if a signal voltage E is modulated 100 per cent the plate voltage will vary between values given by the intersection of the load line with the curve for zero signal and 2E for any other percentage of modulation M, the plate voltage will vary between $E - ME$ and $E + ME$.

[1] J. R. Nelson: "High Level Plate Rectification," *Electronics*, March, 1931.

The plate voltage at which grid current starts may also be drawn in as a guide. Assume grid current starts at some voltage, say —1 volt in the case of 227 tube. The d.c. bias should be the peak value of the a.c. plus 1 volt. The direct current required to give this bias may be found for any given cathode resistor by applying Ohm's law. For example, in Fig. 2 the C bias voltage required for an 8-volt carrier is $8 \times 1.41 + 1$ or 12.28 volts. The cathode resistor is 35,000 ohms so that the plate current required is 12.28/35,000 or .35 milliamperes. The 8-volt carrier gives 35 m.a. when the B voltage is 50 volts so that this point is located at the intersection of the 8-volt carrier and 50 volts B. If this is done for each value of input voltage a curve may be drawn in the I_p-E_p curves as shown in Fig. 2. The intersection of this line and the load line determines the value of a.c. input voltage which may be applied without drawing grid current. As long as the intersection of the load line and the I_p-E_b curve is to the right of the curve

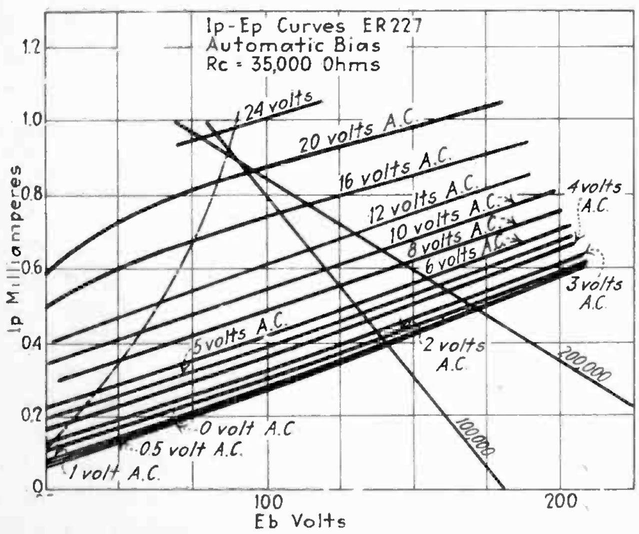


Fig. 2—Dynamic characteristics of a typical self-bias detector

at which grid current starts the grid will not draw current. When the intersection is to the left, the grid will draw current during part of the cycle.

There will be some optimum value of external resistance R_p which will give the greatest value of rectified output voltage for some value of E_b if the magnitude of the a.c. input voltage is not fixed. The problem is to obtain the greatest value of the projection of the dotted curve at which grid current starts and the intersection of the load line and the zero carrier curve on the E_b axis when the load line is drawn from some value of E_b. The load line found to give this value will not give the maximum sensitivity. Two load lines are shown drawn in from 180 volts and 270 volts on the diagram in Fig. 2. It is seen that if the approximate value of the load line from 180 volts were made 200,000 ohms, the sensitivity would be increased but the maximum value of output would be reduced considerably. Very little could be gained by decreasing the resistance so that 100,000 ohms is a good compromise considering both sensitivity and maximum voltage obtainable. It is to be noted that both the sensitivity and the maximum output voltage can be increased considerably by increasing R_p and E_b as shown by the 200,000 ohm load line drawn in from 270 volts.

The values of rectified output voltages, plotted up to the maximum values limited by grid current, using 270 volts for E_b and R_p equal to 200,000 ohms are shown plotted against input voltage for various values of cathode resistors in Fig. 3. These curves were plotted in the usual manner by taking the differences in plate voltages for the intersections of the load lines with curves for various voltages and the curve for zero carrier voltage. The sensitivity is greatest in both cases for the lowest values of R_c used. The maximum output voltage increases with increasing values of R_c up to a certain point after which it will begin to fall off under the conditions used in plotting the curve that is for fixed values of R_p and E_b. It is to be noted there is very little difference between the maximum output obtainable using either 35,000 ohms or 50,000 ohms in Figure 3 although the sensitivity is greater for the case of 35,000 ohms and the rectified curve is more linear for 50,000 ohms.

The rectified voltage curves may be used to find the output voltages for various carriers and percentages of modulation as explained above. For example, if the external resistor is 200,000 ohms and the voltage E_b is 270 volts and R_c is 35,000 ohms, the peak audio frequency output voltage for a 12-volt carrier modulated 50 per cent will be the difference between the rectified voltages for 6 and 18 volts divided by two or $\frac{52.3-13.3}{2}$ or 18.5 volts.

EDITOR'S NOTE:
Other articles on detection, both theoretical and of an engineering nature, which have appeared in *Electronics* are as follows:
Linear Detection of Heterodyne Signals, F. E. Terman, November, 1930.
High Level Plate Circuit Rectification, J. R. Nelson, March, 1931.
Small Signal Detection Theory, E. L. Chaffee, May, 1931.

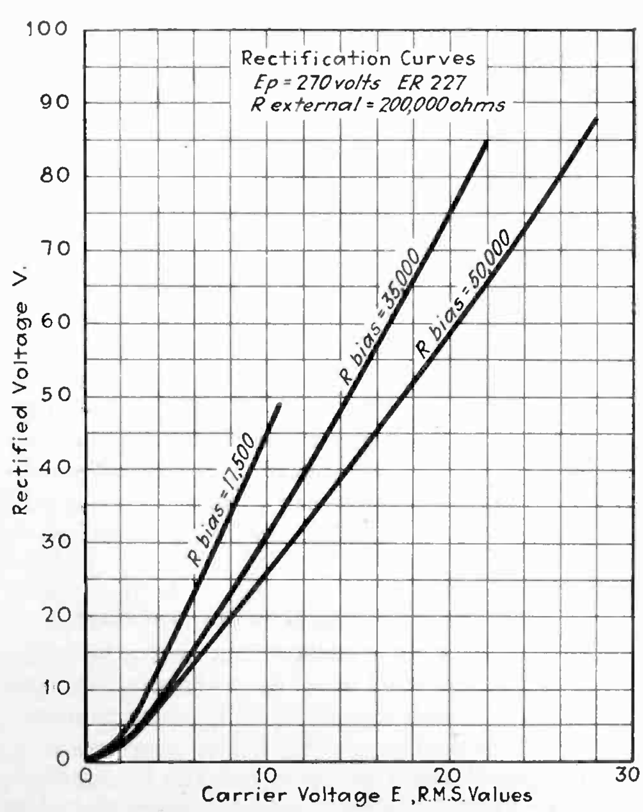


Fig. 3—Rectification curves of typical detector

Buying radio materials by specification

By RALPH P. GLOVER

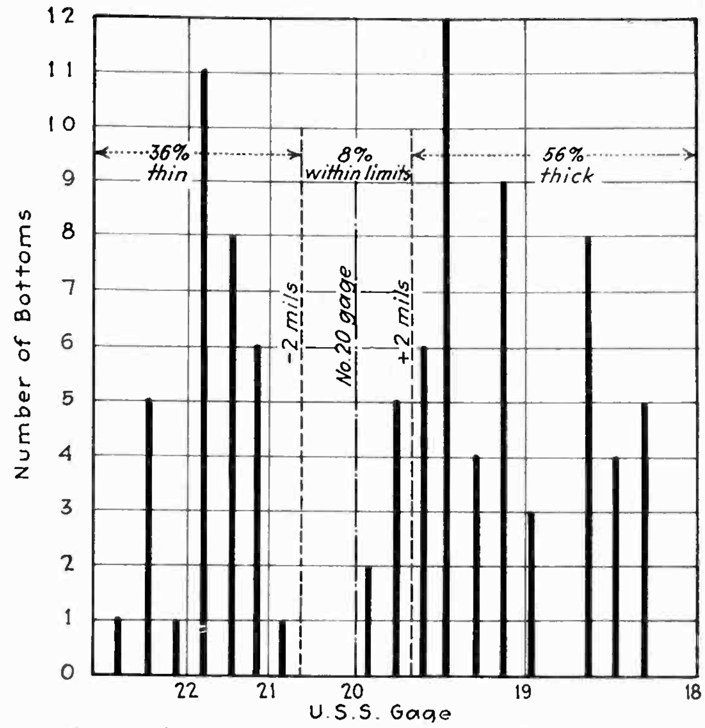
PROBLEMS relating to the selection, purchasing, testing and fabricating of materials are matters of fundamental importance in all manufacturing. However, it is believed that a great many radio executives will admit, at least to themselves, that their attention has been largely focused on technical and sales problems to the near exclusion of the actual stuff which makes up the product.

In reply, we will no doubt hear that so-and-so has an energetic, modern and well organized purchasing staff, and that this staff can practically name its own price for just about everything required. Far from shaking our stand, this undoubted truth merely confirms it. The problems of materials are often obscured by the rather insignificant cost of the materials themselves. This is well illustrated by the familiar picture of the purchasing agent—often with only casual cooperation from the technical staff—pitting one supplier against another for the last possible price reduction. And it is manifestly unfair to place the blame on either the purchasing agent or reliable suppliers when materials are unequal to the task.

A radio receiver is a complicated product, a combination of electro-mechanical mechanisms and electrical apparatus. The functions of various parts are complicated and interrelated. Mechanical and electrical characteristics are important, singly and in combination. Space, style and cost limitations, while exhibiting trends, are subject to sudden and violent upsets that are difficult or impossible to foresee. Intense competition, flurries of technical developments and changing economic and social conditions—all earmark the industry. But before indulging in heroics or self-pity, a little reflection will show that *similar problems are common to present-day industry in general, and/or have characterized past phases of other industries.*

Value of materials-product research

A list of the basic materials which enter the make-up of a radio receiver (and they range from sheet-iron to silk) might, with a few additions or subtractions, apply equally well to a dozen totally different products in alien lines. Well established practices relating to materials in other fields must therefore have considerable application to the radio industry. Among these practices might be named materials-product research, standardization and specifications.



Result of not buying material for chassis bottoms by specification

There are many potential savings possible when new designs are in a formative stage and many "profits" to be taken long before buying orders reach the purchasing agent. Briefly, this principle might be stated in the following theorem: *For any given function, there are a number of possible designs which satisfy the limiting conditions. Of these designs, a limited few involving definite materials, are most attractive, considering material costs, manufacturing costs and methods, and the quality and serviceability of the finished product.* The principle is used intuitively by good designers and a rather simple example will show its workings in the radio field. Metallic cans are used for shielding r.f. transformers. From the material cost standpoint alone, the can dimensions should approach those of the coil as closely as possible and the metal used should be inexpensive—iron, perhaps. On the other hand, electrical requirements necessitate the use of a shield of higher conductivity spaced away from the coil. There is obviously an optimum can design involving some particular metal, which gives the lowest total cost for the required performance.

Materials-product research often points the way toward combined savings and improvements. As practiced by some of the older industries, this includes continual study of all materials which have even a remote possibility of application to the product. The independent radio manufacturer cannot follow these large-scale research methods in detail, but the principle itself offers attractive possibilities. Information relating to materials is necessary at all stages of radio manufacturing from preliminary design to shipping, and is usually of a scope that goes well outside the boundaries of radio engineering. It would seem logical, therefore, to create a separate division of the engineering staff, charged with responsibility for accumulating reliable data on materials and applying this information wherever possible.

The materials division would draw on the many existing specifications or standards for materials, on the publications of technical societies and on the trade journals, on the data and experience of the specialist-suppliers and material purveyors, and on careful tests and measurements, for its basic information. It would apply this data by advising designers as to suitable available materials, by drawing up adequate, intelligent specifications for the purchasing and inspection divisions, by cooperating with the shop on problems involving the processing of materials, and in general, by acting as a clearing house for materials information. For instance, a new impregnating compound for r.f. transformers affords better protection in humid atmosphere, cutting down rejections for low sensitivity and stabilizing over all performance. A change in the insulation on hook-up wire reduces time on the assembly line and saves solder. A slightly more expensive grade of sheet metal results in lowered costs due to savings in the plating process. Of course, these examples only scratch the surface; there are countless others too numerous to mention. Where extensive research cannot be undertaken, a good second choice is to watch and utilize the results of research by others.

Buying by specification saves everybody's money

Definite specifications, as a means of expediting transactions between the purchaser and the vendor, are a recognized institution in modern business everywhere and yet we do not find them used extensively by many radio manufacturers. Erratic, last-minute buying, with price foremost, is partially responsible for the situation in some cases.

Figure 1 shows graphically the results of non-specification buying in one simple instance. Material for receiver chassis bottoms was called for simply as "No. 20 U.S.S. gauge" and was delivered to the stamping jobbers as such. There was considerable spoilage and distortion in stamping due to the diverse thicknesses of the stock. For the particular purpose, the bottoms were "good enough" if the spoilage was overlooked, but later on it was necessary to discard the thin ones for an application in which thickness was found to be important.

The supplier was obviously at fault here, and no doubt unintentionally so, but the moral effect of a definite specification, perhaps calling for the return of off-gauge stock at the steel company's expense, would have insured greater care in filling the order.

The need for specifications increases in proportion to the complexity of the material or component. While a relatively simple specification will do for sheet metal, more elaborate treatment is required for such items as variable condensers, coils and r.f. transformers, for example. In drawing up any specification, it is well to cover the following particulars, emphasizing those of greatest importance in any particular instance.

1. Physical form (size, shape, tolerances—often supplemented by drawings).
2. Mechanical performance.
3. Electrical characteristics.
4. Finish.
5. Means and methods for determining compliance with specification.
6. Disposition of defective material.

Item 5 above deserves special attention. Test values for many components used in radio receivers depend to a large extent on the method of testing. The capacity of electrolytic condensers depends not only on the actual test circuit, but on the previous forming treatment. Paper condenser insulation resistance varies with the time of application of the test voltage. Many resistors possess a marked voltage characteristic. Definite agreement as to methods of testing and inspecting prevents possible misunderstandings.

The actual form of the specification used by the radio manufacturer depends greatly on individual circumstances. As often as not, typed sheets, accompanied by drawings if required, will answer the purpose; such specifications are usually drawn up when and as often as required. If, however, certain items are well standardized and having universal application, it is often economical to draw up basic specifications and have them printed or duplicated in quantities. Such specifications have been found valuable as materials references for the whole manufacturing organization when prepared on punched note-book size sheets. Amendments and additions to the basic specifications are incorporated in particular instances as required. It is often possible to simplify and abbreviate these basic specifications by reference to accepted nationally known standards, or to particular provisions thereof. A partial list of organizations[1] releasing standards to radio engineers follows:

American Institute of Electrical Engineers
American Society for Testing Materials
American Standards Association
Acoustical Society of America
Bureau of Standards
NEMA
Radio Manufacturer's Association

It is always wise to consult with the suppliers when specifications are being compiled. Contrary to the general impression, intelligent purchase specifications are welcomed by the purveyors, for they clarify transactions between buyer and seller.

Another important use of specifications is found in the presenting of technical data describing products offered for sale by the suppliers. Unfortunately, the manufacturer receives few convenient, concise technical specifications and many ambiguous, non-technical sales releases from concerns furnishing components and materials.

A recent canvass of a number of manufacturers marketing insulating materials applicable to radio receivers, brought out a significant fact. In a number of cases, requests for definite technical figures were answered by test results which could not be interpreted, for the test method was not stated and could not be inferred. It is surely trite to remark here that the seller can seldom afford such practices, regardless of the type of product.

Some manufacturers, on the other hand, are careful to present to prospective purchasers of their component parts or raw materials, as complete technical specifications as possible, a few going to the effort of putting such data in loose-leaf form. A condenser manufacturer making a nationally known product gives on a single sheet not only the complete mechanical dimensions of his product with carefully made drawings of the several types but a curve representative of the electrical characteristics of the condensers, a list of stock sizes—with some mention of the superior qualities of the units as well!

Economies are fast forcing set manufacturers (assemblers, in fact) to buy exactly what they want and not to issue blind orders. Such procedure will force more money to be spent on materials research, more careful scrutiny of the actual needs of the production department, and finally to the more general issuance of specifications for material to be purchased.

[1]Interrelations between some of these standardizing bodies are discussed in the 1931 Yearbook of the IRE; p. 43.

Recent European developments in

Electronic musical instruments

By R. RAVEN-HART

Foreign Correspondent, Electronics

WITH only two outstanding exceptions, all recent developments in electronic music in Europe have used the same principle as in the Theremin instrument (see *Electronics*, September, 1930), that of the beat note produced by the interference of two tube-oscillators. The improvements have been principally as regards the facility of playing and the possibilities: e.g., in obtaining a satisfactory and readily produced "detached" effect which was practically impossible with the original instrument, and in giving the player ready control over the tone-quality produced.

As an example of a very fully developed instrument of this type the "Martenot" may be cited, named after its inventor. An indication of the musical importance of this instrument is the fact that it is now produced commercially by the Gaveau piano makers. Here the pitch is controlled by varying the capacity in one of the oscillating circuits, and a dummy keyboard is provided to make playing easier, the player's right hand moving a finger-piece over this keyboard. It is perhaps worth while emphasizing that this is a *dummy* keyboard, and that any intervals can be produced (half, quarter, eighth tones, etc.). The player's left hand controls the volume, a key actuating a variable resistance in the plate circuit of the amplifier; when this key is completely released the instrument is silent.

▼

INTERNATIONAL ELECTRONIC MUSIC CONGRESS MUNICH, JULY 6 to 8

THE holding of an international congress on the subject of electronic music by the European inventors and manufacturers of electronic musical devices shows the practical extent to which the new musical devices have already progressed in Germany, France and other European countries.

▲

Manipulation of tone

The principal point of interest in this apparatus is the control of tone quality. The first tube of the amplifier is made to give a large proportion of harmonics (up to the twelfth), but filter-circuits are provided to remove these at will, three "stops" controlling these and thus giving a choice of eight possible qualities.

Another interesting refinement is the control of the "attack." If the note is produced by depressing the key already mentioned, thus rapidly decreasing the resistance from infinity to a value corresponding to the volume desired, a smooth "attack" is produced; if, instead, another key is used which short-circuits the resistance thus suddenly producing the note, a harsher attack is obtained (trumpet, saxophone); and as a third alternative, a very smooth attack (violin) can be obtained by returning to the normal key but adding a filter circuit to absorb the transients associated with the production of the note.

Of instruments based on principles other than the interference beat-note the "Boreau" and the far more interesting "Trautonium" may be mentioned.

The former uses the vibration of a mechanically-bowed violin-string, fixed at one end and attached at the other to the membrane of a telephone receiver. Pitch is here controlled by varying the length of the vibrating portion of the string, volume by a pedal actuating a resistance in the amplifier circuit and a system of filters is provided to give a choice of tone-qualities.

Dr. Trautwein's "Tratonium"

The "Trautonium" is a recent development at the Radio Research section of the Berlin Academy of Music, an institution unique in the world and which deserves an article to itself. The inventor, Dr. Trautwein, has thus had the direct and permanent cooperation of musicians in his experiments, for example, Paul Hindemith, perhaps the best known of present-day German composers and a professor at the academy, is himself an excellent Trautonium player and has written music specially for it.

The principle here is radically different, and involves a new musical theory, according to which the characteristic tone-color of an instrument is (in most cases) caused, not by overtones which are multiples of the fundamental frequency as in the older (Helmholtz) theory, but by damped vibrations of a fixed frequency or frequencies bearing no relation to the fundamental frequency except accidentally (and then tending to produce undesirable effects, "wolf" tones, etc.). Such "tone-formers" (German 'Hallformanten'') as they are called are caused by some acoustical "circuit" in the instrument being resonant to this fixed frequency and being set in vibration by shock excitation due to small variations in the volume of the fundamental note. It should be noted that the tone-formers are always of a higher frequency than the fundamental; should the fundamental (in ascending the scale) pass one of them, it at once disappears and the timber becomes simpler, e.g., the upper notes of a clarinet are relatively characterless owing to the loss of tone-formers present when the lower register is in use. It is also to be noted that these tone-former vibrations die out before the end of each fundamental period, or are wiped out by the beginning of the following one. A simple example of the control of quality by acoustic tone-formers is the muting of a violin or of a trumpet (by wooden cone or Derby hat!) since the "mute" checks the vibrations of some particular acoustical "circuit."

The application of this theory to electrical music is explained as follows: The pitch is given by the frequency of extinction of a neon lamp, this being controlled by a resistance of the order of one megohm. (The value of the condenser will depend on what portion of the audible scale we wish to cover). The impulses from this circuit are passed to the first tube, the grid resistance serving to keep down back-coupling from the circuit to that of the neon lamp, are amplified, and passed to the tone-former circuit. This has a natural frequency variable between say 400 and 4,000 cycles, and its damping can be increased by the parallel resistance or decreased by the feed-back condenser.

