Eleventh Year of Service

RADIO ENGINEERING

Vol. XI SEPTEMBER, 1931 No. 9

IN THIS ISSUE

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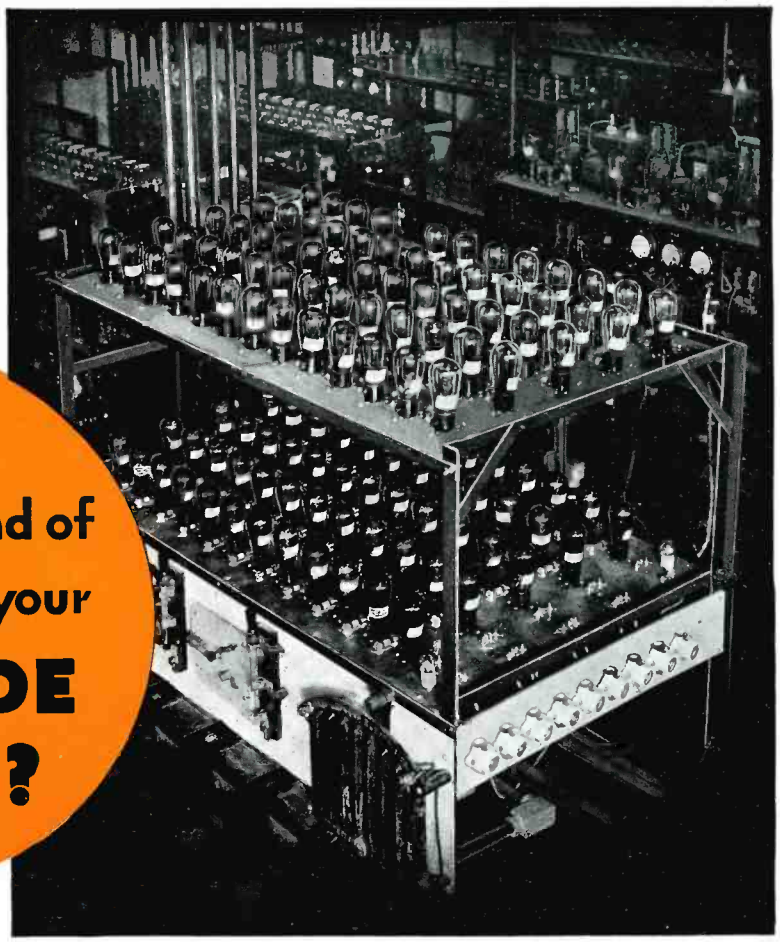
$2.00 per year

The Journal of the Radio Industry

In this laboratory endurance test several hundred standard Arcturus Pentode Tubes are operated under conditions paralleling the most severe usage encountered in a radio receiver. Those tubes, up to the time of going to press, which have already exceeded the life expected from the best radio tubes, show that the important characteristics (including emission) of every tube are above the requirements for efficient performance. These tubes are periodically selected from actual production, and these results are representative of the consistent uniformity of Arcturus Pentodes.

W. B. Kahl
CHIEF ENGINEER

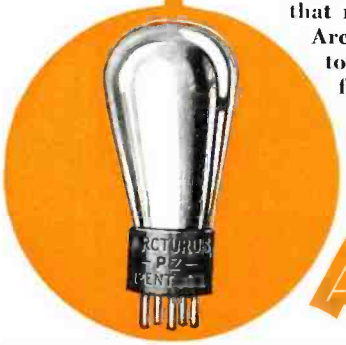


are you getting this kind of service from your PENTODE TUBES?

LABORATORY TESTS SHOW THAT ARCTURUS PENTODES GIVE THE SAME LONG LIFE AS TYPE '45 POWER TUBES OF THE BEST MANUFACTURE. LONGER MANUFACTURING EXPERIENCE EXPLAINS THIS EXCEPTIONAL ENDURANCE

The Arcturus Pentode Tube made possible many important radio improvements, and is performing efficiently in many of the country's leading radio receivers. With this better performance Arcturus Pentodes are giving the same long life that made the Blue Tube famous. Arcturus has been making Pentodes since 1928—more than a full year's extra experience to perfect manufacturing processes for this complex tube. That is the reason why the Arcturus Pentode Tube gives unusually long service—service that has proved most satisfactory to many of the leading manufacturers of today's Pentode Radio Receivers. That is the reason why Arcturus Pentodes are ranked as standard and used in laboratory tests by critical engineers. And that is why jobbers and dealers, to avoid expensive service calls, demand Arcturus Pentodes with their sets.

Remember National Radio Week, September 21-27



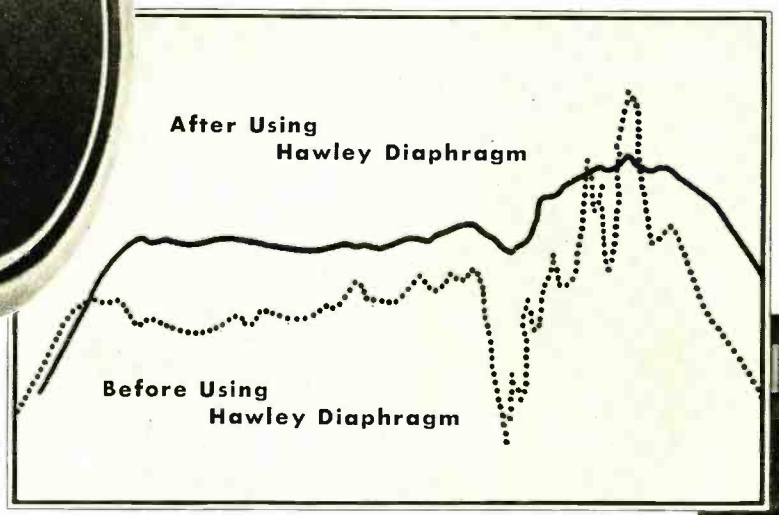
ARCTURUS RADIO TUBE COMPANY, NEWARK, NEW JERSEY

ARCTURUS

"The TUBE with the LIFE-LIKE TONE"

The Hawley Moulded Diaphragm

Plus Hawley Acoustical Engineering *Can do this for your Speaker*

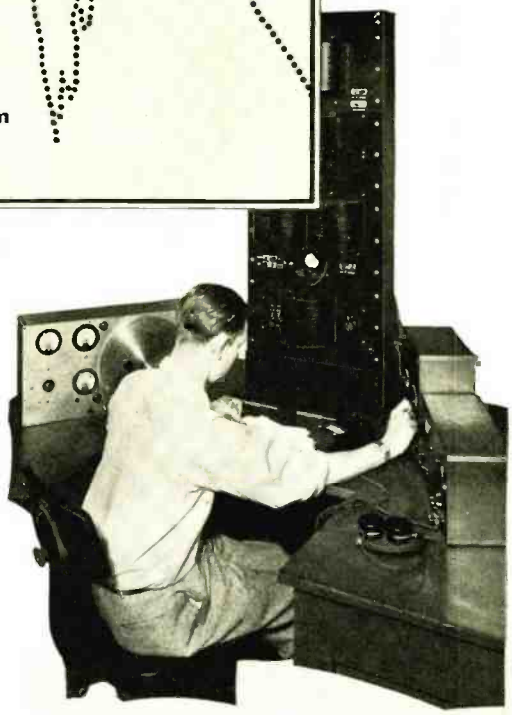


Hawley moulded diaphragms are engineered to meet the individual requirements of your speaker design. The construction of the speaker, submitted for test, is analyzed in every detail, including the magnetic circuit, voice coil, and response curves at all frequencies. A Hawley diaphragm is then designed to fit the special requirements of your speaker. The result is naturally a tremendous improvement in performance.

Submit your speaker to the Hawley Laboratories for analysis. Let Hawley engineers demonstrate what Hawley moulded diaphragms, scientifically applied, can do to improve the response over all frequencies. Make your speaker easier to sell by using the diaphragm now adopted as standard by leaders listed in the Hawley Hall of Fame. Do it today!

HAWLEY
MOULDED DIAPHRAGMS

PRODUCTS AND PROCESSES FULLY COVERED BY PATENTS AND APPLICATIONS



THE HAWLEY HALL OF FAME

These famous radio set and speaker manufacturers equip their speakers with Hawley Moulded Diaphragms

Magnavox	Jensen	Majestic
Utah	Rola	Stromberg-Carlson
Stewart-Warner	American Bosch	Crosley
Operadio	Trans. Corp. of Am.	Melber (Germany)
Lansing	Boudette	Sachenwerk (Germany)
Colonial	P. Smith Stamping	Feldman (Germany)
LaCrosse	Imperial	Neufeldt & Kuhnke (Germany)
Best	Angsten	Platan Texido (Spain)
	Quam-Nichols Co.	

HAWLEY PRODUCTS COMPANY, 201 N. FIRST AVENUE, ST. CHARLES, ILLINOIS

RADIO ENGINEERING

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Member, Audit Bureau of Circulations

Western Editor ULMER G. TURNER

Editor DONALD McNICOL

Managing Editor F. WALEN

Vol. XI | SEPTEMBER, 1931 | Number 9

Contents

OPPORTUNITY FOR RADIO AND TELEVISION PARTS MANUFACTURERS

THE recognized success which attended the exhibit of radio parts and accessories at the I. R. E. convention in Chicago, in June, stamped this type of show as a profitable venture for manufacturers.

The custom of holding a Fall, regional meeting of the I. R. E. at Rochester, N. Y., seems to be established. Rochester is a natural geographical center of a large American and Canadian radio manufacturing territory. This year, the Rochester meeting will be held on November 9 and 10, with headquarters at the Sagamore Hotel. Advance registrations for exhibit space already assure that complete lines of parts will be on display.

November is a good time of year for a technical meeting and a parts exhibit. By that time all concerned have had a good measure of experience with the current year's products and most manufacturers are thinking of the year ahead.

The Rochester meeting of 1931 is almost sure to make radio history.

BRYAN S. DAVIS, *President*
JAS. A. WALKER, *Secretary*

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An Electrical Hair Trigger

THE lightest touch . . imperceptible movement . . . most delicate controlling force . . and the powerful current is set to work. No arcing. No corrosion. No exposed spark. No hangovers. No chattering. Only clean makes and breaks even at high speed. Such is the character and purpose of an entirely new conception of electrical contact now introduced as the

BURGESS VACUUM CONTACT

The simplest, most economical and practical means of controlling an electrical circuit. May be operated manually, mechanically, thermally or electromagnetically. Operates in any position. Unaffected by moving or shaking. No strain on leads. Contacts in vacuum, actuated by movement of extended glass rod. Operates on movement of only 0.02 inch and force of less than 10 ounces. Rated at 6 amperes continuously, 8 amperes intermittently, 220 volts. Handles up to 40 breaks per second. 3 3/8 inches long by 1/2 inch diameter. Particularly applicable to usual telephone type relay.

Descriptive literature, together with engineering service regarding application to any particular problem, available on request.

BURGESS BATTERY COMPANY

RADIOVISOR DIVISION: 295 MADISON AVENUE, NEW YORK CITY

111 WEST MONROE STREET, CHICAGO, ILL.

Editorial

SEPTEMBER, 1931

RADIO EXPANSION

A NEW radio manufacturing company, with plant at Ann Arbor, Mich., has begun operation. One product which meets a need and which will be a factor in this Fall's radio sales is a duo all-wave receiver of midget set dimensions. Two dials and two sets of controls are provided. The short-wave side, on the left, responds to wavelengths from 20 to 200 meters. The broadcast band, 200 to 600 meters, is operated from the right-hand controls. The set has five tubes, including pentode and variable-mu for broadcast reception, and eight tubes for short-wave working. The complete receiver is priced at about fifty dollars, less tubes. The receiver is equipped with a high grade, modern, self-contained loudspeaker.

That new manufacturing companies should be launched at a time when receiver stocks of older manufacturers are reported to be large, is a sign of the times. Improvement in employment and in sales of all commodities will follow when the industrious and the energetic determine to go ahead and make and sell.

▲

BROADCAST ANTENNA DESIGN

IT fell to the lot of the early radio engineers to design transmitting systems, receivers, antenna systems, and all other elements of the radio plant. Each engineer in charge was expected to be qualified to design, install and operate all of the required equipment for a station.

It is a sign of the growth and extension of radio engineering that a time has arrived when specialists must devote their knowledge to solving specific problems.

An instance of this change is that the design of broadcast antennas has become an art aside from the particulars of receiver design and of power and control equipment.

The question of coverage of a given broadcast transmitter has become one of increasing importance. The entire matter of wavelength allocation and of authorized sending powers hinges upon coverage.

From the time of Ballantine's classic paper, "The Optimum Transmitting Wavelength for a Vertical Antenna Over Perfect Earth," experimentation has continued with a view to establishing dependable basic data. Difficulties in the way of verifying Ballantine's mathematical conclusions have not been easy to overcome—especially when resort is had to the operation of a vertical wire supported from a balloon.

The Columbia Broadcasting Company's present undertaking for Station WABC, in New Jersey, is now engaging the attention of engineers. The antenna structure is designed upon the assumption that the physical length and the electrical length are equal. As the antenna structure is reared above 300 feet in height measurements will disclose the relationship between physical length and electrical length.

In these new engineering inquiries into the science of antenna design, and station coverage with given antenna watts, much credit is due Mr. Nicholas Gerten, of New York.

▲

BRITISH RADIO MANUFACTURERS AWAKE

AT least one large British radio manufacturer plans to exploit the fickle, changing public demand for receivers. This company plans in future to introduce new products from time to time designed to meet the changing conditions of the day, instead of formulating a programme for the twelve months or more ahead.

"We believe," adds the statement, "such a policy continually operating throughout the year will be more acceptable to our trade distributors, more adaptable to changing conditions, and less disturbing to established lines."

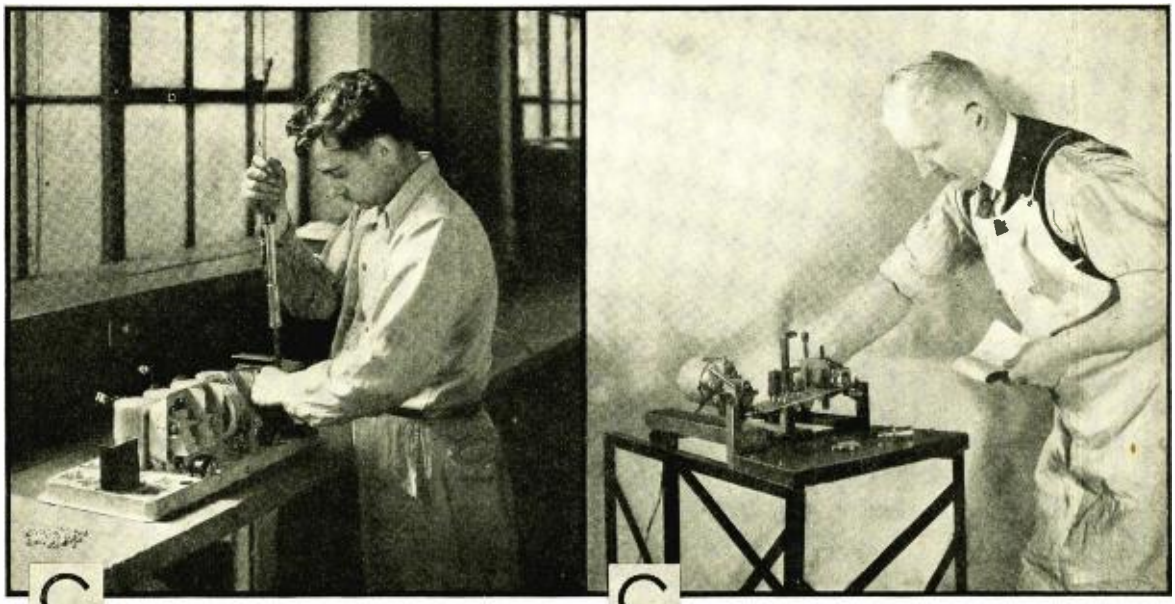
The first step in the new policy is to widen the market for receivers, and new models are to be introduced which will give purchasers quality receivers at competitive prices.

As models are released under the new policy they are to be backed with the fullest sales aids, and national advertising, while the firm's general policy will remain unchanged.

Donald McNicol

Editor.

WHY you should investigate Self-tapping Screws



SAVINGS TO $50,000 A YEAR are made in assembly of well-known radio receivers.

All of the leading radio manufacturers are saving money by assembling with these Screws. One concern cut costs $50,000 a year. Another increased assembly speed, 12%. All save time and labor by this simple, reliable means of making fastenings. If you join sheet metal or make fastenings to sheet metal the chances are that you can do it cheaper with Hardened Self-tapping Screws.

You will find that these Screws make stronger as well as cheaper fastenings. Unbiased scientific tests prove that Self-tapping Screws hold better than machine screws or bolts and nuts under vibration, tension and shear stresses.

STRONGER AS WELL AS CHEAPER fastenings are proved in scientific tests.

No expensive equipment is required to use Self-tapping Screws. And unit savings are the same on limited production as on large output. Find out what these Screws will do on your work. It costs nothing. Our Assembly Engineers will tell you whether you can use Self-tapping Screws to advantage . . . just attach a brief description of one or more assemblies to the coupon below, which brings our recommendations on your applications and the two interesting booklets shown.

Hardened Self-tapping Sheet Metal Screws

For joining and making fastenings to sheet metal up to six gauge; also aluminum, die castings, Bakelite, etc. Simply turn Screw into drilled, pierced or molded hole. It forms a thread in the materiol as it is turned in. Can be removed and replaced.

Type "U" Hardened Metallic Drive Screws

This type of Self-tapping Screw is used for making permanent fastenings to iron, brass and aluminum castings, steel, Bakelite, Durez, etc. Just hammer the Screw into a drilled or molded hole. It forms a thread in the materiol as it is driven.

PARKER-KALON *Hardened* Self-tapping Screws

PAT. IN U. S. AND FOREIGN COUNTRIES

PARKER-KALON CORPORATION, Dept. L, 190-198 Varick Street, New York, N. Y.

Send me free booklets on the Security and Economy of assemblies made with Self-tapping Screws.

Name and Co.----------

Address----------

Impressions and Expressions

By AUSTIN C. LESCARBOURA

BRIGHTENING SKIES

HERE and there the general radio situation appears brighter. Parts manufacturers, who should be the barometer of the radio industry, report greater activity. We visited a resistor manufacturer a few days ago, who was working at the greatest capacity in the career of the organization. A condenser manufacturer tells us that there is plenty of business about to break. A manufacturer of insulating materials tells us that business is looking up and that he feels justified in installing additional equipment to take care of bulk business on moulded pieces.

The skies are becoming brighter. Our industry is once more getting under way for an active and, we hope, profitable season. The general conditions are improving rapidly. Inventories are at a very low level and no doubt the lowest level since radio became a real industry.

How do things look to you? Are you preparing to get your share of the breaks? Can you take care of the reviving business?

After all, there can never be a time when business is good for each and every one of us. Unfortunately, we are too apt to overlook our own shortcomings and to blame others for our tough luck. The time is rapidly approaching when the good old alibi, *depression,* will no longer ring true. Why not begin now to think *hopefully* and to act accordingly?

▲

PROGRAMS

WITH radio sets virtually begging for buyers, most of us are losing sight of the thing we are actually offering the public, namely, a world of entertainment and enlightenment. After all, that is the thing we are selling—the most wonderful service ever offered mankind.

From the National Broadcasting Company we learn that the operating costs and talent fees for the NBC networks during 1931 will be in the neighborhood of $30,000,000. The Columbia Broadcasting System will no doubt spend better than half that sum. The independent stations also spend a huge sum for operating expenses and talent. One authority sets the broadcasting bill of the nation at $75,000,000 for 1931.

A little speculation as to what broadcasting means in terms of the average listener-in is of interest at this time, when receivers are being peddled for whatever they will bring. If there are 14,000,000 radio sets in use, and $75,000,000 is being spent for broadcasting services, each set is being provided with $5.36 worth of programs during the year. Since the average set has a life of five years, it is being catered to by broadcasters to the tune of probably $30.00. That is the actual cost of the broadcasting service made available to that set. In terms of entertainment and enlightenment the programs are worth a hundred fold as much to the average family.

There is certainly lack of salesmanship shown when the most wonderful service ever offered mankind—a never-ending variety of entertainment and enlightenment—is being debased by being offered at prices that create contempt rather than favor.

PRICE CUTS

CONTRARY to general opinion, the price cut is not always effective in generating sales. There are times and places when price cutting is of little avail. And to our modest way of thinking, the present situation does not lend itself to price cutting as a means of stimulating sales.

While we are supposed to rise in our seat, wave our hat and shout that the country is still enjoying the much heralded prosperity, the fact remains that the buying power of the American people has suffered a marked setback during the past year and a half. The serious unemployment, the unfortunate condition of the farmers, the plight of our drought-stricken areas, and the general stagnation in many industries, not to mention the sharp decline in overseas trade, makes money scarce when it comes to luxuries. And no one is going to declare that radio is not a luxury.

Frankly—and this is just a personal opinion—we feel that too much price cutting has already taken place in this old industry of ours. The feverish attempts to force-draft sales by means of new low price levels have been doomed to failure. A study of other industries indicates that price cuts only stimulate more sales when the public, having hesitated to buy, is just about ready to resume buying. It is at that psychological moment that a price cut stimulates the hesitant buyer into action. Until such time arrives, we feel that the constant price slashing going on in the radio industry is just piling up trouble for the future. It's easy to go down but mighty hard to go up. as will be reflected in our profits.

▲

SELENIUM CELLS

THE appearance of English and American selenium cells on the market is a matter for considerable speculation as to the immediate future of the light-control art. These cells, doing away with the elaborate amplifying equipment required by the usual photoelectric cells, are applicable to many uses where simplicity, practicability and low cost are the main considerations. Indeed, these cells introduce the photoelectric art in overalls.

The mention of selenium, of course, generally sets up engineering opposition. Most of us have been seeped in the old dogma that selenium cells are not suitable for practical purposes. We have been taught that selenium cells are soon fatigued under the strain of constant use, and therefore lose their responsiveness and usefulness. Such may be true of the crude selenium cells heretofore employed. But with a selenium surface of extreme thinness, reducing ineffectual shunt resistance to a minimum, and with the use of a glass bulb containing inert gas and eliminating all trace of moisture and dust, we have something quite different in the way of selenium cells. The response curves show quite definitely that the selenium cells are capable of handling some jobs usually associated with photoelectric cells, even to sound-on-film reproduction.

And so we see the dawn of a new era. There is no telling how far the selenium cells will go in popularizing the light-control art, but certainly the field is limited only by the ingenuity of engineers and experimenters.

Illustrations actual size

No. 70 Series, with Switch "Underwriters' Laboratories Inspected" Switch. Rated 1.5 Amps. 250 Volts, 3 Amps. 125 Volts.

No. 70 Series, without Switch

Surprising value and quality in the new "Seventy" Series Volume and Tone Controls

Our new "70" Series Composition Element Volume and Tone Controls, recently announced, offer surprising value and utmost quality in a low-priced unit. Though low in price, due to design economies and improved manufacturing methods, our "70" Series is of remarkably high quality with no skimping of materials or workmanship.

No. 20 Series Single Control

This new Series Control has a unique movable contact making a full wiping contact with the hard, smooth composition element at a relatively high unit pressure. In spite of this, frictional component is extremely low and tests of 100,000 complete cycles of operation fail to reveal any signs of fatigue.

No. 20 Series Tandem Unit

We shall be glad to send to interested engineers literature in which we have more fully described the seasoned principles involved in the construction of these controls. Upon receipt of specifications, we will send without charge, samples possessing electrical and physical characteristics that will exactly suit the desired circuit conditions.

No. 20 Series, with "Underwriters' Laboratories Inspected" Switch. Rated 1.5 Amps. 250 Volts, 3 Amps. 125 Volts.

No. 40 Series, with "Underwriters' Laboratories Inspected" Switch. Rated 1.5 Amps. 250 Volts, 3 Amps. 125 Volts.

CHICAGO TELEPHONE SUPPLY CO.

HERBERT H. FROST, Inc.

SALES DIVISION

General Offices ELKHART, INDIANA *and Plant*

GEARED TO THE REQUIREMENTS OF RECEIVING SET MANUFACTURERS

IN CHOOSING a source of tube supply there are certain definite qualifications manufacturers of receiving sets should look for. . . .

