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THE NEWSPAPER FOR
THE HOBBYIST OF VINTAGE
ELECTRONICS AND SOUND

# THE HORN SPEAKER

## AFTER-THOUGHTS ON SPEAKERS

Did you know as late as 1927 most radio manufacturers in this country favored separate speakers? The cone speakers of today, using the added power of 171 power tubes, operates so much better about ten feet away from the receiving set that the real radio fan will not buy a console with the speaker combined. The public likes the idea of having the speaker separate so that it can be carried from room to room. We do not now nor have we ever considered the built-in speaker successful. We have yet to hear a built-in speaker that equals an external one. We find them particularly weak in transmitting voice tones and will not stand the volume of the horn or cone. We find the public looking for tone quality above all and we do not think it can be obtained with built-in speakers. The average customer realizes that much better results are obtained with the speaker away from the set.

These are just a few comments that set manufacturers had to say about built-in speakers. We know that tubes presented a difficult problem in that era. Sound from the loudspeaker may vibrate a microphonic tube, resulting in uncontrolled feedback and producing howls and squeals in the loudspeaker. Tubes and elements were both large and vibration of loose elements in tube changes the characteristics and modulates the plate current. In effect the tube or tubes acts as a microphone. Electrically it is not always advisable to build the loudspeaker inside the cabinet.

Loudspeakers can be built into cabinets successfully and so shielded that no mecnanical or electrical couplings exist, the answers to this problem must be found in the results that we wish to produce from the standpoint of reproduction. The more we know about electro-accustics of the room in which the speaker is located, the more forcibly is brought to light the fact that the speaker must be portable, or at least capable of being located where it will give the best tonal reproduction. If the speaker is the open cone type, there is more uniform spread to the scund and a large circle of listeners will obtain more satisfactory and uniform results that can be expected when the speaker is built into the cabinet and has to operate through an opening in the side of the cabinet, thus having a pronounced directional effect. People located directly in front of such a speaker will receive a greater intensity of sound that those located at the side. The only reason why this effect is not more pronounced is the reflections from side walls, furniture, etc.

What the radio public will expect in the future from well-designed radio sets is a reproduction of speech and music that is as natural as listening to the original speech or music before the microphone of the distant station. One way to create this illusion is to have the loud speaker portable and so positioned in the room that it will give directly to the listeners of the same sensation that the original would give if present. Shades of our High-Fidelity speaker systems of today.

BY WILLIAM E. HEMBRICK
Route 1, Box 93A
Terra Alta,
West Virginia 26764

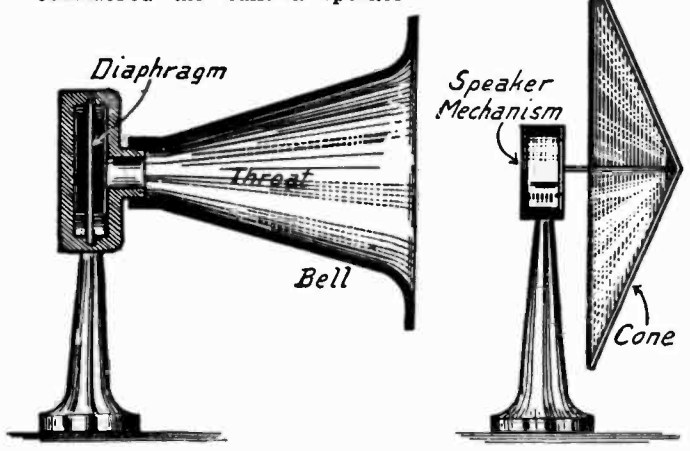
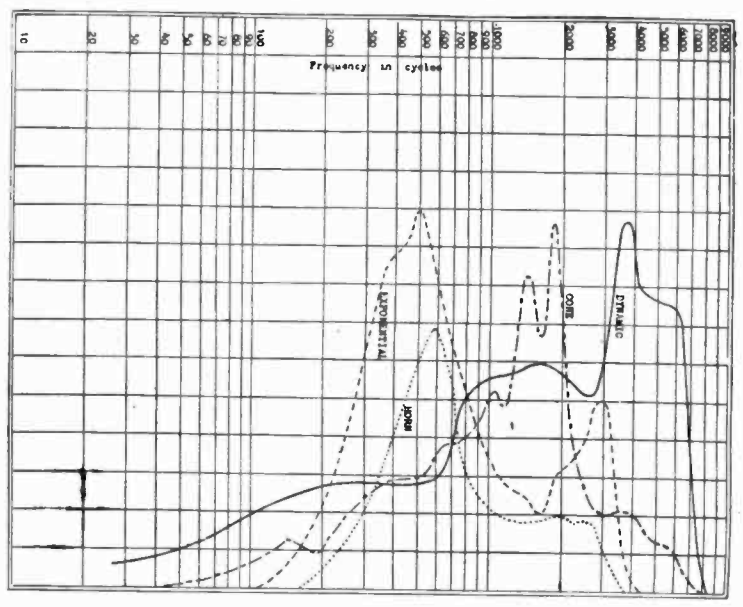



FIG. 1.— Horn Type and Cone Type of Loud Speaker.




Response Curves of Various Types of Speakers.


A phonograph exhibit by William Boruff that won a special award in Dallas, Texas.

## DEPREZ'S GALVANOMETER.

BY GEO. M. HOPKINS.

To rivet scientific facts in the mind, study and practice must proceed together. This is especially true in electricity, where a multitude of conditions are imposed for every phase of the subject.

No one can go very deeply in the study of electricity without reaching the subject of electrical measurements; certainly very little can be done in this direction without a galvanometer of some kind. Among all the galvanometers yet invented, there is perhaps none possessing all the good qualities of the one shown in the annexed engraving. It is very simple; the materials are inexpensive, no great mechanical skill is required in its construction; and its sensitiveness and accuracy are sufficient for the requirements of most electricians. Besides all this, it is perfectly "dead beat," so that no time need be wasted in waiting for the instrument to come to rest.

This galvanometer is the invention of M. Deprez, of Paris, France. It consists essentially of a rectangular coil of fine wire, suspended on strained torsional wires in a strong magnetic field.

To the base is secured, by means of angle plates, a compound U-magnet, 7 inches high, formed of three steel magnets, one-quarter inch thick, secured together and to the angle plates by bolts. The distance between the inner faces of the poles of the magnet is $1\frac{7}{16}$ inches. Two and three-quarter inches behind the center of the magnet a brass column rises from the base, and is provided near its center with an adjustable brass arm, supporting at its outer end, and exactly in the center of the space between the poles of the magnet, a hollow soft iron cylinder, $2\frac{1}{4}$ inches long, $1\frac{3}{16}$ inches in external diameter, $\frac{13}{16}$ inch in internal diameter. The top of this cylinder is even with the upper ends of the magnet. To the top of the brass column is secured, at right angles, an arm that extends over the hollow iron cylinder, and is provided with a vertical sleeve, in which is clamped a rod having on its lower end a small silver hook, arranged axially in line with the iron cylinder.

To a block attached to the base, opposite the center of the magnet, is secured a tapering spring, $\frac{1}{16}$ inch thick and $3\frac{3}{4}$ inches long, carrying at its free end a small silver hook, which is arranged in line with the axis of the iron cylinder.

A rectangular coil of No. 40 silk-covered copper wire, large enough to swing freely over the iron cylinder, is suspended by a hard-drawn No. 32 (0·008 inch in diameter) silver wire from the hook above, and is connected by a similar wire with the hook on the spring below. The upper wire is $2\frac{1}{4}$ inches long between its connections, the lower one $2\frac{3}{4}$ inches.

The sides of the rectangular coil are flat, being about $\frac{1}{8}$ inch thick and $\frac{5}{16}$ inch wide. The resistance of the coil is 150 ohms. The silver hooks are connected with opposite ends of the coil, in the manner shown in Figs. 4 and 5. Each hook is provided with a flat head, which is secured between two thick plates of mica, the shank of the hook projecting through a hole in the outer mica plate. Each pair of mica plates is secured in place on the coil by a winding of silk, which is coated with shellac varnish to prevent the plates from slipping. The hooks are arranged exactly in the middle of the ends of the coil, so that when the coil is supported in the position of use by the silver wires it will oscillate freely between the poles of the magnet and the iron cylinder. The terminals of the coil are soldered to the silver hooks. The upper hook is made a little more than a half inch long, to receive a small concave mirror (as shown in Fig. 4), which is secured in place by cement or wax. The mirror has a focus of 30 or 36 inches.

The relation of the magnet, A, the coil, C, and the iron cylinder, B, are clearly shown in Fig. 3, which is a horizontal section taken through those parts.

A glass shade protects the delicate parts of the instrument. The two binding posts which are outside of the glass shade are connected under the base with the brass column and the spring, so that the current passes from one binding post to the column, thence down the upper silver wire, then through the coil, the lower silver wire, and the spring to the other binding post.

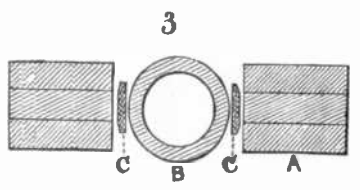
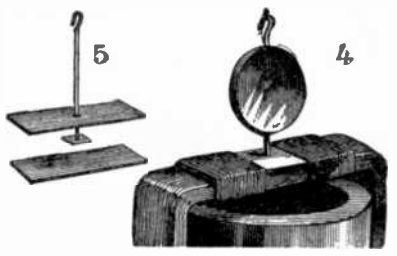



Fig. 3.—HORIZONTAL SECTION OF MAGNET, COIL, AND CORE.




FIGS. 4 and 5.—DETAILS OF DEPREZ'S GALVANOMETER.

