

July 24, 1928.

1,678,077

W. T. POWELL  
THERMIONIC TUBE CIRCUITS

Filed Sept. 17, 1924

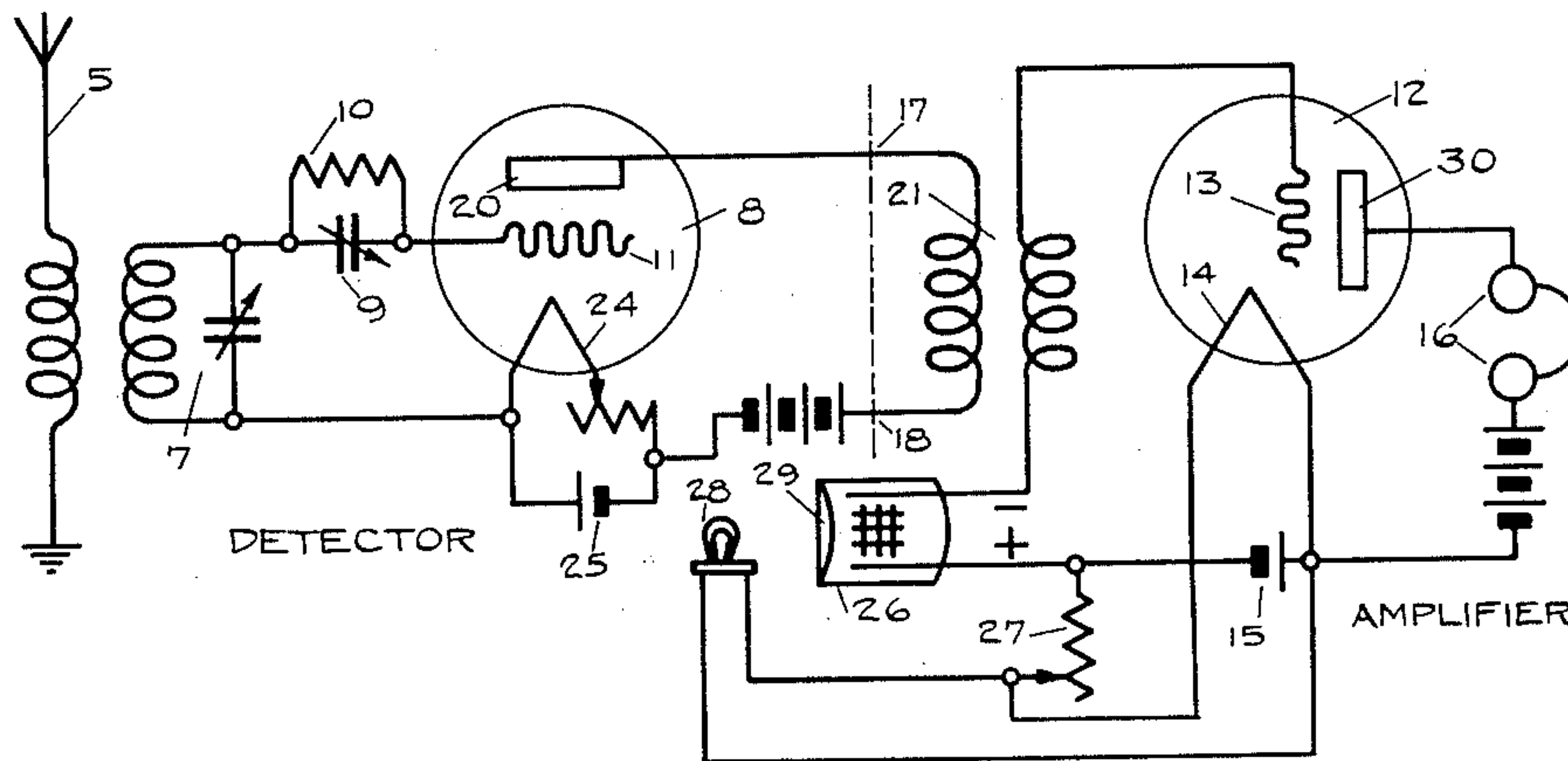


FIG. 1

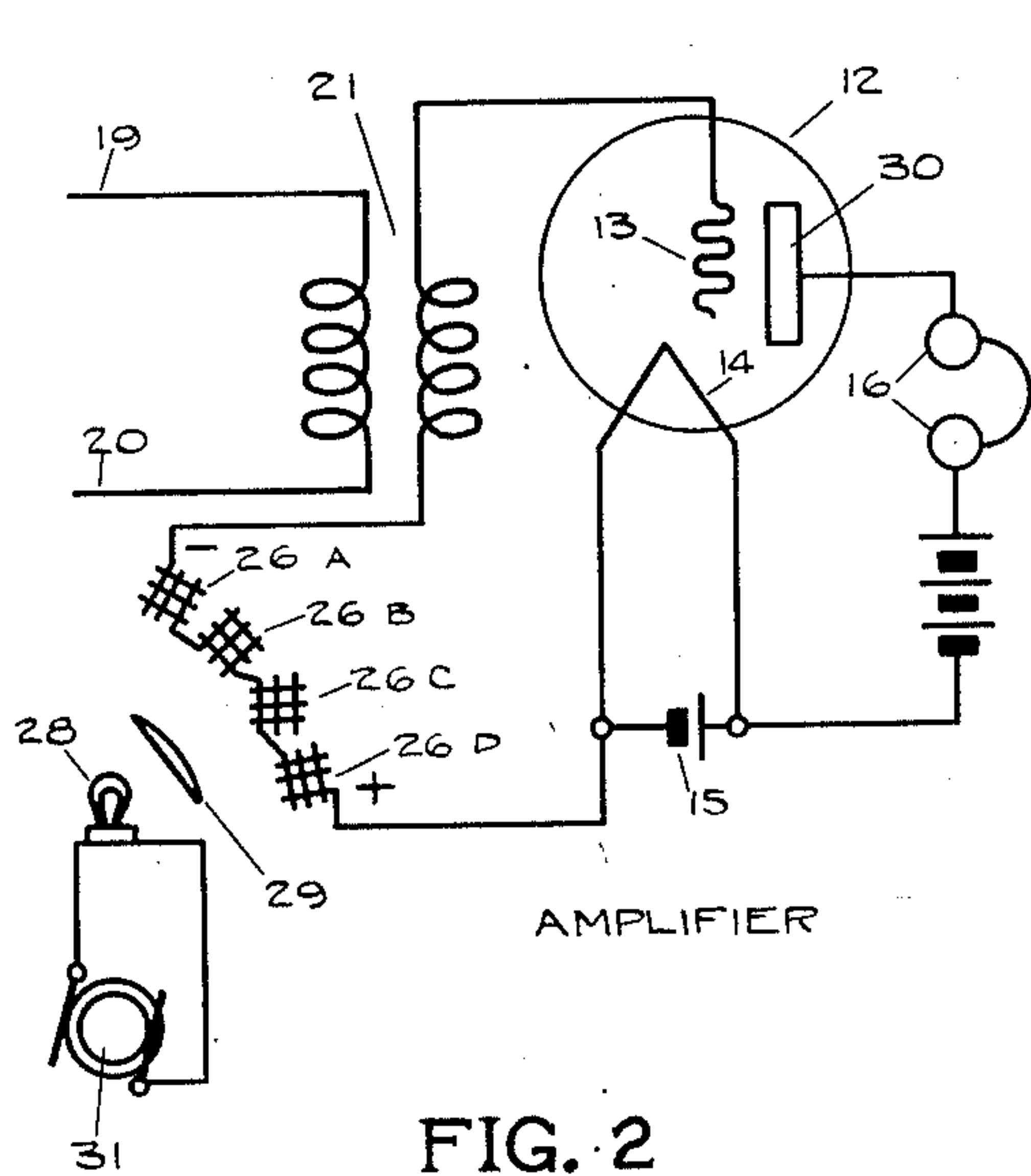


FIG. 2

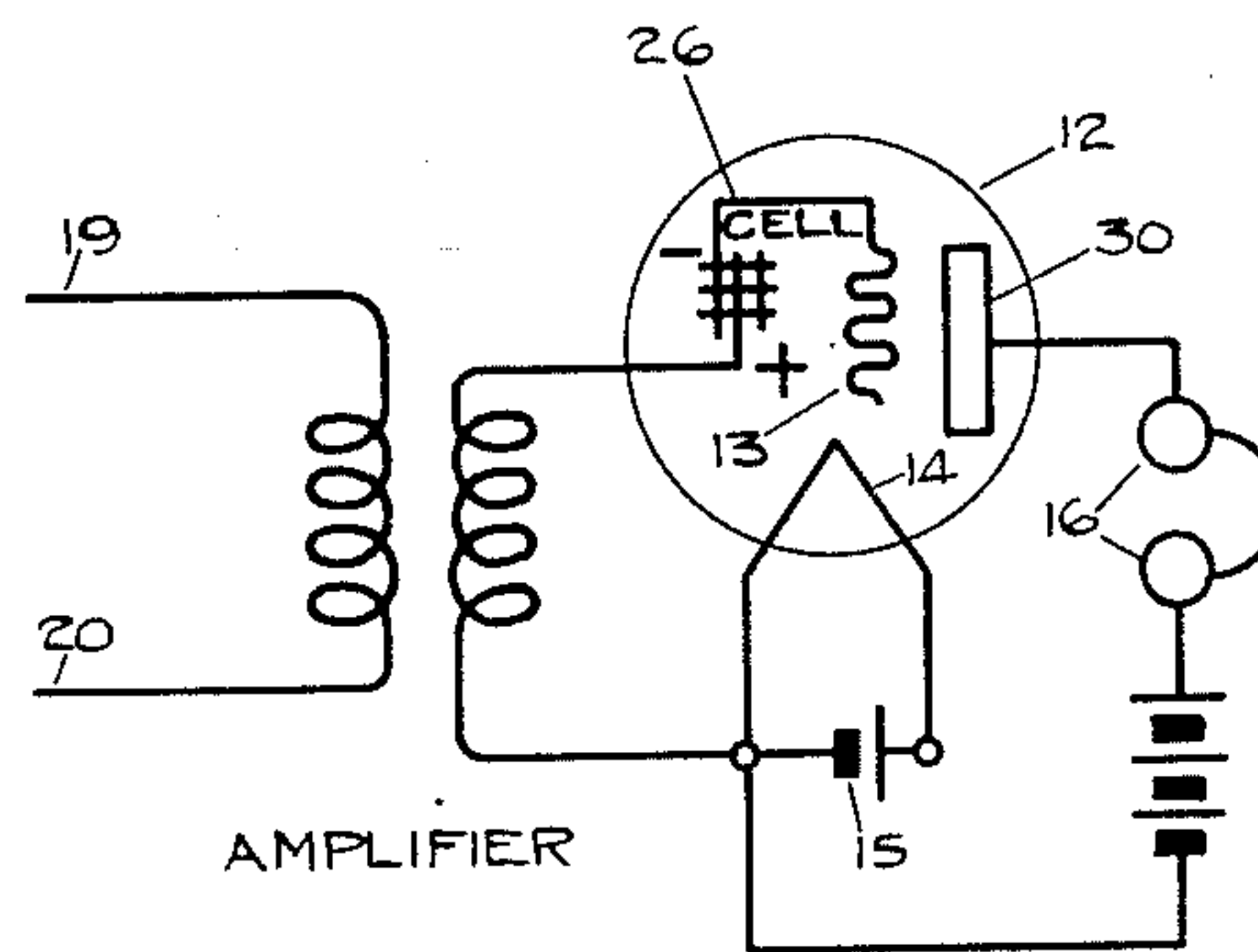


FIG. 3

INVENTOR  
WINFRED T. POWELL  
BY *D. Clyde Jones.*  
ATTORNEY

## UNITED STATES PATENT OFFICE.

WINFRED T. POWELL, OF ROCHESTER, NEW YORK, ASSIGNOR TO THE STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY, OF ROCHESTER, NEW YORK, A CORPORATION OF NEW YORK.

## THERMIONIC-TUBE CIRCUITS.

Application filed September 17, 1924. Serial No. 738,206.

This invention relates to amplifying devices and more particularly to such devices in which thermionic tubes are employed.

It has been noted that radio devices operate more satisfactorily if the control element or grid is maintained at a certain difference