January 26th, 1929 15 Cents

RADIO WORLD

REG. U.S. PAT. OFF.

The First and Only National Radio Weekly

357th Consecutive Issue—Seventh Year

AF Transformer Development

Whims of Short Waves

How a Loop Works

Radiation Visualized

Give Every Don't Its Due

HAVING FAILED TO REACH THE FINALS IN THE ATWATER KENT SINGING CONTEST LAST YEAR, HAZEL CECILIA ARTH THIS YEAR WON FIRST PRIZE IN THE WOMEN'S DIVISION.

CORWICO

Braidlite

HOOK-UP WIRE
"THE BRAID SLIDES BACK"

Safe as insulated wire and as convenient as bare wire. You cannot scorch or burn Braidite with a soldering iron. Use Braidite in your next set.

At All Dealers

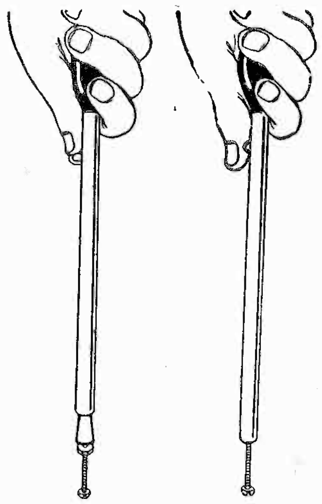
25 Feet Stranded........35c
25 Feet Solid............30c
Red, Green, Yellow, Blue, Black

FREE Send us the name and address of your dealer and we will send you a sample package of Braidite FREE. Include 10c for Postage.

CORNISH WIRE CO.
30 Church St. : : New York City

SOCKET WRENCH

FREE



Push out control lever with knob (as at left) and put wrench on nut. Push down on handle only (at right), then turn nut left or right.

ONE of the handiest tools for a custom set builder, service man or home constructor is a BERNARD socket wrench.

It consists of a 6½" long metal tubing in which is a plunger, controlled by a knob. The plunger has a gripping terminal (called a socket, hence the name "socket wrench") that may be expanded or contracted to fit 6/32, 8/32 and 10/32 nuts, the most popular sized nuts in radio.

Use the knob to push out the plunger, press down on the handle to grip the nut, then turn the nut to left for removal or to right for fastening down. Total length, distended, including stained wooden handle, 10". Gets nicely into tight places. Send $1 for 8 weeks' mail subscription for RADIO WORLD and get this wrench FREE.

No other premium with this offer. Present subscriber may extend subscription by stating he is one, and entitle himself to this FREE premium, making $1 remittance.

RADIO WORLD
145 WEST 45TH ST., N. Y. CITY
A few doors east of Broadway

RADIO WORLD, published every Wednesday, dated Saturday of same week, from publication office, Hennessy Radio Publications Corporation, 145 West 45th Street, New York, N. Y., just east of Broadway. Roland Burke Hennessy, President; M. B. Hennessy, Vice-President; Herman Bernard, Secretary. Roland Burke Hennessy, Editor; Herman Bernard, Managing Editor; J. E. Anderson, Technical Editor; Anthony Sodaro, Art Editor

Recent Issues of RADIO WORLD, 15 cents each Any number published in 1928 available for a short while. Six issues 75 cents, 10 issues $1.00 Send stamps, coin or money order NOW, before the issues are sold. RADIO WORLD, 145 West 45th Street, New York City.

SI-LEN-SER
A TRUTONE PRODUCT

Eliminates Hum! Stops Interference from all Electrical Sources

The SI-LEN-SER makes any electric or any electrified set play as quietly and free from hum as any battery operated receiver. The SI-LEN-SER silences all stray power line noises which enter the receiver through the power packs of electric sets and eliminators. The SI-LEN-SER eliminates absolutely all hum from powerhouse generators, and all bothersome knocks and noises that emanate from such electrical sources as nearby power lines, such electrical devices as electric refrigerators, vacuum cleaners, oil burners and other noise-breeding electric household apparatus.

CAN BE USED ON ANY VOLTAGE
Either Alternating or Direct Current

The SI-LEN-SER is absolutely universal. It works efficiently on either alternating or direct current and on any voltage or cycles, with any eliminator, either old style or new. The SI-LEN-SER is the device that all radio engineers have been seeking to make the electric set perfect. With the SI-LEN-SER, the clear and noiseless reception of a battery-driven receiver is now possible with the convenience of an electric radio.

Easy to Hook Up

All that's necessary is to plug the SI-LEN-SER into your wall or light socket, plug your set into the SI-LEN-SER, then make a ground connection. That's all there is to it. The SI-LEN-SER is small and compact, being 3½ inches in diameter and 5 inches high. In addition to eliminating hum and other noises the SI-LEN-SER also prolongs the life of your A.C. tubes and enables you to use them at their maximum efficiency.

Sold by All Dealers

If your local dealer cannot supply you with a SI-LEN-SER, write us direct. The SI-LEN-SER is approved by radio engineers and fully guaranteed against electrical and mechanical defects.

$12.50 List

JOBBERS AND DEALERS—WRITE FOR DETAILS.

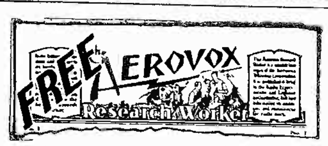
Manufactured and Guaranteed by

TRUTONE RADIO SALES CO.

Makers of the famous Philharmonic A.C. RECEIVERS

114-116 WORTH ST. Phone: Worth 5573 NEW YORK, N. Y.

AEROVOX
BUILT BETTER
CONDENSERS AND RESISTORS



Your name will be put on the mailing list free of charge on request.

A COMPLETE CATALOG with illustrations and detailed descriptions may be obtained free of charge on request.

AEROVOX WIRELESS CORP.
74½ Washington St., Bklyn., N. Y.
PRODUCTS THAT ENDURE

FILL OUT AND MAIL NOW
SUBSCRIPTION BLANK

RADIO WORLD

RADIO WORLD

145 West 45th Street, New York City (Just East of Broadway)

Please send me RADIO WORLD for .... months, for which please find enclosed ....

SUBSCRIPTION RATES:
Single Copy ....$ .15
Three Months 1.50
Six Months 3.00
One Year, 52 Issues......... 6.00
Add $1.00 a Year for Foreign Postage; 50c for Canadian Postage

Vol. XIV, No. 19 Whole No. 357
JANUARY 26th, 1929
15c per Copy, $6.00 per Year
[Entered as second-class matter, March 1922, at the Post Office at New York, N. Y., under Act of March, 1879]

RADIO WORLD

Latest News and Circuits
Technical Accuracy Second to None

A Weekly Paper published by Hennessy Radio Publications Corporation, from Publication Office 145 West 45th Street New York, N. Y.
(Just East of Broadway)
Phone: BRYant 0558 and 0559

PARTY AERIAL NEW PRODUCT MADE BY R.C.A.

A centralized radio transmission system for apartment houses and apartment hotels is the latest radio development of the Radio Corporation and its associated companies, General Electric and Westinghouse.

In this system a single antenna is used for all the receivers in the same house, and this antenna is constructed so as to pick up as much radio energy as possible. It is built from 50 to 75 feet high.

A single short lead-in from this antenna delivers the energy to a battery of coupling units, located on the roof. Each coupling unit consists of amplifying tube and a B battery eliminator, and each is a one-way channel. That is, it can take energy from the antenna and send it down a conductor in the building, but it will not take any energy from the building and send to the antenna, and hence into other coupling units. Mutual interference between the radio receivers on the system is thus impossible.

In Fig. 1 the lead-in is indicated by a and the battery of coupling units by A. Six separate coupling units B1, C1, D1, E1, F1 and G1 are indicated in this battery. All receive their energy from the antenna.

"Risers" Used

From each of the coupling units in A a radio frequency conductor, called a "riser," leads down the building. These "risers" are indicated by b, c, d, e, f and g. All these conductors are shielded so that they do not pick up any energy except from the coupling units to which they are connected. Hence they do not pick up any electrical disturbances originating in the building. Regardless of where a radio receiver may be located in the building the reception is just as good as if that receiver were out in the open country.

Each "riser" terminates in an extension coupling unit, which is also unidirectional in its transmission. In the system illustrated in Fig. 1 there are six of the extension coupling units labeled B2, C2, D2, E2, F2 and G2. Ten may be put in each "riser." Each of these consists of amplifying tubes and a B battery eliminator for each receiver to be served.

Conductors lead from these extension coupling units to the various apartments in the building, and terminate in a convenience outlet in the wall. Any receiver designed for use with antenna and ground can be connected to the outlet, and that receiver will get the signals as well as if it were alone in the building. There is no cross talk between the various receivers due to the unidirectional property of the coupling units.

Not Audio Distribution

This radio frequency distribution system is not to be confused with the old audio distribution system which has been used to some extent in apartment hotels, hospitals and hotels. Such systems distribute the audio output of a central receiver and do not give the listeners any choice of programs. With the new radio frequency distribution system the radio frequency energy is distributed and the listeners can have as

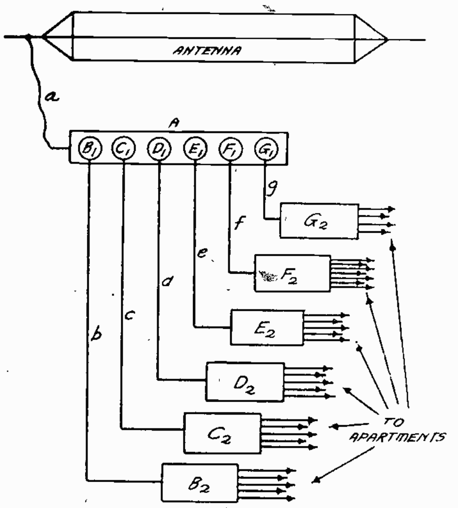


FIG. 1—SCHEMATIC OF THE PARTY AERIAL SYSTEM

many selections as there are stations within reception and tuning range of his receiver.

In a sense the new system is a series of rebroadcasting stations, since each coupling unit contains amplifier tubes. In this respect the transmission line is like the repeaters used in long telephone lines. But it is more than that. It is a true and unidirectional distributor.

There is an obvious need for such a system as this new radio frequency distributor. There will be a single antenna on the roof, and in a large building where such a system would be used, this antenna will be at a considerable distance from all neighboring antennas. Hence there will be no interference from them. The single antenna will be so high up that there will be no obstructions in the way of the radio waves. Also, it will be so high that it will pick up a much larger signal than any ordinary antenna. It will be designed and built with extreme care, and hence will not be subject to the deficiencies of amateur built antennas.

In many large apartment houses the owner of the building objects to the erection of a multitude of unsightly antennas on the roof. When the new distribution system is installed he will not object, for he himself will install it as an attraction of tenants to his building. A single well-installed antenna on the roof will be a constant advertisement that the building is radio-equipped.

When loops are used in large steel buildings, very little signal is picked up because the steel frame work effectively shields the loop. And in such buildings it has not been practical to use an ordinary antenna because of the long lead-ins necessary. The new system obviates the need of a loop and supplies a source of radio frequency energy which does not depend on its strength on the distance to the roof.

How does this system affect DX reception? Will it improve or impair reception from long distances? It will undoubtedly improve DX reception because the antenna system will be more effective than the ordinary, and local noises will not affect the signals so much and limit the audio amplification possible.

Tax on Stations Asked by Robinson

Chairman of Radio Commission Proposes License Fee Before House Committee, to Raise Money for Administrative Cost—No Levy on Listeners

Washington.

Chairman Ira E. Robinson, of the Federal Radio Commission, suggested before the House Committee on Merchant Marine and Fisheries that broadcasting stations be required by law to pay license fees, so that the cost of Federal radio administration could be defrayed that way. Some broadcasters do not appreciate the responsibilities they must meet, he said, and intimated the payment of a fee would bring these responsibilities forcibly to their minds.

Chairman Robinson discussed license fees while under questioning by Representative Gifford (Rep.), of Catuit, Mass. Mr. Gifford had raised the question of censorship of programs broadcast by stations, to which Mr. Robinson replied that broadcasters have very valuable franchises in the public interest.

Don't Recognize Trusteeship

"They do not all recognize their trusteeship," he said. "I have wondered if there should not be license fee. Perhaps if a reasonable license fee was invoked broadcasters would take more seriously their responsibility of trusteeship.

"It might be well to carry a license fee to cover the administrative expense of the Commission."

It was brought out that, for the current fiscal year the Commission has an appropriation approximately $350,000, but that for the ensuing year, if the Commission is continued by passage of the White bill, a greater fund will be needed for additional personnel as well as increased operating expenses.

The Committee chairman, Representative White (Rep.), of Lewiston, Me., pointed out that in previous consideration of radio legislation the suggestion had been made before the Committee that a gradual scale of license fees be assessed, based upon the power and size of the various stations.

No Payment by Listeners

Other committee members questioned Chairman Robinson on license fees.

Replying to Representative Abernathy (Dem.), of New Bern, N. C., Chairman Robinson said that this country could not do away with advertising or sponsored programs via radio, as is done in England and practically all other countries.

"I know of no other way than to charge the listeners themselves to pay for the cost of programs, and the public does not

(*Continued on next page, col. 2*)

CORWICO

Braidite

HOOK-UP WIRE
"THE BRAID SLIDES BACK"

Safe as insulated wire and as convenient as bare wire. You cannot scorch or burn Braidite with a soldering iron. Use Braidite in your next set.

At All Dealers

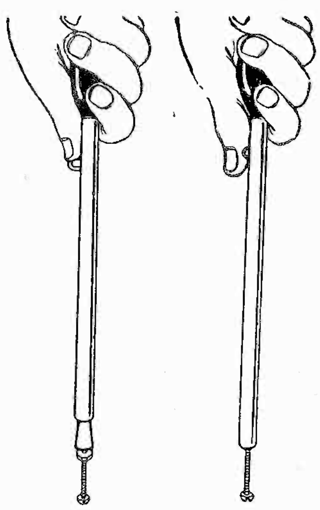
25 Feet Stranded........35c
25 Feet Solid............30c
Red, Green, Yellow, Blue, Black

FREE Send us the name and address of your dealer and we will send you a sample package of Braidite FREE. Include 10c for Postage.

CORNISH WIRE CO.
30 Church St. : : New York City

SOCKET WRENCH

F R E E



Push out control lever with knob (as at left) and put wrench on nut. Push down on handle only (at right), then turn nut left or right.

ONE of the handiest tools for a custom set builder, service man or home constructor is a BERNARD socket wrench.

It consists of a 6½" long metal tubing in which is a plunger, controlled by a knob. The plunger has a gripping terminal (called a socket, hence the name "socket wrench") that may be expanded or contracted to fit 6/32, 8/32 and 10/32 nuts, the most popular sized nuts in radio.

Use the knob to push out the plunger, press down on the handle to grip the nut, then turn the nut to left for removal or to right for fastening down. Total length, distended, including stained wooden handle, 10". Gets nicely into tight places. Send $1 for 8 weeks' mail subscription for RADIO WORLD and get this wrench FREE.

No other premium with this offer. Present subscriber may extend subscription by stating he is one, and entitle himself to this FREE premium, making $1 remittance.

RADIO WORLD
145 WEST 45TH ST., N. Y. CITY
A few doors east of Broadway

RADIO WORLD, published every Wednesday, dated Saturday of same week, from publication office, Hennessy Radio Publications Corporation, 145 West 45th Street, New York, N. Y., just east of Broadway. Roland Burke Hennessy, President; M. B. Hennessy, Vice-President; Herman Bernard, Secretary. Roland Burke Hennessy, Editor; Herman Bernard, Managing Editor; J. E. Anderson, Technical Editor; Anthony Sodaro, Art Editor

Recent Issues of RADIO WORLD, 15 cents each Any number published in 1928 available for a short while. Six issues 75 cents, 10 issues $1.00 Send stamps, coin or money order NOW, before the issues are sold. RADIO WORLD, 145 West 45th Street, New York City.

SI-LEN-SER
A TRUTONE PRODUCT

Eliminates Hum! Stops Interference from all Electrical Sources

The SI-LEN-SER makes any electric or any electrified set play as quietly and free from hum as any battery operated receiver. The SI-LEN-SER silences all stray power line noises which enter the receiver through the power packs of electric sets and eliminators. The SI-LEN-SER eliminates absolutely all hum from powerhouse generators, and all bothersome knocks and noises that emanate from such electrical sources as nearby power lines, such electrical devices as electric refrigerators, vacuum cleaners, oil burners and other noise-breeding electric household apparatus.

CAN BE USED ON ANY VOLTAGE

Either Alternating or Direct Current

The SI-LEN-SER is absolutely universal. It works efficiently on either alternating or direct current and on any voltage or cycles, with any eliminator, either old style or new. The SI-LEN-SER is the device that all radio engineers have been seeking to make the electric set perfect. With the SI-LEN-SER, the clear and noiseless reception of a battery-driven receiver is now possible with the convenience of an electric radio.

Easy to Hook Up

All that's necessary is to plug the SI-LEN-SER into your wall or light socket, plug your set into the SI-LEN-SER, then make a ground connection. That's all there is to it. The SI-LEN-SER is small and compact, being 3½ inches in diameter and 5 inches high. In addition to eliminating hum and other noises the SI-LEN-SER also prolongs the life of your A.C. tubes and enables you to use them at their maximum efficiency.

Sold by All Dealers

If your local dealer cannot supply you with a SI-LEN-SER, write us direct. The SI-LEN-SER is approved by radio engineers and fully guaranteed against electrical and mechanical defects.

$12.50 List

JOBBERS AND DEALERS—WRITE FOR DETAILS.

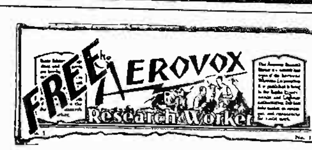
Manufactured and Guaranteed by

TRUTONE RADIO SALES CO.

Makers of the famous Philharmonic A.C. RECEIVERS

114-116 WORTH ST. Phone: Worth 5573 NEW YORK, N. Y.

AEROVOX
BUILT BETTER
CONDENSERS AND RESISTORS



Your name will be put on the mailing list free of charge on request.