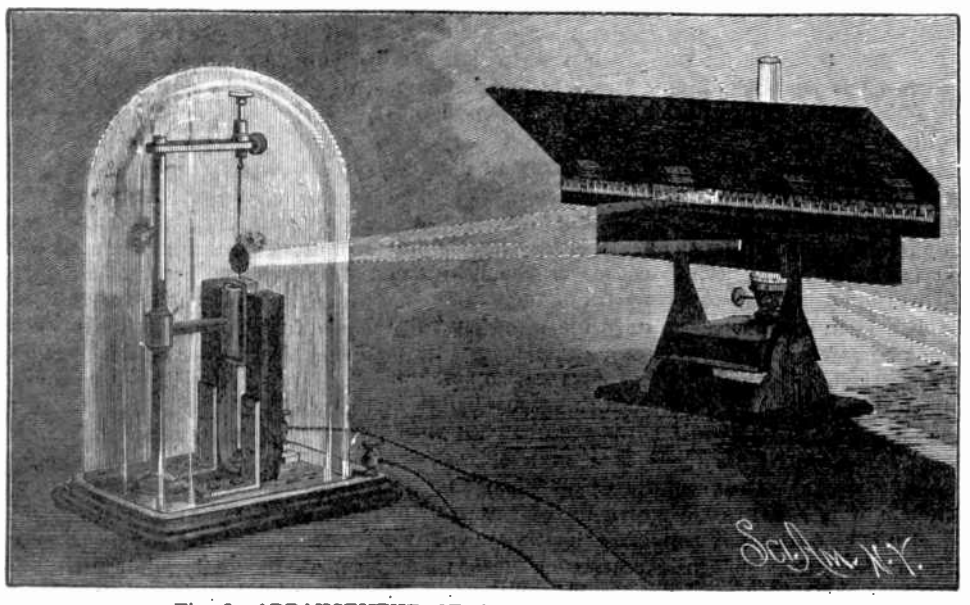



Fig. 2.—ARRANGEMENT OF GALVANOMETER AND SCALE.

The silver wires are placed under considerable tension, and the coil is adjusted to a central position by turning the hooked rod at the top of the instrument.

When an electrical current is sent through the coil, it tends to assume a position at right angles with a line joining the two poles of the magnet, the amount of displacement of the coil from its normal position depending on the strength of the current. As the deflection for a very light current is small, a beam of light reflected from the concave mirror is employed as an index. The scale is arranged as shown in Fig. 2, the light being projected from a lamp, supported at the proper height behind the scale, through a slit below the scale and on to the concave mirror. The mirror reflects the beam on to the scale. The mark at the center of the scale is 0, and arbitrary numbers, running upward regularly, are arranged on the marks on opposite sides of 0. The common paper scale used by draughtsmen answers for this purpose.

When the coil is at rest, the light spot remains at the center of the scale; but when a current passes through the coil, the beam moves steadily forward and stops without oscillation, the distance through which it moves depending, of course, on the strength of the current. The coil is returned to its normal position by the spring of the silver wires.

By employing shunts in the usual way, heavy currents may be measured by the aid of this instrument. The sensitiveness of the instrument is so great as to indicate a current when the ends of two No. 18 copper wires connected with it are placed on opposite sides of the tongue.

The coil is carefully wound over a form covered with paper, each layer of wire being varnished with shellac varnish as the work of winding progresses. When the coil is complete, the coil, together with the form, is heated in a warm oven until its varnish becomes hard throughout the coil.

The concave mirror may be purchased from the optician, or a very fair mirror may be made by cutting a small disk from a double convex spectacle lens of 60 or 70 inch focus, and silvering it. A simple and quick way of silvering a small surface consists in scraping from the back of a piece of ordinary looking glass all of the silvering, except a patch of the size of the mirror to be silvered. A small drop of mercury placed on the patch soon loosens it, so that it may be slid from the glass and transferred to the disk. The disk must be perfectly clean. After the patch is in position on the disk a piece of tin foil is placed on the back of the disk, pressed down firmly, and allowed to remain long enough to absorb all of the surplus mercury. It is then removed, and the transferred silver will be found adhering strongly to the disk.

The various dimensions above given are taken from an almost exact copy of a Deprez galvanometer made by Carpentier, of Paris. The copy operates admirably. It is probable, however, that a considerable deviation from these dimensions might be made without seriously affecting the value of the instrument.

**Scientific American.**

DECEMBER 4, 1886.

# LETTERS

### EDITOR'S MAILBAG

Dear Jim:

Thought you might like to see my crystal set collection. This only shows 45 of my over 57 crystal sets. The balance are such sets as IP-500, Marconi Model 106, SCR-49, BCI4A, Murdock 327, and several other wireless receivers.

All sets are commercial, no home brew jobs.

Good hunting.

Guy M. Martin, Jr.
P. O. Box A
Azusa, Calif. 91702


Hi:

Enclosing money order for $11 for 20 back issues of 1972 and 1973.

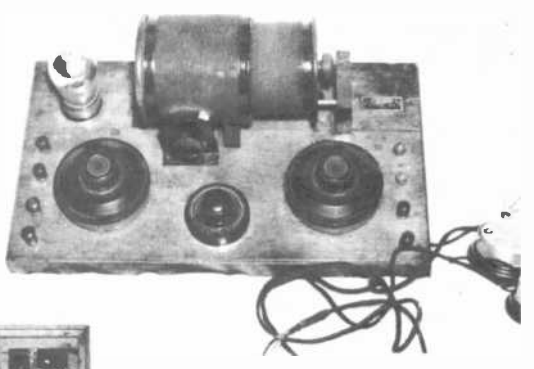
Enjoy Hornblower very much—just got my first subscription.

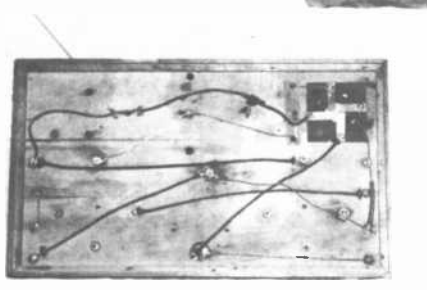
Have you any schematics and information on Grebe CR9(3 tube reg.), CR6 (3 tube reg.), CR5 (1 tube Regen).

If you have schematics and information is there information on coil winding and how many turns on coils and where taps are. As if possible I might reconstruct one.

Thanks,
Jim Hoffman
105 Sherman Ave.
Glen Ridge, N. J. 07028

EDITOR'S NOTE: O. K. Grebe experts.





Dear Mr. Cranshaw:

Received your card in the mail and wish to thank you a lot for printing my letter in your paper.

I had a little time, so with my Polaroid Camera took some pictures of the Gilbert Set.

These pictures are in black and white, which you can have, one picture shows the front view and details, the other one is a bottom view.

Maybe someone can identify it?

Thanks Again,
Your Faithful Reader,
Edward P. Remski
43 Elm Street
Hicksville, N. Y. 11801

COMING SOON...More technical information, more television and telephone.

# Broadcast Receiver Equipment *Now*—1931 *and Then*

*By* John F. Rider

***Fundamentally the difference between radio receivers of today and those of a decade ago is largely a matter of refinement in detail. But what magnitude these details have assumed in producing the modern radio from the embryo of a decade ago***

## Part One

RECOGNIZING the fact that radio fundamentals have changed very little if at all during the past 15 or 20 years, it is interesting to note the remarkable changes and improvements effected upon commercial radio receivers and power amplifiers. This is particularly true when we realize that many of the modern basic structures are practically identical with the basic structures of many years ago.

About 23 years have elapsed since the patent covering the three-element vacuum tube was granted to De Forest. The original circuit as specified in that patent bears a very close resemblance to the systems in use today, as is evident in Figure 1. The only thing missing in this illustration is the grid leak.

If we probe still further we note that very little if any change was effected in vacuum tube receiver design, that is, basically, since the development of the earliest tube receiver, the Ultraudion, by De Forest. A schematic wiring diagram of this receiver as used in 1913 is shown in Figure 2. The receiver as shown was popular for almost 10 years and was still in use, although not very popular, later than 1923.

We do not intend this article as a historical description of the radio development during the last two decades. Its primary purpose is to show that while the fundamentals have not changed, the modern receiver actually differs from the old. About ten years have elapsed since the advent of commercial radio broadcasting as we understand the term today. However, the first six or seven years subsequent to the start of popular broadcasting saw very few changes, that is, with respect to the receiver developments of the years between 1913 and 1920. One major exception, or perhaps two, are the development of the neutrodyne and the super-regenerative receivers. In the case of the former, however, the application of neutralization to radio-frequency amplifiers was based upon prior developments to accomplish the same effects in tuning systems. A more extended discussion will follow shortly.

