electronics

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

The Chicago conventions
I. R. E.
R.M.A.

+

Shall sets be shipped with tubes?

+

Tube costs

+

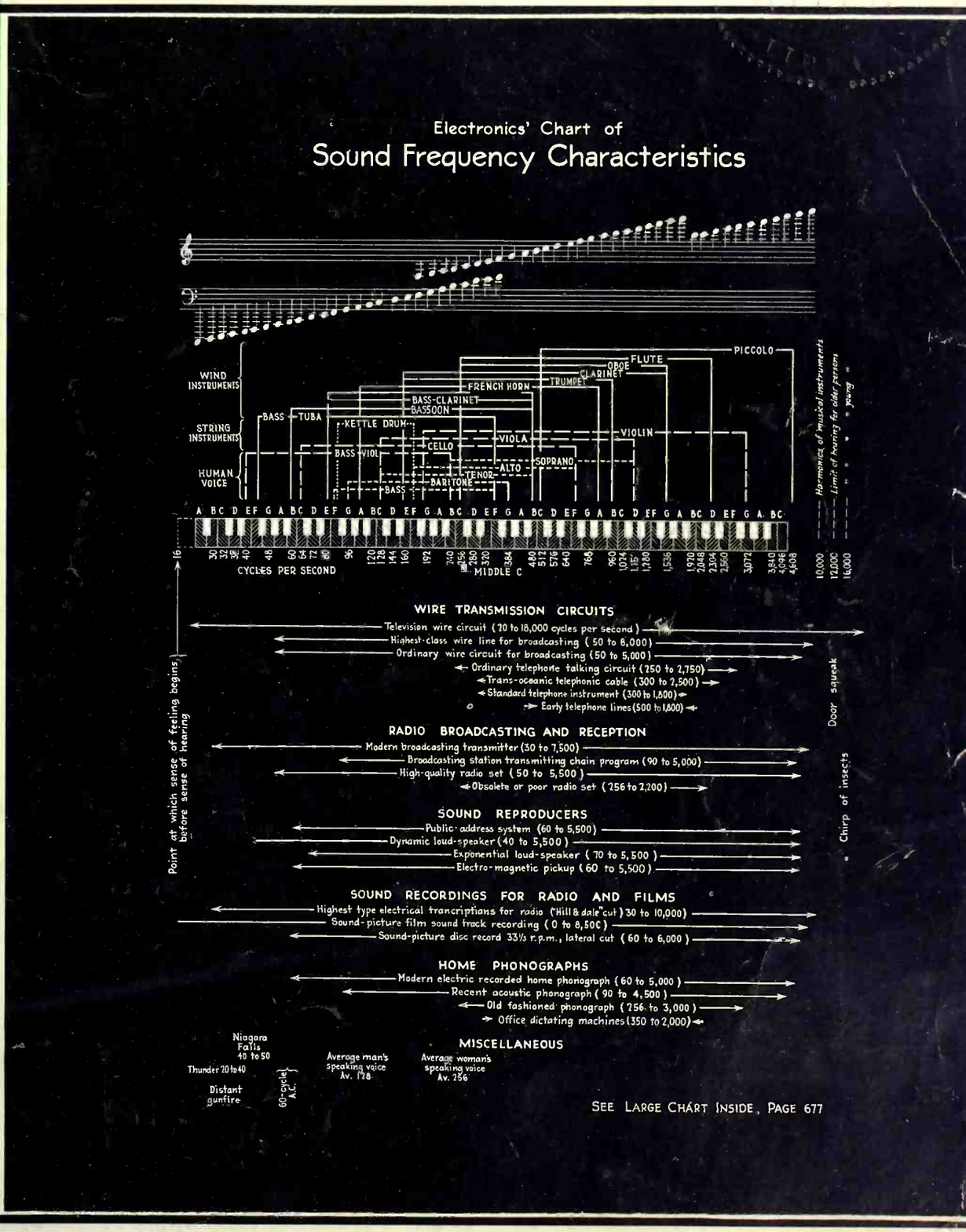
The patent situation

+

Glow-lamp recording

+

Electric-light-wire radio



SEE LARGE CHART INSIDE, PAGE 677

A McGRAW-HILL PUBLICATION

Price 35 Cents

JUNE 1931

Answers to Questionnaire

1. Does dealer carry midget line?
351 answered Yes; 19 answered No.

2. Does he consider midget a good merchandising item?
72 answered Yes; 298 answered No.

3. Do customers [illegible] he carry [illegible]? [illegible] No. [illegible]es?

11. Does dealer install and service midget sets free of charge?
329 answered Yes; 41 answered No.

12. What are the mechanical difficulties most often encountered?
208 answered Tube trouble
9 answered Wiring
92 answered Aerial
40 answered Bad installation
110 answered Selectivity
47 answered Shielding
50 answered Outside noises
42 answered No more trouble than [illegible] sets
[illegible]24 answered Bad treatment by owners

This questionnaire, reproduced from a recent issue of "RADIO", shows the opinions of 370 representative radio dealers on various angles of selling midget sets. Notice question No. 12, where these dealers list the most important mechanical troubles of midgets.

Many Manufacturers
are never bothered
by "Tube Trouble"

See our exhibit at the R. M. A. Trade Show, Booths 45-46, Grand Ball Room Hotel Stevens

Midget sets have shown a high percentage of tube trouble, because they were often equipped with inferior tubes. The object is to cut production costs, but the real cut comes in consumer good will.

Manufacturers who realize the high cost of low-cost tubes, and use tubes of proved dependability, are never bothered by "tube trouble". Many of these far-sighted midget set builders are using Arcturus *Blue* Tubes for standard equipment.

Arcturus Tubes have exclusive features that improve the performance of any set. The Arcturus method of assembling, known as "Unitary Structure", holds all elements rigidly in position and gives extra strength as well as greater uniformity. This rugged construction eliminates microphonism. Actual laboratory tests prove that Arcturus Tubes, made by this method, show 52% less hum than other well-known makes, eliminating many tube complaints. In addition, Arcturus Tubes insure quick 7-second action, and give a pleasing, life-like tone.

If your dealers are reporting too much "tube trouble", try Arcturus Tubes on one month's shipments. The experience of many manufacturers proves that this move practically does away with tube complaints, and keeps the set satisfactorily sold.

ARCTURUS RADIO TUBE COMPANY · Newark, N. J.

ARCTURUS

"The TUBE with the LIFE-LIKE TONE"

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electronics

A McGRAW-HILL PUBLICATION

New York, June, 1931

O. H. CALDWELL
Editor

FRANKLIN S. IRBY, Ph. D.
Associate Editor

KEITH HENNEY
Associate Editor

radio
sound pictures
telephony
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telegraphy
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carrier systems
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electric recording
amplifiers
phonographs
measurements
receivers
therapeutics
traffic control
musical instruments
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metering
analysis
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beacons
compasses
automatic processing
crime detection
geophysics

Chicago—and a broader view

▶ At Chicago during the first two weeks of June, there will gather the engineers and executives of the radio and electronic industries.

▶ The Institute of Radio Engineers meets at the Hotel Sherman Chicago, June 4 to 6.

▶ And the Radio Manufacturers Association will hold its convention and Trade Show at the Stevens, Chicago, June 8 to 12.

▶ These important gatherings will serve for the interchange of views and ideas, and the formulation of counsel at a most perplexing time in radio's history. The new tubes, small sets, tone fidelity, new speakers, television, home talkies, combination units, amplifiers, pricing policies—these will be some of the topics on which light will be thrown.

▶ **But the opportunity and the responsibility that lies before both these Chicago conventions is plain. The time has come to broaden the lines and interests of the men and companies who heretofore have limited themselves to radio. Inevitably the electron tube is pulling these industries far afield into wider and wider ramifications of home entertainment, sound reproduction, and electricity control.**

▶ Radio engineers need to extend their vision into the limitless fields of electronic applications, for which the world awaits their technique and experience. And the commercial radio industry needs to look upon itself as in the business of supplying "home entertainment,"—which includes radio, combination phonographs, home movies, home talkies, amplifiers, and (for the experimentally-minded), television.

▶ Chicago is a city of broad perspectives and long views.

▶ May radio men return from their Chicago meetings with broadened outlook on their radio problems and the electronic opportunities ahead!

SHALL SETS BE SOLD

Industry opinion is sharply divided as to whether set manufacturers should ship sets with tubes

VISITORS to Coney Island a few years ago, were greeted with signs reading

"Big Table d'Hote Dinner $1."

After the hungry diner had entered the restaurant and seated himself, however, he learned, toward the end of his repast, that this "big table d'hote dinner" included no dessert, no coffee, often no bread and butter; these were all extra, and they cost half again as much as the original stripped-chassis table-d'hote, the price figure of which had lured him in.

Something of the same sensation of resentment and feeling of near-deception, has been expressed by many members of the buying public after seeing attractive price-figures in ads for radio sets,—only to discover, upon inquiry, that the price given was "less tubes," this qualification being shown in small type which had before escaped attention.

Most of the Coney Island visitors were "one-time customers, anyway," and it was considered entirely legitimate to confuse or gyp them by this artful device of concealed extras. The same view was for a period applied by radio dealers to the radio buyer as a supposed "one-time customer."

But during the past year or two, a feeling has been growing that the retail price put on the radio set should be its price "ready to operate"; that if a customer was making price comparisons and ultimately discovered he was being quoted in different terms of "with tubes" and "without tubes," the resentment he would experience on discovering the discrepancy would far outbalance the temporary earlier advantage gained by quoting the set at the apparently lower price.

Sets with tubes, ready to operate

As the result, a large number of radio set makers and dealers have now adopted the policy of quoting their sets priced "complete with tubes, ready to operate." Current advertising to the public reveals that the majority of manufacturers employ this plan of pricing complete. Several leading makers, however, still quote prices "less tubes," following the earlier general practice. Dealers are still divided between the two policies, depending on local situations and the immediate trade advantage to be gained from either.

But, increasingly, industry opinion becomes more nearly unanimous that so far as retail sales of sets are concerned, radio sets should be priced complete with tubes when offered to the public. Also, it is agreed pretty generally that tubes should be sold by dealers at the time the set is being sold, so that the customer goes out with a complete and operable outfit.

But as to whether the set should be equipped with tubes only in the dealer's place of business, or should be so supplied by the distributors, or should be fitted out with proper tubes at the set-maker's factory, industry opinion today seems widely divided.

"Dealer, sell the set to the customer, complete with tubes and ready to run." That retail merchandising maxim all sides offer. But whether the dealer shall buy his tubes and sets together or separately, and whether the manufacturer shall or shall not equip the radio sets leaving his plant,—that is still a topic for argument.

Shipping sets with tubes from factory

Those who urge the marriage of the tube and the set, in the nuptial bower of the manufacturer's test room, point out that such practice enables the tubes to be carefully selected and balanced, so that the equipment goes out in best operating trim.

"A set manufacturer who does not exercise supervision over the tubes used in his set," declared one executive, "is taking a tremendous gamble on the possibility of the use of an accessory in his receiver which may completely destroy its satisfactory operation.

"I believe that sales activities during the past year on the part of set manufacturers who have priced their sets to the public complete with tubes, have established in the public consciousness the recognition that a set priced at $75 bare, is more expensive than one priced at $85 complete, assuming in this case that the tube equipment would cost $12 or $15."

Another executive who feels strongly that sets should be shipped complete with tubes, and should be priced to the public at a unit complete price, has this to say:

"I am decidedly in favor of radio sets being sold complete with tubes—in fact, with the tubes installed in the sockets at the factory of the set manufacturer. In this way, the set manufacturer controls the quality of the tubes put out with his sets, and also the tube manufacturer can manufacture tubes, having in mind any refinements required in tubes for a particular circuit. The tubes can actually be tested by the tube manufacturer if necessary in the particular model of set in which they are to be installed by the set manufacturer.

"Then again, it makes a cleaner job all around to advertise to the public the total cost of the set delivered to the home, and with the knowledge that there is nothing else to purchase.

"It also ties together a little more securely the matter of servicing sets, which is quite advisable at the current low prices at which sets are being sold to the public with tubes. Again, it encourages the public to go to only one dealer or one set manufacturer for service and maintenance of a set, without any distinction between tubes, transformers, volume controls, speakers and tubes.

"The result of this practice, I think, will be a more rapid development of improved tubes and better service to the public."

"COMPLETE WITH TUBES?"

But all agree the retail dealer should sell sets to his customers "complete with tubes, ready to operate"

Discount and substitution evils

On the other hand, those who feel that tubes should not be shipped with sets, but should be purchased separately by the jobbers and dealers, present many arguments for this policy.

Supply of tubes to set manufacturers for installation in sets results in extreme discounts which invariably exert a demoralizing effect on other tube sales all along the line.

Dealers are prone to remove standard tubes supplied with sets and shelve these for re-sale later, meanwhile replacing them with substandard merchandise which can be purchased at a price which nets the dealer a comfortable profit on the transaction. This exchange of poor tubes for good tubes, of course, destroys any advantage from matching up the original tubes at the factory, observe the critics.

Tube makers who oppose factory shipments also declare that modern tube-machine production produces so uniform an output that matching of tubes in sets is now unnecessary. Moreover, the jobber and dealer, they declare, today need dollar volume to handle their lines, if they are to continue to exist. Tube contracts swell this volume and also aid in handling replacement business which the tube people still are hopeful can be developed into an "annual renewal" affair, if not a matter of "1000 hours' burning."

Although tube list prices recently underwent a sharp reduction, it is likely that there are still unconsumed margins to be whittled away, and that further price reductions may be in sight, as the tube and set situation stabilizes.

Replacement policies involved

Many tube salesmen, representing both manufacturers and jobbers, employ, as a clinching sales argument, the offer of 100 per cent replacement. Taken at its face value, this means that any tube that a user returns, whether it is broken or whether it has given normal service, will be replaced by a new tube without charge to anyone. Of course, it is impractical that this advantage would be limited to only one link in the distributing chain. The competition existing between the dealers who enjoy the same replacement privilege will cause the extension of this policy all the way to the user. It must per force become universal in its application.

Should the practice, on the part of the set manufacturer, of furnishing his set complete with tubes, become universal and a 100 per cent replacement policy be standardized, just what tubes will the jobber and dealer sell? Outside of a very few experimenters no one would need a tube, except to replace one in a set which came equipped with tubes. These tubes would be replaced for nothing if a universal 100 per cent replacement policy prevailed! The jobber and dealer must then either surrender all interest in tubes, or else establish themselves as service stations for the manufacturer, bear all handling charges, all the overhead expense of doing business, yet realize not one cent of return.

Much to be said on both sides

Where tubes are shipped direct from factory with the sets, it is also pointed out that the renewal business, unless also handled by the set manufacturer through his service organization, will not be equipped to make replacements of tubes of identically the same kind and quality.

Thus the question of whether radio sets shall be equipped with tubes in the factory, and so shipped, or whether tube initial equipment shall constitute an article of merchandise to be handled by distributor and jobber, still remains a moot subject. The industry is not yet agreed, and seems further away from an agreement than a year ago. Both sides have distinguished support, and can marshall strong evidence and convincing argument.

But there is already substantial industry unanimity behind the position that so far as the public is concerned, the dealer should offer his sets "complete with tubes and ready to operate."

THE TWO POINTS OF VIEW

Sets should be shipped with tubes

because:

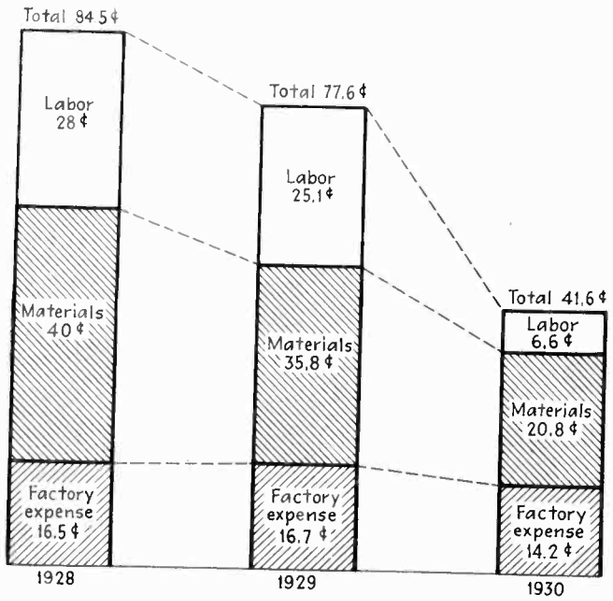
- **Enables set maker to control quality of tubes**
- **Enables set maker to match tubes in sets**
- **Insures set reaching dealer complete**
- **Insures set being merchandised with tubes**
- **Enables initial tubes to be purchased most economically**
- **Encourages public to go back to same dealer**

Objections to shipping sets with tubes

are:

- **Brings about discount evils which demoralize all tube sales**
- **Reduces volume of jobbers' and dealers' businesses**
- **Matching of modern tubes is declared unnecessary**
- **Results in forcing of brands of tubes with sets**
- **Loads dealers with unnecessary stocks**
- **Results in replacing with sub-standard tubes**

ANALYSIS OF VACUUM



Labor and material items in manufacture of 227-type tube

COSTS of making tubes have decreased steadily since the early days when an annual output of 1,000,000 vacuum tubes was considered a record, down to the present time when an average of 50,000,000 a year seems assured.

Tube costs are broken down differently by the several manufacturers but in general they are made up of *material* (about 21 cents per tube), *labor* (about 8 cents per tube), plus *factory overhead* made up of rent, depreciation, heat, engineering salaries, etc. To these costs must be added administration, selling, advertising and other expenses which bring the total average cost of making and selling a tube so perilously close to the price which the tube brings.

Through the cooperation of tube manufacturers the data below are presented showing not only the average unit cost of making tubes at the present time but the spread between these figures and the lowest selling price. This difference between the total manufacturing cost and the lowest selling price, must bear the sales cost, administration expenses, profit—if any,—and other items which eat up the present differential of about 23 per cent.

Figures show that 60 per cent of present tube production goes as initial equipment at about 23 per cent above manufacturing cost, and that about 40 per cent goes to jobbers at about 44 per cent above cost price. The average sale price is about 32 per cent above manufacturing cost.

So low has manufacturing cost become that future profits will probably come from lower distribution costs. One manufacturer states that by dint of working over the figures on all types of tubes for a day or two a cent might be pared from present costs, without throwing into the discard present testing and checking to see that only good tubes leave the plant. Since 1928 the cost of making the 227-type tube has decreased from 84.5 cents to 77.6 cents in 1929, to 41.6 cents in 1930 and to about 40 cents in 1931. Costs—and prices secured—are decreasing asymptotically and it is still a question of whether selling prices will not be lower than cost prices.

Greater output—lower distribution cost

Decreased distribution costs must come from greater output. Tube plants on the average are working at about 25 per cent capacity. Where the additional tubes will go to so reduce the distribution costs that a manufacturer of tubes can make money on them remains a serious question. Undoubtedly the failure of the replacement market to mature was a major blow at the hopes of tube makers; but widespread overproduction (it is said at one time 50 million tubes overhung the market) and the consequent desire to "get out from under" with resultant tremendous discounts to certain markets has been of greater influence than any other toward making the tube maker's business profitless.

A manufacturer can decrease the life of his tubes but would probably be lost himself very soon; there has been some attempt to get all tube makers to advertise to the public the wisdom of changing tubes once a year, but such campaigns are doomed to failure, some tube manufacturers feel, because the public will refuse to be kidded into installing seven or eight new tubes merely because the overworked rectifier has lost its supply of electrons. Heater-type tubes of reputable manufacturers now last 2,000 to 4,000 hours, not the thousand hours expected when plants were doubled in size in 1929.

Perhaps, as some feel, it is time for an enterprising

Margin between production cost and selling price

(in per cent)

Production cost=100%		Set manufacturer's price (Manufacturer No.)					Jobber price (Manufacturer No.)				
		1	2	3	4	5	1	2	3	4	5
Tube type	224	6	0	41	31	29	18	19	64	64	62
Tube type	227	6.5	0	36	41	30	11	19	55	75	33
Tube type	245	4	2	67	47	30	46	22	90	85	47
Tube type	280	4	3	79	56	24	32	30	100	97	47
Tube type	235	...	1.5	42	32	24	..	21	66	48	75

TUBE PRODUCTION COSTS

manufacturer to build a superlative tube, guarantee its existence for 2,000 to 4,000 hours, charge more for it, advertise it as a better tube. Sales might drop off, but the difference in price might mean the difference between profit and loss. Perhaps, indeed, the low price craze has run its course. High discounts are proper for old merchandise not equipped with quick-heater humless cathodes, but why penalize manufacturers of quick-moving lines not snowed under by the results of over-production—so they reason. Others feel that a side line, something else to make and sell, is the only hope, something they can export—present licensees are not permitted to sell tubes abroad or in the domestic market for other than home entertainment purposes. Such items might be cathode ray tubes, Neon signs or other products involving vacuum or gas tube technique.

All feel that something must be done about rash replacement agreements made by some manufacturers and almost automatically forced on the industry. It is said that one maker promised "100 per cent replacement" and to his surprise almost had to make good—over half his tubes came back, nearly all unjustly of course. Another prominent manufacturer stated that although they had few tubes come back they maintain service stations in three parts of the country at considerable expense, just to handle those few cases where replacements may be necessary.

Time will come, according to some, when tubes will be sold like lamps, pay your money and take them away. Once out of the store, there would be no come back. Whether tubes can be sold on such a basis or not remains to be seen, but there is no doubt that replacement policies are in for considerable change. Replacement charges must be borne by the distribution system except those tubes that actually prove to be unfit for service due to some manufacturing or inspection failure.

Unlicensed manufacturers, according to those favored with protection against patent suit, have an economic advantage equal to the royalty percentage. On the other hand those not licensed, and anxious to maintain their reputation for making high grade products claim that this economic advantage does not exist—it is used up in research and development which, they feel, will ultimately be to their advantage in the discovery of new processes or the invention of new items for sale.

Tube manufacturing costs—1931

(Based on five types most used)

Average production cost (does not include sales cost)	**48.7**	**cents**
Average set manufacturer's price	**59.7**	**cents**
Average jobber's price	**70.0**	**cents**
Average dealer's price	**91.0**	**cents**
Average list price	**$1.65**	
Margin between cost and lowest price	**23**	**per cent**
Margin between cost and jobber price	**44.5**	**per cent**

The figures given here include everything up to the point of shipping or selling the tube. They do not include sales costs which in turn must include discounts for cash, advertising expense and the part of administration overhead not carried by the manufacturing department. In some cases this additional burden makes the total cost per tube greater than the average price received. One manufacturer gave figures showing that during the month prior to this survey he had distributed his tubes at an average price of about 11 cents above factory cost.

Individual figures differ greatly as the data above will show. Some manufacturers put license fees in factory cost, some in sales cost and others do not know what to do with them!

Manufacturers of high grade tubes seem unanimous in stating that to decrease prices further will probably decrease quality. Dangerous rocks still to be negotiated by tube makers are the continual clamor of set makers for cheaper tubes, the warehouses of tubes still overhanging the market, disappointment at the replacement market, uncertainty of popular interest in radio, and the depressing effect of patent and technical uncertainty.

▼ ▼ ▼

RURAL LISTENERS DEPEND ON "CLEARED" CHANNELS

My observation is that regional stations give excellent local service, but rarely are heard without interference beyond 50, or at the most, 100 miles. The purely local stations with very low power, of course, can be heard only within a radius of a few miles.

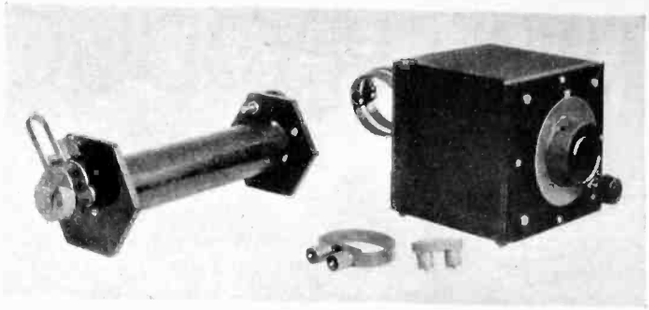
It is the cleared-channel broadcasting stations that are doing the big rural job.

HAROLD A. LAFOUNT
Federal Radio Commissioner

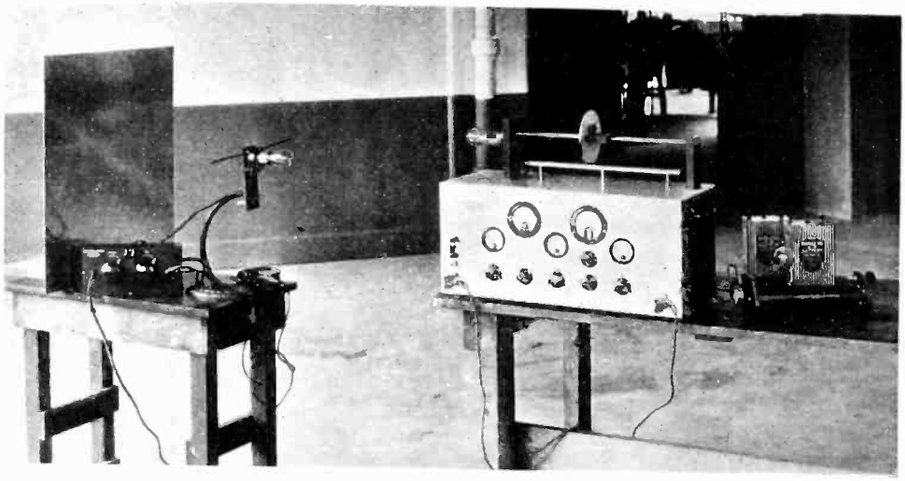
Communication on the quasi-optical frequencies

By EDUARD KARPLUS

General Radio Company

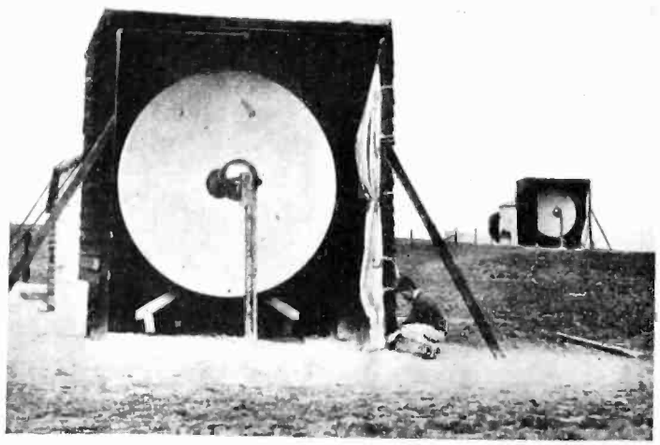


Wavemeters used for ultra-high frequencies. This apparatus covers the range between 0.5 meter and 10 meters wavelength



Laboratory transmitter and receiver for investigating the very high frequencies produced by a Barkhausen oscillator in which the frequency is determined by the time required for electron transit within the tube

THE shortest waves commercially applied today are in the band around 10 meters which is used in long-distance communication. Shorter waves cannot be used over long distances, as they are not reflected from the upper atmosphere and, consequently, may be received only when a direct path extends between transmitter and receiver. Down to about 3 meters the waves still follow the curvature of the earth and are bent around mountains and larger obstacles. At still shorter wavelengths, however, the propagation follows laws similar to those found in optics. Even large buildings completely obstruct the path of waves shorter than 1 meter. Below 10 centimeters almost no radiation is left, as the waves are absorbed and scattered in the immediate vicinity of the transmitter by the humidity of the air and by its content of carbon dioxide. Only the much shorter electro-magnetic waves in the heat and infra-red range radiate once more and can be applied to communication under special conditions.