A COMPLETE CATALOG with illustrations and detailed descriptions may be obtained free of charge on request.

AEROVOX WIRELESS CORP.
74½ Washington St., Bklyn., N. Y.
PRODUCTS THAT ENDURE

FILL OUT AND MAIL NOW
SUBSCRIPTION BLANK

RADIO WORLD

RADIO WORLD

145 West 45th Street, New York City (Just East of Broadway)

Please send me RADIO WORLD for .... months, for which please find enclosed ....

SUBSCRIPTION RATES:
Single Copy ....$ .15
Three Months 1.50
Six Months 3.00
One Year, 52 Issues......... 6.00
Add $1.00 a Year for Foreign Postage; 50c for Canadian Postage

Vol. XIV, No. 19 Whole No. 357
JANUARY 26th, 1929
15c per Copy, $6.00 per Year
[Entered as second-class matter, March 1922, at the Post Office at New York, N. Y., under Act of March, 1879]

RADIO WORLD

Latest News and Circuits
Technical Accuracy Second to None

A Weekly Paper published by Hennessy Radio Publications Corporation, from Publication Office 145 West 45th Street New York, N. Y.
(Just East of Broadway)
Phone: BRYant 0558 and 0559

PARTY AERIAL NEW PRODUCT MADE BY R. C. A.

A centralized radio transmission system for apartment houses and apartment hotels is the latest radio development of the Radio Corporation and its associated companies, General Electric and Westinghouse.

In this system a single antenna is used for all the receivers in the same house, and this antenna is constructed so as to pick up as much radio energy as possible. It is built from 50 to 75 feet high.

A single short lead-in from this antenna delivers the energy to a battery of coupling units, located on the roof. Each coupling unit consists of amplifying tube and a B battery eliminator, and each is a one-way channel. That is, it can take energy from the antenna and send it down a conductor in the building, but it will not take any energy from the building and send to the antenna, and hence into other coupling units. Mutual interference between the radio receivers on the system is thus impossible.

In Fig. 1 the lead-in is indicated by a and the battery of coupling units by A. Six separate coupling units B1, C1, D1, E1, F1 and G1 are indicated in this battery. All receive their energy from the antenna.

"Risers" Used

From each of the coupling units in A a radio frequency conductor, called a "riser," leads down the building. These "risers" are indicated by b, c, d, e, f and g. All these conductors are shielded so that they do not pick up any energy except from the coupling units to which they are connected. Hence they do not pick up any electrical disturbances originating in the building. Regardless of where a radio receiver may be located in the building the reception is just as good as if that receiver were out in the open country.

Each "riser" terminates in an extension coupling unit, which is also unidirectional in its transmission. In the system illustrated in Fig. 1 there are six of the extension coupling units labeled B2, C2, D2, E2, F2 and G2. Ten may be put in each "riser." Each of these consists of amplifying tubes and a B battery eliminator for each receiver to be served.

Conductors lead from these extension coupling units to the various apartments in the building, and terminate in a convenience outlet in the wall. Any receiver designed for use with antenna and ground can be connected to the outlet, and that receiver will get the signals as well as if it were alone in the building. There is no cross talk between the various receivers due to the unidirectional property of the coupling units.

Not Audio Distribution

This radio frequency distribution system is not to be confused with the old audio distribution system which has been used to some extent in apartment hotels, hospitals and hotels. Such systems distribute the audio output of a central receiver and do not give the listeners any choice of programs. With the new radio frequency distribution system the radio frequency energy is distributed and the listeners can have as many selections as there are stations within reception and tuning range of his receiver.

In a sense the new system is a series of rebroadcasting stations, since each coupling unit contains amplifier tubes. In this respect the transmission line is like the repeaters used in long telephone lines. But it is more than that. It is a true and unidirectional distributor.

There is an obvious need for such a system as this new radio frequency distributor. There will be a single antenna on the roof, and in a large building where such a system would be used, this antenna will be at a considerable distance from all neighboring antennas. Hence there will be no interference from them. The single antenna will be so high up that there will be no obstructions in the way of the radio waves. Also, it will be so high that it will pick up a much larger signal than any ordinary antenna. It will be designed and built with extreme care, and hence will not be subject to the deficiencies of amateur built antennas.

In many large apartment houses the owner of the building objects to the erection of a multitude of unsightly antennas on the roof. When the new distribution system is installed he will not object, for he himself will install it as an attraction of tenants to his building. A single well-installed antenna on the roof will be a constant advertisement that the building is radio-equipped.

When loops are used in large steel buildings, very little signal is picked up because the steel frame work effectively shields the loop. And in such buildings it has not been practical to use an ordinary antenna because of the long lead-ins necessary. The new system obviates the need of a loop and supplies a source of radio frequency energy which does not depend on its strength on the distance to the roof.

How does this system affect DX reception? Will it improve or impair reception from long distances? It will undoubtedly improve DX reception because the antenna system will be more effective than the ordinary, and local noises will not affect the signals so much and limit the audio amplification possible.

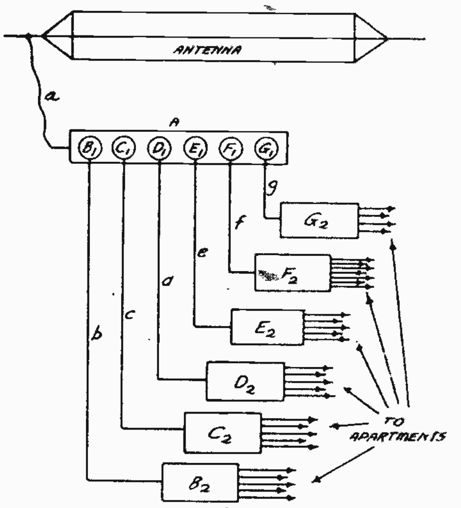


FIG. 1—SCHEMATIC OF THE PARTY AERIAL SYSTEM

Tax on Stations Asked by Robinson

Chairman of Radio Commission Proposes License Fee Before House Committee, to Raise Money for Administrative Cost —No Levy on Listeners

Washington.

Chairman Ira E. Robinson, of the Federal Radio Commission, suggested before the House Committee on Merchant Marine and Fisheries that broadcasting stations be required by law to pay license fees, so that the cost of Federal radio administration could be defrayed that way. Some broadcasters do not appreciate the responsibilities they must meet, he said, and intimated the payment of a fee would bring these responsibilities forcibly to their minds.

Chairman Robinson discussed license fees while under questioning by Representative Gifford (Rep.), of Catuit, Mass. Mr. Gifford had raised the question of censorship of programs broadcast by stations, to which Mr. Robinson replied that broadcasters have very valuable franchises in the public interest.

Don't Recognize Trusteeship

"They do not all recognize their trusteeship," he said. "I have wondered if there should not be license fee. Perhaps if a reasonable license fee was invoked broadcasters would take more seriously their responsibility of trusteeship.

"It might be well to carry a license fee to cover the administrative expense of the Commission."

It was brought out that, for the current fiscal year the Commission has an appropriation approximately $350,000, but that for the ensuing year, if the Commission is continued by passage of the White bill, a greater fund will be needed for additional personnel as well as increased operating expenses.

The Committee chairman, Representative White (Rep.), of Lewiston, Me., pointed out that in previous consideration of radio legislation the suggestion had been made before the Committee that a gradual scale of license fees be assessed, based upon the power and size of the various stations.

No Payment by Listeners

Other committee members questioned Chairman Robinson on license fees.

Replying to Representative Abernathy (Dem.), of New Bern, N. C., Chairman Robinson said that this country could not do away with advertising or sponsored programs via radio, as is done in England and practically all other countries.

"I know of no other way than to charge the listeners themselves to pay for the cost of programs, and the public does not

(*Continued on next page, col. 2*)

11 OF SMALLER STATIONS CALL SET-UP UNFAIR

Washington.

Charges of maladministration by the Federal Radio Commission, tending to work hardship upon "small stations" in favor of the larger ones, and that the Commission has "effected a monopoly in the radio business," were made before the House Committee on Merchant Marine and Fisheries by Joseph Goustin, president of the New Jersey Broadcasters' Association.

Mr. Goustin appeared before the committee in connection with the White Bill to extend the life of the Radio Commission one year after March 15th, the date on which it expires under the present law. New Jersey stations which are members of the Association are WAAT, WAAN, WNJ, WKBO, WEAN, WODA, WBMS, WIBS, WCAP, WOAX and former WTRL.

Criticizing the reallocation of November 11th as "unfair to the small stations," Mr. Goustin declared that Commissioner O. H. Caldwell was a "dictator of the First Zone," in which New Jersey is located. He said that almost all the publicity emanating from the Commission "has worked hardships upon the small stations."

Charges Law Evasion

The Commission, said the witness, "failed to carry out the law" when it promulgated the radio reallocation, asserting that the Davis equalization amendment "did not authorize clear channels on high power, which was the chief result of the allocation." There was no reallocation as provided by the Davis amendment, he said, but, instead, there were created clear channels "90 per cent of which are occupied by chain stations."

In the metropolitan area of New York, Mr. Goustin stated, much space in the ether is going to waste through "wide channel separation" between the larger stations. There is a separation of 340 kilocycles between the large stations in this area, he declared, which, if properly allocated, could be so arranged as to make available seven more channels to the 90 available for the United States for broadcasting.

Can't "See" High Power

The witness declared high power was not necessary, and that allotments of power of over 5,000 watts, in contrast to the present 50,000-watt maximum, is "a downright sin." Chain stations on clear channels, he declared, do not require more than 1,000 watts of power, because they are connected throughout the country by land lines.

Commenting further on the "injustices" of the allocation upon small stations, Mr. Goustin declared that there are six channels out of the 90 upon which 267 broadcasting stations out of the aggregate of 620 have been placed. "In other words," he said, "33 1-3 per cent of the stations are on seven per cent of the available channels."

Makes Proposals

The result of the allocation has been, said the witness, that "the Commission has shoved the small competitors of the big stations in positions where they cannot compete." Consequently, he declared, the small stations are losing their advertising; among the recommendations made by the witness were that there should be legislation prohibiting clear channels for stations of more than 5,000 watts. Under the allocation there are 40 cleared channels for exclusive station use. He recommended also legislation "designed to cure evils of jurisprudence" in radio. He explained that the Commission acts as "judge, jury and prosecutor" in all cases. While the Commission was described as having failed to carry out its functions, Mr. Goustin said he favored a permanent radio commission, "with certain laws to control its procedure."

In closing, he said, the Commission "has placed 75 per cent or more of the broadcasters in this country on 25 per cent, or less, of the available channels. Moreover, he declared, the Commissioners themselves evidently do not inspect stations in their zones as often as the stations would like. To correct this he recommended legislation "making it mandatory for Commissioners to make frequent inspection of stations in their zone."

High Power Ideas Found Garbled

Washington.

Testifying before the House Committee on Merchant Marine and Fisheries, regarding extension of the life of the Radio Commission, Henry A. Bellows, of WCCO, Minneapolis-St. Paul, said that in principle he personally favored both high-power and cleared channels to a moderation.

Discussing movements to limit the power of broadcasting stations to 10,000 or even 5,000 watts, as compared to the present 50,000 allowed by the Commission, he declared this was, to his mind, an administrative matter to be handled by the Federal agency regulating radio, and not a matter for legislative action by Congress.

Engineers hold the view, the witness declared, that in most cases a station with 5,000 watts power will cause as much hetodyne interference as will a 50-kilowatt station. The advantages of high power, he said, are better signal strength, with resultant clearer reception, rather than to serve a materially increased number of listeners.

The service range of a station does not grow commensurate with the increased power assigned it, as most people suppose, said Mr. Bellows. Moreover, he said, the general belief that the higher the station's power the more interference it causes, also is erroneous. Engineers are of the opinion that by moving stations of higher power outside the city limits, perhaps 10 to 15 miles, the blanketing effects of stations, even within the cities to which they are adjacent, are materially reduced.

Tax on Transmitters Asked by Robinson

(*Continued from page* 3)

want that," he said. "Radio had its birth with advertising and has grown to manhood with it. It is the only practical way to support it.

Cigarette Boosts Discussed

"Some sponsored programs emphasize their wares. But there is not so much of this."

Complaints have been received from restaurant owners and preachers against certain programs sponsored by a cigarette manufacturer, said Chairman Robinson, because the advertisers allege that to smoke cigarettes "satisfies the desire for a piece of candy" or "or helps a woman to get thin."

REALLOCATION CONFUSES, SAY BROADCASTERS

Washington.

The House Committee on Merchant Marine and Fisheries, considering the White bill to extend the life of the Federal Radio Commission for one year after next March, heard Henry A. Bellows, former Radio Commissioner, testifying on behalf of the National Association of Broadcasters. The association represents 122 stations in the United States.

The "general method" for realigning the radio broadcasting structure of the nation, pursuant to the terms of the amended Radio Act of 1927, favored by the Commission's chairman, Ira E. Robinson, is construed as "sound" by the association, said Mr. Bellows.

Chairman Robinson, a previous witness, had explained that he opposed the reallocation from the start, indorsing a plan whereby equalization of radio facilities among the States and radio zones, as required by the Davis equalization amendment, would have been effected by "gradual steps" rather than by a sweeping realignment, as the majority of the Commission voted.

Sides with Robinson

Mr. Bellows, general manager of WCCO, declared it was the judgment of the association that the views of Chairman Robinson "should have been followed." The Commission, in the public interest, he declared under questioning by Representative Davis (Dem.), Tullahoma, Tenn., author of the equalization amendment, "should not have effected changes among the 94 per cent of the stations."

The witness said he did not believe that the Commission had adhered "to the letter or to the spirit of the equalization amendment," although in some respects conditions have been improved. He agreed with Representative Davis that the changing of assignments of 94 per cent of the stations tends to "create confusion in the public's mind."

Claims Essential

On local channels the Commission "has done an exceedingly good job," said the witness. The stations on these channels are spaced properly with about the same power, and as a result, no interference of moment is caused.

Discussing chain broadcasting, Mr. Bellows declared the duplication existing is a "somewhat serious menace to the rights of listeners to hear all the programs they want." Chain broadcasting, however, he described as "absolutely essential to radio."

Like a Newspaper

"I believe that any form of regulation of chain broadcasting is going to have a very serious result, probably working against the public interest," he said. "The economics of chain broadcasting will enter the problem within a relatively short time and will work itself out," he said.

Mr. Bellows said a broadcasting station is comparable to a newspaper, dependent upon its outside service just as a newspaper must rely upon a press association for its "national and foreign news." The local demand must be met, just as a newspaper must provide adequate local news, and later a greater flexibility in broadcasting must come, with a station using "foreign material" to fill out local programs.

END OF BOARD RECOMMENDED BY CALDWELL

Washington.

Opposition to the White Bill to extend the life of the Federal Radio Commission another year was expressed before the House Committee on Merchant Marine and Fisheries by Radio Commissioner O. H. Caldwell, who said that it was his conviction that the "commission method is illy adapted for radio administration."

Under the present radio law the Commission becomes a quasi-judicial body after March 15th, with its administrative functions reverting to the Department of Commerce.

No Apologies for Set-Up

"However useful a commission of five may serve as an appellate body to pass on radio controversies, acting as a sort of court or jury, certainly it has been demonstrated that a commission organization is not suited to administer constructively, efficiently or competently a great advancing scientific art like radio," Commissioner Caldwell told the committee.

"At these present hearings members of the committee and witnesses have repeatedly made the comment, as individual situations arose, that these were problems for engineers to study and handle. Radio is a technical problem."

Mr. Caldwell explained that the radio division of the Department of Commerce is manned by "competent radio experts and engineers" and is the logical agency to govern radio.

Farmers Benefited

Discussing the recent reallocation of broadcasting facilities, Mr. Caldwell said members of the Radio Commission who voted for it "have no apologies to make for it." They endeavored to carry out faithfully, accurately and completely the purposes of the radio law, he declared.

The Commissioner defended the setting aside of 40 cleared channels for exclusive station operation, and the grants of high power made by the Commission. Farmers and distant listeners were not served under the set-up existing prior to November 11th, he declared, but the reallocation made possible adequate service to rural listeners, whereas formerly good service was afforded only to the city listeners.

A misconception of "high power" is widely prevalent, Mr. Caldwell explained. A 50,000-watt station is only a "62 horsepower" station, with less force than the average automobile, he declared.

Cleared Channels "Essential"

Cleared channels were described as "essential" by Mr. Caldwell, who stated that the "leading radio engineers of the country recommended the setting aside of 40 such channels in the interest of good reception." He stated at this time he is prepared to recommend 50 or 60 cleared channels so that more and better service might be rendered.

Asked why the Commission had not followed the advice of its Chairman, Ira E. Robinson, by bringing about the reallocation in "gradual steps," Mr. Caldwell said that "too much disturbance would have been created by "broadcasters," and the effect would have been "much more drastic." He declared he was convinced that to change the line-up on any one of the 90 channels would have meant the disturbance of at least one-third of the broadcast band.

NEW ROXY SOPRANO

ETHEL LOUISE WRIGHT, SOPRANO, NEWEST ADDITION TO ROXY'S GANG, WHO SANG FOR THE FIRST TIME RECENTLY BEFORE A STUDIO MICROPHONE DURING THE BROADCAST THROUGH THE N. B. C. SYSTEM

POPENOE DIES DURING VISIT

Charles Broadwell Popenoe, treasurer of the National Broadcasting Company, died recently in the Miami Valley Hospital, Dayton, Ohio, of pleurisy and lobar pneumonia.

A pioneer in broadcasting, Mr. Popenoe was the manager of WJZ as the second broadcasting station in the United States, established in 1921 by the Westinghouse Electric and Manufacturing Company. He piloted it through the early experimental stages and in 1923 was appointed manager of the Broadcast Division of the Radio Corporation of America, when that organization took over WJZ and moved its studios into Aeolian Hall, New York. When the National Broadcasting Company was formed in 1926, he became treasurer of the company.

Mr. Popenoe after a visit to relatives in Dayton was on his way back to New York when he was seized with influenza. He was removed from the train and taken back to his parents' home in Dayton. The next day he was taken to the Miami Valley Hospital.