The development of the vacuum tube receiver was accompanied by the development of the audio-frequency amplifier for the purpose of magnifying the signal. This was back in 1913. Reference to records of that date shows that the circuit structure of a two-stage audio amplifier was like that used today (in battery models) with the exception of such things as bypass condensers and filter resistances. The major difference between an audio amplifier of old times and the modern unit is the available quality of reproduction. Contrast an old audio transformer with a *hard rubber rod as the core* with the modern iron alloy core units. Audio-frequency amplification in

*Continued on page 6*

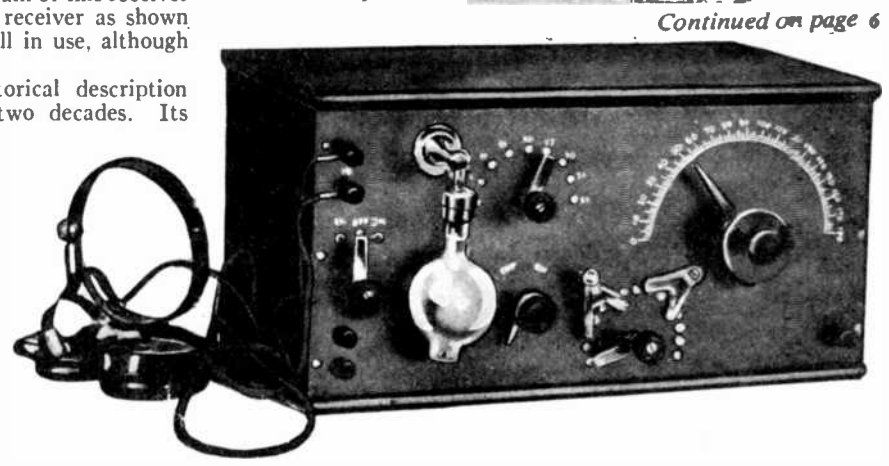


**Figure 3. One of the earliest vacuum tube receivers, employing one of the original De-Forest audion tubes. Quite a contrast to the modern receiver shown above**



## QUESTIONS AND ANSWERS

**L. M.** R., West Hoboken, N. J.—1. Do you intend to **publish** photographs of Collins and Harlan? 2. Are **these** their right names or only assumed? 3. Will any **violin** solos be listed in the near future? 4. Is the "Model C" the best reproducer that can be used on an Edison Standard Phonograph? 5. Are Eugene Rose and Albert Benzler members of the Edison Symphony Orchestra? 6. Can you secure for us a book containing the latest photographs of your musicians and singers, and if so, at what price? 7. Do your singers sing into an ordinary horn? I have heard that they sing into a large egg-shaped one.

[1. They have already appeared twice, July, 1904, and January, 1906, and we have at present no intention of again reproducing them. 2. Their right ones. 3. Possibly. 4. Yes. 5. Mr. Rose is a regular member, Mr. Benzler an occasional one. 6. No. 7. We use horns of many kinds but an egg-shaped horn is not among them.]

H. J. F., Central Falls, R. I.—1. Did you ever have a singer named Nellie Thomas? 2. Is Ada Jones on the vaudeville stage? 3. Is it probable that you shall ever list a solo by Miss Daisy Boulais? 4. When will a photograph of Florence Hinkle appear? 5. Is No. 9400, "The Lover and the Bird," sung in English? 6. Can I get a Record with "Come Back to Erin" in it? 7. Is Ada Jones an assumed name?

[1. Yes. 2. No. 3. No. 4. We do not know. 5. Our Record is in English. 6. We have no such Record. 7. No.]

J. H. B., Central Falls, R. I.—1. Please give the name and number of a selection originally sung by Louise Roberts. 2. In No. 8580, "Hickory Bill," who plays the banjo, Spencer or Hunter? 3. Will Marie Narelle sing again for you?

[1. "Down Where the Blue Bells Grow," No. 8014. 2. Hunter. 3. If she makes another tour in the United States probably yes. She is at present singing in her own country, Australia.]

[ 13 ]

N. N., Seattle, Washington.—We are always ready to answer questions when space permits but we like our questioners to send their names; furthermore, we are never overjoyed at having to pay four cents for an unstamped envelope as we had to do in your case. You ask: 1. How big is the room where we make Records? 2. Do we sing into a little horn like yours? 3. What makes the Edison blank, brown, and the others black? 4. Can you get all the pictures of our singers, and how much would it cost?

[1. We use several rooms for Record making. The one in which orchestral records are made is, approximately, 40 feet by 25. 2. We use horns of all sizes and sorts to produce the best results. 3. The Edison blank is made of a different material from the other. The former is soft wax and the other a specially hardened composition. All master Records are made origiually on soft wax. 4. We have reproduced most of our singers' pictures at various times. The cost of a single number of the PHONOGRAM is two cents, and some of them contain so many as four photographs of Edison talent.]

J. M., Norton Heights, Conn.—1. Who are the singers in the Edison Mixed Quartette? 2. Who takes the part of the Irish woman in Record No. 9487, "Pedro, the Hand Organ Man"? 3. How long ought a sapphire to last that is in constant use?

[1. We prefer not to give the names of members of our various orchestras, quartettes, etc., for the reason that the personnel changes from time to time and unintentionally people might be misled. 2. Steve Porter. 3. We could as easily tell you how long you have to live; with proper care a sapphire should last many years. Like diamonds and other precious stones, they vary in hardness and lasting qualities.]

N. B., New Brunswick, N. B.—Is the first Phonograph invented by Thomas Edison still in existence, and if so, where?

[Mr. Edison's first Phonograph, made in 1877, was presented by him to the South Kensington Museum, London, England, where, with its stylus and tinfoil, it arouses much interest.]

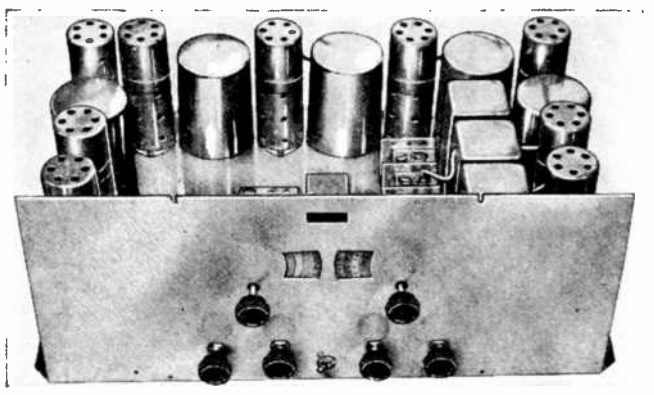
[ 15 ]

# The Classic Radio

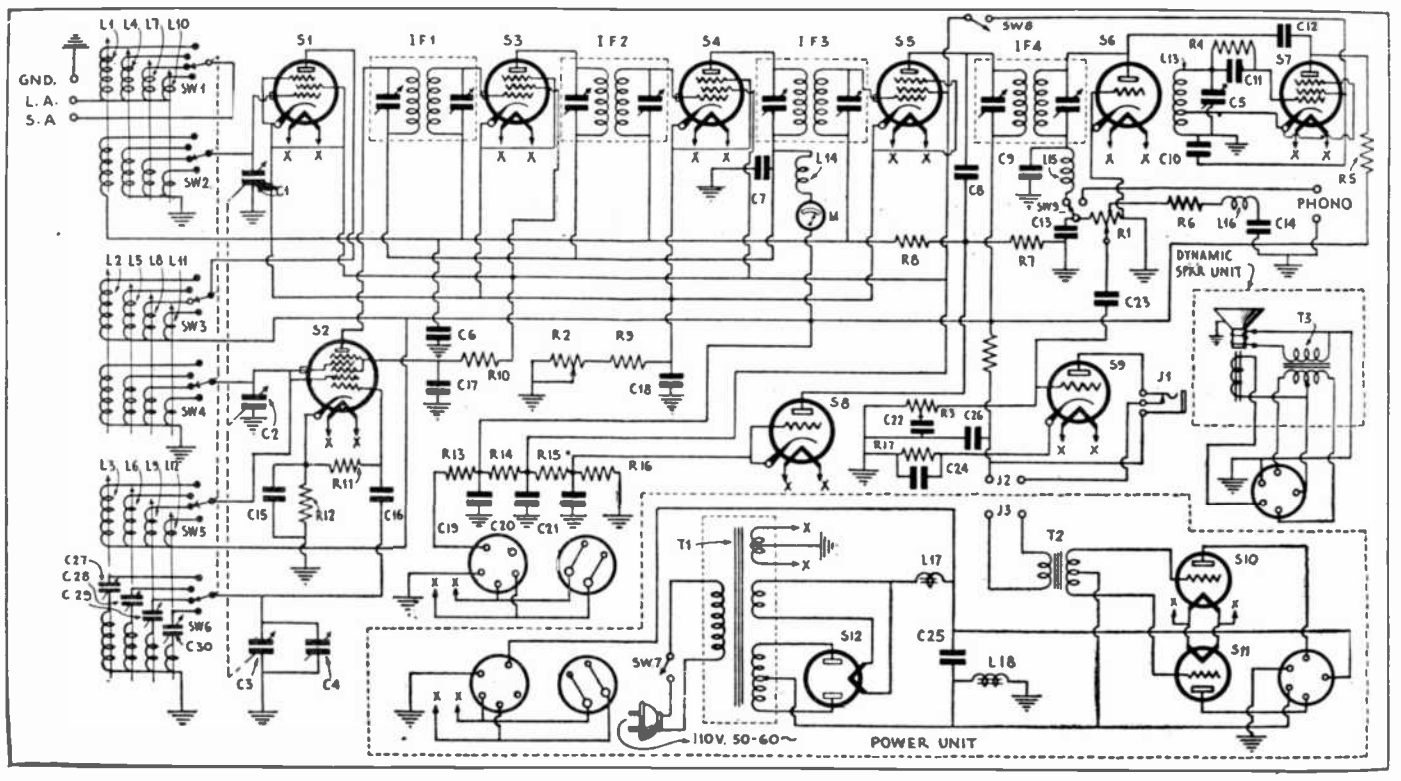
by J. W. F. Puett

McMurdo Silver's Masterpiece II was my second set when I started collecting radios in 1968. I purchased it for $7.50 in a garage sale in Tyler, Texas, where I was teaching Electronics at Tyler Junior College. In the back of my mind I remembered an ad in an old National Geographic magazine. After searching through about a hundred issues—there it was—"the official general-coverage receiver for the Byrd second antartic expedition." Then my memory drifted back to the high-school radio class and my teacher Hal Palmer who told me of the quality of McMurdo Silver radios. This was a special kind of nostalgia for me, although I was only one year old when the Masterpiece II was manufactured.