Character of Product

—a rigid policy of maintaining a high standard of product has been one of the main contributing factors in building the business of HYGRADE SYLVANIA to its present size.

Production Facilities

—to meet stiff delivery schedules on time and to effect economies in manufacture.

HYGRADE SYLVANIA is producing 70,000 tubes a day — now one of the world's largest tube manufacturers.

Experience

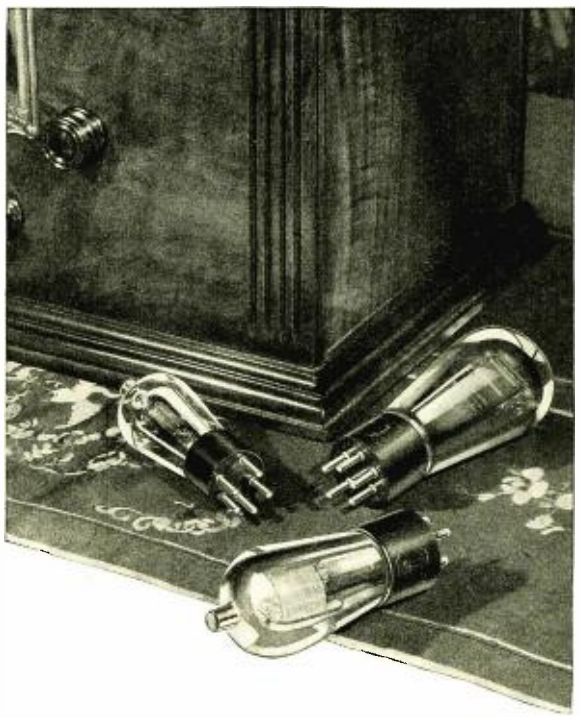
—constant study of set manufacturers' needs has given HYGRADE SYLVANIA Corporation a valuable experience in meeting them.

Engineering Skill

—HYGRADE SYLVANIA'S success has made possible the maintenance of a staff of able engineers. Improvements in tube construction frequently are first introduced by HYGRADE SYLVANIA.

Financial Strength

—HYGRADE SYLVANIA is one of the outstanding successful manufacturers in its field. Only successful companies can give the service required by manufacturers of receiving sets.



NO OTHER TUBE MANUFACTURER IS GEARED SO WELL TO THE REQUIREMENTS OF THE RECEIVING SET MANUFACTURER

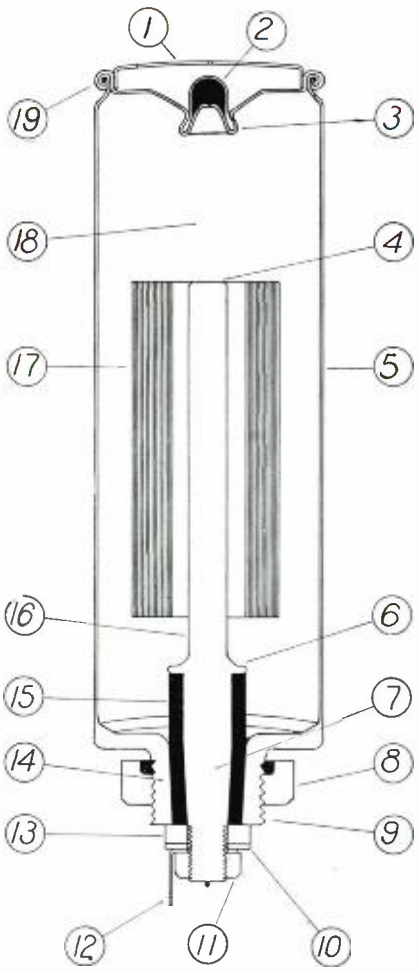
HYGRADE SYLVANIA CORPORATION

HYGRADE LAMP DIVISION
SALEM, MASS.

SYLVANIA DIVISION
EMPORIUM, PA.

ACRACON

ELECTROLYTIC CONDENSERS



Preferred by the Radio Industry . . . because They Have Proved Their Dependability

Acracon is the only electrolytic condenser offering all these features in electrical design and mechanical construction:

1. Metal cover for protection and appearance.
2. Live, rubber nipple.
3. Nipple spun into aluminum shell. Absolutely leak-proof.
4. Anode spiral cold welded into anode, giving rigid construction.
5. One piece extruded aluminum container.
6. Retaining flange for rubber gasket.
7. Tapered anode stem for snug fit.
8. Large cadmium plated steel mounting nut, concave to insure tight connection.
9. ⅜"-16 thread neck for mounting.
10. Metal washer.
11. Anode nut.
12. Anode soldering tab.
13. Large size insulating washer.
14. Tapered hole to take tapered anode.
15. Special live, rubber insulating gasket free from impurities.
16. Heavy, rigid, anode stem of high purity aluminum.
17. High purity anode, spiral, so wound as to eliminate the necessity of insulating liner between anode and container.
18. Special, high, critical voltage electrolyte, well over anode to insure long life.
19. Leak-proof rolled seam as used in canning industry.

Acracon Electrolytic units are now available in capacities up to 16 microfarads at either 440 or 475 volt peak in the single anode type.

Follow the leaders of the industry. Specify Acracon Electrolytic Condensers. Also By-Pass, Wax Impregnated, Oil Impregnated, Power and Transmitting types. Write today, enclosing specifications.

Acracon Features Are Protected By Patents Pending

Condenser Corporation of America

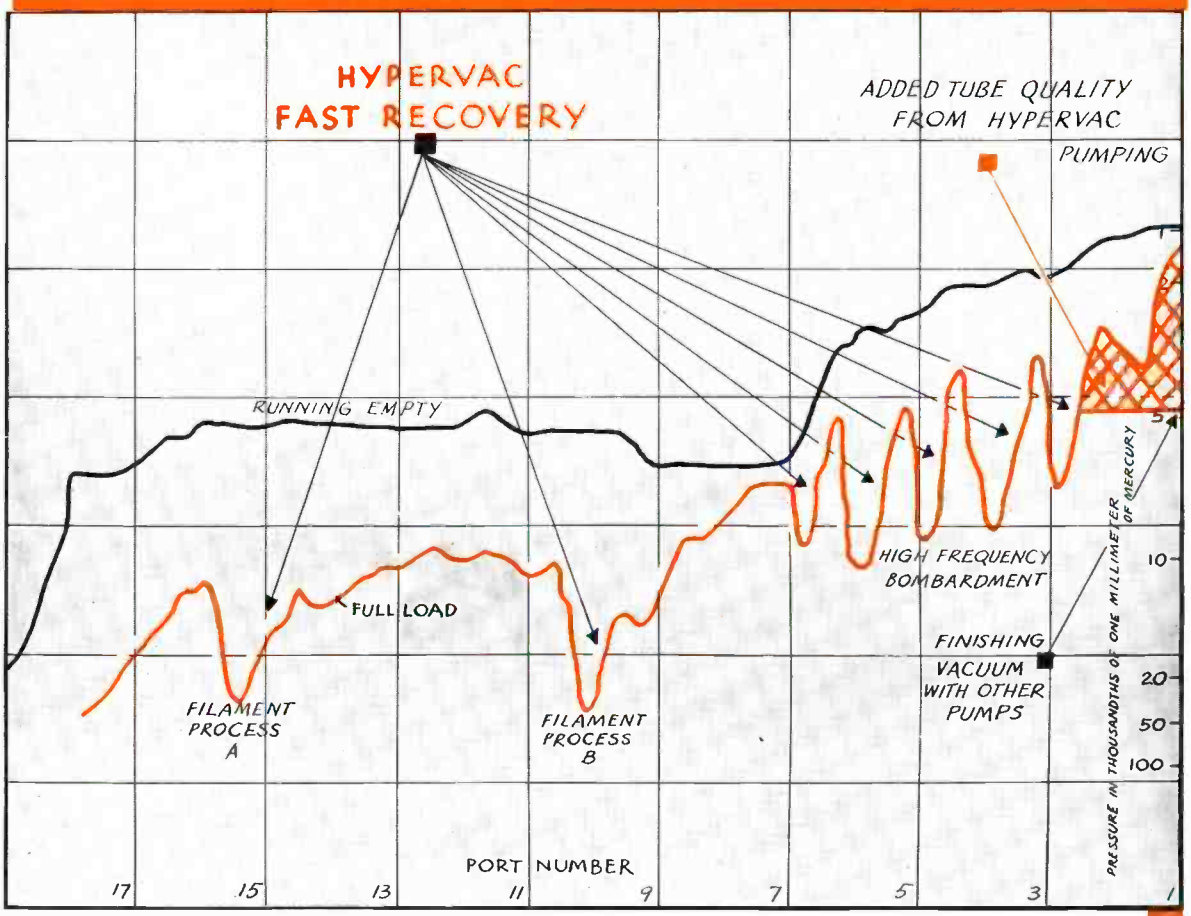
259-271 CORNELISON AVE. JERSEY CITY, N. J.

Factory Representatives in:

Chicago, Cincinnati, St. Louis, San Francisco, Los Angeles, Toronto, and other Principal Cities

How Cenco Hypervac Pumps *increase radio tube quality*

AS TOLD BY PRODUCTION CURVES AT ROGERS RADIO LTD.

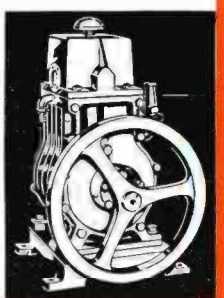


IN PLANTS where accurate records of process efficiency are maintained, it is possible to identify the exact ways in which Cenco Hypervac pumps improve both product quality and product cost.

These graphs, taken from the records of screen grid tube production at Rogers Radio Limited, represent continuous port to port vacuum measurement, with and without load, on an automatic machine whose last eighteen positions are CENCO HYPERVAC pumped. The unloaded curve marks the best vacuum allowed by the characteristics of the exhaust machine itself. The loaded curve approaches this in proportion to the efficiency with which the pumps remove gases as they are released from the load.

Fast recovery—the key to minimum shrinkage losses—is seen in the sharp and prompt return of the loaded curve to high vacuum, following voluminous gas release by filament processes and high frequency bombardment. This is the factor that reduces unit costs.

As to high finishing vacuum, notice that these tubes are sealed off at one micron, practically equal to the limiting pressure of the empty machine. Other pumping equipment previously used finished off at five microns. Here is a constant integral of finer quality that applies to every tube made in a day's run. Address inquiries to the Central Scientific Company, 460 East Ohio Street, Chicago.



CENTRAL SCIENTIFIC COMPANY

CENCO HIGH VACUUM PUMPS

Hyvac Megavac Super CENCO vac Rotovac Hypervac

NEW YORK – BOSTON – CHICAGO – TORONTO – LOS ANGELES

When you need coils QUICKLY

General Cable's coil production facilities are capable of filling your needs *promptly*.

Dudlo, supplemented by Rome, plus unlimited sources of magnet wire provided by other organizations affiliated in General Cable, bring together coil-making facilities that are uniquely extensive. In such facilities lie the advantages of accelerated production, and quick deliveries. Such deliveries are effected without sacrificing any of the General Cable standards of quality. General Cable's capacity to *produce* carries with it equal capacity to *inspect* and *test*. You are sure of getting coils as dependable in all respects under "hurry call," as you are under normal requirements.

When it is advisable to keep your inventories at minimum, and at the same time miss *no* sales owing to failure to deliver your sets promptly . . . you will find General Cable Coil Service an especially valuable aid to profitable operation.

•

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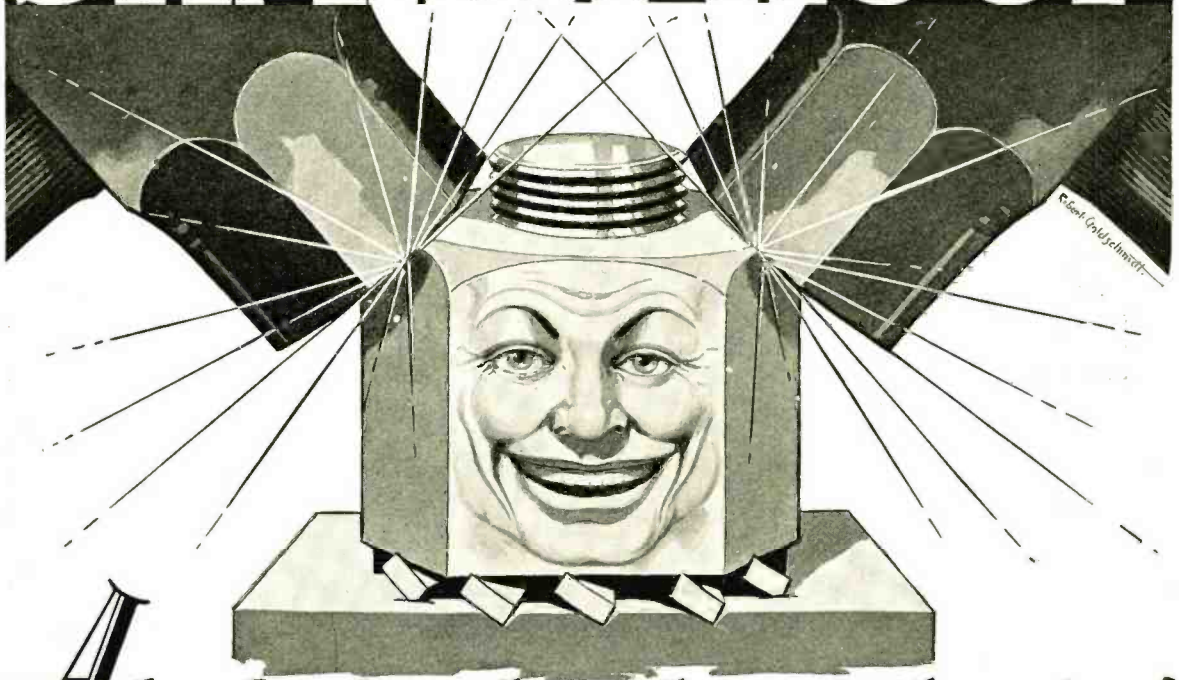


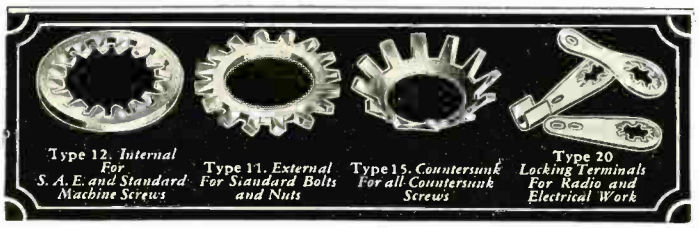
A lock that laughs at vibration!

THE patented twisted teeth of the Shakeproof Lock Washer have added extra years of perfect performance to a multitude of products. This vibration-proof principle keeps connections tight because each nut is securely locked and cannot loosen. Every twisted tooth bites into both the nut and work surface and the greater the vibration the deeper the bite. And—remember this—Shakeproof is tangle-proof and spread-proof, too!

Test Shakeproof on your product today. See for yourself how this patented principle provides real protection from the damaging action of vibration. Mail the coupon for samples—NOW!

U. S. Patents
1,419,564
1,604,122
1,697,954
1,782,387
Other patents pending.
Foreign patents.

SHAKEPROOF
Lock Washer Company
{Division of Illinois Tool Works}
2509 North Keeler Avenue, Chicago, Illinois



Shakeproof representatives are located in the following cities

New York City Philadelphia Boston Pittsburgh Schenectady Cleveland
Detroit Toledo Cincinnati Birmingham, Ala. Dallas, Texas Milwaukee
Los Angeles Seattle San Francisco Toronto, Ontario, Canada

COUPON

Gentlemen: We want to test your Shakeproof Lock Washers. Kindly send us samples as indicated.

Type ..... Size .....

Type ..... Size .....

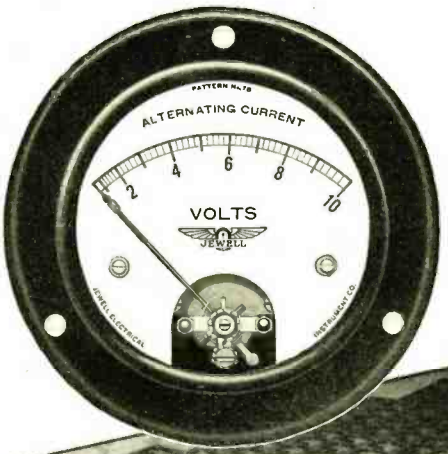
Firm Name .....

Address .....

City ..... *State* .....

By ..... *Title* .....

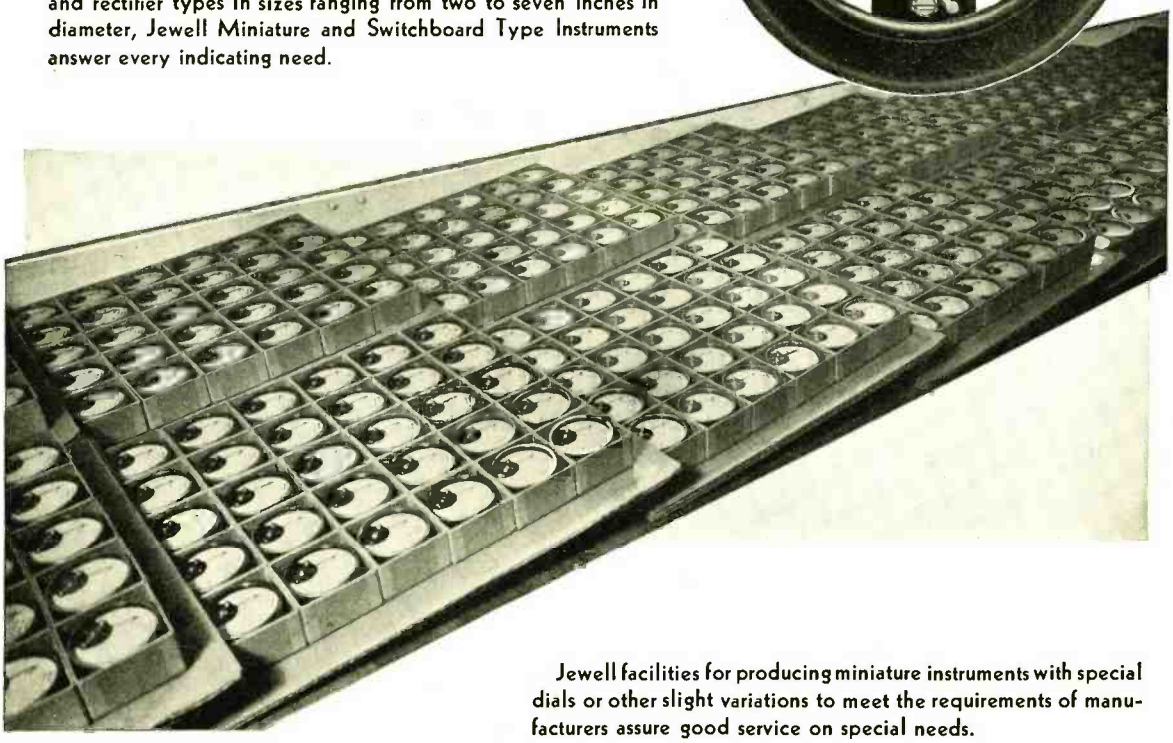
Miniature Indicating Instruments for Every Need...



ON arc welders, X-ray equipment, automotive test equipment, radio service apparatus, and in fact wherever small indicating instruments are used, Jewell Miniature Instruments have proved outstandingly successful.

The striking success of Jewell Miniatures in fields where operating conditions are most severe is indicative of their rugged construction and durability.

Available in direct current, alternating current, thermo-couple, and rectifier types in sizes ranging from two to seven inches in diameter, Jewell Miniature and Switchboard Type Instruments answer every indicating need.



A group of Jewell Miniature Instruments ready for packing. These instruments are made with special dials for a large manufacturer of radio equipment.

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SEPTEMBER, 1931

Hyper-sensitive detection systems

H. G. BOYLE*

THE popular acceptance of multi-tube receivers five years ago, naturally lessened research in the direction of hyper-sensitive detectors. Before radio or intermediate frequency amplification was feasible or useful every periodical carried at least one new circuit in every issue which promised a better detector sensitivity than had yet been obtained. That these promises were not always fulfilled was one of the risks of the game.

In the vanguard of these special receivers were the super-regenerators of Armstrong and Flewelling, the Autoplex and the single control Ultra-Audion. It is doubtful if any of these circuits has been used in any commercial receiver, although they have received some consideration as such for use in the high-frequency bands.

There are many reasons why such circuits will not operate satisfactorily in the broadcast band, although the principles upon which they depend may be used to a very distinct advantage and the objections eliminated.

The sudden and overwhelming popular acceptance of midget sets has once more started the engineer off on the trail of greater amplification per tube. The principles have already been set down, why not use them with the necessary adaptations to modern equipment and practice?

Regenerative Receiver

One receiver has already appeared on the market using a simple regenerative circuit operating at carrier frequencies and its performance rivals many superheterodynes. The apparent selectivity is very good while the use of an audio amplifier peaked at fifteen hundred cycles renders the overall quality of reproduction acceptable.

The demand for selectivity has brought the superheterodyne out of retirement and it is only logical that it be used in applying the principles under discussion. Problems of application are immediately simplified, as the intermediate amplifier is to operate at one frequency only instead of a band.

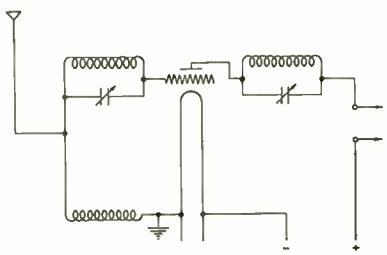

Fig. 1. The fundamental Autoplex circuit upon which the second detector circuit is based.

Any constants of the circuit can be settled for the intermediate frequency and will not be affected by carrier or oscillator tuning.

In examining types of hyper-sensitive detectors the super-regenerative type has been found unsuitable for superheterodyne work for several reasons. An oscillating tube besides the regular beat oscillator produces too many opportunities for interference. The supersonic frequency will become an objectionable factor with high audio gain and any trap circuit to take it out is expensive as well as inefficient at best.

It will be found that a tendency to microphone and whistle on carriers with low modulation is very prevalent. There is also considerable opportunity for the production of beats which continue for considerable time after the cessation of the particular frequency which generated them.

By using the Autoplex principle on the second detector a satisfactory stability can be maintained without the objectionable features of super-regeneration. The fundamental circuit shown in Fig. 1 depends for its action upon a capacity reactance load in the plate circuit. In normal operation such a load will cause a tube to oscillate violently when adjusted to the low-frequency side of grid resonance. By the introduction of the inductance "L" oscillation is suppressed without materially reducing the voltage built up across the input resonant circuit, due to feedback through the elements of the tube itself.

Feedback

When applied to tetrode tubes it is necessary to provide feedback by some other path. This can best be done by simple inductive or capacitive coupling or both. However, the suppression action remains the same, and by choosing the proper value of inductance or resistance ten to twelve times the voltage ordinarily needed to overcome losses and produce oscillation in the circuit, can be fed back through the system.

A double detector system, as shown in Fig. 2, has been set up and a measured gain of two thousand one hundred obtained, with one volt of audio frequency developed across the input circuit to the following tube.

Several peculiarities persist, chief among them being lop-sided selectivity and greater amplification of small inputs than of large ones. The latter characteristic is desirable, while the former can be modified or obviated if necessary, by using at least one stage

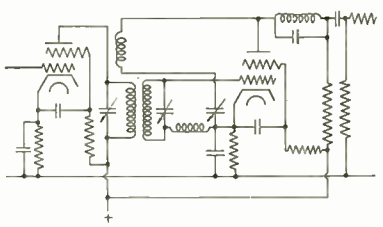

Fig. 2. A typical arrangement for a superheterodyne second detector of high sensitivity.

*Engineer, Crosley Radio Corpn.

▲

For a three-tube receiver market here is a layout that has merit

of tuned amplification ahead of this type detector.

In many instances this provides sufficient selectivity and tuning of the coupler between the amplifier and detector becomes unnecessary, a random wound transformer resonating near the intermediate frequency being satisfactory.

Pentode Output

While any regenerative action produces attenuation of high audio frequencies the use of pentode output tubes will assist the fidelity and where necessary audio-frequency regeneration may be used to improve it still further.