He leaves a widow and three children. The Popenoe family made its home in Glen Ridge, N. J.

RADIO PHONES TO BE ADDED

The British Columbia Telephone Company, Vancouver, which directly and through subsidiaries operates most of the telephone lines in British Columbia, proposes to extend its facilities to sparsely settled and inaccessible portions of the Province by the installation of radio telephones.

KING JOINS ARCTURUS STAFF

John L. King, formerly of the Air Reduction Sales Corporation, has joined the sales department of the Arcturus Radio Company, manufacturers of AC radio tubes, as a sales representative covering Southwestern territory.

9 MORE NAMED AS 'WOBBLERS' GET WARNING

Washington.

Eight more stations were cited by the Federal Radio Commission for frequency deviation in excess of 500 cycles. These stations were notified by telegraph that their applications for license renewal were being held up, pending a hearing on the deviation charge. The stations were:

KPCB—Seattle, Wash., operated by Pacific Coast Biscuit Company on 1,210 kilocycles, 100 watts.

WRHM—Fridley, Minn., operated by Rosedale Hospital Company, Inc., on 1,250 kilocycles, 1,000 watts.

WMBC—Detroit, Mich., operated by Michigan Broadcasting Company on 1,420 kilocycles, 100 watts.

KGER—Long Beach, Calif., operated by C. Merwin Dobyns on 1,370 kilocycles, 100 watts.

WLBX—Long Island City, New York, operated by John N. Brahy on 1,500 kilocycles, 100 watts.

KGFJ—Los Angeles, Calif., operated by Ben S. McGlashan on 1,420 kilocycles, 100 watts.

KFWI—San Francisco, Calif., operated by Radio Entertainments, Inc., on 930 kilocycles, 500 watts.

KMO—Tacoma, Wash., operated by KMO, Inc., on 1,340 kilocycles, 500 watts.

Polymet Acquires Coil-Making Plant

The Polymet Manufacturing Corporation, makers of electric set essentials, announces its entrance into the coil field with the acquisition of the Coilton Electric Manufacturing Company of Easton, Pa. Thus power transformer coils, audio transformer coils, transformers, coils for dynamics and for power packs are added to Polymet's line of filter blocks, condensers and resistances.

The Coilton windings have been established for more than eleven years. Under Polymet direction it is planned to increase the size of the plant by 25,000 tc 50,000 square feet of floor space. Fifty new multiple-winding machines are to be added.

Monopoly Date Asked In House and Senate

Washington.

A concurrent resolution (H. Con. Res. 47), "requesting the Federal Radio Commission to transmit to the Attorney General evidence taken under complaint charging monopoly in radio, and requesting the Attorney General to consider and take such action as may be warranted," was introduced in the House by Representative Davis (Dem.) of Tullahoma, Tenn., ranking minority member of the House Committee on Merchant Marine and Fisheries.

A similar resolution (S. Con. Res. 29), was submitted to the Senate by Senator Dill (Dem.) of Washington.

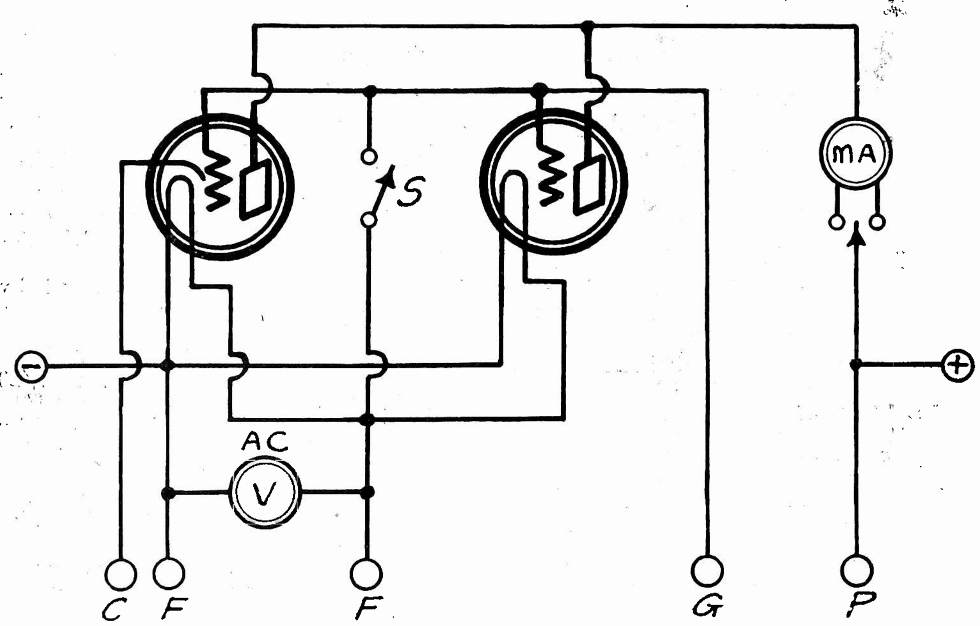
KENNEDY'S NEW OFFICE

James A. Kennedy, representing the Jensen Radio Mfg. Co., has moved his office and demonstration rooms to 1 West 139th St., New York, N. Y. Telephone, Bradhurst 1460.

How to Use the Jiffy

Full Details on Use and Application of This Versatile Outfit

Ten Other Uses Bring



CIRCUIT OF THE JIFFY TESTER, WITHOUT THE HIGH RESISTANCE VOLTMETER HOOKED UP.

A better understanding of the connection of the tester (without the high resistance B voltmeter) may be had with the aid of the above diagram. The two sockets of the tester are shown (5-prong at left, 4-prong at right.) The cable to the receiver under test is represented by the circles at bottom marked C (cathode), F, F (filament), G (grid) and P (plate). S is the grid bias switch. Keep this at right position except for momentary tests. The high resistance B meter (0-300 v.) connects from F at left to + at right center.

THE Jiffy Tester Combination, consisting of the Tester and a high resistance voltmeter, made 13 vital tests of tubes and receivers in 4½ minutes. How to make these tests is explained below. Nobody technically interested in radio, either as a hobby or as a principal or incidental means of livelihood, should be without one of these combinations. If you will turn the pages you will see the announcement of the combination options. Read this advertisement carefully and compare it with the directional data below.

You will find the high resistance meters offered in 0-300 and 0-500 volt ranges. For extreme versatility, so that all B supplies and power packs, including push-pull output, either 112, 112A, 171, 171A, 210 or 250, or any other, may be tested, use the 0-500 meter. The 0-300 meter tests all except 210 and 250 tube plate voltages, whether push-pull or otherwise. From your own experience you will know which one you want.

The only other choice is between high resistance voltmeters on the basis of accuracy. One type (0-300 or 0-500 v.) is accurate to 5% plus or minus, hence at 300 volts it may be 15 volts off, or less, and at 500 volts, 25 volts off, or less. The other type (0-300 or 0-500 v.) is accurate to 1% so will not be more than 3 volts off at 300 volts, or 5 volts off at 500 volts. Of course with either meter at lower voltages the meter will be "off" a smaller number of volts, because the same percentage is taken of the smaller reading. For ordinary use the 5% accuracy is sufficient.

Thirteen Vital Tests Made in 4½ Minutes!

[Here is the detailed, scientific information on the thirteen vital tests, performed in a jiffy by the Jiffy Tube and Set Tester. It tests all tubes except screen grid tubes. Do not try to test screen grid tubes with this device.

These data are extremely valuable as a constant source of reliable reference.]

TEST NO. 1.—To measure filament voltage, either AC or DC.

Remove a tube from the set and insert it in the suitable socket on the tester. Insert the tester plug in the socket in the set vacated by the tube, using the 4-prong plug adapter for four prong tubes, but omitting it for 5-prong tubes. For UV199 tubes attach extra plug adapter to the 4-prong base and put UV199 socket adapter in the 4-prong socket of tester. The voltage indicated on the voltmeter on the tester is the voltage across the filament terminals in the receiver. Repeat operation on the other tubes in the receiver.

TEST NO. 2.—To measure the plate current of any one tube.

Proceed as in test No. 1 and read the plate current on the milliammeter on the tester. Throw the small switch (at lower left on tester) to "high" position to read plate current for power tubes only. Leave it at "low" for all other tubes.

When taking plate current readings the switch at the back should be left in the "off" position, which is toward the right or toward the filament voltmeter, except as outlined in other tests. In some meters the "on" and "off" positions may be interchanged. In that case the "off" position will be recognized by the lower plate current reading.

TEST NO. 3.—To measure the total plate current of a receiver or amplifier.

Open the B-minus lead between the receiver and the B battery eliminator or battery. Connect B-minus on the receiver to the P prong on the tester plug and connect B-minus on the B battery or the B battery eliminator to the P socket on the tester. Throw the panel switch to "high." Read the total plate current on the milliammeter on the tester. If the reading is less than 20 milliamperes, throw small switch on tester to "low."

TEST No. 4.—To measure the plate voltage applied to the plate of any tube in the receiver.

Transfer the tube from the receiver to the appropriate socket on the tester and insert the tester plug in the socket vacated in the receiver. Use the plug adapter for four-prong tube or additional UV199 adapters, if necessary. Connect the 0-300 or 0-500 auxiliary resistance voltmeter to the two binding posts on top of the tester. Read the plate voltage on the auxiliary voltmeter. Repeat the operation for the other tubes in the receiver. The reading will be practically zero on the detector and on any tubes followed by a resistance coupler.

TEST NO. 5.—To determine the condition of a tube.

This test is based on the difference in plate current when the grid of the tube is negative and when it is positive. Transfer the tube to be tested from the receiver to the tester, as explained under Test No. 1. Adjust the filament rheostat, if any, in the receiver until the filament voltmeter on the tester reads the rated value. (See chart herewith) Note the plate voltage on the auxiliary voltmeter. Then read the plate current on the tester milliammeter when the switch at the back of the tester is on the "off" position, that is, to the right. Then turn the switch "on," or to the left, for a moment while reading the plate current. Turn switch to the right as soon as the "on" reading has been obtained. A good tube should show a plate current on the "on" position about twice as great as on the "off" position. The exact values depend on the tube and on the plate voltage applied. Generally speaking, tubes are in better condition in proportion to the change in plate current.

TEST NO. 6.—To measure the electronic emission of a tube.

Provide an auxiliary tube socket and connect a suitable filament voltage across the F terminals. Also connect a suitable plate voltage across the P and F minus terminals on this socket, or across the P and C terminals on a five-prong socket, if you are using a 5-prong extra socket. Insert the tube to be tested in the proper socket on the tester and insert the plug of the tester in the auxiliary socket. Read the emission on the tester milliammeter, with the back switch on the "off" position.

Another way of doing this is to proceed as in Test No. 2 and short-circuit the load impedance of the tube in the receiver, (primary of an audio transformer, for instance) as the emission is the plate current in the tube when the load resistance is zero. In the case of radio frequency circuits it is not necessary to short-circuit unless the coupling is by resistance, which it rarely is. The load impedance is the coupling resistor or

Tube and Set Tester

for Reading Filament and Plate Voltage and Plate Current—Total Tests Up to 13

choke or the primary of the audio transformer.

TEST NO. 7—To regulate AC line, using -27 tube as guide.

The voltage of the AC supply line fluctuates and often in much higher than the rated 110 volts. A rheostat is often used in series with one side of the line to cut the voltage supplied to the power or filament transformers to the proper value.

Measure the filament voltage on the -27 tube as explained under Test No. 1. Adjust the line rheostat until the filament voltage is 2.5 or 2.25 volts as desired.

TEST NO. 8.—To test for continuity of circuit, or to test for open circuit.

Apply Tests Nos. 2 and 4. If the test shows a plate current the plate circuit is continuous, that is the audio transformer primary or other primary load is not open. Likewise if the voltage on the plate shows the expected value, the plate circuit is continuous at least up to the plate. To test a resistor, a choke, or a transformer winding not in the circuit, connect the part to be tested between B-minus on set and B-minus on the plate voltage source. If it is continuous, both plate current and plate voltage should be obtained, but both should be lower than when the part tested is not in the circuit.

TEST NO. 9.—To test for shorts in condensers, inductances and resistors.

Proceed as in Test No. 3, inserting the part to be tested in series with B-minus on set and B-minus on plate voltage source. Note the plate current reading and the voltage reading when the part tested is inserted and when it is short-circuited with a wire. If there is no change in the readings the device is short-circuited.

When a condenser is inserted there should be no reading if the condenser is good.

If radio frequency inductances are "open" this will cause no reading, but if "shorted," the No. 9 test will not disclose the fact, because the difference in resistance between continuity and "short" is too small. Examine radio freauencv coils for "shorts."

TEST NO. 10.—To determine grid bias voltages.

This can be done directly for high biases by the use of the high resistance voltmeter. Connect the minus lead of the meter to the grid of the tube of which the bias is to be tested, and connect the positive lead to A-minus for DC tubes, or to the cathode for AC 5-prong tubes (227), or to the mid-tap of the filament transformer, for 4-prong tubes with AC on the filament.

The bias can be obtained indirectly for high or low bias by applying Tests Nos. 2 and 4. There is a certain plate current for a given plate voltage and grid bias. The plate current for all standard tubes and all the usual plate voltages and various grid bias values can be obtained from charts of tube characteristics. (See examples herewith.)

A more direct determination may be obtained in some cases. Proceed as in Tests Nos. 2 and 4 and note the current. Then open the connection to the grid on the socket in the receiver which contains the plug. Connect a grid battery between the grid post on the socket and to A-minus, the cathode or the mid-tap on the filament transformer, as conditions may require. Adjust the voltage of the battery until the same current flows in the tester milliammeter as flowed before the grid was opened. The voltage of the battery is the bias sought. Remove the battery and restore the grid connection.

TEST NO. 11—To test for overloading distortion.

Proceed as in Test. No. 2 for the final audio tube and watch the needle on the plate current milliammeter on the tester. If there is distortion, the needle jumps around. If there is no appreciable distortion the needle stands still. This test should be applied to the last tube only.

TEST NO. 12.—To test for correct bias.

This plate current reading for the last audio tube also will indicate whether the grid bias on the tube is too high or too low. If the bias is too high, the needle kicks up on loud passages in the signal. If the bias is too low, the needle kicks down. Change the bias until the needle stands relatively still.

TEST NO. 13—To determine the starting and stopping of oscillation.

When a circuit oscillates the plate current is greater than when the circuit is non-oscillatory. The change in the current is sudden when the circuit either starts or stops oscillating. An exception exists in the care of a positive grid return, as in a DC detector, when oscillation may reduce the plate current:

Tube Charts

The plate voltage, filament voltage, grid voltage and plate current of 201A, 112A, 210, 250, 199, 220, 226 and 227—the complete list of the most popular tubes—is given herewith. As for plate voltage, grid voltage and plate current, when any two are known the other value can be found by consulting the chart.

Thus you can readily determine by this method whether the grid bias is correct, a fact otherwise difficult to establish. The figures given herewith are correct averages and should be followed, even if other values are given elsewhere.

Type Tube	Plate volts	Filament volts	Grid volts	Plate milli-amperes, switch "off"
201A	45	5	0	1.6
	45	5	—1	1.0
	67.5	5	0	3.4
	67.5	5	—1	2.4
	90	5	0	5.9
	90	5	—1	4.8
	90	5	—4.5	2.0
	135	5	—9.0	2.5
112A	90	5	0	13.6
	90	5	—6	6.8
	135	5	—9	11.4
171A	90	5	0	15
	135	5	—27	12
	180	5	—40	18
210	180	7.5	—12	7
	250	7.5	—18	12
	350	7.5	—27	17
	425	7.5	—35	22
250	250	7.5	—45	28
	300	7.5	—54	35
	350	7.5	—63	45
	400	7.5	—70	55
	450	7.5	—84	55
199	45	3	0	1.5
	67.5	3	0	2.5
	90	3	0	3.5
	90	3	—4.5	2.5
220	90	3	0	9
	135	3	—22.5	6.5
226	90	1.5	—6	5
	135	1.5	—6	6
227	45	2.5	0	3

When the 227 tube is used as an amplifier the plate current is about the same as for the 112A tube with the same grid and plate voltages.

Audition Winner Turns Professional

Hazel Cecilia Arth, winner of first place in the Kent radio audition, recently gave her first professional recital in the Atwater Kent Radio Hour, assisted by the orchestra under Josef Pasternack.

Miss Arth, Washington chorister, originally from California, won first place over many thousands of women contestants throughout the country. She tried last year, but failed to reach the finals. Her victory this year came as the result of a year of intensive study. She is a contralto.

As Miss Arth stepped before the microphone she laid aside her amateur standing essential to qualification in the Atwater Kent Radio Audition. On the same program was Giacomo Lauri-Volpi, Metropolitan Opera Company tenor. The program was over WEAF and a chain.

Illustration on Front Cover

Si-len-ser Kills Off Noises

Experts have devised various ways and means of curing annoyances caused by AC and DC line noises and interference caused by electrical appliances. All agree that such interference is intolerable.

One school of experts attacks such noises at the source, a good method, but one that runs into money.

Other experts filter out these noises at the line feeding the receiver. A good job of this kind has been accomplished in the Si-len-ser, recently placed on the market by the Trutone Radio Sales Co., 114 Worth Street, New York City.

This device operates on a newly applied principle, filtering the interference out through ground. It is sturdy and compact and instantly installed. It fills a want in insuring a full enoyment of the all-electric set.—J. H. C.

Emergency Box Useful

Several fans visiting a laboratory the other day were impressed by an old emergency box standing within ready reach. They said they were going to copy the idea, so it might not be amiss to pass it along. It held in built-in sockets all the types of Raytheon tubes for the various eliminators, including the 85 and 125 mil. types. The heart of the box was built around a family of Clarostats, starting with the "baby" up to the largest Power Clarostat. These useful and precise variable resistances cover a wide range of emergency uses besides being in actual use all through the lab.—J. H. C.

Doctor Don't Speaks

Tells You What Not to Do So You'll Fare Best

By Dr. A. M. J. Farragut

WHEN sputtering, crackling and grinding noises appear in a radio set look to the contacts, particularly the contacts of the battery terminals and the leads to the set.

