

The Moorhead Tube



**A Perfect Vacuum Tube Detector. A Positive Sensation
Contains No Grid Electrode
Absolutely No Patent Infringement**

Exceedingly stable in operation and reduces static 50%

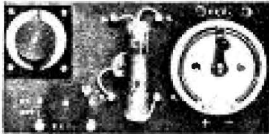
We guarantee the Moorhead tube to be vastly more sensitive than any other type of detector, including our TRONS and ELECTRON RELAY.

**Persistent Oscillator for Undamped Wave Reception.
Super-Sensitive Detector for Damped Wave Reception.
Powerful Amplifier All in One.**

**Guaranteed for Twelve
Hundred Hours**

**Special Introductory Price
\$6.50 Prepaid**

*Operates in Any Circuit—4 volt filament 15 to 35 volt plate.
Delivery guaranteed. Full instructions.*



**Sets for Moorhead Tubes
Special "B" Battery
Potentiometer Control
Ready for Use
\$16.50 Prepaid**

Write for Circulars

DEALERS—Get our proposition. We are not affected by present patent suits or future infringements. Get in on this

Pacific Research Laboratories, Sole Manufacturers

**PACIFIC LABORATORIES SALES DEPARTMENT
534 Pacific Building SAN FRANCISCO, CALIF.**

Fig. 176.

THE SAGA OF THE VACUUM TUBE

By **GERALD F. J. TYNE**

Research Engineer, N. Y.

Part 16. The early manufacture and sale of the "Electron Relay" and other amateur tubes by Otis B. Moorhead.

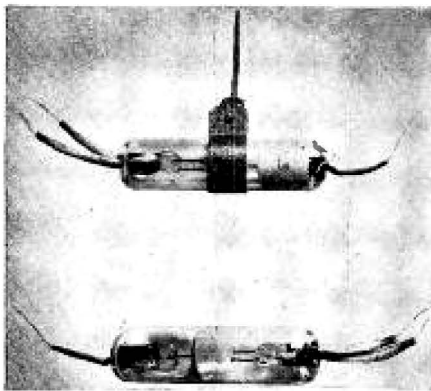


Fig. 177.

IN THE preceding installment of this series there was discussed a number of the so-called "independent" tubes, made prior to the advent of broadcasting and intended primarily for the amateur trade. One of these was the "Audio Tron," made by Elmer T. Cunningham, and which was later manufactured under license. The only other early independent manufacturer to follow a similar procedure, so far as the author has been able to ascertain, was Otis B. Moorhead, of San Francisco.

The first of the Moorhead tubes was known as the "Electron Relay," and

this same name was applied to many of the later tubes which he made. It was the work of Moorhead and Ralph Hyde, and it first appeared in April, 1915.²³³ Moorhead, who had for some time been an ardent radio fan, had worked in the de Forest booth at the Panama-Pacific Exposition early in the year, selling Audions. They sold so well that he was impressed with the possibilities of reaping a financial harvest by their manufacture. Hyde, who was an expert glass blower, had formerly been Superintendent of the Oakland Mazda Lamp Works of the General Electric Company, and had



Fig. 178.

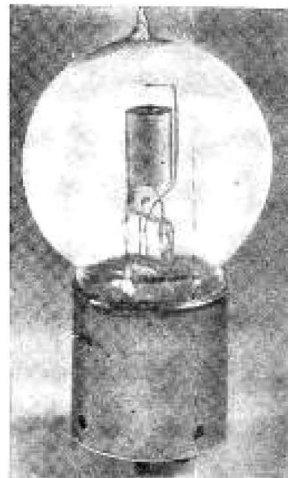


Fig. 179.