The Masterpiece II was a product of the major design features of the original Masterpiece (I) and certain design features recommended by a famous eastern university which acted as a radio consultant to Admiral Byrd. The changes were made to insure satisfactory results in the unusually severe weather encountered during the expeditions two year stay in the Antarctic. Both the tuner and amplifier/power-supply chassies were chrome plated. The receiver featured one rf amplifier stage followed by a separate mixer and oscillator. The rf line up was completed with three stages of IF amplification. A beat frequency oscillator was provided for cw reception. The final audio amplifier featured two type 2B6 tubes. The McMurdo Silver Masterpiece II and the Lincoln were perhaps the only two sets to utilize the 2B6 tube. The Masterpiece II was later offered to the public in a number of beautiful cabinet styles. It was produced for only one year, to be followed by the Masterpiece III in November of 1934. I wonder how many of these historically significant sets are still waiting in attics and cellars of old homes for some collector to claim them?



The Masterpiece II, designed by McMurdo Silver, which covers all waves from 13 to 570 meters; It has "band-spread" tuning.




Here we have the schematic circuit diagram for the new McMurdo Silver "Masterpiece II" All-Wave Superheterodyne Receiver.



days of old was usually of two types, choke and transformer coupling. We recall experiments with five and six-stage choke-coil coupled audio amplifiers back in 1915. The intensity of the speech heard was plenty, but the quality was horrible, that is, in comparison with the modern units.

The major differences between the old and the new receivers may be expressed in a few words: quality of reproduction, selectivity and convenience of operation. The reference to selectivity is based upon the design of the respective receivers rather than upon the fact that selectivity was not available 10 and 15 years ago. Considering the number of stations in operation at that time, very little if any trouble concerning selectivity was encountered. The greatly increased degree of sensitivity available with the modern radio receiver is a matter of tube design and circuit refinements, but let it not be said that some of the receivers used prior to the start of the popular broadcasting stations lacked in sensitivity.

The recent popularity of the superheterodyne receiver has created the impression in the minds of many that this receiver is new. Such an idea is far distant from the truth. The superheterodyne principle of operation had been considered and worked upon by many radio investigators prior to the advent of broadcasting and the general circuit structure of this type of receiver remains the same today as then, although tremendous improvements have been made in details.

Referring once more to sensitivity and selectivity, some very enviable records of the time were created by the type of receiver shown in Figure 4. Such receivers were available prior to 1919 and were used for several years subsequent to 1920. Alone, or when used with an audio amplifier of one, two, three or more stages, they accomplished wonders in the hands of the experienced operator. The popularity of the regenerative detector system waned when the subject of tone quality became of moment, but even today one does not hear anything but complimentary comment about the old single-tube regenerative detector systems.

Convenience of operation was a matter of fifth or sixth importance—perhaps tenth importance. That such a condition should exist is shown by the appearance of a popular tube receiver of the days around 1913 and later as shown in Figure 3. Everything but the batteries are mounted upon the front of the panel. Each and every circuit was equipped with a variable control in the effort to secure utmost sensitivity. Several recent receivers announce multi-wavelength ranges. Such receivers were used many years ago, and one example of a receiver which functioned marvelously upon the 150- to 20,000-meter band is shown in schematic form in Figure 5. It was known as the Weagant "X" circuit, popular for long-wave operation, but it also performed well upon the low waves. Examine this circuit and you will find three independently

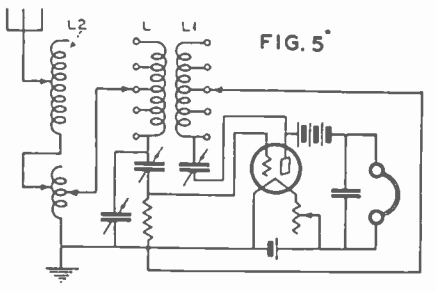



FIG. 5

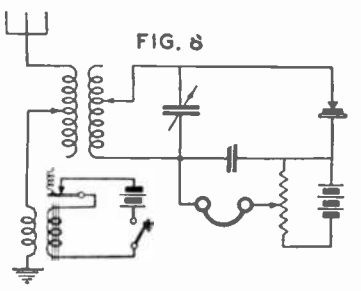


FIG. 8

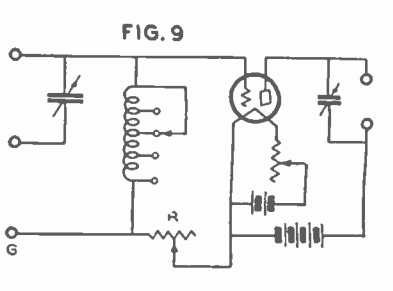



FIG. 9

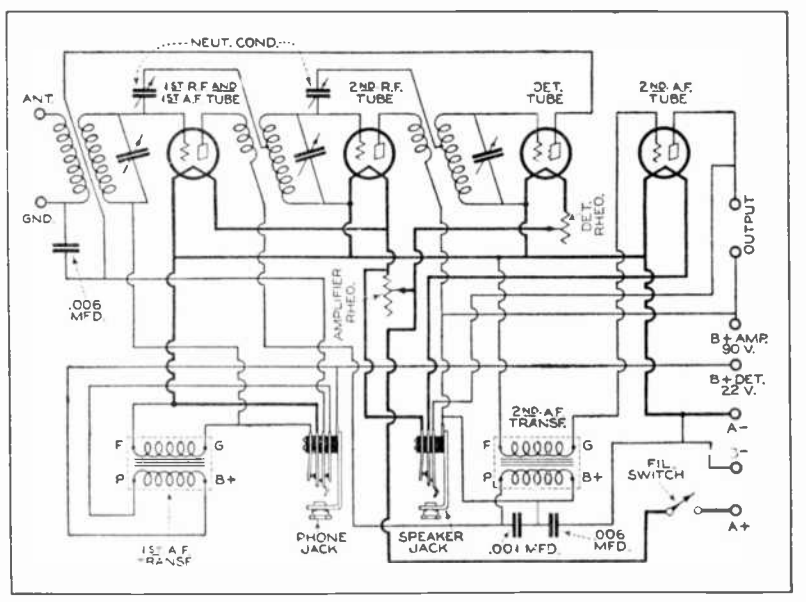



Figure 10. The Fada 160, one of the first neutrodynes. For the sake of economy the first tube was reflexed, serving both as an r.f. and a.f. amplifier

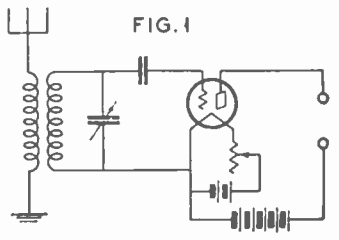


FIG. 1

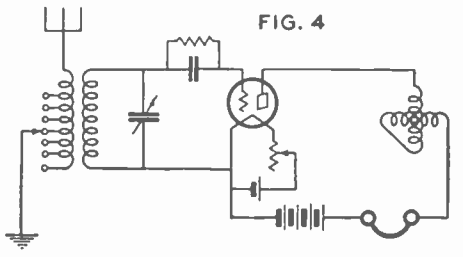


FIG. 4

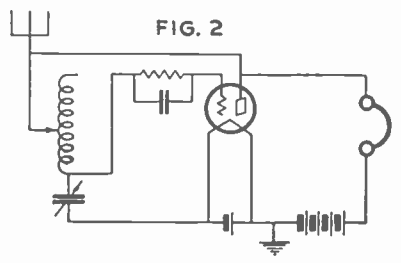


FIG. 2

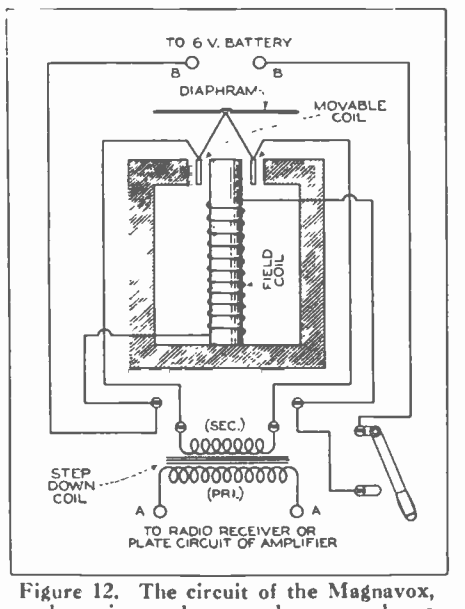
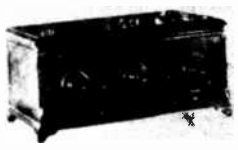



Figure 12. The circuit of the Magnavox, a dynamic speaker popular as early as the year 1919

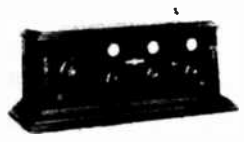
TRADE NAME: Superdyne.
MODEL: 305.
TYPE: One radio, detector and two audio.
TUBES: Four.
BATTERIES: None furnished.
CONTROLS: Two.
AERIAL: Outside or inside. Loud speaker built in.
PRICE: $275.00 without accessories.
MANUFACTURER'S NAME: The C. D. Tuska Company.



TRADE NAME: Superdyne Jr.
MODEL: 301.
TYPE: One radio, detector, one audio reflexed and one straight audio.
TUBES: Three.
BATTERIES: None furnished.
CONTROLS: Three.
AERIAL: Outside or inside.
PRICE: $85.00 without accessories.
MANUFACTURER'S NAME: The C. D. Tuska Company.

TRADE NAME: "Superflex Portable."
MODEL: 3-X.
TYPE: One-stage radio frequency amplification, detector and two-stage audio frequency amplification (reflexed).
TUBES: Three.
BATTERIES: Not furnished.
CONTROLS: Three.
AERIAL: Indoor or outdoor.
PRICE: $75.00 without accessories.
MANUFACTURER'S NAME: Benson Engineering Co.

TRADE NAME: "Superflex Loop Receiver."
MODEL: 4-X.
TYPE: Reflex.
TUBES: Four.
BATTERIES: Not furnished.
CONTROLS: One.
AERIAL: Loop.
PRICE: $90.00 without accessories.
MANUFACTURER'S NAME: Benson Engineering Co.