It is realized that many variations of obtaining the feedback energy and suppression effect is possible and in many cases more stable operation will obtain if coupling is made to the cathode or screen circuits. However, any attempt to operate the screen at a radio-frequency potential higher than the cathode will impair its operation as an amplifier and return it to a condition comparable to a triode detector, the screen serving simply as an extra and more convenient modulating grid.

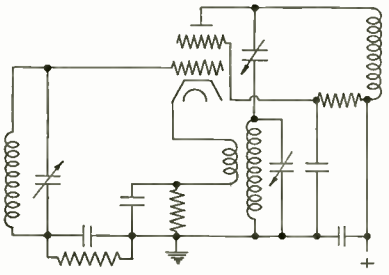

Fig. 3. An example of oscillating, or zero-beat, first detector. Probably the most sensitive detection device known.

If desired this principle can be used with a special first detector in order to combine therein both the function of detector and oscillator. A tube operating in such a manner appears to parallel the action of a zero beat detector which is admittedly the most sensitive detection device known.

It is not so critical in adjustment as its response is governed by the selectivity of the intermediate amplifier and not an audible beat note that must be adjusted to exact zero and inaudibility.

In some cases it will be found that the constants of the selecting intermediate transformer will produce a series or parallel resonant circuit which will stop oscillation in certain portions of the band. If this occurs it may be necessary to utilize the second harmonic of the beating frequency and change the intermediate amplifier accordingly.

Considering all of the principles mentioned above it can be seen that it is possible to produce a receiver with good sensitivity and selectivity with a minimum of three tubes, exclusive of the rectifier, these being an oscillating first detector, an Autoplex type second detector and an audio output stage.

With fidelity an independent characteristic to be altered as required the overall operation can be made much better than is possible with the same amount of apparatus In conventional circuits.

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New association formed

RADIO servicing, which is one of the most important links in the chain comprising the radio industry, has in many particulars long been neglected. Various attempts have been made to formulate a program whereby the men engaged in taking care of the radio sets of the country could associate with others in the same work for the benefit of the men, individually or collectively, as well as the industry at large.

Now comes the Institute of Radio Service Men, organized in Chicago and with national headquarters at 400 W. Madison street in the midwestern metropolis. The Institute is a national organization, entirely divorced from any other organization, but formed to work in collaboration with all other groups in the radio industry, including the Radio Manufacturers' Association, the National Federation of Radio Associations, and the Institute of Radio Engineers.

The Institute has no connection with any commercial enterprise and is not formed for the purpose of making money. It is laid out to function with the radio servicemen in exactly the same manner that the Institute of Radio Engineers does with the engineering profession.

▲

To provide expert receiver servicing.

The new Institute comes about because of the phenomenal success of an experimental collaborative program conducted by the Midwest Radio Trades Associaiton of Chicago, and the radio department of The Chicago Daily News during 1930-1931 season. In a series of twelve meetings engineers from manufacturing and research laboratories, instructors from trade schools, and managers of broadcast stations gave discussions to the large audiences of servicemen that gathered there twice monthly.

Subjects that were pertinent to the work of servicing radio sets were the only ones considered for the discussion. Radio interference, vacuum tubes, superheterodyne circuits, service problems, service equipment and its use, laboratory apparatus, television, and individual parts of current receiver circuits were discussed fully and each meeting was thrown open to general round table discussions afterwards.

The Institute will be divided into sections, the headquarters of which will be located in each radio center of the country. Each section will function under the advice of national headquarters and arrangements will be made for the local chapters to hear the discussions of engineers acquainted with the servicemen's problems. Undoubtedly the servicemen will derive a great deal of benefit, which, in turn, will be manifested in a higher grade of service to the customer and consequently a higher regard on the part of the public for the serviceman and his job.

A monthly periodical that will contain the latest information relative to those things applicable to the work of the serviceman will be published as soon after the Institute is organized as possible. The periodical which will correspond to the Proceedings of the Institute of Radio Engineers will contain papers prepared by engineers, instructors, service managers, sales managers, and others, as well as a section wherein the servicemen may present their problems to obtain aid from other members who may have experienced similar difficulties.

The Institute will begin its activities in conjunction with the Radio-Electrical World's Fair to be held in Madison Square Garden, New York City, September 21 to 26. A convention is being arranged, with papers to be delivered by a selected group of engineers interested in the servicemen's problems and method for solving them.

A sectional convention for the Chicago servicemen is being arranged to be held in conjunction with the Chicago radio show in October. Other sections will follow after the Institute has had an opportunity to begin its operations.

Information relative to the Institute of Radio Service Men may be obtained by writing directly to national headquarters, 400 W. Madison Street, Chicago, Ill.

An analysis of the series type mixing control

By L. B. Hallman, Jr.*

In radio broadcasting, talking motion picture and phonograph recording work, the desirability for using more than one microphone, at times, in order to obtain a more natural and higher quality of reproduction, is very great. Also it is essential to have the level from each microphone under absolute control and to have each control independent of the other.

The demand for such a control has been recognized since the early days of the vacuum tube amplifier and, as a result, several types of potentiometers and hybrid potentiometers have been developed for this purpose.

An ideal mixing control would be so arranged that:

1. The impedance at the amplifier input terminals is a known, constant value for all positions of any of the control units.

2. Each control is independent of the other. That is, as one control is varied from the fully closed to the fully open position it should have no effect on the volume, coming through the amplifier, from any of the other microphones.

3. The output impedance of each unit is a constant value and (usually) equal to the input impedance, or the impedance of the secondary of the microphone transformer.

The interdependence of conditions 1. 2 and 3 is evident. It is true that all of these conditions could be satisfied by using a properly designed "T" or "H" type variable pad for the control unit. Such a pad would necessarily be an elaborate and comparatively expensive affair, however, and the advisability of going to the expense of providing so high a degree of perfection at this particular point is extremely questionable. However, it is desirable to come as close to perfection as is possible without overstepping the dictates of economy.

With the above requirements in mind, consider the arrangement shown in Fig. 1. This type of design is quite generally used today in faders for phonograph pickups, and in the early days was used in microphone mixing units. It is satisfactory where the degree of control required is not great. If it is necessary to control all the way from the fully open to the completely closed position, a glance at the circuit shows that neither conditions 1, 2 and 3 are even approximately satisfied. When the control is being operated at a nearly closed position the impedances in the circuit are very poorly matched and the various controls are far from being independent. The author is familiar with a difficulty at one of the large broadcasting stations of the country where poor quality from a phonograph pickup was experienced. An examination of the fader unit (which was of the type shown in Fig. 1) revealed that due to the gain of the amplifier it was being run nearly closed. Changing the fader circuit brought the quality up to a satisfactory standard.

With a view to correcting some of the inherent defects of the arrangement in Fig. 1, various types of mixing potentiometers have been designed. The most generally used of these consists of two separate resistance elements and a common, sliding contact arm. This unit may be connected in different ways to attain practically the same result. Two arrangements generally are used: (1) the parallel system, shown in Fig. 2, and (2) the series system, shown in Fig. 3. The series system is the later development and has much to recommend it. It gives a more constant impedance relation than the parallel system and is used in the more modern broadcast and recording studios. It is the purpose of this paper to analyze the series system, to establish definite rules for the design of the mixing control unit and to show just how nearly such an arrangement may be made to approach the standards, already established.

In the work that follows the various symbols are used as designated below:

Z—The impedance of the secondary of the microphone transformer.

x + y—The resistance of the element of the control unit shunted across the transformer. (x = KZ — y.)

*Chief Engineer, Station WSFA.

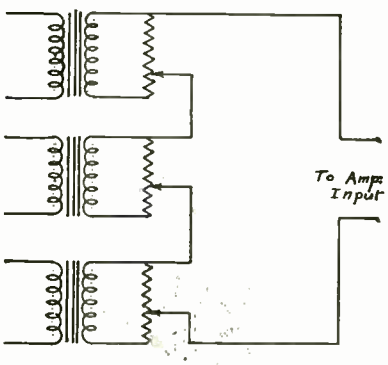


Fig. 1. Common type of fader.

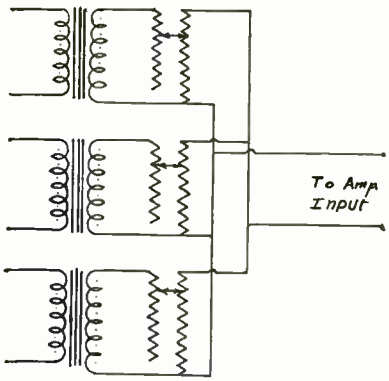


Fig. 2. Parallel system.

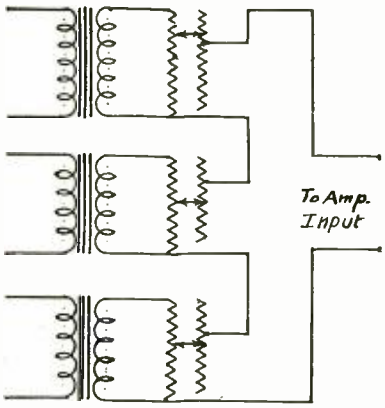


Fig. 3. Series system.

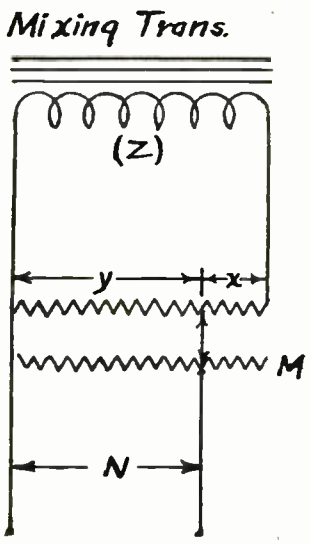


Fig. 4.

N—The output impedance of the control unit.

K—The ratio of the resistance across the transformer secondary to the impedance of the transformer secondary. $(x + y / Z.)$

B—That portion of the compensating resistance element so arranged, and having a value suitable, to make up for the shunting effect of the shunt resistance and keep the output impedance equal to the transformer impedance at the open and near-open positions.

r + u—That portion of the compensating resistance element which performs the same function from the tap to the closed position as the "B" portion of this resistance does from the tap to the open position (see Fig. 6).

g—Practically a constant for any given unit. $(g = u / y.)$

In the work of this paper the objective has been to show just how nearly

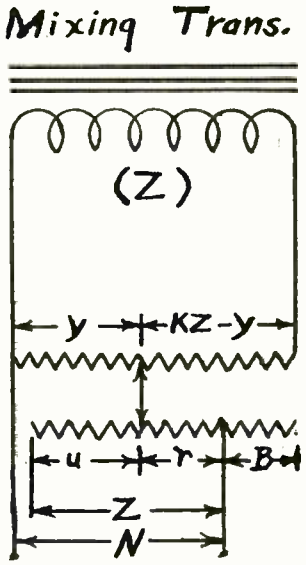


Fig. 6.

constant N could be held with the series type of mixing control—the optimum value of N being taken as equal to Z. It should be noted that the series type control is essentially a variable "T" pad with the resistivity of both elements constant for every position of the control arm.

Assuming the impedance of the transformer to be constant and the control arm set at the position shown in Fig. 4, let:

$$x + y = KZ$$

then:

$$y = KZ - x$$

By inspection of the circuit:

$$N = Z = y\ (x + Z)\ /\ (x + y + Z) = (KZ - x)\ (Z + x)\ /\ Z\ (K + 1)$$

Solving for x:

$$x = Z\left[\tfrac{1}{2}(K-1) \pm \sqrt{(K-1)^2 - 4\tfrac{1}{2}}/2\right] \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

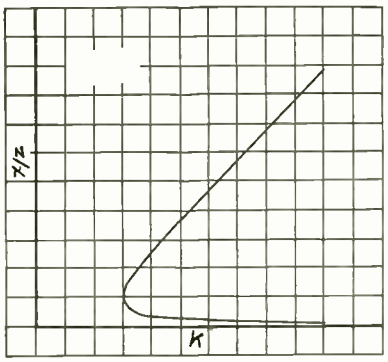


Fig. 5. Resistance-impedance relations of transformer secondary circuit.

From which it is seen that K must be at least 3. That is, the resistance across the transformer secondary must be at least three times the impedance of the transformer secondary (assuming $N = Z$)—for if it is not the expression under the radical becomes negative. In this connection it should be noted that the smaller the value assumed for K the more effective will be the compensating resistance M. In view of these considerations it seems that the most desirable value for K is 3.

The curve in Fig. 5 illustrates how x / Z varies as K is changed. It will be noted that for every value of K above 3 there are two real values of x / Z.

It will now be of interest to derive a general expression for the output resistance in terms of the position of the control arm. This will show just how nearly the control under consideration approaches the ideal condition of a constant output resistance for every position of the variable control.

Assuming the control arm to be set at any position on the lower portion of the compensating resistance other than that shown in Fig. 4, and referring to Fig. 6, we see that:

$$u = gy$$

where g is a constant the value of which depends on the value assumed for K. Also:

$$r = Z - gy.$$

Thus, within the range of the lower portion (Z) of the compensating resistance, we have:

$$N = \frac{1}{1/y + 1/(KZ + Z - y)} + Z - gy$$

$$= -y^2 / Z(K+1) + y(1-g) + Z \ldots (2)$$

Equation (2) also shows the importance of keeping K as low as possible—for as K increases g decreases and the variation of N with respect to y increases. This shows up more clearly if N is differentiated with respect to y. Thus:

$$dN / dy = 1 - [g + 2y / Z\ (K + 1)]$$

which expression increases, almost directly as K is increased.

An examination of the constants involved reveals that when $K = 3$, $g = \frac{1}{2}$. Substituting in (2) gives:

$$N = -y^2 / 4Z + y / 2 + Z \ldots\ldots (3)$$

A curve drawn between N and y is shown in Fig. 7. This curve shows a maximum variation of 25 per cent for N as the control arm is moved over the

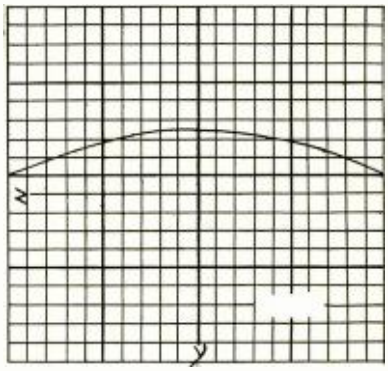


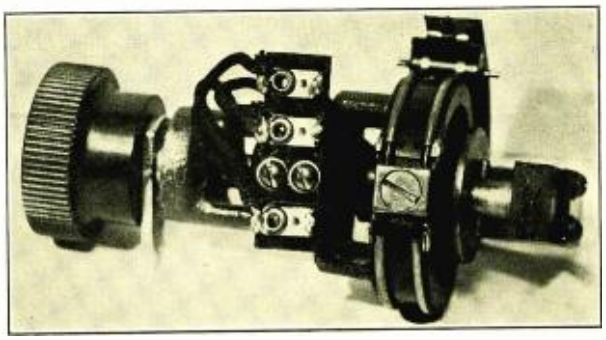
Fig. 7.

lower portion of the compensating resistance. The variation as the control is moved over the "B" portion of the compensating resistance (which for most purposes should be adjusted so as to make $N = Z$ when the control is fully opened) would not be so great. We may therefore take 25 per cent as being the maximum variation of N from the value Z.

When other variable factors involved are taken into account, this 25 per cent

(Concluded on page 35)

Fig. 5. Mixing control.



Television Turns to Projection

By A. DINSDALE*

Radio received pictures in the home are arriving slowly but surely.

TELEVISION is here, all right; and those interested in the entertainment industries are acutely and apprehensively aware of the fact, just as the average man is similarly aware of the presence of a recently arrived baby. Acutely and apprehensively, because he never knows the minute the child will start teething, or get growing pains—or something. Anything may happen, but the ultimate result is invariably and inevitably a disturbance of the peace.

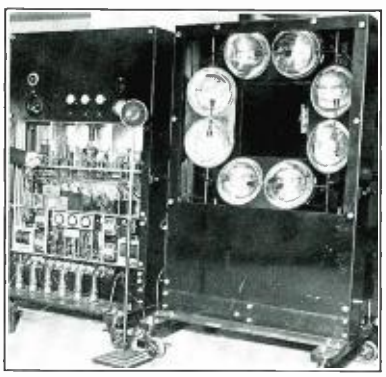
There are three schools of thought on the subject of television. The oldest says: "Television is impossible of achievement, or so nearly impossible that the solution will not be found for years and years." That is the view of your dogmatic scientist, who is perhaps a little passé. You know the idea. These new-fangled inventions come out so thick and fast there's no keeping track of them; we ought to put the brake on to preserve our own prestige.

Then we have our importunate and "inspired" publicist who loses no opportunity of shouting from the housetops that "TELEVISION IS HERE." Verb. sap.

The third school of thought exists among certain members of the radio and movie industries. Not to the discredit of these good people, they have been so busily engaged in their own business that they have not had time to investigate this television business and find out the true position. As a consequence of hurriedly and mistakenly conceived ideas they are on the verge of panic for fear television may break out in a fresh spot somewhere and irretrievably ruin their business, or at least disorganize it. Hence the acute apprehensiveness.

As with everything else, there is a sane middle course, based on an accurate knowledge of the true situation. In what follows, I shall attempt to review the present situation briefly and clearly.

In answer to those who say that television will never be possible, I simply reply that in scientific matters today's impossibilities are tomorrow's commonplace achievements. Television is here already, but only in decidedly limited form. I have seen most of the systems of both Europe and America, and the best that they can do is to present a flickery, none too well illuminated and none too detailed image of a person's head and shoulders. When an attempt is made to enlarge the field of view a considerable strain on the imagination is required to identify the objects portrayed. Enormous difficulties remain to be solved, and their solution *may* take years; on the other hand, they may take only a few months. No intelligent observer who has watched the enormously rapid progress which has been made in the last few years would be so foolish as to attempt to prophesy just when the ultimate solution will be reached.



Sanabria's transmitter, amplifier and photocell frame.

No Trade Disturbance

As to the fears of trade interests, these are groundless. They have no more reason to fear the advent of perfected television than the manufacturers of phonographs and records had to fear the advent of radio broadcasting. Television will be complementary to radio broadcasting, and confer subsidiary benefits to the movie and other industries.

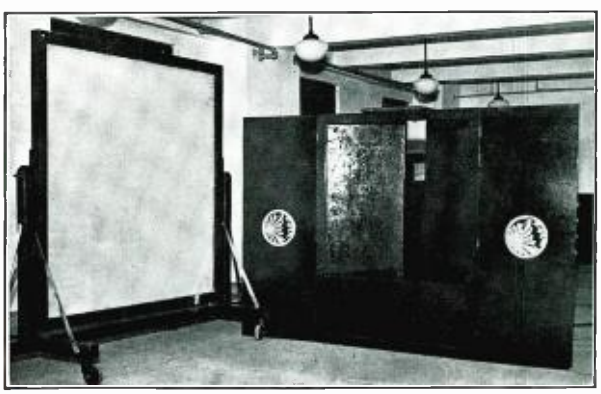
Let's see, now, how the husky infant, television, is progressing.

The receiving apparatus available to the public today is not nearly so foolproof as the modern radio set; it requires a certain amount of technical knowledge to operate it satisfactorily. Furthermore, with the product limited to imperfect head and shoulder views of a human being, it may be said that there is definitely no entertainment value in television today for the man-in-the-street. For the amateur or professional enthusiast, yes; there is much of interest, but only from the technical angle. But then, radio grew up just that way, from just such beginnings. Twelve years ago there was nothing but code for the radio enthusiast to listen to, of interest only to the expert who could read it. And the receivers of those days were complicated and erratic, requiring expert handling.

Present Status

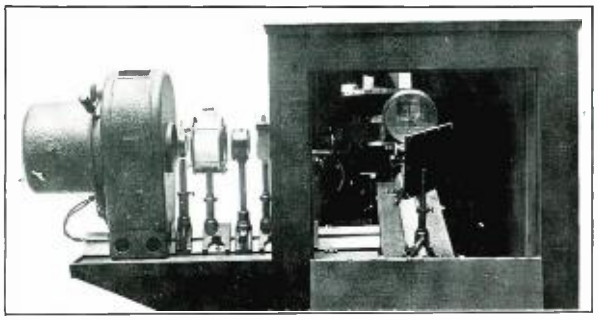
To look at a television image today you have to put your head in just the right position and look through a large magnifying lens. It is like peering into a peep show, and no more than one or two persons can look at once. But radio used to be like that, with its individual earphones. Now we have loudspeakers and all can listen. To continue the parallel still further, in the early days of broadcasting we could only broadcast one or two persons singing to the accompaniment of a piano. Nowadays the sky is literally the limit.

It is inevitable that television will turn to projection as the solution to the problem of permitting a large audience to watch the portrayed images in comfort. Whether the televisionists like it or not, home talking movies are already with us in a highly perfected form, and you just can't stop the public demanding of television an equal standard of



Sanabria's translucent screen and opening between loudspeaker baffles through which receiver light is projected.

*Mem. I.R.E., Member of Council, Television Society, London. Formerly Editor, "Television Magazine," London.



Karolus' projector. Arc at left, then nicol prisms, water cell (for cooling) and Kerr cell.

accomplishment before they will accept it. Of the many problems involved I will deal here with but one, projection.

The first evidence that the need for projection was being realized came in April, 1927, when the Bell Telephone Laboratories demonstrated an admittedly crude image on a screen measuring two and a half feet square. This was not true projection, but the effect was achieved by means of an ingeniously contrived neon tube.

The first example of true projection was demonstrated by Dr. Karolus, of Leipzig University, at the Berlin Radio Exhibition in 1929. By means of an arc modulated by means of a nicol-prism-Kerr-cell combination he projected 48-line images on to a three-foot screen. The detail was quite good, but the illumination was so poor, owing to the tremendous losses inherent in the optical system, that it was difficult to see the image even in a pitch dark room. Last year, Dr. E. F. W. Alexanderson duplicated the experiment more successfully on a six-foot screen in a Schenectady theatre. He used brute force methods in the form of a 150 ampere arc to overcome optical losses.

Large Screen

Last year, also, Baird of England built and demonstrated a two by five feet screen composed of 2,100 tiny flash lamp bulbs to which the signal current impulses were delivered in appropriate order by means of a huge commutator. This arrangement also is not true projection, but a somewhat crude method of achieving a similar result. Needless to say, the images were crude. Baird is now reported to be experimenting with a method of modulating an electric arc directly with the television impulses. If this proves successful, one of the major problems of television projection—that of securing sufficient illumination of the screen—will have been solved.

The latest worker to enlarge his image by projection is U. A. Sanabria, of Chicago, who has recently announced a merger of interests with the Shortwave and Television Corp. Sanabria demonstrated a six-foot image at the radio trade show at Chicago this summer, and later in New York. The highlights of this demonstration were an unexpected reduction of "strip effect" and flicker. In view of the fact that the images contained only 45 lines, and were transmitted at a speed of only 15 per second, this was a meritorious achievement. The explanation lies in the fact that Sanabria, instead of employing the usual single spiral disc, uses a triple spiral disc. Each spiral has 15 holes, and is so arranged or offset that the light spots from the holes of one spiral half overlap those of the previous spiral. This has the effect of improving the vertical detail of the image, and reducing both strip effect and flicker.

Reception

At the receiving end a similar disc is employed in conjunction with a special "neon arc" which is a development of the crater type neon and delivers a light of intense brilliance. The illumination of the screen was, I should say, about half that of a movie screen. Although no wider field of view than a head and shoulders was shown, the detail as I saw it was extremely good, nearly as good, I should say, as the closeup image given by the average home movie projector. The outlines of the image were marked by an unusual (for television) crispness. This improvement in detail, according to Sanabria, is due partly to his discs, and partly to the special amplifier he uses, which, he says, steepens the wavefront of the signal impulses. Taken all around, it was quite the best image, large or small, that I have ever seen. But I would not call it perfect.

Sanabria's 1,000-watt gas-filled lamp transmitting light spot projector.

These various experiments show the trend of television development today, a trend which indicates clearly that the need for the projection of the images on to large screens, for either public or home use, is definitely recognized. The principal difficulty is that of securing adequate illumination, or, put another way, finding ways and means of modulating powerful light sources in accordance with the needs of television.

There still remain to be solved many serious problems connected with the transmission or broadcasting of the electrical impulses from transmitter to receiver, and these must be solved before a much greater improvement in image detail and an increase in the field of view can be presented. But solutions will eventually be found.