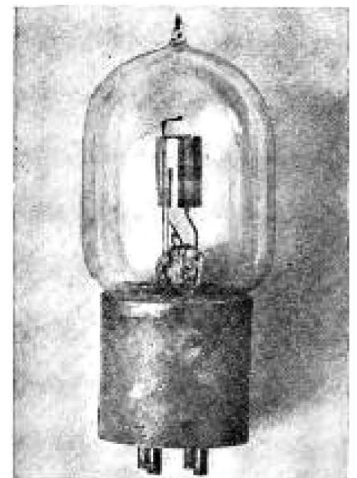


Fig. 180.

been repairing Audions as a sideline.²³⁴ He left the employ of the General Electric Company on March 1, 1913, and later worked with E. T. Cunningham in the manufacture of the "Audio Tron." Hyde joined forces with Moorhead in 1915 to produce the Electron Relay, but this combination later split up and Hyde went back to making bulbs for Cunningham.

The first advertisement announcing the "Electron Relay" for sale appeared in July, 1916,²³⁵ and announced that "the former manufacturers of the Audio Tron are now making a newer and better tube." The Electron Relay was advertised for use as an amplifier, detector, or oscillator, and could be obtained with either single or double filament. The "guaranteed" life was 400 hours per filament, and the price of the double filament type was quoted as \$5.50. The advertisement was signed by "Pacific Research Laboratories—O. B. Moorhead, Manager."

The Electron Relay so advertised was similar in appearance to the Audio Tron, having a straight axial filament of tungsten, a coarse spiral grid of heavy (about No. 18 B. & S.) copper wire, and an anode of aluminum sheet bent into the form of an almost-closed cylinder. It was claimed that these materials were chosen because of their relative positions in the electrochemical series "and also because we could procure these metals with ease on the Pacific Coast."²³⁶ It can scarcely be doubted that the latter of the two reasons was the controlling one. It was claimed that the Electron Relay was a "high-vacuum" device, being exhausted to a vacuum better than .04 mm. mercury.

The avowed purpose of the production of this new device was to "bring the sacred Audion to terms." What it first succeeded in doing was having the makers prosecuted for infringement of the Audion patents. With the Audio Tron, however, it furnished a source of tubes for the lean-pursed amateur and resulted, as has been previously told, in de Forest's putting on the market a similar tube, sold

without the necessity of purchasing the \$18 "little red box."

Although the author has been unable to find any advertisement prior to July, 1916 offering the Electron Relay for sale, it apparently had been sold to a considerable extent in 1915, since on February 15, 1916 the de Forest Radio Telephone and Telegraph Company filed complaint against Moorhead and Hyde, alleging infringement of seven of the de Forest patents. Several Pacific Coast radio "experts" submitted affidavits in reply to the complaint and in support of Moorhead and Hyde. This action was brought at the same time as that against Cunningham.

The action was begun by requesting an injunction against Moorhead, Cunningham, Hyde, and others. The Justice before whom the preliminary action was brought ruled²³⁷ that since the validity of the de Forest patents had not yet been passed on, an injunction would not be granted, but that an indemnity bond would be required from the defendants until the question of validity had been settled. Apparently Moorhead posted the required bond since in July of 1916, the advantage of operating sub rosa having been eliminated by the court proceeding, the above-mentioned advertisement appeared.

The next advertisement, which appeared the following month (August, 1916)²³⁸ announced that there had been a "25% improvement" in the Electron Relay during the preceding month, claimed that the new tube was the "Most Sensitive Wave Responsive Device Known," and was signed by the "Pacific Laboratories Sales Department," Moorhead's name not being mentioned.

Apparently Moorhead did not feel too secure in the matter of patent infringement since the next advertisement²³⁹ was for a totally different tube, the "Moorhead Tube," with a single filament, but guaranteed for 1200 hours operation, and claiming a much superior performance. This advertisement is reproduced in Fig. 176.

A photograph of this tube, given in Fig. 177, shows the radical change in construction. The anode had been changed from aluminum cylinder to aluminum disc, the filament from straight to hairpin-shaped, the grid removed from the tube and replaced by an external control electrode in the form of a perforated band of brass, clamped around the outside of the tube opposite the filament-anode space. The filament of this tube was intended for operation at 4 volts, and the anode voltage was stated to be 10 to 35 volts.

The manufacturer of the tube was indicated by the marking "Moorhead—Patent Pending" in raised letters on the circular disc anode. It is worthy of note that this was the first of the independent tubes to bear the name of the maker indelibly impressed thereon, and to carry information as to operating conditions. This tube with the external control electrode continued to be advertised for the remainder of that year.