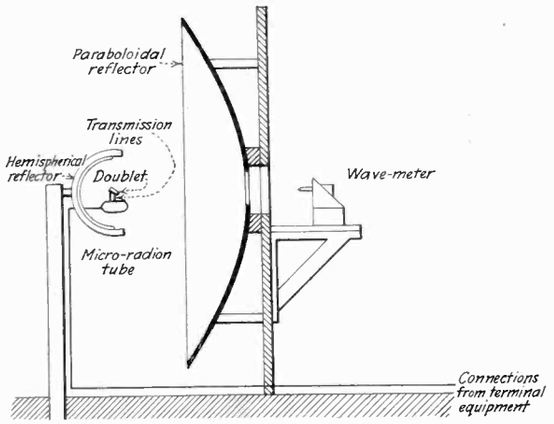
Transmitter and receiver used by the I. T. & T. experiments by which on March 31, 1931, communication across the English Channel was maintained on a wavelength of 18 centimeters

It is possible today to produce electro-magnetic waves in all the range between 10 meters and visible light. Down to 1 or 2 meters, straight oscillating circuits can be used, but the energy is rather small at these high frequencies. One of the difficulties in producing these waves is that it is very difficult to build tuned circuits with sufficiently high impedance. Another difficulty is that the time required for an electron to get from one electrode inside of the tube to the other electrode approaches the time of a whole period of the circuit oscillation.

Both of these difficulties are avoided in the electron oscillator first described by Barkhausen and Kurz. Using that circuit it is possible to produce continuous waves in the region between 5 centimeters and 5 meters. The energy, however, is only of the magnitude of 0.1 watt. An electron oscillator consists mainly of a three-element tube in which the high voltage is applied to the middle electrode and the outside electrode is used to modulate the oscillations. This method of control is used both for modulation in transmitters and for detection in receivers. No closed tuned circuit is used in connection with an electron oscillator; the only tuned circuit is the

radiating system. The wavelength is determined mainly by the voltages applied to the tube and by the dimensions of the electrodes. With commercial tubes, waves of about 40 centimeters can easily be obtained. Special tubes have been designed which oscillate at about 5 centimeters. As mentioned before, the wavelength is mainly determined by the voltage applied. To decrease the wavelengths, the voltage must be increased. As the efficiency of an electron oscillator is very low, the losses in the tubes increase rapidly with increased voltage and limit the frequencies that can be obtained. These losses are particularly serious in an electron oscillator as the heat has to be dissipated by the grid.

To produce even shorter waves, spark oscillators can be used, and harmonics of these oscillators have been detected even in the range of heat waves. Oscillations in the infra-red range are best produced by electrically-excited gases; for instance, helium tubes similar to those used for street signs.



Double-reflector used at Calais in the I. T. & T. experiments. Radiation leaves such a system in practically straight lines. The power used in the English Channel experiments was one-half watt.

Problems of reception

In addition to the laws of propagation and to methods of producing oscillations, the problem of reception of quasi-optical waves discloses features not encountered at longer wavelengths. The types of receivers most frequently used in the broadcast range cannot be used for quasi-optical waves. Radio-frequency amplification with tubes now available is impossible below 10 meters nor can superheterodyne methods be applied as the frequency would not be sufficiently constant. The simplest receiver is therefore an ordinary detector. A detecting crystal or tubes may be used. Tubes can be used only for waves above 1 or 2 meters. As it is very easy to handle these receivers, they are very useful whenever the field strength is high enough. When a tube is used as a detector, an increase in volume can be reached by regeneration. Another method of increasing the volume is by the use of the super-regenerative circuit, which seems to be very useful in the quasi-optical range.

In the range of electron oscillations, out of all the known receiving circuits, the crystal is the only detector which can be used. It works out, however, that an oscillating circuit very similar to a transmitter can be used most effectively as a receiver. With such a receiver, telephone communication has been possible over a distance of 20 miles, using only 0.1 watt output.

For infra-red radiation photo-electric cells, sensitive in the proper region, are used as receivers.

Quasi-optical waves can be applied in short-distance communication and offer the advantage that different stations do not interfere, even at very nearby frequencies, due to the limitation of radiation. By the use of reflector systems, radiation can be still more limited and concentrated in the desired direction only.

Another most important fact is the possibility of modulating quasi-optical waves at very high frequencies so that multi-channel operation is secured.

Ultra-high frequency wavemeters

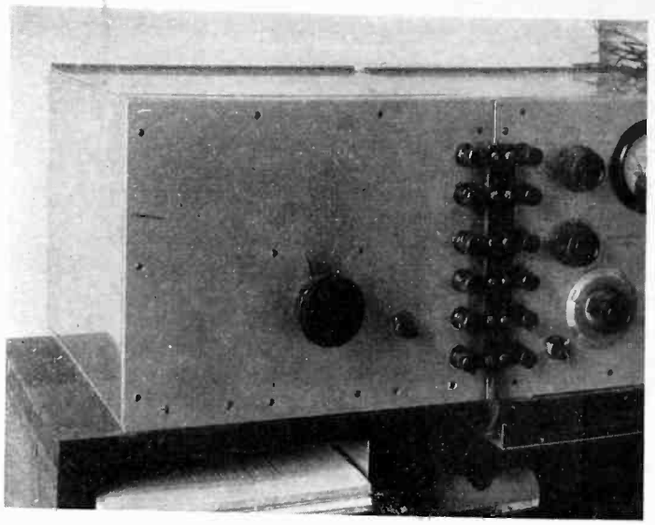
A wavemeter is shown in the illustration for 0.5 to one meter. The inductance and capacitance of that wavemeter are made of a single piece of metal. Another wavemeter covering, with three plug-in coils, the range from 1 to 10 meters is illustrated as well. On the left side of the laboratory photograph is a receiver and on the right side an oscillator for electron oscillation. It can be seen that the only way of tuning the receiver in the usual sense, would be by the doublet on both sides of the tube. Setting of the receiver to maximum volume is done with the two dials, in the wooden case, which change the voltage applied to the filament and to the grid. The oscillator shown is not built for use as a transmitter and hence has no provision for connecting a reflector system. The only tuned system of the oscillator is the system of Lecher wires, extending to the right side of the tube. These Lecher wires can be tuned by sliding the round disk that represents a condenser. Three different socket adaptors are provided that make it possible to use different tubes.

▼ ▼ ▼

Will future broadcasting be on ultra-short waves?

EXPERIMENTS in Germany on waves below ten meters are attracting world-wide interest for they may point a way to the broadcasting structure of the future. Waves a few meters, or even centimeters, in length, once thought useless, may prove to be the future bearers of entertainment and information. Of short range and not so disturbed by static and other noises, the ultra-high frequencies may provide us with hundreds of channels for communication in each local district.

A laboratory oscillator for receiver testing

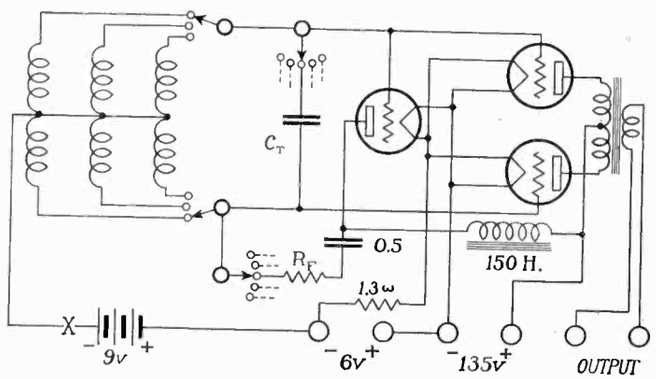


External view of oscillator, showing connections to standard signal generator

By C. J. FRANKS

Radio Frequency Laboratories, Inc.

THE laboratory testing and rating of radio receiving apparatus has in the past two or three years grown out of the old haphazard guessing methods in which anything would get by, into quite a comprehensive and exact science. Competition prohibits the placing into production of any model which has not been thoroughly tested and found to equal or better the performance of contemporary models. For this reason small differences of performance which a short time ago would have passed unnoticed are now made the subjects of exhaustive tests, and no stone is left unturned to work out, in the last detail, every possibility of improvement. The reaction of this upon the engineer in the design laboratory is that his testing methods and equipment must be on par with those of his fellows if his work is to compare in speed and accuracy. As testing requirements become more severe, testing technique and apparatus must keep pace, and the design of equipment must constantly be improved; apparatus with which we were well content two years ago is now almost obsolete. Standard signal generator equipment formerly considered adequate has been proved to be totally unfit for use with the highly sensitive and selective receivers being built today, while, perhaps next in importance to this most important of all testing essentials, our audio frequency apparatus has also rapidly been made obsolete by the advanced technique of today's testing methods.



Circuit diagram of oscillator

It is scarcely necessary to go in great detail into the shortcomings of the various types of audio frequency oscillators at present commercially available. It is safe to say, however, that no existing type of oscillator, exclusive of certain very large, complicated, and expensive beat-frequency designs, is wholly suitable for use with the modern standard signal generator. The chief objections to practically all of the oscillators at present available to purchasers of laboratory equipment are:

(1) Insufficient output. It has been demonstrated that, for satisfactory performance, a standard signal generator must have as its power source a vacuum tube at least as large as a 112-A, utilizing a plate battery of at least 90 volts. In order satisfactorily to modulate such an oscillator, allowing for losses in the filtering and circuits of the generator, the audio frequency modulating source must be capable of maintaining at least 75 volts across a load of 10,000 ohms, which represents a power output of about half a watt. In order to obtain this power from existing types of oscillator an external amplifier stage, with its resultant power supply complications, must be interposed between oscillator and signal generator.

(2) Poor wave form. It is quite common to find harmonic contents up to 20 per cent, especially at the lower frequencies, in even the best existing oscillators.

(3) Length of time required for the setting up of desired frequencies. This is a very serious objection, from the standpoint of laboratory efficiency.

(4) A number of minor objections, such as high initial cost, non-homogeneity of appearance with signal generator equipment, poor output vs. frequency characteristics, etc., will be familiar to the engineer who has had to use equipment not designed for the particular purpose of radio receiver testing.

It was in an attempt to eliminate most of the above objections and to design an oscillator which would provide the utmost of convenience of operation that the following list of requirements was set up:

(A) The frequencies were to be direct reading, no calibration charts or calculations being permitted.

(B) Sufficient frequencies were to be provided to make possible a fairly complete determination of the fidelity characteristics of the usual radio receiver. No attempt was to be made to permit an extremely fine adjustment of frequency such as is required for the test-

ing of loudspeakers, filters, transformers with sharp resonance peaks, etc.

(C) The output was to be constant to, at most, plus or minus 10 per cent as the frequency was varied over the range.

(D) A total harmonic content of 5 per cent maximum was to be permitted.

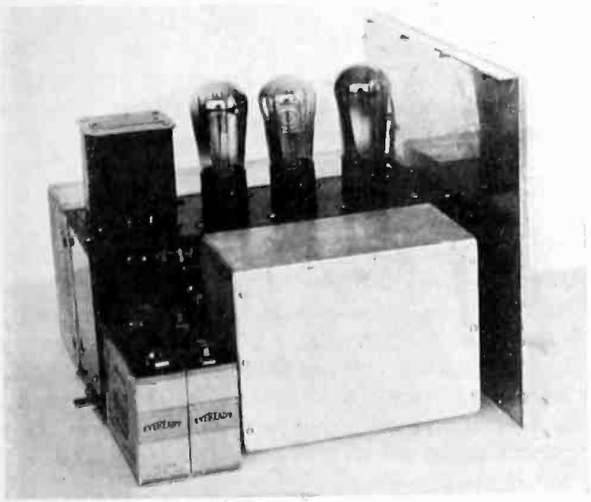
(E) Power for the operation of the oscillator was to be obtained from the source supplying the standard signal generator.

(F) The completed apparatus was to be homogeneous in size and appearance with the signal generator with which it was to be used.

(G) The power output was to be one-half watt minimum.

The oscillator which was built to fulfill these requirements is shown in the accompanying illustrations. It may be of interest to list the features of this oscillator in the same order as the requirements, so that the degree to which it was found possible to fulfill them will be more readily apparent.

(A) All of the adjustments required for changing frequency are performed by a single control knob, provided with a click system so that the point at which the adjustment is correct is made apparent to the sense of touch. In practice it has been found that the operator will memorize the frequencies available and thereafter never even look at the oscillator panel while going through the entire range.



Side view with outer case removed

(B) The oscillator is provided with eleven frequencies, 40, 70, 100, 200, 400, 700, 1,000, 2,000, 3,000, 4,000, and 7,000 cycles per second. Other models have been built with slightly different frequencies distributions in the region 1,000 to 5,000 cycles, in order to make them more useful in determining accurately the rather steep cutoff points found in some modern radio receivers. However, in no model was it found necessary to provide more than fourteen frequencies, and all have retained the essentially logarithmic frequency distribution below 1,000 cycles, this having been found practical, convenient, and entirely adequate.

(C) The method employed for adjusting the output voltage will permit adjustment to almost any degree of precision; the output may be held to plus or minus 1 per cent if desired. It was found convenient, however, to allow the output voltage to vary slightly in such a manner as to complement the signal generator characteristics, as will be explained later.

(D) The output of the oscillator was analyzed by means of a harmonic analyzer and found to contain about 3 per cent total harmonics.

(E) The power required is: 0.75 amperes at 6 volts, and 40 milliamperes at 135 volts. Besides this, a 9-volt biasing battery is contained within the case of the oscillator.

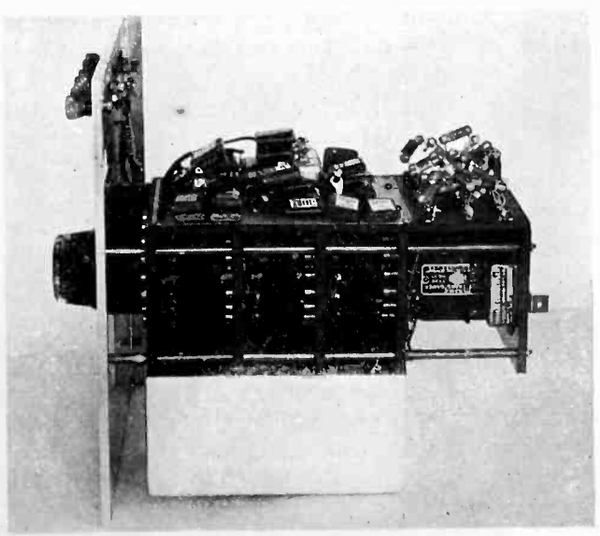
(G) The oscillator will maintain a voltage of 80 across a load of 10,000 ohms.

Technical details of the oscillator

Circuit details are shown on another page. Three 112-A tubes are used, one as an oscillator and the other two acting in push-pull as amplifiers. The oscillator circuit is the well-known Hartley, with the feedback controlled by a resistance R_F in the (a.c.) plate circuit of the oscillator tube. By adjusting this resistance during the calibration of the oscillator, the output amplitude is set at the desired value. Since the harmonic content of the output depends upon the oscillator amplitude, this feedback control may also be thought of as a harmonic control. The theory of operation of this circuit is well known, having been several times described in the literature, and needs no further exposition here.

The tuned circuit inductance is wound in two accurately equal halves, the center point of the coil being grounded. Any current flowing in the circuit will produce two equal voltages, 180° out of phase with each other referred to ground, across the halves of the coil. These two voltages can be applied to the grids of two amplifier tubes whose outputs are combined in push-pull; if the d.c. potential appearing on the coil is also made correct for amplifier action, no coupling devices need be provided, the grids connecting directly to the coil terminals. Besides the beautiful simplicity of this scheme, it is evident that since no coupling means need be inserted between oscillator and amplifier, no unwanted frequency characteristic is introduced, and it is only necessary to maintain constant oscillator amplitude over the frequency range in order to maintain the amplifier grid excursions similarly constant. The only frequency discrimination in the entire system is introduced by the output transformer, but no difficulty is experienced in building such a transformer to have a substantially flat characteristic between 30 and 10,000 cycles.

Three oscillating coils are provided to cover the range 40 to 7,000 cycles, each coil being connected into the



Bottom view of switch mechanism

circuit, by proper paralleling of the switch contacts, for about one-third of the frequencies provided. The largest is an iron-cored coil having approximately 25 henries inductance, and operating over the range 40 to 200 cycles. The middle range is covered by a coil of about one henry inductance, which may be either air or iron-core, while the frequencies above 1,000 cycles are tuned by an air-core coil which may have about 30 millihenries. The values of inductance given are for the entire coil, and are not critical, it being merely necessary when building the coils to obtain a fairly low a.c. resistance, a value of inductance which will be tuned to the desired frequencies by reasonable values of capacitance, and to make certain that each coil's centertap is accurately placed so that the voltages appearing across the halves of the coil will be equal.

It will be apparent that it is quite possible, by careful choosing of coil inductances and oscillation frequencies, to make some of the tuning capacitances serve for more than one frequency. This is not practical, however, because of the difficulties encountered in adjusting accurately the inductance of a coil which must also have an accurate centertap, and because the load of the tube circuits causes the oscillation frequency to depart somewhat from the LC value.

Switching mechanism details

A total of four contacts must be made for each frequency desired: two inductance contacts, one capacitance, and one resistance. In the circuit diagram but one capacity and one resistance are drawn in; it will be understood that there are actually as many of each as there are oscillation frequencies. The switching is accomplished by four lever type switches all mounted on one insulated shaft so as to move together, each having contact points equal in number to the number of frequencies desired.

A suggested method of construction is shown in the figures. The advantage of this type of construction is that it lends itself to a form of unitary assembly of all the elements directly upon the body of the switch mechanism, making the wiring very simple and direct. It has, however, certain disadvantages which are quite serious. One is that of initial cost. All of the switching mechanism is special and must be built by a fairly skilled mechanic.

A much simpler and cheaper design has recently been worked out by M. E. Bond, of the United American Bosch Corporation. His design utilizes the commonly available "anticapacity" key switches, one switch being required for each two frequencies. If the keys are properly arranged upon the panel, wiring becomes very simple and straight-forward, and it is very easy to mount the condensers and resistances for accessibility.

In the design shown the two aluminum boxes mounted on the sides of the switching mechanism contain the circuit elements. One contains the three oscillating coils, the box being filled with a sealing compound to prevent as far as possible any change in the coil characteristics after calibration. The other box acts merely as a dust cover to protect the condensers and resistances, the method of mounting of which, together with the tubes, output transformer, and oscillator plate choke, will be evident from the illustrations.

Methods of calibration

The completed oscillator can most conveniently be calibrated by beating its output with that of another oscillator of known accuracy of calibration, the beats preferably being indicated upon some sort of meter in addition to being made audible. This is desirable especially at the lowest frequencies where aural detection of the beat becomes difficult, and is further useful in that observation of the amplitude of the beats will enable the operator to distinguish between the true fundamental beats and the false beats between harmonics.

The various steps of the oscillator are calibrated in turn, each step having connected to the proper taps a condenser of the value found by trial to tune to the desired frequency and a resistance of the proper value to set the oscillating amplitude to the desired value. This amplitude may be varied through quite wide limits, depending upon the output desired and the permissible harmonic content, and may be indicated during calibration either by connecting a vacuum-tube voltmeter across the oscillating circuit or by inserting in the center-tap lead of the coils in series with the "C" battery (at the point marked X on the circuit diagram) a d.c. microammeter. The reading of this microammeter is a rough indication of the amplitude of oscillation. A current of about 100 microamperes has been found to correspond to an output of about one-half watt and a harmonic content of about 3 per cent total. It has been found desirable to increase the output slightly on the frequencies above 2,000 cycles, in order to compensate for losses in transmission through the usual standard signal generator filter systems, thus obtaining a more constant input to the modulating circuits of the generator. This is done by permitting progressively more grid current as the frequency is increased, a maximum of about one milliampere being permitted at 7,000 cycles. The output with this grid current is about one watt and the harmonics total about 10 per cent, but since they fall far outside of the transmitted range of the signal generator and receiver they can cause no harm. The oscillating circuit used will be found to have a very low second harmonic output, most of the harmonic total being made up of third; this of course is of some advantage when the output is increased as described.

If no calibrated oscillator is available, calibration of a new oscillator may still be accomplished with the aid of any source of frequency which can be adjusted. With this secondary source and one or two known frequencies, such as may be obtained from tuning forks, a complete calibration may be obtained by the use of the harmonics of either source, sufficient frequencies being obtained from the multiples and submultiples of the known frequency to make possible a satisfactory calibration. Or the frequencies may be obtained directly from a piano, the frequency values of the various notes of the International scale being known. However, lacking any of the above sources, a calibration may still be obtained by reference to the power system, the frequency of which is held to considerable accuracy in most places. The lower frequencies are obtained directly from the power system harmonics or by various combinations, as for example, 40 cycles being desired, the third harmonic of the oscillator, 120 cycles, can be beat against the 120 cycle harmonic of the power frequency.

The upper frequencies are then obtainable from those already calibrated, the only tools required being a musical ear and knowledge of the numerical relations of the musical scale. By humming the notes of the major chord whose tonic is the known frequency and bearing in mind that the frequencies of the notes do, mi, sol, do are in the relation 4 : 5 : 6 : 8 a calibration may be obtained.

Where television stands today

A crude device for enthusiasts only—still far from entertainment value—but nevertheless offering considerable immediate market for sales.

ACCORDING to the prophets, television has been "just around the corner" for several years. The truth of the matter now is, that television is here, crude to be sure, but nevertheless here. According to promoters, buyers of television stocks now will find themselves among the numbered few who bought "Radio" and held on, who had the courage to buy Remington or General Motors, who made their millions in one or another of those lucky ways.

Radio dealers buying outfits

Television as engineers view it has not progressed very far in the past year. But lack of progress is no reason why a considerable market can not be built up for present apparatus, crude as the pictures are that owners will see; at least this is the way some television people look at it.

In Boston, activities proceed at a feverish pace with a television station on the air sending out pictures which owners of sets, bought in the form of parts from Kresge stores, can see. In New York no less than four stations are on the air and considerable experiment goes on to improve matters technically. In Chicago two established stations broadcast things to look at.

Public interest in television is tremendous, fostered by glowing reports in newspaper articles and by free demonstrations. Radio dealers, using television sets as curiosity-creators and come-ons to get customers in their stores have, so far, furnished the largest outlet for television receivers. Whether they can interest other "lookers" sufficiently to spend from $100 to $300 for a televisor depends. It is the common guess of engineers and merchandisers that the public will not look long enough to get its money's worth—at present.

There can be no doubt about the sincerity of some of the television people. They have spent time, money, and energy in getting ready for the public television broadcasts and receivers. They have improved the art, they have not been dismayed by the commonly expressed though unfair statement that there is nothing new since the scanning disc. If they desire to test the market and do so by developing good looking receiving equipment practically fool-proof in operation and desire to spend the money for high-grade transmission equipment, that is to their credit and, let us hope, to their profit. Without a doubt technical good will come of such efforts.

Present television "interest-duration"

On the other hand, listing a television stock on the Curb exchange will not provide a substitute for the scanning disc, will not increase the detail or size of a picture. It requires engineering and not promotion for this kind of advance, and nowadays engineering can be bought pretty cheaply.

The public who will, no doubt, be encouraged to buy television receivers must not be told to expect too much if dealers want to get much except the down payment. The interest holding ability of the average material televised now is about five minutes. On the other hand, engineers who decry attempts to put television on the air and who pooh-pooh present systems as being worthless because there still is a scanning disc must remember that many thousands of radio sets were sold and their owners entirely satisfied before a dynamic speaker came on the market, that power tubes were not available until 1925 (sale of receivers began in 1920) and that because of low power of broadcast stations, daytime reception of clean strong signals is still limited to those who live near cities.

Elaborate ceremonies attending opening of a television studio in New York City

The German super-midget receiver

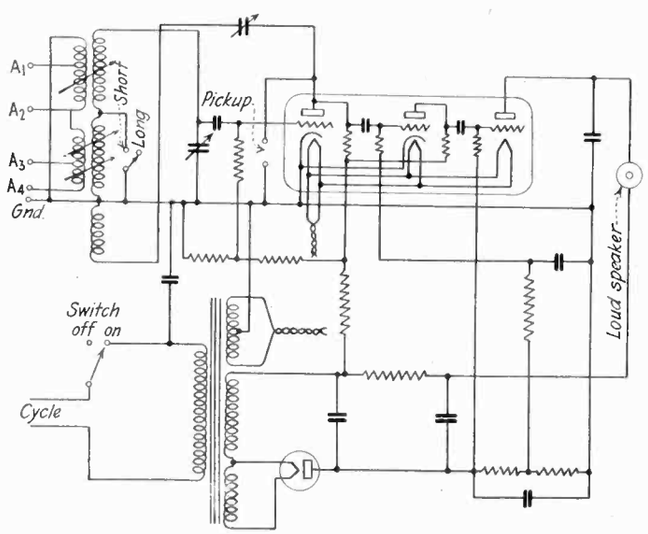
By R. RAVEN-HART

Foreign Correspondent, Electronics

THE "Super-Midget" (or should one say "Infra-" or "Ultra-Midget"?) is very much to the fore in Germany, thanks in part to the economic crisis there as elsewhere, but also thanks to the excellent performance of these little sets and to their compactness and convenience.

There are at least two receivers selling at $25 complete with tubes: in addition, there are several others at slightly higher prices, and others are promised. All are electrified, with built-in loudspeakers, have provision for gramophone pick-up, wave-band switching between the long and normal bands, and alternative antenna couplings to suit local conditions.

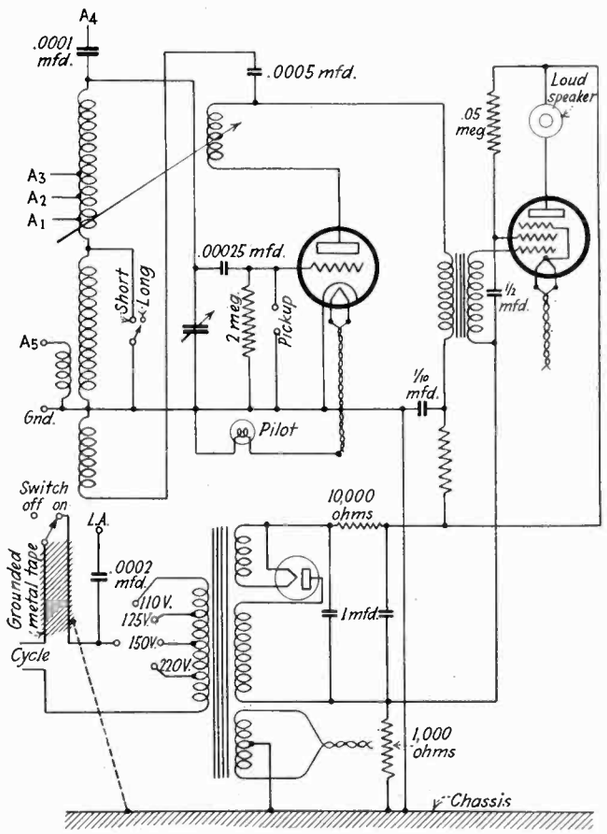
The circuit is the simplest possible. The antenna pin-jacks are to allow of the coupling most suitable as regards selectivity and volume; a jumper to the jack marked "LA" allows the supply mains to be used as antenna. Wave-band switching is effected by short-circuiting a portion of the tuning coil: the extra regeneration coil necessary on the longer waves is left permanently in circuit, but these short-circuited turns reduce its effect on the normal band, by partially screening it. Regeneration control is by a coil revolved within the tuning coil. A link can be changed in position to adjust for the four a.c. voltages met with in Germany.