The infant, television, is here all right, and it is a lusty infant. But it has some distance to go, in terms of development, at least, if not in years, before it reaches full manhood and becomes fitted to shoulder the heavy responsibilities expected of it. Meanwhile, there is no occasion for associated industries to become alarmed; but they would do well to follow and foster the growth of this latest arrival in the worlds of electrical communication and entertainment.

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RADIO TELEGRAPH CIRCUITS TO OTHER COUNTRIES

INTERNATIONAL radio telegraph circuits now in operation by R.C.A. Communications, Inc., are as follows:

Transatlantic: From New York to: Great Britain, Norway, Germany, France, Italy, Poland, Sweden, Holland, Belgium, Turkey, Portugal, Liberia, Spain, Syria, Russia, Czechoslovakia.

West Indies and South American: From New York to: Argentine, Brazil, Dutch West Indies, Dutch Guiana, Colombia, Venezuela, Porto Rico, Cuba, Costa Rica, Chile, Panama, Santo Domingo. From San Francisco to Panama.

Transpacific: From San Francisco to Hawaii, Japan, Dutch East Indies, French Indo China, Philippines, Hong Kong, China (via Philippines), China (Shanghai), China (Mukden), Fiji Islands. From Hawaii to Philippines. From Hawaii to Japan.

Miscellaneous: From New York to Canada (Montreal), Australia (via Montreal), San Francisco. From Porto Rico to New Orleans.

Simplicity extends light-control possibilities

New light-sensitive cell, together with simplified associated apparatus, introduced to engineers and experimenters

MUCH has been written and said in recent years regarding light-sensitive or photo-electric cells. Wonderful things have been predicted through their use in industry. Yet until now the commercial application of light-sensitive cells has been decidedly limited and quite disappointing, due to the limited amount of current that could be passed through cells so far available, to their low degree of light sensitivity, and to the elaborate and costly associated apparatus. An entirely new development along these lines, however, now promises to overcome the previous limitations and to open up an almost unlimited industrial field for the light-sensitive cell.

Known as the Burgess Radiovisor Bridge, the new light-sensitive cell represents the original development work of British scientists, followed by the ingenious applications by German technicians, and finally the adaptation of the cell and its circuits to American practice by our own engineers.

The Cell

The new cell or bridge consists of a tall glass tube with a three-prong base. Inside the bulb is a flat plate occupying the center and supported by two heavy lead-in wires. The plate is of glass upon the front side of which are two interlocking comb-like electrodes of gold, fused in place. These electrodes are covered over by a thin layer of selenium-like enamel, the conductivity of which changes with the amount of light falling on it, thereby providing a light-sensitive cell. Due to the considerable amount of current that can be passed through this cell as contrasted with the minute current passed by the usual photoelectric cell, it becomes possible to utilize simple, practical and inexpensive circuits, thereby multiplying the possibilities of light control. In fact, the cell can operate a relay direct, for controlling a circuit handling a few watts of energy, while a second relay provided with a novel form of vacuum contact permits of handling several hundred watts for heavy duty. For more intricate applications, vacuum tubes can be employed, in which event considerably less amplification is required than in the case of the usual photoelectric cell, due to the higher initial current available.

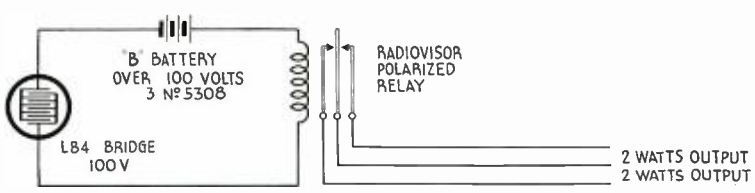

Fig. 1. Direct-coupled circuit to polarized relay for controlling circuit by light variation.

Bridge Circuit

The bridge possesses a high ratio of dark resistance to resistance when subjected to an illumination of 10 foot-candles, and is practically independent of voltage. The bridges can be used at various voltages, but for convenience they are tested at the factory at only one value, which value is stated when the bridge resistance is given. The bridges are available in d-c. and the a-c. types.

Extreme ruggedness characterizes the new light-sensitive cell. It is unaffected by vibration or rough handling. Each bridge has a maximum wattage rating of 0.1 watt per square inch of sensitive surface, the surface of the standard being 1.5 square inches. For greatest sensitivity, the entire active surface should be employed, rather than just a portion. If a sharp beam of light is being employed for light control, a suitable optical system should be introduced so as to spread the light over the entire surface of the bridge. The life of the bridge is almost unlimited, since no measurable deterioration occurs with age whether on current or not.

In the case of the d-c. bridges, it is necessary to observe the polarity, since the cells have been aged and rated on the basis of the indicated polarity. A change in resistance will occur if the polarity is reversed.

As already stated, the light-sensitive surface of the bridge consists of an enamel or coating derived from sele-

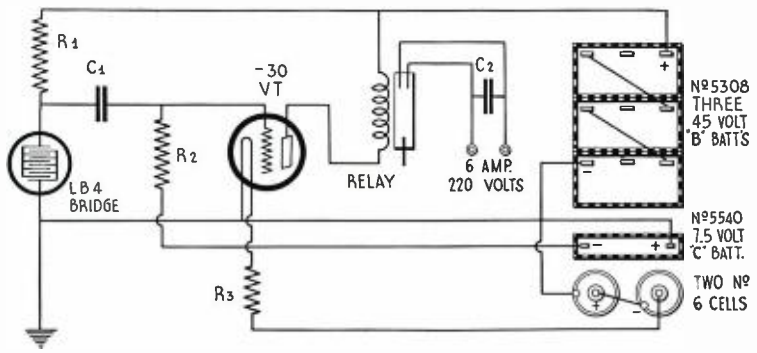

Fig. 2. Impulse circuit for dry-battery operation, with vacuum tube and a power relay fitted with vacuum contact.

nium. The coating is carefully prepared, applied, heat-treated and aged. While the light-sensitive properties of the element selenium have been known for several decades, the many attempts to apply it to light-sensitive cells have left much to be desired. It has remained for the British scientists to develop an entirely new form of selenium cell in which the active material is spread on a glass plate carrying the interlocked gold electrodes, in the form of a film of almost infinitesimal thickness, followed by precise heat treatment for proper annealing. The thin layer of light-sensitive material makes possible the employment of the entire mass for useful purposes, thereby minimizing any useless shunt resistance which might reduce the sensitivity of the bridge. The result is a cell that handles several times as much current as the usual photoelectric cell, that is highly responsive to light variations as proven by its practical application in sound motion picture reproduction, that does not fatigue in continuous use, and does not deteriorate even after long service.

The Burgess radiovisor bridge is produced in Great Britain and is now made available in this country by the Burgess Battery Company. Various basic circuits, together with the associated equipment, have been evolved, in keeping with American practice. A polarized relay is being developed for operation directly off the bridge, in conjunction with a "B" battery. The relay will handle several watts of energy for light work. If real power must be handled, there is a telephone type relay provided with an unique form of vaccum contact now available to American engineers and experimeters as associted equipment for the bridge.

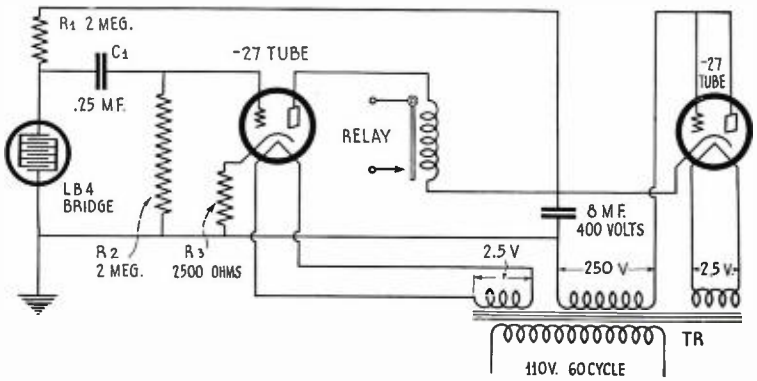

Fig. 3. Impulse circuit for a-c. operation, with bridge feeding heater type tube actuating power relay.

Vacuum Contact

The vacuum contact just referred to comprises an evacuated glass tube containing a pair of contacts broken by the slight movement of a protruding glass rod. The rod is mounted in a glass bellows so as to secure the necessary elasticity from this glass mounting, as well as ample leverage. The vacuum contact will handle up to 8 amperes intermittently, or 6 amperes continuous load, at potentials up to 220 volts. The actuating force may be limited to 0.02 inch at the end of the glass rod, with a pressure below 10 ounces. Because the contacts are in a vacuum, there is a minimum of arc and the contacts cannot corrode. The contact can be operated up to 40 times per second. It provides an instantaneous, clean break. It has a life of tens of millions of makes and breaks.

Given a robust light-sensitive cell that operates a relay directly in a circuit with a standard "B" battery, together with a secondary or power relay controlling several hundred watts, many avenues are opened for the widespread application of light control. The bridge and associated equipment have been applied to burglar alarms, fire alarms, street lighting control, motor car parking lights, for detectors, automatic counting, color matching, railway stop systems, and other purposes. It remains for the inventive genius of American engineers and experimenters to put these tools to work in bringing about a practical light-control era which will simplify many tasks in industrial, social and community life.

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German radio telegraph system to be government operated

THE German Transradio Corporation for wireless overseas transmission has just published its annual statement for 1930 which fails to mention what is to become of the concern after the German Federal Post Office has taken it over. The Post Office will acquire possession of the plant and equipment of the Transradio A. G. on January 1, 1932. Of the book value amounting to 25,800,000 reichsmarks (the reichsmark averaged $0.2385 in 1930), the Post Office will take over 17,000,000 reichsmarks with an addition of 40 per cent; the rest, amounting to approximately 8,800,000 reichsmarks, will be charged to the mortgages and other loans which the Post Office holds against the concern. The amounts accumulated in the sinking, maintenance and renewal funds (3,150,000 reichsmarks) will also be turned over to the Postal Department; as well as the operating of the overseas service. The financial statement of the Transradio A. G. shows a capital reserve of 2,870,000 reichsmarks with 16,500,000 reichsmarks in common stock and 18,000 reichsmarks in preferred stock.

Additional radio telegraphic connections were established between Germany on the one hand and Cuba, Persia, and Shanghai on the other. A new radio telephone service was established between Germany and Brazil; also through opening a second line with Argentina it became possible to communicate in this way with Chile and Uruguay. A radio telephone service was also opened with Siam recently; and one with Mexico is planned. Negotiations are under way to establish a radio telephone service with Egypt. During the middle of June the photograph transmission service between Germany and Argentina was opened to the public. The large radio station of the Eilvese Corporation came into possession of the Federal Post Office on January 1, 1931.

Quartz oscillator wave constants

By E. G. WATTS*

INCREASINGLY extensive application has given to the radio piezo-electric art some degree of standardization in practice and terminology, as well as more complete knowledge of the modes of vibration. Much of the available data, however, is widely scattered throughout the literature. An attempt is made here to coordinate the results of the prominent investigators in the field, presenting in summarized form the data on the constants of longitudinally and transversely vibrating modes, in so far as it is accurately known.

Terminology

Because of the number of combinations possible among the types of vibration, cuts, and methods of excitation, the terminology necessary to describe them is quite extensive. Confusion has resulted at times both from lack of agreement on terms, as well as from the use of a single term for several purposes. The variety of terms used to describe the orientation of the plate with respect to the axes of the natural crystal is an example of the former case. Of the latter, the use of "longitudinal" and "transverse" in classifying the type of vibration, direction of excitation, and in referring to the dimensions of the plate, forms an even less excusable situation. Past usage indicates that these terms had best not be used in referring to the dimensions of the plate.

The present terminology with reference to plate dimensions is based on the designations X for electric axes, Y for those axes 30 degrees from adjacent X axes, otherwise known as mechanical axes, and Z for the optic axis.[1] Dimensions along these axes are designated x, y and z, respectively. The designation of the cut refers to the axis parallel to the smallest dimension. Similarly, vibrations the resonant frequencies of which are determined principally by the respective dimensions are termed X, Y and Z waves. It should be noted that these terms are the only ones referring to the axes, all others referring to the direction of propagation; that is, the direction of the dimension determining the resonant frequency, and to the direction of excitation.

*Formerly, New York, Rio & Buenos Aires Line, Inc.

[1]Cady, Proc. I.R.E., 18, 2136. Dec. 1930.

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Here is an authoritative article on the subject of quartz oscillators.

Modes of Operation

In Fig. 1 are illustrated the relative directions of the axes, vibration, propagation, and applied field (excitation) for four common modes. The direction of the field is taken as normal to the plane of the electrodes, which are shown in contact with the quartz. An air gap does not alter any of the conditions shown. "Longitudinal" and "transverse" are used with "effect" to indicate the direction of the dilatation exciting the resonant vibration, with respect to the direction of the field, and with "vibration" to indicate the direction of vibration with respect to the direction of propagation. The equivalent standing wave for each mode is shown, to indicate the direction of propagation and the nodal plane. It also shows how the "oscillating dimension" is equal to one half-wavelength of supersonic sound in quartz, but does not show the form of vibration beyond indicating that the ends are in greatest motion. The deformations of the vibrating plate are indicated by the dashed lines, in an exaggerated degree. These deformations are closely sinusoidal with respect to time.

The Z wave is not illustrated, but if the Y axis is assumed normal to the plane of the page, it is similar to the X cut Y wave. In the X cut plates it is excited by an elastic reaction from the transverse effect. In the Y cut plates the only effect existing is that of a shear about the Z axis, which produces the transversely vibrating Y wave directly, and other modes by elastic reaction.

The Wave Constant

The quantity most frequently used in connection with finished plates is the dimension-frequency constant, now designated wave constant, and usually expressed in terms of "meters-per-millimeter." This quantity is equal to twice the ratio of the electro-magnetic wavelength to the quartz wavelength (since for a fundamental mode the quartz dimension is one-half wavelength). It is thus also equal to twice the ratio of electromagnetic wave velocity to supersonic sound wave velocity in quartz in the direction concerned, assuming in both cases that the quartz wavelength is expressed in millimeters.

Although frequency is now used more than wavelength as a measure of radio waves, the wave constant expression in

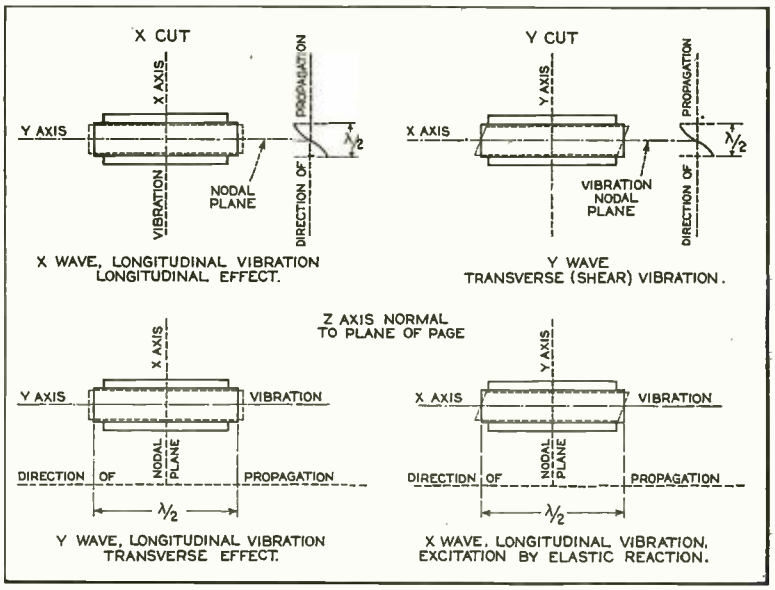

Fig. 1. Quartz oscillator data.

terms of wavelength is often more convenient to use than the equivalent frequency constant, owing to the direct relation between dimension and wavelength. Where it is necessary to plot graphically, the inverse dimension-frequency relation would be difficult to handle. In other respects, however, an expression in terms of kilocycles and inches is obviously more convenient to work with. The resulting figure is of the same order as the meters-per-millimeter figures, and introduces no difficulty in handling. The wave constant expressed in these terms might be referred to as the "kilocycle-inches," since it is the product of these factors. It is also equal in numerical value to one-half the velocity of supersonic sound waves in quartz along the axis concerned, when the velocity is expressed in inches $\times 10^{-3}$ (since the unit of frequency in this case is 10^3 cycles).

To obtain kilocycle-inches from meters-per-millimeter it is necessary to divide 299,820 by the latter, and the result by 25.4. It is convenient to think of the numerical value of the kilocycle-inches as the frequency for a one-inch dimension, since $f = h/\text{inches}$, and $\text{inches} = h/f$, where $h = kc. \times \text{inches}$.

Wave Constant Variations

Quartz plates of exactly the same dimensions and apparently of the same cut do not all have exactly the same frequency. Assuming that the natural crystal is untwinned and otherwise free from defects, this variation in wave constant is due largely to deviation from accurate orientation of the cut. It is difficult to cut the quartz accurately, as well as to locate the axes precisely, so these deviations can be controlled only to a limited extent. The axes can be most accurately located electrically.[2] Even if this cause were eliminated, it is likely that some variation would remain, as marked variations in the quartz constants have been observed. These are ascribed to molecular asymmetry.

Wave constant variations in plates of the same dimensions are small as compared with those encountered in plates of varying dimensions, even when one dimension is the same. Each mode exhibits a different degree of variation. Here the largest factor is the ratio between the frequency of the mode being considered and that of the other modes of the plate, especially when the latter are excited by elastic reaction from the former. When, as is usually the case, the fundamental modes which are so excited are lower in frequency than the directly excited mode, a higher order mode is excited simultaneously with the latter whenever the dimensional ratio is such that their respective frequencies are in the neighborhood of coincidence. The higher order modes are not necessarily in exact integral multiple relation to the low-frequency fundamental mode, and so are overtone rather than harmonic modes. The deviation is usually small.

Inter-mode Coupling

If the frequency of one of these overtone modes is increased toward the high-frequency fundamental by grinding off the low-frequency dimension involved, the frequency of this fundamental and hence its wave constant (since its dimension is unchanged) will increase. The increase is such that the two frequencies remain approximately the same distance apart; i. e., the fundamental increases in frequency at the same rate as the overtone. After an interval which varies somewhat with the order of the overtone, the fundamental abruptly ceases to exist. Up to this point, the strength of the overtone had been approaching that of the fundamental, by virtue of reaction from the latter, and the overtone now becomes the fundamental. As the low-frequency dimension is further reduced, the process is repeated with the next lower overtone, and so on, to and including the low-frequency fundamental. The high-frequency wave constant is thus seen to vary with the dimensional ratio of the plate, the amount of variation being an inverse function of the order of the overtone involved.

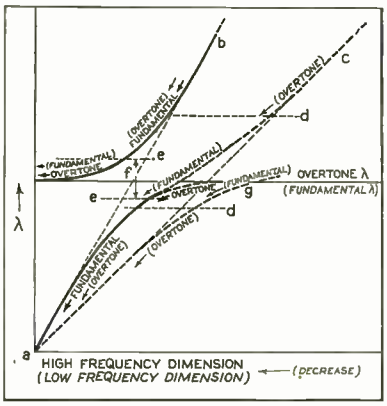

Fig. 2. d=approximate points beyond which overtone is not sustained, as l-f. dimension is reduced. e=points at which fundamental ceases and reappears as h-f. dimension is reduced. f=range into which fundamental cannot be ground without changing l-f. dimension.

When not in the neighborhood of the high-frequency fundamental, the higher order overtones will not usually be sustained without increased regeneration in the oscillator. As the fundamental is approached the overtone may seem to appear suddenly as a second fundamental, when strengthened sufficiently by reaction. Similarly, the apparent disappearance of the fundamental takes place because actually it has become the overtone, which has fallen off in strength and is no longer sustained in oscillation by the existing regeneration.

On the other hand, if the high-frequency dimension is being ground off, as its fundamental approaches an overtone, the frequency of the latter increases. Shortly thereafter, the fundamental, having become the overtone, is no longer sustained, while the new fundamental increases in frequency with the wave constant value it had previously. This transition from fundamental into overtone, and overtone into fundamental, leaves a range of frequency in the neighborhood of each overtone into which the fundamental cannot be ground. It is necessary to place the overtones, by suitably proportioning the low-frequency dimension involved, so that the desired high-frequency fundamental does not fall in one of these ranges.

As the high-frequency fundamental is made to approach an overtone, the strengthening of the latter will serve as a warning that the transition is about to take place. The low-frequency dimension may then be ground off, increasing the frequency of the overtone, and thus allowing the high-frequency fundamental to be further increased. It will therefore be unnecessary to predetermine the overtone frequencies if their appearance is carefully observed during the grinding process. Furthermore, since the fundamental increases in frequency as an overtone approaches it, if not too far, its frequency can be brought to the desired final value by grinding the low-frequency dimension, without bringing the next lower overtone close enough to be sustained.

This interaction between resonant vibrations in quartz is the same as that occurring in coupled electric circuits.[3] The low-frequency fundamental and its overtones are equivalent to a series of parallel resonant circuits coupled to one of the high-frequency, the coupling decreasing as the order of the overtone increases. The heavy line curves of Fig. 2 represent the wavelengths of two closely coupled circuits in function of a linear wavelength variable of one circuit. These curves are applied to the quartz oscillator, the high-frequency fundamental and one overtone of a low-frequency mode being plotted against either of two dimensions as indicated. When the low-frequency dimension is the independent variable, the slope of the line a-b is inversely proportional to the order of the overtone, as at a-c.

If the difference between the high- and low-frequency fundamentals is large; i. e., when the overtones in the neighborhood of the former are close together, reaction from two overtones exists simultaneously. When the dif-

[2] *Dawson, Physical Review, 29, 532. Apr. 1927.*

ference between the fundamentals is small, although the overtones are farther apart, the reaction is stronger than in the former case and also exists simultaneously from two overtones when the fundamental is halfway between them. As a result, the fundamental does not remain constant for an interval between overtones, but varies continually as the low-frequency dimension is reduced, as may be seen in Fig. 2.

From the foregoing it is evident that a statement of wave constant without a specification of dimensional or frequency ratios will be subject to wide variation. It is necessary to determine standard ratios of frequency, one for each overtone, at which the wave constant will have the same value. These ratios will not be integral, nor will they be directly proportional to the order of the overtone. The form "n + kf" will be necessary where n is the order of the lower adjacent overtone, f the low-frequency fundamental (or interval between overtones, approximately) and k a constant which takes account of the deviation of the overtone from harmonic relation, and determines the interval after the overtone at which the wave constant is independent of n. k will vary with n, and probably with other factors which may affect the deviation of the overtone from harmonic relation. Unfortunately, experimental data is too meager at present to allow a tabulation of the values of k.

Occurrence in Practice

Inter-mode coupling is most pronounced in Y cut plates, between the Y wave and the elastically excited X wave. The accentuated overtone, or double fundamental, is still strong in plates of Y wave fundamental at least as high as 4,400 kc., where the overtone was in the neighborhood of the thirty-second harmonic of the X wave fundamental. The accentuated overtone and the Y wave fundamental remained approximately 30-50 kc. apart. What appeared to be coupling from a high order flexural mode has been observed in Y cut plates of lower Y wave frequency.[3]

By taking advantage of the opposite signs of the temperature coefficients of the Y wave and X wave, in Y cut plates, it has been possible to produce plates having practically zero temperature coefficients by suitably proportioning the frequency ratio.[3]

Double fundamentals have been observed in X cut plates, but with greater separation than could satisfactorily be accounted for by the accentuated overtone phenomenon. The separation is usually of the order of 300-700 kc., in plates of X wave fundamental 4,000 kc., while the Y and Z wave fundamentals are around 100 kc., which would place several overtones in the interval between the two high-frequency fundamentals.

Moreover, the frequencies of the latter are unaffected by reducing the low-frequency dimension, only the strength varying, and oscillation of one or the other stopping entirely at intervals. There is some evidence that this occurs at coincidence between overtones of either low-frequency mode and the high-frequency fundamentals. The lower of the high-frequency fundamentals has a wave constant around 97, while the higher is usually somewhat above the normal maximum of 114.6; around 116. The Y wave is nearer 90, considerably below the usual minimum, while the Z is within the normal range. This indicates a deviation from the true X cut. perhaps with respect to the Z axis. No proof is available at present. The two fundamentals may be of equal strength, and as strong as the single fundamental of a normal plate. Both may also be weak if overtones are in the neighborhood of both simultaneously. There is evidence of a reaction on the Z wave fundamental sufficient to stop oscillation. The two fundamentals have been observed in plates of higher X wave fundamental as high as 7,000 kc.