of potential with respect to its filament. In obtaining this result, small sized batteries have been employed, which are known in the telephone art as "C" batteries. These batteries are not only a source of expense due to the fact that they must frequently be replaced, but their voltage varies during the life of the battery.

In accordance with the present invention it is proposed to employ one or more cells which develop an electromotive force under the influence of light, to replace certain of the batteries now in use in thermionic devices.

More specifically this invention resides in the use of a selenium cell for maintaining the proper difference of potential on one of the elements of a thermionic device.

Other specific features of this invention will appear from the description and appended claims.

In the drawings Fig. 1 represents a radio receiving set including an antenna, a detector device with its control circuits and an amplifier device of the vacuum tube type in which a photoelectric cell is connected to the grid of the amplifier. Fig. 2 shows a modified form of the amplifier in which several photoelectric cells are connected in series and are energized by a lamp, lighted by alternating current. It will be understood that the amplifier of Fig. 2 may replace the amplifier appearing at the right of the dotted line of Fig. 1. Fig. 3 shows still another modification of the present invention in which the photoelectric cell is enclosed within the evacuated envelope of the amplifier tube, so that it is energized from the light of the filament. The amplifier of Fig. 3 may likewise be substituted for the amplifier of Fig. 1 to cooperate with the detector arrangement of that figure.