If an A battery is used the acid creeps up on the terminals and corrodes them. The current cannot pass smoothly and easily through the products of the corrosion. If the terminals are of lead little trouble will be experienced from this source. But very often the terminals connected to the battery are of copper, or iron. These give trouble. If lead-covered iron clips are used the lead may wear off, exposing the iron to the action of the acid. A noisy contact invariably results. Don't let the terminals corrode.

The battery should be wiped often with a rag, moist with a solution of ammonia. The acid may also be prevented from creeping up on the terminal lugs by covering these with vaseline.

Wherever electrical contact depends on pressure of one conductor against the other there is danger of noise. The atmosphere will corrode the metals and the corrosion will creep in between the two conductors and break the electrical contact, or impair it. Solder the joint where possible or clamp the two conductors firmly together.

High Voltage Spoils Tubes

Don't use too high voltage on the plates of the tubes. There is a tendency to increase the plate voltage on the tubes just as soon as it is noticed that this increases the volume. This small gain can be obtained only at the expense of the life of the tube. There is only a definite amount of "life" in the tube and if the plate voltage is high the tube dies faster than it should.

Much more service can be obtained from the tube by operating it at a voltage less than the maximum rated volts. It should never be operated at a voltage higher than the maximum rated voltage.

Many control the volue of their radio sets by turning up and down the filament current. And then they complain that

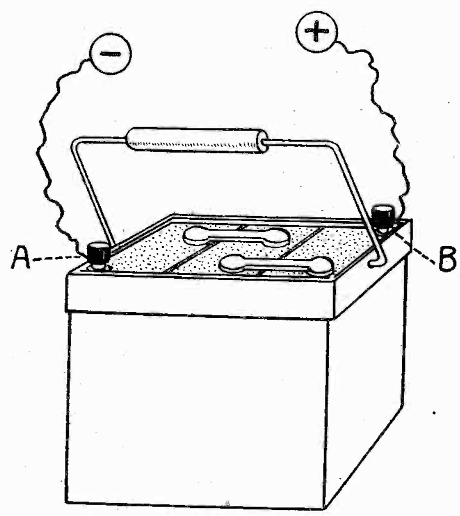


FIG. 1
KEEP THE TERMINALS A AND B ON THE STORAGE A BATTERY CLEAN FOR IF THEY CORRODE THEY PRODUCE NOISE IN THE SET. CLEAN TOP OF BATTERY WITH AMMONIA AND COVER TERMINALS WITH VASELINE TO PREVENT ACID FROM CREEPING.

the more they turn down the volume the worse gets the quality. That is just what happens. As the filament current in the audio tubes is turned down the volume handling capacity of the tubes is cut down. The amplification is not cut down so rapidly. Hence the more the filaments are turned down the worse gets the quality. There is an exception. If the filament current is turned down in the radio frequency tubes alone, the radio frequency amplification is cut down, as is the volume. The power handling capacity of the audio tubes is not cut down because the filament current in them is not altered. The quality is improved by the reduction in the volume.

Hence don't turn down the filament current in the audio tubes to control the volume of the output of the receiver.

Voltage Is Not Power

If you don't get satisfactory results when you hook a certain B battery eliminator to a set, don't blame the set, unless that set fails to give satisfactory results with plate batteries. A B battery eliminator is rated at certain voltage for specified currents. That is, it is rated to give a certain power. If more than the specified current is drawn from the B battery eliminator the voltage is not as high as the rated voltage. It may very much lower. The designer of the B battery eliminator may have had a certain receiver in mind and he designed it so that it would operate this receiver. But if that eliminator is connected to a set which requires much more plate current the voltage will drop so low that satisfactory operation cannot be obtained. Hence if the set does not work with an eliminator blame the combination rather than either component. And who is to blame for making a certain combination?

Essentially the same thing applies to an A battery substitute. Such a device has been designed to give a certain voltage when a specified current is drawn from it. If more current is drawn the voltage drops and the tubes don't get enough. Also, when more than the rated current is drawn from such a device the current delivered becomes unsteady and will often give rise to a sputtering sound. Find out how much current the A battery substitute will safely deliver and don't connect to a set which requires more than that.

Grid Leak Under Suspicion

"My set is not selective. I have replaced the grid leak and used many different values, but no improvement." Such statements are often made by fans. Why should the grid leak be suspected of causing poor selectivity? As it is connected in nearly all sets it has nothing to do with the selectivity. Suspect the coils or the condensers or the connections, but don't indict the grid leak. The grid leak may give rise to noise, if it is defective, but it does not cause broadness of tuning.

Don't expect a peanut tube to operate a loudspeaker. No speaker has yet been devised which is so sensitive and efficient that it will convert the small power a peanut tube can deliver without distortion to create much sound. Some day such speaker may be invented but it is not now in sight.

Don't operate a 250 push-pull radio receiver at full volume in a home. The volume is so much greater that it will partially paralyze the ears. The volume may be turned up gradually without noticing any great increase because the auditory system tires and does not respond in proportion to the volume. But that fact does not prevent other people for blocks around from hearing the speaker. Such a sound center is a nuisance to all who live around it and it approaches a danger to those immediately near it. But a 250 push-pull amplifier is capable of unexcelled quality when it is operated at moderate volume. The fact that the circuit can be abused is no reason for not using it.

Keep Voltage Steady on Audio Filaments

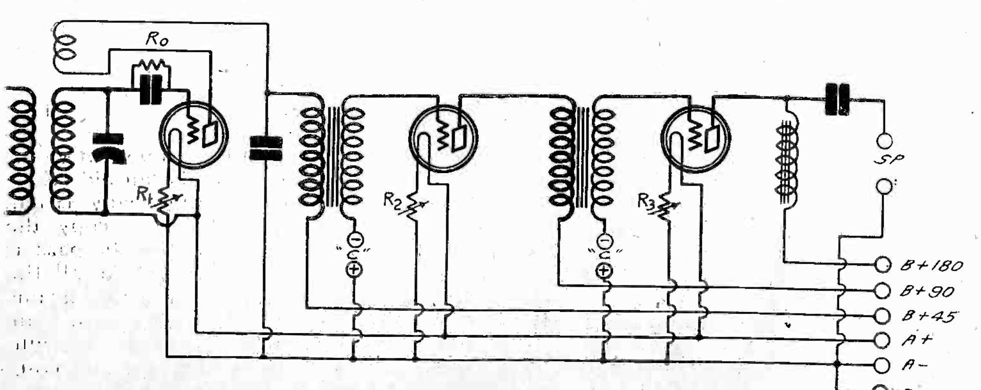


FIG. 2
THE GRID LEAK R0 DOES NOT AFFECT THE SELECTIVITY OF THE SET. THE TUNER DOES. DON'T ADJUST THE VOLUME BY TAMPERING WITH RHEOSTATS R2 AND R3. R1 MAY BE USED FOR THIS PURPOSE.

How a Loop Works

Potential Difference Across Inductance is Utilized

By Capt. Peter V. O'Rourke

Contributing Editor

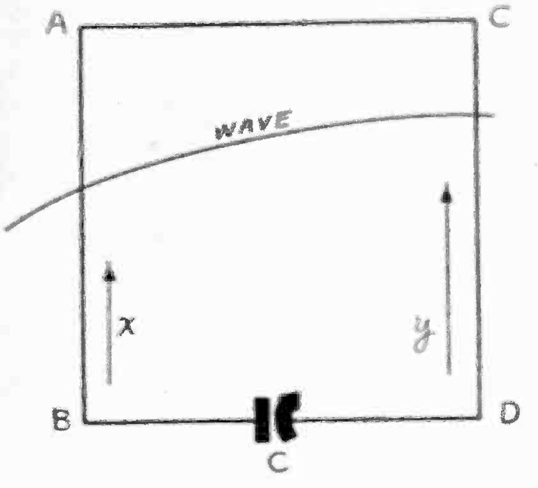


FIG. 1.

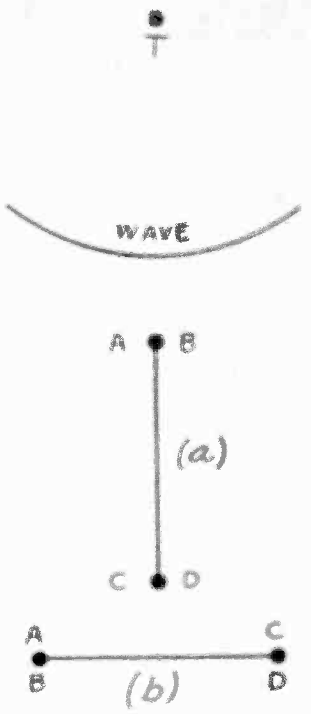


FIG. 2.

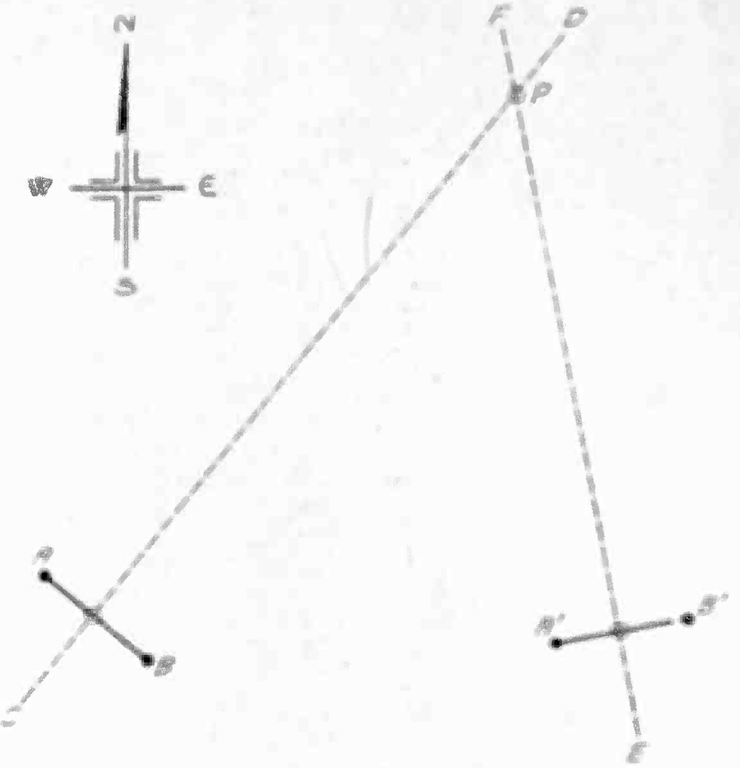


FIG. 3.

FIG. 1, SHOWS A LOOP ANTENNA AND ILLUSTRATES HOW A RADIO WAVE PASSING OVER IT INDUCES A DIFFERENTIAL VOLTAGE IN IT.

FIG. 2, SHOWS TWO POSITIONS OF THE LOOP WITH RESPECT TO THE TRANSMITTING STATION T. POSITION (A) IS THAT FOR MAXIMUM PICK-UP AND POSITION (B) FOR MINIMUM OR ZERO PICK-UP.

FIG. 3, ILLUSTRATES THE METHOD OF USING LOOPS FOR LOCATING A SOURCE OF INTERFERENCE OR THE LOCATION OF A TRANSMITTING STATION.

WHY does a coil aerial, that is, a loop, pick up any signals? And under what conditions does it pick up any signals? Why is it directional in its pick-up? These are some of the questions radio students ask.

Let the ABCD in Fig. 1 be a loop antenna tuned by condenser C1. The loop will consist of many turns, but for this discussion it will be sufficient to consider only one. Fig. 1 at the left shows the side of the loop and the curved line through it represents the wave, which is supposed to come from the left.

The voltage induced in the side AB by this wave is X, which is the product of the strength of the wave at AB and the length of the line. The direction of the voltage is upward, assuming that a positive loop of the wave is passing over the coil at the instant. The voltage induced in the side CD at the same instant is Y, which is the product of the length of CD and the strength of the wave at CD at the instant considered.

Voltages Buck

The direction of the induced voltage in CD is also upward, because the loop is small compared with the wavelength, so that the wave is positive at both sides. It is assumed that the two sides are equal in length and vertical in position. If the sides are not equal the results will be the same but the analysis will be more complex.

The horizontal portions of the loop contribute nothing to the induced voltage if the direction of the wave is parallel to the ground, which is the case in most instances.

Since the induced voltages in the two vertical sides are both upward it is clear that they oppose each other in the circuit formed by the loop and the condenser. The voltage induced in the left side tries to send a current around the circuit in the clockwise direction and that in the right side in the counter-clockwise direction. The sides AB and CD are equal and therefore the induced voltages x and y will be equal, unless the intensities of the magnetic fields are unequal in the two sides. Since a loop does pick up a signal there must be a difference between the field strengths at the two points.

But how can the field strength be different at two points so close together when the same wave passes over the two sides of the loop? The answer lies in the nature of wave phenomena.

The magnetic force in the side AB is not the same as the magnetic force in the side CD at the same instant. The intensity of the magnetic force at AB is measured by the length of the arrow placed beside X. In the side CD it may be measured by the length of the arrow placed beside y. AB is located at the instant considered at a point lower in the wave than is CD. Hence there is a difference between the two induced voltages. The difference between these two induced voltages is the effective induced electromotive force which sends a current around the circuit. At the instant in question the current flows counter-clockwise in the circuit.

Waves Moves On

But this difference between x and y does not remain constant in value. If it did there would be a direct current in the loop. The difference fluctuates both in value and direction as the radio wave passes over the loop. When the wave is located so with respect to the loop that the two induced voltages are equal, the difference between x and y of course is zero, and then no electromotive force is induced in the loop and no current will flow. This condition occurs twice for every wave that passes the loop, once when the crest of the wave is half way between the two vertical sides of the loop and once when the trough is half way between these two sides. Thus the loop picks up least signal voltage at those instants that the magnetic field about it is maximum in either the negative or the positive direction.

The wave in Fig. 1 is supposed to travel toward the right. Thus the magnetic force is decreasing toward zero, as is indicated by the slope of the wave curve. The crest of the wave has just passed over the loop. Although the magnetic field is decreasing, the induced net voltage in the loop is increasing rapidly. It will continue to increase until the zero point on the wave is half way between the two sides of the loop. Then the induced net voltage in the loop will be maximum. Both x and y will then be equal, but they will be in opposite directions in space and in the same direction in the circuit, x being negative and y positive.

Induced Voltage Oscillates

From then on the value of x will increase in the negative direction and y will decrease. Soon y also will change direction, when CD passes through the zero point on the wave. Then the net voltage will de-

(Continued on page 12)

A Comparison of the D

By J. E.

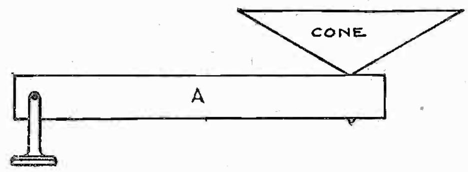


FIG. 11
THE FIRST CONE WAS USED FOR PLAYING PHONOGRAPH RECORDS AND CONSISTED OF A MAILING TUBE WITH A CONE AT ONE END.

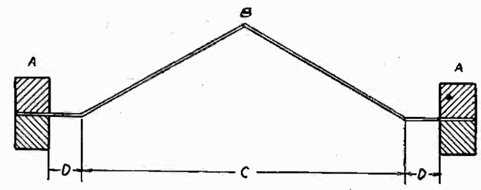


FIG. 11A
THE ORIGINAL HOPKINS CONE USED THIS THEORY, WITH FREE EDGE.

[In last week's issue, dated January 19th, Mr. Smith gave the historical development of the earphone into the loudspeaker, and showed how engineering skill rose to the demand for quality loudspeakers. He analyzed the bi-polar and balanced armature types of motors, as well as the early moving coil types, which, in improved form, are the dynamic speakers of today.]

THE horn length determines the range of response from the loudspeaker. The longer the air column in the horn, the better will be the response of the lower frequencies. As in the case of organ pipes, the longer the air column in an organ tube, the lower will be the note produced. It is, therefore, to be expected that a horn type speaker with a short horn will sound thin and high pitched, lacking in low notes, whereas a speaker with a very long horn will be rich and full in its response, due to the reproduction of the low notes. Horns vary in length from 18 inches to 120 inches, depending upon how they are used. It is not important what material the horn is made of, providing its walls are strong and thick enough to prevent vibrations setting up a natural period of their own.

Besides the bi-polar type of unit for horn type speakers, the balanced armature and moving coil type of units can be employed. Two important types of balanced armature horn type units are shown in Figs. 7 and 8 and the moving coil type shown in Fig. 9.

The Dynamic Speaker

The importance of steels, winding, air gaps and magnets in balanced armature type of units hold the same as bi-polar type of units, and the same efficiency and performance can be obtained from both. The bi-polar type of unit has its advantages in its simplicity of design for mass production whereas the balanced armature has the advantages of slightly better performance by its adaptability to employing special diaphragms which will be taken up later.

The moving-coil type of unit for horn type speakers was introduced early in 1924. It was invented by Sir Oliver Lodge in 1898. He employed large wooden membranes for his diaphragms.

The theory and operation of this very important moving coil system is as follows:

Fig. 10 shows the principle of the moving coil unit. Around the center core of the shell type casting A, is a large magnetizing coil B. When this type of unit came out for a horn type speaker, this winding, which is called the "energizing field," was designed for 6 volts, drawing one to three amperes so that it could be used with a standard 6-volt battery. This winding magnetizes the shell iron casting, so that the center core is north and the outer ring south, as indicated.

Centrally located in the gap between the center core and outer ring is a small coil, VC, known as the voice coil.

This voice coil is in a gap of a very strong magnetic field, set up by the energizing field B. The current which is passed through this voice coil is an alternating current from the last tube of an audio amplifier. The coil is shown cross-sectionally and let us assume that the current in the left winding is coming toward us, as represented by the "dot," and the current in the right winding is going away from us, as represented by the "arrow."

Why Coil Moves

It is the law of a motor that when a current is passed through a coil of wire in a magnetic field, the wire will be forced to move, and by the left-hand rule for a motor, the movement of the voice coil is "down." When the current in the voice coil is reserved, the movement of the coil is "up." By the movement of the voice coil the diaphragm is caused to vibrate.