Average Wave Constants

The wave constants in the accompanying table are averages of plates of random dimensional ratios, and include the averages of most of the investigators in the field. The plus and minus figures are the normal extremes encountered in each type. Inaccurate orientation of the X cut lowers the wave constant, while the reverse is true of the Y cut. It will be noted that in several cases the larger deviations are in a direction which supports the probability of inaccurate orientation.

X cut circular plates show considerably less variation than rectangular plates for all three modes. The unity ratio of y and z dimensions is probably the main factor. This is especially true in the case of the Z wave, where the difference in the deviations for the two shapes is very large. Here inter-mode coupling between Y and Z waves is responsible, the Z wave being excited by elastic reaction. The deviation of the Y wave is similarly affected, but to a smaller extent. The average for circular plates is less than for rectangular, as perhaps might be expected, since the y dimension in the circular plate has an infinite number of values between zero and the maximum. As a result, the average wave constant probably represents the average of this range of dimensions, and not the diameter, or maximum dimension, on which it is based. This evidently does not apply to the Z wave. where even the maximum for rectangular plates is considerably less than the minimum for circular. With square plates in which the directions of Y and Z axes are unknown, the Z wave will be indistinguishable from the Y unless it has a wave constant above the maximum of the Y. In circular plates the wave constants of all three modes are well separated.

QUARTZ OSCILLATOR WAVE CONSTANTS
(KILOCYCLE - INCHES)

X CUT — TEMPERATURE COEFFICIENTS −10 TO −35 IN 10^6		
SHAPE →	CIRCULAR	RECTANGULAR
X WAVE	112.9 $^{+1.06\%}_{-.62\%}$ (114.1) (112.2)	112.9 $^{+1.5\%}_{-2.39\%}$ (114.6) (110.2)
Y WAVE	106.8 $^{+.56\%}_{-.56\%}$ (107.4) (106.2)	108.0 $^{+8.24\%}_{-7.4\%}$ (116.9) (100)
Z WAVE	150.8 $^{+.597\%}_{-.73\%}$ (151.7) (149.7)	116.9 $^{+14.1\%}_{-12.5\%}$ (133.4) (104.4)
Y CUT		
Y WAVE	RECTANGULAR OR CIRCULAR 77.16 $^{+17.7\%}_{-12.64\%}$ (90.8) (67.4)	TEMPERATURE COEFFICIENTS −20 TO +100 IN 10^6
X WAVE	112.9 ---------- ----------	−10 TO −35 IN 10^6

Fig. 3.

The elasticity of quartz has been considered the same for all directions in the X-Y plane, but the X wave shows an average wave constant somewhat above that of the Y wave, which agrees closely with the value calculated from the elasticity. The maximum of the Y wave is, however, above that of the X wave.

As compared with other modes, the variation in the X wave would seem too small for any inter-mode coupling to be present; but when a number of circular X cut plates of exactly the same dimensions were prepared, a considerable reduction in the wave constant variation resulted. Each plate was cut from a different natural crystal, so that the remaining variation of plus .13 per cent. and minus .53 per cent. can be considered as due entirely to deviation in orientation and variation in the quartz itself. The largest variation is here again in the direction which would result from inaccurate orientation. This case forms an interesting example of how small a variation can be obtained under practical conditions. This reduction in variation from that in plates of different dimensional ratios indicates that at least some dimensional effects exist for the X wave.

Turning now to the Y cut plates, it is seen that the variation for the Y wave is larger than for any other mode, as could be expected from the pronounced inter-mode coupling which exists. However, the majority of plates have wave constants close to the average, as the ranges of dimensional ratios which give the extreme values are relatively narrow. The curve of Y wave frequency in function of the x dimension decreases somewhat in slope half-

[3] *Lack, Proc. I.R.E.*, 17, 1123. *July* 1929.

way between the higher overtones, as at g in Fig. 2, so that the wave constants near the average occur in a wider range. Having a lower wave constant than any other mode, the Y wave is not suitable for frequencies much above 5,000 kc., as the plate becomes too fragile. At low frequencies the low wave constant becomes advantageous, giving a lower frequency for a given amount of quartz. This in turn permits better excitation by increasing the capacity between electrodes. The Y cut Y wave is the only mode which can be used when the temperature coefficient is to be minimized, as it is the only one having a coefficient with a normally positive sign.

The X wave in Y cut plates exhibits the same characteristics as in X cut plates, but no data are available on the wave constant variation, nor on the wave constant for circular plates. No data on a Z wave in Y cut plates are available.

Practical Application

Where the variation is large, the wave constant is useful only as an aid in identifying the mode. In those cases where it is normally small, or if it is kept small by using fixed dimensional ratios, the rapid preparation of plates of similar frequencies will be facilitated by the possibility of pre-determining the finished dimension with better accuracy. For high frequencies, circular X cut plates are easiest to produce, the wave constant variation being small, and the plates easily cut from the slabs taken from the natural crystal by means of a revolving tube fed with the abrasive. The high wave constant of the X cut makes possible frequencies around 7,000 kc. without too fragile a plate. When these thin plates are operated at high amplitudes of vibration, however, a large temperature rise occurs which makes the use of thermostat control imperative. The frequency change which results from the rise in temperature is much greater than that which occurs when the same frequency is obtained by multiplication, from a plate of lower frequency operating at the same amplitude.

There is some evidence of an increased tendency toward chipping of the edges in circular plates when operated at high amplitudes, and rectangular plates are preferred in most cases where any amount of power is to be controlled. Circular plates are, of course, unsuitable for the X cut Y and Z waves, and Y cut X wave, if the frequency is to be adjusted. Also, it is well known that the strength of response is to a large extent an inverse function of the amount of variation in dimension, notably of the thickness in the X cut X wave, and Y cut Y wave. For the X cut Y and Z waves, and Y cut X wave, the dimension in circular plates varies between zero and the diameter. Circular plates should not be used for these modes when a strong response is desired.

The Z wave can be used to advantage where two low-frequencies are desired in a single plate. The wave constant for circular plates is higher than for any other mode, but cannot be taken advantage of for intermediate frequencies, as the diameter of the plate would become too small. However, the maximum wave constant in rectangular plates is also higher than in other modes. If the Y / Z frequency ratio is adjusted to obtain this high wave constant, a wider plate can be had in the range of intermediate frequencies where the Y cut Y wave gives too thick a plate, than can be had with the Y wave and a long z dimension. For low frequencies the Z wave has no advantage, since it requires more quartz than is necessary for the same frequency with the Y wave.

Changes in frequency with temperature and air gap (which cause an apparent change in wave constant) are quite negligible in comparison with the variation in wave constant from other sources. The maximum temperature coefficient ordinarily encountered is not much above .01 per cent. per degree Centigrade. The change resulting from increasing the air gap from zero to one wavelength of supersonic sound in air is of the order of .1 per cent. Other changes arising from variation in shunt capacity across the electrodes and oscillator circuit elements are smaller.

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NEW INVENTIONS

Selenium Cells

USE of plates of metal not influenced by selenium solutions (ex.: platinum, nickel, brass) and of plates influenced by selenium solutions (ex.: copper, silver, gold). *"Selenophon" Licht und Tonbildgesellschaft. French Patent* 689,585. *Appl. (Austria) February* 9, 1929. *Appl. (France) February* 7, 1930. *Issued: September* 9, 1930.

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Electric Discharge Devices—Vacuum Tubes

ELECTRON emitting cathodes for electric discharge devices are prepared by coating a refractory core or an oxide-coated filament with a substance which, on heating in the absence of appreciable oxygen, leaves a residue containing the oxide of an electron-emitting metal and free carbon. The tartrates of the alkali or alkaline earth metals, for example caesium tartrate or barium tartrate, may be used as coating-substances which are applied either to a refractory core such as tungsten, platinum, or nickel or its alloys, or to an oxide coated filament comprising a refractory core coated with barium oxide which may contain free barium. *Gramophone Co. Ltd. and Baker, G. B. British Patent* 339,451. *Appl. November* 14, 1929. *Issued: January* 28, 1931.

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Improvements Relating to Magnets

MAGNET systems comprising laminated pole pieces traversed both by a constant and by an alternating flux, for use in relays, telephones, loudspeakers, etc. The pole pieces are built up of at least two kinds of laminations having different magnetic properties, viz., one type having a constant flux permeability and the other an alternating flux permeabality, the magnetic characters being so chosen that for a given field strength the product of field strength, constant flux permeability and alternating flux permeability has the highest value. Both types of laminations consist of nickel-iron alloy containing more than 40 per cent. of nickel, differently treated to produce variation of magnetic properties. *N. V. Phillips Gloeilampenfabrieken. British Patent* 343,908. *Appl. (Holland) November* 13, 1928. *Appl. (Great Britain) November* 11, 1929. *Issued: February* 11, 1931.

Use of a vacuum tube operated relay to control blasting in radio receivers

By Bernard Ephraim

THE variations in grid voltage produced by received signals cause variations of the plate current above and below a constant mean value. This constant mean value is the direct-current component. If the tube is operated on the straight of its characteristic curve, the plate current increases just as much above the mean value as it decreases below that value, and the positive and negative amplitudes are equal, so that the average value of the plate current remains constant. This is shown at A in Fig. 1. If, however, the action takes place at the lower bend of the curve, the increase above the average value is greater than the decrease below that value, the positive amplitude is greater than the negative amplitude, so that while impulses are coming in there is an increase in the average of plate current. This is shown at B in Fig. 1. Whether the tube operates on the straight portion or at the bend of the curve depends on the plate and grid voltages, so that it is a simple matter to adjust the action of the tube to correspond to the desired part or portion of the curve. The plate current surge can be made to operate a relay and thus stop blasting, the relay shunting a resistance across the grid of the last tube to the ground or to the negative filament. The relay can be adjusted so that it will operate on a surge of 1 milliampere above the average value.

It would be possible to adjust the grid voltages of the last low-frequency tube of the receiver so as to cause it to act on the lower bend of the curve and so use the plate current surge to operate the relay. This would not be desirable, however, since it would mean distortion in the output. An amplifier tube should not work on the straight portion of its curve. So solving this difficulty is accomplished by simply connecting another tube after the manner of a vacuum tube voltmeter across the secondary of the last low-frequency transformer. This is called the operating tube. As the operating tube is not in the receiver circuit its action is placed at the lower bend of the curve or its curve without introducing distortion in the receiver output. Fig. 2 shows the relation of the operating tube to the last low-frequency stage.

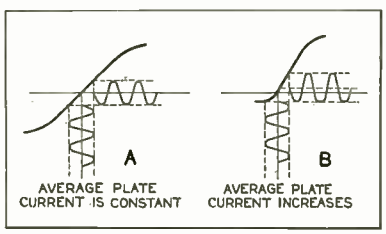


Fig. 1.

It is possible to bias the last low-frequency tube and the operating tube so that one will act on the bend of its curve and the other on the straight portion.

Let EB1 be the voltage of battery B1; EB2 the voltage of battery B2; ES the voltage impressed on the transformer secondary by the two batteries; EG1 the voltage impressed on the grid of the amplifier tube and EG2 the voltage impressed on the grid of the operating tube. ES is common to the two circuits. We therefore have the following relations (Fig. 2):

$$EB1=EG1+ES$$
$$EB2=EG2+ES$$

eliminating,

$$EB1-EB2=EG1-EG2$$

when E=voltages.

By operating the tubes EB1 and EB2 the difference can be made between EG1 and EG2, whatever it is desired to choose. Practically, one cannot connect a milliameter in the plate circuit of each tube and adjust the grid voltages so that one will get a surge in the plate circuit of the operating tube and no surge in the circuit of the amplifier.

Since the grid current of a tube with a negative bias is practically zero, the operating tube takes no energy from the receiving circuit. The only effect of the operating tube on the receiver circuit is that of grid voltage. The grid voltage of the amplifier is not that of its own grid battery but depends on the voltages of the two batteries as has been shown. This does not matter, however, since by adjusting the two batteries we can make the grid voltage of the amplifier whatever we choose. It is therefore possible to secure a plate current surge without introducing distortion in the output of the receiver. There is distortion in the output of the operating tube which is of course the place where it is wanted.

The output of the operating tube may be if necessary amplified to secure a greater plate current surge. The writer has found that a CX340 tube has about the proper characteristics to work efficiently on plate current surges of ½ to 3 milliamperes. By the method described advantage may be taken of both voltage oscillations and plate current surges. The voltage oscillations across the transformer secondary act on the grid of the operating tube and the plate current surges occurring in the operating circuit where they do not affect the quality of the receiver output.

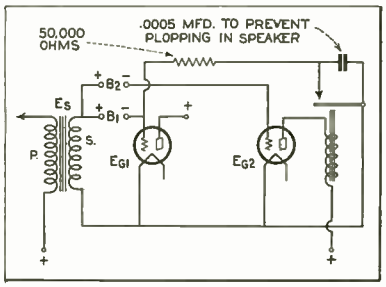


Fig. 2.

In the relay of the magnetic type, as used by the writer, the armature can be caused to operate on a surge of 1 to 3 milliamperes and as low as 200 microamperes. A surge of any preset value with the limits just stated causes a high resistance to be shunted across the grid and filament of the last low-frequency stage of amplification, thereby modulating the amplification of the last stage. A switch of the anti-capacity type is mounted on front of the receiver and takes care both of the DX and local sensitivity of the receiver, but in this case the switch when thrown to DX automatically cuts in the automatic blast control.

The information herein may be put to use to do a host of operations wherever surges of plate current may be made to operate relays to control electrical systems or radio devices.

Radio patent pooling

IN AN effort to develop a fair and equitable solution of the important patent problem in the radio industry, the Radio Manufacturers Association, embracing virtually all prominent manufacturers, has decided to intervene actively in present negotiations toward establishment of a radio patent pool.

According to an announcement by J. Clarke Coit of Chicago, president of the RMA, the Board of Directors of the manufacturers' national organization, meeting July 30 at Niagara Falls, Canada, decided formally to take part in negotiations between the U. S. Department of Justice and the Radio Corporation of America regarding the possible founding of a radio patent pool for the interchange between radio manufacturers of patent privileges.

The patent problem is one of long standing and far reaching effect, upon every radio manufacturer, inventor and the public, it was stated by President Coit. It is felt by the Association's Board of Directors that every manufacturer, large and small, has vital interests at stake in the patent negotiations. Because of the large interests of all radio manufacturers in the outcome of the negotiations between the Department of Justice and the Radio Corporation of America, it was determined by the RMA Board of Directors to enter the negotiations, secure all possible information, data and views of all interests concerned, and assist in developing, if possible, a solution of the patent problems which may be acceptable and equitable to every interest.

President Colt was authorized to appoint a committee or committees to represent the RMA in conferences with various groups of manufacturers and with officials of the Department of Justice and the Radio Corporation of America. Mr. Coit will call meetings soon of various manufacturing groups involved, including the set manufacturers, the tube manufacturers, the speaker and amplifier, and other group interests. The RMA committee or committees will confer with the various groups in an effort to work out some patent plan which may prove acceptable to them and to the government and also the Radio Corporation of America. Plans of the manufacturers' committees will be submitted later to the RMA Board of Directors for approval and subsequently to the Department of Justice.

In the membership of the RMA there are now 34 receiving set manufacturers and a dozen tube manufacturers who are licensees of the Radio Corporation of America and also several other manufacturers without licenses, indicating in part the important interests of other manufacturers in the outcome of the patent pool negotiations. The proposed meetings of the receiving set, tube and other groups with the RMA committees will be held between now and September when, according to official announcement of the Department of Justice, the government negotiations on patent pooling with the Radio Corporation of America will be resumed. By this time it is hoped that some workable patent plan may be evolved through the RMA which will protect the public's interest and also that of all manufacturers and inventors and be acceptable to the government, stabilizing the radio industry, so far as patent problems are concerned, as are the automotive and aircraft industries.

In the discussions of the RMA directors there were wide differences of opinion regarding the possibility or advisability of pooling radio patents, because of the thousands of patents involved and their distribution, but vigorous efforts will be made to solve the patent problem somehow, through an equitable patent pool or otherwise.

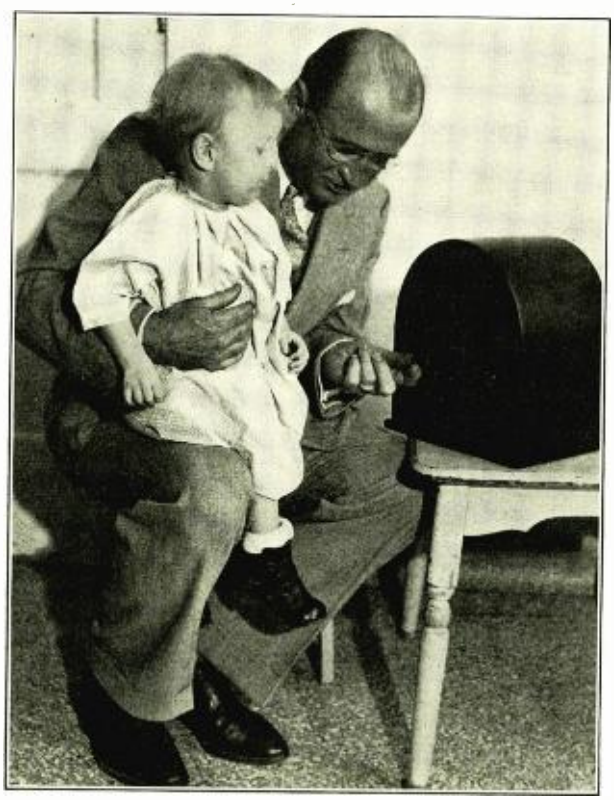
With reference to the patent litigation and the series of conferences recently held in Washington under the auspices of the Department of Justice, a statement issued by the Department reads:

"It was stated that conferences have been going on for some time between the Department of Justice and the principal defendants in the anti-trust suit brought by the Government against the Radio Corporation of America, General Electric Company, Westinghouse Electric & Manufacturing Company, American Telephone & Telegraph Company and certain other companies.

"The Radio Corporation of America was originally formed by the General Electric Company to acquire the American Marconi Company, which was a British-owned company, owned the Marconi patents and was the principal factor in the wireless communication field in America. In the view of the Department there was nothing illegal in this, but almost immediately upon the formation of the Radio Corporation there began the making of a series of contracts between the defendants as to the use by them of their respective patents in the radio and allied fields.

"In the view of the Department, these agreements in a number of their important provisions were illegal as designed to prevent and suppress competition between the parties. . . ."

The R.M.A. is sure to play an important part in the impending negotiations dealing with patent pooling.



J. Clarke Coit, president of the R. M. A., is shown tuning in on one of three Metropolitan midget radios he presented to the Fresh Air Sanitarium in Lincoln Park, Chicago.

Synchronization of Westinghouse Radio Stations WBZ and WBZA ‡

By S. D. Gregory*

RADIO Station WBZ was installed on the roof of the Westinghouse plant in East Springfield, Massachusetts, in September, 1921. It was the first radio station in the United States to be granted a license exclusively for broadcasting, although Westinghouse Station KDKA had been operating a radio telephone transmitter since October, 1920, under a special authorization. WBZ's original license specified an operating wavelength of 360 meters and a power output of 1,500 watts—a comparatively high power for those days.

The studio for WBZ was located in Springfield and depended entirely upon local talent for program material. It was soon evident that those facilities were inadequate and a studio was installed in Boston, where a much more diversified array of talent was available. The new studio proved a boon to the listeners in and around Springfield, but at the same time it created an embarrassing condition in Boston. Signals from the East Springfield transmitter were not heard in that area at all well and the artists complained that their friends could not hear them broadcast.

In order to make the programs from WBZ available to the listeners in Boston it was decided to build a second station there. The new transmitter was installed in the Brunswick Hotel, where the Boston studio was located, and was first put in operation in November, 1924, under the call letters WBZA. It was a self-excited set, operating on 242 meters, with a power output of 250 watts, and, although it was a makeshift affair at the best, it remedied the situation in Boston.

‡*Delivered before the Radio Club of America, June 10, 1931.*

**Radio Engineer, Radio Operations Department, Westinghouse Electric and Manufacturing Company.*

Historical

An interesting fact in connection with WBZA is that it was the first broadcasting station to use a piezoelectric oscillator for controlling its frequency. This apparatus was first installed in March, 1925, and similar equipment was placed in service at WBZ shortly after.

During the following months the first attempts to operate both WBZ and WBZA on the same frequency (900 kilocycles) were made, using crystals ground to zero beat. The results were far from satisfactory, due primarily to the fact that no precautions were taken to keep either the supply voltages or the crystal oscillator temperature constant. The listeners in the suburbs of Boston were troubled with a heterodyne of varying frequency when both stations were operating. After a short trial the two stations went back to their original setups, carrying the same program on separate frequencies.

In April, 1926, true synchronization of the two stations was attempted. The land wire which ordinarily carried the program between Springfield and Boston was used to transmit the synchronizing frequency as well. In order to keep the number of frequency multiplier stages at a minimum, fifty kilocycles was chosen as the carrier frequency for the first trials. The line used was an ordinary telegraph circuit consisting of open wire with the exception of a two-mile section of cable and twisted pair at Worcester, and another fifteen-mile section of cable at the Boston end.

A schematic diagram of the original frequency multiplying equipment used at the two stations is shown in Fig. 1. At WBZ the 50-kilocycle piezo oscillator excited both the first harmonic amplifier and the line amplifier. At that time buffer amplifiers were unheard of. The harmonic amplifiers, of which there were three, utilized the second or third harmonic in each case, the frequencies used being 50 kilocycles, 150 kilocycles, 450 kilocycles, and 900 kilocycles. Two hundred fifty watt tubes were used in the harmonic amplifiers and a 250-watt power amplifier stage at 900 kilocycles excited the output stage. The 250-watt line amplifier supplied about 125 watts of 50 kilocycles energy to the line. The transmitter at WBZA was similar to the one at East Springfield, except that it used 50-watt tubes in the harmonic amplifiers and had a power output of 250 watts.

In spite of all the precautions taken to insure good transmission, in foggy or rainy weather the incoming 50 kilocycles at Boston invariably dropped off to below a useable level. At first the source of trouble was thought to be the section of cable and twisted pair at Worcester, but measurements of the synchronizing frequency at that point showed the same wet weather characteristics as at the Boston end. After making a thorough investigation it was

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This interesting article tells the story of the Westinghouse Company's attack upon the problem of synchronizing two broadcast transmitters situated in separate localities. Further simplification of amount of equipment employed and tubes used is in prospect.

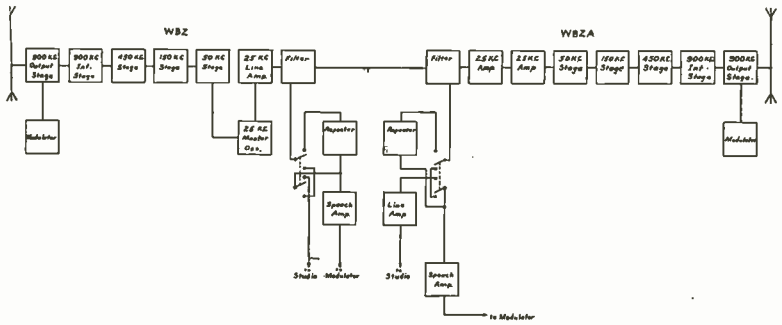

Fig. 1. Original Frequency Multiplying Equipment.

decided that the transmission frequency was too high. When the crossarms became wet the metal insulator pins were connected together by a high resistance path, and the water on the insulators greatly increased the capacity from line to pins. The resulting increase in charging current caused a corresponding increase in power loss along the line and accounted for the higher attenuation during damp weather.

The frequency was lowered to 25 kilocycles and an additional multiplier stage was added at both stations. At that time there were no 25-kilocycle crystals available, so a stable master oscillator was built, using a UX-210 tube. On May 20, 1926, the new synchronizing setup was tried out and the results were encouraging. Tests were continued until July 5, 1926, at which time the two stations commenced synchronous operation on regular schedules.