A Loewe midget. Note the "three-in-one" tube

Good quality in spite of low price

Several points that can be criticised are: the danger of interference from such a simple regeneration control, the loss of high notes associated with regeneration, the effect on the pick-up characteristics of the parallel resistance, etc., the scanty filtration, and so on. Nevertheless,



The two-tube Brand midget, selling for $25

the writer must admit that the reproduction of local stations is quite pleasant—far better, for example, than that of the average French superheterodyne receiver—always assuming that a reasonably low volume level is maintained and that regeneration is not abused.

The other diagram is that of one of the slightly more expensive sets, using the interesting Loewe "three-in-one" tubes. Here, it will be noted, in addition to the alternative antenna positions variable antenna coupling by moving coils is provided, one external lever actuating the two halves of the antenna coil simultaneously. Another point of interest is the complete decoupling of the whole of the feed system. The writer has had little experience of this set, but according to the London *Wireless World* it gives all the volume one wants without overloading, "very good" reproduction of music, especially as regards the upper notes, and reasonable selectivity.

The German experience has been that these little receivers have opened up an entirely new market. Of course, $25 means far more in Germany than in the United States (one can live quite comfortably in Berlin itself on 75 cents a day!) but, nevertheless, this new price has made radio a possibility for thousands who previously could not even envisage it.

Sixth annual convention of IRE June 4 to 9

AS *Electronics* goes to press a number of the papers to be delivered at the Sixth Annual Convention of the Institute of Radio Engineers are available for digest. These papers represent reports on the latest advances in the art; some of them, notably those on the use of Rochelle salt crystals as loudspeakers and other acoustic apparatus and on the attainment of high audio output from small amplifier tubes, may presage important changes in the radio and sound picture industries.

The convention meets at the Hotel Sherman June 4-6 and has its high point with the ceremony of giving the Morris Liebermann award to Stuart Ballantine for his "outstanding theoretical and experimental investigation of numerous radio and acoustic devices" and the Medal of Honor to General Ferrie "for his pioneer work in upbuilding the radio communication of France and the world and his long continued leadership in the communication field and outstanding contributions to the organization of international cooperation in radio."

Other papers presented at the meetings of the Institute which unfortunately were not available when the above digests were made are as follows:

"Some Observations of the Behavior of Earth Currents and Their Correlation with Magnetic Disturbances and Radio Transmission," by Isabel S. Bemis.

"The Spokesman for the Radio Engineer," by S. C. Hooper.

"Acoustical Measurements of Loudspeakers," by Stuart Ballantine.

STUART BALLANTINE
Morris Liebermann Award Recipient

"Amplitude and Phase Modulation," by Hans Roder.

"Application of Printing Telegraph to Long-Wave Channels," by Austin Bailey and McCann.

"Propagation of Short-Waves Over North Atlantic," by C. R. Burrows.

Inspection trips to the plants of local radio manufacturers, studios of prominent broadcast stations and to the telephone company as well as a lecture by Professor A. H. Compton on the electron offer additional opportunity for members to spend their time profitably.

▼ ▼ ▼

Some characteristics of thyratrons

By J. C. Warner
General Electric Company

Differences between gas content tubes of the thyratron type, in which the grid does not have complete control of current flow, and triodes are discussed. The advantages of the thyratron as an electrical switch, as a rectifier or as an inverter, transferring d.c. into a.c. were discussed and illustrations of tubes carrying as high as 100 amperes or tubes handling 15,000 peak inverse volts at 64 amperes are given.

Some acoustical problems of sound picture engineering

By W. A. MacNair
Bell Telephone Laboratories

To understand and to control adequately the conditions under which modern sound motion pictures are made has necessitated considerable research in general acoustic problems. A discussion of these problems is given in this paper. Acoustical distortion due to interference is discussed together with means of minimizing it.

Constant frequency oscillators

By F. B. Llewellyn, *Bell Telephone Laboratories*

The paper discusses the various methods taken to either prevent any frequency changes in familiar oscillator circuits with battery voltages or to minimize these changes. These oscillators are not controlled by piezoelectric plates or by other than proper circuit impedance adjustments. Methods of eliminating changes of frequency due to battery voltage changes consists usually in placing between the tuned circuit and the tube an impedance. Then over a certain spectrum the frequency generated by the tube and circuit was independent of battery voltages.

Changes necessary to stabilize familiar oscillating circuits are discussed making it a paper of particular value to laboratory engineers and those needing sources of constant frequency.

Producing color from music

By Edward B. Patterson

Various audio frequencies from music are filtered out by means of selective networks; these frequencies control thyratron tubes which in turn control illumination of various colors. Thus from a musical record a color display can be made of any desired power. A brief discussion of the future of color music of this nature is given.

High audio power from small tubes

By Loy E. Barton
RCA-Victor Co.

An important paper relating the research toward using class B amplifiers for audio output by using the tubes in push-pull with proper terminal impedances so that low distortion results. The author states that from a UX-112 A an output of 6 watts can be obtained when driven by a single UY-227 tube at maximum rated voltages. From RCA-230 tube, a battery tube, as much as one watt can be obtained with a battery drain of 14 ma. at a total battery voltage of 180, with low second and third harmonic content.

Readers interested in this development should see *Electronics* June, 1930, "A New Power Amplifier with a Positive Grid Bias," by Lincoln Thompson, and patent No. 1,699,110 granted to A. V. Loughren, January 15, 1929.

Developments in common frequency broadcasting

By G. D. Gillett, *Bell Telephone Laboratories*

Description of the experiments leading to the isochronous operation of radio stations WHO and WOC in which complete experimental stations were set up in the laboratory modulated with high quality material and the resulting reception tested on typical receivers as the relative isochronism of the two stations was varied. It was found that when the frequency difference was small, a ratio of field strength of less than 10 db. is sufficient to secure unimpaired reception but when any appreciable difference of frequency existed a field strength ratio of 20 db. was necessary. Field strength surveys showed that 5-kw. stations separated by two or three hundred miles delivered a field strength ratio of 20 db. only within the service areas of the individual stations.

Apparatus developed at the time of the laboratory tests was installed and maintained the two stations within one cycle per minute of absolute isochronism with periodic checks of frequency. In actual operation with plate voltage not maintained absolutely constant the frequency of the station controlled varied between seven cycles above and seventeen cycles below the assigned frequency.

Use of field strength measurements to determine broadcast station coverage

By C. M. Jansky, Jr., and S. L. Bailey, *Washington, D. C.*

A discussion of methods of rating broadcast station coverage by actual field strength measurements rather than by vague ideas of the relation between power and area covered, illustrated by concrete examples of coverage obtained by various stations in several locations as determined by measurements in the field. Suggested definitions of certain classes of stations are offered.

New methods of frequency control employing long lines

By J. W. Conklin, J. L. Finch, and C. W. Hansell
RCA Communications, Inc.

Use of quartz crystal for control of frequency of stations operating in the ultra high frequencies (35,000 kilocycles and above) proving expensive and inefficient other means of control are sought. A long line acting as a resonant circuit will control frequency much as a crystal does; similarly long lines can be used as regeneration coupling. At such frequencies the length of line is such that the cost is low compared to crystal control with necessary buffer and amplifier stages.

Experiment indicated that at between 35,000 and 50,000 kilocycles such lines would control frequencies to within 0.02 per cent without temperature control of line.

Development of short-wave directive antennas

By E. Bruce, *Bell Telephone Laboratories*

Development of directive transmitting antennas

By P. G. Carter, C. W. Hansell, and N. Lindenblad
RCA Communications, Inc.

Two papers dealing with the problem of increasing directivity and efficiency of antennas for receiving and for transmitting. The Bruce paper deals with receiving only and treats of the work leading to the development of a new type of antenna of superior directivity, efficiency, and reduced cost. By it several frequencies can be received eliminating the costly structures by which only a narrow band can be received on a given antenna.

The second paper tells of the research leading to new transmitting antennas for short-waves. The final antenna has a directivity of 65.6 compared to early efforts giving an antenna directivity of 16.4, and having a 16 db. power gain over a half-wave dipole.

Vacuum tubes as high frequency oscillators

By E. B. McArthur and E. E. Spitzer

Triodes and split anode magnetrons for generation of waves below five meters are discussed. Curves are shown for various tubes showing relation between efficiency and output as functions of wavelength at five meters and below. Down to 1.5 meters the triode is most useful tube, between 1.5 and 0.75 meters the split anode magnetron is most useful and below that figure oscillators must be resorted to in which the frequency is controlled by the time of transit of electrons.

Rochelle salt crystals for electrical reproducers and microphones

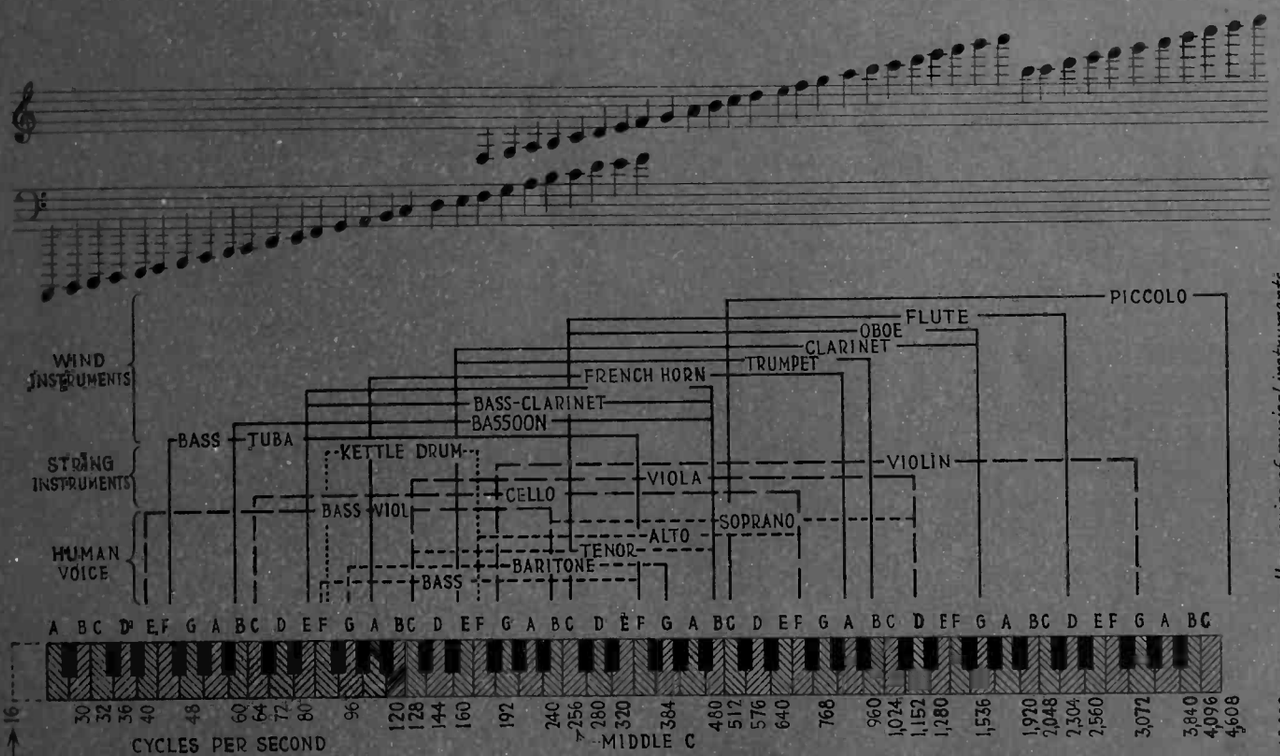
By C. Baldwin Sawyer

Use of Rochelle salt crystals which are Piezo-electric as loudspeakers, phonograph pickup units, and microphones is discussed with considerable experimental data. High voltages are developed across the crystal faces under mechanical displacement which of course can be applied directly to a vacuum tube grid circuit.

The advantages of Rochelle salt crystals are:

1. Inherent cheapness and simplicity.
2. Long life and freedom from fatigue failures.
3. Flexibility of design.
4. Generation of high voltages for tube grids.
5. Direct match with output tubes of high impedance (pentodes).
6. Freedom from necessity of exciting currents, permanent magnets, or polarizing bias.
7. Large output force of mechanical displacement suitable for driving large diaphragms.

Electronics' Chart of
Sound Frequency Characteristics



Point at which sense of feeling begins before sense of hearing

WIRE TRANSMISSION CIRCUITS

Television wire circuit (20 to 18,000 cycles per second)
Highest-class wire line for broadcasting (50 to 8,000)
Ordinary wire circuit for broadcasting (50 to 5,000)
Ordinary telephone talking circuit (250 to 2,750)
Trans-oceanic telephonic cable (300 to 2,500)
Standard telephone instrument (300 to 1,800)
Early telephone lines (500 to 1,800)

Door squeak

RADIO BROADCASTING AND RECEPTION

Modern broadcasting transmitter (30 to 7,500)
Broadcasting station transmitting chain program (90 to 5,000)
High-quality radio set (50 to 5,500)
Obsolete or poor radio set (256 to 2,200)

Chirp of insects

SOUND REPRODUCERS

Public-address system (60 to 5,500)
Dynamic loud-speaker (40 to 5,500)
Exponential loud-speaker (70 to 5,500)
Electro-magnetic pickup (60 to 5,500)

SOUND RECORDINGS FOR RADIO AND FILMS

Highest type electrical trancriptions for radio ("Hill & dale" cut) 30 to 10,000)
Sound-picture film sound track recording (0 to 8,500)
Sound-picture disc record 33⅓ r.p.m. lateral cut (60 to 6,000)

HOME PHONOGRAPHS

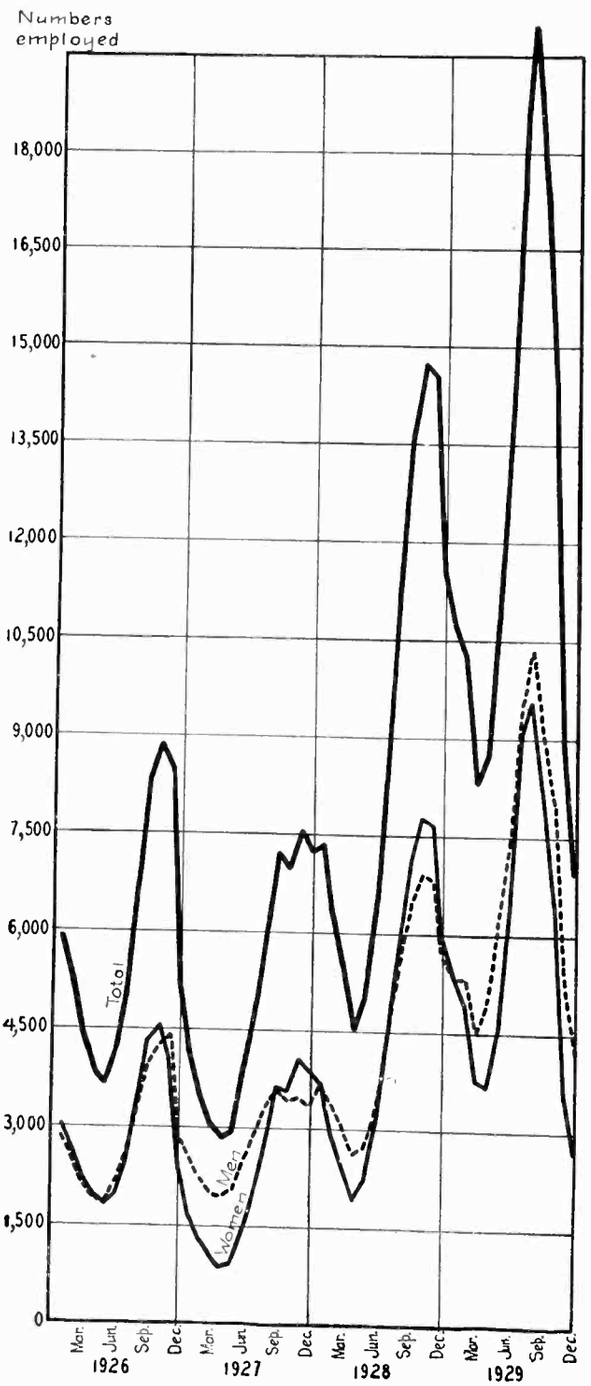
Modern electric recorded home phonograph (60 to 5,000)
Recent acoustic phonograph (90 to 4,500)
Old fashioned phonograph (256 to 3,000)
Office dictating machines (350 to 2,000)

MISCELLANEOUS

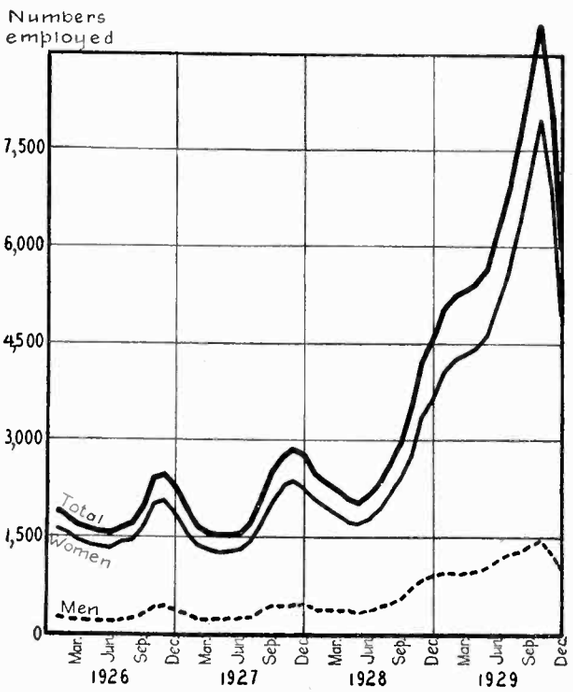
Niagara Falls 40 to 50
Thunder 20 to 40
Distant gunfire
60-cycle A.C.
Average man's speaking voice Av. 128
Average woman's speaking voice Av. 256

Swings of employment in the radio industry

Compiled by United States Department of Labor



Radio set manufacture. Swings of employment in group of set factories



Radio tube industry. Fluctuations of employment in ten plants

Fluctuation in employment in 16 radio set factories for a typical year

Month	Total Number of Employees	Number of Men	Number of Women
January	19,853	9,182	10,671
February	18,104	8,703	9,401
March	13,688	6,848	6,840
April	13,045	7,086	5,959
May	14,900	8,328	6,572
June	18,765	10,190	8,575
July	25,906	13,587	12,319
August	31,163	16,228	14,935
September	30,696	16,439	14,257
October	28,377	14,978	13,399
November	20,566	11,058	9,508
December	13,086	7,917	5,169
Average	20,679	10,879	9,800
Maximum	31,163	16,439	14,935
Minimum	13,045	6,848	5,169
Per cent minimum is of maximum	41.9	41.7	34.6

The lines tracing the employment of men and women parallel each other fairly closely throughout the year, but the outstanding characteristic of all curves is the sudden development through the summer and the even more abrupt decline in the late autumn and winter months.

In all cases the peak months were August, September, and October. In September as many as 55,000 persons were working in the 24 factories, and the number was practically as great in October, but by December about 32,000 were no longer employed. In the plants whose figures are reported by sex the per cent of decline was 57.5 for total employees, 53.1 for men, and 63.5 for women.

Glow lamp sound-on-film recording

By VERNE T. BRAMAN

Vice-president, Blue Seal Sound Devices, Inc.

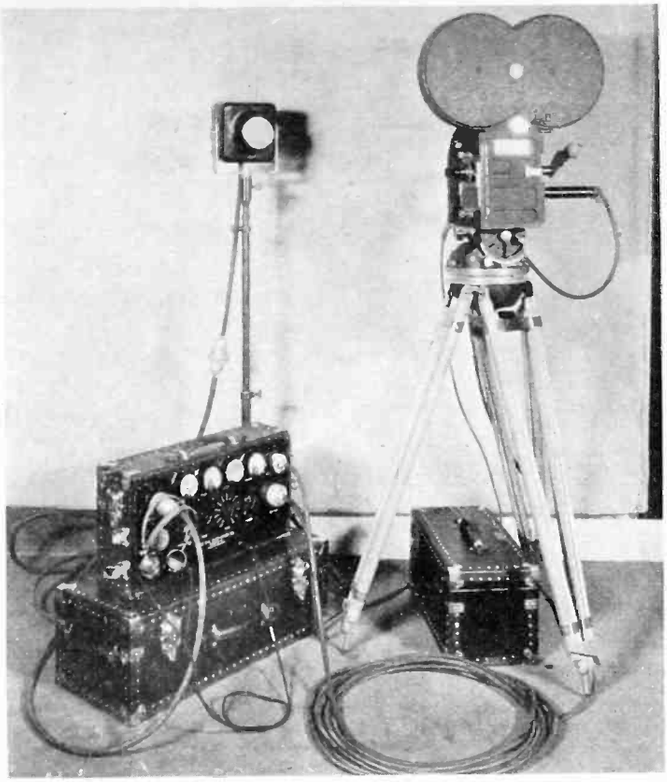


Fig. 3—Portable sound recording unit utilizing glow lamp with an Akeley sound camera. Complete amplifier and mixer with connections for four cameras is shown at left.

DUE to its freedom from mechanical complications the glow lamp provides one of the simplest and most fool-proof method of sound-on-film recording. In general, a sound recording glow lamp is a tube containing the proper electrodes and rarified gases at a pressure sufficient to concentrate the glow in the region of the cathode. The nature of the gases determines the striking voltage and actinic properties of the lamp. A tube containing neon, for instance, glows at a comparatively low voltage and provides very little exposure to orthochromatic film, whereas argon requires a considerably higher voltage and provides much greater exposure. Experimental evidence indicates that there is some relationship between the shortest wavelength of light emitted and the cathode drop of the lamp.

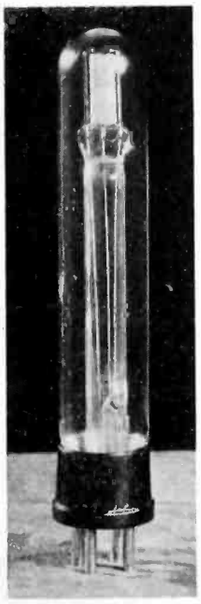


Fig. 1—A three-element glow lamp.

If the cathode is covered with an alkaline earth oxide and is in a form which can be heated or will heat of itself because of the cathode drop, the resistance of the tube is reduced and it can be worked at comparatively low voltages. This principle is employed in certain glow lamps now in common use. Disadvantages of this type of lamp are that sputtering (the removal of microscopic particles from the cathode) is more noticeable with a hot cathode, and the action of the oxides is dependent upon their age, condition, and temperature. On the other hand, the cold cathode glow lamp, with the disadvantage of higher battery voltage, has the advantage of stability and constancy of illumination with applied voltage.

In sound-recording work the glow lamp is lighted by a battery or other voltage source which supplies a steady current upon which is superimposed the sound frequency currents. Since the illumination follows the variation in current we have a modulated light source varying in frequency and intensity in conformance with the wave form of the sound currents. This light source is photographed on motion picture film through a very narrow slit which allows the high frequencies to be recorded without overlap and the resultant attenuation. With a slit of .001 inch effective width, the theoretical cut-off is at 18,000 cycles, which corresponds to the condition where a full wavelength (with the film moving 90 feet per minute) is equal to the slit width.

The slit can be either of the contact or optical type. The optical slit is much to be preferred, however, due to the freedom from possibility of clogging the slit or scratching the film, and because a much sharper and finer slit can be procured by optical reduction.

In either case there are certain precautions to be taken in glow lamp design. It is well known that if the glow is not confined to a certain region, the *volume* of the glow rather than its intensity will vary when the lamp is modulated. If the area of the glow extends beyond the area subtending the angle of effective transmission of light to the film, the peaks of the waves will not be photographed, with resultant distortion. With the contact slit it is necessary to either confine the area of glow or to move the lamp away from the slit far enough to include the maximum area of glow, with the resultant loss of intensity. This is true also of the optical slit where no condenser lens is employed. With the optical slit employing a condenser lens, it is essen-

tial to confine the area of glow and modulate its intensity. This is usually accomplished by an insulator or electrically isolated conductor which surrounds the cathode and extends in front of it. The glow can be further confined by increasing the gas pressure up to a certain point. Other effects of gas pressure will be discussed later.

Proper design of the glow lamp

In designing a glow lamp many factors must be taken into consideration to get the maximum life and exposure and the proper electrical characteristics. The life of a glow lamp is determined mainly by the amount of cathode sputter. The fine particles that are liberated by the cathode not only tend to blacken the glass, but absorb a considerable amount of gas, thus reducing the pressure which allows the glow to spread and increases the lamp's impedance. The amount of cathode sputter, or disintegration, is determined by the metal of the cathode, the temperature of the cathode, the nature of the gas, the current through the tube, the pressure of the gas, and the fall of potential at the cathode.

When used as cathode material some metals, such as platinum and copper, show a marked tendency to sputter badly, while other metals such as aluminum and tungsten disintegrate much more slowly. Many metals disintegrate rapidly if the temperature is raised appreciably. The rise in temperature of the cathode is roughly proportional to the current. The nature of the gas has a very marked effect on the degree of sputtering that a metal exhibits. Hydrogen, nitrogen, and carbon dioxide do not in most cases favor the effect while mercury vapor, helium, argon, and neon bring about pronounced disintegration of most metals.

The potential applied to a glow lamp is not distributed evenly between the electrodes. The greater part is used up close to the cathode; there is a gentle potential gradient in the space between the electrodes, and the remaining fall of potential occurs close to the anode. The amount of sputtering depends on the cathode—fall of potential, and this increases as the pressure of the gas is lowered. The nature and pressure of the gas as well as the area of the cathode determine the impedance of the lamp, which in turn determines the current at a given voltage. By judicious regulation of these variables, the power required to provide 100 per cent modulation of the lamp can be altered to suit given conditions. This power is $\frac{I^2}{2} Z$, where I is the unmodulated lamp current, or the peak modulating current.

If the voltage applied to the glow lamp terminals be increased, there will be a corresponding increase in current and lamp intensity. If on the other hand the voltage be decreased, the current will decrease accordingly until a certain minimum voltage, called the extinguishing voltage, is reached, at which voltage the lamp current drops to zero and the light is extinguished. If, after extinguishing, the voltage be increased, the lamp will not again light until a somewhat higher value of voltage, called the ignition voltage, is reached. At this point ionization of the gas is effected and the current suddenly rises from zero to a definite value. Thus when the voltage is modulated down to the extinguishing voltage and back again, the current will not exactly follow the voltage modulation, but when reaching zero will remain there until the ignition voltage is reached, a hysteresis loop being introduced into the modulation curve. The current remains at zero over a portion of the cycle and then rises suddenly, causing a waveform which is very productive of undesirable harmonics and distortion, due to its extremely sharp wave front.