Range of instrument

The following experiment goes a long way to prove the new theory and incidentally to demonstrate the possibilities of the new instrument. Let the neon lamp circuit be adjusted to give a frequency below the audible limit; a series of isolated "ticks" will be heard, of a pitch controllable by the circuit and not unlike the various bars of a xylophone as this circuit is varied. If now the frequency of the neon lamp circuit be increased so as to produce a musical note, the pitch previously heard (from S) suddenly disappears, and the *new* pitch (from the neon lamp) is alone heard, but with a definite tone-quality. Further, the pitch (neon-lamp frequency) may be varied almost at will without this tone-quality changing (so long as the pitch frequency does not reach that of S; should it do so, the tone-quality disappears altogether). If on the other hand the pitch is left unchanged and a new value of S taken, the tone-quality changes, e.g., a low frequency for S may suggest a bassoon, a higher one a 'cello, and a still higher one a trumpet.

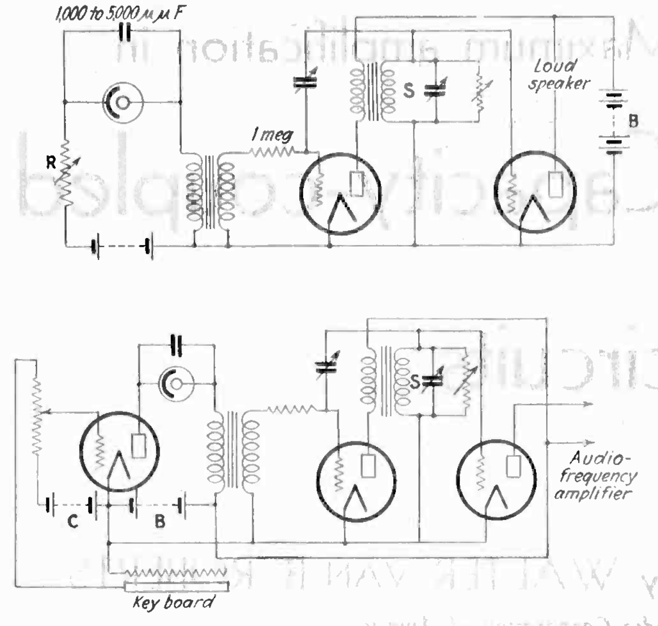
This is the fundamental experiment, but there are many fascinating bypaths which can only be mentioned here, the inventor's own book should be consulted.

For example, if the damping of S be reduced, the quality becomes more acid, heavy damping giving more rounded tones. Dr. Trautwein suggests that this may be the principal cause of difference between (for example) a good violin and a bad one.

Again, a second tone-former (S) circuit can be added, with the primary of its transformer in series with that shown and with the secondary feeding the same tube; this completely changes the quality produced. It will be realized that, since each S circuit is theoretically capable of an infinite number of settings, the result of two such circuits in combination gives literally an almost unlimited number of distinguishable qualities.

Another interesting experiment is to keep the pitch steady and alter the frequency of the tone-former circuit slowly. The ear can then easily hear the *two* tones and can follow the change in pitch of the upper one; but as soon as this latter is left constant the ear loses it, and the "quality" effect reappears.

If both pitch and tone-former circuits be altered simultaneously, animal-like noises are produced, and Dr. Trautwein suggests that the development of human speech from these came with the acquisition of the power to hold the vocal tone-former steady. It is a fact that certain fixed values of tone-formers do very strongly suggest the vowels (more especially the French nasalized vowels). Here, however, the new theory links up with the Hermann theory of "Formanten" in speech-sounds: the term "Hall-formant" was chosen to indicate that the new theory is in a sense an extension of the "Formant" theory.



Circuits of "Tratonium" electrical musical oscillator

Linear relationship of pitch and fingering

In the practical instrument the variable resistance R is replaced by the internal resistance of a triode in order to obtain a linear relationship between pitch and fingering, the actual playing being done by pressing a stretched wire into contact with a metal plate. Were such a wire to be connected directly, the fingering at one end of the scale would be inconveniently cramped. This method has also the advantage that when the wire is released the first tube is entirely blocked, thus avoiding the monotonous glissando effects that were one of the chief disadvantages of some earlier electronic instruments. (Of course such effects are available when required, by merely sliding the finger along the wire).

Volume control is usually by a pedal actuating a resistance in the amplifier circuit that follows the last tube of Fig. 2: other methods can also be used, some of which present great interest.

It is of course perfectly practicable to mount several "keyboard" wires side by side, each controlling its own neon lamp and all feeding the same amplifier and loudspeaker, so that one player can produce a multiplicity of tones simultaneously; but it may be queried whether this is desirable, at any rate at present, in view of the difficulties in execution involved.

A practical point is the difficulty in finding suitable

[*continued on page 42*]

Maximum amplification in

Capacity-coupled circuits

By WALTER VAN B. ROBERTS

Radio Corporation of America

IN *Electronics* for October, 1930, there appeared a paper by Dr. Louis Cohen on a form of capacity coupling. A formula was derived which gave the amount of coupling capacity required for maximum amplification. The derivation of the formula, however, was based upon simplifying assumptions some of which would be difficult if not impossible to justify in the case of tubes having a very high internal impedance such as the screen-grid type. In the following analysis only two approximations are introduced and neither of these is believed to be capable of making an appreciable difference in any ordinary circuit.

Figure 1 is the circuit under consideration, there being no magnetic coupling between the two coils. Figure 2 is the circuit of Fig. 1, simplified for purposes of calculation. In Fig. 2, R represents the plate resistance of the tube, μ its amplification constant, and the other letters the impedances of the various branches. It should be noted that Z_1 is the impedance of the element conveying space current to the tube when this element is shunted by the plate capacity of the tube and any other stray capacities in parallel therewith. Similarly Z_c includes the grid capacity of the tube across whose input it is connected.

The problem is to maximize the voltage across Z_c with respect to Z_c and then to maximize this maximum value with respect to Z_k, thus ending up by obtaining an expression for the greatest grid-to-grid amplification obtainable by any combination of adjustments of Z_c and Z_k as well as an expression for the value of Z_k that will yield this "max-max" amplification. The straightforward solution of this problem is to calculate the amplification, reduce it to its absolute value, and then differentiate with respect to the proper variables is the usual way. This method, however, turns out to be extremely tedious and in this particular problem a short cut to the solution is easy if the expression for amplification is thrown into suitable form such as follows:

$$\frac{i_c Z_c}{e} = \mu \frac{Z_d}{R(Z_d + Z_k)} \frac{1}{\left[y_c + \left(\frac{1}{Z_2} + \frac{1}{Z_d + Z_k} \right) \right]} \quad \text{equation 1}$$

which is easily checked up by reducing to a ratio of two polynomials and comparing with the expression for

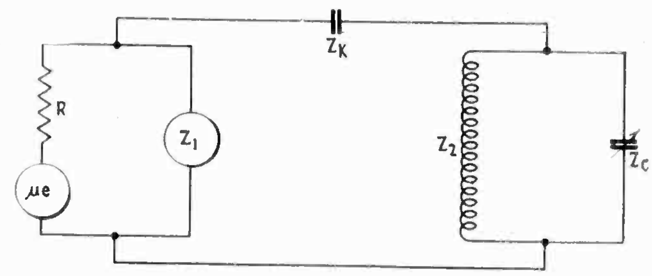


Fig. 2—Equivalent circuit of amplifier

amplification obtained by a solution of the circuit equations. In equation 1 y_c stands for $\frac{1}{Z_c}$ while Z_d stands for the divided circuit impedance $\frac{RZ_1}{R + Z_1}$.

Now if y_c is pure imaginary it is evident that the amplification will be a maximum with respect to Z_c if y_c is adjusted in value to wipe out the imaginary part of the expression in square brackets, which immediately gives as the maximum amplification obtainable by adjustment of the tuning condenser

$$\left(\frac{i_c Z_c}{e}\right)_{max} = \mu \frac{Z_d}{R} \frac{1}{Z_d + Z_k} \frac{1}{\text{real part of } \left[\left(\frac{1}{Z_2} + \frac{1}{Z_d + Z_k} \right) \right]} \quad \text{equation 2}$$

Now let $Z_d + Z_k = a + jb$ and $Z_2 = r + jl$ and equation 2 becomes

$$\left(\frac{i_c Z_c}{e}\right)_{max} = \mu \frac{Z_d}{R} \frac{1}{\sqrt{a^2 + b^2}} \frac{1}{\frac{r}{r^2 + l^2} + \frac{a}{a^2 + b^2}} \quad \text{equation 3}$$

In case Z_k is pure imaginary, the value of Z_k affects only b and therefore $\sqrt{a^2 + b^2}$ may be considered as an independent variable, in which case the ordinary method of maximization very quickly shows that maximum amplification results if $\sqrt{a^2 + b^2}$ is made equal to $\sqrt{\frac{a}{r}}\sqrt{r^2 + l^2}$ or in other words

$$|Z_d + Z_k| = |Z_2| \sqrt{\frac{a}{r}} \quad \text{equation 4}$$

If Z_k is chosen to satisfy equation 4 the amplification becomes

$$\left(\frac{i_c Z_c}{e}\right)_{max\ max} = \mu \frac{|Z_d|}{R} \frac{|Z_2|}{2\sqrt{ar}} \quad \text{equation 5}$$

Equations 4 and 5 are the expressions which were sought. In certain cases equation 4 may be reduced to the expression given by Dr. Cohen. For let Z_d be negligible in comparison with Z_k and let Z_1 be so large in comparison with R that a may be replaced by R, and also replace Z_2 by Z_c and equation 4 becomes $|Z_k| = |Z_c| \sqrt{\frac{R}{r}}$

[*continued on page 42*]

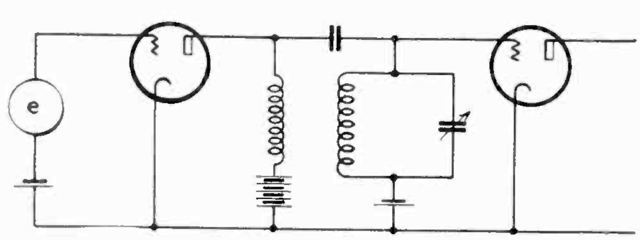


Fig. 1—Capacity coupled radio frequency amplifier

Super-midget radio transmitter

for tracking meteorological balloons in inclement weather

By CAPTAIN JAMES A. CODE, Jr.
Signal Corps, U. S. Army

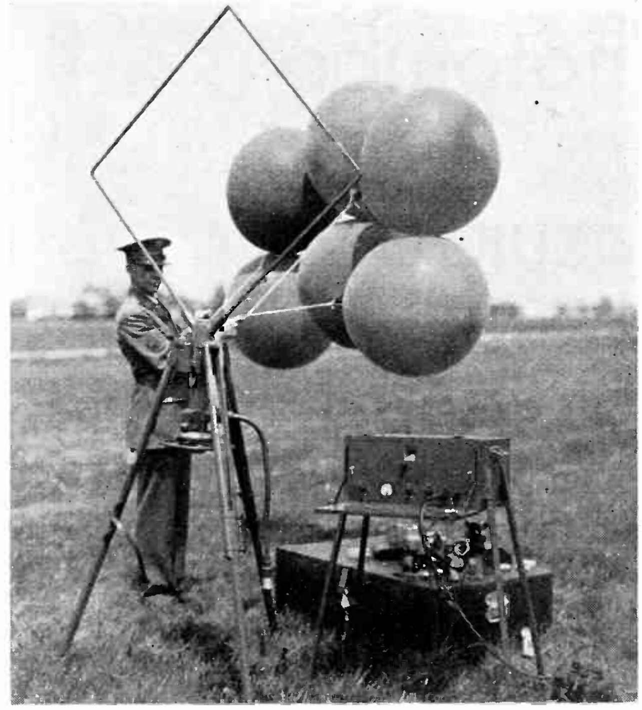


Fig. 1—Radio compass equipment used to obtain bearing of transmitter attached to balloon cluster

IT is often desirable to attain meteorological observations over terrain which is inaccessible and upper air observations during inclement weather. Ordinarily, these observations of wind direction and speed are made by releasing a small rubber balloon and following it by means of theodolites. In order to overcome poor visibility during inclement weather or at night, or over inaccessible terrain, the radio tracking transmitter was developed. This method is to release a transmitter which is attached to the balloon and to follow it with radio direction finders instead of theodolites. This method has many advantages over the old method of attaching bombs with time fuses to a balloon, in securing the direction and sound range of the explosion. It also has advantages over the light method which provides for attaching to the balloon some means of illumination and following it as long as visible.

The transmitter itself is of interest as its weight is but 17½ ounces. It consists of a small flashlight 4½-volt battery which serves to heat the filament of a 199 tube and simultaneously to energize the primary circuit of a buzzer transformer. The turns ratio of the transformer is about 50 : 1 and its iron core is provided with an air gap to give leakage flux for operation of the vibrator, which is included in the primary circuit. The secondary voltage is, of course, intermittent at the rate of vibration of the interrupter, and it is this voltage, or rather that part of it which makes the plate positive during each cycle of the vibrator, which is applied as B voltage to the 199 tube.

The transmitter is attached to the balloon so that the supporting and trailing wires constitute an antenna and counterpoise. Perhaps it would be better to say that they act as two legs of a rather ideal dipole radiator and it is this radiating system which gives the transmitter its effectiveness in spite of the small amount of energy supplied to it. The frequency or wave length radiated depends on the length of the legs chosen in conjunction with the circuit inductance. The length of these legs is arbitrarily chosen as 40 feet to set the wavelength near 125 meters, but this length is not critical and the legs may be shortened or lengthened as desired, to change

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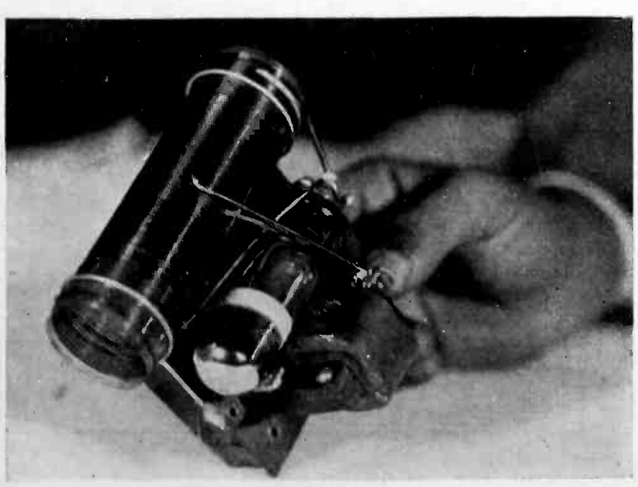

Fig. 2—Detail view of the 17 oz. radio transmitter using one 199 tube

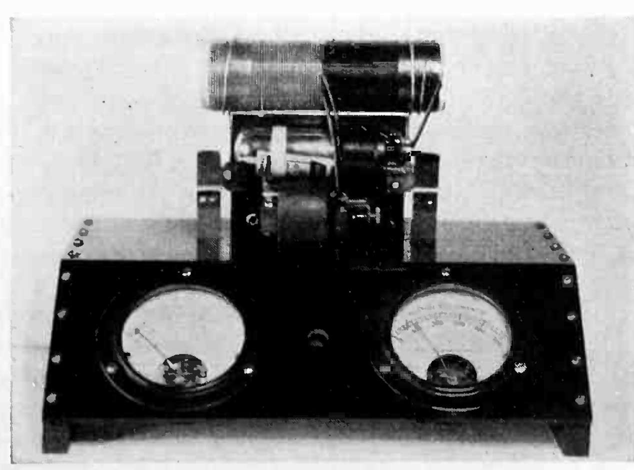

Fig. 3—Radio transmitter on test stand for adjustment prior to release

Phototube circuit design for sound-pictures

By C. A. WYETH

Engineering Department
Pacent Electric Company, Inc.

In selecting the most suitable type of phototube to be used in the reproduction of sound from film, many factors, both electrical and mechanical, must be considered. Chief among the electrical factors are the frequency response characteristic, sensitivity, impedance and noise level; and the mechanical factors are the shape and size of the cell, mounting facilities required, and sturdiness of physical construction.

Four distinct types of phototubes are now more or less in extensive use—the potassium, caesium, selenium, and photolytic types. The following will deal with the suitability of these tubes for use in sound-picture reproduction.

The proximity of the head amplifier to the phototube housing determines to a great extent the most efficient type of tube to be employed and the type of coupling circuit required. In the case of most theater installations, the head amplifier is located either on the front of the sound-head or directly ahead of the projector on the front wall of the booth. In either of these positions, a line connecting the head amplifier to the phototube will necessarily be reasonably short. However, in the case of typical portable sound-on film reproducing equipments, it is sometimes convenient to locate the amplifier at a comparatively greater distance from the phototube than in the case of a permanent installation.

Potassium, caesium, and selenium cells are the high impedance type and therefore require a high impedance coupling circuit to the head amplifier. Owing to the characteristics of a high impedance coupling circuit, necessary with the high impedance tubes, the permissible distance from the head amplifier to the phototube will be limited. To obtain the maximum fidelity of reproduction, it is essential in the case of these cells, that the length of the high impedance coupling circuit be as short as possible to prevent loss of the high frequencies owing to the inherent capacity effect of the line. In addition, the line is susceptible to inductive interference if not kept at a minimum length. As a result of these circuit difficulties, it is desirable to attach the head amplifier directly to the sound-head, thus reducing the length of the coupling circuit to a few inches.

One of two methods is generally employed for coupling the high impedance type of tube to its amplifier. The first and most extensively used is the resistance coupled type of circuit, and secondly, the transformer coupled type of circuit. (See figures 1 and 2). The resistance coupled method is the more economical and the more ideal from a frequency response standpoint. The value of the resistance R_1 varies from 1 to 20 megohms according to the impedance of the phototube used. A one to two megohm resistance has been found in practice to give the most satisfactory results in connection with the average high impedance phototube available for sound picture purposes.

Great care is necessary in selecting the type of resistance to be used at this point of the couping circuit, since one which is faulty in any way will cause extraneous noises to be introduced into the amplifier. The average type of grid leak will give but temporary satisfactory results since they are not capable of passing the required phototube current for any appreciable length of time. It is therefore imperative for perfect results that a resistance be used which is capable of passing the required phototube current. This resistance unit, in addition to having the proper current rating, must also be the type which is not affected by normal weather and temperature changes.

The coupling capacity C must have a d.c. voltage rating sufficiently high to withstand the potential impressed on the anode of the phototube. A condenser whose capacity lies between 0.01 and 0.05 mfds. with a 200 volt d.c. rating will be found satisfactory.