Apparently this new construction was not as great an advance over the former one as was claimed, since with the advertisements in January, 1917²⁴⁰ the external control electrode tube was given less attention and the Electron Relay came again to the fore. The Electron Relay which was advertised had again undergone improvement "within the last thirty days" and the "improved tube" could be identified by the letters "ER" stamped on the cylindrical anode. This tube is shown in Fig. 178. It may well be that the decision handed down in an Eastern court, holding the de Forest Audion patent to be subservient to the Fleming diode patent, had something to do with the reappearance of the Electron Relay.

In February, 1917 the "Pacific Research Laboratories" was taken over by "Moorhead Laboratories, Inc."²⁴¹ but the advertisements for the Moorhead tubes continued to be signed by the "Pacific Laboratories Sales Department."

In this month Moorhead sent to the

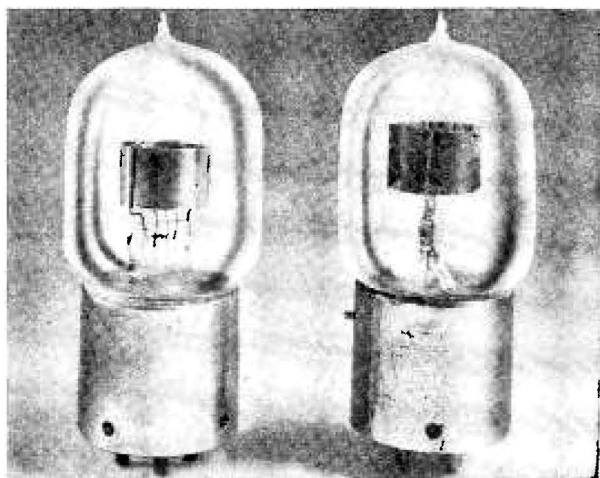


Fig. 181.

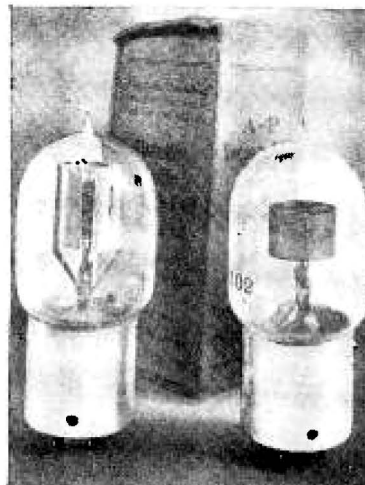


Fig. 182.

-and here it is!

Licensed for use only in apparatus manufactured by the De Forest Radio Tel. & Tel. Co.

You have hoped for it. You have looked for it. You have asked for it. And here it is—a transmitting tube for telephone and telegraph C-W transmission, built right up to British and to French Government specifications. Capacity about 12.5 watts, and any number may be used in parallel—four, make telephone conversation possible over 25 miles, telegraph signals over 50 miles.

The plate of this transmitting tube is nickel, a special molybdenum grid is provided and the high vacuum permits operation on plate potentials of five hundred volts without breakdown.

By connecting the grid and plate together, the tube may be used as a rectifier for obtaining from an alternating current supply the high plate potential necessary for the generator tube.

Adapted by the De Forest Radio Tel. & Tel. Co. as its standard transmitting tube for all De Forest sets of ten class. Licensed under the De Forest, Audion and Fleming patents. Other patents applied for and pending.

Atlantic Radio Supplies Co. Pacific Radio Supplies Co.
5 Kirk Place, Newark, N. J. 638 Mission St., San Francisco, Cal.

Distributors for Moorhead Laboratories, Inc., Manufacturers of

Equipped with the SHAW standard four-prong base. PRICE \$7.50. Order from your dealer.

The A-P Transmitting Tube

Fig. 183.

—for experimental cw

NEW A-P RECTIFIER TUBE MAKES EXPENSIVE HIGH VOLTAGE D-C GENERATOR UNNECESSARY.