TRADE NAME: "Super-Flex."
MODEL: Consolette.
TYPE: Reflex; built-in loud speaker.
TUBES: Three.
BATTERIES: furnished.
CONTROLS: Three.
AERIAL: Outside.
PRICE: $89.50.
MANUFACTURER'S NAME: Bosserman Radio Laboratory

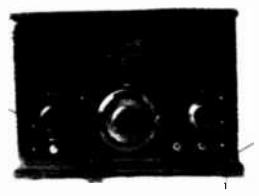
TRADE NAME: "Super-Heterodyne.
MODEL: Regular.
TYPE: Super-Heterodyne.
TUBES: Eight UV-199.
BATTERIES: "A," "B" and "C" furnished.
CONTROLS: Two.
AERIAL: Loop.
PRICE: $149 complete.
MANUFACTURER'S NAME: Bosserman Radio Laboratory.

TRADE NAME: "Super-Pliodyne.
MODEL: 9.
TYPE: Five stages of tuned radio frequency, detector and three stages of audio frequency amplification.
TUBES: Nine.
BATTERIES: "A," "B" and "C" needed.
CONTROLS: One.
AERIAL: Loop.
PRICE: $295.00 without accessories.
MANUFACTURER'S NAME: Golden-Leutz, Inc.

TRADE NAME: Super Reinartz.
TYPE: Regenerative circuit using a combination of the Hartley and Reinartz circuits.
TUBES: Three.
BATTERIES: Not furnished.
CONTROLS: Two.
AERIAL: Inside or outside.
PRICE: $57.60.
MANUFACTURER'S NAME: Elgin Radio Supply Co.

TRADE NAME: "Telemonic Three."
TYPE: Three stages tuned radio frequency; crystal or tube detector; two-resistance audio frequency; reflex, and one transformer coupled audio.
TUBES: Seven.
BATTERIES: Not furnished.
CONTROLS: Four.
AERIAL: Outside or inside.
MANUFACTURER'S NAME: Danziger-Jones, Inc.

TRADE NAME: Terafone.
MODEL: TA.
TYPE: Two stages of radio frequency, detector and two stages of A.F.A. using the Satterlee antennaless circuit.
TUBES: Five.
BATTERIES: None furnished.
CONTROLS: One.
AERIAL: None needed but will work on any type.
PRICE: $100.00 without accessories.
MANUFACTURER'S NAME: The Moon Radio Corporation.



TRADE NAME: "Terlee Acme Reflex."
TYPE: One-stage tuned radio frequency, three stages of untuned detector and three stages of untuned audio; crystal detector.
TUBES: Four.
BATTERIES: None furnished.
CONTROLS: Two.
AERIAL: Outside or inside.
PRICE: $165.00 without accessories.
MANUFACTURER'S NAME: Terlee Electric and Manufacturing Company.

TRADE NAME: "Timson."
TYPE: Tuned radio frequency.
TUBES: Five.
BATTERIES: None furnished.
CONTROLS: Three.
AERIAL: Outdoor or indoor.
PRICE: $60.00 without accessories.
MANUFACTURER'S NAME: Terrio Radio Mfg. Corp.

cont[illegible] tuning condensers and four separately tuned inductances. The coils designed as L, L1 and L2 were fr[illegible] 24 to 30 inches long and stood upright upon the table. These coils were finally replaced by the honeycomb type of inductances.

The modern receiver with its single tuning control for four or five stages represents an infinite advance over the old system, as is shown by the panel view of a receiver manufactured during the first few years subsequent to the start of broadcasting. The Grebe CR-8 afforded a wavelength range of from 500 to 24,000 meters and the panel view appears as shown in Figure 7. A typical broadcast receiver with a wavelength range of from 170 to 580 meters, the Grebe CR-6, is shown in schematic form in Figure 6. This receiver consisted of a regenerative detector system and two stages of audio. Each tube in the receiver was equipped with its own filament control unit. Grid bias was not used upon any of the audio stages and distortion as we know it today was rampant. Plenty loud but poor quality, although it was good for those times. In contrast to the long-wave CR-7, the CR-6 was known as the Grebe short-wave receiver. Short waves as we know them today are wavelengths below 150 meters, or the range between 40 and 150 meters, assuming that the waves below 40 meters are called ultra-short waves. Each stage was equipped with a filament and plate circuit control jack. Insertion of the plug connected to the headphones or to the loud speaker into any one of the jacks automatically extinguished the filaments of the succeeding tubes.

The start of broadcasting saw the popularization of the crystal receiver. The models manufactured at that time were even then much more crude than the crystal receivers in use for the ten years previous to 1920. The circuit diagram of a then de luxe type of crystal receiver is shown in Figure 8. The aerial and secondary circuit were tuned and a potential was applied to the carborundum crystal so as to secure best operation. A buzzer system was a part of the receiver and was used to enable pre-adjustment of the crystal contact. A crystal of this type was far more stable than the usual run of light contact crystals such as Galena. Strong bursts of static or signal interfered with the response of the Galena type of crystal. The required contact was very light

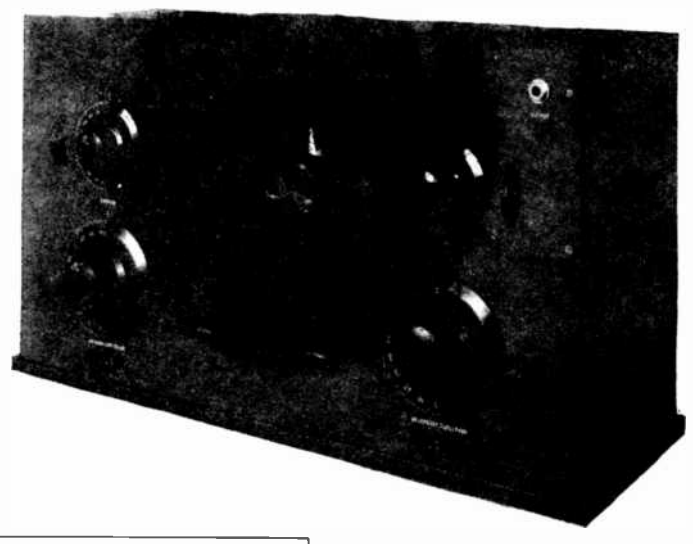


Figure 7. The Grebe CR-7, a high-grade one-tube receiver of 1922, had about everything on the panel but the kitchen sink

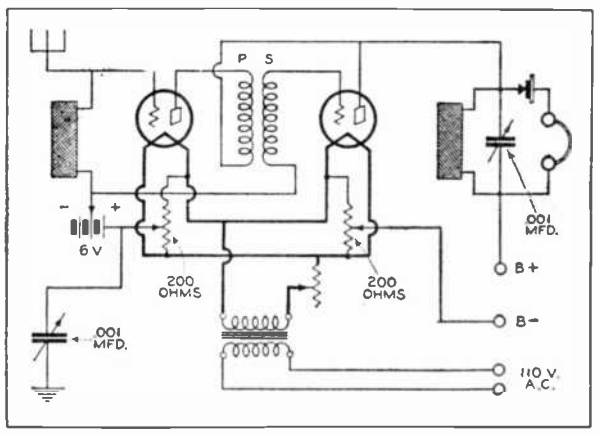



Figure 11. One of the first receivers to draw its filament supply from the a.c. lines. This circuit was published in RADIO NEWS 'way back in the dim past of December, 1922

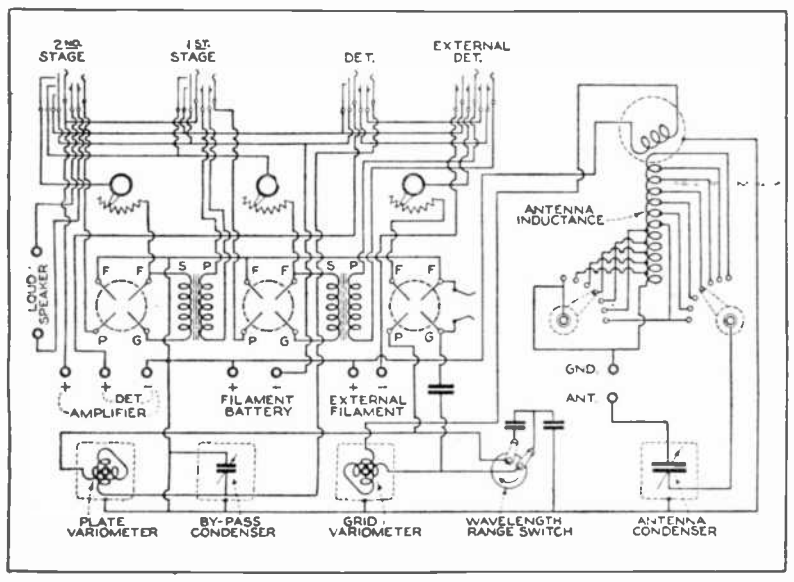



Figure 6. The circuit diagram of the Grebe CR-6 broadcast receiver, 1922 model. It had four tuning dials plus numerous rheostats and switches to keep the operator amused

and nary a program was completed without some loss of time and program because of required readjustments. The modern receiver owner complains if an SOS signal interferes with his program. What would he have done in the past if a slight jar interrupted the program and perhaps ten minutes were required to locate another sensitive spot upon a crystal used in the open and subject to oxidization?

The number of incorrectly operated regenerative detector receivers multiplied with leaps and bounds. So much so that within two years subsequent to 1920 more miniature transmitters (although not intended as such) than receivers were in use. The heterodyne interference caused by these receivers mounted to such proportions that it was practically impossible to listen to a complete program without a series of shrieks, howls, growls and whistles emanating in some other receiver perhaps a mile away. The condition of the air today is sublime silence by comparison. The present-day form of electrical disturbance was unknown in years gone by because of insufficient sensitivity, few sources of such disturbance and the lack of power line operation.