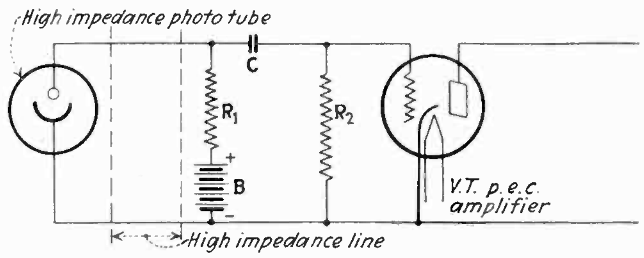

Fig. 1—Circuit generally employed where head amplifier is mounted adjacent to projector

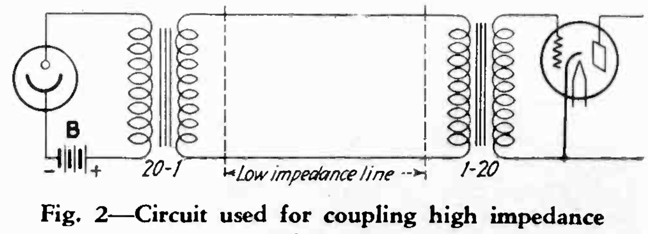

Fig. 2—Circuit used for coupling high impedance phototubes to amplifier remote from projector

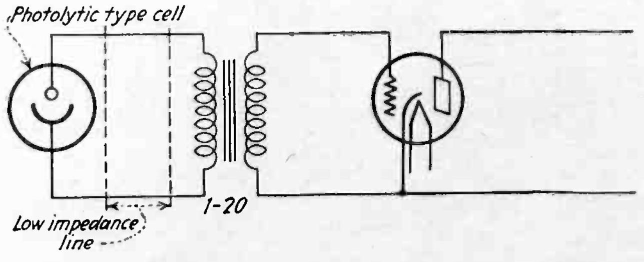

Fig. 3—Coupling circuit used in connection with low impedance phototubes

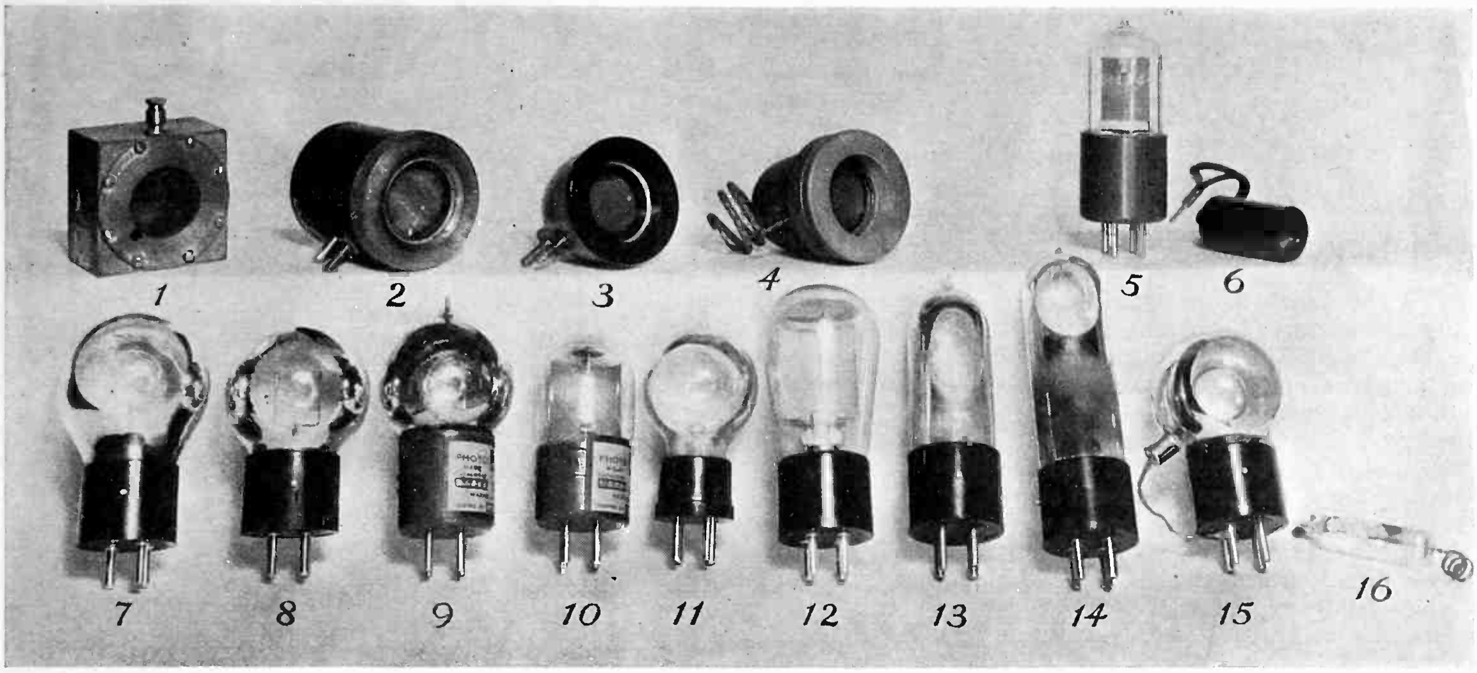

Fig. 4—Classes of phototubes showing lack of standardization. Numbers 1, 2, 3 and 4 liquid type; 5, 6 selenium cells, 10, 12 caesium, remaining cells potassium

The grid-cathode resistance R_2 does not require the care in selection as does R_1, but it is recommended that a good quality grid leak type of resistance unit always be used.

In the transformer coupled type of circuit Fig. 2, the high impedance of the phototube is matched to a low impedance line leading to the input transformer of the amplifier by a transformer having a high step-down ratio of 20:1 or greater. In this way, the line between the phototube transformer secondary and the amplifier input possesses the desirable characteristics of the low impedance circuit. However, the inherent characterestics of the coupling transformers affect the frequency response to a far greater extent than is noticeable in the use of the conventional resistance coupled type of circuit. Great care must be exercised in the transformer coupled circuit in shielding and mounting the two coupling transformers since their position in the amplifying circuit makes them very susceptible to the mechanical vibrations and stray electrical fields. Both transformers must be spring suspended to insulate them from all vibration and each unit must be thoroughly and affectively shielded to prevent intreference from being introduced into the amplifier. These necessary precautions contribute to the cost of the system which lends more weight to the use of the resistance coupled type of circuit.

In the case of the photolytic type of cell, which has a low impedance in the neighborhood of 500 to 1,500 ohms depending upon the frequency, the coupling circuit, Fig. 3, does not present the same difficulties as mentioned in the case of the high impedance line. It is therefore possible to increase the distance between the cell and head amplifier any reasonable amount without noticeably affecting the frequency characteristic of the equipment. High frequencies are not appreciably attenuated and inductive interference is kept at a minimum. The transformer best suited for coupling the photolytic cell to the first amplifying tube will have a turn ratio of aproximately 1 : 20 and a primary impedance between 500 and 1,500 ohms.

The same transformer mounting and shielding precautions are necessary as mentioned in connection with the transformers used in the circuit sketch shown in Fig. 2.

By inserting a 2 mfd. condenser in series with the photolytic cell and the primary of its coupling transformer, the useful life of the cell may be considerably lengthened. However, the insertion of this condenser causes the amplifier output to fall off to a degree approximately equivalent to the removal of one stage of amplification. This condition is especially objectionable in the case of portable reproducing equipment where the weight of the amplifier is of prime importance. A switch may be connected in series with the cell in place of the condenser to allow the cell to be open-circuited whenever it is not in use. In this way the maximum life of the cell may be realized without impairing the overall efficiency of the amplifying system.

Lack of uniform characteristics

At the present stage of phototube development, as in the early days of vacuum tube manufacture, it is difficult to produce cells in quantity of which all have uniform characteristics. Owing to the divergence of the characteristics between one cell and the next, it is often necessary to adjust the conditions in the reproducing equipment in such manner as to produce equal output from both projectors. The easiest method in the case of the high impedance type of phototubes is to vary the plate potential of the individual cells so that the output level of each is the same. When the photolytic type

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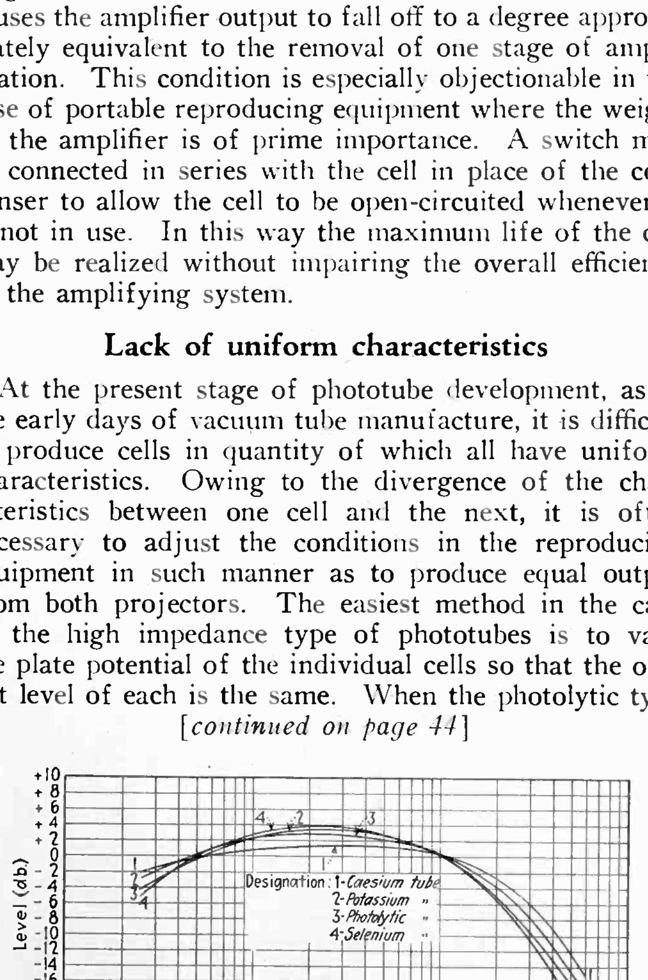

Fig. 5—Frequency response characteristic curves for four classes of phototubes made with a standard frequency film

+ + + ELECTRONIC TUBES

Calibration of grid gain controls

By W. O. Watson, research engineer, Monarch Pictures Corporation, Ltd. It is often desirable to control the gain of an amplifier in terms of decibels. In order to accomplish this a calibrated voltage divider or gain control must be employed. This control works into the grid circuit of the first or second stage in the amplifier. It is considered a voltage divider as the load into which it works draws no current. So it may be defined by the expression.

$$N = 20 \log \frac{R}{r} \text{ (Fig. 1)}$$

R being the total resistance of the divider and r being the resistance used between 2 and 4.

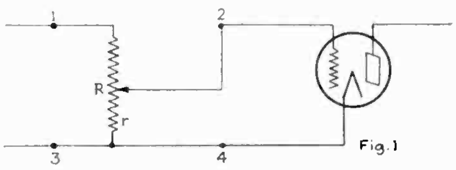

Fig. 1

The total resistance of the gain control must be decided upon, this value to be usually larger than the impedance of the secondary of the input transformer in that stage. However, it does not need to be any specific amount so long as it is larger. A 175,000 ohm or 200,000 ohm resistor is sufficient to use across a 150,000 ohm secondary; this is a normal lead for the input transformer and this type section maintains a constant impedance for all values of attenuation. Although this is not true looking out of the control, it is not necessary as the grid of the vacuum tube effects no load.

Attenuation in decibels in this voltage divider represents a certain percentage of reduction in voltage. This percentage of reduction in voltage is also a like reduction in resistance. Solving the expression

$N = 20 \log \frac{R}{r}$, in terms of $\frac{R}{r}$; where

$$\frac{R}{r} = \text{antilog} \frac{N}{20}$$

Let K = percentage of resistance used for each step (resistance between 2 and 4 (Fig. 1) for N decibels attenuation. Then

$$K = \frac{r}{R} \times 100; \; K = \frac{100}{\text{antilog } N/20}$$

Suppose we calibrate a 175,000 ohm gain resistor in ten steps of 3 decibels per step. Then

$$K = \frac{100}{\text{antilog } 3/20} = \frac{100}{\text{antilog } .15}$$

referring to table of common logarithms, antilog .15 = 1.41

$$K = \frac{100}{1.41} = 70.9\%$$

For the first step
r = 70.9% of 175,000 = 124,075 ohms
Since we are building up the total resistance of resistances used in each step as the resistance in first step between A and 1 and resistance in second step between 1 and 2 (Fig. 2), etc., we must use the difference between R and r (Fig. 1). Then

175,000 — 124,075 = 50,925 ohms

resistance used in the first step (between A and 1 (Fig. 2).

The second step, r = 70.9 per cent of the remaining resistance, which is 124,075 or 87,969 ohms, and the resistance between 1 and 2 is 124,075 — 87,969 or 36,106 ohms.

The third step,

$r = .709 \times 87{,}969 = 62{,}307$

Resistance between 2 and 3 is 87,969 — 62,307 = 25,599 ohms, and so on for the remainder of the ten steps, each time taking 70.9 per cent of the remaining value of resistance.

Between the tenth step and B (Fig. 2) will be the last remainder of resistance 5,694 ohms.

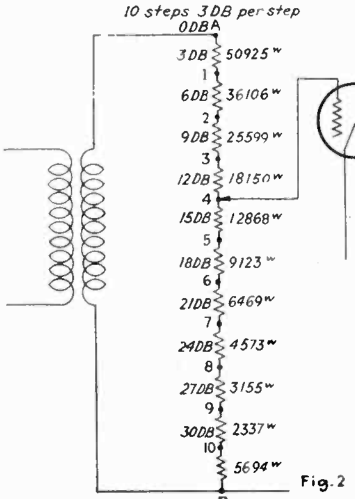

Fig. 2

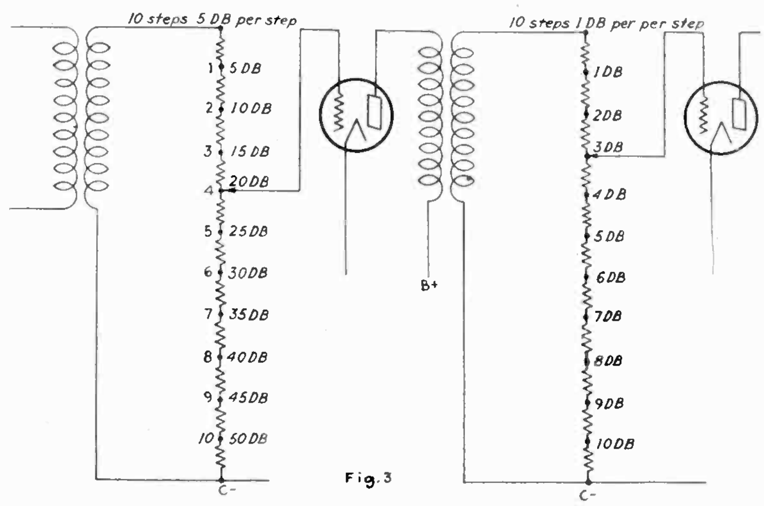

Fig. 3

If it is desired to have one decibel steps from 1 decibel loss to 60 decibels loss, a 10 step 5 decibel per step gain control can be connected in the grid circuit of the first stage and a 10 step 1 decibel per step gain in the second stage (Fig. 3). The loss in this combination due to both controls is 20 decibels in the first control and 3 in the second control, total 23 decibels. If the contact arm in the first control was on the 7th step which is 35 decibels loss and the contact arm of the second control was on the second step or 20 decibels loss, the total loss would be 37 decibels.

In this way changes in attenuation as much as 60 decibels in steps of one or 5 decibels can be accomplished. These calibrated gains or voltage dividers may also be used in the construction of level indicators as a means of increasing or decreasing the range of the instrument a desired and known amount of decibels.

A very simple design of gain control can be made using Electrad resistors and adjusting the clips to the desired resistance with a decade box or high grade ohmmeter.

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Glow-tubes check operating voltage

The Gray Telephone Pay Station Company, Hartford, Conn., makes use of a photo tube in the semi-automatic testing of coin-collector relays. When this test was changed from manual to semi-automatic it was considered necessary to have some positive check of the operating voltage and this was accomplished by use of two CX-374 glow tubes. A voltage increase or decrease of 0.2 per cent will stop the test and it cannot be restarted until the voltage is corrected.

IN THE LABORATORY + + +

Progress in sound analysis and measurement

F. Trendelenburg, Siemens, Berlin, writing in *Zeitschrift f. Hochfrequenz Technik*, March, 1931, states there are few fields which have profited so much by the advance in the electronic arts as acoustics.

Two of the more recent methods of analysis are the carbon microphone bridge circuit with variable search tone (E. Meyer) for automatic work and the push-pull device with search tone (M. Gruetzmacher) which is also able to analyze noises. A composite musical sound to be analyzed acts on the microphone R (Fig. 1), where it adds itself to the variable tone from the source S. Different low beat-tones $(s - p)$ are produced when s is varied and the amplitude of the component p is directly indicated by the maximum deflection of the vibration or string galvanometer G responding to low notes, only provided that the amplitude of J is kept constant. The bridge should always be adjusted so as to give no deflection for the search tones alone. By using two constant frequencies and replacing R by a different microphone, the presence of combination tones would indicate that the new microphone distorts.

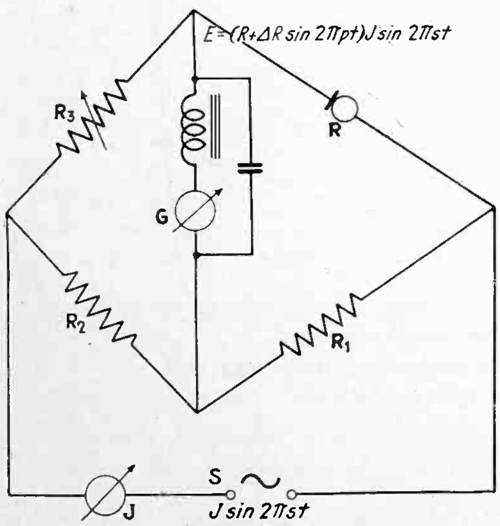


Fig. 1—Circuit for testing microphone distortion

For noises, where the components lie too close together, the push-pull arrangement (Fig. 2) used in the region of the square-law portion of the tube characteristics gives for the difference between the intensities $(s + p)$ and $(s - p)$ the potential $-2E_s -4E_nE_s$, and therefore the intensities of the noise components which may be filtered out and measured by a thermocouple. An analysis of the hissing sound s shows that when carefully pronounced, it contains frequencies up to 13,000 cycles per second. For work on noises (motors, heart beat) amplifiers have also been made available which possess the same sensitivity for different frequencies as the human ear.

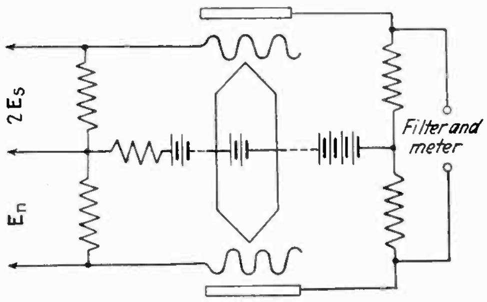


Fig. 2—Circuit for analyzing sound components lying close together

For pressure amplitude and phase measurements compensation methods have been improved. A current of known frequency and of adjustable phase.

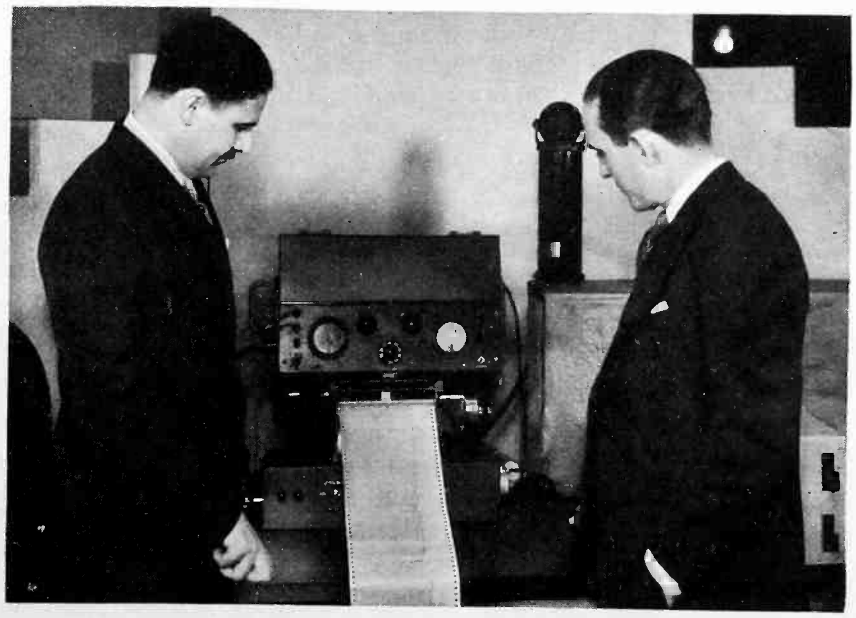
Direct measurement of the power L radiated by a source, considered impracticable not many years ago, was obtained by Meyer and Just by placing the sound source to be studied inside a room with highly reflecting walls, of volume V cubic meters. The average energy density E is then $4L/Ac$ (where A total absorption in room, c velocity of sound). E is determined by measuring the pressure amplitude with the aid of a condenser microphone A by measuring the duration T of reverberation $(AT = 0.16\ V)$. In order to avoid errors caused by standing waves it is best to work with slowly varying frequencies to obtain good results.

Graphic noise level recorder

The Bell Telephone Laboratories has recently developed two noise level recorders for Electrical Research Products, Inc. One of these units gives the noise level reading directly in decibels on a visual scale. Where a continuous graphic record is desired a level recorder (as illustrated) may be substituted for the visual indicating meter.

The instrument is designed to record the effects of noise in terms comparable to the loudness sensation as judged by the ear. It consists essentially of a microphone, amplifier, weighting network, indicating meter, and necessary battery supply, contained in two cases. The microphone picks up the sound, converting it into an electrical current which is a counterpart of the original sound. This is then amplified by a vacuum tube amplifier and actuates a meter reading the loudness of the sound directly in decibels. The decibel scale is an arbitrary one in which each unit represents approximately the smallest change in loudness than can be detected by the normal ear. Zero of this scale is near the threshold of hearing or the point at which sound becomes inaudible in a very quiet place. Since the apparent loudness of a sound of specified energy is not the same for all frequencies, the amplifier is adjusted by means of a weighting network to simulate the sensitivity of the ear.