This type of unit for a horn type loudspeaker was not very popular, because the field coil was too much of a drain upon the six-volt storage battery, wearing down the battery too quickly and requiring recharging the battery too frequently. This moving coil principle was soon to become the outstanding development of the dynamic speakers.

Diaphragms in horn type speakers vary from 1½ inches to 4 and 5 inches, and in thickness from .006 inch to .032 inch. Larger diaphragms are used in loudspeakers than in headsets to obtain greater frequency response.

Diaphragms employed in bi-polar type of units are perfectly flat and made of a good grade of magnetic material, generally silicon steel.

In the balanced armature type of unit, great varieties of diaphragms are used.

It has been brought out that the first horn type loudspeaker was nothing more than a horn on an ordinary headset unit, but great improvements were made by proper consideration of unit design, larger and thicker diaphragms and longer and better horns. However, after all of these improvements it was still noticed that speech lacked good articulation. Reproduction of music was unnatural, with exaggeration of some notes.

The lower frequencies of a horn type speaker can be controlled by the following factors:

(1)—Low reluctance magnetic circuits.
(2)—Large diaphragms.
(3)—Long air column horns.
(4)—Strong magnetic fields.

The higher frequencies can be controlled by:

(1)—Laminated magnetic pole pieces, to reduce the magnetic losses.
(2)—Small or thick diaphragms.
(3)—Short horns.

Good Range from 100 to 5,000

For good reproduction of speech and music a loudspeaker should reproduce frequencies from 100 cycles to 5,000 cycles per second, that is, the diaphragm should be able to respond faithfully from 100 vibrations to 5,000 vibrations per second.

Because a diaphragm is clamped at its edges it is very difficult for it to vibrate at a very high frequency, the best horn type speaker being capable of vibration at not much more than 2,500 to 3,000 cycles per second. Also to obtain the fundamental notes at 100 to 200 cycles, the diaphragms would necessarily have to be very large, and if large enough to get the lower frequencies, the higher frequencies would suffer. The use of very long horns to obtain these low notes is an economical difficulty both in development and manufacture. At its best, the choice of parts in the design of a horn type speaker is a compromise. Satisfactory high frequencies could not be obtained and lower frequencies were obtained with difficulty.

This was the problem in horn type speakers when the cone was introduced.

The first cone known to be used as a real sound producing device was in 1908 when two English scientists, Starling and Cole, used a cone to reproduce music from a phonograph record, as shown in Fig. 11.

Hopkins Gets Patent

A is an ordinary 2-inch mailing tube, with a cone 6 inches in diameter made of manila paper, glued at its apex to one end of the mailing tube. As the mailing tube rides over the tubular reproducing record, the mechanical vibrations from the record are transferred to the mailing tube, and thus to the cone, giving a feeble response of sound. This device was used only where loud response was not required, for if this cone vibrated too much, its edges would whip and vibrate in a local vibration causing rattles.

Of course cone type diaphragms were

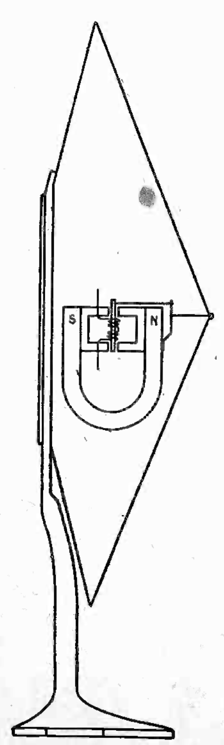


FIG. 11B
One type of cone speaker. This was popular in the early days. It used the push-pull principle. The heavy, thick armature, clamped at the edges, prevented satisfactory response at the high audio frequencies.

ifferent Types of Speakers

Smith

used in horn type speakers but their diameters rarely exceeded 4 inches and were not used as the direct acting radiator of sound.

In 1918 the first important patent on a cone type invention was allowed to Marcus L. Hopkins in his letters patent No. 1271529 granted July 2d, 1928, but it was some time before it was used commmercially. The patent relates to a cone diaphragm of the direct acting type, to reproduce sound from a phonograph record. The theory of this cone is shown in Fig. 11A.

Improvement Noted

Hopkins calls the portion within the ponderous rings AA, a tympanum, which consists of a conical central portion C and a plane peripheral portion DD. The edge of the conical portion C is not held rigidly at its edges, and thus the conical portion is free to move in accordance with the vibrations given to it at its apex B.

This diaphragm was intended to be used for the reproduction of sound from a phonograph record, and complicated and elaborated mechanical devices were necessary to transfer the mechanical vibrations from the record to the apex of the cone. On account of the mechanical parts involved, serious difficulties were encountered and the cone type speaker was not very successful in the reproduction of sound from a phonograph record. However in the cone type speakers and construction of the majority of the cones came within the claims of the Hopkins patent, so today a number of manufacturers of cone type speakers are paying royalty on the Hopkins patent of 1918.

The introduction of a cone on a unit is a great improvement over the flat and other diaphragms of horn type speakers (Fig. 11B). It had been realized for some time that large diaphragms were desirable, but in most instances flat diaphragms of variety of materials were used, which proved unsatisfactory because the flat surfaces would break up into local vibrations of their own, introducing harmonics into the original vibrations given to the diaphragm, resulting in distortion. By shaping the diaphragm in the form of a cone the diaphragm became stiff and rigid and vibrated in accordance with the vibrations given to it at its apex.

Balanced Armature Better

Fig. 12 shows one of the early forms of interesting cone speakers employing the bi-polar principle, two of these units used in push-pull. As the current of the windings of one of the units sets up a magnetic field about the pole pieces to attract the armature, the current in the windings of the other unit is in such a direction as to give a magnetic field to repel the armature. The cone is connected to the armature at the center by a connecting link. Although this unit was popular for some time, the limitation of a heavy thick armature clamped at its edges prevented satisfactory response of the high frequencies.

Better results were obtained from the balanced armature principle which has always been desirable because the mechanical system of the unit itself, consisting of a small armature free to pivot inside an exciting coil, was flexible to satisfactory slow vibrations and capable of extremely high vibrations. These high vibrations were limited to the diaphragms in the horn type speakers, not to the mechanical system of the unit, and so when cones were employed improvement in results was immediately noticed.

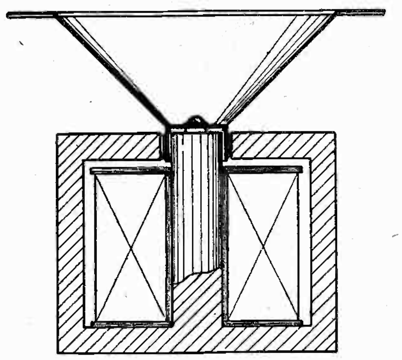


FIG. 12

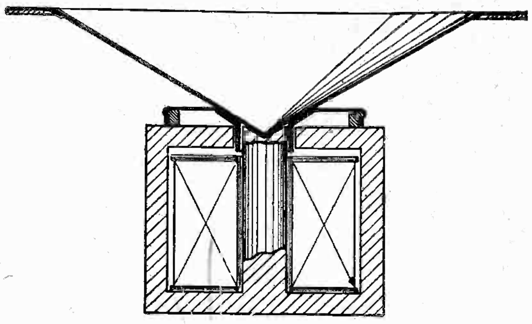


FIG. 12A

FIG, 12, THE FIRST COMMERCIAL TYPE OF DYNAMIC CONE POWER SPEAKER.

The cone is so designed that it is free to vibrate without distortion, in accordance with the mechanical vibration actuated at its apex. By the vibration of the cone, it sets up an air displacement about it and reproduction of sound results.

Referring back to Fig. 11A, the conical portion C is generally made out of a good grade of paper, ranging in thickness from .005 inch to .025 inch and from 6 inches to 36 inches in diameter. The plane peripheral portion D may be paper, rubber, leather or even strings, supported at the ponderous rings AA.

As the apex is actuated from a mechanical source the cone is set into vibration.

The Eccentric Cone

Cones are generally circular but some cones are made eliptical or egg-shape. There is very little advantage gained in using cones of peculiar design as the cost and difficulty of manufacture do not warrant the slight acoustic gain possibly obtained.

As the cone is made to vibrate, a rarefication of air occurs in front of the cone and a condensation of air in back of the cone setting up sound waves in front of the cone, this wave, being in opposite phase to the sound waves emitted from the front of the cone, will neutralize the sound wave from the front. This is particularly noticeable on the lower frequencies or longer waves, since the length of the sound wave at the lower frequencies is sufficient to extend around to the front of the cone.

It is for this reason that the "Baffle Board" plays such an important part in the reproduction of the lower frequencies of a cone speaker.

Cone With Baffle

A suitable baffle board may be used with a cone. The baffle board should be of such proportions to prevent the sound waves from the back of the cone from interfering with the waves emitted from the front of the cone. This baffle board is made out of strong hard wood about ¾ inch to 1½ inch thick to prevent having vibrations of its own.

It has probably been noticed that when a cone speaker is placed in a cabinet a difference in response is noticed, particularly in the lower frequencies. This is due to the "baffle effect" of the cabinet, the partitions around and behind the cone serving as a good baffle. Very small cones with large baffles can produce practically the same results as large cones with small or no baffles.

A cone of large diameter not only reproduces lower frequencies on account of its lower natural frequency, but on account of its large size it acts in itself as a baffle.

The Dynamic Speaker

The types of cone speakers mentioned so far excelled by far the horn type speakers because able to reproduce the higher frequencies much better, going readily as high at 4,000 cycles per second, and the reproduction of the lower frequencies more pleasing and natural.

For a loudspeaker to reproduce lower frequencies satisfactorily, the cone and armature must vibrate at large amplitudes. Also for a speaker to give out large volumes, the amplitudes become so great as to cause rattles by the armature hitting against the pole pieces, and distortion by the whipping and movement of the paper cone.

Power from audio amplifying tube circuits is necessary for the proper reproduction of the low notes and volume. Ordinary speakers cannot use this power to full advantage. To obtain better quality of reproduction with large volumes, the dynamic or moving coil principle of cone speaker was developed.

Why It Is "Dynamic"

The reason that this is called a dynamic speaker is because the moving coil principle is the principle of the motor or dynamo and the reason that these speakers are called power cones is because they take power from a power tube such as the 171, 210 or 250 for satisfactory operation.

The first important commercial dynamic or power cone speaker was developed by C. W. Rice and E. Kellogg, two General Electric research engineers of Schenectady, N. Y. This power cone speaker was put on the market the latter part of 1925, known as the Radiola 104 Power Speaker. The principle of this speaker is shown in Fig. 12.

[*The conclusion of this article by the president of the National Radio Institute will be published next week.*]

The Baffling Problem

By J. E.
Technical

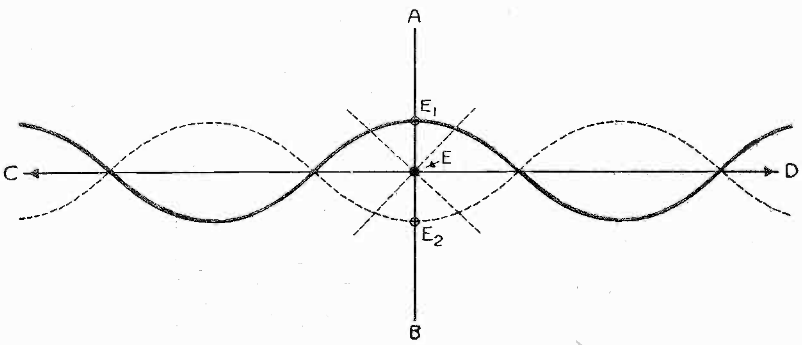


FIG. 1

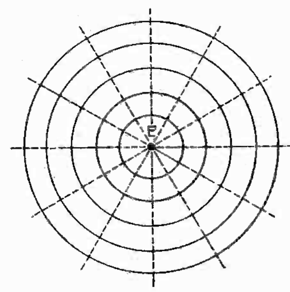


FIG . 2

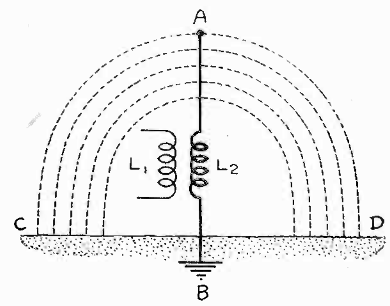


FIG. 3

CURVES ILLUSTRATING THE RADIATION OF RADIO WAVES FROM AN ANTENNA.

TRANSMISSION of radio waves has always been a fascinating and baffling problem

It is difficult to picture the mechanism of transmission, because the waves cannot be seen and they are different from all other waves which occur in media which we can see or feel. The waves are transverse, that is, the effect is at right angles to the direction in which they travel. In this they are like water waves of the gravitational and ripple types.

But they are dual in character, for they consist of magnetic and electric components. In this they are unlike water waves. There are corresponding components in a water wave. The motion of the water corresponds to the magnetic component of the radio wave and the stress due to position in the water wave corresponds to the electric component.

The difference between the two comes in the time element. In the water wave the motion of the water is greatest when position stress is zero; that is, when a moving particle of water is at the mean position, and the stress is greatest when the motion is zero; that is, when a water particle is at the lowest or the highest point. Thus in the water wave the stress and the motion components are 90 degrees out of phase in time. In the radio wave the magnetic and the electric components are in phase. That is, the magnetic component reaches the maximum, or any other value, at the same time that the electric component reaches the same value.

Analysis Reveals

The only way that the radio wave can be treated adequately is by mathematical analysis. By this means the action taking place at any point in space around an antenna can be determined. This is not because the mathematician can picture the wave any better than any one else, but because he is satisfied when he has determined what happens to the quantities involved. He does not care by what mechanism it happens.

At least he has to be satisfied until some one has succeeded in conceiving a mechanism which explains how it happens as well as what happens to the electrical and magnetic quantities with which he is dealing.

It is well known that the magnetic force associated with a radio wave is right angles to the electric force, both being at right angles to the direction of travel of the wave. In the water wave the motion and the stress are parallel, except that there is a motion parallel to the direction of travel. Thus there is a great difference betwen the two types of wave. If the electric force is compared with the stress in a water wave, the magnetic force cannot be compared directly with the force producing motion of the particles of water.

There appears to be no mechanical analogy of a radio wave. But it may be that some property of the radio wave may be conceived which would make such analogy possible. The analogy would probably have to be looked for a rigid body rather than in a fluid.

The Field of an Electron

The ultimate unit of electricity, as far as is known, is the electron, which is a tiny nucleus of electric charge. It has an electric field about it which varies in strength inversely as the square of the distance away from it. Thus if the intensity of the field at a given point is E, the intensity twice as far away is ¼E. In this respect the field is like the luminous field about a candle or the sound field about a sounding body.

The electric field is conceived of as lines radiating in all directions from the nucleus, just as light radiates in all directions around a candle. When the electron is regarded in this manner it is possible to form a picture of the radiation of waves from it.

Let AB, Fig. 1, be a vertical wire, such as an antenna. Let E be one of the electrons in it, and let the intersection of the lines AB and CD be the position of rest of that electron. The lines of force radiate in all directions from that electron, but consider only those lines which lie in the equatorial plane. Since the figure is two-dimensional, only two of these lines can be shown; that is, ED and EC.

Electron Move

Now suppose that the electron E be suddenly moved to E1 in the direction A. The near end of the lines ED and EC will be dragged along. The entire line CD does not move up the same distance at once, for the upward movement of the line travels outward with a finite velocity, that of light. If the electron were to come to rest at E1 the entire line CD would soon come to rest in a new position parallel to CD, because the disturbance would have traveled a very great distance.

Suppose the electron does not come to rest, but as soon as it has reached the point E1 it reverses its direction. The line of force is carried downward, and the new disturbance travels away from the electron with the velocity of light. The electron does not stop at E, its normal position of rest, but it carries on to E2, a point which is as far below E as E1 is above it. The line of force is carried down with it.

It is clear that if the electron moves up

Quirks Develop in Tracing Inter

(*Continued from page 9*)

and at those two points it changes direction. Hence the induced voltage changes direction and the resulting current occillates.

It is interesting to note that the induced net voltage in the loop is in time quadrature with the magnetic force of the wave. That is, there is a 90 degree phase difference.

Another view of the loop and the advancing wave is shown in Fig. 2. T represents the broadcasting station which sends out the wave. The magnetic component, which is effective in the loop, is a circle. A portion of this circle is shown. Consider such circles advancing over the loop.

The loop is shown in two positions. In the upper position (A) the plane of the loop points toward the broadcasting station. The wave reaches side AB first, as it did in Fig. 1. By the time it reaches CD it has a different value at AB and a net voltage is induced, as explained under Fig. 1. This is the position of the loop which gives the maximum difference between x and y, and hence the maximum signal pick-up.

In the lower position (b) the plate of the loop is at right angles to the direction from which the wave comes. Now the sides AB and CD are symmetrically located with respect to the wave, or with respect to the station, and the voltage x induced in AB is always the same as the voltage y induced in CD. The difference between the two is zero, no matter what portion of the wave passes over the loop. Hence no signal voltage at all is picked up. This is the position of the loop which gives zero signal. The position is critical, and for that reason it is used in direction finders and compasses. The slightest tilt from the position of perpendicularity with the direction of the signal will bring in a signal.

Discovering Noise Sources

It is this property of the loop which is used in tracing down electric disturbances to their source, as well as to locate ships at sea. Suppose it is required to locate a source of waves, whether these waves proceed from a transmitting station or a source of noise. Set up any receiver provided with a loop somewhere within reception range of the waves. Let AB, Fig. 3, be the position

# of Picturing Radiation

Anderson

ditor

and down rapidly, the line of force will be a wavy curve, and that the wave travels outward with the velocity of light. This picture of the production of a radio wave is capable of mechanical comparison.

Suppose CD is a very long stretched wire and that E is a small bead, such as a lead pellet attached to the wire. If this pellet is caused to vibrate in the vertical line AB very rapidly, the wire will become wavy and the waves will travel outward along the wire. It is assumed that the wire is so long that its ends cannot affect the motion, for if the wire is of finite length the wave will be reflected from the end and come back as an echo.