A wonder—this newest A-P tube—a Rectifier that can be used effectively with any transmitter tube of any voltage up to 750, and without a high voltage D-C generator. Step up your 110 V A-C lighting supply to 350, 500, or 750 volts, using a small transformer, and two of the new A-P tubes do everything else, rectifying both halves of the cycle so the plates of your transmitter tubes get all the high potential direct current necessary—without the use of a high voltage D-C generator.

The A-P Rectifier has a 75 milliamperes carrying capacity, which is sufficient to operate five A-P Transmitting Tubes in parallel. For high power CW transmission, use additional A-P Rectifier Tubes in parallel.

A-P Rectifiers used in Type O A-C De Forest Radiophones, equipped with the SHAW standard condense four-prong base, and licensed under SHAW patents. Price \$9.75. Order from your dealer, or direct from each address below.

Diagram of Connections Furnished Free With Each Tube

And for the best book on Radio, ask your dealer for "Elements of Radiotelegraphy" by Lieut. Eilery W. Stone, U. S. N., or order direct from—

ATLANTIC RADIO SUPPLIES CO.
5 KIRK PLACE, NEWARK, NEW JERSEY

PACIFIC RADIO SUPPLIES CO.
638 MISSION ST., SAN FRANCISCO, CAL.

Fig. 184.

Institute of Radio Engineers a paper entitled "The Manufacture of Vacuum Detectors."²⁴² In this paper he described the processes used in the manufacture of the Electron Relay. In the light of present-day knowledge of the factors affecting the electrical characteristics of vacuum tubes, one statement contained in that paper is of interest. On page 429 Moorhead says:

"The spacing between the elements is not very critical in this type of device but it is best to wind the grid to a large enough diameter so that it will strike the plate rather than the filament when the tube is jarred."

With the Presidential Proclamation of April 6, 1917 all amateur activity ceased and the amateur market for this apparatus practically disappeared.

During World War I Moorhead made

tubes for the U. S. Navy and for the British Government.²⁴³ Those made for Great Britain were high-vacuum tubes patterned after the British "R" type valve. These tubes could be operated at 6 volts and .84 ampere filament. At 400 volts on the anode the tube was required to dissipate 15 watts for three minutes. When operated at 4-volts filament it had a life of 800 hours. The earlier models, one of which is shown in Fig. 179, had the axis of the element assembly vertical but later they were made with horizontal elements, to conform with the British and French practice. It should be noted that the bulb is spherical, also to conform with foreign practice.

The SE-1444 made for the U. S. Navy during World War I was designed by the Navy Department and made for the Navy by Moorhead. It was similar in construction to the

tube made for British use except that the bulb was cylindrical and the element assembly vertical. It is shown in Fig. 180. The filament of this tube operated at 4.5 volts with a current of .65 ampere. It had a mutual conductance of 180 micromhos, amplification factor of 9 and anode impedance of 50,000 ohms. It was usually operated at 40 volts anode and — 1.3-volts grid.

After the war there existed a stalemate in tube manufacture because of the decision in the Fleming-de Forest patent suit. The first step toward breaking this stalemate was taken on November 30, 1918 when the Marconi Company granted to the Moorhead Laboratories a nonexclusive license to make and sell apparatus under the Fleming patent, for sale to amateurs and to any Government. By the terms of this agreement the Moorhead Laboratories admitted its past infringements; paid damages, and agreed to pay royalties to the Marconi Company on future products. With this agreement in hand the Moorhead Laboratories approached de Forest, with a view to obtaining a license under the de Forest Audion patents.

The end result of negotiations conducted over a considerable period was a series of agreements²⁴⁴ between the Marconi Company, de Forest, Moorhead Laboratories, and Otis B. Moorhead as an individual. These agreements were first concluded on April 30, 1919, and later modified on June 6, 1919. They provided that Otis B. Moorhead and the Moorhead Laboratories were to manufacture tubes for de Forest. De Forest in turn agreed to sell all such tubes to the Marconi Company. The Marconi Company agreed to sell tubes back to the de Forest Radio Telephone and Telegraph Company, to be sold by them to the public for amateur and experimental use in radio reception and amplification. These agreements were to run until February 18, 1925, the date of expiration of the Audion patent, except that they could be cancelled by either party on six months' notice.

