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May 2, 1933.

E. F. W. ALEXANDERSON ET AL

1,906,441

AMPLIFYING ELECTRICAL IMPULSES

Filed Oct. 17, 1928

D.C. Amplifier
Optical feed back thru
galvanometer-operated
light valve —
Compensates for changes in amp. constants.

D.C. Amplifier

Fig. 1.

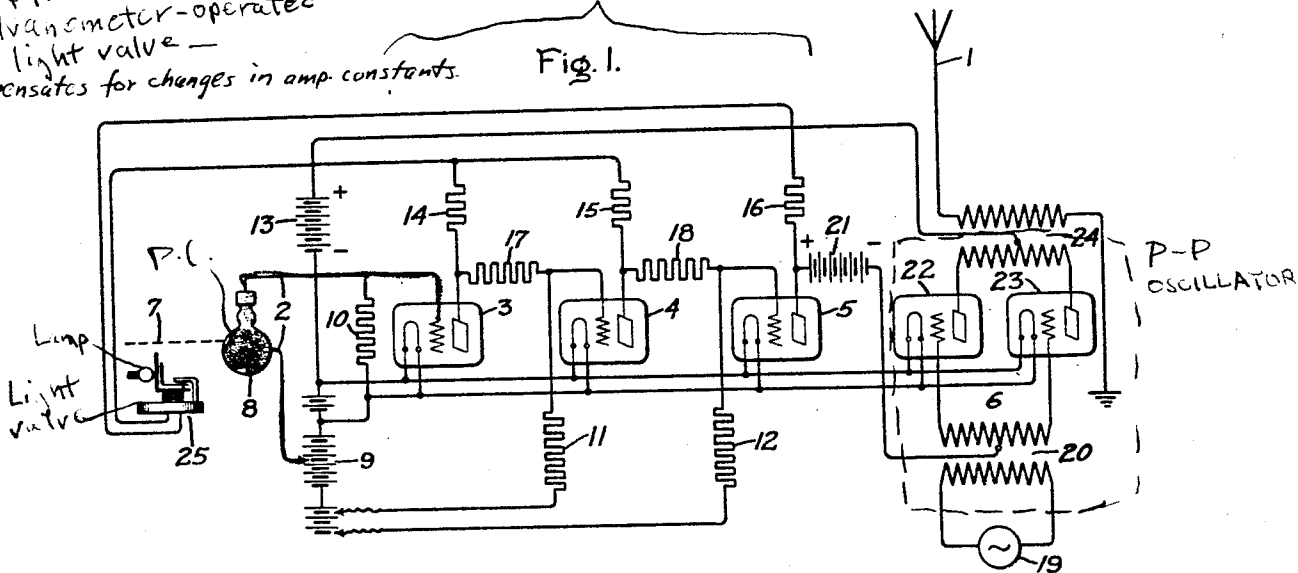
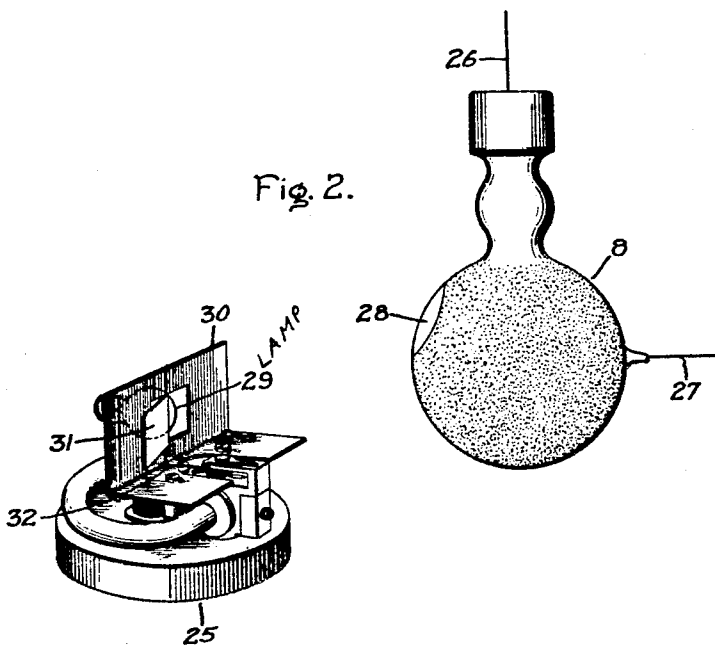


Fig. 2.