A Well-Known Experiment

There is a well-known experiment in physics which illustrates this point, known as Melde's experiment. A long string is stretched by a weight over a pulley. One end of the string is connected to a tuning fork. When the fork is set into vibration and the tension on the string is adjusted properly the string assumes a wavy form. The waves are reflected at the weighted end and a series of loops and nodes appear on the string.

Standing radio waves also can be set up. If very short radio waves are set up—a few inches in length—and if a large sheet of metal is placed at a distance from the source, or radiator, the waves are reflected from the metal sheet and a series of loops and nodes are set up in the space between the oscillator and the plate. While these nodes cannot be seen they can be detected by a suitable radio receiver. This was one of Hertz's original experiments, proving that radio waves exist.

Another way of illustrating the radiation of electric waves is to stretch a large sheet of thin rubber like a very large drum head. If a rod such as the driving pin of a loud speaker is attached to the centre of the rubber sheet, and this in turn is caused to vibrate at right angles to the plane of the rubber, a set of waves will be seen in the rubber sheet, provided that the vibration is fast enough and not so fast that the waves would be too small to be visible.

Looking Down on Field

This stretched drum head of very large dimensions appears somewhat like a horizontal section of the electromagnetic field about an antenna. The magnetic field about the antenna would be circles concentric with the antenna, just like the circular waves in the drum head. The direction of the wave would be radial at right angles to the circles. This is shown in Fig. 2. E at the centre represents the vibrating electron, or a cross section of the antenna wire at the point where the electron is. The direction of the electric field is at right angles to the plate of this figure, or parallel to the motion of the electron.

Another cross section of the field is shown in Fig. 3, which is a vertical section made by a plane passing through the antenna. The antenna is shown in the centre as the line AB. The curved lines represent the direction of the electric force. This represents the steady condition; that is, when the antenna is charged, or it represents the force when the electron has been displaced farthest in one direction. To represent the case when the electron is vibrating rapidly, lines of electric force would have to be represented by semi-loops, closed at the top and open at the ground.

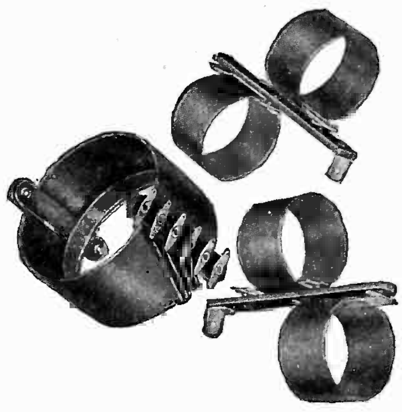
Images in the Ground

The ground is supposed to be a perfect conductor. As such it is also a perfect mirror. This means that every feature of the electromagnetic field above the ground has an image counterpart in the ground. There is an image of the antenna, of the magnetic circles of force and of the electrical loops of force. Thus the loops are actually closed at both ends if the image is considered a part of the actual field.

This image in the ground does not mean that an equal radio wave radiates into the ground. No power is represented in the image at all. The image is no more real than the person back of a mirror.

But the ground is not a perfect conductor, or mirror. In so far as it is not, radio waves enter the ground. But that part of the wave which actually enters is not like the real field above the ground. It has a different shape and the wave that enters the ground travels at a slower velocity than the air wave. When some of the energy from the antenna enters the ground the reflected portion, or image, is made more feeble. It is the wave which actually enters the ground that is used in geophysical exploration of mineral content in the ground.

Hammarlund Coils Permit Band Filter



A set of three space-wound coils for use with .00035 mfd. "Midline" Hammarlund condensers was designed for use in the new Hammarlund-Roberts "Hi-Q 29" Master receiver, one of the outstanding hits of the season. The coils also have been found by engineers and fans to be very desirable for experimental circuits.

The antenna coupler primary has three taps brought out to convenient soldering lugs, permitting wide variation in antenna coupling to meet all aerial requirements.

The radio frequency transformers are designed for special band selector circuits in which both the grid and plate circuits are tuned. Used in shield-grid tube circuits these coils permit high and uniform amplification over a narrow frequency band closely approaching the ideal flat-top, square cut-off tuning curve. These coils are the result of long and careful research on the part of Hammarlund engineers and will give the best results in any circuits wherein they are used. The code number is HQ-29 and the list price is low for the set of three coils. No fan, custom-set builder or dealer should be without the complete catalog of Hammurlund precision parts which is sent for the asking. Write for it today. Address the Hammurlund Manufacturing Company, Inc., 424 West 33rd Street, New York City. Mention RADIO WORLD.—J. H. C.

ference with the Aid of a Loop

of the loop. Turn the loop until the signal disappears in the receiver, or until it is minimum. It is then known that a line passing through the centre of loop, at right angles to the plane of the loop, also passes through the source of the waves. Let CD be this line. Draw this line on a map of the region. Although only one point on the line is known, its direction is known, and with the help of a magnetic compass the line can be drawn.

Having found one line, move the loop to another location, or use another loop receiver in the other location. Tune in the same signal at that point and adjust the loop until the signal disappears or is minimum. Draw another line just as before. Let A' B' be the new location of the loop and EF the new line. The source of the signal must also lie on this line. But the two lines CD and EF can only have one point in common, the point of intersection. That point is the location of the source of the signals or noise. That point is given by P. in Fig. 3.

Disturbing Factors

Since there will be many disturbing factors which will give spurious results it is not absolutely certain that the indicated point is the actual source of the disturbance. When ships are to be located the disturbing factors are usually known and can be allowed for. But if a source of noise is to be located the disturbing factors are not known. Hence the indicated point gives only an approximate position of the source of noise. The loop receiver can then be moved closer to the indicated point and other observations made. For example, observations may be taken all around the indicated point. The second set of lines will remove the uncertainty or it will confine the possible source of the noise to a very small area.

If all the lines point to a power house it is reasonably certain that the noise comes from some machine or device inside. If they point to a pole with a transformer on it, that is probably the seat of the noise. Or if they point to an antenna it is probable that that antenna is radiating the noise.

The same procedure is used by Federal radio inspectors in locating unlicensed stations, or any licensed station which is violating regulations.

The Five Components

Pointers on Front and Subpanel

By Herman

Managing

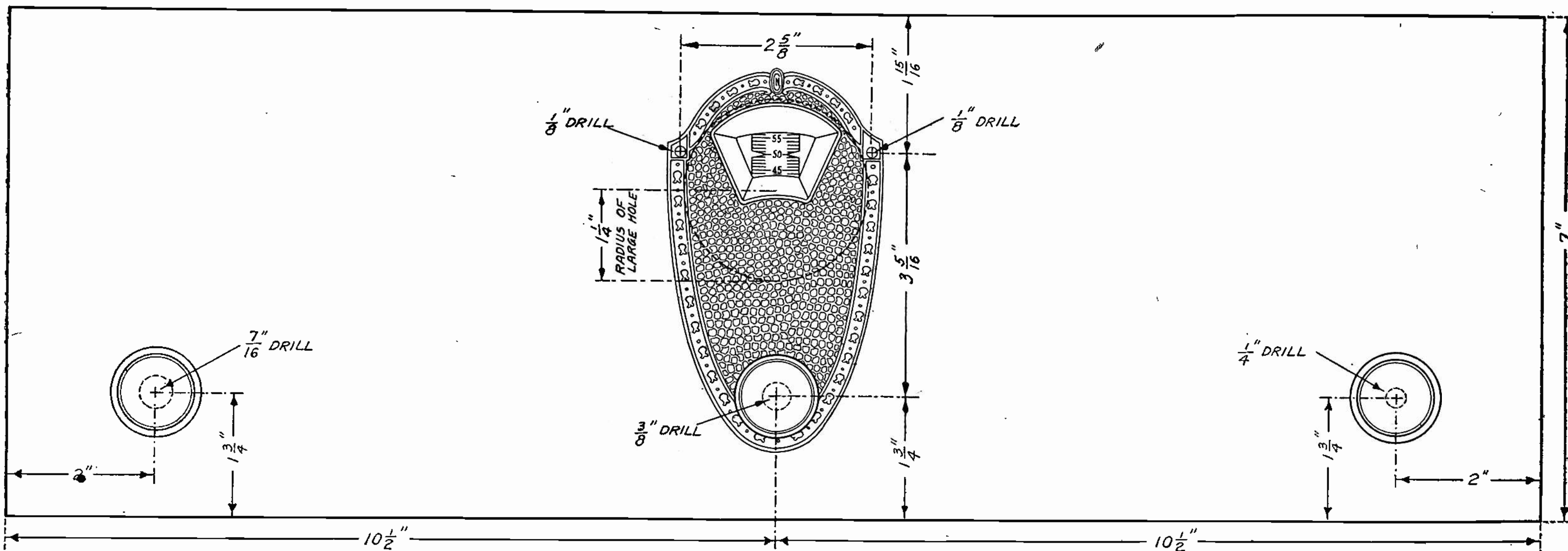


FIG. 3. HOW THE FRONT PANEL IS PREPARED. THE COMBINATION VOLUME CONTROL AND AC SWITCH IS AT LEFT, THE NATIONAL DRUM DIAL PLATE AT CENTER, AND A DUMMY KNOB "AT RIGHT TO KEEP UP APPEARANCES."

THE five components of the AC4 are the front and subpanels, the filament transformer, the B eliminator and the two-way AC socket.

The pilot light PL is an extra part of the dial equipment (50 cents extra), and should be included in every AC4 that is constructed, for not only is this a pilot light, or telltale lamp, warning against accidentally leaving the set turned on, but it brightly and fetchingly illuminates the scale, by shining through the translucent celluloid.

Dummy at Right

At extreme right is a dummy shaft, secured at rear with a collar equipped with setscrew, while at front is affixed a knob to match the one on the volume control switch. No bracket screws protrude through the front panel to mar its neatness, for the front panel may be slipped into a perpendicular groove with which most 7x21x12 inch cabinets intended for all-electric circuits are equipped.

Even if no groove is in the cabinet the panel may be put in place in the "frame," and will be held tight by the mounting of the tuning condenser to the drum dial and the mounting of the chassis to the floor of the cabinet. Since an attractive walnut cabinet, with groove for front panel, and equipped with nickeled self-locking piano hinges, may be obtained for about $8, there is no deterrent to the possession of an adequate cabinet.

The placement of the coils, two section tuning condenser, sockets, audio transformer, bypass condensers, etc., was shown diagramatically last week, issue of January 19th, the full lines denoting those parts atop the chassis, the dotted lines those parts placed underneath. A commercial subpanel is obtainable, with sockets affixed, with holes drilled for other parts, and it is convenient indeed to avoid a lot of drilling by obtaining one of these, although any one desiring to prepare his own subpanel and front panel need not hesitate for lack of details.

Exact conformity of coil placement with the stated dimensions is absolutely essential, otherwise the good results re-

[The technical reasons for the selection of the AC4 as a design well worth following exactly, and a statement of some of the accomplishments of this receiver, in distance reception, tone quality and ease of control, were set forth last week, in the first installment of this article. The AC4 uses three heater tubes, type 227, and one 171 or 171A as the output tube. The circuit is the first AC design to come from the laboratories of Herman Bernard, whose illuminating article gives persuasive reasons why you should build this receiver. Part II of his article follows herewith and more details about the AC4 will be published next week, issue of February 2d.—EDITOR.]

ported last week, as to selectivity and distance, need not be expected. One of the few secrets of the success of this receiver is the relative and absolute positions of the coils.

No mention has been made until now concerning the method of securing the subpanel, nor of the elevation of the supporting brackets. The subpanel or chassis has six right angle brackets (included as part of the kit hardware) so that rigidity is attained. When you insert or remove tubes the whole platform does not sag or lift, as it does in many another kit-set. The chassis remains rigid, as it should, since the support is maintained at six points, rationally distributed. Wood screws, long ones, pierce the subpanel from the top and anchor the subpanel in place.

No Trouble from Hum

The National audio transformer, a new product, is mounted in an unusual way—instead of on its feet it is on its side, maintained thus by two more brackets. This is not a fancy trick but a real advantage, since the fields of the power transformer in the adjacent B eliminator and in the audio transformer itself are thus at magnetic right angles, avoiding inductive coupling that would bring about hum.

Indeed, every precaution was taken against the production or introduction of hum, and it is safe to say that scarcely any AC electric receiver exists that has a smaller hum component than the AC4.

It is almost impossible to tell, from mere listening for hum, whether the receiver is all-electric or all-battery operated. Personally I would be inclined to venture it is all-battery operated, only I happen to know better! This is no warning, either!

The 2.5-volt filament transformer secondary should be able to carry without any self-heating at least 7 amperes, although only 5.25 amperes are drained by the heaters of three tubes. Each heater of a 227 tube draws 1.75 amperes at 2.5 volts. The 5-volt secondary, for heating the pilot light and the power tube (either 171 or 171A), should be able to stand 1.5 amperes without any self-heating, although only .5 ampere is drawn for a 171A and a pilot lamp, or .75 ampere for a 171 and a pilot lamp. Actually the pilot light at 5 volts draws about .2 ampere, rather than .25 ampere.

Usually the regulation is better with filament transformers that have abundant reserve, whereas those wound with small wire, close to the utilization point in their capacity, are fickle, because of heat, which changes the wire resistance.

Where Filament Transformer Goes

The filament transformer is placed at the rear of the subpanel, not on it, however, and is about in the center of the cabinet rear. To its right is the B supply.

Holes are drilled in the subpanel so that leads may be brought up directly to the binding posts of the National Velvet-B. These leads are cut to fit, and capped either with fish-hook or forked lugs. There are five such leads—as was shown in the subpanel construction layout last week—and they are (B minus), 22 to 45 volts adjustable, 67, more or less; 90 or less and 180. The only non-adjustable voltages are 0 (B minus) and 180.

Of course these voltages, inscribed on the B supply, are merely indicative, and not adamant. The voltage at all points except at zero depends on the current

of the New AC 4

Filament Transformer, B Supply and AC Socket

Bernard

Editor

drain through the resistor which is built across B minus and B plus 180, and on the drain at any intermediate voltage where the current traverses the part of the resistor from B minus to the utilized tap.

The adjustments are made by finger-point sliders that protrude through the bakelite terminal strip built into the B supply.

Voltages Measured

As an actual measurement, with an AC input of 111.5 volts, under full-range, adjustment were: 0; 21 to 42 volts; 30 to 50 volts; 50 to 85 volts; 185 volts. I hasten to add, however, that the lower voltages scales fell short a bit because I was working the B supply for 30 milliamperes extra, at 50 volts, to energize the field coil of a DC type dynamic speaker.

There is nothing critical at all in these intermediate voltages, therefore, without the extra 30 mil drain, you will obtain approximately the labelled voltages.

Some variance from marked voltages must be expected. It is hardly possible to have any B supply that gives exactly the same voltage in every installation, since not only will the drain vary, but the AC line voltage is not an absolute constant, nor the potentiometer network always identical. These words are written to comfort those not experienced in B supplies and who get alarmed when their voltmeters (usually wrongly of the low resistance type) give unexpected and indeed often inaccurate readings. Mine were taken with a high resistance voltmeter of 1 per cent. accuracy, plus or minus.

The AC Socket

The multiple AC socket is the last of the five components. This should be of the mountable type, so that a screw may be put through a hole at either end of the device, and driven home through part of the interior cabinet wall.

The AC socket may be put at the left side, or at the rear, next to the filament transformer, the AC cables of the filament transformer and the B supply being cut, to keep the AC leads at a minimum length.

The male plug is then removed from the severed piece and carefully attached to the new end, no strands being permitted to spray out, for they might strike the opposite prong, and short the line.

Insulate the wire to the very point of connection, and preferably twist the bare end of the wire to form as narrow a strip as possible, and wind a circlet, fixing it with a bit of solder. Then bring bicycle tape right, torn to ¼ inch width, right up to the circlet, even beyond the solder, and tighten down the screw. As the screw is usually not removable, the circlet will have to be twisted around the screw before the soldering is done.

[*Other constructional details will be taken up next week, issue of February 2d, including pointers on actual wiring. The location of the switch and the ground connection will be expounded. Later the circuit diagram and interior and other views of the B supply will be published.*]

Wires as Guides of Electrical Energy

By Montgomery Fairchild Spendworth

It is generally thought that an electric current travels in a conductor. When this view of the transmission of electrical energy is taken the transmission of radio signals seems to be a mystery not related to wire transmission. But there is another way of looking at the transmission of electrical energy by wire, and that is to suppose that it travels in the space around the wire rather than in the wire itself. The wire then merely becomes a guide. When this view is taken of the phenomenon, wire transmission is simply a special case of the general transmission of electrical energy through space.

Open Power Line

Suppose there is an open power line along which a direct current travels. The return conductor is the ground, or a wire which is grounded at intervals. There is a moving electric field all around the open wire. And because there is a moving electric field, there is also a magnetic field around the wire. It is customary to say that the electric field around the wire is radial and that it is symmetrical around the wire, and also that the magnetic field is circular concentric with the wire. But that is not true because the wire is not alone in space.

The wire and the earth constitute the circuit and the electric field around the wire terminates on earth. There are only two lines of the electric field that are radial. One is that which is directly under the wire, which goes straight to earth. The other is that directly over the wire, which goes on to infinity. All the other lines of electric force leave the wire and find their way to earth by curved paths. In the region directly under the wire the lines of force are crowded but farther away they are farther apart.

An Analogy

An analogy will help to conceive the distribution of the electric force. Suppose the wire is a hollow water pipe parallel to the ground and that this pipe is perforated with minute holes distributed equally around the wire. If the pipe is filled with water under high pressure a tiny stream of water will squirt out of each hole. The stream from a hole directly under the pipe will go straight to earth. Streams from holes on the sides will shoot out sideways but ultimately they will go to earth in curved lines.

Water Different

This analogy fails to represent the electrical case in that the water which is shot upward will rise a certain distance and then fall through the other streams. No two electrical "stream lines" can cross each other. Those that are shot upward do not stop and return but keep on until they can reach the earth without crossing any other. The one that goes straight up has to travel forever without getting a chance to get to earth.