The vacuum tubes to be made under these agreements were of several types, described as follows:

Type A—This was a hard amplifier tube, the same as had been supplied to the U. S. Navy during World War I under the designation SE-1444. It had a cylindrical bulb and a standard Navy 4-pin base of the Shaw type. The filament was of drawn tungsten wire, approximately .0024 inch in diameter and about 13/16 inch long. The grid was an 11-turn spiral of nickel wire, with an internal diameter of .167 inch. The plate was of sheet nickel, about .009 inch thick rolled into a cylinder of about 3/8-inch internal diameter. The tube operated with a filament current of about .7 ampere at 4 to 5 volts, and with an anode voltage of 60 to 90 volts.

Type B—This was similar to tube "A" but with low vacuum for operation.
(Continued on page 144)

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Amazing Book Shows How "Crack" operators rely on something besides practice to develop their high speeds and proficiency; it explains the "knack" of sound-send and sound-consciousness—the secret of speedy sending and receiving. Once you acquire these mental processes, reading code becomes almost second nature to you; just as the swing rhythm of a dance band becomes automatic to musician and dancer.

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Used in training Commercial Operators, Amateurs, and Radiotelegraph Specialists in Signal Corps, Navy, Marine Corps, Coast Guard, Naval Reserve, Airlines. Wherever the fastest and most efficient operators are found, there you will find Candler trained men.

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an analogy. It is a fact that every automobile manufacturer who has attempted to put on the market an automobile considerably lower in price than the cheapest models available had to either withdraw it or go bankrupt. Car quality is something one can discover by use, despite all the salesman's glowing promises, and it is my opinion that the same will hold true for television; picture quality is an item everyone will be able to judge as the movies have already set standards for us. To return once more to the automobile industry we find that manufacturers produced thousands of cars per year (3,698,328 in 1940) at a price of approximately \$1,000.00 each. A large percentage of these cars were bought for pleasure use, and of these the greater part was purchased by people of average means. This was made possible by the medium of installment buying, a highly successful American institution. If the public was only eager to buy the lowest-priced cars, the large percentage of "de Luxe" and "Custom de Luxe" sales would have been impossible. It is my firm belief that once the public has been educated to the point where they conclusively will know that they cannot expect quality below a certain price level, buying of television receivers, will speed up, helped, of course, by the "deferred payment plan."

Good programs will have to be provided simultaneously, just as good roads spurred the automobile sales skyward. To sum up, it is my opinion that the industry is on the wrong track in trying to provide "cheap" television, that the public probably will not accept. Educational advertising has worked miracles before, and can still be relied upon to put commercial television over the top.

-30-

Saga of the Vacuum Tube

(Continued from page 54)

tion as a detector with 18 to 40 volts on the anode.

Type C—This was similar to type "A" except that the grid was of molybdenum instead of nickel of 22 turns with a pitch of .030 inch. It was to operate at anode voltage of 80 to 500.

Type D—This was the same as the unbased "Electron Relay" previously made by Moorhead.

Type E—This was the British Standard Type "R." It was similar to type "A" except that it employed a spherical bulb, and was based with the British standard 4-pin base.