At frequencies near 2,000 cycles per second, the amplifier is most sensitive and decreases in sensitivity with increase or decrease in frequency from this value.



Noise meter designed to make a continuous graphic record of noise level in comparison to the sensation produced on the ear

A meter for indicating 100 per cent modulation

By G. F. LAMPKIN

In a broadcasting system the volume level is monitored in several places and ways—in the studio, along the wire lines, at the station. Usually the final check is had at the station on a modulation-percentage meter.

In some of the newer stations capable of completely modulating the carrier an oscilloscope is used to monitor the modulation peaks. While a modulation-percentage meter may be, and usually is, also part of the equipment, still it does not accurately indicate instantaneous peaks. Because of its inertia it is both slow in responding and prone to overswing when actuated by rapidly varying forces. On the oscilloscope a calibration may be made for the maximum allowable peak, and all modulation may be held within this limit. However, an oscilloscope is a relatively expensive piece of equipment, and its indications are not as easily read as would be those of a meter.

If the static input-output characteristic of a transmitter be a proportional one, then a very simple arrangement may be set up to indicate when the modulation goes out of bounds. The word proportional, in this instance, is used in a strict sense. Figure 1 illustrates the point, where the plot is not only linear but intercepts at the origin.

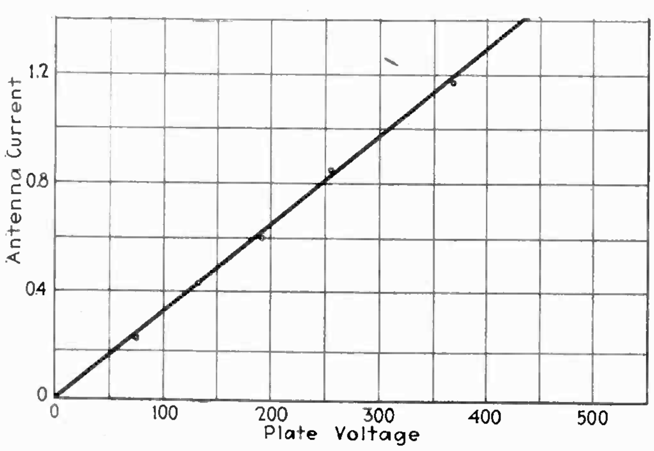


Fig. 1—Linear relation between plate voltage and antenna current

The data in Fig. 1 were taken using the circuit of Fig. 2 with a type UX-210 tube. The abscissae are d.c. plate voltages, the alternating voltage $E_{a.c.}$ being zero, and the ordinates are proportional to the radio-frequency output of the oscillator. It is evident that, with a characteristic of this sort, when the antenna current touches zero on the valley of a modulation cycle, the plate voltage on the modulated tube has prerequisitely gone to zero.

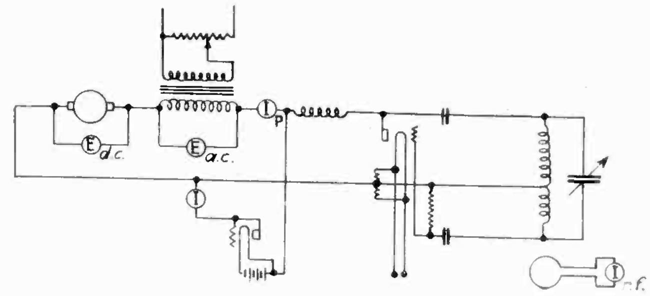


Fig. 2—Circuit diagram of indicator for 100 per cent modulation

Now let an indicator tube be connected reversed fashion to the plate supply of the modulated tube. Normally its anode is negative and its filament positive, so that no anode current flows. But let the plate voltage go a fraction past zero on one of the modulation valleys and the voltage appears in the correct direction on the indicator tube—the indicator anode meter shows a momentary current. Thus we have an indicator that is quiescent until the modulation just reaches 100 per cent then it gives warning. Of course it is assumed, when using such a device, that the transmitter is adjusted so that twice normal antenna current may be reached on the opposite side of the operating point.

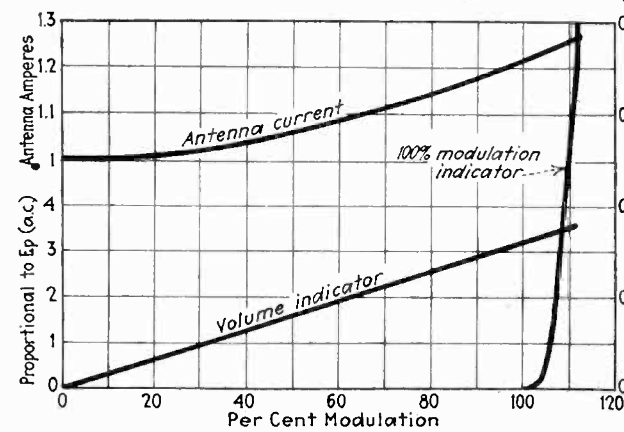


Fig. 3—Several methods of indicating 100 per cent modulation

In Fig. 3 are compared three methods of reading modulation percentage. The increase in antenna current from 1.00 to 1.22 amperes from zero to full modulation is apparent. The plot labeled volume indicator has ordinates which are proportional to the a.c., or audio component of plate voltage. The ordinates of the 100 per cent-modulation-indicator curve are readings on a 1-milliampere d.c. meter in the anode of the indicator of Fig. 2. The indicator tube was a type UX-112. The abscissae in Fig. 3 were determined from the ratio of the peak 60-cycle alternating voltage to the steady d.c. plate voltage of 320. It is evident that in this setup the flickering of a 200 micro-ampere indicator meter, for instance, during the transmission of the loudest passages, would accurately indicate 100 per cent modulation.

NEW BOOKS ON ELECTRONIC SUBJECTS

Radio handbook

By James A. Moyer, S.B., A.M. and John F. Wostrel, Director of University Extension and Instructor, respectively, Massachusetts Department of Education. McGraw-Hill Book Company, New York, N. Y.; 886 pp. Price $5.

THE SUBJECT OF this handbook does not give a complete picture of its contents, as additional sections are included giving condensed information on the following subjects: Photo-electric cells; television; industrial applications of vacuum tubes; and sound motion pictures. The sections devoted to radio subjects include: Fundamental units and radio glossary; electricity in radio; radio accessories and instruments; fundamentals of radio communication; power supply systems and apparatus; vacuum tubes; vacuum tube circuits; radio receiving sets; transmitting circuits; broadcasting transmitters; marine commercial transmitters, and laboratory equipment and methods.

✦

Recording sound for motion pictures

Edited by Lester Cowan for The Academy of Motion Picture Arts & Sciences. McGraw-Hill Book Company, New York, N. Y.; 404 pp. Price $5.

THIS IS THE first authoritative book published on the essential technical features of recording sound-pictures. It is a compilation of 24 special papers prepared for the sound Technician's School conducted by the Academy of Motion Picture Arts and Sciences. The leading motion picture engineers in Hollywood contributed to produce this book. Eight chapters are given to the principal methods of sound recording, covering equipment now in general use. Four chapters cover the subject of the film record, and the technique of handling sound films. Five chapters are given to studio acoustics and technique, and an equal number on sound reproduction.

A complete glossary of motion picture terms is included in the appendix. This book is profusely illustrated with photographs and diagrams. Those in the motion picture industry will find this volume an authoritative text for reference. Other engineers, as well as non-technical persons, will find it interesting reading, as it is completely free of mathematics or highly technical matter.

Radio frequency measurements

By E. B. Moullin, M.A., Charles Griffin & Co., Ltd., London; J. B. Lippincott, Philadelphia. 487 pages, 289 illustrations. Price $12.50.

IT HAS BEEN FIVE YEARS since the first edition of this excellent work appeared. For some time the book has been out of print, although still in demand. This second edition represents the labor of three years on the part of the author, has been entirely re-set and greatly enlarged. It is still the best book on the subject in English; its augmentation in size and scope make one of the several necessary books on radio and high-frequency.

The author is well known in the literature as a painstaking and careful student of high-frequency phenomena, and as an excellent experimenter. This book is typically British in the interest in small details of circuit analysis jumped over by American writers and experimenters until trouble arises and forces a closer inspection. For example, to what frequency will an anti-resonant circuit resonate if there is inductance in both branches? What happens to the effective resistance if the proportion of inductance in the two branches is changed?

The book is a particularly effective combination of the theoretical and the practical. It is at once a text and a handbook of practice. The analytical and, in many cases, quantitative answers to many perplexing problems are within its covers. Five years ago this reviewer praised this book; it seems to be immeasurably better now. Withal its solid value it is human, a quality not found in many serious books written by experts. The author does not hesitate to inject parenthetical expressions and statements where necessary or even interesting, such as, for example, pointing out the ambiguous method British tube manufacturers have of rating their tubes and describing their characteristics.

✦

A dictionary of color

By A. Maerz and M. Rea Paul, New York, McGraw-Hill Book Company, 207 pages, 56 color plates. Price $12.

UNDOUBTEDLY the finest presentation of the subject of color ever attempted between book covers is this remarkable reference volume. Primarily it is intended for persons who seek to identify colors by their common names, and true to its function as a dictionary it samples, lists and defines all color terms in use in the English language.

Its many sheets of color reproductions are the result of years of collecting color charts and cards, textile samples, etc., and the terms applied are those used throughout industry and art.

Among the subjects covered in the volume are the standardization of color names, sources of names, textile names, traditional names, scientific names, common errors in color-name usage, definitions, color matching, etc. The appendices include tables of color terms found in literature, a table of principal color names, a color bibliography, a history of standardization of colors, various indexes, etc. The authors are well-known authorities on color; Mr. Maerz is director of the American Color Research Laboratory, and Mr. Paul is consulting colorist for the National Lead Company.

✦ ✦ ✦

A LETTER TO THE EDITOR

Patents on industrial uses of light-sensitive cells

I desire to call attention to the existence of U. S. Patents 1,455,795 and 1,471,342 of May 22, 1923 and October 23, 1923, respectively, relating to the control of production processes by light-sensitive means.

Light-sensitive cells have been extensively advertised for a wide variety of uses in the control of production processes without reference to the patent situation. The policy of powerful interests of ignoring the patents of others in fields in which they have largely failed to visualize the possibilities, and of attempting, when it serves their purpose, to give the impression that inventions which they do not control are public property, places the prospective user under the necessity of proceeding with the greatest caution in regard to the patent situation. I wish accordingly to point out that the foregoing patents relate to a large portion of the field of process-control by light-sensitive means and to emphasize the unwisdom of proceeding indiscriminately with applications of process control by such means without a careful investigation of the patent situation. I may add that the field of application to which my patents relate is in part outlined in an article in the *Journal of Industrial and Engineering Chemistry*, vol. 15, pp. 40-43 (January, 1923).

LLOYD LOGAN, *associate professor, Johns Hopkins University, Baltimore, Md.*

electronics

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O. H. CALDWELL, Editor

Volume III — JULY, 1931 — Number 1

Adding "salability" to products

EVERY aggressive manufacturer in the electronics field (and this is applicable to other industries as well) has some new improvement or product to announce periodically. In many cases, this represents a minor change or no change in the electrical characteristics of a component part, but physically changes have been made that have produced a more marketable article. While it is realized that certain basic raw materials are limited perhaps in their chemical, physical or electrical changes, improvements in packaging, forms, etc., have the quality of adding that "something" which gives the product from a sales point of view, a new life.

Organizations having on their payrolls development engineers would find it well worth the time to have them mix more freely with the sales force, perhaps to the mutual benefit of both.

The phototube—an aid to the human eye

USERS of phototubes sometimes deplore the fact that the response of these electronic devices does not follow the response of the human eye to light waves of various colors. Rather should these critics of nature be thankful that out of the vast spectrum of electromagnetic waves the phototube was accommodating enough to coincide—however poorly—in its response with that of the photoelectric surfaces out of which the human retina is made.

Modern technique has extended the range of frequencies over which phototubes respond. Early instruments responded easily to the ultra violet, poorly to the visible, and not at all to the infra red. Now tubes are made which give appreciable output to colors so deep in the red the human eye does not see them.

And this is one of the beauties of the phototube; it is an electric eye that can be made to see colors to which no human eye will respond; it enables the scientist to explore invisible high and low frequency vibrations; the phototube extends the usefulness and range of the human eye.

See the world—from a porthole

RADIO operators, according to their organ "CQ," do not have the well paid opportunity of seeing the world at some one else's expense advertised by radio schools. Neither are they granted social equality with captains or mates or engineers. It is admitted they wear uniforms, frequently displaying as much braid as the skipper, but ship's rules are such that use of this gaudy equipment to further their acquaintance with the once gentler sex is not permitted.

Radio operators are paid between $55 per month as in the California-Australia run, where they must purchase $100 worth of uniforms, to $125-150 for chiefs on such vessels as the Malolo or the Leviathan. At $140 a month a combination purser-operator working twelve hours a day is considered (by the shipping company) as well paid. Some vessels in the Gulf cut operators salary in half when in port and make them night watchmen.

Flooding of the market with embryo operators by schools; attitude of operators only temporarily interested in the sea, total lack of opportunity for advancement—the radio operator is the only person aboard ship who cannot succeed to a better job—all have contributed to the social and economic downfall of the sea-going radio man.

A major disaster in which an overworked, poorly paid, radio man figures may call attention to the sad state into which an honorable—and frequently dangerous—profession has fallen.

Broadcasters who still bask in a "bull market"

THE world at large has pretty well gotten over its belief in the roseate expanded values of 1929 of stocks and other things, but there is one industry which still manages to keep its August, 1929, illusions, and even to expand them in a constantly rising 1931 "bull market."

These are the broadcasters of New York City.

While other values go down, prices quoted on broadcast stations keep going up—in the owner's minds, at least.

For example a nice 100-watt broadcaster, sharing time with three others, of similar third-class quality, and reaching its cultural climax with a singing turn of two superannuated vaudevillians, can be purchased for $85,000. (This station's haywire apparatus originally cost $900 to hook together.)

A 500-watt Newark station is now being "offered" at $160,000, whereas a year ago its owner was tearfully begging for bids at $50,000. A New York 1,000-watter is, by its management, "conservatively valued at $250,000."

Owners of a certain 5,000-watt metropolitan station recently turned down a cool three million for the plant and good will, although four years ago the same station's total equipment comprised $10,000 worth of copper coils and gadgets on a roof. Dizzy dreams of inflation like this make one wonder who, after all "got stung" when WEAF changed hands, back in 1926, with a grandiose gesture of "a million dollars," which at the time everybody felt was a walkaway for the rich A. T. & T. at the expense of the newborn and helpless N. B. C. Now figure out for yourself whether the then-inexperienced Deac. Aylesworth was buying a gold brick or a blue chip!

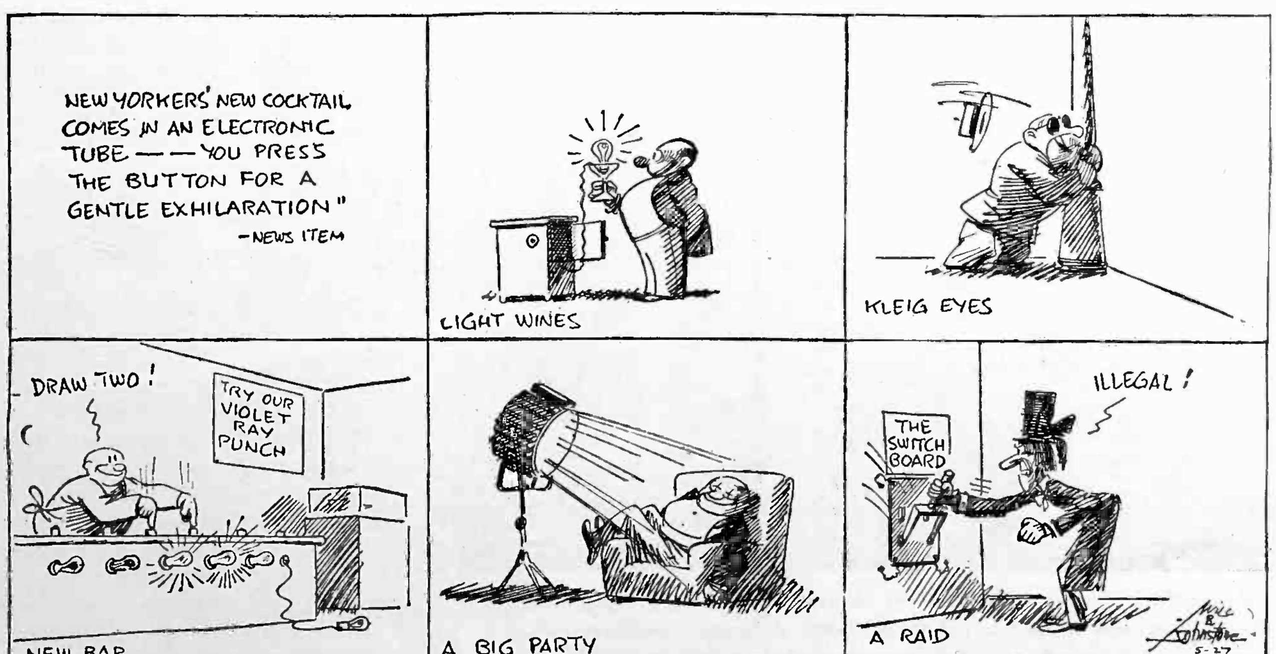
Valuations based on "future appreciation"

OF course the present fictitious valuations of broadcast stations, like the common-stock values of yesteryear, are in no sense based on earnings, but chiefly on the owner's vague notions of "future appreciation,"—a term so general in August, 1929!

New York City real estate ran up a thousand fold, "and so will stakes in the metropolitan ether," declare the present possessors of broadcast licenses. This on the theory that no further broadcasting stations will be licensed.

But how far will these balloon valuations collapse when synchronizing methods now being developed are utilized on the channels carrying numerous small stations, making it possible to issue a greatly increased number of station licenses?

Short-wave stimulation—as the cartoonist sees the electronic future



From the New York World-Telegram

The march of the electronic arts

Radio Commission upholds RCA license renewals

In a three to two decision handed down June 24, the Radio Commission held that Section 13 of the Radio Act does not necessarily bar the renewal of some 1,400 licenses held by the Radio Corporation and its four subsidiaries. In accordance with this decision, all licenses were renewed to the National Broadcasting Company, RCA Victor Company, RCA Communications, Inc., and Radio Marine Corporation. Commissioners Robinson, Lafount, and Starbuck signed the majority opinion, and Commissioners Saltzman and Sykes dissented.

"It is the opinion of the majority of the Commission," the written decision declared, "that the judgment of the District Court of Delaware in the case of Arthur D. Lord, receiver, against the Radio Corporation of America is not such judgment as is described in Section 13 of the Radio Act, and it is hereby decided that renewal licenses should not be denied the applicants heard by the Commission on June 15, 1931."

Chairman Saltzman, in his dissenting opinion, said: "The language of the Delaware District Court, when considered in the light of the fact that vacuum tubes are an essential part of radio broadcasting receivers, and so necessarily of radio broadcasting communication, precludes an escape of the condition that the Radio Corporation of America was unlawfully attempting to monopolize radio broadcasting communications in the purview of Section 13 of the Radio Act."