Referring especially to Fig. 1, 5 designates an antenna which is inductively coupled to a tuned input circuit 7 of a three-element detector or thermionic tube 8. This input circuit includes the grid condenser 9 and well known grid leak 10 in series with the con-

trol element or grid 11. The input circuit is also connected to one side of the filament 24, which is lighted from the filament battery 25. The output circuit extending from the plate 20 and one side of the filament lighting circuit is inductively coupled by a transformer 21 to the input circuit of the amplifier tube, generally designated 12. This input circuit includes a photoelectric element 26 and is connected at one point to the grid 13 and at its other end to the filament 14 through battery 15. This photoelectric element may be in the form of a polarized selenium cell, which is capable of developing a difference of potential under the influence of light. A particular type of selenium cell which is effective for the purpose specified, is known as the Fritts type, described in chapter 2, on page 16 of the treatise, entitled "Selenium cells", by T. W. Benson.

This cell is formed by melting selenium directly on a copper plate and pressure is then applied so that the soft selenium enters into chemical combination with the copper and adheres firmly thereto in the form of a thin film. When the selenium film is cooled, gold leaf is applied thereto. The gold leaf forms one electrode and the copper plate the other electrode of the cell. Suitable protecting strips serve as a mounting frame and a sheet of very thin mica serves as a protection to the gold foil surface.

The filament of the amplifier tube is lighted from a source of "A" battery 15, regulated by a rheostat 27. This battery serves to light the lamp 28 and its light is focused on the selenium cell by the lens 29. The rheostat 27 provides means for varying the intensity of light from lamp 28, so that any desirable amount of difference of potential may be applied to the grid 13. The output circuit of the amplifier including the receivers 16 extends from the plate 30 to one side of the filament 14.

In the operation of this circuit an incoming signal is received on the antenna 5 and is induced into the tuned circuit 7 to effect the controlling element or grid 11 of the detector tube. As is well known the detector transforms the incoming signal into audio frequency currents which the transformer 21 transfers to the input circuit of the amplifier. These audio frequency currents are amplified by the amplifier 12, so that they are audible

in the receivers 16. The photoelectric cell 26 applies such a negative potential to the grid 13 of the amplifier with respect to its filament that it functions without substantial distortion.

The amplifier of Fig. 2 is substantially similar to that of Fig. 1 and may be substituted therefor, by connecting the portion of the detector at the left of the dotted line, at points 17 and 18 to the conductors 19 and 20 of Fig. 2. In this modification several photoelectric cells, 26<sup>A</sup>, 26<sup>B</sup>, 26<sup>C</sup> and 26<sup>D</sup> are connected in series. A source of alternating current 31 serves to light the lamp 28 and the lens 29 concentrates the light on the several photoelectric cells.

In the modification shown in Fig. 3, which may replace the amplifier of Fig. 1, the photoelectric cell is enclosed within the evacuated envelope of the amplifier tube together with the filament, grid and plate elements. The cell is so positioned that the light from the filament affects its functioning to produce the desired difference of potential on the grid 13.

While the present disclosure shows one or more photoelectric cells replacing the so-called "C" batteries, it will be understood that the present arrangement may be used to replace other batteries in the circuits of detector and amplifier devices.

What I claim is:

1. In an amplifier device, a thermionic tube including a filament, a plate element and a controlling element, an input circuit connecting said filament and said controlling element, an output circuit connecting said filament and said plate element, heating current for said filament, and a light controlled unit for developing a difference of potential between one of the elements of said thermionic tube and said filament proportional to said heating current.

2. In an amplifier device, a thermionic tube including a filament, a plate element and a controlling element, means for heating said filament, an incoming circuit connecting said filament and said controlling element,

an output circuit connecting said plate element and said filament, and a photoelectric unit energized by said filament for developing a difference of potential between one of the elements of said thermionic tube and said filament.

3. In an amplifier device, a thermionic tube including a filament, a plate element and a controlling element, enclosed within an evacuated envelope, an input circuit connecting said filament and said controlling element, an output circuit connecting said filament and plate element, and a photoelectric unit within the envelope of said thermionic tube for developing a difference of potential between one of the elements of said thermionic tube and said filament.

4. In an amplifier device, a thermionic tube including a filament, a plate element and a controlling element, a source of heating current for said filament, an input circuit connecting said filament and said controlling element, an output circuit connecting said filament and said plate element, and a photoelectric device for impressing a potential upon the controlling element of said thermionic tube more negative than said filament, said potential being proportional to said heating current.

5. In an amplifier device, a thermionic tube including a filament provided with two terminals, a plate element and a controlling element each having a terminal, a source of heating current connected to said filament terminals, an input circuit connecting a filament terminal and said controlling element terminal, an output circuit connecting one of said filament terminals and said plate element terminal, and a photoelectric device for developing a difference of potential between two of said thermionic tube terminals proportional to the heating current employed in said filament.

In witness whereof, I hereunto subscribe my name this 12th day of September, A. D. 1924.

WINFRED T. POWELL.