The interference caused by regenerative detector systems became so great that more than one publication discussed the possibility of licensing the owners of such receivers. Agitation was started and one of the earliest types of radio-frequency amplifier units intended as a blocking as well as amplifier stage for use between the aerial and the oscillating detector was announced in 1922. The circuit of the Grebe RORO, a single-stage, tuned radio-frequency amplifier is shown in Figure 9. R in this illustration is the equivalent of the modern grid suppressor.

Hazeltine, early in 1923, announced the neutrodyne receiver, with the result that the tuned radio-frequency amplifier offering increased selectivity, made necessary by the fact that about 570 broadcasting stations had been licensed in the United States and about 60 in Canada, greater sensitivity and freedom from excessive regeneration, quieter operation and more friendly attitude toward one's neighbor, started the decline of the regenerative detector system. In a sense this invention constituted one of if not the greatest contribution towards the complete acceptance of radio broadcasting by the public. A

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## Before Long

(Phonograph gives evidence. Machine-made testimony admitted by Pittsburg Magistrate.—*Newspaper Headline.*)

COURT OFFICER (*in the near future*).—Do you solemnly swear that evidence which you give in this case will be the truth, the whole truth and nothing but the truth? So help you Edison.—*Puck.*



schematic diagram of one of the earliest neutrodynes, the Fada 160 is shown in Figure 10. The receiver employed four tubes to do the work of five, the first audio stage being reflexed to also function as the first audio-frequency amplifier. Contrast this circuit with a modern tuned radio-frequency receiver. It is much simpler in every respect and its advantages were found in its extreme simplicity. It was sufficiently sensitive to afford satisfactory distance reception. All in all, it performed to the king's taste, his palate having not as yet been whetted by modern receiver design.

Mutterings about a.c. filament operation were heard back in 1922 and an example of a suggested receiver using honeycomb coils, a crystal detector with a two-stage untuned radio-frequency amplifier with a.c. filament operation is shown in Figure 11. This diagram appeared in the December, 1922, issue of RADIO NEWS.

A.C. filament operation was not popularized until some time in 1926, but it had been used for quite a few years prior to that time in connection with amateur transmitters. The modern "B" battery eliminator did not appear upon the market until some time in 1925, but a.c. form of plate voltage supply had been used for many years. In fact, that modern "B" battery eliminator as a part of a complete a.c. receiver is almost identical with the old plate supply systems used in transmitters. One change is the use of the tapped filter choke or the parallel resonated filter choke.

The dynamic speaker so popular during the last two years was used back in 1919 and the schematic layout of this type of speaker as made by the Magnavox Company is shown in Figure 12. It was d.c. operated, employing a 6-volt battery to provide the excitation current for the voice coil. The output transformer was self-contained. The horn was made of metal. The diaphragm was small in contrast to the present-day large-size cones.

Basically the modern dynamic speaker is identical with the one shown, but as far as reproduction is concerned, the old style unit operated over a frequency range which represents but a small portion of the present-day range.

Accompanying greater selectivity, greater sensitivity and the gradual decline of regenerative receivers was an increasing interest in tone quality. More and more numerous became the discussion pertaining to tone quality. The intensity of the received signal was sufficiently great, but the haphazard methods of making these sounds audible to a group of listeners created interest in loud speakers. One of the earliest of these was simply a horn to the base of which a pair of headphones were clamped to serve as the loud speaker unit.

Push-pull amplifiers were of interest because of the Western Electric two-stage audio amplifier, battery-operated with push-pull output. This power amplifier was classed as the king of all audio amplifying systems. In contrast with the modern form of volume control the amplifier in question made use of a tapped secondary winding upon the input transformer, as shown by the movable contact illustrated in Figure 13.

Subsequent to the development of the neutrodyne receiver very little improvement was noted in receiver design for several years. It is true that several reflex receivers made their appearance, but they were short-lived. The major interest was devoted to improvements in tone quality. The requirements as presented by the musical scale were topics of discussion. Resistance coupling made its appearance late in 1924 and many heated arguments relating to the respective advantages of resistance, choke and transformer forms of audio-frequency amplifier are recorded in print in some of our leading radio journals.

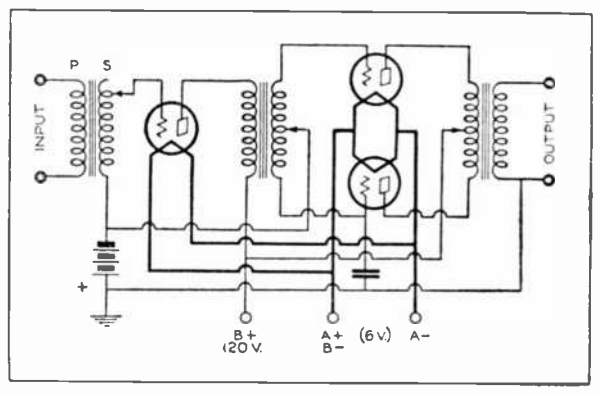


Figure 13. The Western Electric power amplifier in 1923 introduced the push-pull stage now so popular

The demand for greater convenience accompanied the demand for greater quality. The gradual increase in the number of tubes used in receivers made necessary more frequent recharging of the storage battery form of filament power supply. The 1-ampere tube was replaced by the dry-cell tube and the .25 ampere tube. Vibrating and vacuum-tube chargers made their appearance. They were applied to plate and filament power supply units. The bulk of the "wet" storage "B" battery limited its sales, but the elaborate receiver was equipped with a storage "B" as well as storage "A" system and a charger, thus making the complete system and an electrified arrangement. In fact, this form of operation presented such an improvement over the ordinary form of operation that it was at one time considered one of the paramount reasons for the dislike of the first batch of a.c. tube receivers.

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| 1A3 | n | $3. | 5Z4 | nu | $2. | 7A4 | nu | $3. | 14C7 | n | $3. | 56 | nu | $3. |
| 1A4 | nu | $3. | 6A3 | n | $3. | 7A5 | n | $3. | 14F7 | n | $3. | 57 | u | $3. |
| 1A5 | u | $3. | 6A4 | nu | $4. | 7A6 | nu | $3. | 14F8 | n | $3. | 58 | u | $3. |
| 1A6 | n | $3. | 6A5 | n | $3. | 7A7 | nu | $3. | 14H7 | n | $3. | 59 | n | $3. |
| 1A7 | nu | $2. | 6A6 | nu | $3. | 7A8 | nu | $3. | 14J7 | nu | $3. | 70A7 | n | $3. |
| 1B4 | n | $2. | 6A7 | nu | $4. | 7AF7 | nu | $3. | 14N7 | n | $3. | 70L7 | nu | $3. |
| 1B5 | u | $3. | 6A8 | nu | $3. | 7AG7 | nu | $3. | 14Q7 | nu | $3. | 75 | nu | $3. |
| 1C5 | nu | $3. | 6B4 | nu | $4. | 7AK7 | u | $3. | 14W7 | n | $3. | 76 | nu | $3. |
| 1C6 | n | $3. | 6B5 | nu | $4. | 7B4 | nu | $3. | 14X7 | n | $3. | 77 | nu | $3. |
| 1C7 | u | $4. | 6B6 | nu | $4. | 7B5 | nu | $3. | 15 | u | $5. | 78 | nu | $3. |
| 1D5 | u | $4. | 6B7 | nu | $4. | 7B6 | nu | $3. | 19 | nu | $3. | 79 | nu | $3. |
| 1D8 | nu | $4. | 6B8 | nu | $3. | 7B7 | u | $3. | 24A | nu | $3. | 80 | nu | $2. |
| 1E5 | u | $3. | 6C5 | nu | $2. | 7B8 | nu | $3. | 25A6 | n | $3. | 81 | u | $5. |
| 1E7 | n | $3. | 6C6 | nu | $3. | 7C5 | nu | $3. | 25A7 | nu | $3. | 82 | u | $3. |
| 1F4 | n | $3. | 6C7 | n | $3. | 7C6 | u | $3. | 25B6 | u | $3. | 83 | n | $3. |
| 1G4 | nu | $3. | 6C8 | nu | $3. | 7C7 | nu | $3. | 25C6 | u | $3. | 84 | nu | $3. |
| 1G5 | u | $3. | 6D6 | nu | $3. | 7E6 | u | $3. | 25L6 | nu | $2. | 85 | nu | $3. |
| 1G6 | u | $2. | 6D7 | n | $3. | 7E7 | nu | $3. | 25S | u | $3. | 89 | n | $3. |
| 1H4 | u | $3. | 6E6 | n | $3. | 7F7 | nu | $3. | 25Z5 | nu | $2. | 117- | | |
| 1H5 | nu | $3. | 6E7 | u | $3. | 7F8 | nu | $3. | 25Z6 | nu | $2. | L7 | nu | $4. |
| 1H6 | nu | $2. | 6F5 | nu | $3. | 7G7 | u | $3. | 26 | u | $4. | 117- | | |
| 1LA4 | n | $3. | 6F6 | u | $3. | 7H7 | u | $3. | 26A6 | n | $3. | Z6 | nu | $3. |
| 1LA6 | nu | $3. | 6F7 | nu | $5. | 7J7 | n | $3. | 26A7 | nu | $3. | 9002 | n | $3. |
| 1LB4 | u | $3. | 6F8 | nu | $2. | 7K7 | u | $3. | 27 | u | $3. | 9003 | n | $3. |
| 1LC5 | n | $3. | 6G6 | nu | $3. | 7L7 | nu | $3. | 28D7 | nu | $3. | VT52 | u | $4. |
| 1LC6 | n | $4. | 6H6 | nu | $2. | 7N7 | nu | $3. | 30 | u | $3. | XXB | n | $3. |
| 1LD5 | nu | $3. | 6J5 | nu | $3. | 7Q7 | nu | $3. | 31 | nu | $3. | XXFM | u | $3. |
| 1LE3 | n | $4. | 6J7 | nu | $3. | 7R7 | n | $3. | 32 | n | $3. | XXL | nu | $3. |
| 1LF3 | n | $4. | 6J8 | u | $3. | 7S7 | nu | $3. | 32L6 | u | $2. | | | |
| 1LQ5 | n | $3. | 6K5 | nu | $3. | 7V7 | nu | $3. | 32L7 | n | $3. | WATCH | | |
| 1LH4 | nu | $3. | 6K6 | nu | $3. | 7X6 | n | $3. | 33 | n | $3. | THIS | | |
| 1LN5 | nu | $3. | 6K7 | nu | $3. | 7Z7 | u | $3. | 34 | nu | $3. | COLUMN | | |
| 1N5 | nu | $3. | 6K8 | nu | $3. | 7Y4 | nu | $3. | 35 | u | $3. | FOR | | |
| 1P5 | nu | $3. | 6L5 | n | $3. | 7Z4 | nu | $3. | 35Y4 | u | $2. | DELETIONS | | |
| 1Q5 | nu | $2. | 6L6 | nu | $3. | 12A7 | nu | $3. | 35Z3 | nu | $2. | AND | | |
| 1V | n | $4. | 6L7 | nu | $3. | 12A8 | u | $3. | 36 | u | $3. | ADDITIONS | | |
| 2A3 | nu | $5. | 6N5 | n | $3. | 12B7 | u | $3. | 37 | u | $3. | EACH | | |
| 2A4 | nu | $4. | 6N6 | nu | $3. | 12B8 | u | $3. | 38 | nu | $3. | MONTH. | | |
| 2A5 | u | $3. | 6N7 | nu | $3. | 12C5 | nu | $3. | 39 | nu | $3. | | | |
| 2A6 | nu | $3. | 6P5 | nu | $3. | 12C8 | nu | $3. | 41 | nu | $3. | | | |
| 2B7 | nu | $3. | 6Q7 | nu | $3. | 12F5 | n | $3. | 42 | nu | $3. | | | |
| 3Q6 | n | $3. | 6R7 | u | $3. | 12J5 | nu | $3. | 43 | nu | $3. | | | |
| 3LF4 | n | $3. | 6S7 | nu | $3. | 12J7 | nu | $3. | 44 | nu | $3. | | | |
| 3Q5 | u | $2. | 6S8 | n | $3. | 12K7 | nu | $3. | 45 | u | $4. | | | |
| 5R4 | u | $2. | 6T7 | u | $3. | 12K8 | nu | $3. | 46 | nu | $4. | | | |
| 5T4 | nu | $2. | 6T8 | n | $2. | 12Q7 | nu | $3. | 47 | nu | $5. | | | |
| 5U4 | nu | $2. | 6U6 | nu | $3. | 12Z3 | u | $3. | 48 | n | $5. | | | |
| 5Y4 | nu | $2. | 6U7 | u | $4. | 14A6 | n | $3. | 49 | n | $4. | | | |
| 5W4 | nu | $2. | 6V6 | nu | $2. | 14A7 | u | $3. | 50A5 | nu | $2. | | | |
| 5X4 | nu | $2. | 6V7 | nu | $3. | 14B5 | n | $3. | 50C6 | n | $2. | | | |
| 5Y3 | nu | $2. | 6Y6 | nu | $2. | 14B6 | nu | $3. | 50X6 | nu | $3. | | | |
| 5Y4 | nu | $2. | 6Z4 | nu | $2. | 14B8 | n | $3. | 51 | u | $3. | | | |