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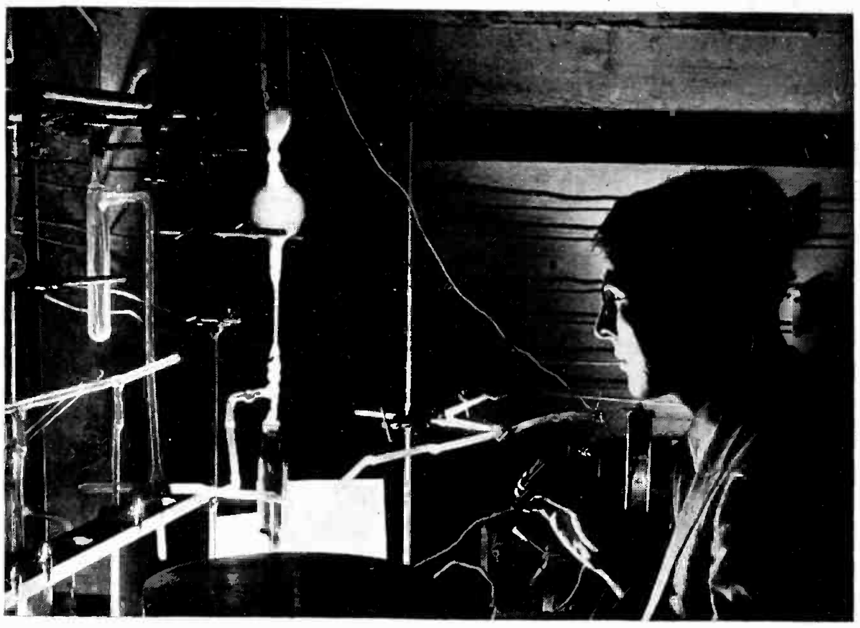
AURORA BOREALIS REPRODUCED IN TUBE



Dr. Joseph Kaplan of the University of California reproduces aurora spectrum in a vacuum tube by passing an electrical discharge through air at a pressure of .001 mm. of mercury

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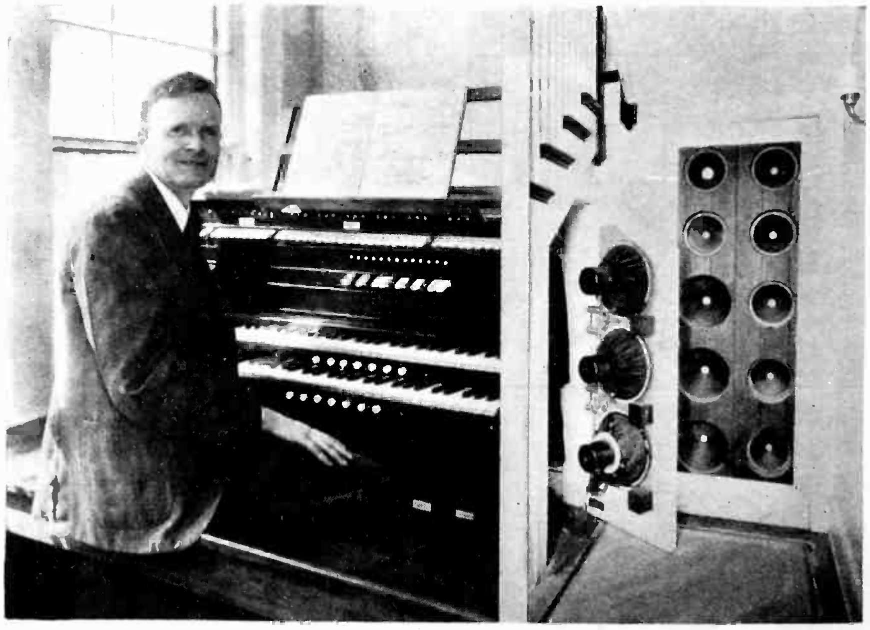
AMPLIFIERS REPLACE ORGAN PIPES



Richard H. Ranger with his latest electronic organ employing eleven amplifiers and speakers, produces 3,000 different combinations of sound and tonal effects. No microphone is required in broadcasting as circuits are connected direct

5,300,000 tubes sold in England

During 1930, 5,300,000 radio vacuum tubes were sold in England, and the total number of radio sets (all classes) totaled 649,100. This figure on tubes is approximately 10 per cent of the 52,000,000 tubes sold in 1930 in this country, and about 20 per cent of the total radio set and phonograph combinations, which amounted to 3,727,800. Total number of tubes sold in Europe is approximately four times the sales for England alone.

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War Department testing public address systems

Tests are being made by the War Department with public address systems using powerful loudspeakers, in order to determine their suitability for use in transmitting firing data in connection with field artillery practice. The tests are being made at Fort Bragg, North Carolina. The loudspeakers are installed at the battery position and when the commands are received over wire from the officer conducting fire at a distant observation point, they are broadcast directly to the gun crews.

New RMA officers

J. Clarke Coit, president of United States Radio & Television Corporation, was elected president of the Radio Manufacturers Association at the annual meeting held in conjunction with the trade show in Chicago. Other officers elected include: A. S. Wells, president, The Gulbransen Company, 1st vice-president, and Leslie F. Muter, president of The Muter Company, treasurer. Fred D. Williams, New York City, manager Radio Tube division, National Carbon Company, Inc., and N. P. Bloom, president, Adler Manufacturing Company, Louisville, Ky., were elected, respectively, second and third vice-presidents.

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Telegraphic code for electrical industries

The new telegraph code, both for radio and electrical uses, which has been developed after months of work by the RMA, NELA, NEMA, Radio Wholesalers Association, Society for Electrical Development, and other interests is expected to be ready September 1st. It has been compiled under expert supervision from within the radio industry by a committee headed by R. F. Pierson of Ft. Wayne, Indiana. It provides for economy in communication and also for cheaper, more frequent, more accurate and more comprehensive exchange of information of immediate necessity.

The new code is the first instance of the electrical industries uniting on a general code and its success depends upon the scope of its adoption.

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BROADCASTING WITHOUT A MICROPHONE

Grand piano used by Berlin Broadcasting stations has its steel strings adjusted to transmit oscillations direct to microphonic device mounted on top

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World's Fair radio committee

The administration of the Chicago World's Fair, 1932—"A Century of Progress"—has appointed a committee to supervise radio matters and exhibits as follows:

A. J. Carter, president Carter Division, Utah Products Company, Chicago.

Don Compton, executive vice-president, Grigsby-Grunow Company, Chicago.

H. C. Cox, president, Columbia Phonograph Company, New York City.

George H. Clark, Radio Corporation of America, New York City.

Orestes H. Caldwell, Editor *Electronics*, New York City.

Powel Crosley, president, Crosley Radio Corporation, Cincinnati.

Herbert H. Frost, president, Frost-Minton Company, New York City.

William S. Hedges, National Association of Broadcasters, Chicago.

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MILLIONS HEAR LADY'S HEART THROB!

Miss Elizabeth Gallin having her heart beats broadcast over NBC network during the annual convention of American Medical Association, Philadelphia, Pa., by means of a special amplifier

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Electric industries form joint committee on radio affairs

The Radio Manufacturers Association, the National Electric Light Association, and the National Electrical Manufacturers Association have formed a joint coordination committee with the object of furnishing electrical facilities of each type to the public in the most efficient manner.

Improvement of radio reception, nationally and locally, by eliminating or reducing various noises and other interference in radio reception and broadcasting, is a major effort of the joint industry committee. Coordination of radio with other electrical utilities, with study of many engineering problems involved, to promote harmony in various uses of electricity, is the objective of the committee.

REVIEW OF ELECTRONICS LITERATURE
HERE AND ABROAD

Birth of radio

[CORRET] Article fixing Branly's position as the inventor of the coherer, indispensable in Marconi's first experiments, and proving by reproduction of original documents that the priority claimed for Calzecchi as regards the coherer in Radio is non-existent.—*La T.S.F. pour Tous, Paris, May, 1931.*

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Calorimeter measurements of losses in fluid insulants

[VOGLER] A description of the method is given, using a Kerr-cell electrometer for the measurement of the radio-frequency voltage and a calorimeter for the measurement of the losses, followed by results on various fluid insulants from 25 to 100 meters. It was found that the losses varied approximately as the square of the applied voltages, linearly with the frequency, fell with the rise of temperature from about 5 to 30 degrees and then rose again.—*E.N.T., Berlin, May, 1931.*

✦

Multiple modulation

[BUSSE] Description of sending and receiving sets suitable for the double modulation of ultra-short waves (the modulation of these waves by a frequency corresponding to normal broadcast wavelengths, this being in turn modulated at audio frequencies). As regards receivers, only the "first demodulator" is described, since this can precede any normal receiver.—*Funk, Berlin, May 15, 1931.*

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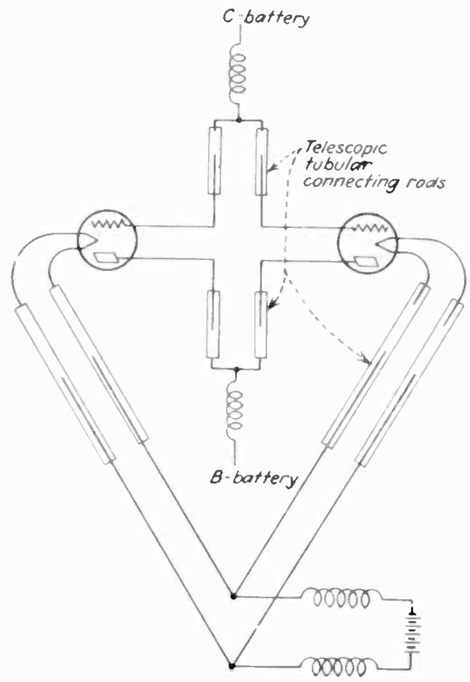
Reception of short C.W.

[PETRASCO] Development of the Mesny system of superregeneration with a separate oscillator for unmodulated c.w., and verification of the stroboscopic phenomenon between the beat frequencies and the frequency of the modulating tube of the superregenerator. The disappearance of the typical superregenerative background noise in the presence of a pure c.w. emission to which the receiver is tuned is shown to be due to partial or complete saturation of the local oscillator. The strikingly anti-parasitic character of the reception is described and explained and examples of recorded reception through atmospheric and industrial interference are shown.—*L'Onde Electrique, Paris, April, published May 8, 1931.*

Experiments with a short-wave push-pull transformer

[MÜLLER and ZIMBALINI] The novelty of the circuit described is that not only do the two grids and the two anodes form tunable circuits with their interconnections, but also the two filaments and their leads. It is shown that suitable tuning here may give greatly increased (eight-fold) oscillation intensities. The theory is discussed and further details are promised.—*E.N.T., Berlin, May, 1931.*



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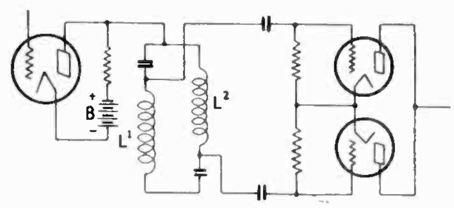
Improvements in frequency-stabilizers

[FLOISSON] Description of a new form of mounting for quartz crystals in which they are supported at nodal points on their edges only, the electrical contacts being through a metallization of the crystal faces. Steps taken to avoid parasitic vibrations in the surrounding supports, air, etc. are also described: distancing of the walls from the vibrating faces by some centimeters so that the parasitic vibrations are absorbed by the air, mounting in vacuo, roughening of the walls of the container so that the irregularities are of the same order as the wavelength of the parasites, etc.—*L'Onde Electrique, Paris, March, 1931, (published April 29).*

Band amplifiers

[COUILLARD] The diagram shows the the simplest type, in which essentially the voltages applied to the grids are in phase for frequencies lying between two definite values and in opposition for frequencies lying beyond those limits.



Another method permits of one tube replacing the two shown in the diagram in parallel, by using a third coil coupled to L 1. The practical application to the intermediate-frequency amplifier of a superheterodyne is given, as also certain developments (use of screen-grid tubes, etc.)—*L'Onde Electrique, Paris, April, published May 8, 1931.*

✦

Amplitude of loud speaker cones

[M. J. O. STRUTT] Philips Research Laboratory, Eindhoven. A platinum strip of 0.001 cm. thickness is fastened along a radius to the cone surface. A copper point at the end of a springy metal strip fastened to a micrometer spindle at the other end, is made to touch the platinum strip and this contact is controlled by measuring the strength of an electric current flowing across it. Now the cone is set in motion (frequency p), the micrometer thimble is moved a distance A until the former current reading is obtained. When p is the natural frequency of the spring, the maximum amplitude of the copper point, and therefore of the disk, is Ap_0^2/p^2, and displacements of 0.0001 cm. can be measured to within 5 per cent. Paper cones of the stiffness generally used (top angle 120°) give one circular node at 500 cycles and three circular nodes at 821 cycles. A still larger number of radial nodes occurs. At two sides of a nodel line different parts of the surface move in opposite directions; in the case of radial nodes the mean displacement of the cone is the same, but circular nodes decrease the effective mass of the cone and the amplitude of the sound.—*Experimental Wireless, May, 1931.*

Permittivity and power factor of mica

[C. DANNAT and S. E. GOODALL] The superiority of mica over other solid insulators has been so little questioned that there is a lack of information regarding the actual characteristics of the most common grades: ruby and green mica (both potassium mica) and amber mica (ferromagnesia group). Tests were made at 60 cycles per sec., with the samples in one arm of a bridge network of the Schering type; it was compared with a standard air condenser of low power factor (less than 0.00001). The detector was a vibration galvanometer in conjunction with a valve amplifier. Comparative measurements were possible to within 0.01 per cent in capacitance and 0.0001 in power factor. Average values were:

	For power factor	Permittivity
Ruby	0.00024	7.1
Green	0.00078	7.05
Amber	0.005	6.0

The work shows that surface dirt films produce contact electrode effects which must be eliminated.—*Journal of the Insitution of Electrical Engineers, April, 1931.*

✦

Oscillating sulphide crystals

[E. HABANN.] Certain crystals of lead sulphide and other sulphides found in nature have falling characteristics and may be used for producing oscillations of over 12,000 kc., but it is difficult to find the sensitive points on the crystal surface. It is found that impurities are responsible for the effect and that artificial crystals obtained by melting lead sulphide with 4 to 10 per cent zinc sulphide, or still better by melting zinc oxide powder with 2 to 3 per cent of copper oxide powder between graphite electrodes, show greatly enhanced effects (characteristics falling from 65 volts and 1 milliamp. to 10 volts and 60 milliamp. at 20°C., a platinum wire of 0.1 mm. diam. acting as negative electrode). The effect is very pronounced in oxygen and very poor in hydrogen. A negative space charge formed under the influence of the current by molecules of oxygen picking up electrons, the cathode tending to repel this absorbed surface layer, explains the effect. *Annalen der Physik, April, 1931.*

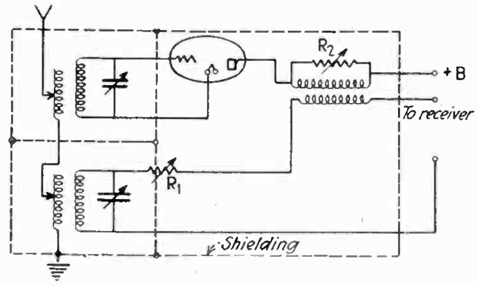
✦

Light-sound-generator for frequency measurements

[SCHÄFFER and LUBSZYNSKI] The advantages of the "light-syren" (rotating disk interrupting the light energizing a photocell) over other audio-frequency generators are detailed, especially as regards simplicity of operation and the pureness of the wave-form produced. —*E.N.T., Berlin, May, 1931.*

Wave-trap

[ECKERT] Description of the apparatus which received the first prize from the German Broadcasting authorities. As will be seen from the diagram the undesired frequency is absorbed by the



wave-trap in the usual manner but is also amplified and fed inductively in reversed phase so as to oppose whatever may remain in the feed to the receiver, the amount of this opposing voltage being controlled by R_2. The object of R_1 is to vary the coupling to the receiver: the author states also that it reduces the effects of highly-damped interference not susceptible of removal by the wave-trap proper.—*Funk, Berlin, April 24, 1931.*

✦

Radio and aviation

[MARTY] Brief historical summary, followed by a full description with diagrams and photographs, of a modern French airplane set. The transmitter uses three tubes, two in parallel as oscillators and one as modulator, taking filament current direct from the normal plane lighting battery of 24 volts and plate power also from this by means of a 1,500 volt generator. A particular feature is that tuning from 450 to 1,500 meters is obtained without switching, the tuned circuit consisting of a fixed condenser, a variable condenser and a variometer inductance, the two latter being mounted on a common shaft and controlled by one dial. The receiver uses one tuned radio-frequency amplifier, regenerative detector and two audio-frequency tubes, all A and B currents being taken from the 24 volt lighting battery and double-grid tubes being used to make this low B voltage possible. The only controls are tuning (one dial) and regeneration. The absence of any special radio generator, batteries, or accumulators is emphasized. A full description is also given of the automatic position and distress sender fitted. Direction-finding apparatus using a very small shielded loop external to the fuselage but capable of being withdrawn within it when not in use is described; as is also the Abbeville radio beacon which uses the normal two loops at right angles emitting "D" and "U" respectively but which can also be used as a rotating beacon for chronometric measurements by the plane observer.—*L'Onde Electrique, Paris, March, 1931, (published April 29).*

Principal sources for foreign Electronics digest

La Nature. Twice a month. Masson et Cie, 120 Blvd. St., Germain, Paris VI. Editor not stated. Three francs 50c. plus postage: 110 francs.

Science et la Vie. Monthly. 13 rue d'Enghier, Paris X. Editor not stated. Four francs plus postage: 80 francs.

L'Antenne.—Weekly. 53 rue Réaumur, Paris II. Editor Berché. One franc 25c. plus postage: 85 francs.

Radioélectricité. Monthly. 53 rue Réaumur, Parris II. Editor not stated. Six francs plus postage: 100 francs.

La T.S.F. pour Tous. Monthly. Chiron, 40 run de Seine, Paris VI. Editor Aisberg. Four francs plus postage: 50 francs.

L'Onde Electrique. Monthly. Chiron, 40 rue de Seine, Paris VI. Editor not stated. Six francs plus postage: 80 francs.

Funk. Weekly. Weidmannsche Buchhandlung, Berlin S.W. 68. Zimmerstr. 94, Editor Band. 60 pfennig plus postage: 28 marks 80 pfennig plus postage.

Funk-Magazin. Monthly. Berlin W 30, Hohenstanfenstz. 13, Editor Nesper. Thirty cents (postage included): $3.

Radio B. F. für Alle. Monthly. Franckh'sche Vertagshandlung, Stuttgart, Pfizerstz. 5, Editor Günther. One mark plus postage: 12 marks plus postage.

E.N.T. Monthly. Hirschwaldschen Buchhandlung, Berlin NW 7, Unter den Linden 68. Editor Wagner. Four marks plus postage: 42 marks plus postage.

Radiogiornale. Monthly. Viale Bianca Maria 24, Milon. Editor Montú. Four lire (postage included): 40 lire.

NOTE.—Second price is per year, with postage to U. S. unless otherwise stated.

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Radio direction finding for aerial navigation

[ETIENNE] Second article (these Digests, March), dealing with commercial methods using a direction-finder on the plane itself. The systems described, with diagrams and photographs, are those of the L. L. Company (rotating loop antennae, six-tube superheterodyne receiver, total weight of loop and receiver but without batteries 10.7 kilogrammes); of the Société Française Radioélectricité (screened rotating loop antenna, specially intended for external mounting; eight-tube superheterodyne receiver, total weight without batteries 19 kilogrammes); and of the Radio Industrie Company (two fixed loops on the Bellini-Tosi principle, eleven-tube superheterodyne receiver with preceding radio-frequency amplification, weight not stated).—*Radioélectricité. Paris. March, 1931.*

Resonant frequencies of quartz oscillators

[E. A. GIEBE and A. SCHEIBE] German Bureau of Standards P.T.R. When the ratio of largest width to length is above 0.8, the resonant frequencies of longitudinal waves in quartz prisms are far from being harmonics in the usual sense, not even in the simplest case: bars of 0.5 to 15 cm. length in the direction of the electrical axis, of rectangular cross-section (longer side of a few mm. length in the direction of the optical axis). The higher modes of vibration, in most cases up to the twentieth and thirtieth harmonics, of about 20 samples were studied by observing the electric discharge at low pressures (recent Engl. Pat. 340361); (3680 kc. or 81.5 m. for a bar of 5 mm. length and 0.5x0.5 mm. cross-section) The deviation of the harmonics from the whole number ratios increases in each case towards that wave-length which corresponds to an odd multiple of the longer side-length of the rectangular cross-section. The disturbance is therefore due to the existence of two systems of oscillations, one along the axis, the other at right angles to the shortest dimension of the bar, both waves forming a coupled system the frequency of which depends on the coefficient of coupling. (Poisson's ratio of contraction.) An accurate formula is deduced giving all the actual resonance frequencies F_k

$$\frac{(F_k)^2}{(kf)} = \frac{g^2+1}{2} \text{ — square root of } \left[\left(\frac{g^2-1}{2}\right)^2 + g^2 P_k^2\right]$$

where kf is an integer multiple of the fundamental frequency and g equal to f_{II}/kf, with f_{II} as the fundamental lateral frequency. When as is most often the case, the long axis of the bar is made perpendicular to the electric and to the optical axis, the frequency conditions are still more complicated, as torsional vibrations are invariably present (26 rods examined). The temperature coefficient now being studied in detail amounts to a few millionth per deg. C. Valuable details concerning imperfect crystals are also given in this long, but clearly written article.—*Annalen der Physik, April/May, 1931, p. 93-175.*

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Single side-band short wave communication

During the period from April, 1930, to March, 1931, single side-band tests have been carried out over the following links: Buenos Aires to Madrid, Madrid to Paris, local 80 km. tests at Madrid. The average result showed a gain of 12 db. to 13 db. when compared with the double side-band receiver. This is equivalent to increasing the power of the transmitter more than 16 times. The difficulty of synchronizing 15 m. waves is overcome by transmitting an unmodulated radio frequency pilot wave in addition to, and some 400 cycles outside, the speech side-band which had a width of 3,000 cycles.—*The Electrician, May 22, 1931.*

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Magnetostriction oscillators at radio frequencies

[J. H. VINCENT] Experiments carried out on bars of corronil (71 nickel, 25 copper, 4 manganese), nickel and glow-ray (a kind of nichrome, 65 nickel, 20 iron, 15 chromium) in which frequencies of 1,280 kc. per sec. were obtained with a glow ray oscillator 1.9 mm. long, 1.2 mm. diameter and weighing less than a fiftieth of a gramme. The oscillator coil L was in the inductive side of the tuned-plate circuit, but depending on the position of a double-throw switch ABC it was (series arrangement) or was not (parallel arrangement) traversed by the d.c. component of the anode current. By exchanging the position of the wires leading to L, the d.c. could be made to assist or to oppose the initial polarization of the bar obtained by means of a small permanent magnet NS. The peak values of either the grid (100 micro amp.) or the anode (1 ma.) galvanometer may be used to indicate resonance. By reducing the coupling between grid and plate coil in the case of a 378 kc. corronil oscillator a sharp stable resonance peak is obtained with no oscillations for higher and for a certain range of lower settings of the condenser.