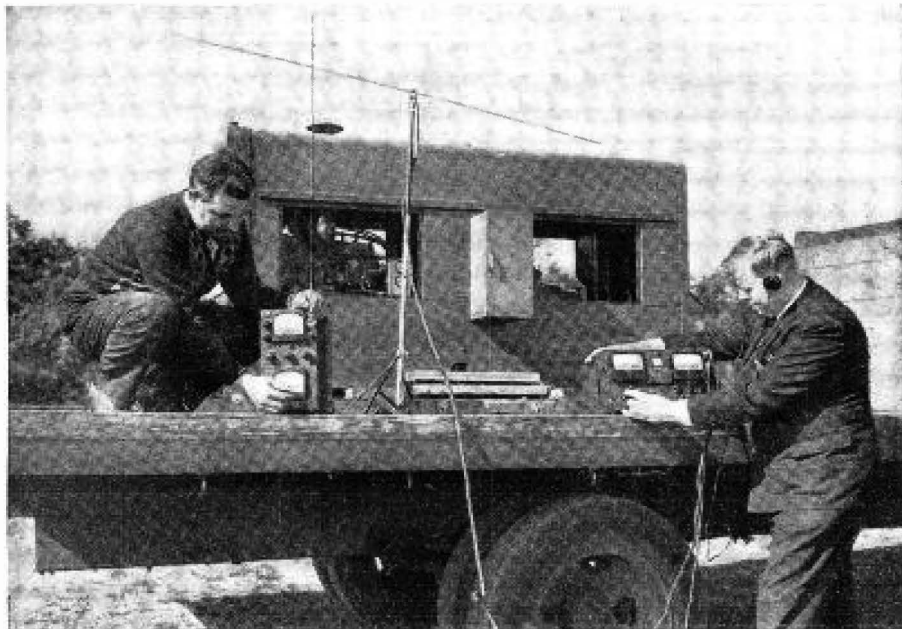
Type F—This was similar to type "E" but with low vacuum, like type "B."

Type G—This was similar to type "C" but in a spherical bulb and with British standard 4-pin base. This was the same as the British Standard Type "B" tube.

The tubes advertised and sold by the Marconi Company in 1919 and early 1920 as the "Marconi VT" were Type "A" and Type "B" as described above. In the advertisements Type "A" was designated as "Marconi VT—Class II" and Type "B" as "Marconi VT—Class I."²⁴⁵ A life of 1500 hours was claimed for these tubes.²⁴⁶

The first group of these tubes, about 25,000 in number, which were delivered to the Marconi Company, bore no Marconi or de Forest markings. They were stamped on the glass with the legend "Moorhead Audion—San Francisco." The cartons in which they were packed were marked to restrict their use to amateur and experimental purposes. About 8,000 of these tubes were sold. The balance had the words "Patented Nov. 7, 1905—Sold

A Golf Course serves as an ideal location for Tobe Deutschmann filter engineers in field-testing a military power plant, using a newly designed Filterette.



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4" — \$1.00 6" — \$1.20 10" — \$2.00
5" — \$1.10 8" — \$1.65 12" — \$2.25

PROMPT SERVICE
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only for amateur and experimental use" stamped on the bulb before being sold.

Subsequently, the brass bases carried both the Marconi and de Forest markings, Fleming and de Forest patent numbers, and the restrictive legend. See Figs. 181 and 182.

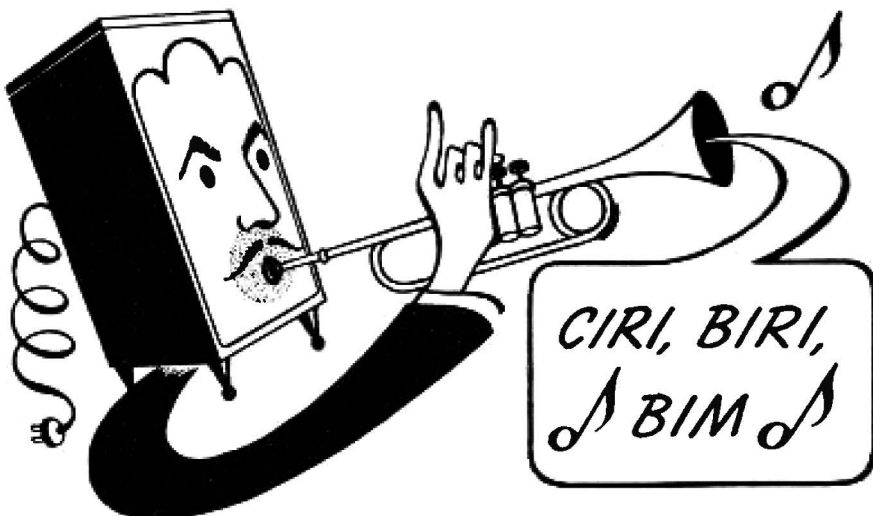
The contracts between Moorhead Laboratories, the de Forest Radio Telephone and Telegraph Company, and the Marconi Company were cancelled on January 30, 1920 by the Marconi Company, the cancellation being effective, in accordance with the six months' clause, on July 30, 1920. This was probably done because the necessary de Forest license was in a fair way of being acquired by the Marconi Company's successor, The Radio Corporation of America, by virtue of the cross-license agreements between RCA, AT&T Co. and General Electric Company, concluded on July 1, 1920, a month before the cancellation finally became effective. A contributing factor to this cancellation undoubtedly was the fact that the Marconi Company experienced great difficulty in obtaining from the Moorhead Laboratories deliveries of sufficient satisfactory tubes to meet their demand. All the shipments received contained a large percentage of defective tubes, in some cases as high as 75%, which had to be weeded out before deliveries could be made to customers.