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British 335 068
discarded

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UNITED STATES PATENT OFFICE

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AMPLIFYING ELECTRICAL IMPULSES

Application filed October 17, 1928. Serial No. 313,144.

Our invention relates to means for amplifying electrical impulses and has for its principal object the provision of an improved amplifying apparatus and method of operation whereby instability of the amplified impulses due to temperature variations and other causes is avoided.

Various apparatus have been proposed in the past for amplifying weak electrical impulses, such as those produced by variation in the shade of the light applied to a light sensitive cell. One apparatus suitable in many respects for this purpose is disclosed by a Letters Patent of C. W. Rice, No. 1,401,644. This apparatus includes a plurality of space discharge amplifiers provided with high resistance elements connected in their input and output circuits and with coupling condensers for connecting them in cascade with one another.

In the operation of such amplifiers, difficulty is sometimes encountered due to oscillations resulting from the capacity coupling between the various parts of the amplifier and to the amplification of the slight variations produced in the voltage drops of the resistors by temperature changes and the like. In accordance with our invention, these difficulties are avoided by the provision of an amplifier wherein the various space discharge devices are coupled together by resistance elements and wherein means operable in accordance with an electrical condition such as the output current of the amplifying apparatus are utilized for the purpose of neutralizing the effect of temperature changes on the voltage drops of the coupling resistors and the input and output circuit resistors.

Our invention will be better understood from the following description when considered in connection with the accompanying drawing and its scope will be pointed out in the appended claims.

Referring to the drawing, Fig. 1 is a wiring diagram of an amplifying apparatus wherein our invention had been embodied; and Fig. 2 illustrates an apparatus including a light sensitive cell suitable for controlling the input circuit voltage of the am-

plifier and a device which may be utilized for regulating the illumination of this light sensitive cell in accordance with an electrical condition in the output circuit of the amplifier.

The amplifying apparatus illustrated by Fig. 1 includes an antenna 1 and an input circuit 2 between which a plurality of space discharge amplifiers 3, 4 and 5 and a push-pull oscillation generator 6 are connected in cascade with one another. Electrical impulses modulated in accordance with variation in the intensity of a beam of light indicated at 7 are applied to the input circuit 2 through means shown as a light sensitive cell 8, part of a battery 9 and a resistor 10 which is connected between the cathode and grid of the device 3. It will be noted that the battery 9 is also connected to the input circuits of the devices 4 and 5 through adjustable taps and the resistors 11 and 12 respectively; that current is supplied from a source 13 directly to the output circuit of the oscillation generator 6 and through resistors 14, 15 and 16 to output circuits of the devices 3, 4 and 5; and that the devices 3, 4 and 5 are coupled together through coupling resistors 17 and 18.

The oscillation generator 6 may be of any suitable type. It is illustrated as provided with an input circuit which is coupled to a high frequency source 19 through a transformer 20 and is connected to the output circuit of the device 5, through both a source 21 for producing a negative bias potential and the input terminals of a pair of space discharge devices 22 and 23. The generator 6 is also provided with an output circuit which is coupled to the antenna 1 through a transformer 24.

The output circuit of the device 5 includes a current responsive device 25, the source 13 and the resistor 16. As indicated more clearly by Fig. 2, the light sensitive cell 8 is provided with terminals 26 and 27 and with a window 28. The device 25 may be similar in construction to any type of meter or galvanometer which produces a deflection dependent on an electrical condition, such as current. It is preferably so arranged

that it does not obstruct the light beam 7 and projects into the window 28 another light beam of an intensity dependent on the output current of the device 5. In one practical embodiment of the invention, this result has been satisfactorily produced by means of a moving coil type of galvanometer provided with a lamp 29, with a screen 30 having an opening adjacent the lamp and with a small piece of white paper 31 mounted on the indicator 32 of the galvanometer and arranged to move more or less into alinement with the opening of the screen, thus diffusing the light of the lamp 29 so that more or less of it is projected into the window 28.