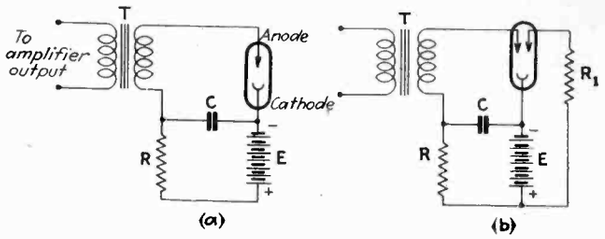


Fig. 2(a)—Shows circuit used for two-element glow lamp, and (b) modifications made when using a three-element lamp.

The three-element glow lamp

To eliminate this form of distortion, the author introduced a third electrode into the standard two-electrode glow lamp. The function of this third electrode is to make the ignition voltage equal to the extinguishing voltage by allowing a very small unmodulated ionizing current to flow at all times. This ionizing current is independent of the modulated current between the two normal electrodes, and causes the gas to remain ionized with a faint cathode glow even when the normal lamp current is reduced to zero.

Figure 1 shows a three-electrode lamp. In this lamp the cathode is surrounded by an insulator which extends beyond the face of the cathode, thus forming a crater for confining the glow. The two anodes are shown on either side. These anodes are identical and either one may be used as the third electrode. When the bulb is blown, steam is forced into the opposite end of the mold so the bottom of the bulb does not touch the end of the mold. This makes the glass window perfectly clear and free from imperfections which would obstruct the passage of light.

To insure uniformity, extreme care must be exercised in the making of glow lamps. The lamp shown in Fig. 1 was heated in an oven under vacuum for several hours to remove impure gases from the parts. While still under vacuum, the metal parts were bombarded to a white heat to remove all gases and volatilize any oils, etc., present. The proper gases were then mixed and allowed to enter, being absorbed by the hot metals and glass. After cooling, these gases were removed, taking the remaining impurities with them, and fresh gases were injected. The tubes were then ignited and allowed to age on the pumps before the final sealing and basing.

Figure 2(a) shows a typical circuit of two-element recording glow lamp. The sounds are picked up by a microphone and amplified in the usual way. The amplifier output is fed into transformer T (which may be

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THERE has been very little information published on glow lamp recording though it is one of the principal methods used in sound pictures. The principal characteristics of design and operation are given in this article.

▲

the amplifier output transformer). The glow lamp is supplied with current by battery E through resistance R. This resistance has a twofold purpose. The resistance of a glow lamp decreases as the current increases, so that a stabilizing resistance is necessary. In addition to this, if R is sufficiently large to have an appreciable voltage drop, any decrease in the tube current caused by ageing will decrease the drop across R, thereby increasing the potential across the glow lamp, and tending to keep the illumination constant.

Condenser C is charged to a potential essentially that of the unmodulated glow lamp terminal voltage. The sound frequency voltages supplied by the secondary of transformer T, being in series with the voltage of condenser C, cause a modulation of this latter voltage, thus modulating the glow lamp current accordingly.

Figure 2(b) shows the circuit of the three-element glow lamp. This circuit is essentially that of Fig. 2(a), the only difference being the addition of a second anode which is supplied with an unmodulated ionizing current through a very high resistance R_1 on the order of one megohm.

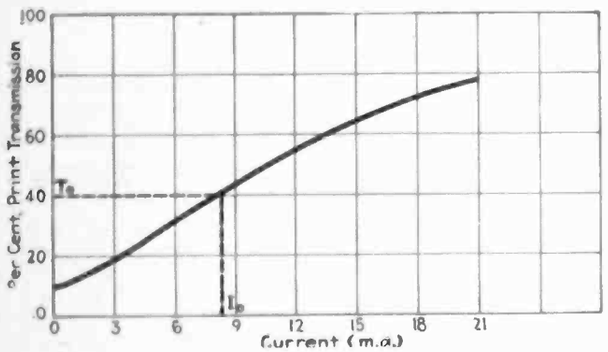

Fig. 4—Curve showing relation between glow lamp current I_o and transmission of negative T_o

The main advantage of the glow lamp lies in the fact that it is purely an electronic device and has no mechanical moving parts. This allows for a frequency response well beyond the audible range. With a fixed slit and variable light source the attenuation of the higher frequencies for a given slit width is much less than with a fixed light source and variable slit width, such as is used in a moving ribbon system of recording.

The three-element glow lamp may be modulated within ½ db. of 100 per cent at any frequency without distortion. The effect of overmodulation is similar to that of overloading a vacuum tube, the peaks of the waves being flattened with the resultant distortion. A certain amount of this is not highly objectionable during extremely loud sounds or transient noises. Accidental overloading does no harm to a glow lamp.

A light valve, however, is modulated considerably below 100 per cent at the lower frequencies, due to the fact that it has a resonant peak at a high audible frequency which must be kept below the overload point.

When optical recording is employed with the glow lamp, the slit can be sealed in a lens tube and the focus adjusted and sealed. As with a standard projecetor optical, no further adjustment need be made. Being completely enclosed, there is no danger of dust or dirt collecting.

Figure 3 shows the complete sound-on-film recording units utilizing a glow lamp in the sound camera. This is a portable equipment with the sound recorded on the same film as the picture. The camera shown is the new Akeley Audio Camera, which has been expressly designed for sound recording work. This camera is extremely quiet in operation, being provided with fibre gears and ball-bearings throughout. The gears are precision ground to insure constant velocity of the film, and the sound sprocket is provided with a mechanical filter. At the point where the sound is applied, the film weaves through three heavy rollers, the sound slit being focused on the film as it passes over the upper roller.

The glow lamp is placed in a tube which also contains the lens and slit assembly. There is no focusing necessary, as this is all done at the factory, the lamp merely being pushed in as far as it will go. Additional equipment which provides a complete recording unit consists of an amplifier, battery box, and microphone. The entire outfit, including the camera motor, is run by means of dry batteries, no storage batteries being necessary unless desired.

Operation of the system

The setting up of the units for recording is comparatively simple. Monitoring is done by means of head phones and a volume indicator. When the cameraman is ready for a "take" he throws his camera motor switch (on the back of the camera) which simultaneously starts his camera and turns on the glow lamp. The glow lamp current meter on the amplifier panel indicates to the sound man that the camera is running and the monitored sounds are being recorded.

When the camera is not running, the glow lamp circuit can be checked by means of a push button on the back of the camera. A small eye piece fitted with a magnifying lens enables the operator to observe the slit image directly on the film, serving not only as a check on glow lamp exposure but as a means of comparing the sound track exposure with the picture exposure to get a good balance.

In photographing sound-on-film, the relationship between the glow lamp current, which represents the recording amplifier output, and the light transmission of the positive print, which represents the reproducer photoelectric cell input, must be linear over the exposure range utilized to get undistorted sound quality. Figure 4 is a curve showing this relationship. This curve was made with a three-element recording lamp. The negative was photographed on DuPont Pathe sound recording positive, and the print on ordinary DuPont Pathe positive film stock. I_o represents the normal glow lamp current and T_o the normal light transmission to the photoelectric cell. The sound negative was developed to the point where its transmission at normal exposure (I_o) was 40 per cent and the printer light was so adjusted, that with normal development of the print, the normal print transmission (T_o) was 40 per cent corresponding to the 40 per cent normal negative transmission.

From this curve it is seen that a practically linear relationship exists between the print transmission versus glow lamp current for 100 per cent modulation of the glow lamp. This results in a print transmission variation of from 10 per cent to 70 per cent, or 60 per cent modulation of the photo electric cell light.

A complete set of curves for different types of film and different timing of development will be given in a later article in *Electronics*, together with circuits and principles adapting the glow lamp to the so-called "noiseless" recording method, or variable average print transmission.

Radio program distribution over lighting circuits

By TOWNSEND D. MacCOUN

Chief Research Engineer, Radio Systems, Inc.
By arrangement with Deforest Radio Company

ANY centralized radio system, for the distribution of radio programs in buildings such as hotels, apartment houses, schools, etc., should meet the following requirements:

1. It should offer a choice of at least four programs;
2. It must be free from cross-talk;
3. The volume must be unaffected by the number of listeners;
4. The maximum volume must be under complete control to avoid disturbing adjoining rooms;
5. Volume control should be provided at all outlets;
6. Stray noises must be reduced to a minimum;
7. The quality should be as good as that of a high-grade modern radio receiver;
8. The equipment should be flexible, to allow for the addition of more programs and future developments.

At the present time there are two methods in use. The first is the Audio System, in which all of the rooms are wired to a centralized location where the programs are picked up, amplified and distributed at audio frequencies. The second method, with which this paper deals, is the "Guided Radio" method, invented by Dr. Francis LeRoy Satterlee, and developed by Radio Systems, Inc. This system is designed to meet the above requirements. With this method it is unnecessary to wire the building. The distribution is accomplished by applying the programs, as modulated radio-frequency currents, to the building framework proper and the normal electrical wiring. It is obvious that this feature of the system in itself has an economic advantage over system requiring complete wiring of the building.

A METHOD of distributing radio programs by using the regular lighting wires without the expense of rewiring the building for audio-circuits is described. Estimated savings are $30,000 for a 1,200 room hotel.

An installation of this system has just been completed in the Lincoln Hotel, New York City, by the Deforest Radio Company. The transmitting equipment is located on the twenty-eighth floor. The photograph (Fig. 1) shows this equipment in use. On the left-hand rack the four channel receivers are mounted. These are used for picking up the radio programs to be distributed. In the center of this section is a phonograph turntable, which is used as an alternate source of program material. The second panel from the left is the master control unit, from which the entire operation is controlled. To the right of the control panel are the four channel transmitters. The five switches on the top panel of the master control unit are the master switches for the receivers and transmitters. Under this panel is the volume indicator panel. The volume indicator may be connected in on any circuit to give the operator a visual check on the volume level which may be adjusted to any predetermined level.

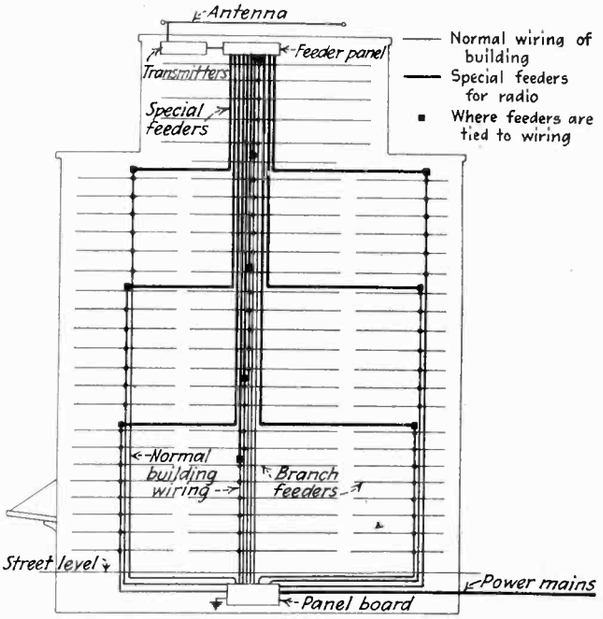

Fig. 2—Wiring circuits for a typical hotel building

The next unit on this rack is the monitor receiver which is used to tune in the transmitters as a check of the quality of transmission. Below the monitor receiver is the inter-connecting panel. The input and output terminals of all units are connected to this panel. By the use of short patch cords it is possible to interconnect any of the units as desired. This panel is also provided with a comparator switch. This is for the purpose of rapidly switching the monitoring loudspeaker from one circuit to another. To illustrate this more clearly, the output of a receiver may be connected to the switch and the output of the monitor receiver connected to the other terminals. It is then only necessary to throw the switch to compare the quality before and after transmission.

Due to the flexibility of the inter-connecting board it is possible to have any combination of programs. Any of the transmitters may be modulated by any of

the receivers or by the phonograph or microphone. It is readily possible to modulate all of the transmitters simultaneously with the same program. Additional amplifiers, mixers, attenuators, etc., may also be introduced in any circuit desired.

The next lower panel on this rack is the microphone mixer and attenunator. Below this is the frequency meter and the direct-reading per cent modulation meter. By means of these two instruments a constant check can be maintained on the output of each transmitter. The lower unit on this rack is a speech amplifier for use with the phonograph or microphone.

The transmitters proper are specially designed for this purpose. They are of the master oscillator, power amplifier type. All modulation circuits are designed with the utmost care to insure the highest quality transmission. Modulation is applied to the power amplifier stage. To further insure frequency stability the oscillator and intermediate amplifier have a separate power supply. Time-delay relays and indicators are incorporated to safeguard the tubes and promote long tube life. Jack strips are provided to enable the operator to check all currents and voltages. The transmitters are capable of modulation up to 100 per cent and are throughout of the most modern design.

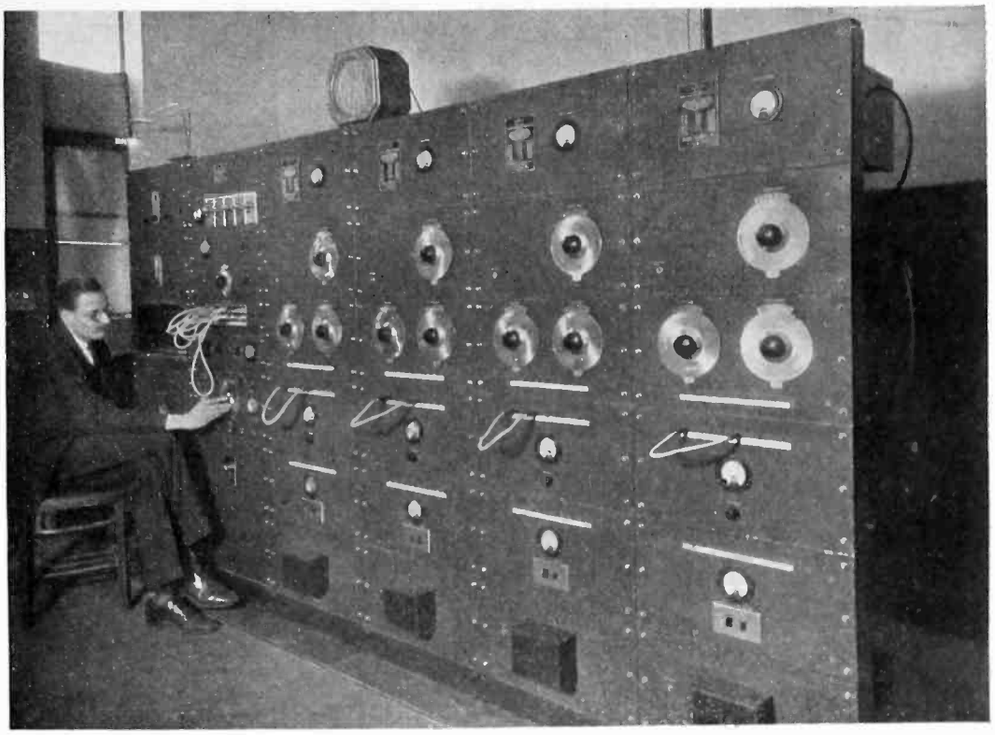

Fig. 1—Receiving and transmitting panels as installed in the Lincoln Hotel, New York City. Four channel receivers are mounted on left rack and multiple channel transmitters are shown to right

By the use of a special receiving antenna located on the roof and connected to the receivers through a new type of transmission line, motor noises and other electrical disturbances are eliminated. This is very necessary for quiet, clear-cut reception.

After programs are picked up by the four receivers they are re-converted into modulated radio frequencies and distributed as described later. Figure 2 illustrates how a typical hotel is wired for electric service. The power mains enter the basement and terminate in the panel board. In order to distribute the load evenly and to avoid the use of excessively large wires, the lighting wiring is split up into a number of risers. These are indicated by the light lines. Each riser feeds five to ten floors in a certain section of the building. Branch lines run from small panel boxes on each floor to the various rooms. The neutral of the three-wire system is connected to the ground in the basement. These risers have practically no resistance to the power current. However, they present an appreciable impedance to high-frequency currents, such as are used in our transmission. The structural framework of the building, because of its large cross-section offers a low impedance path to ground, even at the high frequencies. If we then pass a radio frequency current through the circuit formed by the riser, ground and the framework. we can establish a potential between the end of the riser and ground.

Due to the distribution of the impedances practically the full voltage of the transmitter can be established. It can be seen, then, that it is only necessary to couple the extreme ends of all the risers to the transmitters (through special feeders, indicated by the heavy lines) to attain uniform distribution throughout the building. We have now established a radio frequency voltage between the lighting circuit and ground (radiator) in each room of the building. We can utilize this voltage to actuate a simple receiver.

[*Continued on page 706*]

Fig. 3—Individual radio receivers using one tube are installed in a standard bed-side table

HIGH LIGHTS ON ELECTRONIC

Controlling chemical processes by electron devices

By James A. Lee

In the electrochemical industries the electron tube has been applied to increase the accuracy of measurements and to increase production economy.

Perhaps of greatest interest to the electrochemist is the tube's use for the measurement of the acidity or alkalinity of a solution. For this purpose the photoelectric cell gives more accurate data than can be obtained by any other known method. The electrochemical industry has also found the photoelectric cell a convenient and accurate device for the measurement of temperature in the electric furnace, and for counting objects leaving the automatic plating equipment. Apparatus for counting may be designed to operate at great speed and is capable of counting much faster than a workman. Additional advantages offered by the "electric eye" are greater reliability and lack of fatigue.

Uses in paper making

The paper industry has a difficult problem in the control of the thickness and moisture-content of the sheet on the paper-making machine. Excessive thickness is a loss to the manufacturer and variation in moisture affects the quality of the product. Several mills are now controlling these variables with an electron device. Variations in the paper passing through the detector change the capacity of a condenser, which in turn affects the frequency of an oscillating circuit. This actuates the control mechanism of the machine. A photoelectric detector has replaced the workman who formerly watched for breaks in the paper during the process of drying on the machine. When a break appears, an audible signal is given thus avoiding the necessity for continual visual observation. An the paper industry, like most others, is finding the photoelectric tube a convenient and efficient instrument for the comparisons of color and capacity.

Today, most bottles are blown by automatic machines and strains often develop which result in a weakened product. Such bottles are susceptible to breakage if brought into contact with hot water or other hot liquids. The formation of strains is one of the greatest evils in the glass industry and only the most expert are capable of seeing any of these imperfections. Recently, a means has been found to apply the photoelectric cell to this problem and as a result such flaws may be found automatically.

The rubber manufacturer uses the electron tube for controlling the thickness of rubberized fabric, and the chemical industry for substituting continuous operation for intermittent processes.

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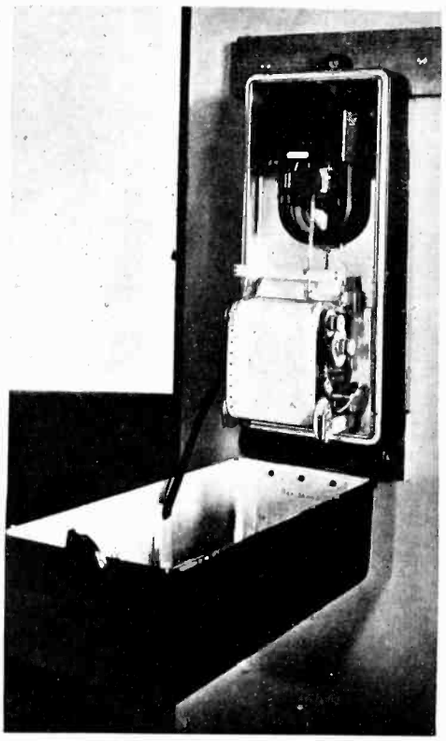
Smoke-density recorder for power plants



Smoke-density recorder for power plants

In the plant smoke-density recorder developed by Frank Sawford, consulting engineer of Vancouver, B. C., and installed in a number of power stations, the cathode and anode of the photo-cell are connected to the grid and plate of the amplifier respectively. A sufficiently high negative potential is impressed on the grid of the tube to reduce the plate current to 0.1 milliampere, with the photo-cell dark. Upon the application of light to the cathode of the cell, the positive potential of the plate passes across the cell to the grid, thus reducing its negative potential by an amount proportional to the light intensity. As the negative potential of the grid is lowered, the plate current increases, this increase being indicated on the milliammeter, which is marked in terms of per cent smoke density.

The photo-cell, amplifier rectifier and lamp are all operated well below their normal ratings in order to obtain long life and reduce renewals to a minimum, and a life in excess of 10,000 hours for these parts has been obtained under actual commercial operating conditions.

The exciting lamp is fitted in a silvered parabolic reflector with a glass front and is hinged to a cast-iron ring clamped to the orifice pipe, the lamp and reflector assembly being held in position by springs so that it may be quickly swung away from the tube for cleaning or inspection, and returned to position again without disturbing any adjustments. The lamp assembly is arranged with universal adjustments so that the maximum concentration of the light beam may be projected along the tube on to the condensing lens. The exciting lamp and dial lamp are standard 21 c.p. 6/8 volt, double contact automobile lamps, but standard sockets are not used as trouble has been experienced with contact resistance in these. The conductors for furnishing power to the filaments are soldered directly to the contacts on the lamp bases, and brought out to separable connectors on the outsides.

Between the ends of the orifice tube and the mounting rings, a space of about $\frac{1}{8}$ inch is left to allow a stream of air to enter the tube, induced by the stack draft. This stream of air serves the double purpose of cooling the optical system moutings, and keeping the orific tube swept free of smoke. This stream of air has no effect on the readings, as, after passing along the tube it passes out of the downstream orifice into the flue-gas stream.

✦

Photo-cell adding machine works in billions

An adding machine to be used in determination of factors of numbers greater than 2,000,000,000 will be constructed by Professor Derrick N. Lehmer of the University of California.

Included in the mechanism is a shaft on which 30 gears of 100 teeth each are set. Meshing with these gears are 30 other gears with a varying number of teeth, depending on the prime or indivisible numbers from 1 to 127.

The main shaft gears revolve at the same speed, but the gears meshing with them revolve at different speeds, because of the varying number of teeth. When in the course of perhaps hundreds of thousands of revolutions one hole in each wheel reaches the same point at the same time, when thirty holes are lined up, in other words, a beam of light goes straight through the machine, strikes a sensitive photo-electric plate and stops the machine instantly.

A counter, which records the number of revolutions made by the main shaft, gives a number from which the factors of the large number under analysis can readily be obtained.

DEVICES IN INDUSTRY

Self-opening door in English restaurants

J. LYONS & Co., LTD., a company which operates a large chain of restaurants throughout the United Kingdom, has put into operation a new application of the selenium cell, in the form of a door in one of its larger restaurants which opens of its own accord when any person approaches it.

About 10 feet from one of the service doors in the restaurant, a light has been made to shine on a photoelectric cell suspended opposite. When a waitress carrying a loaded tray approaches this door she passes across the line of light and breaks it for a moment. This gives impulse to an amplifier on the other side of the service door, which promptly operates on delicate apparatus in such a manner as to cause a spring coil attached to the top of the door to draw back and the door opens.

It is the first time that the invisible ray idea has been commercially applied in this country. The apparatus and labor involved in the preparation of the invention cost approximately $150 and it is estimated that the perfected invention will cost even less. The firm anticipates that the cost of maintaining the door for a year will not be more than $50.

✦

Electric ear analyzes motor noises

A PORTABLE "ELECTRIC EAR" to separate various sounds has been developed in the Westinghouse Research Laboratories by J. P. Foltz. It consists of a microphone, an amplifier of several stages to raise the energy level, a filter circuit which permits only one frequency at a time to pass, a meter for reading amplitudes, and batteries to furnish power. The complete equipment weighs about 60 lbs., and is independent of any outside current supply.

The microphone may be of either the electro-dynamic or condenser type. It is connected to the sound analyzer by a wire and plug. By turning certain knobs and dials, sensitivities on the "selector" from one to 10,000 are possible. Frequency ranges from 60 to 7,000 cycles can be obtained.

This new portable "electric ear" may be used as an advance fault-finder for air plane motors and propellers. So much more sensitive than the human ear, it will hear loose wrist-pins, piston-rings, main bearings, warped or split propellers long before they are loud enough—and consequently dangerous—to be heard by the human ear. It is not unlikely that when developed this apparatus will be made part of an airplane's required inspection before flight.

Indeed, such an "electric ear" could be incorporated in an airplane's dashboard so that a bad motor part or propeller blade developing during flight would instantly show up with a red light to warn the pilot of prospective trouble. Then, with the cards on the table, the pilot would be able to decide whether he could go on or should land at the nearest airport to have the trouble remedied.

✦

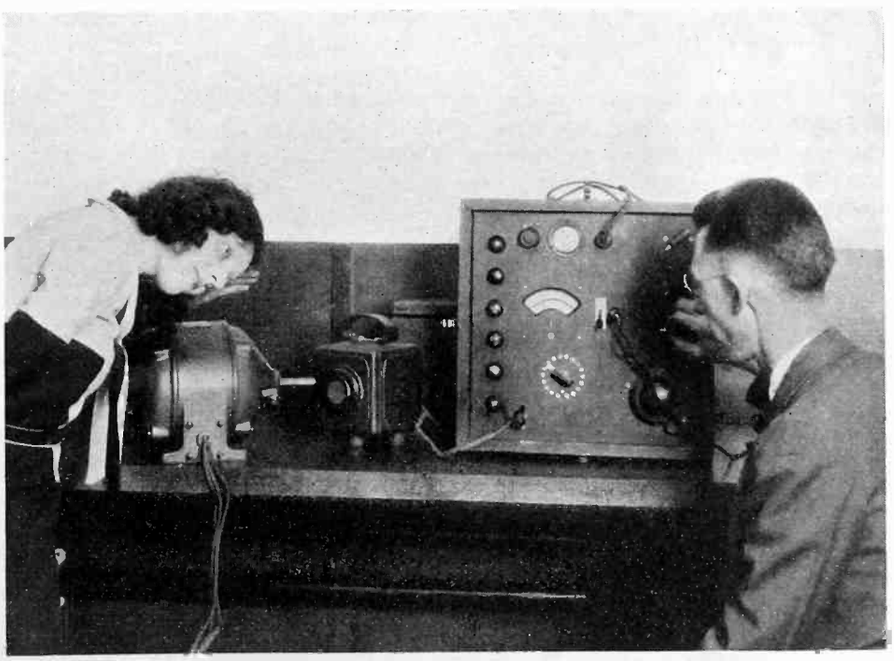
Automatic radio compass

TWO ENGINEERS, Gerhard Fisher and G. Kruesi of the Western Air Express Company, have developed an automatic radio compass which can be used on any CW or ICW Department of Commerce station, or any broadcasting station.

While the principles of the marine radio compass were generally utilized, the method of operation was entirely changed. The rotating loop had to be abandoned and substituted by a fixed directional antenna system. The taking of bearings by minimum methods were unadvisable due to the extremely high noise level and the enormous speed of aircraft as compared with marine vessels. In the new system two comparatively strong signals are received which are matched against each other in a specially designed tube circuit. Depending on their individual values, they influence an indicator which is installed on the instrument board in front of the pilot. It is quite similar to the ammeter on the dashboard of an automobile, but instead of showing "charge" and "discharge," the aircraft compass is marked "left" and "right."