Brunswick Hotel Station

The setup just described was operated for more than a year with only minor changes. Very little difficulty was had with the synchronizing apparatus; what trouble occurred was due largely to the fact that the grounding system at the Brunswick Hotel was unsatisfactory, the building being of frame construction. As it was impossible to remedy this difficulty, arrangements were made to move to the top floor of the Statler Hotel. A complete new transmitter was constructed and was placed in operation in June, 1927. The new set differed from the Brunswick transmitter chiefly along constructional lines, the electrical details being substantially the same. Improved filters were installed for separating the radio and audio at the Boston terminal of the synchronizing line.

At several times during the transition period three transmitters—WBZ at East Springfield, and the old and new WBZA outfits at Boston—were successfully operated in synchronism—the first time that this had been done in this country. The new transmitter put a much stronger signal into Boston, due to the improved antenna system, to an increase in power to 500 watts and to the higher percentage of modulation of which it was capable. A few months later similar multiplier and low-power amplifier stages were built for WBZ. Both of the new transmitters gave satisfactory service and were operated for more than two years with no major changes in equipment.

On November 11, 1928, the new allocation plan for the broadcast spectrum went into effect and the frequency of Stations WBZ and WBZA was changed to 990 kilocycles. Shortly after the change was made listeners began to complain about interference from harmonics from WBZ. These harmonics were in reality combinations of the various multiplier frequencies resulting in modulated radiations within the broadcast band. Previous to the reallocation, these radiations happened to fall on broadcast channels in which reception was already ruined by cross-talk and heterodyning. The use of 990 kilocycles shifted the interference to frequencies occupied by cleared channel stations, and listeners immediately registered protests. A readjustment of the harmonic amplifiers helped the situation temporarily and new equipment, which will be described shortly, gave permanent relief.

Another effect of the frequency change was a marked decrease in signal from the two stations around the outer edge of their service areas. Even the comparatively small increase of ninety kilocycles was enough to cause a noticeably higher attenuation.

Frequency Multiplying Equipment

In December, 1929, improved frequency multiplying equipment was installed at WBZA, using UX-210 tubes in place of the larger power tubes. Three of the multiplier stages were replaced by a multivibrator, operating from 55 kilocycles to 990 kilocycles. As an additional precaution against the radiation of any harmonic frequencies a crystal filter was installed between the multivibrator and the 990-kilocycle power amplifiers.

The multivibrator setup proved satisfactory and a few months later similar equipment was installed at WBZ. That is, the construction of the apparatus was the same, but the multivibrators, of which there were two, were used as frequency dividers. The WBZ transmitter operated from a 990-kilocycle crystal the same as a conventional broadcast installation. The crystal oscillator output was also used to excite a multivibrator, which divided the frequency to 165 kilocycles. The second multivibrator further divided the frequency to 27.5 kilocycles, which was fed to the synchronizing line through a power amplifier consisting of four UV-845 tubes in parallel. Parallel operation of this type of tube effected a very efficient transfer of energy to the line. Suitable filter systems were used to keep the synchronizing tone from feeding back into the audio system and the audio from getting into the multivibrators. A schematic diagram showing the multivibrator equipment and associated apparatus at both stations is shown in Fig. 2. As mentioned before, this new equipment remedied the interference caused by unwanted radiations.

Receiver Distribution

Although the synchronized operation of WBZ and WBZA gave satisfactory program service to Boston and Springfield, it was rather an illogical arrangement as the 15-kw. transmitter was located in the smaller of the two cities and the 500-watt set in the larger. On the other hand, it was not desirable to locate a powerful transmitter within the limits of a large city. Inasmuch as a large part of the population of the New England States is concentrated in the three cities of Boston, Providence and Worcester, it was decided to build a new station in some location which would adequately serve those cities and to move the WBZA transmitter to East Springfield to serve that area. After careful investigation as to elevation, accessibility to power and telephone lines, type of soil, etc., a location on Dover Road about two miles northeast of Millis, Massachusetts, was tentatively chosen for the new station. A 500-watt test transmitter was set up and several weeks were spent in taking field strength measurements, using a portable checking set installed in a light truck. The three cities mentioned before were thoroughly covered in the survey, and, in addition, readings were taken along six radials in order that field intensity contours could be plotted. Data was available from which the probable output in meter amperes of the proposed 15-kw. transmitter could be calculated, and a comparison of that value with the meter ampere output of the test transmitter

gave the approximate coverage to be expected from the new station. As the three cities in question fell within the calculated good service area the Millis location was definitely decided upon and construction work was started immediately.

As the transmitter which was installed is an RCA coordinated set, Model 50-B, a detailed description is hardly necessary. Kaar and Burnside covered this type of transmitter in their paper, "Some Developments in Broadcast Transmitters," published in the Proceedings of the I. R. E. for October, 1930. However, there are a few points which it might be well to mention.

The usual duplicate crystal control units are incorporated in the transmitter. Additional equipment was installed for synchronizing the two stations as before, a new type of frequency multiplier being used. Fig. 3 shows the details of the multiplying equipment and the method used for tying it in to the main transmitter. The apparatus is connected so that the Millis transmitter automatically changes to its own crystal oscillator in case the synchronizing tone from East Springfield drops below a certain level. When the leven returns to normal the station automatically changes back to synchronized operation. A sensitive relay operated by the grid current in a low-power 900-kilocycle saturated amplifier keeps the plate circuit of the crystal unit buffer stage open as long as the level of the synchronizing tone remains high enough to keep the grid current of the saturated amplifier above a certain value. Below that value the regular crystal unit functions normally and the relay opens the plate circuit of the saturated amplifier.

Apparatus Units

The synchronizing apparatus proper is located in the room which houses the station audio equipment. The incoming 27.5 kilocycle frequency passes through a band-pass filter which keeps the audio and any line interference from getting into the multiplying equipment. A two-stage 27.5 kilocycle amplifier feeds a coupling tube, the plate of which is connected to the tank circuit of a special 165-kilocycle oscillator. The second 27.5 kilocycle stage, operating saturated, takes care of any small variations in the level of the incoming 27.5 kilocycles. The coupling tube, having its grid excited strongly by 27.5 kilocycles, has a high percentage of harmonics in its output; consequently, the 165-kilocycle oscillator, oscillating at a frequency which is the sixth harmonic of 27.5 kilocycles, locks in step with the exciting frequency. The oscillator could be made to lock in at any harmonic frequency within certain limits, but 165 kilocycles was chosen in order to arrive at the operating frequency in two steps.

The output of the oscillator feeds through a coupling tube into a second oscillator operating under like conditions at the sixth harmonic of 165 kilocycles, thus producing the desired frequency, 990 kilocycles. The output of the second oscillator passes through a double crystal filter as shown in Fig 3 and into a two-stage power amplifier, which feeds a transmission line running to the saturated amplifier located on the crystal control panel of the main transmitter. The transmission line, which is about 100 feet in length, is rather novel in that it consists of low capacity twin conductor lead cable running through an iron conduit.

The Audio System

In the original synchronizing setup it was possible to feed programs either way between Springfield and Boston. The erection of the Millis station introduced a new problem as the transmitter is situated between the two cities in which the studios are located. The synchronizing line, which also carries the audio, was re-routed through Millis at the Boston end, the section between those two cities carrying program only. Fig. 4 shows the present audio layout.

Two bridging amplifiers are used in the line terminating equipment at Millis. The output of one feeds the transmitter, the other acts as a repeater and feeds audio to the studio which is not furnishing the program. That is, to Boston when the program originates in the Springfield studio, and vice versa. The switching of amplifiers and lines is done by relays controlled by the announcer at the Boston studio. In this way the switching takes place automatically as the program source is transferred from one city to the other. The line terminal and switching equipment, including amplifiers, volume indicators, relays and rectifiers is provided in duplicate, so

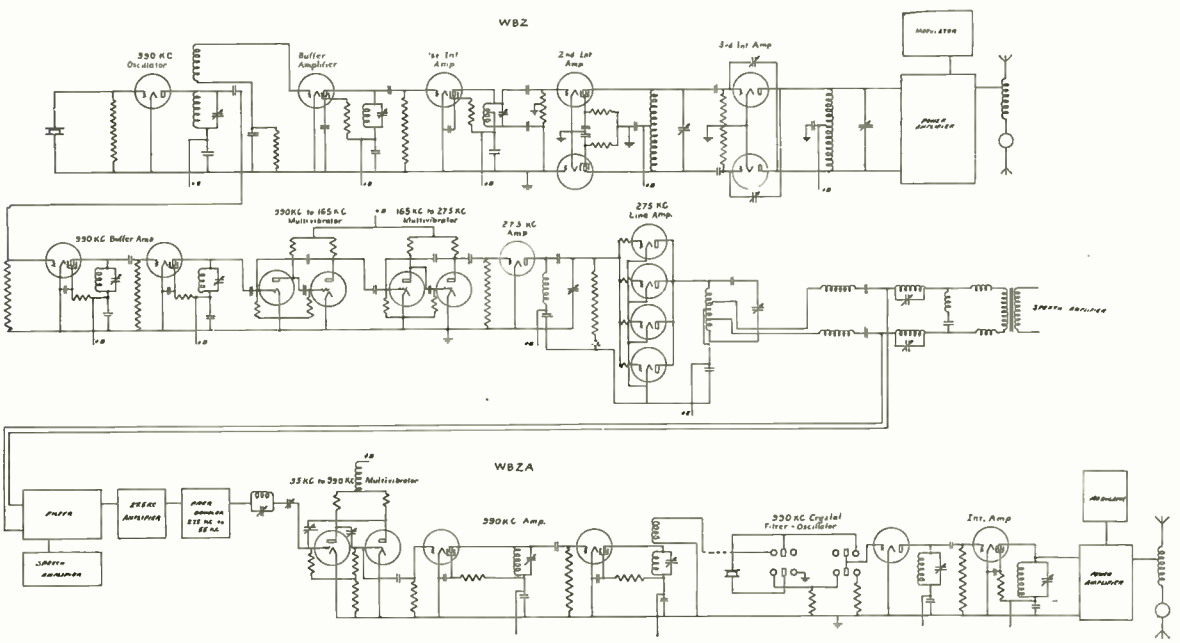

Fig. 2. Multivibrator Equipment and Associated Apparatus.

that in case of trouble the spare set may be used. The sub-harmonics of the synchronizing frequency are kept out of the audio equipment by means of low-pass filters which cut off at about 8,000 cycles.

Monitoring

Monitoring facilities are so arranged that the station operator can monitor the program on the line, at either stage of the speech amplifier, or, by means of a rectifier, at the output of the final radio-frequency power amplifier. A microphone control and amplifier are provided so that announcements can be made from the station during test work or in case of emergency. All amplifiers have separate rectifiers for plate supply, using 280 type tubes. Filament power for both the audio and synchronizing equipment is supplied from a 12-volt battery.

Low-level modulation is used, the last three power amplifier stages being operated as Class B amplifiers. The output stage has been modified to use six UV-207 tubes, three on a side, in place of two UV-862s, giving a maximum rated carrier power of 15 kilowatts. The transmitter is normally modulated 100 per cent, an oscillograph being used to check the modulation. The manufacturer's design specifications call for a frequency response flat within two decibels from 30 to 10,000 cycles, and within one decibel from 100 to 5,000 cycles.

Power is fed to the antenna over a two-wire transmission line terminated in a tuned tank circuit of the correct impedance to match the characteristic impedance of the line. The antenna is a vertical cage supported between two 300-foot insulated steel towers spaced about 700 ft. apart. Both a fan counterpoise and a buried wire ground are used, the combination of the two giving considerably better results than either one separately.

Important Developments

In reviewing the development of synchronizing of broadcasting stations as carried on by Westinghouse, it is evident that many problems have had to be worked out. A brief discussion of these might be of interest. Inasmuch as the backbone of any synchronizing system is the method or source of frequency control that subject will be discussed first.

The methods of control with which our engineers have experimented are master oscillator, piezo oscillator, and tuning-fork. As stated previously, a master oscillator was used for some time at Stations WBZ and WBZA. The circuit was a regular Hartley with a high-capacity tank, using a special Litz-wound inductance. It was found necessary to carefully filter the power supply in order to prevent the ripple from the filament machine from causing frequency modulation of the oscillator output. The frequency stability of the stations when operating from master oscillator control was well within the required limits. In fact, for several years WBZ was listed in the Radio Service Bulletin of the Department of Commerce as a constant frequency station.

Mention has already been made of the use of matched crystals for controlling the simultaneous operation of two stations. Westinghouse engineers gave the idea a trial in 1925, but the art of grinding crystals to narrow limits had not advanced enough to warrant further experimental work along that line. However, the use of a master piezo oscillator to control the synchronized operation of two or more stations has proven very successful so long as the usual precautions are taken against variations in temperature, load and supply voltages.

Crystal Filters

While we are on the subject of quartz crystals it might be in line to say a few words about crystal filters. Westinghouse engineers have been working on this problem for several years and were the first to make use of such a filter in connection with a radio transmitter. A crystal filter acts as extremely narrow band-pass and the use of two or more crystals in cascade results in practically a point-pass filter.

The use of a tuning-fork as the master control for synchronized operation was not found necessary at WBZ as the characteristics of the line between the two stations made possible the use of frequencies above the usual range of tuning-forks. However, in the experimental synchronization of KYW and KDKA in 1927 it was necessary to use a lower tie-in frequency and a tuning-fork was chosen as the logical source of control frequency. In that case a master fork operating at 5,000 cycles controlled the frequency of the KDKA transmitter through a system of harmonic amplifiers, and, in addition, was used to modulate a short-wave transmitter. At Chicago the short-wave signal was picked up and the 5-kilocycle tone was fed through a tuning-fork stabilizer into similar harmonic amplifiers. In case of fading of the short-wave signal the inertia effect of the stabilizer was sufficient to carry over until the end of the fade, then the incoming tone was automatically re-connected in the proper phase relation.

Another problem concerning which our engineers knew little when synchronizing was first attempted was the transmission of frequencies above the audio range over land wires. At the outset no extra precautions were taken

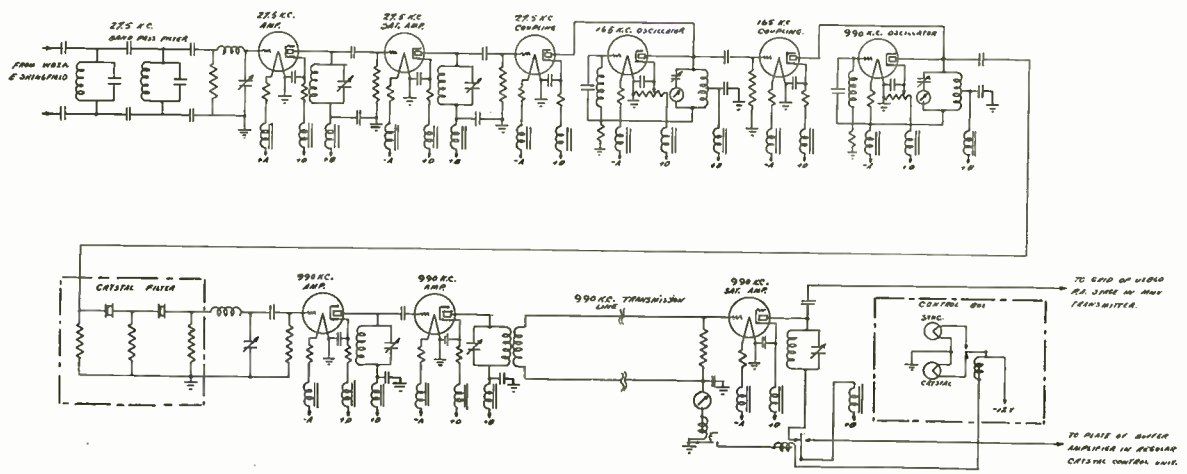

Fig. 3. Details of Multiplying Equipment, and Method of Tying it Into Main Transmitter.

to fit the lines for carrying the synchronizing frequency, but experience soon brought out the necessity of balancing the lines, using extra insulation, etc., in order to insure good transmission the year round. The problem was complicated in that the same line carried audio, telegraph, and telephone in addition to the tie-in frequency.

Over a long line such as the one between Boston and Springfield some difficulty due to electrical disturbances was to be expected. The trouble from that source proved to be slight, and has caused very little time off the air during almost five years of synchronized operation.

Synchronizing Systems

Continual research is being carried on in an effort to reduce the amount of equipment and number of tubes necessary for a synchronizing setup. To that end, several types of harmonic amplifiers, as well as the so-called multivibrator, has been experimented with. Each type of frequency multiplier or divider has its advantages and disadvantages, depending upon the conditions under which it is to operate and upon the order of harmonic or sub-harmonic necessary in order to arrive at the final frequency. If a comparatively low order of harmonic, such as the second or third, is desired the ordinary harmonic amplifier, in which a series of harmonics are produced in the output by strongly exciting a tube that is biased beyond cutoff, is to be recommended. Such an amplifier is also preferable from the standpoint of stability inasmuch as it does not require a regulated power supply.

The special harmonic controlled oscillator which has already been described in connection with the Millis station has the advantage of producing an output comparatively free from unwanted sidebands. If operated from regular power sources it can be used to obtain as high as the eighth harmonic.

A multivibrator such as shown in Fig. 2 has an output rich in harmonics due to the fact that the plate current of each tube goes from zero to saturation during alternate half cycles. The frequency at which the plate current changes is dependent on the time of charge and discharge of the coupling condensers through the bias resistors. Under ordinary conditions it will operate satisfactorily when using as high as the tenth harmonic and, with well regulated supply voltages, up to the fortieth can be used for special applications. The disadvantage in using multivibrators in a synchronizing setup is that they are easily affected by cross-talk. Either audio or modulated radio getting into them will cause frequency modulation in their output.

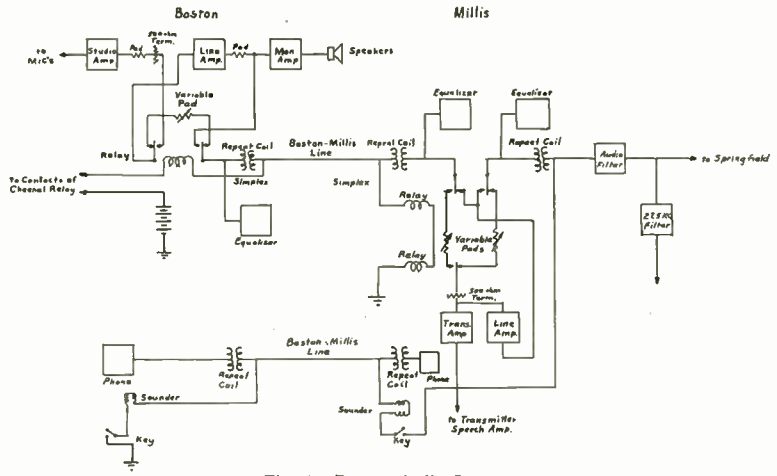

Fig. 4. Present Audio Layout.

The problem in connection with synchronizing which has been most widely discussed is the interference pattern which results when two broadcasting stations operate on the same frequency. In the case of Stations WBZ and WBZA, the bad quality area resulting from synchronized operation has been found to be quite limited and at no place within the service area of the two stations has the reception been poorer than it was found to be with either station alone. With the original synchronizing setup the area in question fell on the outskirts of Boston, between that city and Springfield, but very few complaints of poor reception in that area were received.

In achieving success in the automatic synchronization of Westinghouse Stations WBZ and WBZA our engineers were forced to depart from prevailing practices in many instances and to carry on developments along new lines. Among the outstanding developments which have since come into more or less general acceptance were the first use of a quartz crystal for controlling the frequency of a broadcasting station. the use of matched crystals to control the simultaneous operation of two stations on the same frequency, the automatic synchronization of two or more stations by means of a tie-in frequency transmitted over land wires, the use of radio as a transmission medium for a synchronizing frequency, the use of a tuning-fork as a stabilizer in connection with the synchronized operation of two stations and the use of a quartz crystal in the role of a narrow band-pass filter. For the past eight years Westinghouse engineers under the supervision of Dr. Frank Conrad have been engaged in experimental work on these and other problems associated with synchronization.

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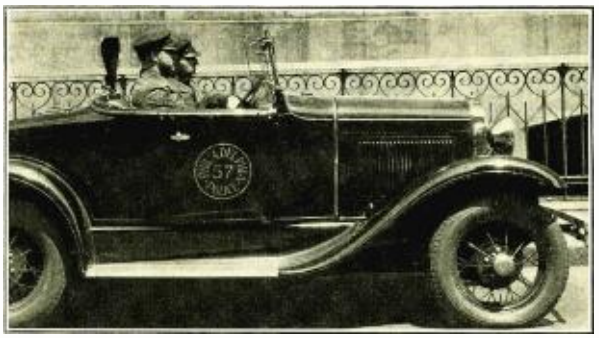
Extensions of television

The interest in television continues to expand. Applications received by the Federal Radio Commission for television transmitter permits include the following recent additions: Crosley Radio Corp., Cincinnati, Ohio, for a 1 kw. station; American Television Laboratories, Ltd., Hollywood, Cal., 10 kw. station; Easton Coil Co., New York, 500 watt station, and the Pilot Radio and Tube Corp., Lawrence, Mass., for a 250 watt station.

Companies newly incorporated, which propose to engage in some phase of television operation, include: The Continental Television Corp., Belleville, N. J.; Globe Television Corp., Wilmington, Del.; Broadcasting Institute, New York; Sanabria Television Corp., Dover, Del., and the Universal Radio and Television Corp., New York.

Radio to the rescue

By William J. Barkley*



Cruising police car in continuous touch with headquarters by radio.

A CAR swerves on two wheels into 107th Street, New York City. A machine gun rattles away at a man asleep on a chair against a wall of a building. Children playing in the crowded street are killed and the gunmen escape. The police become incensed at their own fruitless efforts at capture. A special squad is formed, consisting of sharpshooters armed with machine guns, patrolling the streets in cars and shielded motorcycles—one man to drive, one to shoot.

A few weeks later a payroll is held up, two policemen killed, the robbers killed only after a 12-mile chase through crowded New York streets in the course of which a child is killed and others wounded. The question arises, "We've formed special sharpshooting patrol units; what more can we do?" Before the question can be answered three men are kidnapped in front of a dance hall in Brooklyn, taken to a lonely spot, lined up against a wall and shot. But lonely as the spot was, a night watchman heard the shots. And therein lies the cue to the answer to the question.

Already the question is answered in New York as it has been in many other cities, in at least one state and in many counties and small municipalities—police radio. An appropriation of $100,000 is asked for New York. It is granted to the extent of $125,000.

Gunmen can be hired to kill for $10. $50 is high price. Why? Because they are so sure of escaping. Again why? Because they use the swift modern methods at their disposal, train, auto, even airplane. Because the police have been so slow getting on the trail. But that situation will soon be corrected—by police radio.

* DeForest Radio Company.

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The potential value of radio in combatting crime and some requirements for its efficient use.

Witnesses

Almost all crimes are witnessed by some one. Unless the victim of the crime is incapacitated he can raise the alarm soon after the crime. Often passers by or other disinterested parties witness the crime and can inform headquarters at no risk. Again, burglar alarms or other automatic devices notify police headquarters at the very time the crime is being committed. In short, headquarters is informed immediately. But heretofore it has taken headquarters too long to relay this information to those in a position to give chase. Precinct stations must be telephoned, and they in turn can inform the police automobiles only when the latter phone in or drive in to the stations. Often half an hour or more is lost before the chase is actually begun. And this first half hour is more important to the criminal than the ensuing ten hours.

By the use of police radio headquarters can relay information of the crime instantaneously to all precinct stations and police cars, and can, in addition, keep in touch with the pursuers during the chase. This first vital half hour is cut to a fraction of a second. For on the police sergeant's desk is a microphone into which he speaks as he receives word over the phone. And in every police precinct station and car is a short-wave radio receiver, tuned to and locked on the wavelength of the short-wave police transmitter, the tubes of which are kept at half glow that no time need be lost in broadcasting the crime.

As soon as a crime is reported to headquarters, which, due to the presence of witnesses, is usually immediately on its taking place, all those in the department in a position to chase are notified. The strings of the police net are immediately pulled tight from all directions, the net closes tightly and quickly, the criminals are caught, often before they have been able to leave the scene of the crime. This means "caught with the goods," which means easy, sure and swift conviction and imprisonment. The police, the district attorney and the public have permanently washed their hands of those offenders. And the use of police radio deters potential criminals, who strike from their lists of easy pickings those cities so equipped.