The magnetic lines are everywhere at right angles to the electric. Since the electric lines are not radical the magnetic lines cannot be circles concentric with the wire. They are circles but the center moves higher and higher. The circle passing near the earth has its center at an infinite distance above the wire and hence the lines of magnetic force near the earth are straight lines parallel with the surface to the earth.

Circles Near Wire

The magnetic lines near the wire are circles concentric with the wire, because near the surface of the wire the electric lines are radial. That is the electric lines all leave the wire at right angles to the wire.

The electric current "in the wire" is simply a motion of these electric lines to force between the wire and the earth, and the magnetic lines, or circles, which result from the motion of the electric lines.

If the current in the wire is alternating the electric lines and the magnetic circles disappear when the current is zero, and as the direction of the current reverses the lines reverse direction. When the wire is positive with respect to earth the electric lines leave the wire and go to earth. When the wire is negative the lines leave the earth and go to the wire. As the current varies in intensity the number of lines vary in number, so to speak, or in intensity.

The magnetic circles are always in the same position but the force in any circle varies in direction as the electric lines change direction.

Mechanical Force Present

The electric lines between the wire and the earth behave somewhat like rubber bands stretched. That is they try to shorten. Hence they exert a mechanical pull on the wire. When a current flows in the wire the poles holding the wire up have to be just a little stronger than when no current flows.

The tension in the electrical lines between the earth and the wire is proportional to the potential difference between them, that is to the voltage of the overhead wire with respect to ground. If this voltage is too high it may be that the lines will "break." Then there is a short circuit or a flash. Of course this does not happen except where the distance between the ground and the wire is small. It might happen at a pole, or at any place where the wire comes near to a tree or where it sags too much.

HERTZBERG IN NEW JOB

Robert Hertzberg, managing editor of "Radio News," resigned to go with Pilot Electric Mfg. Company, of Brooklyn, N. Y. He also plans to devote considerable time to free-lance writing.

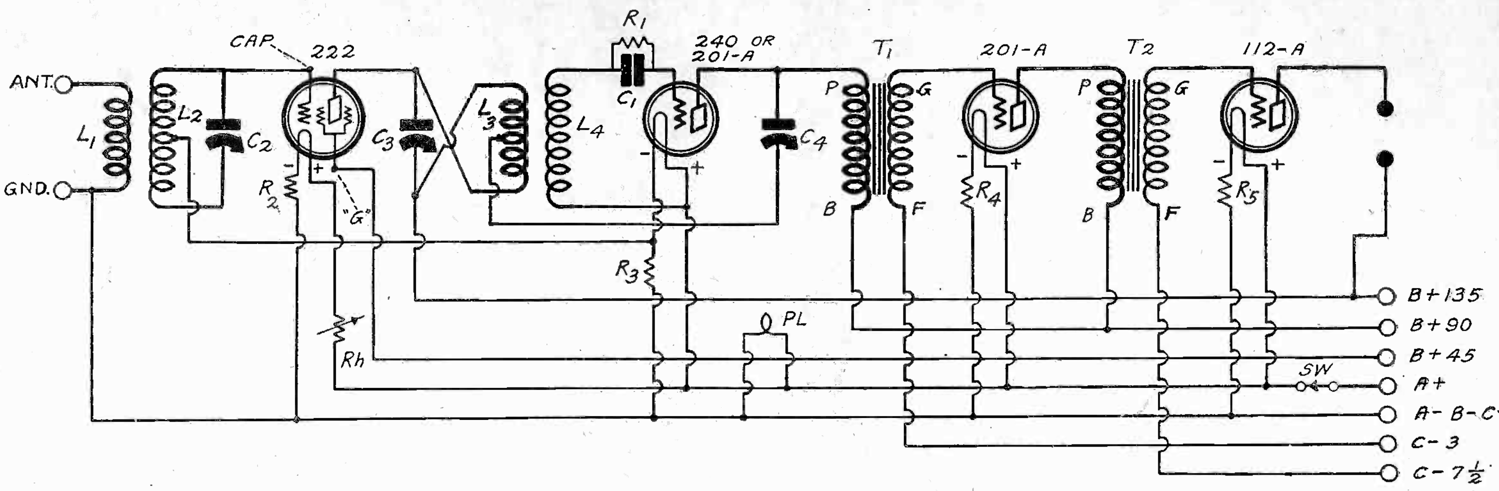


FIG. 726. THE CIRCUIT DIAGRAM OF THE UNIVERSAL SCREEN GRID DIAMOND, A VERY SENSITIVE AND SELECTIVE RECEIVER. CIRCUIT REQUESTED BY PATRICK MAHONEY.

Radio University

A QUESTION and Answer Department conducted by RADIO WORLD, by its staff of experts, for University members only.

When writing for information give your Radio University subscription number.

IS THERE any way of stepping up the voltage of a B battery eliminator from 220 volts to 1,000 volts?

(2)—Would it be possible to connect two B battery eliminators in series so as to get the sum of the voltages of the two?

KURT KAPPEL,
St. Louis, Mo.

(1)—No, there is no way.

(2)—Yes, it is possible. Connect the plus of one to the minus of the other and use the two remaining terminals as the plus and minus of the combination. If any by-pass condensers are connected across the entire circuit they must be designed for the higher voltage.

* * *

PLEASE DESCRIBE a simple wave trap and tell how it should be used to cut out an interfering station.

SAMUEL COHEN,
Jamaica, Long Island.

(1)—Put 43 turns of No. 22 DCC wire on three-inch diameter bakelite tubing 2½ inches long and connect a .0005 mfd. condenser across this winding. Also put 12 turns of the same wire on the tubing and connect this winding in the antenna circuit. Tune the condenser until the interfering signal disappears, or until is is minimum. Accurate tuning is necessary.

* * *

I WISH TO BUILD a six-tube receiver having four tuned circuits and incorporating five -27 tubes and one -71A tube. Could such a receiver be built successfully?

(2)—If convenient will you please publish a diagram of such a circuit?

(3)—Which is better, an output transformer or an output choke?

PAUL INGALLS,
Toronto, Canada.

(1)—Yes, such a circuit could be built without much difficulty. The only question is the prevention of oscillation in the RF amplifier. This can be solved by the use of grid suppressors and by shielding the tuned stages.

(2)—You will find the diagram of such a circuit in Fig. 725.

(3)—There is little difference between the two. The choke and condenser method has the advantage that the signal current may be kept out of the plate voltage source by returning the speaker to the filament. This cannot be done with a transformer.

* * *

I AM UNFAMILIAR with radio. I read a great deal and hear a great deal about electric sets. What are they exactly. They need no batteries, I read. Also I am told, or rather imagine, they need no aerial and no speaker. Please set me straight.

OSCAR BURR,
Quebec, Ont., Canada.

An electric set is one which operates without batteries by employing house lighting current. The AC electric set uses reduced-voltage alternating current to heat the tube filament or cathode, and rectified AC of high voltage to supply the plates. The rectified voltage and current are DC, the object of the rectifier being to make them so. The other type of electric set is the DC type, where the house current is direct current. The filaments are heated by this current, which is reduced to proper values by a resistor. The 110 volts or thereabouts (the line voltage) are supplied to the plates. There is nothing to the belief that the aerial is eliminated, or the speaker either. All sets need some sort of aerial and always will. The idea no speaker is needed on an electric set arises from the fact that many such receivers are in consoles that have the speaker concealed. Another idea, that the AC or DC electric set uses no battery eliminator also is fallacious. The AC electric has a special B eliminator built in, while the DC electric filters and chokes the rippling DC line voltage and current to make them pure enough to serve as plate supply, and that's an eliminator, too.

* * *

WILL YOU PLEASE publish a circuit diagram of a sensitive and selective four-tube receiver using one screen grid tube and transformer coupled audio?

(2)—Will a 112A tube in the last stage give good loudspeaker volume with only 135 volts on the plate?

(3)—What is the best method of adjusting the plate voltage applied to the different tubes in a receiver when using a B battery eliminator?

PATRICK MAHONEY,
Boston, Mass.

(1)—Fig. 726 gives a diagram of a circuit such as you request. It is that of the Screen Grid Universal, which has given very good results. It was described in the December 1st, 8th and 15th issues of RADIO WORLD.

(2)—Yes, it will give good loudspeaker volume.

(3)—With the aid of a high resistance voltmeter. The voltage cannot be varied unless the voltage divider in the B battery eliminator is provided with variable resistors or many taps.

* * *

I HAD BEEN LED to believe that my volume would be greatly increased by using a 250 type tube in place of a 210. Consequently I purchased one and made the substitution. Now I don't get nearly as much as I did before. Why is the claim made that the 250 tube gives more volume when it does not give as much?

RALPH WHITING,
Oakland, Calif.

(1)—You are confusing amplification with volume. The 210 is a much better amplifier than the 250 because the amplification constant of the 210 is nearly 8 while that of the 250 is about 3. That accounts for the lower volume, as you call it, which you get with the 250 tube. But the 250 tube will give several times as much undistorted output power as the 210, provided that you put the required signal voltage into it.

Whims of Short Waves

R. C. A. Expert Reports on Some of His Experiences

AT a meeting of the Radio Club of America, held recently at Columbia University, H. E. Hallborg, communications engineer of the Radio Corporation of America, presented a paper entitled "Seasonal Variations in Short-Wave Transmission."

This paper covered graphically seasonal variations observed in long-distance short-wave communication circuits in various spots of the world over a year's period. "The most fascinating factor in long-distance short-wave communication is not the transmitting equipment, nor the receiving equipment, but rather that most intriguing and baffling medium which intervenes between the transmitter and the receiver which we call the ether," said Mr. Hallborg.

Calls Layer Not Proved

"Much has been written on the function of the Heavyside layer in short-wave transmission. The heights of the upper ionized layer have been studied by a great number of workers under various conditions, and many of the variables involved have been recorded. It is to be noted, however, that the existence or non-existence of a reflecting layer is still a mooted scientific question. We shall use the term 'medium' in view of our practical rather than scientific analysis.

"Our existing knowledge of this cosmic medium is all too meagre. Many of its major characteristics are obtained only after years of observation and measurement in commercial service."

Mr. Hallborg compares the path of radio waves to the path of a projectile in flight. A projectile in flight follows a curved path due to the combined effects of initial power, air friction and the law of gravitation. A radio wave similarly follows a curved path due to the combined effect of frequency input power and a variety of other factors.

Frequency Determines Distance

The distance which a gun may shoot is determined to a certain extent by the elevation of its muzzle. The distance that a radio wave will reach is likewise determined to a great extent by its frequency or wavelengths. Shortening the wavelengths (increasing the frequency) is therefore equivalent to increasing its angle of elevation. By angle of elevation is meant the trajectory of the wave in space.

"There is this significant difference between the flight of a projectile and the track of a radio wave: the elevation of the gun cannot be raised sufficiently high to prevent its return; the elevation or frequency of the radio wave may be made so high that it does not return to earth.

"The high angle radio wave consequently assumes the characteristic of light travelling in straight lines normal to the radiating surface. For these reasons radio waves below 5 meters (60,000 kc.) are normally not audible at distant receiving stations on the earth. It may happen, however, that these high radio frequencies (below 5 meters) occasionally may be brought down to earth by abnormal cosmic conditions, but this must be considered as a freak condition in the present state of the art."

The Earth's Photo-Electric Condition

The processes of short-wave transmission may be looked up as being controlled by the earth's photo-electric condition, that is, by the relative amount of light and darkness in the path between transmitting and receiving stations, said the speaker. As the amount of current that will flow through a photo-electric cell is determined by the amount of light which strikes the cell, so the amount of energy at a given frequency that will pass between sending and receiving stations is determined by the relative ionization or illumination of this medium.

"It will be apparent that the shorter wavelengths will require high ionization to bring them down to earth," he continued. "Consequently, they will be daylight waves. The longer wavelengths having lower elevation would be more effective at night when the ionization of the signal track is low. The seasonal characteristic is determined by the relative distribution of light and darkness over the path throughout the year and will vary in different latitudes."

A considerable difference in the actual hours of signaling has been found to exist in North-South transmission as compared with East-West transmission.

Effect of Ionization

The difference is ascribed to the greater variation in the ionization of the signal path for different months of the year in an East-West direction than there is in a North-South direction. Long-distance transmission in a North-South or South-North direction is more constant throughout the year for a given frequency since the path of the wave is through conditions of two seasons at all times and the twilight periods are relatively short. The total average ionization over the path consequently tends to be more uniform throughout the year.

The speaker also cited the following about trans-Atlantic communication:

A wavelength of 14.02 meters has been found to be inferior as a daylight wavelength to 16.17 meters, since its angle of elevation is too high for a circuit joining New York and Berlin (3,850 miles). It has been found, however, that 21.48 meters is a very good day wavelength in Winter, and a night wavelength in Summer. 43 meters has been found to be a very favorable trans-Atlantic night-time wavelength, both in Winter and Summer.

Another fact brought out by Mr. Hallborg which was the topic of much discussion by the members of the club was that of frequency separation for short-wave transmitters.

Point of Saturation

The long-distance short-wave stations of the world are at present separated by channel widths of .2 per cent. The increasing demand for channels is so great that it appears likely that a separation of .1 per cent will eventually be necessary. Even with this .1 per cent separation only 1,587 standard channels distributed among the nations of the world are available between 1,500 kc. (200 meters) and 23,000 kc., which is 13.11 meters.

There is a definite saturation point in the ultimate number of long-distance radio circuits and that the most stringent measures are necessary to keep each and every service in its own allotted channel.

Log of the Stations Produced by Bole

John Bole, director of Kits, Inc., 135 Liberty Street, New York City, has brought out a radio log covering the new wavelengths. It has space for dial listings with room for memoranda and gives the frequencies in kilocycles as well as wavelengths in meters. This concern has a permanent exhibit of new circuits and supplies kits and parts to fans and custom-set builders. It also conducts a testing, repairing and building service. Among the circuits shown are the Hammarlund-Roberts Master "Hi-Q" 29, the new Victoreen, Silver-Marshall and National. For further information on any of these or the radio log, address John Bole, at above address. Mention RADIO WORLD.

ANSWERED

JIM—Is Miss Banks a sensible girl?

JAM—She does the radio exercises every morning.

New Waves Used by British Stations

European broadcast stations have operated since January 13th under the international agreement known as the Plan de Bruxelles, which was worked out by the technical committee of the Union Internationale de Radiotelephonie. Under the new plan the stations of Great Britain and northern Ireland use the following frequencies and wavelengths:

Kilo-cycles	Wave Length Meters	Stations
192	1,562.5	Daventry 5XX
622	482.3	Daventry 5GB
748	401.1	Glasgow
793	378.3	Manchester
838	358	London
928	323.2	Cardiff
964	311.2	Aberdeen
991	302.7	Belfast
1,040	288.5	Relays and Bournemouth
1,230	243.9	Newcastle

New Schedule Effected for Short Wave Programs

A new schedule of television broadcasting is now in effect from the short wave stations of the General Electric Company, Schenectady, by W2XAD, operating on 19.56 meters, sends out television signals every Tuesday, Wednesday and Friday from 1:30 to 2 P. M. and every Sunday from 11:15 to 11:45 P. M. W2XAF, operating on 31.48 meters, broadcasts every Tuesday from 11:30 to 12 P. M.

Diehl Joins Jenkins

Philip H. Diehl has joined the Jenkins Television Corporation as treasurer. Mr. Diehl was secretary and treasurer of the Kelly-Springfield Motor Company. He has also been identified with the Pierce-Arrow Motor Car Company. C. E. Huffman has become chief engineer of the Jenkins Television Corporation.

The Advance of to Superb

THE development of audio frequency transformers to their present state of high quality has been a slow process. The first transformers used for broadcast reception were designed for code work. For this they were excellent, but were wholly unsuited for broadcast reception. The requirement for code work is that the transformers amplify much at that frequency at which the human ear is most sensitive and very little at other frequencies. Since the ear is most sensitive at about 1,000 cycles per second, the transformers were made to have a peak at that frequency. Headsets also were designed to respond at that frequency.

The audio transformer intended for code reception had a relatively high turns radio, often as high as 1-to-9. And this high ratio was obtained by using a small number of turns on the primary to get the total number of turns on the small forms used. This resulted in a low impedance primary winding and consequently very poor voltage transfer except at that frequency at which the transformer acted as a tuned circuit. That by design, or as often by accident, was made at approximately 1,000 cycles.

Sharply Tuned Circuit

The transformer so constructed acted very much as a sharply tuned circuit. There was practically no amplification at frequencies as low as 500 cycles and below about 250 cycles there was an actual voltage loss in the coupling unit. Again, at frequencies about 2,000 cycles there was little amplification and for higher frequencies there was a loss. The loss at the higher frequencies was due to the distributed capacity of the secondary as well as to the capacity between the windings.

When these transformers were put into circuits designed for broadcast reception the resulting quality was atrocious. The use of loudspeakers or headsets which had the same characteristics did not help in the least.

The first step to improve the amplification characteristics of the coupling transformers was to decrease the ratio of turns. This was done both by increasing the number of turns on the primary and by decreasing the number of turns on the secondary. This change did not necessarily decrease the amplification obtained from a tube and one such transformer. The higher impedance of the primary resulted in a more effective voltage transfer from the tube to the transformer, and this in part compensated for the lower ratio.

The gain was particularly high at the lower frequencies, but also at the higher frequencies there was a gain in the amplification due to the decrease in the distributed capacity and the more effective voltage transfer from the tube to the transformer.

The greatest gain by the change was the lowering of the peak at the middle frequencies.

Second Step Toward Quality

The second improvement in audio transformers was an increase in the dimensions of the core. The ratio of turns was held at from 1-to-2 to 1-to-4. The increase in the size of the core increased the primary impedance and hence increased the amplification at the lower frequencies. Transformers were good down to 100 cycles per second. The improvement at the higher frequencies was effected by changing the windings so as to decrease the distributed capacity and the magnetic leakage between the windings. That is, the windings were coupled more closely and at the same time the capacity was minimized.