A zero reading is provided in the center. In practice, as the aircraft is flying toward a radio station the needle of the indicator will stay on zero if the plane is in its course. The polarity of the indicator can be so arranged that swinging the plane to the right the indicator needle will point to the left, showing that the radio station is on the left of the pilot and that a left turn has to be made to bring the ship back on its course. An opposite movement will reverse the indication. The new homing system is sufficiently sensitive to allow a plane to find its way to a radio station 200 miles distant.

In addition means is provided to indicate to the pilot in case he had overflown the radio station he was headed for. In a marine compass an undirectional device takes care of this problem, but when using the aircraft homing system it was found to be necessary only to turn the nose of the ship slightly from its course and the indicator would point toward the radio station. If, for instance, the plane were suddenly turned to the left and the indicator needle pointed to the right, it would be an indication that the radio station was located ahead. If it turned to the left it would be a positive indication that the radio station had been passed.



This "electric ear" fits into an ordinary suitcase and hears noises which the human ear does not. It can separate the various sounds that make up the whirring of an electric motor

Buying habits and replacements for sound equipment

IN THE April, 1931, issue of *Electronics,* a survey was given of the buying habits of radio-set manufacturers. A similar survey has now been conducted, covering the purchasing habits of the principal manufacturers of sound equipment. This survey included those companies building sound-picture and public-address equipment. Data from previous years in this particular field are not available, but the figures given in the accompanying table are representative of present buying habits of some 36 companies, from which reports were requested.

Space does not permit giving individual reports of all companies reporting, but those given in the tabulation were selected as being representative of concerns manufacturing a complete sound system. The percentage of parts purchased is approximately 90 per cent, as against only 10 per cent manufactured in individual plants. This is to be expected, in view of the smaller quantity of parts required to meet the needs of this field.

In some cases, units such as loudspeakers, rheostats, metal cases, etc., are built to specification. In others, standard units have been adapted to the use required. Invariably, machine parts and other mechanical components are built in individual plants, while electrical equipment is purchased. There is considerably more standardization of units in the latter class, than in the former.

Sound heads for projectors, and associated PEC amplifiers, are generally built in individual plants, rather than purchased even to specifications, while in the case of main amplifiers, approximately one-third of the companies purchase this equipment, and the remaining companies build their own. Those companies which build their main amplifiers, purchase about 85 per cent of the essential component parts for such units. This compares to about 50 per cent of parts purchased by radio set manufacturers.

The component parts designed for sound equipment are selected with more care in view of the service expected, than in the case of ordinary radio receivers. The competition, from the point of view of price alone, has not been as acute a question for components going into sound equipment, as in the radio set field. This perhaps is due to two factors—lack of large quantity orders and special requirements in specifications for such units.

The replacement of sound equipment

Users of amplifier equipment rely on the original manufacturer for replacement of component parts in 75 per cent of the cases reported. This means that only 25 per cent is purchased direct from the manufacturer of components. In the case of vacuum tubes, photoelectric cells, exciter lamps, motors, batteries and other parts which are easily replaceable and also sold under a trade name, the influence of the original sound-equipment manufacturer is only about 25 to 35 per cent on replacements. The remaining percentage of replacements are purchased from manufacturers direct. These purchases are handled in various ways.

The largest theater chains have already established engineering groups to supervise purchasing of replacement and maintenance of sound equipment. Even in the case of licensed equipment, some of the larger units have found it advantageous to have their own sound-engineers for supervision of maintenance and checking of replacements. In some of the smaller theater chains, comprising less than 25 theaters, economies have been effected by appointing a supervising sound engineer. In all chain groups, purchases of sound equipment and other supplies are handled through the central office. Individual theaters in such groups are limited in such purchases to emergencies only.

The principal item of replacement for theaters at the present time is tubes. While the types of amplifiers in theaters vary considerably in design, the following classes of tubes cover the range of those used 101, 102, 104, 112, 205, 210, 211, 224, 227, 239, 245, 250, 280, 281, 841 and 845. Special tubes have also been produced for replacement purposes in some cases.

The average upkeep of sound equipment for theaters seating between 1,200 and 1,500 people ranges from $39 to $118 per month. Theaters seating above 1,500 approach an average upkeep around $100 a month, and those seating below 1,200 average around $50. These figures check fairly closely with the average reported from 12 theater chains. The average upkeep is approximately $75 per month, and of this sum, between 50 and 60 per cent represents the replacement for tubes alone.

With over 13,000 theaters equipped for sound, and using $42 as an average figure for replacement, the total annual cost for tubes alone is approximately $7,000,000. This figure appears to be reasonable, in checking with reports from the larger chains and the percentage of houses controlled against the total number of theaters.

Up to this time, approximately 25 per cent of the tubes for replacement appear to have been bought through the manufacturer of sound equipment. Between 25 and 50

1. **Sound equipment manufacturers purchase 90 per cent of their component parts.**
2. **Average maintenance cost of sound-equipment for theaters is $900 annually.**
3. **Tube replacements represent 60 per cent of the total.**
4. **Competition in purchases is not as keen as in the radio set field.**
5. **Original manufacturer influences 25 to 35 per cent replacements.**

Percentage of parts purchased (P) or made (M) by individual companies

Manufacturer	1 P	1 M	2 P	2 M	3 P	3 M	4 P	4 M	5 P	5 M	6 P	6 M	7 P	7 M	8 P	8 M	9 P	9 M	10 P	10 M
Amplifiers (main)	...	100	...	100	...	100	100	...	100	...	100	...	100	...	...	100	...	100	...	100
PEC Amplifiers	...	100	...	100	...	100	...	...	...	100	...	...	...	100	...	100	...	100	...	100
Audio transformers	100	...	...	100	100	...	100	...	100	...	...	...	...	...	100	...	100	...	...	100
Power transformers	...	...	...	100	100	...	100	...	...	...	...	...	...	...	100	...	100	...	100	...
Condensers	100	...	100	...	100	...	...	...	100	...	...	...	...	...	100	...	100	...	100	...
Choke coils	...	...	100	...	100	...	...	...	...	...	...	...	...	...	100	...	100	...	100	...
Fixed resistors	100	...	100	...	100	...	100	...	100	...	...	...	...	...	100	...	100	...	100	...
Variable resistors	100	...	100	...	100	...	100	...	100	...	...	...	...	...	100	...	100	...	100	...
Metal cases	100	...	...	100	...	100	100	...	...	...	...	...	...	...	100	...	...	100	100	...
Panels	100	...	...	100	...	100	100	...	100	...	...	...	...	...	100	...	...	100	100	...
Sockets	100	...	100	...	100	...	100	...	...	...	...	...	...	...	100	...	100	...	100	...
Loud speakers	100	...	100	...	100	...	100	...	100	...	100	...	100	...	100	...	50	50	100	...
Rheostats (Faders, etc.)	100	...	100	...	100	...	100	...	100	...	100	...	...	100	100	...	...	100	...	100
Rectifiers	...	...	100	...	...	...	...	...	100	...	100	...	100	...	100	...	...	...	...	...
"B" Batteries	100	...	...	...	100	...	...	...	100	...	100	...	100	...	...	...	...	...	100	...
"A" Batteries	100	...	...	...	100	...	...	...	100	...	100	...	100	...	...	...	...	...	100	...
Motors	100	...	100	...	100	...	100	...	100	...	100	...	100	...	100	...	100	...	100	...
Converters	...	...	100	...	100	...	100	...	...	...	100	...	...	...	...	...	...	...	100	...
Motor Generators	...	...	100	...	100	...	100	...	...	...	100	...	...	...	...	...	100	...	...	...
Optical Units	100	...	...	...	...	100	100	...	100	...	...	...	100	...	100	...	100	...	100	...
Turntables	100	...	100	...	...	100	100	...	100	...	100	...	...	100	100	...	50	50	...	...
Pick-ups	100	...	100	...	100	...	100	...	100	...	100	...	100	...	100	...	100	...	...	...
Meters (all types)	100	...	100	...	100	...	100	...	100	...	100	...	100	...	100	...	100	...	100	...
Vacuum tubes (all types)	100	...	100	...	100	...	100	...	100	...	100	...	100	...	100	...	100	...	100	...
Photoelectric cells	100	...	100	...	100	...	...	...	100	...	...	...	100	...	100	...	100	...	100	...
Exciter lamps	100	...	100	...	100	...	...	...	100	...	...	...	100	...	100	...	100	...	100	...
Battery chargers	100	...	100	...	100	...	...	...	100	...	100	...	...	100	...	...	100	...	100	...

per cent has been purchased from tube manufacturers direct, and the remaining percentage purchased through various theater supply houses and miscellaneous sources.

Equipment other than tubes

Approximately 40 per cent of the upkeep goes for miscellaneous items that require renewal. This includes phototubes, exciter lamps, battery chargers, batteries, meters, etc. The annual replacement cost of miscellaneous sound equipment for theaters alone is estimated at $5,200,000. Total replacement with tubes is approximately $12.200.000. Renewal parts are required for a large number of small mechanical units which are almost entirely furnished by the original manufacturer of the sound equipment. Component parts of amplifiers, including transformers, condensers, resistors, etc., are replaced by direct purchases in those theater chains having engineering supervision. In other units where the personnel is not equipped to make substitution of this equipment, replacements are made through the manufacturer of the equipment. In some cases complete substitution of amplifiers has been made, with the necessary repairs made later by the manufacturer.

Figures available on replacement will be subject to revision in the future due to obsolescence of present equipment and higher replacement costs, due to the number of months in use. Data furnished in practically all cases has been based on equipment less than two years old. The rate of amortization varies, but from present indications of improvements and advances in the art, complete replacements may be expected every four years. It has been estimated that close to 2,000 theatres have had earlier equipment replaced with more up-to-date apparatus, where the original equipment was not satisfactory. A reasonable amount of business may be expected from this cause in the future, as well as that due to replacement caused by the intensive use to which theater equipment is put.

Next to the large number of theaters equipped with sound apparatus, the replacement requirements of the sound studios run into sizeable figures. There are approximately 152 recording channels, a great many portable recording units, as well as location and news-reel trucks in use. Accounting procedure in the case of the larger studies has not made it possible to obtain an analysis of replacement cost of individual components. Additions to present equipment and replacement have not been separate in many cases. In several studios,

[*continued on page 706*]

SOUND PICTURE EQUIPMENT MARKET

Annual replacement:	
Vacuum tubes	$7,000,000
Miscellaneous component parts, batteries, exciter lamps, transformers, etc.	5,200,000
Total replacements	$12,200,000
Annual Sales:	
Sound equipment (1930)	$29,200,000
Accessories, installation material, etc.	3,435,000
Export sales (1930)	8,250,000
Total sales (1930)	$40,885,000

THE DOLLAR COST OF

FOLLOWING are figures on first cost and annual maintenance of broadcasting stations, compiled for the National Advisory Council on Radio in Education, by its committee on engineering developments, whose members are Dr. A. N. Goldsmith, Radio Corporation; C. W. Horn, National Broadcasting Company; E. A. Cohan, Columbia Broadcasting System; John V. L. Hogan, consulting engineer; C. M. Jansky, consulting engineer; Lloyd Espenschied, A. T. & T. Co.; Dr. L. M. Hull, Radio Frequency Laboratories; Ray H. Manson, Stromberg Carlson Co.; R. H. Marriott, consulting engineer; Dr. W. C. Cady, Wesleyan University; Erick Hausmann, Brooklyn Polytechnic Institute; and O. H. Caldwell, *Electronics*.

No program costs are included in the estimates, which cover only plant and studio equipment.

1,000-watt station

CAPITAL INVESTMENT

1. *Transmitter and control-room apparatus*		
Crystal-controlled transmitter	$22,900	
Installation of above	7,500	
Total		$30,400
(Optional additional equipment: For two (2) studio, low level operation, add $1,350. For remote control, add $3,340. For two (2) outside pickups, add $1,220)		
2. *Antenna*		
150-ft. towers, erected	$6,825	
Antenna and ground material	1,125	
Total		$7,950
3. *Engineering services*, survey, installation supervision		1,000
4. *Furnishings*		
One studio, $1,750, Reception room, $1,500; Offices, $1,000; Control and radio room, $300; Studio acoustical treatment, $1,000.		
Total furnishings		$5,550
5. No estimate for land or buildings for 1000-watt transmitters, as these are generally installed in existing structures.		
Total investment—Not including optional additional facilities listed above under 1		$44,900

MAINTENANCE

Studios and Offices		
1. Interest of first cost, at 5%		$2,600
2. Offices, studios (including depreciation of furniture, insurance, and rental of 1750 sq.ft. of space)		5,000
3. Salaries		10,700
4. Miscellaneous (telephone, printing, publicity, etc.)		6,600
Total studio and office maintenance		$24,900
Plant—1. *Apparatus*		
Depreciation and obsolescence at 25%	$10,000	
Insurance and taxes	1,000	
Total		$11,000
2. Rentals—estimated		1,000
3. *Salaries*		
Chief operator and two assistants		6,500
4. Power		1,550
5. Maintenance of apparatus including towers		1,600
6. Tubes		2,500
Total plant maintenance		$24,150
Total annual station maintenance		$49,050

The above is based on five hours per day operations.
For ten (10) hours per day (over a fourteen-hou period) add: Salary two announcers, $4,800; *Transmitter and control room*—Two operators, $4,000; Power, $1,550; Maintenance, $5,000;
Total additional.....$15,350

5,000-watt station

CAPITAL INVESTMENT

1. *Transmitter*:		
For one studio, including control-room apparatus	$51,500	
Installation of above	12,500	
Total		$64,000
(Optional additional equipment: For two (2) studio operation, low-level switching, add $1,500; For two (2) studio operation, low level switching, add, $3,800; For two (2) outside pick-up equipments, add, $5,600)		
2. *Land*		
Ten acres (outside of city) minimum		$5,000
3. *Building* (outside of city) minimum		
Including water system, power line and building furnishings		25,000
4. Antenna—including two 250-ft. towers		16,000
5. Engineering services		2,500
6. Offices and studios:		
Furnishing—one studio, one reception room and office	$9,500	
Acoustical treatment	$5,000	
		14,500
Total investment—not including optional additional facilities listed above under 1		$127,000

MAINTENANCE

Studios and offices:		
1. Interest on first cost, at 5%		$6,500
2. Offices and studios, including depreciation of furniture, insurance and rental of 3,200 sq. ft.		10,500
3. Salaries		25,000
4. Miscellaneous: telephone, printing, publicity, etc		10,000
Total studio and office maintenance		$52,000
Plant—1. Apparatus		
Depreciation and obsolescence on		
(a) Transmitter—25%	$16,000	
(b) Other equipment—15%	2,000	
(c) Buildings—3%	1,000	
(d) Furnishings—10%	1,500	
Total		$20,500
2. Electrical equipment		$3,500
3. Structure		500
4. Tubes		7,000
5. Land and buildings:		
Taxes	$1,000	
Insurance	500	
Total		$1,500
6. Salaries:		
Engineer-in-charge and staff of nine men		24,500
7. Power		4,500
8. Wire lines:		
(a) Three pairs between studio and		

BROADCASTING STATIONS

station at $80 per mile per year.....	$3,600	
(b) Local service for outside pick-ups	7,500	
Total.....		$11,100
Total maintenance of plant.....		$73,100
Total annual station maintenance..		$125,100

Above is based on five hours' operation per day. For ten hours per day (over a period of fourteen hours), add: Additional personnel:
(a) In city offices and studio, $9,000; (2) In transmitter and control room, $20,000.
Total.....$29,000

50,000-watt station

CAPITAL INVESTMENT

1. One 50-kw. transmitter, cost of installation, complete with antenna system.....		$200,000
(Optional: Outside pickup equipment add	$2,800)	
2. Land: 20 acres (outside of city—minimum).		11,500
3. Building: For transmitter.....		75,000
4. Transmitter house furnishings and fittings, control room, etc.....		4,000
5. Service: Power sub-station and line.....	$22,000	
Garage.....	1,000	
Total.....		23,000
6. Offices and studios: Furnishing of studios, offices and reception rooms.....	$14,500	
Acoustical treatment, ventilation....	10,000	
Total.....		$24,500
Total—not including additional facilities, as extra equipment for additional studios, outside pick-up equipment, etc.....		$338,000

ANNUAL MAINTENANCE

Based only on twelve (12) hours per day operation (required by Federal Radio Commission).

Studios and offices:		
1. Interest on first cost, at 5%.....		$17,000
2. Offices and studios, including depreciation of furniture and insurance, and rental of 4,500 sq. ft.....		16,000
3. Salaries.....		40,000
4. Miscellaneous: Telephone, printing, publicity, etc.....		10,000
Total, studio and office maintenance.....		$83,000
Plant—1. Apparatus: Depreciation and obsolescence		
(a) Transmitter—25%.....	$50,000	
(b) Other equipment—15%.....	2,000	
(c) Buildings—3%.....	2,250	
(d) Furnishings—10%.....	2,500	
Total.....		$56,750
2. Land and buildings: Taxes.....	$1,500	
Insurance.....	1,000	
Total.....		$2,500
3. Salaries.....		45,000
4. Power.....		30,000
5. Maintenance of equipment: (a) Electrical, $9,000; (b) Structures, $1,500;		
(c) Tubes, $50,000.....		$60,500
6. Wire lines: (a) Studio to transmitter.....	$8,400	
(b) Local wire pick-ups.....	10,000	
Total.....		$18,400
Total, maintenance of plant.....		$213,150
Total annual station maintenance.		$296,150

Figures given are minimum costs

The figures given in the accompanying tables are to be regarded entirely in the light of suggestions as to *minimum costs* involved. For example, in the case of a 50-kw. or 50,000-watt transmitter, the cost of installation together with antennae and ground system is likely to vary many thousands of dollars, depending upon the part of the country in which construction is undertaken, the height and type of antennae, whether the installation is union or non-union, the form of foundation required for the building and towers (because of local soil conditions), etc.

The same uncertainty applies to the figures of cost of the property on which the transmitter is built, the furnishings and fittings, of the building, the type and size of power sub-station and the length of lines. In fact, to everything except the actual transmitting equipment itself. It is conceivable that any item appearing in the tabulations might increase as much as 100 per cent.

▼ ▼ ▼

Summary of broadcast-station investment and operating costs

(No program costs are included)

	1,000-watt	5,000-watt	50,000-watt
Capital investment.....	$44,900	$127,000	$338,000
Annual maintenance and operating costs:			
Studios and offices.....	$24,900	$52,000	$83,000
Plant.....	$24,150	$73,100	$213,150
Total annual costs, minimum schedule.....	$49,050 (For five hours daily)	$125,100 (For five hours daily)	$296,150 (For twelve hours daily)
Total annual costs, 10 hours daily.....	$64,400	$154,100	$296,150
Grand total of investment and operating costs for first year	$109,300	$281,100	$634,150

Intermediate frequency tuning condenser requirements

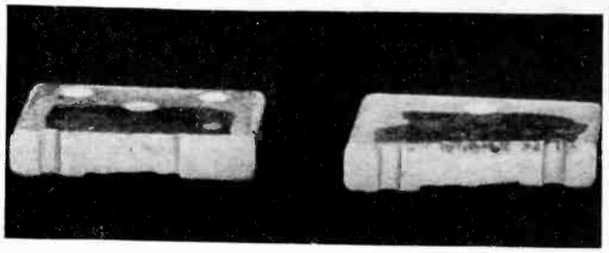
By HOWARD E. RHODES

Consulting Engineer

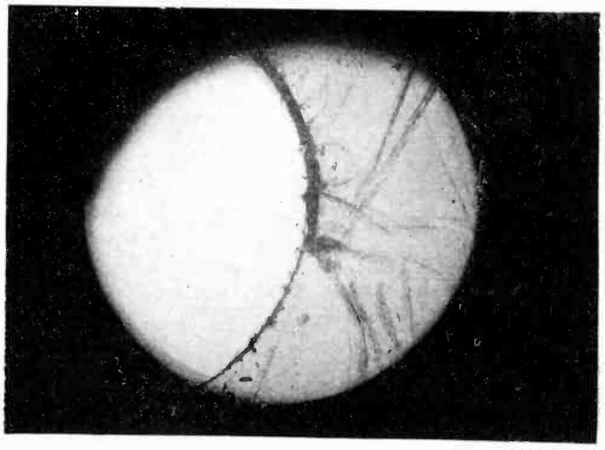
FEW indeed are the number of radio manufacturers who will not market a superheterodyne receiver during the coming months. And although a fundamental knowledge of the design problems of such receivers is possessed by most engineers, time may prove, once again, that there is a lot more to the making of a good set than building up a model that works well in the laboratory. Even the experienced manufacturer of superheterodynes discovers many things about these receivers, when they actually get into service, that were not apparent from laboratory tests. Most any intermediate frequency transformer, for example, will work in the laboratory. But the question is—how well will the laboratory measured characteristics be maintained after the set leaves the factory. If experience is any guide it proves (though the statement may appear somewhat trite) that only the greatest care in the selection of parts and construction of the set make it possible to build a set that will give consistently good performance.

At least six manufacturers starting on their first year of superheterodyne production experienced trouble due to variations in the characteristics of the intermediate frequency amplifier, variations caused by changes in the inductance and resistance of the coils and capacity and resistance of the tuning condensers. It is natural that most of the difficulties should arise in the intermediate frequency amplifier since most manufacturers have had years of experience in the design of tuned r.f. sets and this portion of the super should consequently cause little trouble. The danger to be avoided is not that of unsound technical design of the circuit, but failure in service of parts of the apparatus.

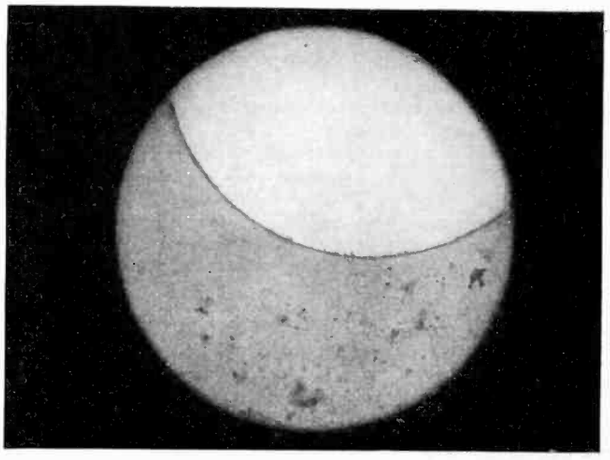
Changes in the characteristics of an intermediate frequency amplifier must be due to changes in the induc-



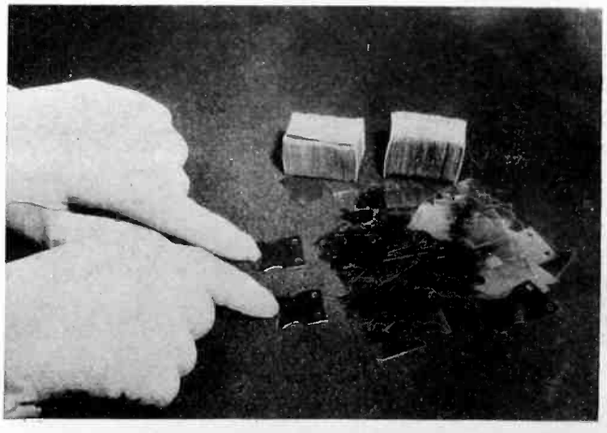
Comparison of treated and untreated ceramic material



Punched mica plate showing signs of fracture



Photomicrograph of mica sheet properly drilled. Magnification about 400 times



Mica for tuning condensers must be "handled with gloves." It is visually tested for flaws by looking at it against black cloth

tance, capacity, or resistance of the transformes. Vibration, humidity, temperature, insecure mounting of coils, lack of permanence of the condenser capacity due to "give" in the threaded adjustment screw are common causes of trouble. Our purpose here is to outline the factors which experience has shown must be considered in the design of i.f. tuning condensers.

Because the tuning condensers of the i.f. amplifier must be compact it is general practice to make them of small plates with mica dielectric and to arrange one plate in the form of a spring so that the capacity can be adjusted to the proper value; by adjustment of the movable plate it should be possible to change the total capacity by a factor of about two to one. The tuning condenser really consists therefore of a fixed condenser in parallel with a single plate variable condenser. The adjustment of such a condenser is of course much less critical than would be the adjustment of an ordinary variable condenser.

These tuning condensers are usually mounted on a ceramic material and it is the nature of all such materials to absorb moisture on each declining temperature cycle. Ceramic bases may sometimes have an insulation resistance between faces as low as 250,000 ohms and the resistance will vary widely with temperature and humidity. For these reasons set manufacturers have found that the bases, which are generally Isolantite, must be treated by an application of suitable material immediately after the bases are withdrawn from the kilns. If the bases are properly treated they will be impervious to moisture and will show infinite resistance under all atmospheric conditions. A simple test for moisture absorption can be made by dropping some ordinary ink on the face of the base, allowing it to dry and then breaking the base in two. Untreated, or improperly treated bases will absorb the ink. A picture of two bases so treated is shown above. At the left a properly treated base; the ink stain is only on the surface. At the right we have an untreated base showing how the ink has penetrated into the base. Treated bases must be used if the condensers are not to vary in characteristics with weather conditions.

Mica must be properly drilled and handled

The quality of the mica pieces, the manner in which they are mounted in the condenser and the care with which they are handled during manufacture are important points. Even if the best mica is used an average of one out of every ten pieces will be found defective. The mica must be inspected for waves, spots, color, bubbles, holes and fractures especially around the edges and around the holes. The mounting holes must be drilled (not punched) to prevent fracturing the pieces. The microphotographs above serve to show how the mica surrounding a drilled hole is quite free from fracture, whereas if the hole is not drilled many small fractures are produced.

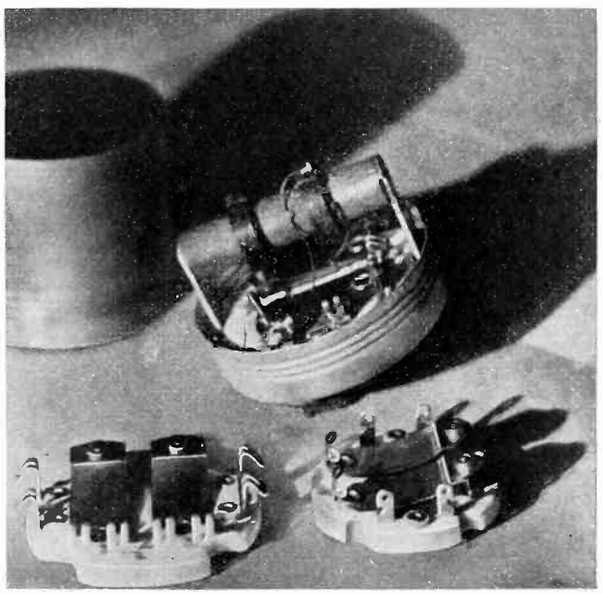
In production the mica pieces should preferably be handled only with gloved hands to prevent moisture from getting on the pieces. Handling these pieces is specialized work and the operators must be trained.