Experience in Los Angeles

This is the theory and practice of police radio. How does it actually work? We can do no better than take the records of the first month's operation of the DeForest Radio Police System in Los Angeles, California, made public in the report of Captain F. T. Hawtrey, in command of the Police Radio Division. It represents May, 1931.

Messages broadcast	11,796
Runs	9,914
Average time per run.....3 min., 34 sec.	
Arrests	517
Arrest runs.....	430
Average time per arrest run.3 min., 36 sec.	

The last item is perhaps the most pertinent. The average time for catching criminals with the aid of police radio is about 3½ minutes. No time to dispose of stolen goods, sneak away, fix up alibis, get together with tricky lawyers, get off with a not guilty if and when captured.

According to the *Los Angeles Examiner* the Police Radio Division of that city set a record with 66 more arrests the first month of its operation than the entire force arrested in the month previous, and faster. Said the *Examiner:* "April, the month before the radio was in use, uniformed men made 559 arrests, of which 41 were for felonies. In May, the officers manning the 43 radio equipped cars made 625 arrests, of which 178 were for major crimes. During April 177 robberies were reported. In May, with radio cars cruising the streets day and night, robbery figures dropped to 133." That corroborates the claim that criminals keep away from radio equipped cities.

With the ever increasing amount of evidence of the value of police radio,

states, cities, counties and groups of municipalities, any one of which is too small to warrant the installation of a system of its own, are equipping their police departments with radio.

The DeForest Radio Company, through exhaustive studies of police procedure and through long experience gained in installing such police radio systems as the one in Los Angeles, the Michigan State state-wide system at East Lansing, the police radio system now used in Philadelphia as well as others provided to cover large and small areas in densely and sparsely settled districts, realizes the necessity for certain conditions if the system is to be efficient.

Before any police radio system is installed a field strength test should be made of the area to be covered. Such a test may uncover unsuspected conditions which, well known, may well save money and enhance the value of the system. Sometimes such a test will reveal the need of a less powerful transmitter than was originally thought necessary. A knowledge of this fact will permit the saving of considerable sums both in capital outlay and operation costs. On the other hand, a field test survey might disclose the necessity for more power than was anticipated. This revelation is equally important, for unless an adequately powerful transmitter is used the police radio system fails of its intended purpose to inform police cars of vital facts. Some police departments have already learned the costly lesson from experience, with the result that for several months their systems have been inefficient and their transmitters had to be replaced by more powerful ones, or their own re-made, at a monetary and efficiency loss that might easily have been saved by a preliminary field strength survey.

Coverage Survey Important

Such a survey is of value also in determining the most efficient place for the location of the transmitting antenna. It is quite possible, especially in crowded cities, that if the transmitting antenna is placed at police headquarters, usually in the center of the community, electrical interference prohibits the reception of signals at any great distance and necessitates the use of far greater power than would be required to cover the same area were the transmitter placed at some other point. It is a fallacy to suppose that a radio signal may be heard equally far from the transmitter in all directions, that the strength of the signal decreases in exact proportion to the increase of distance. There are other factors, many of them determinable only by tests, made by responsible police radio concerns with portable equipment and finely attuned measuring instruments. The field strength test determines the most efficient place to install the transmitter to cover the area and the least amount of power required of that efficiently placed transmitter to assure good reception throughout that area at all times. Without such a test every portion of the community may receive well on a given power except one section for which the power has to be increased many fold. The inefficiency of such an installation is apparent.

The field strength test made, and place and power of transmitter determined, the next move is construction. The transmitter should be the best possible. On it may depend many lives and the welfare of persons and property. The antenna may or may not be far from headquarters. In any case, broadcasting can easily be controlled from any desired place. Sometimes it is desirable to have more than one microphone, perhaps a second in the police barracks. The police receivers must be especially made to permit reception on noisy thoroughfares, the signal undistorted by the ignitions of the cars in which they are installed. They must be rugged to withstand vibrations of constant and often quick riding over rough pavements, and continuous operation for many hours daily.

Radio transmitter and microphone at police headquarters.

In short, police radio is growing in importance to police departments and the vigilance of society against crime. Its efficient use demands scientific tests relative to its installation in each community. Its design and manufacture involves special problems which must be met by specialists in the field, whose ability has been proven by long experience and whose integrity will assure the complete and efficient protection of the community.

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AN ANALYSIS OF THE SERIES TYPE MIXING CONTROL

(*Concluded from page* 18)

variation does not appear serious. For example: The impedance, Z, of the transformer secondary, is not a constant value, but is

$$\sqrt{R^2 + (wL)^2}.$$

It is seen that different frequencies will be attenuated differently as the control arm is moved from one extreme to the other. In practice, transformer impedances are usually measured at around 1,000 c.p.s. This being the case of the transformer under consideration, our calculations hold good only at 1,000 c.p.s. At other frequencies different conditions exist. This is true of any form of attenuation network, however, and if compensation for this factor is desired, it must be taken care of elsewhere in the circuit.

The best mixing controls in use today are designed along the lines described in this paper and give results that are satisfactory in every respect.

A mixing control of this type and which is widely used in broadcasting stations and recording studios throughout the country (see Fig. 8), was investigated. This control was designed to operate across a fifty-ohm transformer. The resistance, $x + y$, was found to be 160 ohms., $r + u$ was found to be 50 ohms and B was 35 ohms. To determine the resistance variation of the output of this control from the completely closed to the fully open position, a fifty-ohm resistance was substituted for the transformer impedance (Z), and the d-c. resistance measured at various positions of the control arm. The values obtained by actual measurement checked with the values as computed by equation (2) within the accuracy of the measurements.

Thus, it would appear that equation (2), which was derived under general conditions, would be useful in designing mixing controls for various transformers and load impedances. Also, checking a given mixing control with equation (2) will show just "how good" it is.

In conclusion, the type of control analyzed is very satisfactory and its use is to be recommended. The increased cost of a more elaborate variable pad would more than off-set the slight advantage to be gained by its use.

Broadcast station coverage

HOW many persons are in the audience of a radio station? Theories, suppositions and even guesses frequently have entered into the many answers that have been made. Westinghouse Radio Station KDKA at Pittsburgh, through its manager of sales promotion, Benjamin Soby, has arrived at an answer in which guess work has been eliminated and a definite check has been made of the audience of that station.

By following the system adopted by KDKA, any other radio station can determine its audience. Much research work, scanning of government figures, tabulations and other diversified data were in order to enable officials of KDKA to tell definitely just how many persons gather around the family radio in order to listen to programs.

Of primary importance in determining the audience has been the establishment of a "Zone of Primary Influence" —the district where signals of the station are sufficiently strong to draw consistent attention to the station. A sharp line was drawn to make clear beyond a doubt that mere "coverage" was not taken to mean an audience. "Coverage," as the sales promotion manager explains, indicates that area in which the signals are strong enough to attract consistent interest, but should not be construed with audience," which, of course, includes only those who actually "tune in" to the station.

By following the same system that has been used at KDKA, the size of the audiences of the other Westinghouse broadcasting stations will be determined.

The Factors

In brief, the deciding factors entering into the equation are the total population, percentage having radios, and number of listeners per radio. The population is obtained from the Federal Census taken last year, which removes any guess work from the first step. The next move is to determine the number of radios, and this likewise is known definitely as the same government enumeration of population also listed families having radio receivers.

Pursuing this same positive line of calculation, it has been determined how many listeners there are to each radio. Personal investigation by competent representatives has disclosed that the number of listeners per radio averages 3.1. This gives the total number in the radio audience in any given district that "tunes in" to all the stations.

Now, Mr. Soby was confronted with the problem of breaking down this mass information into specific divisions and classifying it according to "audience per station." Determined that no indefinite hypothesis should have any part in the calculation, he gathered figures from specific sections of the "Zone of Primary Influence," which showed from a personal survey just what percentage of listening time is devoted by. the average family to the various broadcasting stations.

With this information it is only necessary to engage in a mathematical problem of percentage or fractions to determine what share of the total audience listened to the Westinghouse Station.

In discussing some of the problems confronting the solution of this interesting problem, Mr. Soby said:

"When we have stated that the Primary Zone of Influence of KDKA comprises 33 trading areas with a total population of 6,000,000 persons, the questions which naturally follow are, 'That is all very well, but how many people comprise the audience of Station KDKA? What is the number of daily listeners?'

"There are two factors which will give us the answers to these questions— the number of radio sets owned, and the listening habits of the people.

"The United States Census for 1930 is authority for the following information on the 'Primary Zone of Influence.' 1. Population. 2. Families. 3. Families with radios.

"We know from more than a year of continuous research, the following: That 73 per cent of all radio sets are tuned in some time every day, and that the daily average number of listeners to each set is 3.1."

In applying his system to a definite area, the Wheeling, W. Va., district has been selected with a population of 280,000. The number of families as disclosed by the census is 62,300. Families with radio receivers number 23,051 or 37 per cent of the total. Sets tuned in daily are 16,827. As there are 3.1 listeners per average set, the total daily average number in the Wheeling district audience is 52,164.

The same procedure likewise may be applied to any area or geographic subdivision.

Radio officials are especially anxious to determine the number of listeners in the "Zone of Primary Influence" as it is in this district that any particular transmitter has its most influence. In the case of KDKA, the "Zone of Primary Influence" is taken as the circular area surrounding Pittsburgh, which has an average radius of 125 miles. Station KDKA is heard from coast-to-coast and in many foreign countries, but in setting out to determine the audience, that small area was selected as the "proving grounds" on account of the station being in this area the undisputed transmitter so far as strength of signals or "coverage" is concerned.

Trading Centers

In subdividing the district into various trading centers, they were named after the principal cities of the area as that method aids in identifying them both on the map as well as in the mind. For purely abstract charts and other such material, radio audiences may be separated according to numerals showing the number of any designated section.

In speaking about the part that station mail has played in former methods made to determine audiences, Mr. Soby declares:

"Station mail response has been used to 'prove' many things in connection with broadcast advertising—particularly station coverage and audience.

"Station mail at least shows the location of those listeners who wrote letters or cards in response to programs. Station mail considered in bulk; that is, all the mail received for one month, has two significances. The absolute meaning, for example, of the 25,000 letters and cards received by Station KDKA in May is that at least 25,000 persons heard in KDKA programs—and did something about them."

The subject of radio audience is one that long has had the attention of broadcasting officials as well as the interest of the general public. With this system the former guess work from such calculations is removed.

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Seventy-three per cent of radio receivers are tuned-in at some time daily. Daily average number of listeners is 3.1 per receiver.

Hotel Lincoln, New York, installs directed radio

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New system eliminates wiring for room reception —steel frame of building serves as aerial.

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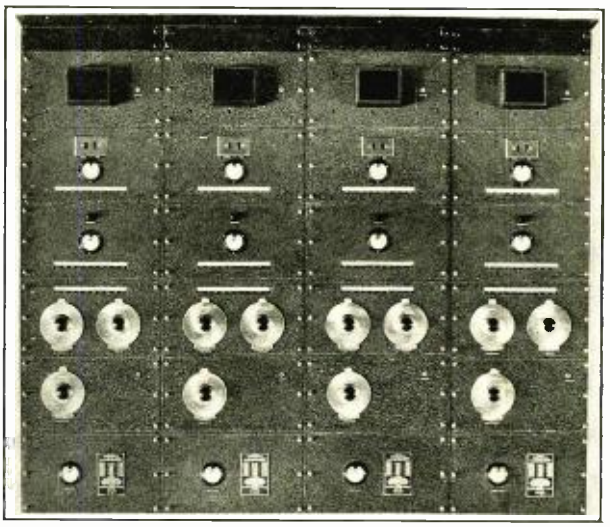
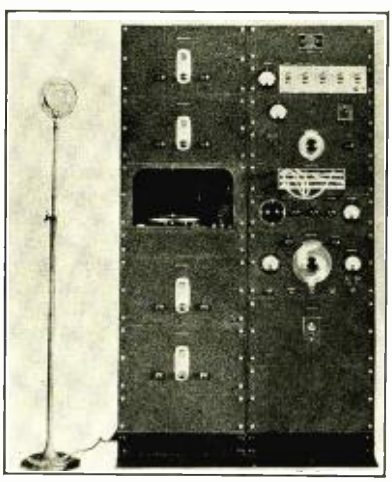


Four Type TDL hotel transmitter.

ANNOUNCEMENT was made recently by the Hotel Lincoln, Eighth Avenue, 44th to 45th Street, New York, that each of its 1,400 guest rooms, as well as its public rooms, are being equipped with directed radio, a newly perfected system of multiple radio reception. The master equipment has been installed and has been put through a testing period of about two months' duration. Several hundred individual rooms have been equipped and the remaining rooms will be equipped within the next few days.

Directed radio, in brief, is the principle by which a radio program is retransmitted from a master receiver within the building to a great many individual receiving points within that building without the aid of wires. In directed radio, the steel frame of the building is the transmitting agent and the program reaches the listener through a special-type receiver which requires at each point only connection with an electrical outlet and grounding in the usual manner. Until the perfection of directed radio, wired systems have been necessary for multiple reception. If four programs were to be heard, four pairs of wires had to be carried from four master receivers to each point at which service was desired, an operation requiring in a building such as a hotel, the installation and maintenance of several miles of wire.



Type ADL master control unit for hotel equipment.

Technique Simple

The technique of directed radio is comparatively simple. When it was first utilized in its experimental form two years ago at the Lincoln. the installation consisted of several master receivers of regulation make, battery-operated and in no way different from other sets except that they were completely shielded. These sets were located on the twenty-ninth floor of the hotel. All were connected to one aerial and each set was permanently tuned upon one station. From the master receivers the output was carried by wire to a transmission room on the floor below where an operator at a monitor table exercised control over modulation and volume of each program. From the monitor table the programs were carried into a specially designed enclosure of copper-mesh wire which served as a static shield. In this room was a series of oscillators and a set of miniature transmitters, one for each program. Here the programs were modulated to new wavelengths and transmitted into the steel frame of the building to be re-detected by one-dial receiving sets in each guest room.

For the past year the experimental work at the Lincoln has been largely in the direction of refinements of quality of reception, volume control and experimentation with various types of individual receivers. There never has been any problem of eliminating electrical interference, although the master program receivers have been located adjacent to the elevator machine room of the hotel. Programs have been received in an electrically-driven elevator while it was in motion from the basement to the thirtieth floor.

In spite of the extreme sensitivity of the receiving apparatus, it has been impossible to pick up the retransmitted programs outside the hotel. The refinements accomplished during experimentation have included volume control which keeps the reception at the same level at all times regardless of the number of receivers in use throughout the building. The individual sets are gauged for total volume in such a manner that at no time can they be heard in adjoining rooms. The room receivers used during the experimental period and in limited numbers available to guests were of a portable type with built-in amplifiers. The permanently installed receivers are fitted into the bed tables. They are of a one-tube type with dynamic speakers. One dial serves for tuning. A combination switch and dial both puts the sets into operation and controls the volume. The master-receivers and transmitters are combined into a group of units oc-

cupying a total floor area of three feet by ten feet.

Four Stations Tapped

Although as many as ten stations were received by directed radio during experimentation, the permanent installation provides for four stations, as a result of a careful survey which revealed that 95 per cent of all radio listeners in New York hotels choose one of four New York stations. The reception, modulation and re-transmitting equipment, however, have two reserve channels for the future rebroadcasting of television programs as well as a channel for the retransmission of electrical recordings. Electrical recordings will be employed in the same manner as radio transmission and will make possible specialized programs or programs when no suitable radio programs are available. With amplifiers the radio programs and recordings may be stepped up sufficiently to be heard in all parts of the dining rooms and lobbies.

Radio facilities first began to be extended to hotel rooms about four years ago. Since hotel patrons began to ask for radio in their rooms, new hotels have been equipped during construction with wired radio systems which are about as complicated as wiring systems for telephones or electric lights, the installations being made before the building of partitions and floors. Hotels built before the radio era were facing the necessity of expensive wire installations as well as loss of revenue during installation because the wire installations required that floors, walls and ceiling be torn open. Directed radio requires only that the receiver be attached to an existing outlet. At the Hotel Lincoln about twenty minutes has been all the time necessary to put a set in service in a guest room, including testing.

While directed radio is primarily for hotels, it can be used in apartment houses, hospitals, schools and on ships. Eventually it will still forever all family arguments over a choice of programs. With directed radio the average home may have simultaneously as many programs as there are either master or individual sets.

The installation at the Hotel Lincoln has been made by the DeForest Radio Company of Passaic, New Jersey, which has obtained from Radio Systems, Inc., a Delaware Corporation, a special license under the patent rights upon which the application of the principle is based and which has been experimentally applied in the Hotel Lincoln since March, 1929.

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New photoelectric lighting control relay

TO enable the intensity of natural light to control artificial lighting automatically, a new photoelectric lighting control relay had been developed by the Westinghouse Electric and Manufacturing Company. When the intensity of daylight decreases to a certain point, this device operates to turn on electric lights; and, conversely, when the natural light increases to a certain intensity, it causes the lights to be turned on.

The operation of the lighting control relay is effected by variation in the intensity of light falling on a photoelectric tube. These variations produce proportional changes in the amount of current passing through the tube; and this changing current, amplified in a specially designed amplifier tube, energizes a primary relay controlling an auxiliary contactor, which, in turn, operates the main contactor controlling the lighting installation.

The new Westinghouse photoelectric lighting control relay with panel removed showing adjusting dials and plug switch.

On the upper side of a micarta panel in a cast-aluminum box, with a glass hood to admit the light, are mounted the photoelectric tube, the amplifier tube, and the primary relay; mounted under the panel are fixed condensers, a transformer, the auxiliary contactor, and potentiometers for adjusting the device for operation at different intensities. Two dials, mounted on a panel on the side of the box, are used for regulating the potentiometers, one controlling the intensity at which the device turns on lights, and the other the intensity at which it turns them off. The foot-candle range of these dials is varied by a three-position plug switch located between them.

Some of the many applications for this device are found in providing automatic control for lights in office buildings, show windows, signs, schools and in floodlighting, street lighting, airport lighting and navigation lighting installations.

With a photoelectric lighting control relay installed in an office or a factory, variations in natural light can never interfere with good working illumination on any day of the year, since the control of the lights is entirely independent of individual judgment, which is usually inaccurate. The use of this relay also effects savings in power; it has been found in several installations that automatic control of factory interior lighting has saved approximately one-half of the power needed without such control.

The photoelectric lighting control relay installed in an office for turning the artificial lights on and off without human supervision.

Automatic control applied to illuminated signs and show windows effects a maximum of advertising value, since it turns on their light whenever artificial lighting can increase their visibility, and turns them off when artificial illumination fails to enhance their attention-getting power. During early morning hours, usually from one to five o'clock, a time clock may be used to turn off the lights, a combination of the lighting control relay and a time clock giving complete automatic control of illumination.

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Do we want line voltage control?

By Austin C. Lescarboura

And if so, should it be in the form of an accessory or incorporated in the initial equipment?

RECENTLY a number of representative radio dealers throughout the country were asked to give their candid opinions and recommendations regarding the problem of line voltage fluctuations and its solution. The survey was to determine whether or not there is a demand on the part of radio dealers for line voltage control as part of the initial equipment of the radio receiver. It sought to learn whether the service problems due to fluctuating line voltage are confined to a few localities far behind the times, and so place the control definitely in the category of an accessory, or whether they were general and widespread enough to make the device valuable as initial equipment.

The survey brought forth a number of points regarding service problems from dealers all the way from Oregon and Washington to Florida, and from Maine to Texas, with all points between. Replies were received from ninteeen States situated North, East, South and West, as well as Central. Not more than ten per cent of the replies received came from any one State. Fifty-four per cent were from urban communities, which ties in very well with the population distribution of the United States. All in all, the survey represents a fair cross-section of the radio business.

The analysis of the returns indicates that there is unqualified evidence of the need of the line voltage control feature in the initial radio equipment as a positive sales aid. Also, dealers and servicemen appreciate the necessity of an automatic line voltage regulator in keeping down service costs. To get down to cases:

Of all the answers, the most consistent is in answer to the question, "Would self-adjusting or automatic line voltage control be considered a worthwhile sales feature in merchandising radio sets?" Only 2 per cent of the answers are in the negative. These organizations point out quite humorously that it is against their interest to make trouble-free sets. But the great majority or 98 per cent of those answering simply say "Yes." That means that in the cross-section of dealers, from city and country and from all parts of the States, the answer is overwhelming in favor of having the line voltage control feature as part of the initial equipment of the radio set.

Other things being equal, dealers report that they would push the sets having the automatic line voltage regulator feature ahead of other sets. This opinion is genuine, and there must be sound reason for it, for it has been maintained even in the face of a later question that suggests a three-dollar increase in price to incorporate the feature.

The survey indicates that service is taking a great deal out of the small margin of profit that competition has left in the merchandising of radio sets. By the time the dealer has paid the forty or fifty dollars per week for the servicing of sets under his guarantee. the profit is cut to a minimum if not entirely wiped out. This is particularly true at this time when the lower priced sets with their correspondingly lower profit margins command the bulk of the sales. Nearly all correspondents in this survey agree that tubes cause more trouble in the servicing of sets than all the other ills put together. The serviceman on the job usually cannot determine whether the tube failure has been due to an overload or not. In fact, he is not interested, for the customer insists that the overload, if any. is not his fault and stands on the set guarantee. Tubes can be replaced under a 100 per cent replacement policy which excessive competition brought into being among tube manufacturers. but those same manufacturers do not pay for the serviceman's time or salary. Nor can the manufacturers restore the good will that has been lost through a number of breakdowns and service calls, no matter how prompt and obliging.

From the answers to the present questionnaire, it is found that there is a definite service problem which is depriving the dealer of his profit. There is reason to believe that a goodly share of that service problem is due to tube failure directly traceable to fluctuation in line voltage. Contrary to the general conception outside service circles, geography has little to do with this prevalence of fluctuation. Cities are afflicted as well as the rural communities. Dealers all over the country are cognizant of this condition and welcome the inclusion of the bulb type line voltage control as part of the set equipment. In fact, several of the dealers in Texas, which seems to be particularly afflicted with this condition, have adopted the practice of equipping all sets sold by them with a self-adjusting line voltage control.

In short, it is clearly indicated by the survey just completed that the place for the self-adjusting line voltage control is in the radio set when it is delivered to the dealer and is best appreciated by the dealer. The customer is not asking about the technical details: he is buying entertainment and he insists on uninterrupted entertainment. If the dealer tells him that the item is necessary after a few tube failures and perhaps a power pack breakdown, the customer assumes the dealer to be at fault for not knowing about it in the first place. For the dealer, the price of one service call is more than the cost of the device. For the manufacturer, the cost is nothing, strange as it may seem, for the additional socket required in the chassis is more than offset by the usual "high" and "low" primary winding taps which become unnecessary. The additional item of a regulator tube of the Amperite type has proved a distinct aid in the merchandising of standard sets incorporating the line voltage regulator feature.

▲

DE FOREST SILVER ANNIVERSARY SOUVENIR

COMMEMORATING the twenty-fifth anniversary of the invention of the DeForest audion or practical vacuum tube upon which the present-day radio industry is founded, the De-Forest Radio Company of Passaic, N. J., has just issued an attractive souvenir booklet. This booklet tells the brief story of the audion, early broadcasting days, the first transcontinental telephone and first transoceanic radio telephone experiments, and other developments leading to the achievements of today. A copy may be had for the asking.

REDUCTION OF BACKGROUND NOISE KEYNOTE FOR 1932

Describing the general trend of radio progress for the 1931-32 season, Arthur H. Lynch, vice-president and general manager of the Stenode Corporation of America, believes that a significant aspect will be the reduction of background noise. "Reduction in background noise," said Mr. Lynch, "means genuine reception enjoyment on distant stations as well as locals." Background noise is caused by natural and artificial radio strays—irregular and scratchy signals that find their origin in static and electrical appliances such as electric fans, auto ignition systems, traffic lights, dial telephones, incinerators, elevators, etc. And with these appliances rapidly on the increase, the seriousness of the background problem becomes immediately evident. As a matter of fact it is rapidly encroaching upon the heretofore unaffected local services. The reduction of background noise is today one of radio's most serious problems, and I feel that the lessening of this interference by means of a super-selective receiver, such as the Stenode, will indicate the high mark in radio progress for 1931 and 32."

The Stenode receiver is said to tune so sharply that very few extraneous sounds are admitted, with a corresponding reduction in background noise. Engineering theory states that the sharper a receiver tunes the less opportunity there will be for noise, which extends over the entire tuning scale, to seep in and interfere with the enjoyment of radio programs. Noise has always been more serious on distant reception, when the sensitivity of the receiver is naturally increased, by turning up the volume control, to compensate the weakness of the signal.