In order to ensure stable operation of the amplifying apparatus, it is desirable that the device 25 be so mounted and arranged that the paper 31 moves across the opening of the screen 30 only far enough to project through the window 28 the amount of light required to neutralize the effect of changes in the temperatures of the resistors of the amplifier and shifting bias potential. Under these conditions, the tendency of the last stages of the amplifier to drift out of their working range due to temperature or other changes is avoided and the operation of the amplifier is rendered independent of the temperature or other conditions under which it is operated.

The operation of the amplifying apparatus as a whole is well understood by those skilled in the art and need not be described in details. It should be noted, however, that capacity effects between the various parts of the apparatus are minimized due to the fact that the grid bias potentials of the devices 4 and 5 are derived from the battery 9 which, together with battery 13, is preferably grounded and enclosed by a separate shielded casing. The proper grid potential in each case is of course established by adjusting the tap through which the grid is connected to the battery. It has been found that this method of adjusting grid potential not only minimizes undesirable oscillations but also produces a high degree of amplification.

As previously indicated, slight changes in the resistance of the input resistor 10 or in the bias voltage of the battery 9 tend to cause the device 5 to be subjected to a grid potential which causes it to drift or prevents it from operating properly. This result is prevented by the device 25. Thus any decrease in the output current of the device 5 produces a decrease in the current of the device 25 and operates the shutter 31 in a manner to decrease the light projected into the cell 8. This action restores the amplifier to the balanced condition which is initially established by adjustment of the variable taps on the grid bias battery 9.

As will be readily understood by those skilled in the art, the amplifying apparatus differs from that of the aforesaid patent in that it responds to either alternating or direct current whereas the capacity coupled amplifier disclosed by the patent responds only to alternating current and does not require a critical balance because any slight change in the resistance of the resistors or in the value of the grid bias potential is not transmitted through the coupling condensers of the system.

The embodiment of the invention illustrated and described herein has been selected for the purpose of clearly setting forth the principles involved. It will be apparent, however, that the invention is susceptible of being modified to meet the different conditions encountered in its use and we therefore aim to cover by the appended claims all modifications within the true spirit and scope of our invention.

What we claim as new and desire to secure by Letters Patent of the United States, is:

1. The combination of an amplifying apparatus, light responsive means arranged to control the operation of said apparatus, and a device for applying to said means light of an intensity dependent on the temperature of said apparatus.

2. The combination of an amplifying apparatus provided with a plurality of space discharge devices connected in cascade with one another through resistance elements and with input and output circuits, and means including a light sensitive element interposed between said input and output circuits for neutralizing the effect of temperature changes on the voltage drops of said resistance elements.

3. The combination of an amplifying apparatus provided with a plurality of space discharge devices connected in cascade with one another through resistance elements and with input and output circuits, a light sensitive element for controlling the operation of said apparatus, and a device operable in accordance with an electrical condition of said output circuit for varying the illumination of said light sensitive element in response to variation in the temperatures of said resistance elements.

4. The combination of an amplifying apparatus, main and auxiliary light sources, light responsive means arranged to control the operation of said apparatus in accordance with variation in the intensity of said main light source, and a device operable in accordance with temperature changes in said apparatus for regulating the light applied to said light responsive means by said auxiliary light source.

5. The combination of an amplifying apparatus provided with a plurality of space discharge devices connected in cascade with

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one another through resistance elements and
with input and output circuits, a source of
light arranged to modulate the potential of
said input circuit, and means including an
5 auxiliary light source connected to said out-
put circuit for regulating the potential of
said input circuit in accordance with resist-
ance changes in said resistance elements.

In witness whereof, we have hereunto set
10 our hands this 13th day of October, 1928.

ERNST F. W. ALEXANDERSON.

RAY D. KELL.

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