Since mica is so easily fractured the method of mounting the mica in the condensers is extremely important. They must not be pinched around the edges of the plates and the flexible plate must be mounted on a washer so that the top piece of mica will not be cracked when the flexible plate is forced against the upper mica. The construction must be such that the mica pieces lay perfectly flat to prevent any undue strain.

It is desirable that the condenser have a uniform rate of change of capacity with adjustment to facilitate aligning the various transformers. This means that the bronze flexible plate must be properly tempered, as checked by a scleroscope. If the movable plate is not properly tempered the variation of capacity with adjustment will not be uniform; the plate may also tend to buckle causing the capacity to *decrease* as the adjusting screw is turned to *increase* the capacity. Adjusting screws with tapered self-aligning heads and with machine cut rather than rolled threads are small mechanical points but important; the edges of a rolled thread are frequently quite thin and, under tension, such a thread will "give" and cause a gradual change in condenser capacity.

Even soldering technique is important

The soldering must be done with rosin. If even a small amount of ordinary soldering flux works its way into the condenser the unit is rendered worthless. To check this point some 50 condensers were taken and leads to 25 of them were soldered with ordinary flux; rosin flux was used for the connections to the other 25. All



Intermediate frequency apparatus—tuning condenser and transformer

of the latter condensers tested perfect; all but two of the other 25 proved to be practically worthless. The condensers were tested by connecting them across a coil coupled to a 175 kc. oscillator. The condenser was then adjusted to bring the circuit to resonance as indicated by a vacuum tube voltmeter connected across the coil. The good condensers gave almost full scale deflection on the voltmeter; while all but two of those soldered with ordinary flux gave a deflection of only about one-half a division.

A properly built condenser, using the best grade of mica and properly treated base will show a change in capacity of less than one per cent at temperatures from 0 to 150° F. and humidities from 0 to 95 per cent.

Final tests on such condensers should include measurement of minimum and maximum capacity, losses and breakdown. For the breakdown test some 300 volts a.c. can be applied between the two sets of plates.

Condensers by Hammarlund and a transformer by Sickles are shown above.

electronics

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O. H. CALDWELL. *Editor*

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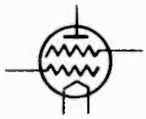


Radio and the "little red schoolhouse"

IT IS high time some of the real facts about radio were injected into the heads of politicians and educators who are now indulging in flights of oratory about reaching the little red schoolhouse with educational programs.

Just at present the favorite delusion of these educational enthusiasts seems to be that by building a 500-watt station (about as much power as a breakfast toaster consumers) their speakers can cover the school rooms of the whole nation. The fact is, of course, such a 500-watt station can be depended on to deliver a dependable program only *two to 15 miles* during daylight hours. Even a 5000-watt station can serve a radius of *only 15 to 40 miles,* and 50,000-watts *only 30 to 100 miles,* under average daylight conditions.

It requires a chain hook-up of 50 to 75 large stations in all parts of the country to cover the city and suburban populations of the nation. And even with such a nation-wide urban coverage, it is doubtful whether during daylight more than one-third or one-half of the district-school houses out in the country will be reached with radio signals strong enough to be of any use for instructional purposes to a roomful of pupils.

In other words, frankly, radio broadcasting as a daytime service to the little red schoolhouses of the nation is not yet dependable in more than 50 per cent of the cases for which it is needed. Moreover, its usefulness will probably remain so impaired, depriving millions of school children of nation-wide radio programs, until the members of the Federal Radio Commission grant 50-kilowatt licenses to the twenty or more great stations now applying for high power.

Like automobile, like radio

RADIO industry is fond of considering its vagaries in the light of what has happened in the past to the automobile industry. There are some similarities no doubt. In his annual report to stockholders, Royce G. Martin, president, Moto Meter Gauge and Equipment Corporation states that the decrease in sales volume for 1930 of 56 per cent clearly reflects the dependence of his company upon the automotive industry. Compare this with the tube manufacturer who depends entirely upon radio as an outlet. But says Mr. Martin, "Knowing this condition, every effort has been put forth to introduce and create new products in our laboratories."

A single new product might break the back of the depression into which the tube industry has fallen by virtue of overproduction, excessive distribution costs, uneconomical replacement policies, unprecedented discounts and business instability.

"Dubbing" or re-recording for broadcasting

ONE of the evils which have come into radio broadcasting along with "electrical transcriptions" has been the re-recording or "dubbing" of commercial phonograph records for broadcasting purposes. Such a dubbed record has technically the right to be called "an electrical transcription especially prepared for broadcasting." But this, of course, is a mere circumvention, looked at from any angle.

Such dubbing is detrimental to radio for the following reasons:

1. The frequency characteristics of re-recorded electrical transcriptions are such that reproduction on the air is decidedly below the standards of electrical transcriptions produced from live talent.
2. While the electrical transcription is made exclusively for broadcast purposes, the original production was made exclusively for phonograph use. The program therefore, becomes a composite of phonograph recordings differing only from the broadcasting of phonograph records in that the re-recordings are inferior in tone reproduction.
3. The use is unfair to the artists and in-

directly, if not directly, a circumvention of the rules of the Union, the American Federation of Musicians, since their rates are lower for phonograph recordings than for recordings for broadcast purposes.

4. When such records are broadcast with the station definition that they "are made exclusively for broadcast purposes," there is an *actual* deception of the public, even if not a legal one!

Information = time × frequency

INVENTORS of the past busied themselves with perpetual-motion machines; college laboratories are full of workless examples of this type of device; college professors have been threatened with physical harm because they refused to believe that such machines would work.

Inventors' pastime nowadays seem to be toward transmitting a given amount of information on a smaller wave-band than either mathematics or practical experience dictates is necessary. Such inventors have their eye on television. Out of their work something may arise, but it is doubtful if they will be able to transmit a given amount of information without using up a given product of time and frequency.

In every electrical communication system without exception, the information to be transmitted is expressed as a single-valued function of time. Such a function may be expressed equally well by a series of sinusoidal functions of proper frequency, amplitude and phase. If the time characteristic is not repeated, Fourier's methods must be applied based on the use of an infinitesimal number of sine functions, each of infinitesimal amplitude and separated by infinitesimal frequency increments.

Regardless of how the single-valued function of time is expressed in terms of sinusoidal components, none of these components can be disregarded without losing some of the information. Transmission of a given amount of information is rigorously associated with a given time-frequency product. A reduction of this product, therefore, results in a reduction of the information associated with the product.

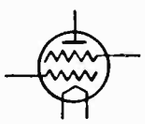
In radio or television, as in business, it is difficult to get something for nothing.

The cathode-ray tube—a time divider

WHAT the microscope does in separating elements which lie close together in space, the electronic oscillograph achieves in separating events closely following each other in time. In the same way as improvements in the design of high-power microscopes have furthered progress in scientific and industrial fields, the high-speed cathode-ray oscillograph is bound to promote our understanding of important phenomena.

Present types of cathode-ray tubes suffer the comparatively short life of the electron emitters and the lack of brilliant wave patterns. At a meeting of the Institute of Radio Engineers, recently, a cathode-ray tube made by the well-known German investigator, von Ardenne, was used to show to a very large audience various wave forms. So brilliant was the pattern that it could be seen in the rear of a large hall without the necessity of turning out the lights; it is said that proper choice of gases within the tube and other factors have made possible a life of over 2,000 hours.

Introduction of such a tube in this country should provide many laboratories with an excellent research tool.



Vitamins, bacteria and electrons

INCREASING evidence is at hand of the part which electronic devices are to play in the preparation of the foods of the future. Dr. George Sperti of the University of Cincinnati has just announced some revolutionary experiments in the production of Vitamin D by ultra-violet waves from mercury-vapor arcs. Another interesting feature is the marked destruction to all living cells which occurs at wavelengths of 2,950 Angstrom units. Milk, orange juice and other foods may thus be both sterilized and improved in value, and kept suitable for use for many months.

Short radio waves also have an important future in food treatment, it would appear from the experiments already made in other directions.

The work of the electron in the kitchens of mankind is just commencing.

The march of the electronic arts

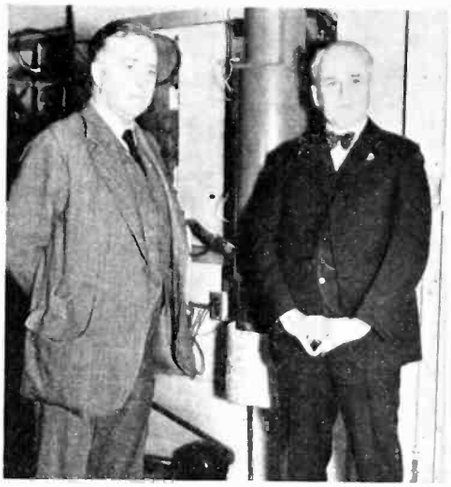
Commission to hold hearing on RCA licenses June 15

As a result of the Supreme Court ruling against the Radio Corporation in the "Clause 9" case, a hearing on applicability of Section 13 of the Radio Act of 1927 has been ordered by the Radio Commission on June 15. The Radio Commission by this move is taking the first step to determine whether the several communication subsidiaries of the Radio Corporation must forfeit the 1,400 or more wave-length licenses they now hold. Final decision in this case will undoubtedly fall upon the Federal Courts.

The situation necessitating an answer arises out of the recent refusal of the Supreme Court of the United States to review the decision of the lower court in the "Clause 9" litigation in which RCA was held to have violated the Clayton anti-trust act by requiring all its radio set licensees to equip their sets initially with tubes of RCA manufacture.

Section 13 states: "The licensing authority (the Federal Radio Commission) is hereby directed to refuse a station license and the permit hereinafter required for the construction of a station to any person, firm, company or corporation, or any subsidiary thereof which has been finally adjudged guilty by a federal court of unlawfully monopolizing or attempting unlawfully to monopolize, after this act takes effect, radio communication, directly or indirectly, through the control of the manufacture or sale of radio apparatus, through exclusive traffic arrangements, or by any other means, or to have been using unfair methods of competition."

ELECTRONS TO UNIVERSES



Sir James Jeans, visiting British physicist (left), and Dr. R. A. Millikan, discuss cosmic problems of the universe in Pasadena, California

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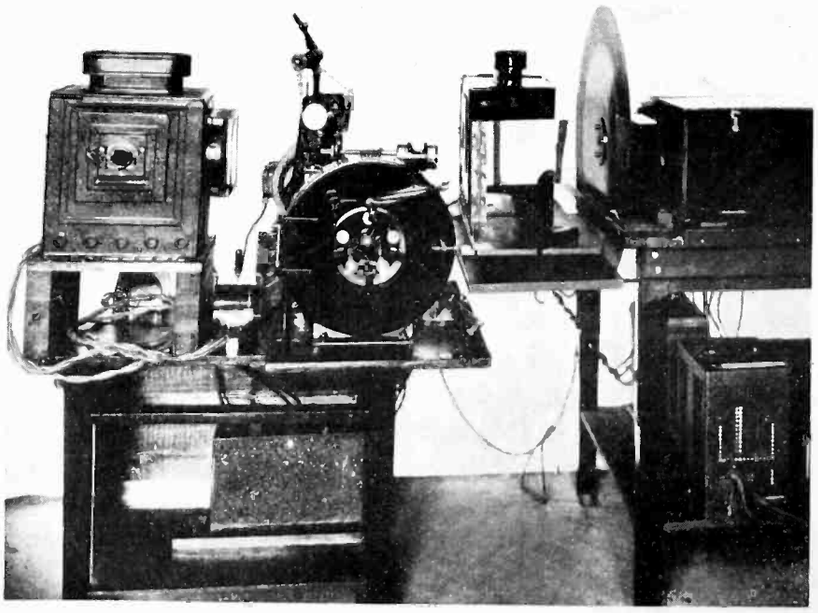
TELEVISING SOUND PICTURE FILMS



Apparatus, developed by Denis Von Mihaly, which is being used by Berlin's television station at Doeberitz for the wireless transmission of sound films

Successful RMA show predicted in Chicago

The indications are, as *Electronics* goes to press, that in business conducted, attendance and exhibits, the Trade Show at Chicago during "Radio Week" beginning June 8 will be one of the most successful RMA conventions ever held. More new radio products, including television and home movies, will be exhibited at the Stevens Hotel than ever before in one year.

One hundred and thirty of the leading radio manufacturers will have exhibits. A larger proportion of manufacturers will have exhibit space than ever before at any RMA Trade Show for the last three years. The attendance will be stimulated by the concurrent convention during the week of June 8 of the Music Industries and the annual "Furniture Mart" of the furniture industry as well as members attending the IRE convention June 4-6.

✦

Ultra-violet sound recording

It is reported that the Gaumont Laboratories in France have successfully demonstrated a new process of ultra-violet sound-on-film recording. The full width of the film is used in place of the present sound track by this method. Reproduction is accomplished by means of a mercury arc lamp. The sound record is recorded on one film and the picture on another similar to present studio methods using two films. Later the two are superimposed to make the finished print. The sound record is made by the use of ultra-violet rays and is not sensitive to the ordinary projection light so that no images from the sound appear on the screen.

✦

Stations improve frequency control

Although the Federal Radio Commission intends to give American broadcasting stations a whole year in which to perfect their transmitting equipment to the point where they will not "wobble" or deviate off their assigned wavelengths more than 50 cycles, which is one-twentieth of the one kilocycle dial mark on the average receiving set, inspectors of the Radio Division of the Department of Commerce report that 65 stations have already achieved this high standard of technique.

They are cited on the fourth monthly "honor roll" of stations measured by the federal radio inspectors.

Public will demand freedom of broadcasting

"THE AMERICAN PUBLIC guards its freedom of the press and this same public will demand that its broadcasting be kept free from government domination."

Such was the reply of Philip G. Loucks, managing director of the National Association of Broadcasters, to the resolution favoring public ownership and operation of broadcasting passed by the National Congress of Parents and Teachers at its annual meeting held the first week in May in Hot Springs, Ark.

The resolution read: "We believe radio broadcasting is an extension of the home; that it is a form of education; that the broadcasting channels should forever remain in the hands of the public; that facilities should be fairly divided between national, State and county governments; that they should be owned and operated at public expense."

"This action," says Mr. Loucks in a bulletin to the 160 members of his association, "undoubtedly is one of the by-products of the aggressive and well-financed campaign being conducted by organized educators to secure broadcasting channels for the exclusive use of the educational institutions through federal legislation.

"It would cost the American public millions of dollars annually in taxes to support a government monopoly of broadcasting such as that advocated. Furthermore, with competition eliminated from the industry, programs of inferior quality would follow. But the principal danger of government monopoly is the temptation it provides for political patronage."

✦

M. I. T. to organize electronic courses

THE APPOINTMENT OF Dr. Ralph D. Bennett as associate professor of electrical engineering at the Massachusetts Institute of Technology was announced by President Paul T. Compton on May 18. Dr. Bennett will develop courses and research work dealing with the applications of the newer electrical devices, such as amplifiers and gas discharge devices in the field of electrical measurement and electrical control.

Dr. Bennett is a graduate in electrical engineering from Union College and received his PhD. degree from the University of Chicago where he was associated with Professor Arthur H. Compton in research work. He later held a National Research Fellowship in Physics at Princeton and also at the California Institute of Technology where he developed several interesting electrical devices, including the million-volt X-ray tube.

BERLIN NOISE-MINDED

The traffic noises of Berlin being measured at the traffic-tower on Potsdamer Platz with acoustic devices

✦

Russia completes second of four 100-kw. stations

Russia's second 100,000-watt broadcasting station, proto-type of a series to be built throughout the country by the Soviet Electrical Trust under the "Five Year Plan," has just been placed in operation at Kolpine, according to the *Soviet Union Review*. The other 100-kilowatter is Moscow Komintern, and it has been reported that Russia is planning still another super-power broadcaster of 500,000 watts near Moscow.

Two more 100,000-watt stations are under construction, one in Noginsk, near Moscow, and the other in Novosibirsk.

Radio networks spend over $5,000,000 on phone tolls

BY FAR THE LARGEST single class of users of the telephone system of the United States are the two major radio networks, the National Broadcasting Company and Columbia Broadcasting System, and the various regional network services, which link stations together by telephone lines for national and regional programs. The services and the various remote control pickups employed by individual stations represent a revenue to the telephone system of well over $5,000,000 annually.

✦

Station KNX forfeits 50,000-watt permit

STATION KNX, Los Angeles, was forced by the Commission to default the construction permit it has held for more than a year to erect a new 50,000-watt transmitter.

The dropping of KNX from the roll of the fourteen stations that had already been admitted to the high-power ranks leaves three instead of two choices for new high-power stations in the fifth zone of far western and Rocky Mountain states. Chief Examiner Yost, limited by order of the Commission to four choices per zone and with KFI and KNX already holding authority to build 50,000-watters in the fifth zone, selected KOA, Denver, and KPO, San Francisco, recommending 25,000 watts for KSL, Salt Lake City, and KGO, Oakland, Calif., the other applicants for 50,000 watts.

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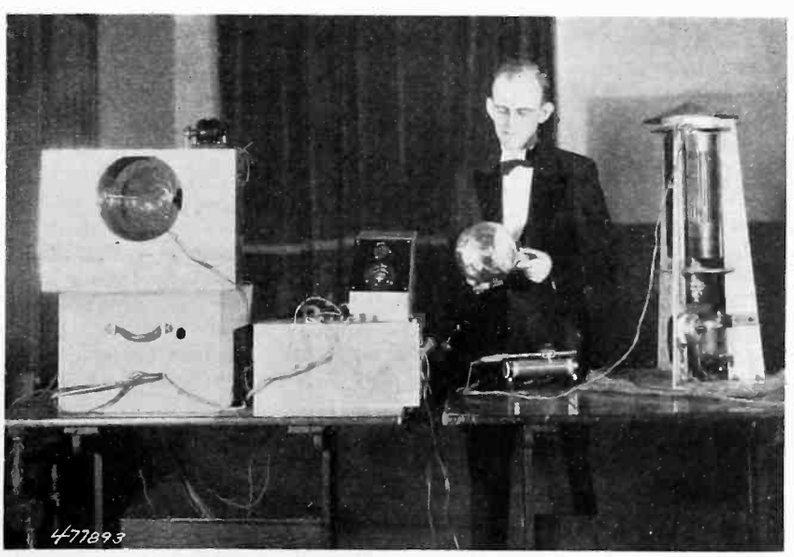
PHOTOCELL BEACON TO AID FOG-FLYING



Equipment designed by General Electric Company to aid aviators to land in fog, consists of phototube receiver for the plane (left) and 1,000 cycle neon beacon (right) for ground station

REVIEW OF ELECTRONICS LITERATURE

HERE AND ABROAD

Broadcast on trains

[HÉMARDINQUER] Description of methods and apparatus used on government lines in France, and shortly to be extended to privately-owned lines also. A receiver placed somewhere on the train is connected to jacks in each carriage into which head-telephones can be plugged. The receiver is also used to transmit gramophone records and information for passengers spoken into a microphone. The filament current is taken from the train-lighting system at 20 volts, the anode current from accumulators recharged from this system, at 140 volts.—*La Nature, Paris, April 15, 1931.*

✦

Method of decrement measurement by capacities

[SCHLESINGER] From the von Ardenne laboratories. A simple apparatus permits measurement of decrements and resistances at resonance of oscillatory circuits by what is essentially a capacity bridge, by simple reading of a capacity. The same procedure also allows of simple measurement of the sensitivity of receivers. Practical difficulties and their avoidance are described.—*E.N.T., Berlin, April, 1931.*

✦

Ultra-short waves for broadcasting

[UNSIGNED] Conservative and guarded communication from the German Postal Department, on the experiments carried out during the past months by the Department in cooperation with two Berlin firms (Lorenz, Telefunken) on 6.75 and 7.05 meters with a power of one kilowatt antenna. Results were in general satisfactory, giving loud-speaker reception with simple receivers and indoor antennas throughout even such an extensive city area as Berlin. Shielding of antennas by metallic masses in buildings frequently occurred, but as a rule the moving of the antenna a few meters removed it. Interference from electrical machinery was met with, but to a less degree than on the normal wave-bands. Before any practical decision can be made, several important points remain to be cleared up: for example, the extent to which an ultra-short-wave sender interferes with normal wave reception in the close neighborhood, what type of receivers can be used, and how far normal receivers can be adapted to ultra-short-wave reception.—*Funk, Berlin, April 10, 1931.*

Tubes of 1931

[SCHWANDT] Summary of the German tubes, 106 receiving tubes being produced by three makers only, not including special two- and three-in-one tubes nor rectifying tubes. The actual number of different *types* is less than this, several makers producing practically identical tubes with different designations, but at least 75 distinct types can be traded. Besides types normal on the U. S. market four types of double grid tubes are represented (for low anode voltages or as the "mixer" tube in superheterodynes); four types of "gridless," capacity-controlled tubes (these Digests, October, December 1930); and eleven pentodes. In addition some six two- and three-in-one tubes are listed, but it is stated that manufacture of these is being discontinued; and the Loewe company continues its two- and three-in-one tubes with built-in coupling devices. Some 120 rectifying tubes are also listed. For the receiving tubes the following details are given: filament current, voltage, and wattage; maximum anode voltage; anode dissipation (for loudspeaker tubes); average anode current; internal resistance; mutual conductance ("Steilheit", given in milliamperes per volt); "Durchgriff" (reciprocal of μ given as a percentage); μ; "Güte" (product of μ and mutual conductance); maximum anode wattage handlable without distortion; grid voltage for given anode voltages; type of base (20 different bases being in use); and price. These last range from $1.25 to $2.50 for low-power battery tubes, $3.50 to $4 for similar indirectly heated tubes, $3 to $5 for screen-grid tubes, $4.75 to $5.50 for low-power pentodes. —*Funk, Berlin, February 20, 1931.*

✦

Battery receivers

[NESPER] Lengthy description of the receivers where only two A and two B battery connections are necessary, all adjustments of voltages being made within the receiver by fixed resistances etc., as in the case of electrified sets, and where these two connections are made automatically by spring contacts on inserting the accumulator or dry battery. Total B battery currents are 3.5 mA for the "local" receiver (probably two-tube) and 5.2 mA for the "distant" receiver using a screen-grid radio amplifier, regenerative detector, and two audio-frequency tubes.—*Funk Magazin, Berlin, May, 1931.*

Shielded antenna down-lead

[RECHNITZER] Results of experiments at the A.E.G. showrooms in Berlin where interference is unusually strong owing to the demonstration of all sorts of electrical appliances and machinery. Some twelve meters of down-lead were shielded, from the guttering of the roof to the receiver, it being impracticable to shield the free portion from antenna to guttering. Bergmann tubing of 35 millimeters diameter was used, the lead being maintained central within this by means of small wooden blocks. (This is standard German lighting conduit, consisting of a thin metal envelope over an insulating tube.) The electrical continuity of the metal envelope was ensured by bridging all tube-to-tube junctions with soldered copper-wire links. The total capacity to ground was of the order of 500 micromicrofarads: with untuned antenna coupling this merely increases the natural wave-length of the antenna and is not normally disadvantageous; with capacity coupling the shielding decreased volume to one-fifth or even one-tenth. Previous to the shielding even the local Berlin transmitter could not be received through the interference.—*Funk, Berlin, April 24, 1931.*

✦

Neon lamps and aerial navigation

[ETIENNE] General study of applications: especially interesting is the marking of high-tension lines in proximity of aerodromes by neon tubes some 30 centimeters long, hanging freely from one conductor and with one electrode only in contact with it, the second electrode being fitted with a multiplicity of sharp points and the tube acting by virtue of the discharge from these.—*Radio-électricité, Paris, April, 1931.*

✦

Technical requirements for cable-connections

[UNSIGNED] Report of a lecture by Höpfner of the German Postal Dept. It was stated that the cable network connecting German radio transmitters carries satisfactorily frequencies from 50 to 7000 cycles (to be 8000 shortly), and that volume relationships of 100 to 1 are dealt with, the noise-level never being more than 1/20 of the weakest signal.—*Funk, Berlin, February 16, 1931.*

Radio-beacons for aerial navigation

[ETIENNE] Deals chiefly with the experiments at the Bureau of Standards, but gives also details of the beacon serving the Paris-London route for the past two years. This uses two loops at right angles, each with its own one-kilowatt sender, emitting "F" and "L" respectively in Morse on a common wave-length, the observation on the planes being by ear. Another beacon, using double modulation and the vibrating reeds as developed in U. S. is to be put into service shortly.—*Radioélectricité, Paris, May, 1931.*

✦

Fundamentals for ultra-short-wave receivers

[LIEBAU] Discussion of the difficulties met with both in the case of ordinary regenerative detectors and with super-regenerative circuits. Emphasis is laid on the need for excellent shielding and radio-frequency choking, especially to avoid "fringe-howl"; on the desirability of regeneration control by variation of plate resistance rather than by the more usual means; and on the disadvantages of superregeneration (mutual interference between such receivers although no such effect exists between a superregenerative set and a normal detector). Full descriptions with photographs and circuits of two receivers built for experimental purposes at the Heinrich Hertz Institute are given, one using super-regeneration with a separate tube, and the other using a single tube for both purposes, both being also readily usable as ordinary regenerative detectors. Both are for battery use, no work on electrified sets having as yet been done. —*Funk, Berlin, May 1, 1931.*

✦

Variable condenser and a wavemeter for high frequencies

[E. B. MOULLIN] At frequencies of the order of 30,000 kc. the total capacitance of an oscillating circuit is very small, and the main part of the resonance curve will be included within a change of the order of one mmfd. Its half-width, for instance, for a decrement of 2 per cent (power factor 0.657 per cent) and 35 mmfd. is 0.385 mmfd. Suitable variable condensers are difficult to calibrate. In the case of a cylindrical condenser, consisting of two cylinders, accurately machined aluminum castings, eccentric with one another and one cylinder always totally enclosed and screened by the other, the change in capacity obtained by rotating the inner cylinder about an axle, can be calculated; its residual inductance can also be computed. In the sample described and tested in detail the capacity is increased by 1 mmfd. by rotating the cylinder through 45 deg. from the minimum; the total change is 16 mmfd. The accuracy is illustrated by means of resonance curves for 41.5 and 11.4 and 10.1 m. waves. By changing the cross section of the inner cylinder a more regular scale should be obtained.—*Journal Institution El. Engineers, April, 1931.*

✦

Radio patents

Austrian 116562, Goebeler, avoidance of interference from high-frequency medical appliances, essentially by grounding the patient through a condenser to the leads feeding the interruptor. Austrian 116811, Telefunken-Meissner, short-wave sending circuit for the avoidance of fading effects by the simultaneous transmission on two very close frequencies, so that one receiver is affected by both. Austrian 116206, Telefunken-Schröter, avoidance of fading effects in picture transmission by changing the wave-length after each line of exploration (rotation of cylinder, etc.), simultaneous changes being made at the receiver.—*Funk Magazin, Berlin, May, 1931.*