In a following article S. Butterworth discusses and tests for the first time the detailed equivalent circuit of a magnetostriction oscillator element having the shape of a laminated or solid ring.—*Proceedings Physical Society, March, 1931.*

Sound waves from quartz oscillators

[H. STRAUBEL] When the neutral axis of the crystal, instead of being parallel to the long axis of the bar (orientation II) is approximately made parallel to the diagonal of the largest surface, the sound waves emitted by the head of the quartz prism are perfectly regular. Interference effects, standing waves, reflections, may be strikingly demonstrated with the aid of two two-watt transmitters (quartz bar 35 mm. long, length along electrical axis 5 mm., in the perpendicular direction 10 mm., frequency 75,000 c.p.-sec. or 4.4 mm. wavelength). Quartz disks cut at right angles to the electric axis should not be made circular; when the different diameters are proportional to the square root of th emodulus of elasticity along the different directions, the slab possesses one single frequency, as shown by photographs. — *Phys. Zeitschrift, May, 1931.*

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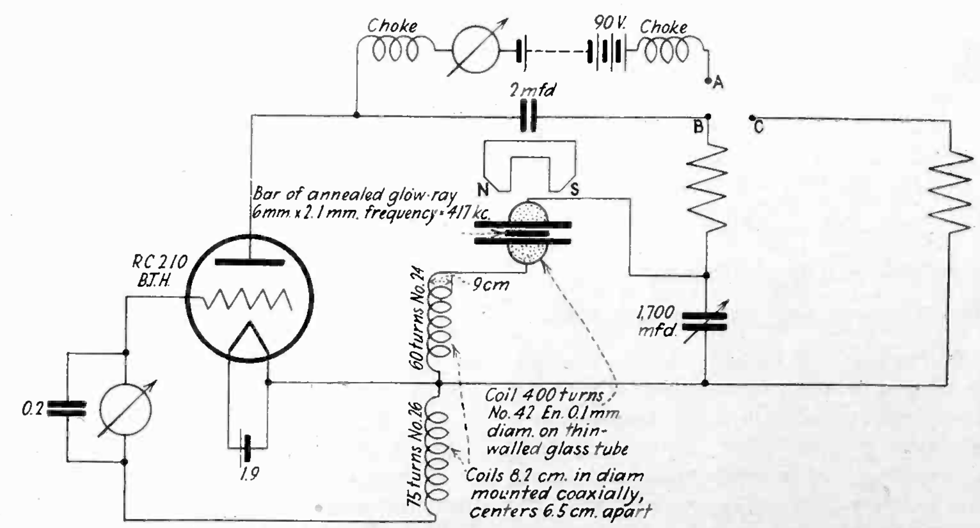
Influence of the surroundings on the frequency of quartz oscillators

[E. GROSSMANN and M. WIEN] A reflecting surface (bakelite disk of 34 mm. diameter) facing an emitting quartz crystal (el. axis 5 mm., opt. axis 12 mm., third axis 27 mm. frequency 98100) in the grid circuit causes changes in the frequency of up to 70 cycles (0.007 per cent) when the distance disc to emitting surface is a whole multiple of one-half wavelength (1.7 mm.). The reflector causes interference between the emitting surface and its image, the coupling between the two systems depending on the distance. The change in frequency is often accompanied by a strong drop in the amplitude of the vibrations.—*Phys. Zeitzshrift, May, 1931.*



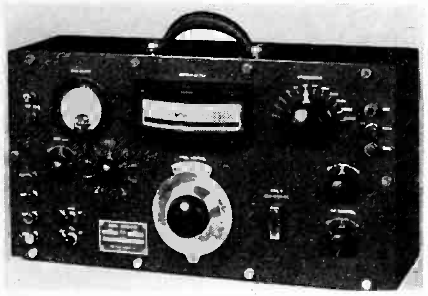
Circuit used by Vincent in Magnetostriction experiments

+ NEW PRODUCTS

THE MANUFACTURERS OFFER

Standard signal generator

DESIGNED TO COVER a wide frequency range, 75 kc. to 10,000 kc., and a voltage range from ¼ microvolt to 2 volts is the new Standard Signal Generator TMV-18 developed by the RCA Victor Company, Camden, N. J. Modulation is



provided by a 400 cycle oscillator capable of modulating output up to 80 per cent in steps of 10 per cent indicated by a percentage modulation meter. A push-pull r.f. oscillator is used to obtain stable operation at the high frequencies and to reduce distortion at high modulation percentages. Six plug-in coils are available to cover the entire frequency range. List price complete with coils, $875.00. RCA Victor Company has just brought out Bulletin "A" describing some 30 laboratory and test instruments developed by its Engineering Products Division. Copies may be obtained by writing the company direct.—*Electronics, July, 1931.*

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Megohm decade resistance boxes

A SERIES OF decade resistance boxes is announced by the Shallcross Manufacturing Company, 700 Parker Ave., Collingdale, Pa. The wide range of high resistances available in these boxes provides comparison tests for high resistance standards, insulation measurements and other uses. The following series of catalogs describe the boxes in detail:

Cat. No.	Maximum Resistance	Price
923	110 ohms in steps of 1 ohm......	$85.00
926	1,100 ohms in steps of 10 ohms...	87.50
929	11,000 ohms in steps of 100 ohms	90.00
932	110,000 ohms in steps of 1,000 ohms.	95.00
935	1,100,000 ohms in steps of 10,000 ohms	100.00
945	11,000,000 ohms in steps of 100,000 ohms	150.00
960	60,000,000 ohms in steps of 1,000,000 ohms	350.00

Calibrated to an accuracy of .1 per cent; maximum voltage, 5,000 volts; dimensions, 5½ in. x 7 ft. x 9 in.—*Electronics, July, 1931.*

New dry cell

NATIONAL CARBON COMPANY, 30 East 42nd St., New York City, has announced a change in construction of all Eveready flashlight unit cells and its Eveready 6-in. dry cell batteries. The new construction is said to increase materially the shelf life of the cells in addition to increasing their service life. The new development is the substitution of a crimped metal top instead of the conventional sealing compound top. It also eliminates the possibility of cracks in the battery's top as the result of rough handling in shipment, thereby removing what has been in the past one source of battery trouble. The manufacturers report that the metal top is far more effective in conserving the moisture of the mix than has heretofore been possible with the old type sealing compound top. Dry cells are of course not "dry" at all, and the life of the cell, both on the shelf and in actual service, is to a large extent dependent on conserving the moisture.—*Electronics, July, 1931.*

✦

Complete line of rheostats

AMONG THE NEW MODELS of rheostats announced by Central Scientific Company, 460 E. Ohio St., Chicago, Ill., is the precision adjustment rheostat No. 5002 which is similar to its 5000 series except for improvements in the sliding contact. The special feature of these rheostats is an ingenious arrangement of the slider by which slow, precise motion of the sliding contact is made possible. By pressing down on the grip of the sliding contact the micrometer adjusting mechanism is disengaged and the contact may be moved freely. A complete series of resistance ranging from 89 ohms to 1,435 ohms can be furnished. For complete information on all models ask for Bulletin No. 173.—*Electronics, July, 1931.*

✦

Precision potentiometer

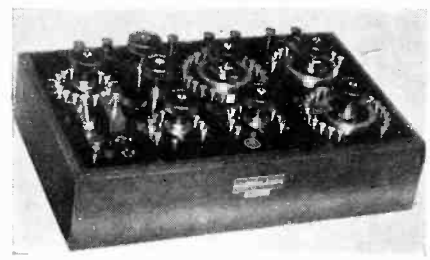
A PRECISION POTENTIOMETER of maximum sensitivity and accuracy has been developed by the General Electric Company. Designed for laboratory use in electric measurements, the instrument reads from one microvolt to 2.1 volts; and, by use of a volt multiplier, to 21, 105 or 1,050 volts. Shunts are available for measuring currents of from 0.1 to 500 amperes, and special shunts for values less than 0.1 amp. can be supplied.

Among the advantages claimed are:

(1) A precision of reading to one microvolt may be obtained without interpolation of the galvanometer reading;

(2) Balance against the standard cell is made without changing the position of the ratio plug; and

(3) Readings are taken from the position of the dial switches.

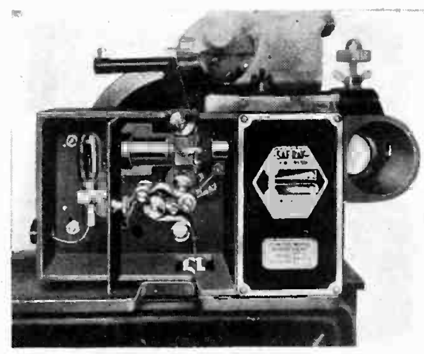


The potentiometer is in a walnut case measuring 17¾ in. by 11 in. by 7 in., and weighs 22 lb. All switches, coils, wiring, etc., are attached to the black moulded top. At the back of the panel are the various binding posts for storage battery, standard cell, the e.m.f. to be measured, and the galvanometer.—*Electronics, July, 1931.*

✦

Light-beam sound system

A SOUND HEAD FOR motion picture machines which does not require the photocell to be mounted in the unit on the machine has been developed by Simplimus, Inc., 67 Church St., Boston, Mass. This system requires only one photocell for two projectors. The construction of the sound head has several unique features. A lens assembly is sub-



stituted for the regular position of the photocell. The light from the sound track is picked up by this lens and focused on a periscopic unit located in front of the head. This unit reflects the light on a mirror facing the photocell. The mirror is pivoted and can be adjusted to divert the light from either projector to the photocell making a noiseless changeover.—*Electronics, July, 1931.*

Audio by-pass condensers

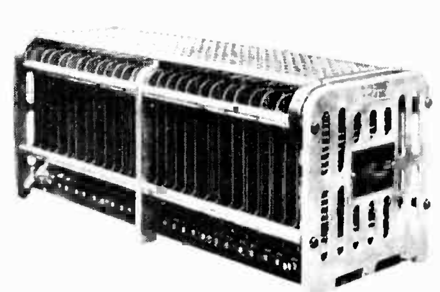
Elkon audio by-pass condensers are the latest development of the Elkon Division of P. R. Mallory & Co., Inc., Indianapolis, Ind. The principal features of these new audio by-pass condensers are small size, compactness and efficient operation with a range of capacities and voltages from $\frac{1}{2}$ mfd. to 8 mfd. up to 150 volts and $\frac{1}{4}$ mfd. to 2 mfd. at 450 volts. Outside dimensions of the condensers

range from $\frac{1}{2}$ inch by $\frac{1}{2}$ inch by 2 inches to 1 inch by 1 inch by 2 inches. The outer covering consists of the same type of sturdy, wax-dipped cardboard carton which is being used successfully on the regular Elkon non-aqueous hi-volt filter condensers. Special mounting bands are available for manufacturers who wish to mount the by-pass condensers on the chassis.—*Electronics, July, 1931.*

✦

Resistors for high frequency circuits

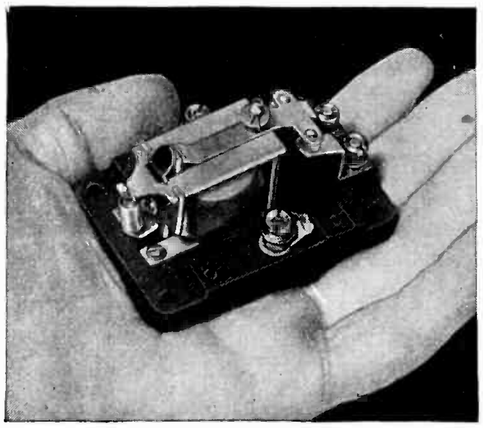
The ohm spun resistor unit manufactured by the States Company, Hartford, Conn., is practically non-inductive and has negligible distributed capacity, making it suitable for radio frequency circuits. Instead of the wire being wound around a form, it is woven with asbestos thread as warp, and a resistance wire as the woof. The advantage of such a construction is that the wire



is supported by a minimum of material, and the zigzag arrangement of the wire keeps the inductance quite low. The unit is not only light in weight, but the wire being so nearly completely exposed to the air permits a comparatively large amount of energy to be dissipated at a low wire temperature. Because of its low inductance and low distributed capacity, the Ohm Resistor meets the requirements for radio circuits satisfactorily. Also another use in the radio field is on constant temperature crystal boxes, etc., where a flat heater unit affording uniform heat distribution over a large surface is essential.—*Electronics, July, 1931.*

Miniature relays

The new Dunco line of minature relays, to be known as "MID-GETT" is being made in eight contact arrangements by Struthers Dunn, Inc., 148 N. Juniper St., Philadelphia, Pa. They are on standard bases, and measure $1\frac{7}{8}$ in. by $2\frac{3}{4}$ in., and follow in detail the

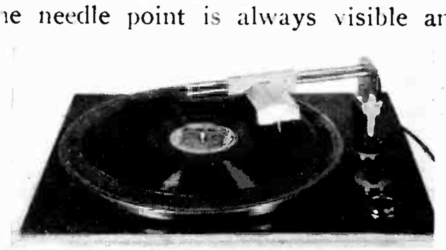


design of regular type Dunco Relays, having the three-legged stool principle of construction, form-wound, moisture-proof coils, renewable contacts, accessible terminals, with molded bases having a high di-electric. They operate on from 6 to 120 volts a.c., or 24 volts d.c., depending upon the coil used. These relays are adaptable to a multiplicity of uses, especially where space is a factor.—*Electronics, July, 1931.*

✦

Tangential pick-up

The Oro-Tone Company, 1010 George St., Chicago, Ill., are announcing a new and radically different type of pick-up and arm. This equipment has been designed to secure reproduction which is almost identical with the original recording. By the needle traveling in a radial line across the record it follows the same path as the original recording needle when the record is made. It is always tangential to the groove of the record regardless of the diameter of the record. The manufacturers claim this new construction greatly prolongs the life of a record and enables a needle to be used a greater number of times without change. The pick-up, itself, lies parallel to the face of the record but the needle point is always visible and



the body can be turned to a vertical position so the needle can be easily changed. As the over-all height is only $2\frac{3}{8}$ inches above the motor-board this equipment is well adapted for use on shallow cabinets.—*Electronics, July, 1931.*

Mercury vapor rectifier tube

Perryman Electric Company, 4901 Hudson Blvd., North Bergen, N. J., announces a type 588 mercury vapor rectifier tube specially designed for smaller radio sets.

The ratings of the mercury vapor type 588 and the vacuum type 280 are virtually the same in all particulars with the two exceptions, that of the plate voltage and current. A comparison of the two types is given as follows:

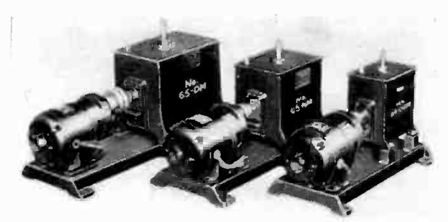
	Type 280	Type 588
Filament voltage	5 volts	5 volts
Filament current	2 amps.	2 amps.
A.C. volts per plate (max. r.m.s.)	400	500
Total output current (max.)	110	300

The manufacturers claim that a small receiver using a type 588 mercury vapor rectifier will require a smaller transformer, thus reducing cost of the set. It will help also reduce the cost of the filter block as well as enable the speaker manufacturer to use a heavier wire in the coil winding.—*Electronics, July, 1931.*

✦

Direct drive high vacuum pumps

The Eisler Electric Corporation, 756 South 13th St., Newark, N. J., has recently redesigned three sizes of its "High Vacuum" compound pump line. These new units are driven by means of a reduction geared motor which rotates pistons at the proper speed. This direct drive is noiseless and efficient in opera-



tions. These pumps are made in three sizes, namely—midget, super-midget and standard. The Eisler Compound "High Vacuum" pump is a self contained unit, requiring no preliminary or finishing pump. It will produce a vacuum of 0.05 micron of mercury, McLeod gage reading, or better when connected to vacuum tight system, in which no vapors are given off. Other tests have shown an average pressure of 0.03 micron of mercury, McLeod gage reading and sometimes slightly better. The breaking of the vacuum cannot injure the pump. —*Electronics, July, 1931.*

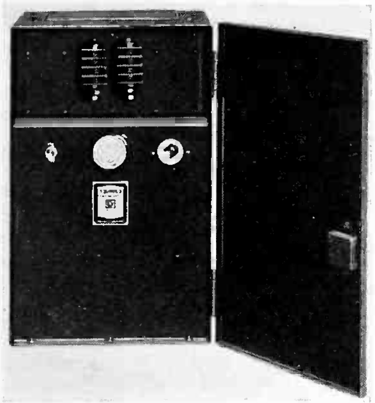
✦

New bulletins available

The Cannon Electric Development Company, 420 West Ave., Los Angeles, Calif., has recently brought out a bulletin describing in detail its Type M-1 series of plugs and receptacles for power and signal equipment.

Power filter unit

Manufacturers of telephones, intercommunicating systems, public address systems, talking picture equipment and other sound producing apparatus, who have sought some economical method of supplying noiseless, non-pulsating d.c. power from the ordinary a.c. line may be interested in the Power Filter Unit recently introduced by the Square D.

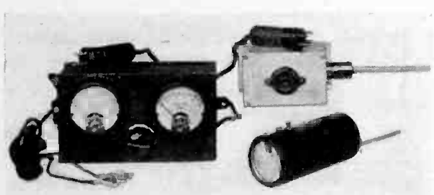


Company, 6060 Rivard St., Detroit, Mich. There are no moving parts in this unit—the action is entirely electrical. The manufacturers claim little or no maintenance is required; also that it is noiseless, has no hum and has large condenser capacity. It permits a.c. low voltage for ringing, besides pure d.c. for talking.—*Electronics, July, 1931.*

✦

Vacuum gauges

A means of measuring vacuum conditions instantaneously and continuously has been developed by the Continental Electric Company, St. Charles, Ill. The indicating mechanism can be installed at any point, either at the machine with the gauge unit, or any other location.