Meantime, the Moorhead Laboratories, early in 1920, underwent a reorganization and de Forest became associated with them.²⁴⁷ Two distributing companies were formed, the "Pacific Radio Supplies Company" to handle business in the West and the "Atlantic Radio Supplies Company" to be the East Coast distributors.

The first tubes offered for sale by this combination were the unbased Electron Relay, shown in Fig. 178, and the "Moorhead VT Amplifier-Oscillator."²⁴⁸ The unbased Electron Relay was soon replaced by another soft tube, also denoted as the "Moorhead Electron Relay."²⁴⁹ Early designs of this tube had a cylindrical anode and spiral grid. Both grid and anode were supported only from the press, the upper ends being left free. This construction was extremely sensitive to mechanical disturbances, since the grid and anode were free to vibrate under mechanical impulses. Two tubes of this construction are shown in Fig. 181. They differ in the fact that the surfaces of the anodes are unlike. That at the left in the figure has a glossy, almost polished, surface, whereas the one at the right has a dull, possibly oxidized finish. It will be noted also that the diameter of the anode was somewhat greater than that used in the hard amplifier tube.

A later type of Moorhead Electron Relay, in which steps have been taken to reduce the sensitivity to mechanical disturbances, is shown in Fig. 182. In this tube the anode structure has been extended at the top to permit the addi-

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That's me back in '41 when I was new. Among the first programs I carried was one of a new band, headed by a Harry James. The kids said he played "divinely." I played pretty well myself then, too, but I've worked so many long steady hours in the past four years I should be in a service shop this very minute. A lot of my contemporaries are. It's a lucky thing for us—and radio

servicemen—that Rider Manual Vol. XIV is now out for they make the diagnosis and correction of our ills easy, fast and accurate. We radios have our war job and we want to be working at it with as few interruptions as necessary. When you order Rider Manual Vol. XIV from your jobber, please be patient if he is out of it right then. He and the Rider folks will get your volume to you as fast as WPB limitations permit.

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 Two to five times as fast as slide rule . . . 7.50
Hour-A-Day-with-Rider Series—
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If you are short of money, you can start now and pay most of your tuition after you graduate. Many earn while learning. Free Lifetime Employment Service to graduates. EXTRA training in INDUSTRIAL ELECTRONICS — no extra cost.

FREE BOOK

Whether you're 16 or up to 40, get the facts. Big illustrated booklet tells about your future in Radio-Electronics-Television. Mail coupon today.

Men with Physical Disabilities—we have special facilities for you, if you have a physical disability of any kind write me when you send coupon.

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500 S. Paulina St., Dept. 35-1K, Chicago 12, Illinois
Send me FREE BOOK on COYNE RADIO-ELECTRONICS-TELEVISION TRAINING, extra Industrial Electronics course, and details of "Pay-After-Graduation" Plan.

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ADDRESS.....

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6AC5	.61
6SA7	.61
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*39-44	.54

*65N7 Adaptor to replace 2525-No. 1.....\$.60
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WINDINGS—Two 5V. @ 3 amps. ea.
One 6.3V. @ 3.6 amps.
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Size: 4¼ H. x 4¾ W. x 3¼ D.
Shipping Wt. 8 lbs.

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tion of a mica spacer to position the grid more accurately with respect to the anode and to provide mechanical support. Also the bottom of the anode has been extended in the form of two tabs which are bent to rest against the sides of the press, and thus provide stiffening for the element assembly to some extent.