✦

Technique of the ultra-short waves

[LEITHÄUSER] Important general discussion of the uses of these waves for broadcasting. Some points not brought out by other authors are the difficulties in sender building (capacity effects in radio-frequency chokes and resistances, glass or quartz insulation for condensers); avoidance of interference on normal broadcast wavelengths by not grounding the sender and by the use of effectual radio-frequency chokes in all leads to the (grounded) accumulators and dynamos, these measures having made possible DX reception on the normal waves in the same room as the ultra-short-wave sender at the Heinrich Hertz Institute; use of quarter wave-length doublets at considerable heights above surrounding buildings, etc.; use of Armstrong superregenerative and Flewelling circuits in receivers; avoidance of ground connections in receivers, a two-meter rod antenna and a similar counterpoise being preferable, this also decreasing interference from ultra-violet apparatus and the like (although such interference is in any case less than on normal waves); losses in buildings, making desirable a simple lead from the roof down, well separated from the walls, when reception in the lower stories is desired; television and sound-film possibilities.—*Funk, Berlin, May 1, 1931.*

Vacuum tube performance and illumination

[L. PUNGS and K. SCHULZE] Brunswick Institute of Technology. Although the experiments described relate to Telefunken screen-grid tubes with oxide-coated cathodes, they are of interest because some American firms claim that tubes work better when light is excluded. It is found that the changes depend on the presence of the mirror formed by the getter material which loses electrons when illuminated. The result is a change in frequency when producing oscillations or a change in anode current of up to 20 microamp.—*Zeitschrift f. Hochfrequenz Technik, April, 1931.*

✦

Measurement of resistance at radio frequencies

[F. N. COLEBROOK and R. M. WILMOTTE] Radio Research Board and National Physical Laboratory. The method developed depends on the change in reactance of a valve-maintained oscillating circuit when it is coupled to the elements under investigation. At measuring frequencies of 10,000 kc. its accuracy is better than 3 per cent with little expense beyond that involved in the provision of good quality condensers. Two oscillating circuits are required (dynatron oscillators below 10,000 kc. making use of the negative characteristics of screen-grid tubes). The frequency of the first circuit is adjusted to the required value, that of the second circuit is varied until no beats are heard between the heterodyne frequency and a constant audio-frequency (from a dynatron oscillator with one stage of amplification) supplied to the telephone. A third circuit consisting of the coil under investigation and a calibrated condenser and coupled to the first circuit is now closed and the condenser adjusted to make the beat note disappear. This gives the resonant value of the condenser. Its setting is now slightly changed, and the beat note eliminated by varying the capacity in the first circuit; here silence is obtained for two different settings in the coupled circuit and from these three values of capacity the resistance is found.—*Journal Institution of El. Engineers, April, 1931.*

✦

Adapter for ultra-short waves

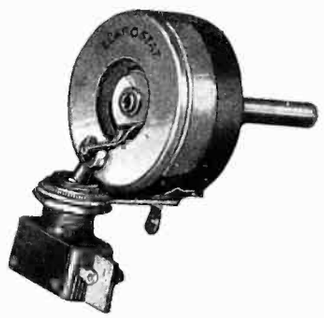
[UNSIGNED] Very full details, intended primarily for amateur builders, of a suitable ultra-short regenerative detector for attachment to the audio-frequency portion of a normal receiver. A further article to deal with the addition of a second tube for superregeneration will follow.—*Funk, Berlin, May 1, 1931.*

✦ NEW PRODUCTS

THE MANUFACTURERS OFFER

Isolated rotor volume control

OF VALUE IN THE control of the new variable mu tubes, a new wire-wound volume control with "dead" or insulated contact arm and mounting bushing has just been announced by the Clarostat Manufacturing Co., Inc., 285 North 6th



St., Brooklyn, N. Y. This improved model of the Clarostat control makes the use of insulating mounting bushing entirely unnecessary as all exposed parts are out of the electrical circuit. It is supplied with or without dust cover and may also be had with 110-volt switch attached.—*Electronics, June, 1931.*

✦

High sensitivity thermo-couple

A HIGH SPEED THERMOCOUPLE for all radiometric measurements, has been announced by R. C. Burt Scientific Laboratories, 890 E. California St., Pasadena, Cal. Its sensitivity is high, giving one microvolt for 1×10^{-8} calories per second, falling on the receiver (.4 mm. × 1.5 mm.), when pressure is less than 10^{-4} mm. of mercury. It is also quick acting; thermal equilibrium is reached in .1 seconds, and is linear, the current produced being proportional to the amount of light falling on the receiver. This thermocouple has a pyrex housing, which makes it easy to join to other apparatus, or to a calcium tube if the thermocouple is to be permanently evacuated. — *Electronics, June, 1931.*

✦

Silent turning device

GIVING VISUAL INDICATION of the station as well as tone and glowing with a brilliant red light, the 3½-in. gas-filled tube, known as the "Tune-a-Lite," has recently been announced by the Duovac Radio Tube Corporation, 360 Furman St., Brooklyn, N. Y. It makes possible silent tuning and every audible station in the general broadcast range can be brought in unerringly even though the volume control is turned down to a point where no sound issues from the speaker. Proper tone and station is indicated by a small column of red brilliancy that appears in the "Tune-a-Lite" as the station is approached. This column of light rises to a maximum height as the station is reached and then gradually diminishes as the station is passed. All standard circuits will allow for Tune-a-Lite installation with comparative ease and slight change.—*Electronics, June, 1931.*

✦

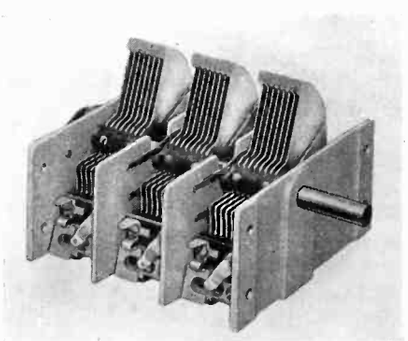
Tube socket washers

A NEW PRODUCT of the Sampson Industries, Inc., 4225 Olive St., St. Louis, Mo., is the "Stiktube" socket washer. This device consists of a wool felt, double coated on each side with a high grade adhesive. The exterior diameter is the same as that of the base of a standard radio tube. The center is stamped out making it possible to fit the washer on the base of the tube. Upon inserting the tube in the set, the washer and tube are securely retained. This washer provides the necessary shock absorber for shipping sets with tubes installed.—*Electronics, June, 1931.*

✦

Radio condensers

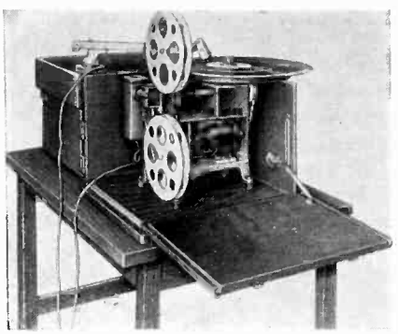
THE SCOVILL MANUFACTURING COMPANY, Waterbury, Conn., announces a line of standard radio condensers available at moderate prices. The accompanying illustration shows the three-gang low shield type. The Scovill line also includes two-gang and four-gang models. All models are furnished for



either clockwise or counter-clockwise rotation. A standard size line of the same general construction is also offered. —*Electronics, June, 1931.*

Home movie equipment

TWO MODELS OF home movie apparatus have been announced by Sprague Specialties Company, of Quincy, Mass. One is a portable model and the other is in cabinet form. The portable type "Visivox A" lists at $119. This model includes the phonograph synchronization apparatus, pick-up and projector. The "Visivox C" is a complete machine in a walnut cabinet, including projector,



phonograph apparatus, amplifiers and loud speaker. It lists at $189. The cabinet shown folds up completely as a portable set not much larger than a midget radio.—*Electronics, June, 1931.*

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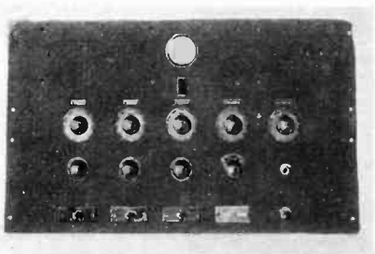
Microphone amplifier and mixing panel

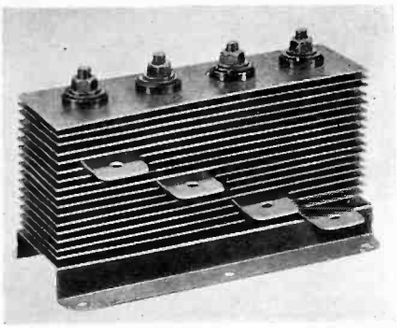
THE "FADE-IN" is a unique feature of a microphone amplifier and mixing panel, announced by Webster Electric Company, Racine, Wis. The unit is



battery-operated, and has a two stage microphone amplifier and mixing panel, which will accommodate up to three microphones. A special control permits the fading in of music or the voice. This unit is built to the following specifications: Frequency response, flat from 40 to 10,000 cycles; output designed to work into a line or load of 500 ohms; the input is designed for three standard two-button carbon microphones and a 500-ohm phonograph pick-up; the gain is 48 db. This unit can be furnished for rack mounting, or with a metal case to mount on the wall or on a bench.—*Electronics, June, 1931.*

Heavy duty rectifiers

A NEW LINE OF heavy-duty rectifiers has been announced by the B-L Electric Manufacturing Company, 19th and

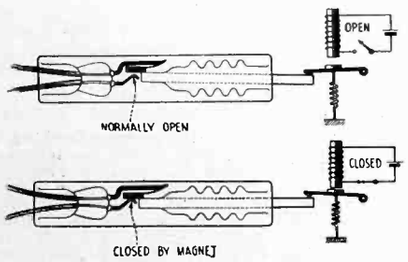


Washington Ave., St. Louis, Mo., supplementing the line of smaller size rectifiers which they have had on the market for some years. The new rectifiers are constructed entirely of metal plates without any moving parts and are of rugged construction. They are used to obtain low voltage, direct-current from the ordinary a.c. lighting or power lines and for this purpose require the use of small transformers.—*Electronics, June, 1931.*

✦

Vacuum contact

THE BURGESS VACUUM contact sold by Burgess Battery Company, 295 Madison Ave., New York City, is a new and improved device for use wherever a positive, rapid and durable electrical contact is needed in circuits handling up to 6 amperes continuous load or 8 amperes intermittently, at potentials up to 220 volts. It can be operated by hand, by mechanical means, or again by electromagnetic agency in conjunction with the usual telephone type relay. This contact is especially well adapted for use in telegraph and telephone circuits, for railway switches and signals, for fire and burglar alarm systems, con-



trollers, advertising signs, rectifiers, electric ranges and other applications where a considerable wattage must be controlled by a minimum of energy. The make and break are positive and clean, without the hang-overs and chattering experienced with other forms of contacts, as proved by comparative oscillograph recordings. The vacuum contact requires a movement of only 0.02 inch at the end of its stem, which can be brought about by a force of less than 10 ounces, and usually but 6 ounces.—*Electronics, June, 1931.*

Intermediate tuning condensers

INTERMEDIATE TUNING CONDENSERS in both dual and single style, for superheterodyne and other similar circuits are now being manufactured by the Hammarlund Manufacturing Company, 424 West 33rd St., New York City. These condensers, which are made especially for manufacturers' use, in the single style are known as the "ICS," and in the dual style as the "ICD" type. The duals are made in two sizes, $1\frac{1}{8}$ in. for a shield 2 in. in diameter, and $2\frac{3}{8}$ in. for a larger size shield. The single condenser base is $\frac{1}{8}$ in. by $1\frac{1}{4}$ in. They are made in capacity ranges of 10 to 70 mmf.; 70 to 140 mmf., and 140 to 220 mmf.—*Electronics, June, 1931.*

✦

Theater reproducer

MANUFACTURED ESPECIALLY FOR reproduction of sound films, the new Model No. 109 theater reproducer has recently been announced by Wright-DeCoster, Inc., St. Paul, Minn. The horn has a hard wood interior and a soft insulating exterior. The frame holding the horn is made so that the horn can be held

firmly in the exact position required from a height of 7 feet to the floor level and at any angle. The horn and unit are not sold separately. The rectifying unit uses a tube, is completely housed in a metal cabinet and is installed in the projection room. This cabinet is designed so that the tube can be changed instantly. Price, horn and speaker unit complete, $125. Horn rack, $17.—*Electronics, June, 1931.*

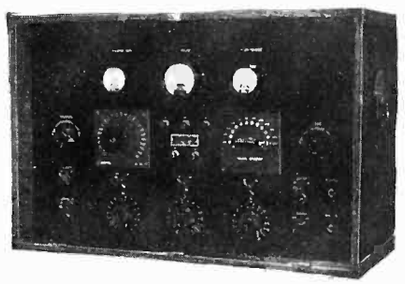
✦

Loudspeaker

MANUFACTURE OF A new type of speaker is announced by the Magnavox Company, Ltd., Chicago, Ill., known as the new Magnavox "140" symphonic speaker. Manufacturers claim that with this new speaker it is possible to reproduce the full range of the human voice, military band or symphonic orchestra, with every note clear and true at its natural value. This speaker is compact and easy to mount and makes set-assembly easy.—*Electronics, June, 1931.*

Portable recording amplifiers

FOR RECORDING sound-on-wax or film, a complete portable recording system with input provision for one to three condenser transmitters and output for two 500-ohm standard wax cutters has been



announced by Jenkins & Adair, Inc., 3333 Belmont Ave., Chicago, Ill. This is known as the Type A recording amplifier. Its dimensions are 25 in. by 17 in. by 11 in. This unit contains a built-in three-position mixer, volume indicator, full set of meters, push-button controlled, and monitoring jacks. Apparatus is mounted on $\frac{1}{4}$ in. black enameled aluminum panel contained in an aluminum case and weighs 87 lbs. Tubes used: Three 112-A's, two 245's, one 240 for volume indicator.—*Electronics, June, 1931.*

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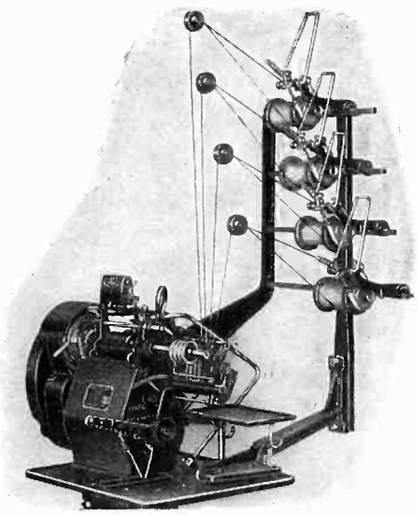
Coil winding machine

AMONG THE NEW winding machines announced by Universal Winding Company, Providence, R. I., is the No. 84 four-coil winder. Manufacturers claim output of 900 to 1,000 coils from one machine in a working period of eight



hours, the coil averaging 625 wire turns. Other features include: Efficient unrolling supply for the wire spools; the wire guide holders can be adjusted for a variety of coil positions. The machine is mounted on a sturdy pedestal (not shown in illustration).—*Electronics, June, 1931.*

Electro-dynamic and magnetic speakers

TWO NEW LOUDSPEAKERS announced by the Jensen Radio Manufacturing Corporation, 6601 South Laramie Ave., Chicago, Ill., will be shown at the RMA Trade Show. The manufacturers claim the permanent magnet speaker to be electro-dynamic in its tone quality and capable of handling large volume. This speaker is very compact. The new dynamic speaker known as Jensen J-1, has a cone diameter of six inches overall and has been designed to meet the latest requirements of the smallest midget and mantle type sets. From the standpoint of tone quality, sensitivity and ability to handle volume, the manufacturers claim that this speaker equals speakers of considerablely larger cone size. Several innovations are included in this unit. All connections are completely enclosed. The new speakers are

available with transformer equipment for use with any of the regular amplifier tubes or the new pentodes. In addition to these two speakers, other new dynamic speakers will be shown with seven, nine and twelve-inch cone structure.—*Electronics, June, 1931.*

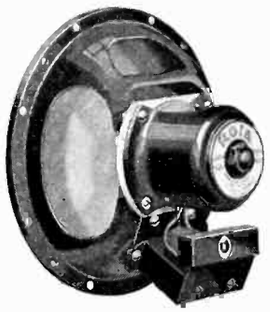
✦

Continuous film oscillograph for recording

FOR OBTAINING PERMANENT oscillographic records, the General Radio Company, Cambridge A., Mass., has announced a continuous film camera for recording. This instrument designated as the Type 408 oscillograph camera was designed primarily to be used as an adjunct to the Type 338-L string oscillograph but with proper arrangements it may be adapted for use with other makes of oscillographs. It uses 100 ft. reels of standard 35 mm. motion picture film or paper so that individual exposures of any length up to this amount may be made. Complete description may be found in the *General Radio Experimenter,* Volume V, No. 11, and may be obtained by writing the company direct.—*Electronics, June, 1931*

Dynamic speaker

DESIGNED TO MEET the requirements of 1931 radio sets and home talkie outfits, a new dynamic loudspeaker unit, known as Model F, has been announced by the Rola Company, Cleveland, Ohio. The



overall diameter of the unit is only 8 inches and it weighs under 5 lbs. Manufacturers claim that it successfully meets the requirements of the new pentode power tubes.—*Electronics, June, 1931.*

✦

Variable condensers

A NEW SERIES OF "Midway" featherweight variable condensers has just been announced by the Allen D. Cardwell Manufacturing Corporation, 81 Prospect St., Brooklyn, N. Y. The new line includes two-gang (dual) condensers, with shielding between the sections and with type "C" plates, having a turning curve commencing with straight frequency and changing to straight capacity. The new dual condensers are available in maximum capacity ranges of from 26 mmfds. up to 200 mmfds. (each section). The single section condensers are made in maximum capacities ranging from 26 mmfds. (3 plate), to 365 mmfds. (35 plates). Both single and dual condensers are very small and compact and of extremely light weight calling for a panel surface of only $2\frac{3}{4}$ in. by $2\frac{1}{8}$ in. They are especially applicable for midget sets, airplane receivers, automobile radio sets etc.—*Electronics, June, 1931.*

✦

Pentode output tube

A NEW PENTODE TUBE designed primarily for use in the output stage of a.c. line-operated broadcast receivers has been announced by the Hygrade Lamp Company of Salem, Mass. This new tube is known as Hygrade 247 and conforms with specifications recently established as standard for a 2.5-watt pentode by the Vacuum Tube Committee of the Radio Manufacturers' Association. Manufacturers claim a special strong construction has been incorporated in this new pentode thereby insuring good operation and long life under the most severe service and shipping conditions.—*Electronics, June, 1931.*

New bulletins available

The Jefferson Electric Company, 1500 South Laflin St., Chicago, Ill., has recently brought out a bulletin describing its line of replacement audio transformers, among which are the No. 370A, a low-priced audio replacement; No. 372 tapped, for push-pull or straight audio—universal bracket; and No. 373 tapped output transformer.

The Gray Instrument Company, 64-70 West Johnson St., Germantown, Philadelphia, Pa., announces publication of a new 12-page bulletin illustrating its reduced price list covering "Queen" electrical measuring instruments, such as potentiometers, resistance boxes, Wheatstone bridges, etc.

The Daven Company, 158 Summit St., Newark, N. J., announces publication of two new bulletins describing in detail its line of wire-wound heavy duty resistors and wire-wound precision resistors.

The Trumbull Electric Manufacturing Company, Plainville, Conn., has recently issued Catalog No. 15, describing its line of Trumbull safety switches, panel boards, knife switches, wiring devices and switch boards. Among the new items announced are type T.M. motor starting switches with thermostatic overload protection and also Type M.D. double throw and motor reversing switches.

Metalastic, Inc., Union City, N. J., announces publication of a new 8-page booklet describing the new Metalastic packing in coil form which will be sent free to any user of packings. This booklet contains a number of interesting pointers on packings.

The Central Radio Corporation, 156 Roosevelt Ave., Beloit, Wis., has available a new bulletin containing complete mechanical information, type charts and telegraphic code in C R C sockets.

The Pacent Electric Company, 91 Seventh Ave., New York City, has recently issued a manual on how to plan and install a modern public address system. This manual outlines in detail, by questionnaire form, as well as by detailed explanation, the principal requirements for a public address system. The form will assist an engineer in drawing up specifications for public address systems under practically all conditions.

The Best Manufacturing Company, 1200 Grove St., Irvington, N. J., has issued a series of bulletins describing its complete line of speakers for all radio and sound reproduction, together with a complete listing of various other units manufactured.

The International Resistance Company, 2006 Chestnut St., Philadelphia, Pa., announces that an engineering bulletin covering features of the new Type K metallized resistors has just been issued.

The Bryant Electric Company, Bridgeport, Conn., as announced in recent bulletins, is now marketing some of the following new devices: No. H271 tumbler type hemco cord switch; or No. UR flush motor plug car; No. 3952SH, slush tumbler switch with stamped steel handle; No. 4399 porcelain receptacle; and Nos. 9420, 9421, 9422 and 9423 weatherproof porcelain sockets with die cast caps.

Any of these bulletins may be obtained by writing representative companies direct.

Correction

Electronics has been informed by Western Electric Piano Company, 850 Blackhawk St., Chicago, Ill., that their record-changing units are sold separately or complete with cabinets. This record changer is designed to play 15 records on both sides automatically, giving 30 selections in all. It is particularly applicable also to centralized radio and public address systems. Any combination of playing time and programs can be arranged.

PATENTS

IN THE FIELD OF ELECTRONICS

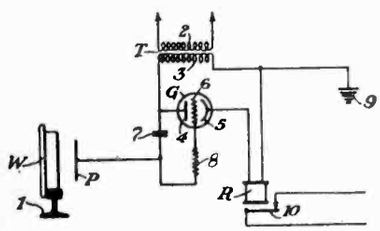
A list of patents (May 26) granted by the United States Patent Office, chosen by the editors of *Electronics* for their interest to workers in the fields of the radio, visio, audio and industrial applications of the vacuum tube

Electronic Applications

Carrier current communications. A method of communicating with moving vehicles by putting carrier current on a transmission line inductively associated with the vehicle. H. A. Affel, assigned to A. T. & T. Co. No. 1,803,453. Also No. 1,803,454.

Regulator system. A vacuum tube bridge circuit for controlling the output of a generator. H. M. Stoller, assigned to B.T.L. Inc. No. 1,804,126. Also patent No. 1,804,178, granted to E. R. Morton and assigned to B.T.L. for preventing hunting in dynamo electric machines.

Railway control apparatus. A circuit involving a grid-glow tube for indicating the passage of railway vehicles. H. A. Sorensen, assigned to Union Switch & Signal Co. No. 1,806,093.

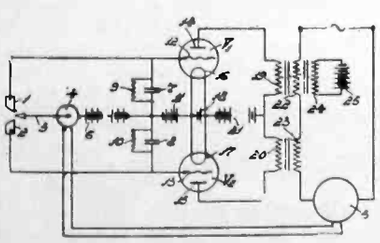


Apparatus for comparing radiant energy. A photo-electric system for comparing radiant energy from two sources. A. C. Hardy, and F. W. Cunningham, assigned to G. E. Co. No. 1,806,199.

Carrier current system. A method of applying carrier current to a transmission line inductively connected with a moving vehicle for communication purposes. H. A. Affel, assigned to A. T. & T. Co. No. 1,803,454.

Motor controller. A vacuum tube controlled motor system. C. W. Kuhn, assigned to Cutler-Hammer, Inc. No. 1,805,491.

Vacuum tube regulator. A push-pull circuit designed to maintain temperature in a device constant. P. R. Dijksterhuis, Eindhoven, Netherlands, assigned to Philips. No. 1,804,325.



Underground exploration system. A method of exploring for underground mineral deposits by causing alternating electric currents to flow in the earth between two electrodes imbedded in the surface. The magnetic fields are explored and the location of mineral deposits determined thereby. N. H. Ricker, Houston, Texas, assigned to J. P. Scranton. No. 1,803,405.

Photo-Cells, Vacuum Tubes, Etc.

Ballast resistor. A receptacle filled with an inert gas at a relatively low pressure, and a ballast device mounted therein, consisting of a pair of series-connected nickel and iron resistors. H. A. Jones, assigned to G. E. Co. No. 1,804,344.

Heater type tube. A method of connecting in the base of a tube a resistance as a means of connecting the cathode to a point electrically connected to the heater circuit, having a potential equal to the average of the alternating potential of the filament. W. L. Krahl, assigned to Arcturus Radio Tube Co. No. 1,802,950.

Photo-electric cell. A method patent, consisting in depositing on a metal cathode a very thin and normally invisible film of photo-sensitive material, sensitizing this thin film by the passage of an electric discharge of hydrogen through the cell, and finally, filling the cell with hydrogen. N. R. Campbell, Watford, England. No. 1,803,000.

Gaseous rectifier. A double wave gaseous cold cathode rectifier. E. A. Quarrie, assigned to C. E. Mfg. Co. No. 1,803,976.

Vacuum tube. A double grid tube. F. W. Hochstetter, Pittsburgh, Pa. No. 1,803,850.

Evacuated inductance. A method of putting an inductance in a glass bulb similar to a vacuum tube and evacuating it. F. J. Bullivant and F. A. Miller, St. Louis, Mo. No. 1,802,371.

Uni-potential cathode tube. A type of tube in which the cathode terminals appear on the top. G. A. Yanochowski, assigned to Kellogg Switchboard & Supply Co. No. 1,805,794.

X-Ray tube. An X-Ray tube which can be surrounded by an insulating liquid. J. B. Wantz, assigned to G. E. X-Ray Corporation. No. 1,805,503.

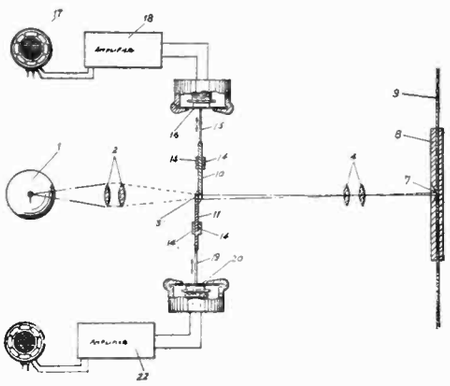
Hot cathode tube. F. S. McCullough, Edgewood, Pa. No. 1,806,108.

Sound Producing Apparatus

Sound reproducer. A light source energized by alternating current is modulated by a sound record. A photo-electric device receives the light and translates it into an output circuit in which is a mechanically resonant filter tuned to the alternating frequency of the circuit. D. O. Whelan, assigned to G. E. Company. No. 1,804,295.

Electro-optical system. A scanning system comprising a movable element of opaque material and a light aperture having alternate sections of relatively opaque and transparent material. Frank Gray, assigned to B.T.L. Inc. No. 1,803,700.

Photographic sound recording system. A light slit, including a pair of overlapping plates movable toward and away from each other, to vary the size. Freeman H. Owens, New York, N. Y. No. 1,803,346.



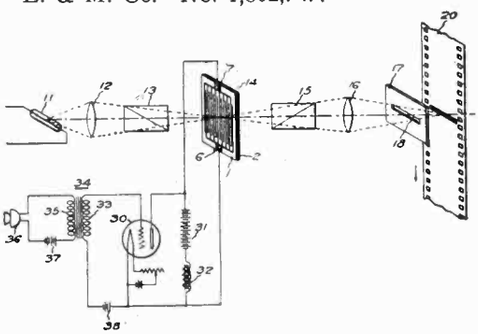
Sound reproducer. A diaphragm composed of a panel of several parallel abuttings, mutually damped slats of differing resonance. Adriaan Nagelvoort, assigned to Delaware Chemical Engineering Co. No. 1,802,826.