▲

WIRE CLOTH

The Newark Wire Cloth Co., 351-365 Verona Ave., Newark, N. J., announce that they have appointed The Pacific Metals Co., Ltd., as West Coast representatives. This concern will carry a limited stock both in Los Angeles and San Francisco.

▲

DUMONT TO PERRYMAN

Al Dumont, for years chief engineer of De Forest Radio Company and Jenkins Television Corporation, has joined the staff of the Perryman Electric Company it was announced August 29 by President Joseph D. R. Freed.

Simultaneous with this announcement, H. B. Foster, vice-president and general manager of the Perryman organization, announced plans for a Perryman photo-electric cell, and Perryman plate and crater-arc type neon lamps. Plans for these important additions to the Perryman line are being announced, according to Mr. Foster, only after extensive research into the possibilities inherent in the television field at this time.

The research indicated that the interest in television is increasing and that merchandising authorities confidently expect that there will be an extensive public demand for television tubes within the next six months, a demand that Perryman, in keeping with its traditions, was anticipating.

▲

MOULDED RESISTORS

The Erie Resistor Corporation of Erie, Pa., announce the opening of a Canadian plant at Toronto, Canada. The new plant, in charge of Rodney Wese, is already in production and it is reported that a very satisfactory volume of business has already been attained. Mr. Wese is well known in Canadian manufacturing circles, having been associated with the radio and electrical industry in Toronto for many years.

▲

WIRE ROPE AND WIRE

John A. Roebling's Sons Company, Trenton, N. J., has issued a new and attractive book on the subject of wire rope and wire. Copies will be sent to engineers and purchasing departments, upon request.

▲

IGNITION INTERFERENCE ELIMINATED FOR AUTOMOBILE RADIO

Once considered a serious obstacle in the path of successful automobile radio, the ignition interference problem is readily and inexpensively solved today. No longer is it necessary to employ shielded ignition cable and elaborate shielding for the ignition components. Instead, a few suppressor units readily installed at the proper points in the ignition system, in combination with suitable by-pass condensers, completely eliminate ignition interference so that the automobile radio set may be enjoyed while the car is bowling along.

The suppressors are of three types. First, there is the spark plug suppressor, which is inserted between spark plug terminal and ignition cable lug. Secondly, there is the distributor suppressor, inserted between center distributor terminal and ignition cable going to the spark coil. Thirdly, there is the screw-in cable suppressor inserted in the main ignition cable which is severed for the purpose. Left and right hand threads at the ends of the resistor permit of screwing it into the ends of the severed ignition cable. The proper resistance inserted at the proper place in the ignition system serves to minimize the oscillations in the circuit that would ordinarily interfere with a nearby radio receiver. Meanwhile, suitable by-pass condensers are shunted across the generator armature and other disturbance-creating elements of the car, completing the installation, according to the engineering staff of the International Resistance Company of Philadelphia, Pa.

The suppressors must be of correct resistance value. The resistance element should be enclosed in a ceramic tube possessing a high degree of mechanical and dielectric strength, as well as the ability to withstand extreme heat without cracking. Hermetically sealed in such a tube, the suppressor resistance remains constant at all times.

▲

DUBILIER DUCON REDUCED IN PRICE

A price reduction on the Dubilier Ducon or light socket aerial is announced at this time by the Dubilier Condenser Corporation of New York City. This antenna substitute has been listed at $1.50 ever since its introduction seven years ago. Because of its steadily increasing popularity and large volume production, the list price is now reduced to $1.00.

▲

RECORDERS AND RELAYS

Sensitive tape recorders and small current relays to be operated by radio and other vacuum tube circuits are being used to an increasing extent. A line of dependable instruments of this type are manufactured by J. H. Bunnell & Co., Bunnell Bldg., Fulton St., New York.

▲

INSULATION

The American Lava Corporation. Chattanooga, Tenn., has issued a new booklet entitled *Lava and Magnesium, Specialty Insulation.* Items are illustrated for use in forming thermocouples, resistors, cores, bushings and discs. The booklet contains valuable information on the subject of insulation.

▲

SYNTHANE APPOINTS MIDWEST DISTRIBUTOR

Synthane Corporation, Oaks, Pa., have appointed the Industrial Products Sales Corporation, St. Louis, Mo., J. E. Jury, General Manager, as distributors covering St. Louis and surrounding territory.

The above appointment was arranged by J. B. Rittenhouse, vice-president of Synthane Corporation, in charge of the Chicago office.

▲

ACCESSORIES IN ST. LOUIS TERRITORY

The Acme Wire Company of New Haven, Conn., announces the appointment of E. B. Henderson Company, 826 Clark Avenue, St. Louis, Mo., as exclusive distributor to the manufacturers in that territory of magnet wire, coils, varnished insulations and condensers. Complete stock will be carried.

HUMIDITY AND RESISTANCE

Users of resistance-coupled audio amplifiers of a few years ago were frequently puzzled by impairment of set performance with a change to damp weather. In fact, it was this uncertainty of performance which paved the way for the return of the audio transformer, although today, with resistors reasonably immune to the effects of dampness, resistance coupling is once more in good standing.

Complete immunity against moisture is entirely feasible in the properly designed resistor, according to the engineers of the International Resistance Company of Philadelphia. The latest Type K metallized filament possesses humidity characteristics that prove its ability to withstand conditions of high humidity. Metallized filament units are initially measured for resistance and placed in humidifiers in which temperature and humidity are controlled. Resistances are measured from day to day to determine the effect of temperature and humidity on range. The "cold moisture" conditions correspond to 22 degrees C. and 85 per cent relative humidity, and "hot moisture" to 40 degrees C. and 90 per cent relative humidity. Over extended periods of time the latest metallized resistors do not change more than about 10 per cent. In other words, under all humidity conditions normally encountered, such resistors will provide satisfactory results without any special treatment.

However, in order to be sure of 100 per cent freedom from moisture effects, so as to eliminate one more variable in practical operation, the metallized resistors are impregnated in a special compound which prevents moisture from causing any change in the resistance of these units. Thus moisture need no longer be a factor in the operation of a radio set.

▲

SECONDARY EMISSION IN TUBES

The efficiency of certain types of vacuum tubes is impaired by phenomena resulting from the presence of "secondary" electrons.

An article on this subject which outlines the method in which a three-electrode vacuum tube functions, how secondary electrons are produced and the manner in which a substance such as colloidal-graphited water may be employed to retard their formation, may be procured by communicating with Mr. Raymond Szymanowitz, Technical Editor, Acheson Oildag Co., 654 Madison Ave., New York.

▲

CRYSTALS AND HOLDERS

The present wide use of crystals in radio transmitters and in the Stenode receiver has resulted in marked improvements by manufacturers selling these accessories.

The American Piezo Supply Co., 1101 Huron Bldg., Kansas City, Mo., have issued bulletin No. 27 illustrating and describing crystals and holders.

▲

REPLACEMENT TRANSFORMERS

It is reported that the great demand for Stancor high quality transformers from the distributors of various receiving sets for replacement purposes has developed to such a volume that the Standard Transformer Corporation, Chicago, has added a special transformer replacement division to its organization.

The Standard, by equipping its regular line of transformers with special brackets to fit the various sets in use, is said to permit the rebuilding of receivers to the highest quality at a very reasonable cost. For instance, the company has one transformer that is being used on various types of Atwater Kent sets, making them universally adaptable as replacement units. Stancor type No. P 567 is used on models Nos. 37-38-40-42-44-52, while type No. P 568 is adaptable to set No. 46.

▲

CONDENSERS ON PACIFIC COAST

The Condenser Corporation of America, Jersey City, N. J., recently appointed the Northwest Pacific Agencies of Tacoma, Washington, to represent the Acracon line of condensers in the Washington and Oregon territory. James V. Griffith of the Northwest Pacific Co. heads the staff of engineers.

▲

A NEW GRADE OF PHENOLITE (LAMINATED BAKELITE)

Radio engineers have long known that the incoming signals in radio receiving sets must be expertly handled to prevent the loss of power, and distortion through amplification when the signals are feeble. They will, therefore, be interested in the new grade of Phenolite (laminated bakelite), which has recently been developed by the National Vulcanized Fibre Company of Wilmington, Delaware, and is known as their XP 209.

The power factor of this grade at 1400 kc. is 2.67 per cent. and represents a distinct advantage in this respect without sacrifice of dielectric strength or mechanical properties. It may be punched, sheared or manipulated in the same manner as other grades of Phenolite and the manufacturers are offering to those who are interested samples for examination.

The manufacturers claim that a decided improvement may be noted in variable condensers used in amplification systems when this insulation is used. This is also true on any other device where the power factor of the insulation used is an important consideration.

▲

AEROVOX AWARDED PATENT ON ELECTROLYTE

The Aerovox Wireless Corporation, 70 Washington Street, Brooklyn, New York, has recently been granted U. S. Patent No. 1,815,768, covering the special electrolyte used in the manufacture of Hi-Farad dry electrolytic condensers.

Hi-Farad dry electrolytic condensers are manufactured not only in accordance with this new patent but also according to patent No. 1,789,949, covering the mechanical and electrical design of these condensers.

▲

RCA-VICTOR EXPANDS

M. B. McCullough, of the RCA-Victor Company, Camden, N. J., announces that the sales and manufacturing facilities of the RCA-Victor Company (Mass.), formerly the Wireless Specialty Apparatus Company, makers of "Faradon" condensers, are being transferred to the RCA-Victor Company, Inc., in Camden, N. J.

A new sales section known as the "Industrial Products Section" has been formed to handle the sales of products formerly manufactured at the Boston Plant, together with those formerly handled by the "Component Parts Section" of the RCA-Victor Company, Inc. This new section, as the name implies, will handle the sale of industrial products to manufacturers, laboratories, colleges, etc.

Some of the more important products available for sale to radio manufacturers and others by this section are as follows: Loudspeakers, transformers, magnetic pickups, electric phonograph assemblies and parts, laboratory and test instruments, commercial receivers, "Faradon" capacitors, geographical apparatus, rectox units, paper capacitors.

▲

CAPTAIN SPARKS DENIES RUMOR

An announcement issued on August 20 by President William Sparks, of the Sparks-Withington Company, Jackson, Mich., reads:

"Information has reached me that a great many rumors are passing around in the industry that The Sparks-Withington Company are about to start branches of their own to handle their product in place of distributors.

"Therefore, will you please publish this item as a contradiction of these rumors? We never have had branches and today it is the farthest from our thoughts to handle our distribution in any such way."

▲

HIGH-VOLTAGE CONDENSER PRICES REDUCED

New developments in design and production, together with an anticipated increased demand, have justified marked reductions in the list prices of Dubilier high-voltage condensers, according to the Dubilier Condenser Corporation of New York City.

Without sacrificing in the least the more than liberal safety factor and long

life for which they are known, the Dubilier high-voltage condensers Types 686-A, 689-A, 688-A and 690-A, of 1000, 1500, 2000 and 3000 volts, and 1 to 4 mfd. capacity, have been reduced in price to the point where the new list prices average from one-fifth to one-third less than formerly.

▲

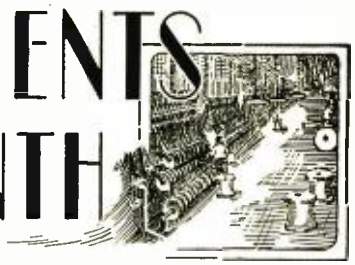
CARRARO JOINS ARCTURUS IN SOUTHWEST TERRITORY

C. E. (Jack) Carraro, has joined the sales staff of the Arcturus Radio Tube Company, Newark, N. J.

Mr. Carrara has had considerable experience in the southwest territory. For eight years he was manager of the radio and phonograph departments of a very large department store in Tennessee. After that he was for two years territory superviser for a large set manufacturer in the state of Texas. His experience is rounded out by later becoming branch manager of a big radio jobbing house in Texas.

This comprehensive sales experience with the dealer, jobber and manufacturer, ably fits Mr. Carraro for his new duties with Arcturus.

NEW DEVELOPMENTS OF THE MONTH



LOUDSPEAKER FOR MIDGETS

In keeping with the trend of the trade toward smaller midget receivers, The Rola Company announces a new Model, F-5, specially designed for compactness and simplicity.

Its overall diameter measures 6½ inches; depth, 3½ inches; weight, 3¼ lbs; effective cone diameter, 5 inches.

Because of its light weight and compactness, this unit may be incorporated in

the smallest of midgets. No detail of construction has been omitted that might contribute to its quality, and its performance is in keeping with the rest of the larger Rola units.

▲

RECEIVER TRANSFORMERS

Leading radio manufacturers use Acme transformers both as prime equipment for current radio receivers and as necessary components for their export shipments. The high quality of these transformers is made possible not only through the proper choosing and processing of raw materials in the Acme transformer factory, but also because of the engineering skill in designing, inspecting and testing of the finished product. Acme transformers meet the exacting requirements of the serviceman and will give customers years of satisfactory radio service, and every radio repair man knows that satisfied customers are his greatest asset.

They are manufactured by the Acme Electric & Mfg. Co., 1444 Hamilton Ave., Cleveland, Ohio.

▲

AUTO-RADIO CONTROLS

With the Carter remote control, automobile radio takes another important forward step. It brings to radio in the motor-car the one thing such radio seriously needed to make it successful; namely, safe, reliable control.

By the use of this clever device, the receiver may be located at any convenient location in the car, underneath the floor boards to the rear of the car, back of the back seat, in trunk, or in fact almost anywhere it might be desired. It is well known that placing the set far away from the motor, ignition disturbances are largely eliminated. Complete control is directly under the driver's hands, in easy, comfortable reach, so that the set may be turned on and off, tuned and volume adjusted without taking eyes from the road. No longer may the objection be raised that automobile radio disturbs the driver from his business of safe driving.

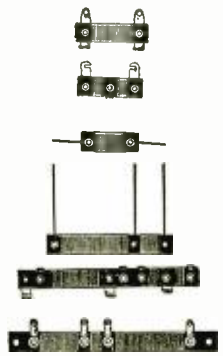
Coupled with the outstanding development and advancement in automobile receiver design and construction, this control is already proving a distinct stimulus to the sale of this type of radio. Manufacturers, distributors and dealers are now giving considerable attention to this great market.

Manufactured by the Carter Radio Company, 407 S. Aberdeen St., Chicago, Ill.

▲

FIXED RESISTORS

These fixed resistors are available in a very large variety of soldering and mounting lugs only a few of which are illustrated. They are wound with high resistance wire having substantially unvarying resistance with changing temperatures over practical ranges. All elements are wound on specially treated genuine bakelite strips. Resistors can be supplied with



windings wrapped to prevent damage to them in handling at very slight additional cost. Available in standard widths of .475", .552", ¾" or 1". Standard thickness of all strips is 1/16". Length of resistors depends largely on the amount of current to be dissipated. Manufactured by The Chicago Telephone Supply Co., (H. H. Frost Division), Elkhart, Ind.

▲

CRYSTAL TUBE DEVELOPED FOR STENODE

The laboratories of the Stenode Corporation of America announce the development of a standard crystal tube for use in commercial models of the Stenode receiver. This tube, which will be manufactured independently by licensed manufacturers, has approximately the same overall dimensions as the type —45 power tube, and is mounted on a standard UX base. The quartz crystal, upon which the phenomenal selectivity and remarkable tone quality of the Stenode receiver are said to depend, is mounted ruggedly in a medium vacuum and is electrically terminated at the tube cap and the plate prong on the base. The vacuum is not essential to the satisfactory operation of the crystal circuit, and is employed principally as a matter of temperature insulation.

Due to the simplicity of grinding quartz crystals resonating at approximately 175 kc., and the ease of evacuating the tube, the crystal tube is said to be very economical to produce, representing a cost to the manufacturer and the final consumer considerably less than the component parts of the average tuned circuits which it replaces.

▲

KILOVOLTMETER MULTIPLIERS

Shallcross kilovoltmeter multipliers, with and without self-contained meter, were developed to fill a need of the measurements of relatively high voltages both a-c. and d-c. employed with radio transmitting equipment, X-ray apparatus, etc.

The kilovoltmeter multipliers, without the self-contained meter, are provided with steps from one to five of resistances which are also useful as high resistance standards for all physical and engineering laboratory tests.

Special kilovoltmeter multipliers are also available in the same general form in connection with the measurement of high voltage with radio transmitters operated at frequencies as high as 30,000 kilocycles. Manufactured by Shallcross Mfg. Co., Collingdale, Pa.

▲

MINIATURE CONDENSERS

The Condenser Corporation of America, Jersey City, N. J., has added a new miniature condenser to the famous Acracon line. The new type is known as "mikes" and is available in practically all capacities and voltages from .01 up. The wire

leads on these condensers are so attached as to be permanent even under severe abuse. All "mikes" are non-inductively wound, thus insuring low r-f. resistance.

BINDING POSTS

The Alden Mfg. Co., 715 Center St., Brockton, Mass., is marketing a new and improved type of binding post for radio receivers.

One eyelet or screw fastens it to the set. Knobs cannot be unscrewed and lost. They are molded solid to threaded rods, the ends of which are enlarged to prevent removal.

One piece of metal forms the guide and connection, the center drawn to the form of an eyelet. This is riveted as an eyelet to the Bakelite and the inside threaded. It is the few parts and simple construction that makes the cost of this binding post reasonable.

▲

TUBE SELLER AND MERCHANDISER

The Jewell Electrical Instrument Co., 1650 Walnut St., Chicago, has issued a new booklet describing types of combination tube testers and merchandisers. The set gives meter pointer indications reading

directly as "unsatisfactory," "doubtful," and "satisfactory." The tester is serviceable for all types of tubes.

▲

NEW HICKOK SG-4700 RADIO SET TESTER AND ANALYZER

The Hickok Electrical Instrument Co. of Cleveland, Ohio, New York office, 15 Laight Street, announce their new Model SG-4700 radio set tester and analyzer.

As customary with all previous Hickok set testers, separate meters are supplied for each portion of the screen-grid circuit, making it easier to operate the instrument and to secure complete readings of a screen grid circuit. Several new developments are incorporated in this tester, as follows:

First: A self-contained ohmmeter operated by an internal battery instantly available for use by means of a double pin-jack plug attached to test leads.

Second: A self-contained capacity meter available by plugging in the a-c. line and then plugging in the test leads in another set of pin jacks.

Third: Self-contained resistors for reading line voltages and transformer secondaries up to 160 and 800 volts.

Fourth: Individual use of meters immediately available by plugging in the double pin-jack test leads.

Fifth: Grid swing test accomplished by merely pressing one button, as there is a self-contained "C" battery.

Sixth: Cathode voltage reading available by pressing button marked "Cathode."

Seventh: The pin-jack method of effecting connections to the various circuits reduces the number of cables and adapters necessary for the instrument.

▲

LITTLEFUSES

The Littlefuse Laboratories, 1772 Wilson Ave., Chicago, advise: "We have recently added to our line 3AG Type radio fuses (1¼ in. x ¼ in. dia.) in 1, 1½, 2 and 3 amperes capacity. This type is now used in the primary of the power supply of radios. While not as quick and accurate as our Littlefuses they are carefully made and inspected and conform fully to Underwriters specifications. For the B circuit we recommend the No. 1004 ⅛ ampere Littlefuse."

▲

HI-FARAD ELECTROLYTIC CONDENSERS IN CARDBOARD CONTAINERS

In order to meet the demand of radio manufacturers for an electrolytic condenser possessing the same general characteristics of Hi-Farad dry electrolytic condensers in their familiar aluminum can containers at comparatively lower cost, the Aerovox Wireless Corporation, 70 Washington Street, Brooklyn, New York, has recently announced new Hi-Farad electrolytic condensers encased in heavy paper cardboard boxes. These new type P condensers have the same electrical characteristics as the units in aluminum cans but are sealed in cardboard containers with high melting point pitch and provided with long terminal lugs.

These units are available in single sections from one to eight microfarads, and in double section combinations from two to eight microfarads per section. The working voltage of these condensers is 500 volts peak, permitting their practical use in most standard, comparatively high voltage, power supply units. The dry characteristic of Hi-Farad electrolytic condensers makes it possible to mount them in any desired position and they are also unaffected by high and low temperatures or moisture. They are fully self-healing and surge proof and have a very low initial leakage. Their life is far in excess of requirements of the average radio assembly and provide high filtering efficiency continuously.

▲

NEW A-C. INSTRUMENTS

A new instrument, consisting of a copper oxide rectifier and d'Arsonval d-c. galvanometer, has been developed by the Westinghouse Electric and Manufacturing Company as an addition to their line of a-c. instruments. In this new instrument, the alternating current is first rectified, and then indicated by the instrument proper. The use of the d'Arsonval movement, in which a strong field, permanently established by the magnet, enables a moving coil with a very weak field of its own to develop a high torque, effects a high sensitivity with very low internal energy consumption.

It is the development of the "Rectox" unit, or copper oxide rectifier, that has made possible the manufacture of a rectifier type instrument for general use. Previous to its development, rectifier instruments were complicated, unpractical under other than laboratory conditions.

This new type of instrument differs in principle from the usual a-c. instruments in that the torque and deflection is proportional directly to the current, rather than to its square; and, therefore, the rectifier instrument measures according to the average value and not the r.m.s. (root mean square) value of the a-c. wave. However, the scale is usually calibrated to read the r.m.s. value of a pure sine wave; and changes of waveform effect an error.

Consequently, since such instruments read correctly only on a pure sine wave, their application is limited to cases where the waveform is either a sine or of a known form for which a correction can be applied to the readings. This limitation necessitates the recommendation of these instruments only for applications where the usual type a-c. instruments are inapplicable due to the amount of energy they consume. On a 60-cycle circuit of good waveform, and at room temperatures, rectox instruments can be depended upon for an overall accuracy of 3 per cent or better under conditions for which they are suitable.

▲

NEW TUBE DEVELOPMENT TO IMPROVE AUTO RADIO

A new radio tube to overcome the limited power of present-day automobile radio sets is now in the experimental stage at the laboratories of the Arcturus Radio Tube Company, Newark, N. J., according to George Lewis, vice-president and engineer.

After a thorough study, over a period of months, into the efficiency of automobile radio sets, Mr. Lewis states that "this new tube with the increased volume which it makes possible will overcome the usual noises encountered when driving with the windows open, not to mention body squeaks and the rumble of driving over rough roads.

"The automobile set of today delivers between 300 to 400 milliwatts of power, which is not adequate to overcome the so-called driving noises. Tests show that the ideal automobile set should deliver at least 750 milliwatts to give ample volume and at the same time provide reserve power when required. This is similar to the condition of a car traveling along at 45 miles per hour, but yet retaining a reserve power of say 70 miles per hour when necessary.

"The new tube which is now being developed will enable this increased output and make possible ideal reception in automobile radio sets, with no inconvenience by extraneous noises."

▲

A NEW ENAMELER

The Leon J. Barrett Co., Worcester, Mass., announces a new centrifugal filwhirl enameler which will coat a wide variety of articles of wood, fiber, or metal, weighing from a fraction of an ounce to several pounds. The saving in time, evenness of the coating, and freedom from drip and thick spots, together with bulk handling, shows a vast improvement in such operations. Articles are placed in the container and the coating materials enter the machine through a valve. The parts become immediately and completely coated. Any unused excess is thrown off, leaving only the desired even thickness of covering. Every corner and crevice becomes coated uniformly.

The October Issue of Radio Engineering is out at the time of the October Radio-Electrical Exposition in Chicago, Illinois. (Oct. 19 to 25.)

Advertising forms close
September 25

Paid A.B.C. circulation of Radio Engineering is over 9,200 — nearly twice that of any competing electronic or industrial radio publication.

INDEX OF ADVERTISERS

CRC SOCKETS ARE *BUILT* TO STAND the GAFF

PREFERRED
by the Radio Industry
because:

●

They are more *Rugged* than they need be.

●

The *Tempered Steel Springs* insure *maximum contact tension* that is *permanent*.

●

Cadmium plated contacts with large size terminals permit *easy soldering*—thus *speeding up production*.

●

CRC Clips are now available to manufacturers who have assembling facilities.

●

Write for samples.

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Cam switches with housings of Bakelite Molded used in Universal All Wave Receiver made by Pilot Radio and Tube Corp., Lawrence, Mass.

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