If desired a recording device may be connected with the instrument and a continuous record of vacuum kept. The manufacturers claim the gauge shows no discrimination between gases and reads water vapor as well as dry air pressure. A midget portable model is also available and fills the same uses as Model 6 but is slightly less accurate. —*Electronics, July, 1931.*

✦

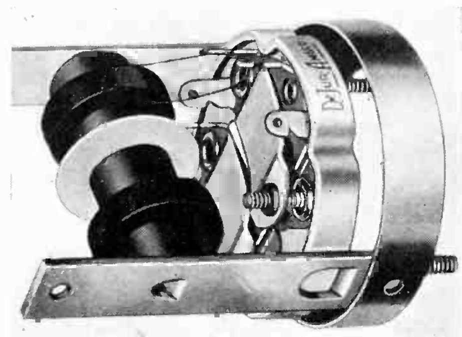
Insulating material

Dilecto K-4 is a new insulating material being produced by the Continental-Diamond Fibre Company, Newark, N. J., manufacturers of laminated Bakelite materials and vulcanized fibre. In addition to high electrical insulating properties, Dilecto K-4 claims high thermal insulating efficiency and does not attract odors. It is finding a wide use as breaker strips on electric refrigerator cabinets. Dilecto K-4 is also highly resistant to alkali solutions, and to water and moisture. This material will be made in sheets, rods and tubes. It can be machined readily.—*Electronics, July, 1931.*

✦

Intermediate frequency transformer

DeJur-Amsco, Inc., 95 Morton St., New York City, announces production of an intermediate frequency amplifying transformer—the "Transitor"—for which a high order of electrical efficiency is claimed. The Transitor is made in three standard broadcast types, the variations being in the order of selectivity, and include a sharply tuned filter stage, a standard type, and a very broadly tuned unit especially engineered for use in the Stenode receivers. The Transitor claims an unusually high gain. Under average circuit conditions the



units may be peaked, by means of small semi-fixed condensers, anywhere from 167 to 183 kc.—*Electronics, July, 1931.*

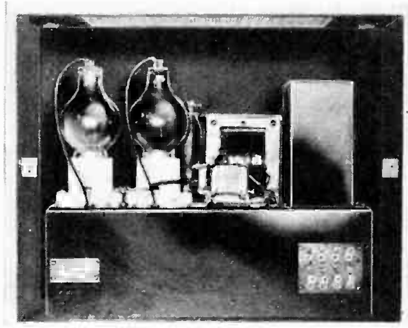
✦

Automotive series of tubes

To meet the demand of automotive radio equipment, three series of tubes have been announced by the CeCo Manufacturing Co., Inc., 1200 Eddy St., Providence, R. I. The three tubes comprising this new series have been designed in accordance with RMA standards, to fill three distinct requirements: that of radio frequency amplification, detection, and audio output. CeCo type 236 is of the screen-grid type designed primarily for radio frequency amplification and power detection. Ceco type 237 is a general purpose tube which can be used as detector, amplifier or oscillator. Ceco type 238 is a power output pentode which will deliver 375 milliwatts of undistorted power output for loudspeaker operation. All three tubes are of the high vacuum type and employ indirectly heated, 0.3 amp. cathodes. Cathode design is such as to permit wide variations in filament voltages without appreciably affecting the performance or serviceability of the tube.—*Electronics, July, 1931.*

A.C. sound equipment

Two power supply units designed for the elimination of all batteries in sound picture reproducing equipment is announced by the Weber Machine Corporation, 59 Rutter St., Rochester, N. Y. These units consist of an "A" unit for the supply of smooth d.c. current to the exciter lamps and filaments of the head amplifier tubes, and a "B" unit for supplying correct plate voltage to the head amplifier and photoelectric cell. An automatic relay is included in

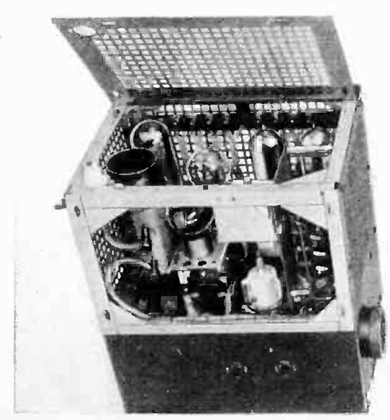


the circuit, which functions to maintain a constant output voltage, by cutting in an equalizing resistance when fader is at zero position. The "B" unit is equipped with an efficient multi-stage filter system. Separate voltage control is provided for each PEC circuit, which facilitates the adjustment for correct operating voltage for any type cell.—*Electronics, July, 1931.*

✦

Marine radio transmitter

A radio transmitter specially designed for marine purpose but applicable to other uses has been developed by the Western Electric Company, 195 Broadway, New York City. The transmitter has a carrier power of 50 watts and is arranged for substantially complete modulation allowing a peak power output much greater than its normal rating. The transmitter may be ad-



justed to any frequency in the range of 1,500 to 6,000 kc. (200 to 50 meters). The output of the transmitter is maintained to within plus or minus .025 per cent of the assigned frequency under even the most adverse conditions by the use of a thermostatically controlled crystal oscillator. — *Electronics, July, 1931.*

PATENTS

IN THE FIELD OF ELECTRONICS

A list of patents (June 30) granted by the United States Patent Office, chosen by the editors of *Electronics* for their interest to workers in the fields of the radio, visio, audio and industrial applications of the vacuum tube

Electronic Applications

Indicating device. Push-pull tubes, shunted inductances in each plate circuit arranged to actuate an armature carrying an indication device. A. F. Moulton, assigned to R.C.A. No. 1,809,637.

Frequency indicator. Vacuum tube circuit for producing frequency indications. A. S. FitzGerald, assigned to G. E. Co. No. 1,809,683.

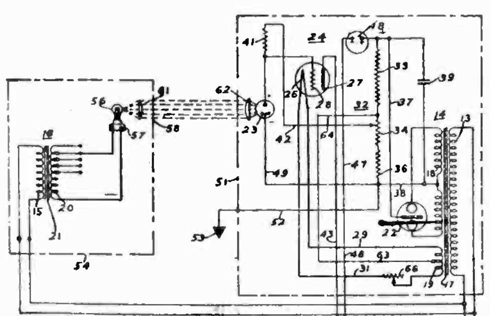
Light-sensitive electrical generator. Generating oscillations and modulating them by means of light beams of variable amplitude and frequency. C. A. Culver, assigned to Wired Radio, Inc. No. 1,809,676.

Sound recording. Modulating light beam by a record, passing light beam into several phototubes, using output of cells to modulate an electric current, thence to an amplifier and loud speaker. F. H. Owens, assigned to Owens Dev. Corp. No. 1,809,310.

Condenser bushing voltage control. Electronic tube, situated in the electrostatic field between condenser bushing and tank, controls device according to voltage across bushing. Phillips Thomas, assigned to Westinghouse E. & M. Co. No. 1,810,063.

Audible signboard. Traffic passing a sign turns on the sign and causes it to give out some audible message. F. W. Bonitz, Charlotte, N. C. No. 1,810,264.

Smoke indicator. Phototube system for indicating amount of smoke in a stack of the type popularly described within the past year. E. H. Vedder, assigned to Westinghouse E. & M. Co. No. 1,810,739.

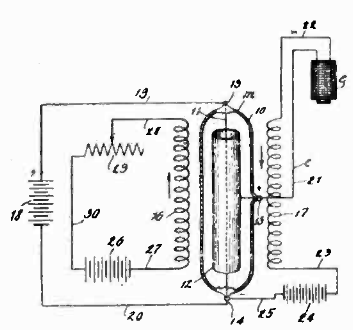


Battery-charging circuit. A transformer supplying a.c. to a rectifier-filter system for charging batteries, designed to operate at or above its saturation point, so that the effects of voltage fluctuations in supply source will be reduced or suppressed. C. A. Wright, assigned to National Carbon Co. No. 1,807,331.

Power distribution system. A circuit using mercury-vapor valves, condensers, etc., for distribution of power. A. H. Mittag, assigned to G. E. Co. No. 1,807,426.

Power limiting system. A 2-way telephone circuit, and a method of increasing the gain of one amplifier when the voltage applied thereto is high, and decreasing the gain when the voltage is low. Wm. T. Wintringham, assigned to A. T. & T. Co. No. 1,806,657.

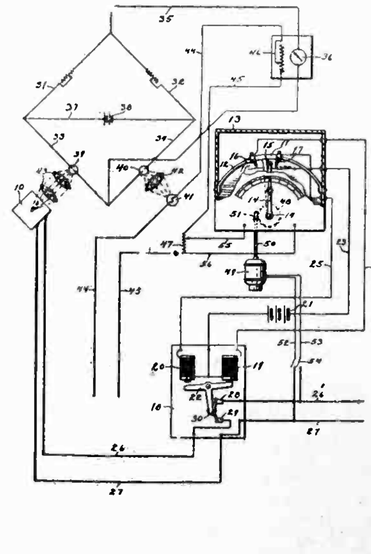
Magnetron circuit. Two patents granted to Theodore Bodde, and assigned to the Regan Safety Devices Co., Inc., of New York, for controlling the operation of a magnetron tube, which in turn controls accessory circuits. Patent Nos. 1,807,097 and 1,807,098.



Insect exterminator. A method of exterminating insects, consisting in radiating sound waves having a frequency approximating that of the notes produced by the vibrating wings of the insects, and pneumatically drawing the insects attracted by the radiated sound, into a receptacle. H. N. Sweet, Boston, Mass. No. 1,807,076.

Vibration regulator. A vacuum tube controlling the magnitude of a vibrating system. Walther Bock and Carl Rath, assigned to C. Lorenz, Berlin, Germany. No. 1,807,190.

Photoelectric temperature control system. Use of phototubes in a Wheatstone bridge for controlling temperature. Anson Hayes, Ames, Iowa. No. 1,810,-172, filed Nov. 6, 1926.



Radio and Communication Circuits

Gain control. A Wheatstone bridge arrangement of four resistances to automatically increase the current through an amplifier when the intensity of the received current decreases. W. O. Barnes, Worcester, Mass. No. 1,811,420.

Telegraph system. A method of impressing a biasing potential upon the grids of vacuum tubes in a code-signalling system during a definite phase interval of the alternator. M. I. Pupin, assigned to the Commercial Cable Co. No. 1,811,368.

Shortwave apparatus. A method of physically separating the low frequency and direct current apparatus in high frequency circuits of an ultra-shortwave receiver. Eduard Karplus, assigned to Lorenz, Germany. No. 1,811,357.

Level control. In a broadcast system consisting of a microphone, amplifiers, modulators and a radiation system, a method of decreasing changes in volume of transmitted signals by impressing a polarizing potential on the microphone, and regulating this potential in accordance with the level variation in an intermediate path. R. K. Potter, assigned to A. T. & T. Co. No. 1,811,025.

Vacuum tube repeater for superposed telegraph system. R. V. Morgenstern, assigned to Western Union. No. 1,811,824.

Manufacture of rectifiers. A method of producing a rectifier unit consisting in treating a copper blank to form cuprous oxide, and then placing the treated blank in a bath of molten metal, to reduce the outer surface of the oxide to copper. B. G. Ackerly, assigned to Union Switch & Signal Co. No. 1,811,603.

A.c.-d.c. meter. A combination of a rectifier and a d.c. measuring instrument for measuring alternating current, and a means for changing the current flow by a fixed small fractional part under constant input conditions. V. A. Johnson, assigned to Supreme Instrument Corp. No. 1,811,319.

Direction finder. Combination of several goniometers into a common circuit. John Brown, assigned to R.C.A. No. 1,810,461.

Direction finder. Means for continuously indicating direction from which energy is being received and the average amplitude of this energy. H. C. Forbes, assigned to Westinghouse E. & M. Co. No. 1,809,967.

Variable resistance. Resistance-film type. Emil Reisman, assigned to Technidyne Corp. No. 1,808,790.

Resonator. Piezo-electric resonator having an annular shape. E. Giebe, and A. Scheibe, assigned to R.C.A. No. 1,809,624.

Magnetic structure support. Method of preventing flux or leakage paths do not cut supports. L. L. Jones, Oradell, N. J. No. 1,808,778.

Secret transmission. Method of inverting order of transmitted signals. Carl Schapira, Berlin, Germany. No. 1,809,070.

Antenna arrays. Directive antennas. John Stone Stone, assigned to A. T. & T. Co. Nos. 1,808,867 to 1,808,869 inc.

Protective system. Receiving system in which the filament is opened at an audio rate if the filament voltage gets too high. E. G. Danielson, San Francisco. No. 1,809,027.

Secret transmission system. A method of continuous wave multiplex transmission of signals, consisting in modulating each of several high frequency carriers with different low frequency signals, and transmitting the carriers simultaneously in such amount that the sound of the unmodulated portions of said carrier waves will be equal to zero, conveying one or more dephased carriers of the same frequency from the point of origination to the receiving point over a separate medium. E. E. Clement, Washington, D. C. No. 1,807,510.

Radio broadcasting system. A method of simultaneously transmitting from a plurality of stations each operating on substantially the same carrier frequency, a set of signals from an electrical source. Method comprises simultaneously causing the amplitude of the unmodulated carrier frequency component to vary with the amplitude of the said set of signals whereby the detected beat note resulting from two slightly different carriers will be the product of two carriers, each of abnormally small amplitude, when the amplitude of the desired signal is small. Ralph Bown, assigned to A. T. & T. Co. No. 1,806,666.

Power circuit control for radio receivers. A method of controlling the output of a transformer in the power-operated radio receiver. H. A. Gates, assigned to Zenith Radio Corp., Chicago. No. 1,806,796.

D.C.-A.C. radio receiver. Radio receiving apparatus arranged to operate universally from direct as well as alternating current power supply. Alexis Poncel, Long Island, N. Y. No. 1,807,343.

Miscellaneous Apparatus

Radio coils and windings. R. F. Sickles and F. W. Sickles, Springfield, Mass. No. 1,807,606 and 1,807,605.

Apparatus for metering gaseous fluids. Radioactive substance ionizes the gas and a vacuum tube measures degree of ionization. A. E. Blake, assigned to United Gas Improvement Co., Philadelphia. No. 1,808,709.

Electrooptical system. Light waves corresponding to elemental area to be produced modulated at a distinct super-audible frequency. R. V. L. Hartley, assigned to B.T.L. Inc. No. 1,808,137.

Visionograph records. A method of projecting a distant scene upon a light-sensitive cell through a scanning disk whence it is translated into sound vibrations and recorded on a disk. C. E. Alberti, Chicago, Ill. No. 1,807,270.

Diathermic apparatus. A method of drawing, by means of a partly metallic body, a capacitive field to the place where treatments are to be applied. G. Irwin Schliephake, Jena, Germany. No. 1,807,105.

Generation, Detection, Etc.

Audio frequency coupling. Arrangement for preventing d.c. from flowing through winding of interstage transformer which carries the a.c. currents. H. P. Donle, assigned to Radio Inventions, Inc. No. 1,808,726.

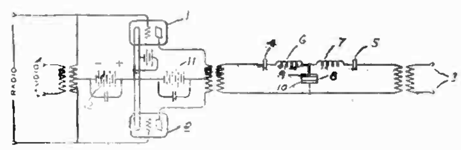
Generator. Determining frequency of a generator by means of a circuit whose permeability can be continuously varied. L. J. Sivian, assigned to W. E. Co. No. 1,808,579.

Transmission regulation. Method of deriving from the heating circuit of a vacuum tube system a variable potential to be applied to a cold electrode in the system. J. C. Gabriel, and Frank Hubbard, assigned to B.T.L. Inc. No. 1,808,538.

Battery charge regulator. System of controlling charge of storage battery from rectifier system by means of voltage and current relays closing or opening at proper condition of charge. C. E. Stryker, assigned to Fansteel Pro. Co. No. 1,808,717.

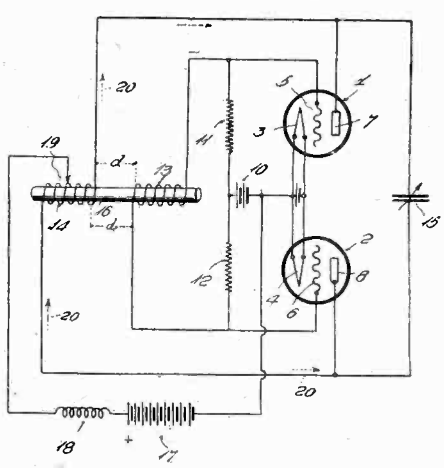
Measuring active components of electric quantities. A voltmeter, a transformer secondary to supply the voltmeter with an auxiliary voltage bearing a known phase with the current and being equal and opposite to the inactive voltage. Mendel Osnos, Berlin, Germany. No. 1,809,062.

Piezo-electric filter. Use of piezo crystal across a circuit whose frequency of vibration is such that it will eliminate undesired frequencies. I. F. Byrnes, assigned to G. E. Co. No. 1,808,524.



Coupling system. Several link circuits are used to couple one tube to another, the tube circuit of one link being coupled to the tube circuit of the next one by an open coil. G. A. Somersalo, New York, N. Y. No. 1,811,443.

Balanced magneto striction oscillator. Three patents. Nos. 1,811,126 to 1,811,128, inclusive, embodying some 27 claims granted to J. R. Harrison, assigned to Wired Radio, Inc., on magneto oscillators of a balanced type.



Rectifier regulator. Rectifier circuit unstable at certain loads and stable at others. W. W. Brown, assigned to G. E. Co. No. 1,808,522.

Parasitic prevention. Three-winding transformer such that oscillations of a Rice neutralized amplifier at a high frequency determined by the input conditions of the tube are prevented. H. C. Silent, assigned to A. T. & T. Co. No. 1,807,759.

Coupling system for radio receiver. Primaries of several interstage transformers are varied simultaneously with respect to their secondaries. O. E. Marvel, assigned to General Motors Radio Corp. No. 1,807,994.

Feed-back system. Method of feeding back into an amplifier some output energy of a second stage. Percival J. Townsend, Los Angeles. No. 1,808,150.

Keying system. Remote control of transmitter consisting in applying to the line plus and minus potentials and at the transmitter utilizing the potentials due the rate of change of control current for blocking transmitter grid. C. W. Hansell, assigned to R.C.A. No. 1,808,220.

Mercury vapor lamp. Induction lamp, source of current of over 5,000 cycles frequency, and circuit containing envelope containing conductive circuit whose characteristics are partially governed by the electrical reactance of the circuit and partly by the characteristics of a primary circuit. Montford Morrison, assigned to Westinghouse Lamp Co. No. 1,807,927.

Synchronous driving system. Non-symmetrical waves, inductive circuit containing iron to control output, and network to make waves symmetrical. A. M. Curtis, assigned to B.T.L. No. 1,809,832.

Transmitting circuit. Conventional tuned-plate tuned-grid circuit with antenna coupled to inductance of output circuit and an inductance in series with the tuned output circuit having a reactance equal and opposite to the condenser reactance in output circuit. Wilhelm Kummerer, assigned to Telefunken. No. 1,809,630.

Repeater circuit. Branched circuit employing rectifiers arranged that one branch having only steady a.c. flowing in it is predominant at this time, and when voice currents flow in the other branch it is predominant. B. G. Björnson, assigned to B.T.L. Inc. No. 1,808,915.

Synchronizing system. Synchronizing moving systems as used in television, facsimile transmission, etc. J. W. Horton, assigned to B.T.L. Inc. No. 1,808,923.

Directive antenna. Several radiating sections in line, and broadside, are fed co-phasially from a source, and phase relations between the sections are slightly varied to warp the directivity of the antenna. C. W. Hansell, assigned to RCA. No. 1,806,755.

Rectifier control circuit. Full-wave rectifier using triodes in which the effective turns-ratio supplying the tubes is automatically varied to control rectified current. E. V. Griggs, assigned to W. E. Co. No. 1,809,625.

Transmitter. Push-pull generator, means for varying individual impedance of tubes from infinity to small finite values, tubes being in a circuit having constant impedance, and selecting elements arranged to transmit desired frequency but to suppress undesired. R. A. Heising, assigned to W. E. Co. No. 1,808,894.

Interference eliminator. Push-pull amplifier with input tuned to desired frequency and coupled to an audio frequency generator, tuned circuit coupled to output circuit together with heterodyne receiving detector using a beating frequency the same as the input frequency and producing a frequency equal to the locally generated frequency. Alexander Meissner, assigned to G. für D. T. No. 1,809,134.

Miscellaneous Products

Magnetic alloys. An alloy of nickel and iron, in approximately equal proportions, having maximum permeability greater than 40,000. This is apparently the alloy called "Hipernik." T. D. Yensen, assigned to Westinghouse E. & M. Co. No. 1,807,021.

Radio transformer. A radio transformer having a core comprising an alloy of iron and nickel in approximately equal proportion, having a permeability of 20,000 to 100,000 at magnetizing forces ranging from H = .1 to H = 1.0. T. D. Yensen, assigned to Westinghouse E. & M. Co. No. 1,807,022.

Method of insulating high frequency transformers. An insulating liquid exists in the interstices between the laminae of an iron core high-frequency transformer, forming a thin insulating layer of uniform thickness, to reduce hysteresis and eddy current losses. Karl Schmidt, assigned to C. Lorenz, Germany. No. 1,807,176.

Television, Etc.

Scanning system. A rotating screen interposed between the source of light and the object to be scanned, having several series of spirally-arranged apertures and a set of light-sensitive devices receiving modulated light from each of these series of apertures. J. L. Baird, assigned to Television, Ltd., London, England. No. 1,807,465. Also patent No. 1,807,464, granted to Baird and assigned to Television, Ltd., on a scanning system.

Quartz tuning fork. A method of producing constant frequency electric impulses from a quartz tuning fork. R. H. Ranger, assigned to RCA. No. 1,807,010.