The other tube which was offered for sale at this time, the "Moorhead VT Amplifier-Oscillator," was the same as the Marconi VT—Class II.

Beginning with the August, 1920²⁵⁰ advertisement, these tubes were designated as the "A-P Electron Relay" and "A-P Amplifier-Oscillator" and were represented as being licensed under the de Forest and Fleming patents. This was misrepresentation, since the license under the Fleming patent had been cancelled as of July 30, 1920. The December advertisements²⁵¹ announced the "A-P Transmitting Tube," which was the same tube as had been made for the Marconi Company under the designation "Type C" above. This also was represented as being licensed under the Fleming and de Forest patents. See Fig. 183. Still another tube, designated as the "A-P Rectifier" was advertised as shown in Fig. 184, in May and June of 1921.²⁵² It will be noted, however, that this advertisement makes no claim as to license.

Shortly after these advertisements began to appear the Moorhead Laboratories were notified by the Radio Corporation of America, successor to the Marconi Company, that these tubes were not licensed under either the Fleming or de Forest patents. The finances of the Moorhead Laboratories were in a chaotic condition, and the business was being managed by a stockholders-creditors committee, of which Henry S. Shaw was the Chairman. Considerable stocks of raw materials were on hand and the indebtedness was large. In order that the situation might be cleared up to the benefit of all concerned negotiations were entered into and the Radio Corporation granted to the Moorhead Laboratories a license, dated January 25, 1921, under the Fleming and de Forest patents, for the manufacture and sale of a limited number of tubes. This license was delivered to the Moorhead Laboratories in July of 1921, and subsequent advertisements stated correctly that the tubes were being made and sold under license from RCA.

After this license had run its course the Moorhead Laboratories consented to an injunction restraining from the further manufacture or sale of vacuum tubes.

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248. Advertisement of Pacific Radio Supplies Company, *Pacific Radio News*, Vol. 1, No. 10, May, 1920, inside back cover.
249. Advertisement of Pacific Radio Supplies Company, *Pacific Radio News*, Vol. 1, No. 11, June, 1920, inside back cover. *Radio Amateur News*, Vol. 1, No. 12, page 711. QST, Vol. 3, No. 11, June, 1920, page 73.
250. Advertisement of Pacific Radio Supplies Company, *RADIO NEWS*, Vol. 2, No. 2, August, 1920, page 119.
251. Advertisement of Pacific Radio Supplies Company, *RADIO NEWS*, Vol. 2, No. 6, December, 1920, page 389. QST, Vol. 4, No. 10, December, 1920, page 99.
252. Advertisement of Pacific Radio Supplies Company, *RADIO NEWS*, Vol. 2, No. 11, May, 1921, page 833. QST, Vol. 4, No. 10, May, 1921, page 99.

CAPTIONS FOR ILLUSTRATIONS

Fig. 176. Advertisement announcing Moorhead Tube with external control electrode. Reproduced from page 355 of September, 1916, *Electrical Experimenter*.

Fig. 177. Moorhead Tube with external control electrode. Bottom—with control electrode removed. Note raised marking on anode. Top—complete tube assembly. Photograph courtesy Bell Telephone Laboratories.

Fig. 178. Moorhead Electron Relay, original unbased type. Note marking "ER" on anode. Photograph courtesy Bell Telephone Laboratories.

Fig. 179. Moorhead version of British Type "R" in spherical bulb.

Fig. 180. Marconi VT.

Fig. 181. A-P Electron Relays. Left—with glossy surfaced anode. Right—with dull surfaced anode.

Fig. 182. A-P Electron Relays. Right—same tube as at right in Fig. 181, but turned 180 degrees to show de Forest marking on base. Left—improved construction with mica spacer and bracing tabs. Anode is aluminum.

Fig. 183. Advertisement announcing A-P Transmitting tube. Reproduced from page 389 of December, 1920 *RADIO NEWS*.

Fig. 184. Announcement of A-P Rectifier Tube. Reproduced from page 911 of June, 1921 *RADIO NEWS*.

(To be continued in May issue)