TABLE 2 - OLD STYLE GLASS ENVELOPE TUBES - all are used, thoroughly tested
Tube type numbers are listed under manufacturers names.

| Ace: | | Cunningham: | | Magestic: | | Philco: | | Radiotron: | | Sylvania: | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| X-224 | $2. | C324 | $4. | G27 | $3. | 24 | $3. | UX222 | $4. | ST224 | $4. |
| Arcturus: | | CX326 | $4. | G35S | $3. | 26 | $4. | UY224 | $4. | SY227 | $3. |
| (blue glass) | | C327 | $3. | G45 | $4. | 27 | $3. | UX226 | $4. | SX280 | $2. |
| No. 27 | $5. | CX332 | $4. | National | | 30 | $3. | UT227 | $3. | Tung Sol: | |
| No. 51 | $5. | CX345 | $4. | Union: | | 37 | $3. | 231 | $4. | 24 | $3. |
| Crosley: | | 56 | $3. | NY224 | $4. | 42 | $3. | 35 | $2. | Wizard: | |
| 56 | $3. | CX371 | $5. | 39 | $2. | 71A | $5. | UX245 | $4. | 226 | $4. |
| Ken Rad | | 80 | $2. | Perryman: | | 80 | $2. | 56 | $3. | | |
| UX245 | $4. | CX380 | $3. | PA-224 | $4. | | | 71A | $5. | | |
| 45 | $3. | | | | | | | UX71A | $5. | | |
| | | 212F used 15.00 | | | | | | UX280 | $2. | | |
| | | 852 used 15.00 | | | | | | UX281 | $4. | | |

WATCH THIS TABLE EACH MONTH FOR ADDITIONS AND DELETIONS.

TABLE 3 - TUBE COLLECTOR SPECIALS

| Radiotron: | | Cunningham: | | Majestic: | |
|---|---|---|---|---|---|
| 10 used | $5.00 | CX350 used | $6.00 | A.P.(rectifier) used | $5.00 |
| WX12 used | $7.00 | De Forest | | Raytheon: | |
| UX200 new | $9.00 | Audion: | | B-H (rectifier) used | $5.00 |
| used | $5.00 | 450 used | $6.00 | BR (rectifier) used | $5.00 |
| UX240 used | $5.00 | | | VISITRON (photo cell) new | $5.00 |

WATCH THIS TABLE EACH MONTH FOR DELETIONS AND ADDITIONS

TABLE 4 - MORE RECENT TUBE TYPES - prices listed for new tubes used tubes are half new price

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0A2 | n | $2. | 6AT6 | nu | $2. | 12A5 | nu | $3. | 35Z5 | nu | $2. | 1629 | u | $3. |
| 0A3 | u | $2. | 6AU6 | nu | $2. | 12A6 | nu | $3. | 35Z6 | nu | $3. | 1633 | u | $2. |
| 0B3 | u | $2. | 6AV6 | nu | $2. | 12AT6 | nu | $2. | 40Z5 | u | $3. | 1634 | u | $2. |
| 0C3 | nu | $2. | 6BA6 | nu | $2. | 12AT7 | u | $2. | 45Z3 | n | $3. | 1635 | u | $2. |
| 0D3 | nu | $2. | 6BE6 | nu | $2. | 12AU6 | nu | $2. | 45Z5 | nu | $3. | 2050 | nu | $3. |
| 0Y4 | n | $3. | 6BJ6 | nu | $2. | 12AU7 | nu | $2. | 50B5 | nu | $2. | 2051 | nu | $3. |
| 0Z4 | nu | $3. | 6C4 | nu | $2. | 12AV6 | nu | $2. | 50C5 | nu | $2. | 5686 | n | $2. |
| 1L4 | n | $4. | 6J6 | nu | $2. | 12BA6 | nu | $2. | 50L6 | u | $2. | 5691 | n | $2. |
| 1L6 | n | $5. | 6S4 | n | $2. | 12BE6 | nu | $2. | 50Y6 | nu | $3. | CK- | | |
| 1R5 | nu | $2. | 6SA7 | nu | $3. | 12L6 | nu | $3. | 50Y7 | nu | $3. | 5703 | u | $2. |
| 1S4 | n | $1. | 6SB7 | nu | $3. | 12SA7 | nu | $2. | 117- | | | 5749 | u | $2. |
| 1S5 | nu | $2. | 6SG7 | nu | $2. | 12SC7 | n | $3. | Z3 | nu | $3. | 5751 | nu | $2. |
| 1T4 | nu | $2. | 6SD7 | nu | $3. | 12SF5 | n | $2. | 117- | | | 5814 | n | $2. |
| 1T5 | nu | $2. | 6SF5 | n | $2. | 12SF7 | n | $2. | Z4 | u | $3. | 5879 | n | $2. |
| 1U5 | nu | $2. | 6SF7 | n | $2. | 12SG7 | nu | $3. | 807 | nu | $5. | 5881 | u | $4. |
| 2C26 | u | $3. | 6SG7 | nu | $3. | 12SH7 | n | $3. | 879 | n | $3. | 5992 | n | $2. |
| 2X2 | n | $3. | 6SH7 | nu | $2. | 12SJ7 | nu | $3. | 884 | n | $5. | 6080 | u | $4. |
| 3A4 | nu | $2. | 6SJ7 | nu | $2. | 12SK7 | nu | $2. | 930 | n | $3. | 6842 | n | $2. |
| 3A5 | nu | $2. | 6SK7 | nu | $2. | 12SL7 | nu | $3. | 950 | u | $4. | 6973 | n | $2. |
| 3A8 | n | $3. | 6SL7 | nu | $2. | 12SN7 | nu | $2. | 955 | n | $4. | 7193 | u | $2. |
| 3Q4 | nu | $2. | 6SN7 | nu | $1. | 12SQ7 | nu | $2. | 958 | u | $4. | VR90 | nu | $2. |
| 3S4 | nu | $2. | 6SQ7 | nu | $2. | 12SR7 | nu | $3. | CK- | | | VR- | | |
| 3V4 | nu | $2. | 6SR7 | nu | $2. | 12V6 | nu | $3. | 1005 | u | $3. | 105 | n | $2. |
| 6AB4 | nu | $2. | 6SS7 | nu | $2. | 12W6 | n | $2. | E1158 | u | $3. | VR- | | |
| 6AB7 | nu | $2. | 6SU7 | n | $2. | 12X4 | n | $2. | 1201 | u | $3. | 150 | nu | $2. |
| 6AQ5 | nu | $2. | 6SV7 | n | $2. | 19T8 | nu | $3. | 1203 | u | $3. | | | |
| 6AG7 | nu | $3. | 6W6 | u | $2. | 35A5 | nu | $3. | 1232 | u | $3. | WATCH FOR | | |
| 6AK5 | nu | $2. | 6X4 | nu | $2. | 35C5 | nu | $2. | 1273 | u | $3. | ADDITIONS & | | |
| 6AL5 | nu | $2. | 6X5 | nu | $1. | 35L6 | nu | $2. | 1612 | u | $3. | DELETIONS | | |
| 6AL7 | u | $2. | 6Y5 | u | $2. | 35W4 | u | $2. | 1625 | u | $4. | EACH | | |
| 6AQ5 | nu | $2. | 6Y7 | u | $2. | 35Z4 | nu | $2. | 1626 | u | $3. | MONTH. | | |

TABLE 5 - BALLAST TUBES - $3.00 each - all are new

JFD Type A,B & C; K36A; K49B; K80C; K92B; KX49B; L55B; 2B14; 3H7; 4P45; 7H11; 40A1; 100-77; 100-79; 165R; 165R4; 185R4; 250R; 6092A. We have one old style Duresite 110 used, all others new.