Multiplex reproducing. A system of reproducing pictures with multiplex transmission system, including several glow lamps, etc. R. H. Ranger, assigned to RCA. No. 1,807,012. Also No. 1,807,011, granted to R. H. Ranger and assigned to RCA for an analyzing system using photo-cells for multiplex facsimile transmission.

Scanning system. A scanning system in which each scanning line of the entire path of one complete scanning partially overlaps two scanning lines of a preceding one. Pierre Mertz, assigned to A. T. & T. Co. No. 1,806,638.

Scanning system. Transmitting motion picture film and scanning system whereby in a unit time less frames of film are scanned than pass before a given point. T. A. Smith, assigned to R.C.A. No. 1,810,188.

Television receiver. Screen made up of intersecting wires on a frame connected to cathode and anode of an electronic device. George Wald, Belleville, Ill. No. 1,810,692.

Vacuum Tubes, Phototubes, Etc.

Audion tube. Tube containing a thermopile. R. B. Dowler, Jr., Memphis, Tenn. No. 1,809,475.

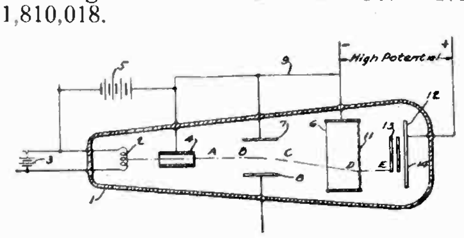
Tube construction. Patent dealing with internal structure of elements particularly the arbor and grid in W. E. type tubes. Filed Nov. 2, 1915. H. D. Arnold, assigned to W. E. Co. No. 1,808,099.

Luminescent tubes. Patent Nos. 1,808,825-826. George E. Teasdale, Kansas City, Mo.

Apparatus for X-ray treatment. F. S. Smith, Brooklyn, N. Y. No. 1,809,078.

Oscillograph film holder. J. W. Legg, assigned to Westinghouse E. & M. Co. No. 1,810,021.

Cathode ray tube. Method of accelerating electrons after leaving a foraminate plate at the same potential as a tube for confining electron into a stream. D. E. Howes, assigned to Westinghouse E. & M. Co. No. 1,810,018.



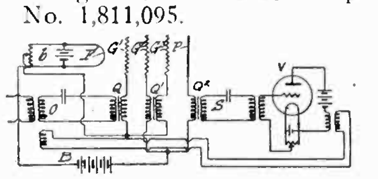
Gaseous rectifier. Electron emissive material situated in the leakage path of a gaseous discharge tube to be heated by the leakage current. Samuel Ruben, assigned to Ruben Patents Co. No. 1,809,912.

Gas discharge tube. Ionic glow discharge tube containing gas and a non-thermionic cold cathode, anode and a grid for controlling a glow discharge. Johannes Schmierer, assigned to Radio Patents Corp., New York. No. 1,807,177.

Light valve. A shutter for polarized light, whereby light is transmitted in accordance with the angle of the plane of polarization. Philo T. Farnsworth, assigned to Television Laboratories, Inc., San Francisco. No. 1,806,935.

Photo-electric cell. A photo-electrolytic cell having a copper electrode plate with a surface layer of copper oxide, a cooperating electro-plate, and a translucent electrolytically conductive crystal plate interposed between and in surface contact with the electrode. Samuel Ruben, assigned to Ruben Tube Company, New York, N. Y. No. 1,807,326.

Multi-grid tube. Patent applied for in 1920, 24 claims, by H. J. Round, and assigned to Radio Corp. of America, Inc. Consists of a combination in a high frequency receiving system, of a vacuum tube having the three usual elements, and a plurality of auxiliary electrodes disposed between the control grid and the anode, said auxiliary electrodes being biased to different potentials. No. 1,811,095.



Discharge tube. A gaseous discharge tube with a shield, forcing a discharge to go the long way around between two electrodes. Carl von Wedel, assigned to Electrons, Inc. No. 1,807,140.

Light sensitive element. Construction of a light-sensitive cell in which is a translucent film on a metallic film, comprising a conductor the resistivity of which varies in response to the intensity of radiations thereon. V. K. Zworykin, assigned to Westinghouse E. & M. Company. No. 1,807,056.

Luminous discharge tube. A method of making photographic sound records from a luminous gas discharge device connected to the output of an amplifier; also, a glow recording lamp of particular construction. Lee DeForest, assigned to DeForest Phonofilm Corp. No. 1,806,746.

Operation of luminous tubes. A gas discharge tube having a period of the order of seconds, at the end of which flickers appear and means for supplying current to the said tubes for a period not greater than the period in which the flickers appeaar. Cyril S. Preaty, assigned to International Neon Company. No. 1,811,110.

Photo-electric cell. Photoelectric cell envelope adapted to permit the whole of a beam of light to fall upon the cathode at different points over a substantial range of displacement of the beam. R. K. Potter, assigned to A. T. & T. Co. No. 1,811,023 and 1,811,024.

Acoustic Devices

Loud speaker. Construction patent for dynamic type speaker. E. S. Pridham, assigned to Magnavox. No. 1,811,367.

Motion picture screen. No. 1,810,168 and 1,810,169. Fabric and mesh screens covered with small cylindrical glass particles. James A. Gray, St. Paul.

Sound shutter. Method for interrupting passage of light through a film when a splice occurs. F. H. Owens, New York, N. Y. No. 1,810,527.

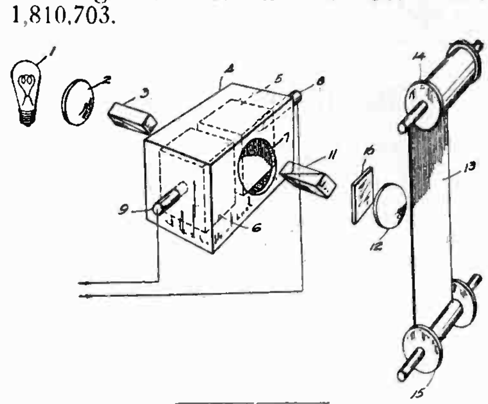
Sound reproducing apparatus. Method of taking off a double-recorded disc. F. H. Owens, New York, N. Y. No. 1,810,324.

Optical recording system. Exposing a sensitized plate by light beam modulated by sound. J. Weinberger, assigned to R.C.A. No. 1,810,234.

Thermal recording. Recording on a disc by a heated stylus. E. H. Hanson, New York, N. Y. No. 1,810,705.

Sound recorder. H. P. Hollnagel, assigned to G. E. Co. No. 1,810,605.

Kerr cell recorder. Method of using a nitro-benzol Kerr cell for recording involving a blue transparent filter to compensate the yellow color of the liquid. Walter Gallahan, assigned to Westinghouse E. & M. Co. No. 1,810,703.



Cartoon sound production. Photographing moving sound chart and simultaneously recording the corresponding sounds. F. H. Owens, New York, N. Y. No. 1,809,599.

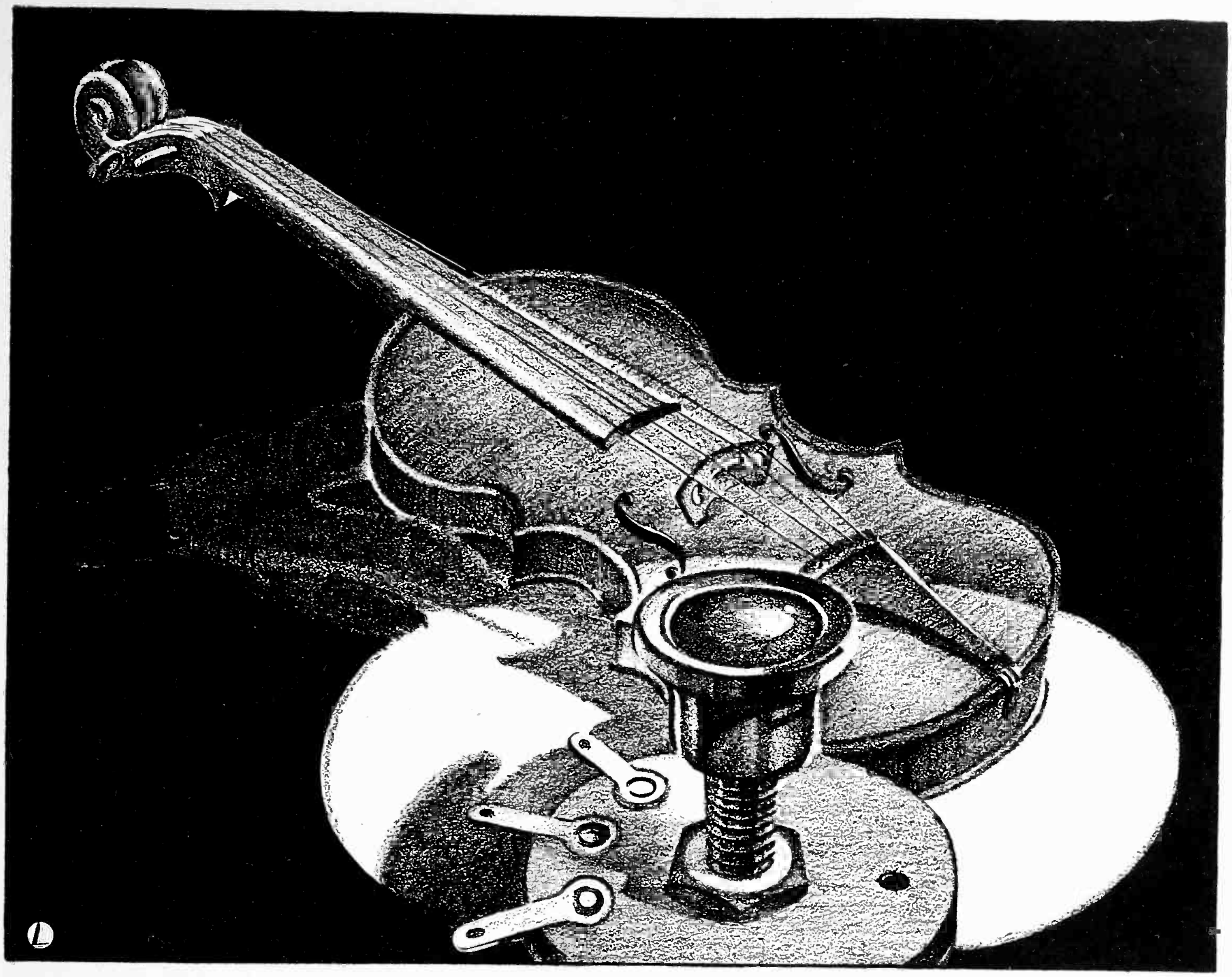
Electrostatic loud speaker. J. J. Steedle, Scranton, Pa. No. 1,809,754.

Loud-speakers. Sound reproducing device employing a gas, modulated in accordance with voice current. Lee DeForest, assigned to General Talking Pictures Corp. No. 1,806,745.

Sound intensity measuring system. A sound analyzer comprising mechanical vibration members and vacuum tube amplifiers. W. E. Bower, Washington, D. C. No. 1,806,871.

Sound reproducing system. Push-pull amplifier connected to two light sensitive devices, common light source with light entering only one light sensitive device being modulated. A. S. Radford and M. B. Manifold, assigned to Victor Talking Machine Co. No. 1,807,602.

Tone control. Method of controlling tonal response of electrically operated sound producing apparatus comprising reactance variations. J. E. Stafford, Lincoln, Cal. No. 1,807,940.



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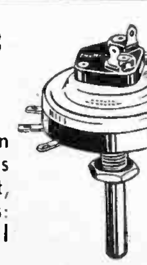

Maximum amplification in capacity-coupled circuits

[*Continued from page 20*]

which is equivalent to Dr. Cohen's expression.

The maximum value of amplification obtainable from Fig. 3 is approximately $\frac{\mu Z_c}{2\sqrt{rR}}$ when, as is usually the case, the impedance of the primary coil is negligible in comparison with the tube resistance R. It is interesting to note that this amplification is almost exactly the same as that obtainable from Fig. 2 if in Fig. 2 the impedance of Z_1 is so great that both Z_d and α may be replaced by R in equation 5, a result pointed out by Dr. Cohen.

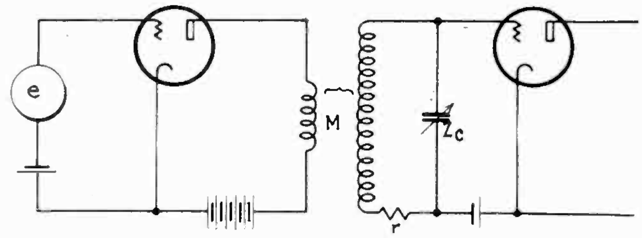

Fig. 3—Mutual inductance-coupled circuit

It will be noted that equation 4 may be satisfied by two different values of Z_k. The smaller of two possible values of coupling capacity should be chosen if the best selectivity consistent with maximum amplification is desired. On the other hand, it may be that no optimum value of coupling capacity exists at all. Such a state of affairs would occur for example if Z_d were a pure resistance or a condensive impedance already greater than the value given by the right-hand side of equation 4, because the addition of a pure negative imaginary to the left side of equation 4 could not then reduce the absolute value of the expression, and hence the best amplification would be had when the coupling capacity is infinite (a condition very likely to occur in screen-grid tube circuits).

Recent European developments in electronic musical instruments

[*Continued from page 19*]

neon lamps, having extinction and illumination voltages close together. It was amusing to notice in Berlin that each player had his pet lamp which he brought with him, guarding it as a clarinettist does his pet reed!

"Glorious low notes"

From a musical point of view it will be realized that all Dr. Goldsmith's desiderata (*Electronics*, September, 1930) are fulfilled. Any tone quality, known or unknown, is available; any pitch can be obtained (and the glorious quality of the low notes must be heard to be appreciated); any desired volume is obtainable; and any desired form of control can be adopted, since it is merely a question of making it vary a resistance. Further, the instantaneous and *gradual* (not step by step) variation of tone quality is a new feature: Dr. Trauntwein writes of the "peculiar" effects obtainable by changing the quality while playing a tune—"peculiar" is putting it very mildly!

The only serious criticism which may be made from a musician's point of view is that the "attack" (the commencement of a note) is harsh, like that of a trumpet. In glissando groups this attack is of course heard only at the commencement of the group, as is also the case in legato phrases, where there is no break from note to note. Further, in slow detached passages it is possible to obtain a delicate attack by releasing the volume pedal and depressing it for each note, thus building up the tone without harshness; but in rapid passages this does not appear possible, at any rate to judge from the demonstrations given.

A point of unusual interest musically which has perhaps not received adequate attention in previous publications (including the inventor's own book) is the possibility of new rhythmic effects when the Trautonium is used as a "percussion" instrument by working below the audible limit: the "pitch" (neon lamp frequency) now becomes the "rhythm," and the tone-former circuit gives the pitch, as if a group of timpani were playing, or a xylophone. The "quality" is now chiefly controlled by the damping of the tone-former circuit, a heavily damped circuit suggesting drums or the tap of a drumstick on wood, less heavy damping a xylophone, and a lightly damped tone-former circuit giving bell effects.

Finally, as an example of the way in which this new theory is likely to alter our ideas, two interesting suggestions may be quoted. One is, that the "resonance peaks" in loudspeaker response curves are in reality not offensive as such, the ear hearing as it does logarithmically, but give unpleasant results by acting as electric or acoustic tone-former circuits and thus giving false qualities, and that the improved results often obtained by using a parallel condenser is chiefly due to the absorption by this of the impulses that set such tone-former circuits in oscillation.

The second is, that the striking distortion which occurs when a phonograph record is run at an incorrect speed is readily explainable by the new theory, since a change in speed alters the pitch, not only of the fundamentals themselves but also of the tone-formers recorded with them, and therefore changes the tone quality of the instruments playing.

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Super-midget radio transmitter

[*continued from page 21*]

the frequency. One leg may be omitted entirely and the frequency, as determined by the capacity of a single wire, is sufficient to maintain effective oscillations at a much shorter wavelength.

A detail view of the complete transmitter is shown in Fig. 2. The 4½-volt battery is mounted on the back of the transmitter and held in position by spring clips. Figure 3 shows the transmitter in place on the test stand. The dummy antenna is simply a small 20 mmf. capacity in series with a thermo-milliammeter shown on the panel.

In placing the transmitter on the test stand, with the battery in position, the other meter is cut into the circuit to indicate the d.c. drain from the battery. The vibrator of the buzzer is adjusted for tone and pitch and to assure that only 200 mils are drawn from the battery. With such an adjustment the high-frequency current through the dummy antenna should be about 30 mils. It may be noted that this is equivalent to the high frequency current which the set would furnish if a plate current of 120 volts were used in place of the buzzer transformer plate supply.

The instrument itself weighs 11 ounces, the battery 4½ ounces; the antenna legs and reel, 2 ounces. Its transmitted signals are readable to 11 miles and with a fresh battery, the set will continuously operate from 3 to 5 hours. In cases where the battery does not readily polarize, the signal has been continued for over seven hours and has therefore permitted an entire day of testing with the direction finders at various distances from the signal. In making actual balloon tests the transmitter is adjusted on the test stand immediately before releasing the balloons as described, and is kept operating until the moment it is removed for attachment to the upper antenna leg which holds the balloons captive. Clusters of 4 and 6 balloons have been used. These are standard 6-inch uninflated balloons used for theodolite work but a single large balloon has now been designed to replace these clusters.

The signal in this transmitter is a clear musical note apparently being that of a tone modulated continuous wave. The entire energy of the signal is confined to a narrow frequency band. Since no carrier wave exists in this system or heterodyne reception is resorted to after the balloons have traveled two or three miles and the signal has become weaker, results in giving the signal a characteristic hissing sound which is readily recognizable from any other type.

While only a few of these transmitters have actually been used in balloon tracking tests, no transmitter as yet failed and accurate direction has been secured by their aid to less than one half degree.

Phototube circuit design for sound-pictures

[*continued from page 23*]

cell is used there will be no plate battery potential to vary, therefore, it will be necessary to introduce suitable attenuators in the amplifying system, in order that the volume outputs may be made equal.

No particular standard has been set as to the size and shape of the various cells available, as these two factors are largely determined by the space available in the sound-head. Figure 4 illustrates a few typical cells which are in general use. It will be noted that there is a great divergence as to size and shape, and that mounting methods vary considerably. Four prong vacuum tube bases are most extensively employed on the caesium, potassium, and selenium type of cells. Two and three prong bases are employed in the photolytic type of cell. In most cases, however, whether the base be provided with 2, 3 or 4 prongs, they are located in such manner as to permit their insertion into a standard four hole vacuum tube socket. In equipment where space is greatly limited, the cartridge shaped tube may be used to advantage. Two examples of this type of construction is illustrated in Fig. 4 under numbers 6 and 16. From Fig. 4 it is evident that no serious attempt has been made to standardize the construction of phototubes for sound reproduction.

None of the four types of cells mentioned come anywhere near approaching the ideal type of cell for reproduction of sound from film. Such a cell should necessarily have a linear frequency response characteristic, a low internal impedance, and a considerably higher output in order to make it possible to decrease the number of stages of amplification.

A cell which promises fair to approach most closely to the ideal phototube is the photolytic type. This cell possesses a reasonably high output and a very desirable frequency response characteristic. In addition, it requires no plate voltage supply inasmuch as it produces its own potential between its electrodes as the result of the light impinging on its sensitized anode.

No definite standard as to the plate potential to be impressed on various types of cells has been made. However, in the case of the caesium type of phototubes which are the ones most extensively used at the present time, 90 volts anode potential is more or less standard with an ionization potential 15 per cent or greater. In the case of the potassium type of cell, no set voltage prevails. This type of cell has been successfully operated on potentials ranging from 150 to 275 volts. The potassium type of tube, owing to its low degree of sensitivity as compared with the caesium type of cell, is gradually being replaced by the latter. The selenium type of cell possesses a very high output but its frequency response characteristic is somewhat less than the other types.

A satisfactory and inexpensive method of determining the frequency response characteristic of a phototube may be made by utilizing the so-called tone wheel or perforated disk. The disk is mounted directly on the shaft of a high speed direct current motor. Variable resistors are connected in the line and the motor field, thus enabling a wide range of speed to be obtained. Disk speeds may be determined by the use of a stroboscope.

Frequency response characteristic curves Fig. 5 of the four types of phototubes were made by means of a standard frequency film and an amplifier having approximately 50 db. gain. This method is preferable to a tone wheel for several reasons, principally from the fact that tests may be made under actual operating conditions. The tubes in order of their fidelity of response are the caesium, potassium, photolytic and selenium. The four types of tubes dealt with in this article have been tried in connection with standard theater equipment and the results obtained in every case were very satisfactory.