As a further means of bringing out the lower tones the number of turns on both the primary and the secondary was increased. Transformers became fairly good at this stage and the loudspeakers were decidedly the weakest link in the installation. But the latter speakers were developed and the need of still better transformers became necessary.

The next step was the introduction of special steels for transformer cores. These steels had a high permeability, giving very high primary impedances for a given number of turns and a given core area. This change improved still further the low note response, and some transformers are now almost as efficient at 30 cycles as they are at 1,000 or at 2,000 cycles. There is practically no change in the amplification between these limits. These transformers at about 5,000 cycles and above show a very rapid drop in amplification.

But the location of the cut-off is very largely at the command of the designer of the transformer.

Saturation of Core

Steels having a high permeability, saturate magnetically very quickly, and when the core is saturated the permeability is very low. Saturation results from the direct current which flows in the primary. When the core is saturated the impedance is low. Hence the use of high permeability steel and a large number of turns on the primary defeats the purpose for which they are used. The only way to counteract this is to use a core with large area, at least the only way that has been used to any great extent. But the special steels are expensive and therefore a transformer which is large enough not to saturate is not only bulky, but it is very expensive.

A way of preventing saturation by the direct plate current has been suggested recently by Glenn Koehler of the University of Wisconsin, in a paper in "Proceedings of the Institute of Radio Engineers" for December, 1928. Before explaining the principle of this method let us consider the magnetic behavior of a transformer.

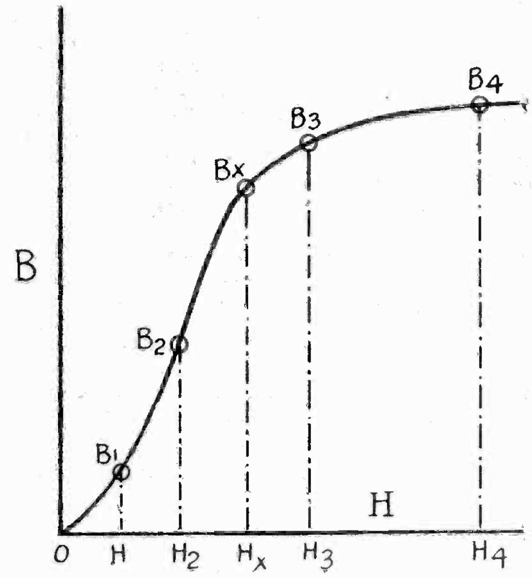


FIG. 1
GRAPH SHOWING THE RELATION BETWEEN THE MAGNETIZING FORCE OR AMPERE-TURNS, AND THE MAGNETIC FLUX DENSITY IN TYPICAL TRANSFORMER STEEL.

New third winding introduced as a bucking coil to prevent core saturation

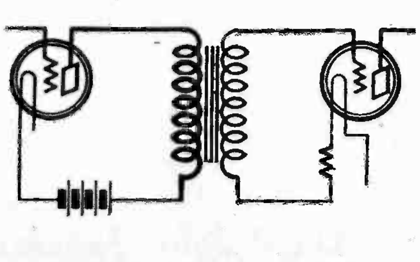


FIG. 2
THE ORDINARY METHOD OF COUPLING A TRANSFORMER TO A TUBE, WHICH ALLOWS ALL THE STEADY PLATE CURRENT TO FLOW THROUGH THE PRIMARY.

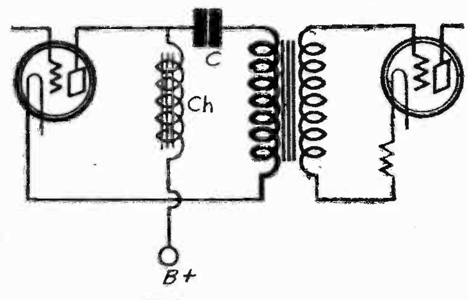


FIG. 3
HOW A CHOKE COIL AND A CONDENSER MAY BE USED TO KEEP THE DIRECT PLATE CURRENT FROM FLOWING THROUGH THE TRANSFORMER PRIMARY.

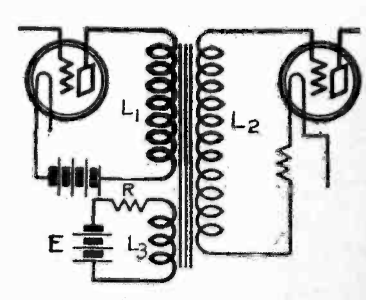


FIG. 4
SCHEMATIC DIAGRAM IN WHICH THE THIRD WINDING IS USED TO COUNTERACT THE EFFECT OF THE DIRECT CURRENT IN THE PRIMARY.

Transformer Design Performance

In Fig. 1 is shown a curve which is the relation between the magnetic force H and the flux density B. The flux density B is the magnetic flux per unit area of the cross-section of the transformer. The magnetizing force H is proportional to the ampere-turns of the primary. That is, it is proportional to the number of turns as well as to the current flowing. For a given transformer, H is proportional to the current alone, since the number of turns is fixed.

Permeability of Steel

The permeability of the steel, of which the curve in Fig. 1 represents the relation between the flux density and the magnetizing force, is the slope of the curve at any given point. When the magnetizing force is H1 the flux density is B1. At this point the slope has a certain value, which is the permeability at that flux density. As the magnetizing forces increases, the slope also increases, up to a magnetizing force H2 and flux density B2. At this point the permeability is maximum. At a magnetizing force H3 and flux density B3 the slope is considerably smaller than at B2. At H4 and B4 it is still smaller. Saturation may be said to have set in at B3.

Since H is proportional to the current that flows through the primary, the operating point on the curve depends on the current. If the current is low the operating point may be at H1. At this point the slope is not as great as it could be. Neither is the impedance of the primary circuit. If the current is larger, so that the operating point is at H2, the slope is greatest, as is also the impedance of the primary. This is the point at which any given transformer should be operated.

If the current is greater so that the operating point is at H3 or H4 the impedance of the primary is again much lower, and the efficiency of the transformer is impaired. For any given transformer the only way to lower the operating point to H2 is to decrease the current through the primary. But the transformer may be designed so that the operating point for any given current will fall at H2, or lower, by making the core suitably large. Or for any given area of the cross-section of the core and for a given current, the operating point may be made to fall at A2 or below by decreasing the turns.

Variable Flux

The signal current in the primary is a large portion of the total current. Thus it is not possible to operate the transformer at any given point but about a given point. Neither is it practical to operate about the point of maximum slope or permeability. To make the best use of the transformer the operating point should be at the point where H is zero. The swing may be as high as Hx or Bx, both in the positive and negative directions. Only the positive part of the curve is shown. When the core is operated about the zero point the positive and negative voltage loops in the secondary of the transformer will be equal because the curve is symmetrical about the zero point.

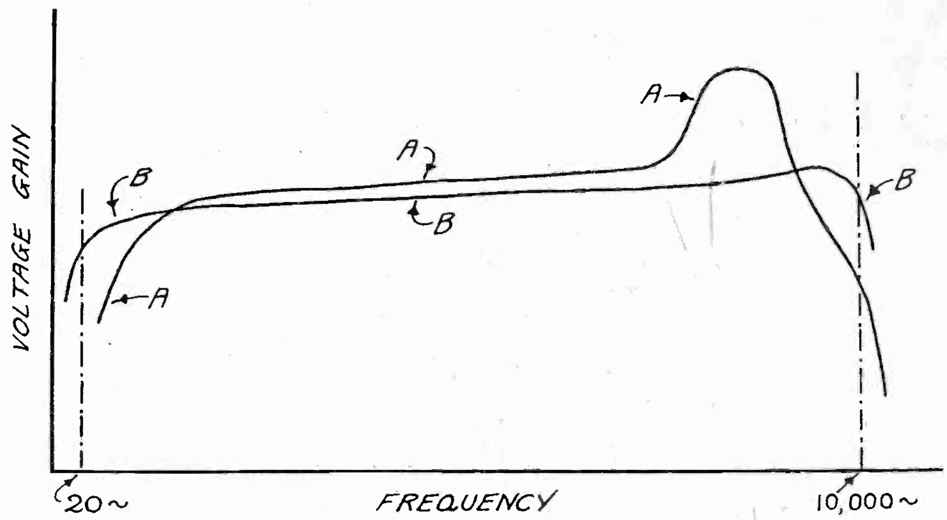


FIG. 5

TWO GRAPHS SHOWING QUALITATIVELY THE EFFECT OF INTRODUCING A THIRD WINDING IN A TRANSFORMER FOR BUCKING THE EFFECT OF THE DIRECT PLATE CURRENT. CURVE A IS RESPONSE WITHOUT THE THIRD WINDING AND CURVE B RESPONSE WITH IT.

The only way to operate the transformer at the zero point is to eliminate entirely the effect of the direct current in the primary.

The ordinary connection of a transformer is shown in Fig. 2. All the direct plate current flows through the primary. If this current is high the operating point may be at H4, B4. Then the transformer distorts the signal considerably both as to wave form and as to frequency response. If the current is less, so that the operating point is at H2, B2, there is little frequency distortion, but there is still some wave form distortion. If the current is so small that the operating point is H1, B1, that is some distortion of both forms.

In Fig. 3 is a connection of the transformer which eliminates the effect of the direct current entirely. That is, it makes the operating point on the B, H curve at zero. While H2, B2 is the best operating point for very small signal voltages, the zero point is preferable for larger signal voltages, such as are likely to be met in the transformer.

The circuit in Fig. 3 has several disadvantages. In the first place, two extra parts are necessary, a choke coil Ch and a condenser C. These add to the bulk and the cost. In the second place, both of these parts tend to discriminate against the lower frequencies and in so doing defeat one of the purposes of using them. Furthermore, what wave form distortion is eliminated by keeping the direct current out of the primary of the transformer is introduced by the choke coil, for this, too, has an iron core which may become saturated. Nevertheless, some improvement is effected in the performance by the introduction of Ch and C if the choke is suitably designed and the condenser is large enough.

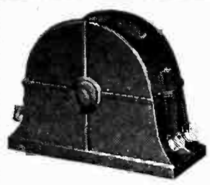
Let us now turn to Fig. 4, which illustrates the method suggested by Mr. Koehler. This strikes a new note in transformer design, and transformers based on this principle undoubtedly will be made available soon.

The transformer contains three windings. L1 and L2 are the usual primary and secondary windings. L3 is a compensating winding. Its sole purpose is to carry a current which will exactly neutralize the effect of the direct current through L1. The magnetizing force of the ampere-turns of L3 is equal and opposite to the magnetizing force of the steady ampere-turns of L1. If the voltage E, the resistance R and the turns on L3 are adjusted to the proper value, the operating point of the transformer will be at zero.

The question arises as to whether this arrangement is any better than that which employs a choke coil and a condenser. An extra winding is needed on the transformer. But this does not necessarily mean that the transformer has to be bulkier because the use of the winding with its current reduces the necessary size of the core. A resistance is necessary to adjust the current to the proper balancing value, as well as for another reason. But this resistance may be in the wire itself so that no external resistance is necessary. A source of voltage E is also necessary. But this may be the same as that which supplies the current to the plates of the tubes. Hence, it would seem that all is gain.

But that is not quite so. A coupling transformer is supposed to have an open secondary and no short circuited turns. That is, it is supposed not to require any power except that which is used to magnetize the core. But the third winding is necessarily closed. Hence, an alternating current will flow in it. This will lower the impedance of the primary winding, and hence it seems that we come back to where we started.

But there is a very great gain. The desired gain is at the low frequencies—from 100 to 20 cycles. In this region there is a considerable gain in the amplification. At the middle frequencies there is a slight loss. But at the very high frequencies there again may be a gain, mainly because of special precautions in winding. The improvement is shown in Fig. 5.—J. E. Anderson.

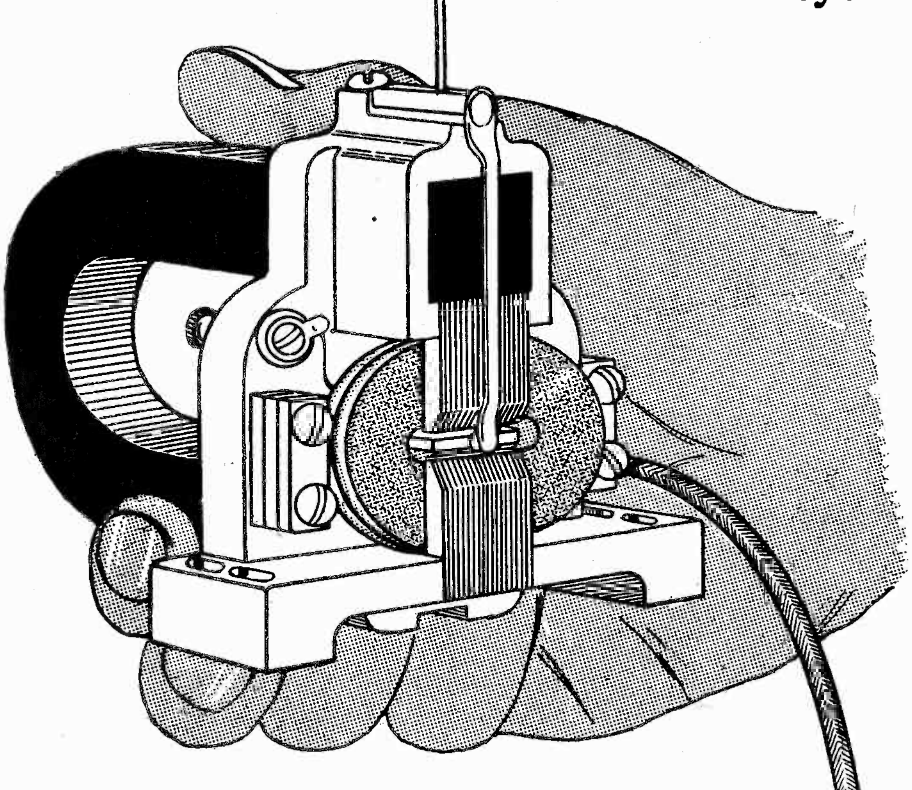


VICTOREEN
Super Coils
Write for Free Blueprints of New Victoreen Circuits
Geo. W. Walker Co.
2825 Chester Avenue
Dept. B Cleveland, O.

Blueprint of the
AC4
Price $1.00
RADIO WORLD
145 W. 45th St., N. Y. City

HBH Unit

Partial Payment Plan and Money-Back Guaranty!



Manufactured Under BBL License

GUARANTY RADIO GOODS CO.,
143 West 45th Street, N. Y. City
(Just East of Broadway)
Check off proper squares below:

☐ Please ship AT ONCE on 10-day money-back guaranty one HBH unit with 10-ft. cord at $5.50. I will pay postman $4 plus postage; balance of $1.50 in 90 days.

☐ 65c extra for moulded metal tri-foot mounting bracket.

NAME ....

ADDRESS ....

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

IF you are looking for a unit that gives you MOST volume, NO trouble, FINEST frequency response and MOST rugged construction, order an HBH Unit (illustrated). This is supplied with 10-ft. cord. Price $5.50. Pay postman only $4, plus little extra for postage. Try this unit for 10 days. If not delighted, return it in that time and get your $4 back promptly. If you keep the unit pay the balance of $1.50 in 90 days.

10-DAY MONEY-BACK GUARANTY

FERRANTI
Radio Products for *Real* Reception

Highest quality heavy duty audio and output transformers for power and general purpose amplifiers.

High grade iron core chokes for "B" Eliminators. Three range portable meters. 1,000 ohms per volt. 10/50/250 scale. Three range portable meters. 200 ohms per volt. 150/7 ½ volt and 15 Mill. scale with switch. By-Pass condensers—2MF—200 volt and 400 volt.

Technical data and prices sent on request.

FERRANTI, Inc.
130 W. 42nd St., New York

Ferranti, Ltd. Hollinwood England	Ferranti Electric Limited Toronto, Canada

PARTS FOR THE AC 4

Complete Kit of Parts for the AC4, less B eliminator $36.75

Complete Kit of Parts for AC4, with National B eliminator (180 v.) including 280 tube $54.75

Complete Kit of Parts for AC4, with National B eliminator, 280 tube, cabinet, three 227 tubes, one 171A tube and Table Model Polo Speaker (nothing else to buy) $75.00

GUARANTY RADIO GOODS CO.
143 West 45th Street
New York City

COILS FOR THE NEW AC 4

Two AC5 (for .0005 mfd.) @ $1.50 each....$3.00
Two AC3 (for .00035 mfd.) @ $1.75 each.... 3.50

SCREEN GRID COIL CO.
143 West 45th Street
N. Y. City
(Just East of Broadway)

Quick Action Classified Ads
Radio World's Speedy Medium for Enterprise and Sales
10 cents a word — 10 words minimum — Cash with Order

SHIELD GRIDS. AC., $4.00; DC, $3.50; Raytheon Kino-Lamp, $6.00; 1929 kits. Write H. Davis, 230 So. Adams, Glendale, Calif.

I HAVE twelve dynamic chassis speakers—AC models—fine speakers, brand new. Be one of the lucky dozen to get these at $17.50. Guaranty money back in 5 days. P. Cohen, R 1214, at 143 W. 45th St., N. Y. C.

EIGHTEEN microfarads of capacity, using Mershon condensers that will not ruin, because they're self-healing in case of puncture. This large capacity gives stability and humless quality in a marvelous new B eliminator, using the —80 full-wave rectifier tube on 50-60 cycle 105-120 v. AC maximum output voltage at 35 milliamperes is full 180 volts for —71 or —71A power tube, or lower voltage may be used for —12 or —12A power tube. The voltages are (B—) (B+22 to 45 variable) (B+67 to 85 variable) (B+90 to 135 variable) (B+180). Size 6¼ inches high by 7 inches wide. Equipped with finger-tip adjusters and insulated binding post strip. Price, all built up in de luxe metal housing with crackled gloss finish, including tube, $18.00. Immediate shipment. Send remittance and we pay cartage. Order C.O.D. and you pay cartage—Custom Set Builders Supply Co., 57 Dey Street, N. Y. City. Tel., Barclay 8659.