TABLE 6 - TV AND MISC. TYPES - tubes in this table are priced at — $2.00 new, $1.00 used

| | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1AX2 | n | 3BN6 | nu | 4BQ7 | n | 5AZ4 | n | 5T8 | nu | 6AM8 | u | 6AX4 | nu | 6BN4 | nu | 6GG7 | nu | 6CU8 | nu | 6EM8 | n | 10DE7 | n | 12BH7 | nu | 17DQ6 | nu |
| 1B3 | nu | 3BU8 | nu | 4BZ6 | u | 5B8 | n | 5U8 | u | 6AN8 | nu | 6AX5 | n | 6BN6 | nu | 6GG8 | n | 6CX8 | u | 6ES8 | u | 10JY8 | n | 12BK5 | n | 19AU4 | n |
| 1D21 | n | 3BY6 | n | 4BZ7 | u | 5BK7 | n | 5V6 | u | 6AQ7 | nu | 6BA7 | n | 6BQ5 | u | 6GK4 | u | 6CY5 | u | 6EZ5 | n | 12AD6 | n | 12BQ6 | u | 19BG6 | n |
| 1E2 | nu | 3BZ6 | nu | 4CB6 | nu | 5BR8 | n | 5X8 | n | 6AR5 | n | 6BC5 | nu | 6BQ6 | nu | 6GL6 | n | 6CY7 | u | 6GK6 | n | 12AF3 | n | 12BY7 | nu | 25AC5 | n |
| 2BN4 | nu | 3CB6 | nu | 4CS6 | n | 5CG8 | nu | 6AC5 | nu | 6AR6 | u | 6BC7 | u | 6BQ7 | nu | 6GL8 | u | 6CZ5 | u | 6JZ8 | n | 12AH7 | nu | 12BZ7 | n | 25AV5 | n |
| 2CY5 | u | 3CS6 | nu | 4DK6 | u | 5CL8 | nu | 6AC7 | nu | 6AS5 | nu | 6BD6 | n | 6BW8 | n | 6GM6 | n | 6DA4 | u | 6ME10 | u | 12AJ6 | u | 12CA5 | nu | 25AX4 | nu |
| 2GK5 | u | 3DK6 | u | 4DT6 | n | 5CM8 | n | 6AD6 | n | 6AS7 | u | 6BF5 | n | 6BX7 | u | 6GM7 | nu | 6DB5 | u | 6U8 | nu | 12AL5 | u | 12DQ6 | u | 25BK5 | n |
| 2W3 | nu | 3DT6 | nu | 4EJ7 | u | 5CQ8 | n | 6AD7 | n | 6AS8 | n | 6BF6 | n | 6BY5 | nu | 6GM8 | n | 6DE6 | u | 6V3 | n | 12AV7 | nu | 12DT5 | u | 25BQ6 | nu |
| 3AL5 | u | 3DZ4 | u | 4HT6 | u | 5DH8 | u | 6AE6 | n | 6AT8 | nu | 6BG6 | u | 6BY6 | u | 6GN7 | u | 6DM7 | n | 6V4 | n | 12AX4 | nu | 12EG6 | u | 25CD6 | n |
| 3AU6 | nu | 3ER5 | n | 4JC6 | u | 5FG7 | u | 6AF6 | nu | 6AU4 | u | 6BH6 | n | 6BY8 | u | 6GQ8 | n | 6DQ6 | n | 6W4 | nu | 12AX7 | u | 12EK6 | n | 25DN6 | n |
| 3AV6 | n | 3GK5 | n | 5AM8 | u | 5GX7 | u | 6AN4 | n | 6AU5 | nu | 6BH8 | u | 6BZ7 | n | 6GR6 | n | 6DT6 | u | 7AU7 | nu | 12AZ7 | u | 12FX5 | n | 25W4 | n |
| 3B2 | u | 4AU6 | u | 5AN8 | nu | 5J6 | n | 6AH6 | n | 6AU8 | nu | 6BK5 | nu | 6CB5 | u | 6GS6 | nu | 6DX6 | n | 8AW8 | nu | 12BA7 | n | 13DE7 | u | 35EH5 | u |
| 3BA6 | u | 4AV6 | u | 5AQ5 | nu | 5KE8 | n | 6AJ5 | n | 6AV5 | u | 6BK7 | nu | 6CB6 | nu | 6GS7 | u | 6EA7 | n | 9AD7 | n | 12BD6 | n | 13DR7 | u | 50EH5 | u |
| 3BC5 | u | 4BN6 | u | 5AT8 | nu | 5LJ8 | u | 6AK6 | n | 6AW8 | nu | 6BL7 | u | 6CD6 | n | 6GU6 | n | 6EA8 | u | 9BR7 | u | 12BF6 | n | 17AX4 | nu | | |

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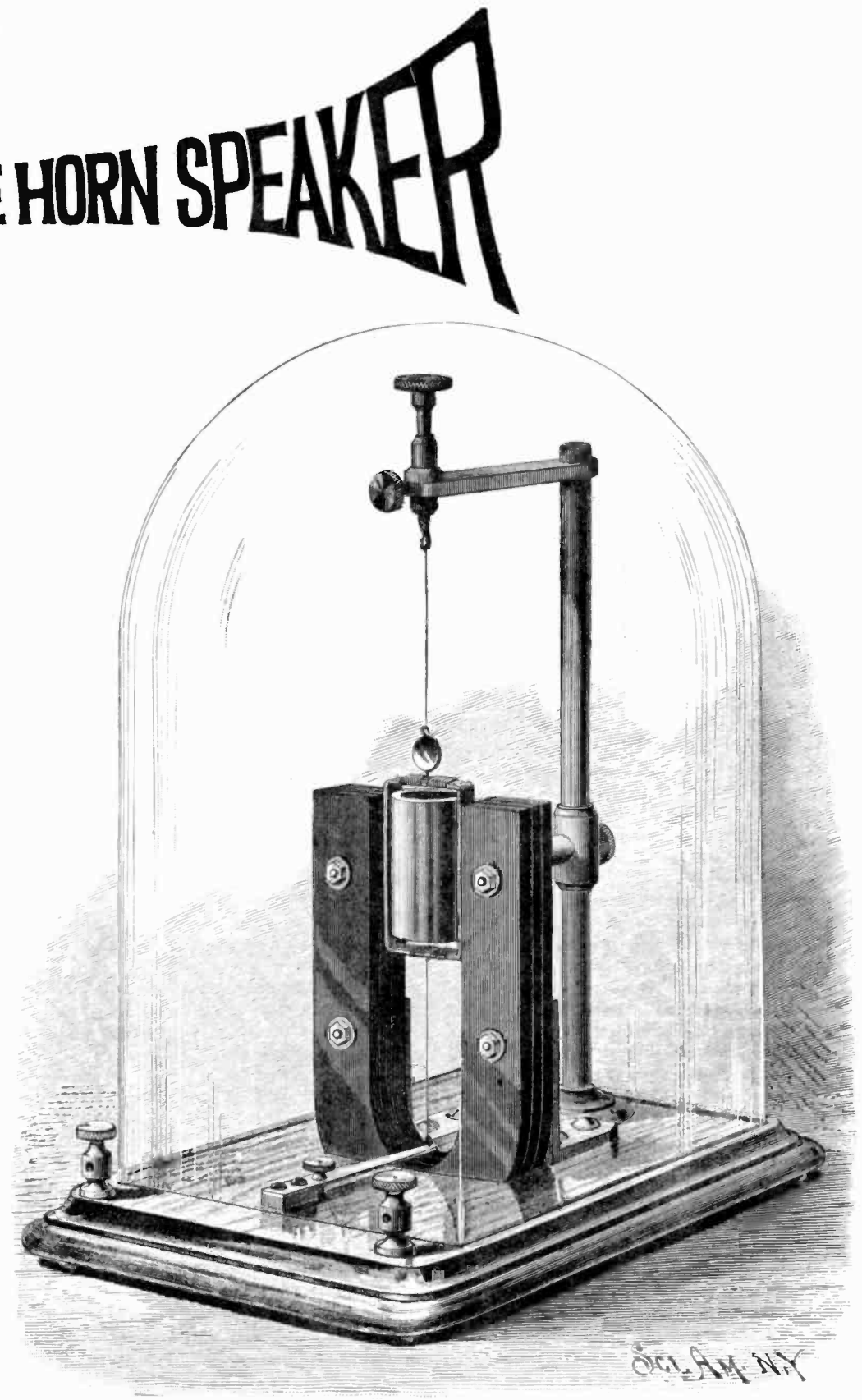

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