Piezo electric loud-speaker. A series of patents granted to Chas. B. Sawyer, assigned to the Cleveland Trust Co., using Piezo electric materials of the Rochelle salt type, for generating air waves from a diaphragm for loud-speaker purposes. Patents No. 1,802,780-1,802,783 inclusive, and 1,802,830.

Sound screen. A method of producing a wide fan of sound waves to and through a motion picture screen by a plurality of loud-speaker units. Harold W. Rogers, New York, N. Y. No. 1,802,480.

Phonograph pick-up. An electrostatic pick-up comprising a member capable of permanently retaining an electrostatic charge. O. B. Parker, assigned to Pacent Electric Co. No. 1,804,364.

Recording system. A system of recording electrical fluctuations on a film by means of a Kerr cell. Vladimir K. Zworykin, assigned to Westinghouse E. & M. Co. No. 1,802,747.



Radio Circuits

Electrical network. A complicated electrical network having a number of meshes, and a method for preventing the adjustment of any of the individual meshes from effecting the natural frequencies of the system. Walter Van B. Roberts, assigned to RCA. No. 1,802,738.

PATENTS—

Electrical circuit. A system in which the supporting members for the various parts of a radio circuit form the conductors also. F. K. Herschmann, New York, N. Y. No. 1,803,017.

Radio circuit. A method of supplying C bias through the secondary of a transformer, the primary of which is tuned by a condenser and connected to the input side of the circuit. Thos. H. Berkland, assigned to W. E. Co. Re-issue No. 18,055.

Static eliminator. A balancing system to be placed between the antenna and a radio receiver, to eliminate static and interference. A. G. Anderson, Whiteland, Ind. No. 1,803,419.

Radio receiving circuit. A method of automatically opening the power circuits of a receiver when the desired carrier wave is not being received, and closing it during reception of the carrier wave. H. B. Coxhead, assigned to A. T. & T. Co. No. 1,804,526.

Radio telephone receiving apparatus. Signalling circuits designed to be connected with, and disconnected with, the power circuit, according to a prearranged time schedule, or to be operated independently of the time mechanism, by an operator. H. P. Clausen, assigned to B.T.L. No. 1,804,675.

Radio broadcasting system. A method of transmitting broadcast material from a central broadcasting station to subscriber stations in given areas, and power wire network connecting the central station and the subscriber stations. E. E. Clement, assigned to E. F. Colladay, Washington, D. C. No. 1,805,446.

Signalling system. A method of generating a wave of carrier frequency and transmitting the carrier frequency at a suitable energy level through space. Voice frequency signals are generated, producing a side-band of the carrier frequency raised to the energy level of the carrier frequency, combined with the side-band and the energy of the carrier frequency is prevented from re-acting upon that of the side-band. R. K. Potter, assigned to A. T. & T. Co. No. 1,805,596.

Directional radio system. A loop radio compass and an indicating circuit which is closed when the movable member of the system is in a direction normal to the direction of the coming energy. F. A. Kolster, assigned to Federal Tel. Co. No. 1,806,577.

Loop radio system. A doubly-shielded radio compass receiver. Malcolm Ferris, Washington, D. C. No. 1,805,942.

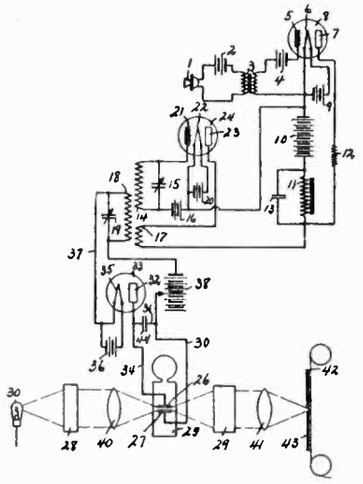
Short wave receiving antenna. Antennas for receiving vertcially and horizontally polarized waves from a transmitter. Russell F. Ohl, assigned to A. T. & T. Co. No. 1,805,591.

Television, Facsimile, Etc.

Storage battery for television. A storage battery of the invertible type, having a high speed rotary reflector having a relatively great gyroscopic action. F. E. Best, Seattle, Wash. No. 1,802,802.

Television device. A method of projecting on a photoelectric cell continuous traveling fluctuating light impressions, and means to eliminate recuperative effects from the cell. F. E. Best, Seattle, Wash. No. 1,802,803.

High frequency control of a Kerr cell. A method of modulating a high frequency oscillator by means of a Kerr cell. T. W. Case, assigned to Case Research Lab., Inc., Auburn, N. Y. No. 1,803,278.



Light valve. Controlling a polarized beam of light by electric current impulses by means of a Kerr cell, by applying current impulses to the cell electrode for producing electric double refraction of light beams, and simultaneously applying to the cell electrode a magnetic bias for decreasing the conductivity of the solution. Sidney Bloomenthal, assigned to RCA. No. 1,802,699.

Message transmission. A number of keys turn on and off the current into a plurality of lights. These lights have between them and a photo-electric cell, amplifier and transmitter, a rotating disk. A. B. Clark, assigned to Alfred H. Howard, Boston, Mass. No. 1,805,390.

Radio Testing Equipment

Radio testing device. A combination of a tester plug having plate, filament contacts, etc., to test tubes in a receiving circuit. J. A. Burtch, assigned to Jewell Electrical Instrument Co. No. 1,805,074.

Set checker. A testing circuit for examining the condition of vacuum tubes in a receiving set. J. C. Hoover, assigned to Jewell Electrical Instrument Co. No. 1,805,094.

Radio testing device. A circuit for testing the condition of circuits and vacuum tubes in radio receivers. Patent filed on April 23, 1926, having 37 claims, granted to Douglas Hawley, assigned to Jewell Electrical Instrument Co. No. 1,805,089.

Miscellaneous Equipment

Automatic phonograph. A conveyor belt system for transferring records to a playing or non-playing position in an automatic phonograph. G. H. Pitman, Jackson Heights, N. Y. No. 1,802,831, also No. 1,802,830.

Pick-up device. Sound tracks formed by paramagnetic material are taken off in the form of a current, by a magnet. P. A. Robbins, Highland Park, Ill. No. 1,803,038.

Loud-speaker diaphragm. A conical diaphragm with strengthening band fastened to the diaphragm. G. H. de Jongh, assigned to RCA. No. 1,802,910.

Air-driven tuning fork. A method of vibrating a tuning fork by means of a resonant air chamber. R. H. Ranger, assigned to RCA. No. 1,802,478.

Generation, Detection, Etc.

Water cooled transmitter. Inductance of a transmitter which can be cooled by circulating water. L. A. Gebhard, assigned to Wired Radio, Inc., re-issue No. 18,070.

Radio frequency amplifier. A multi-stage amplifier in which the capacity coupling between grid and plate in each succeeding stage decreases toward the output end of the circuit. F. S. McCullough, Edgewood, Pa. No. 1,806,109.

Shortwave oscillator. A method of generating a fundamental short wave, splitting it into several waves, one at least of which is shorter than the fundamental, and transmitting the short wave. Abraham Esau, Jena, Germany. No. 1,806,245.

High voltage d.c. supply. A d.c. generator delivers low voltage current to the filaments of vacuum tubes on the locomotive circuit of an automatic train control system. Commutator rings connected to a transformer take from the d.c. generator a low potential alternating current to be used as plate voltage supply. C. S. Williams, assigned to Electric Service Supply Co., Philadelphia, Pa. No. 1,805,679.

Oscillation generator. A system for reducing the effect of fading, the method consisting of sending alternatively the output of two oscillators. A. Meissner, assigned to Telefunken. No. 1,805,918.

Anti-fading transmitter. A frequency modulation transmitter combined with a diversity reception receiver. C. W. Hansell, assigned to RCA. No. 1,803,504.

Speech transmission system. A network compensating the irregularities of speech transmission due to non-uniform reflection of acoustical waves. N. R. Stryker, assigned to B.T.L. No. 1,804,127.

Radio frequency amplifier. E. Bruce and A. C. Friis, assigned to B.T.L. No. 1,804,087.

Radio phonograph circuit. A method of connecting a sound reproducer such as a phonograph pick-up, to the detector tube of a radio receiver. LeRoy Leishman, assigned to Elec-True-Tone Corp. No. 1,803,555.

High frequency generator. A method of producing ultra-high frequency oscillations by electron pendulum movements within a vacuum space, and a circuit in which a system is tuned to a frequency greater than the natural frequency of the electron movements. H. E. Hollmann, Darmstadt, Germany. No. 1,803,528.

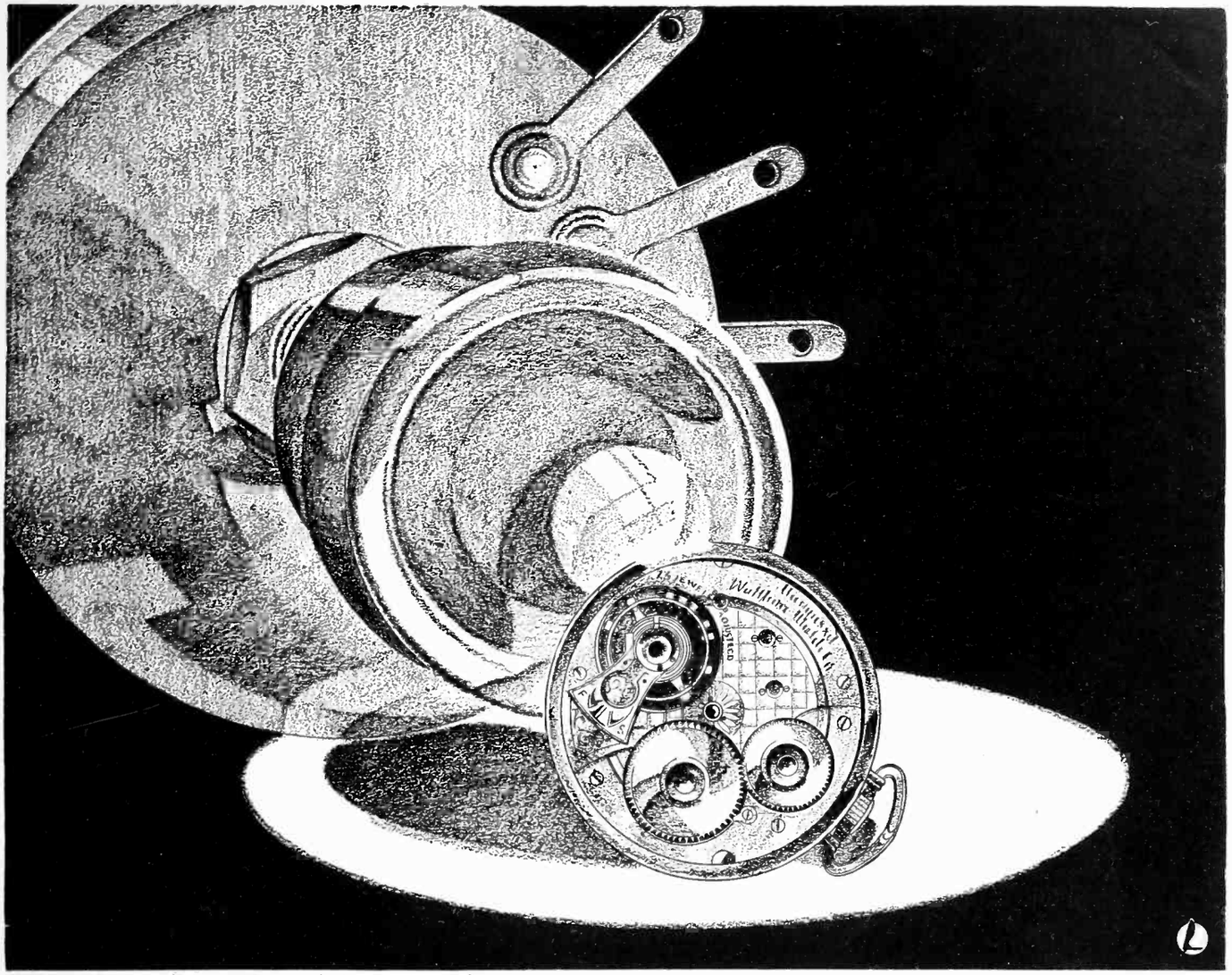
Current controlling device. A method of stopping the charging of a storage battery when the voltage rises above a certain point. R. D. Siradusa, assigned to Wilson Electric Labs. No. 1,802,483.

Carrier current system. A method of transmitting modulated carrier frequency currents over a low frequency power transmission line, and separating out the desired modulating currents at the receiving end. Edward Austin, assigned to G. E. Co. No. 1,803,161.

Heterodyne detector. An autodyne method of detecting continuous wave signals. J. M. Grigg, Chicago, Ill. No. 1,803,247.

Synchronizing system. A method of using the harmonics of a power line frequency to drive a motor synchronously. August Karolus, assigned to RCA. No. 1,802,470.

[*continued on page 704*]



21 JEWEL DEPENDABILITY

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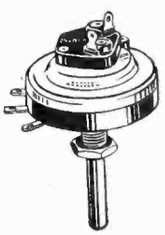


PATENTS—

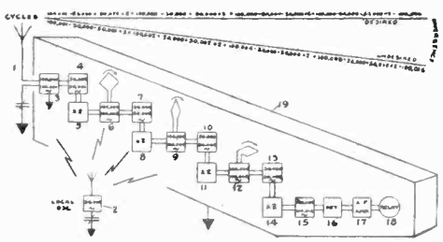
[*Continued from page 702*]

Condenser modulator. A method of connecting a condenser telephone to an oscillating circuit to effect modulation. Hans Muth, assigned to Gesellschaft für Drahtlosie Telegraphie. No. 1,802,734.

High frequency current generator. Constant voltage is supplied to a rectifier output terminals, comprising a saturated iron core inductance connected to the primary of a transformer. Ludwig Kühn and Erich Geissler, Charlottenburg, Germany. No. 1,802,563.

Signal filtering system. A method of filtering out frequencies in a spectrum of frequencies, by tuned circuits. Walter Hahnemann, assigned to C. Lorenz. No. 1,802,555.

Frequency separating system. A method of separating desired from undesired frequencies, consisting in amplifying the current in a series of stages, and introducing during such amplification a progressively increasing frequency diversion between desired and undesired current by means of beat frequencies. D. G. Gage, assigned to RCA. No. 1,802,760.



Multiplex system. A method of transmitting several signals over the same system, by introducing several individual tone frequencies and successively keying each cycle of all the tone frequencies. J. N. Whitaker, assigned to RCA. No. 1,802,745.

Prevention of parasitics. A method of preventing push-push parasitics in a push-pull amplifier, by causing the push-push parasitics to take the capacity rather than the inductive path from the grid to the cathode, in order to make the potential of these parasitics degenerative in phase. C. W. Hansell, assigned to RCA. No. 1,804,830.

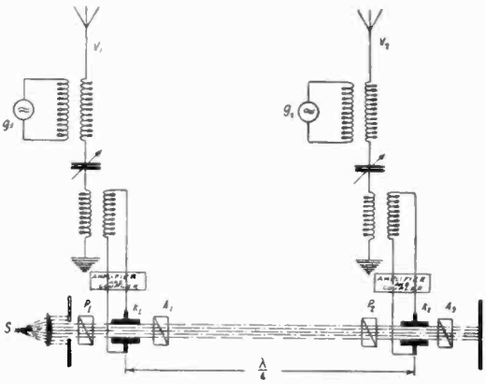
Piezo-electric oscillator. A method for converting electrical energy into mechanical movements by impressing alternating current upon the plates of a Piezo-electric oscillator, whereby a body is caused to rotate. A. Meissner, Berlin, Germany. No. 1,804,838.

Filtering system. A method of running a radio set from alterating current by rectifying the alternating current, filtering it, operating the filaments of the receiver in series, and supplying the plate circuit with power in parallel. Patent has 21 claims, and was filed December 12, 1923, by Geo. B. Crouse, assigned to Conner-Crouse Corp., New York, N. Y. No. 1,804,859.

Oscillating circuit. A method of maintaining a fixed ratio of inductance to capacity and resistance in an oscillating circuit, at various wavelengths. Wilhelm Kummerer, assigned to the RCA. No. 1,802,767.

Wave-signalling system. A 3-phase wave transmitting system comprising a source of 2-phase modulated carrier current, cathode ray tube, etc. F. X. Rettenmeyer, assigned to B.T.L. No. 1,804,952.

Phase indicator. A method by which a Kerr cell, a light source, etc., is used to indicate phase differences between feeble high frequency currents. G. Von Arco, Berlin, assigned to Gesellschaft für Drahtlosie Telegraphie. No. 1,802,742.



Production of electrical oscillation. Arc apparatus for producing oscillations. T. C. Rives, New Haven, Conn. No. 1,805,187.

Method of controlling the amplitude of alternating current. Temperature-actuated responses are used to control the amplitude of alternating current in a vacuum tube circuit. E. R. Hentschel, assigned to Wired Radio, Inc. No. 1,805,463.

Patent Suits

[Notices under sec. 4921, R. S., as amended Feb. 18, 1922.]

(Official Gazette of the United States Patent Office)

1,173,079, E. F. Alexanderson, Selective tuning system; 1,195,632, W. C. White, Circuit connections of electron discharge apparatus; 1,251,377, A. W. Hull, Method of and means for obtaining constant direct current potentials; 1,297,188, I. Langmuir, System for amplifying variable currents; 1,728,879, Rice and Kellogg, Amplifying system, filed Mar. 12, 1931, D. C., E. D. Mo. (St. Louis), Doc. 9412, Radio Corp. of America et al. v. Trav-Ler Mfg. Corp. Same, filed Mar. 13, 1931, D. C., S. D. Calif. (Los Angeles), Doc. T-69-H, Radio Corp. of America et al. v. F. R. Smith (Westerner Radio Mfg. Co.). Same, filed Mar. 16, 1931, D. C., S. D. Calif. (Los Angeles), Doc. T-75-H, Radio Corp. of America et al. v. May Department Stores Co.

1,201,270, L. Deforest, Oscillating current generator; 1,201,272, same, Telegraph and telephone receiving system; 1,221,035, same, Apparatus for use in wire or radio communications; 1,311,264, 1,314,252, same, Oscillating generator; 1,348,157, same, Apparatus for amplifying pulsating electric currents; 1,377,405, same, Audion circuit; 1,417,662, 1,507,016, same, Radio signaling system; 1,680,207, Deforest & Logwood, same; 1,218,195, C. V. Logwood, System for transmitting communications; 1,440,834, same, Radio communications; 1,525,941, same, Radio-signaling system, filed Mar. 24, 1931, D. C. Md., Doc. E 1859, Deforest Radio Co. v. Radio Victor Corp. of America.

1,180,159, I. Langmuir, Incandescent electric lamp, D. C., S. D. N. Y., Doc. E 58/139, General Electric Co. v. Cupples Co. Dismissed Mar. 17, 1931.

1,231,764, F. Lowenstein, Telephone relay; 1,426,754, R. C. Mathes, Circuit for electron discharge device; 1,465,332, H. D. Arnold, Vacuum tube amplifier, filed Mar. 12, 1931, D. C., E. D. Mo. (St. Louis), Doc. 9413-2, Radio Corp. of America et al. v. Trav-Ler Mfg. Corp. Same, filed Mar. 13, 1931, D. C., S. D. Calif. (Los Angeles), Doc. T-70-H, Radio Corp. of America et al. v. F. R. Smith (Westerner Radio Mfg. Co.), Doc. T-76-H, Radio Corp. of America et al. v. May Dept. Stores Co.

1,271,529, M. C. Hopkins, Acoustic device, D. C. Del., Doc. E 671, Lektophone Corp. v. Robelen Piano Co. Dismissed upon stipulation Mar. 18, 1931. Doc. E 712, Lektophone Corp. v. Miller Bros. Co. Dismissed upon mandate of U. S. Supreme Court Mar. 17, 1931.

1,533,858, L. A. Hazeltine, Method and means for neutralizing capacity in audions, D. C., S. D. N. Y., Doc. E 55/216, Hazeltine Corp. v. United American Bosch Corp. Consent decree for plaintiff Mar. 16, 1931.

1,791,030, L. L. Jones, Radio receiving system, filed Mar. 27, 1931, D. C., S. D. N. Y., Doc. E 59/88, L. L. Jones et al. v. Radio Corp of America.

1,648,808, L. A. Hazeltine, Wave signaling system; 1,755,114, same Uni-control signaling system; 1,755,115, same, Variable condenser, filed Mar. 16, 1931, D. C., S. D. N. Y., Doc. E 58/366, Hazeltine Corp. v. Sears, Roebuck & Co., Inc.

Adjudicated Patents

(C. C. A. N. Y.) Jones patent, No. 1,658,804, for capacitative-coupling control system, claims 1, 2, 4-11, Held invalid. Jones v. Freed-Eisemann Radio Corporation, 47 F. (2d) 174.

(C. C. A. N. Y.) Jones patent, No. 1,658,805, for capacitative-coupling control system, claims 1-16, Held invalid. Id.

(C. C. A. N. Y.) Hazeltine patent, No. 1,533,858, for method and means for neutralizing capacity coupling in audions, claims 1, 2, 5 and 13, Held valid and infringed. Hazeltine Corporation v. National Carbon Co., 47 F. (2d) 573.

Government loses suit against Public Condenser Corporation

The Federal Court of Delaware dismissed the suit of the Government against the Public Condenser Corporation for title to patents developed by Percival Lowell and F. W. Dunmore, while employed by the Bureau of Standards, covering the "socket plug-in unit" which enables radio set owners to energize their radios directly from home a.c. supply, rather than batteries.

The Court held that the two young inventors, who have turned over half rights to the Dubilier Corporation, were within their rights in claiming the patent to themselves, even though developed in a Government laboratory. Their patents have been upheld by the Delaware Courts against the Radio Corporation, which disputed their validity, so that the path is now cleared for an adjudication in the Circuit Court of Appeals.

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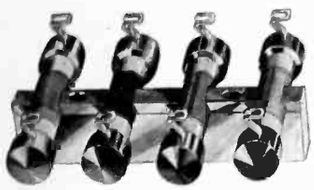

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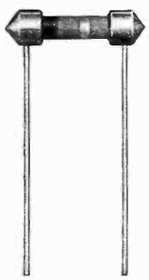

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Radio program distribution

[*Continued from page 683*]

In modern buildings these risers will be found in shaftways and ducts, and terminate in panel boards on each floor. Fuses are provided for the circuits on each floor. They are usually located near the service elevators and hallways. The special feeder lines are run through these same shaftways to the panel boards on each riser. It is not necessary to drill a number of holes in the walls or otherwise disturb the building. In the Hotel Lincoln of 1,400 rooms, it was only necessary to run 2,500 feet of wire.

In this particular installation the receivers were installed in the small bed tables provided for each room. The photograph (Fig. 3) shows the installation of one of these receivers. It consists of a simple tuning device, a single tube operating as a power detector, a dynamic loudspeaker and a volume control. By virtue of its simplicity the maintenance is reduced to a minimum. The volume is ample for the size room found in buildings of this type. The receiver is plugged into a base receptacle and a ground lead connected to the radiator.

The entire system has been designed to meet the eight requirements for a centralized radio system as given in the opening paragraph. The first of these was a choice of four programs. Second, freedom from cross-talk is accomplished by the choice of frequencies with which the transmitters operate. These frequencies may be adjusted to any degree of separation desired.

The correct volume level is recognized as one of the principal problems in any system. In an audio wired system the energy which operates the individual loudspeakers is derived from the main amplifiers. As the number of listeners varies throughout the day, the amplifier load changes. Unless the operator is careful in constantly adjusting the volume on all programs, the volume level will be almost continuously changing. During the peak load which normally occurs in the evening when special programs (such as Amos 'n' Andy) are on, the volume drops below a satisfactory level unless very large amplifying tubes are employed. The quality is also subject to variations with changing load conditions.

In contrast to the above, there is no change in volume due to the number of listeners by this method. The additional energy is derived from the tube in each individual receiver. The volume is unaffected for the same reason as in the ordinary broadcast receiver.

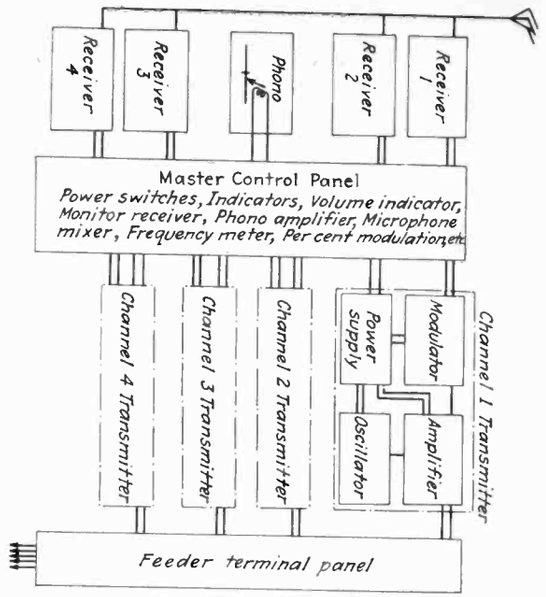

Fig. 4—Schematic layout for receiving, control and transmitter circuits used in the centralized system

The fourth requirement of the system, relating to maximum volume, is met by the visual indicators and controls provided at the transmitters. The fifth requirement calls for individual volume control in the rooms. It is possible to reduce the volume to any level below the maximum at the receivers in the usual manner.

The matter of stray noises, which was our sixth requirement, is very closely tied up with cross-talk. In a wired system the same things that cause cross-talk can also cause noise pick-up. Parallel wiring of power circuits (particularly circuits with leakage to ground) causes bad hums, crackling noises and other disturbances. In the Guided Radio method this is reduced to a negligible quantity by virtue of the fact that the sensitivity of the receiver is very low. The signal level is very high in comparison. The seventh requirement of high quality is achieved by designing all units of the system with care. The receiver is particularly simple in design, uses a high-grade dynamic loudspeaker and has a wide frequency range.

From the point of view of the hotel owner the eighth requirement is perhaps the most interesting. He is interested in knowing that the equipment is flexible and that additional programs can be added at any future date without any additional wiring. With this system it is only necessary to add one or more transmitters at relatively low cost. Such additional improvements as the future may bring can readily be adapted.

Buying habits and replacements for sound equipment

[*Continued from page 687*]

Additions to present equipment and replacement have not been kept separate in many cases. In several studios, figures were obtained where separate classifications were made of components purchased for replacement. These figures vary from as low as $2,500 for annual replacement for location equipment, to $9,000 for a complete recording channel.

The principal item of replacement appears to be microphone cable and other portable cables for motors and power supply. The replacement of microphones due to their unit cost and handling required also represents a sizable figure. Sound studio personnel are in a position to make their own replacement in the case of all component parts of their sound equipment, which includes a long list of such items as transformers, relays, condensers, resistances, rectifiers, meters, etc. Measuring instruments of all sorts are included in the list of items purchased. Rapid advancement in the art, requiring new methods for testing has required the establishment of testing laboratories in practically every study.

Total sales of sound-picture equipment for 1930 amounted to $40,885,000, (See March *Electronics*). Of this sum, domestic sales amounted to $29,200,000, while accessories, installation material, etc., amounted to $3,435,000. Total export sales amounted to $8,250,000.