

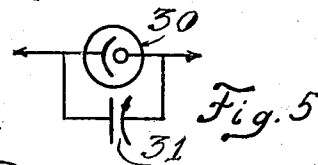
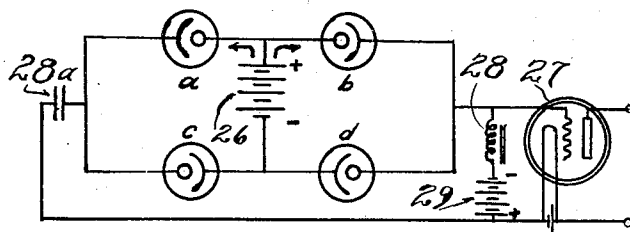
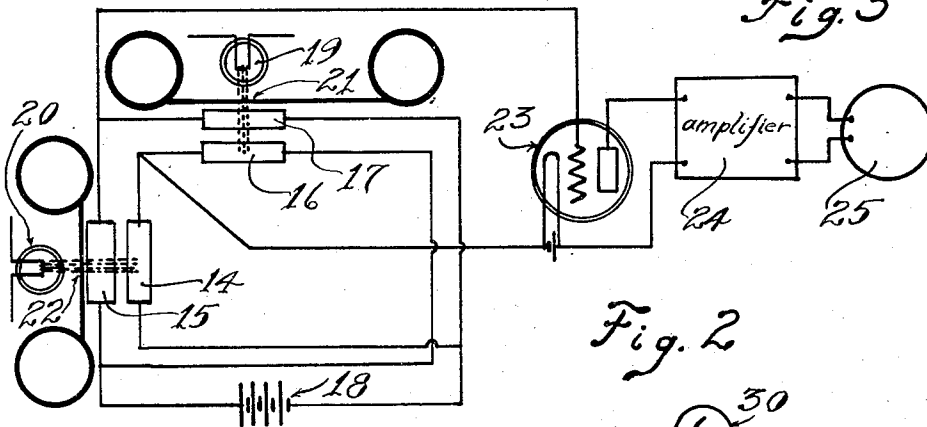
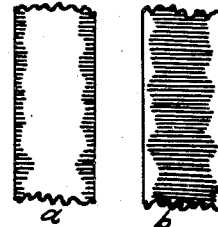
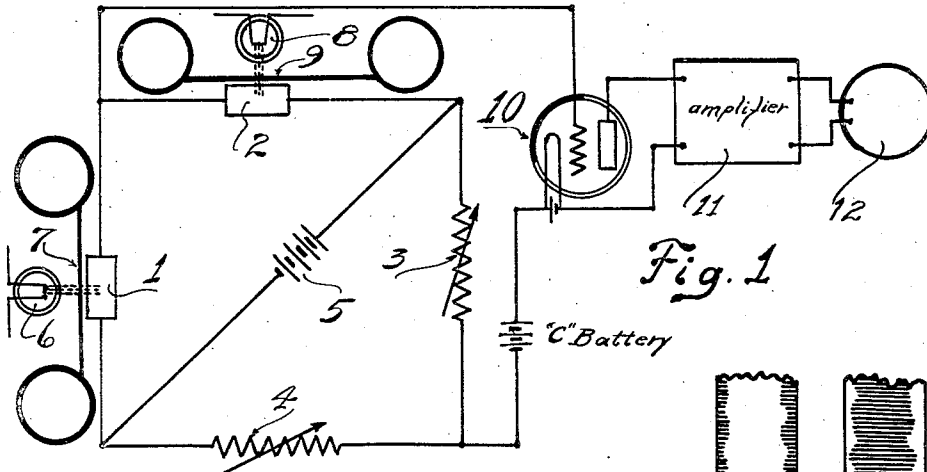
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APPARATUS AND METHOD FOR SOUND REPRODUCTION

Filed Dec. 2, 1929



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APPARATUS AND METHOD FOR SOUND REPRODUCTION

Application filed December 2, 1929. Serial No. 411,181.

This invention relates to light sensitive cells and circuit arrangements therefor; more specifically this invention relates to methods and means for amplifying the effects produced by corpuscular radiations upon cells sensitive thereto.

The object of this invention is to provide a circuit arrangement whereby the combined effects of a plurality of light sensitive cells may be amplified.

Another object of this invention is to provide a circuit arrangement whereby the effect of a photo electric cell is intensified.

Still another object of this invention is to provide a circuit arrangement employing a plurality of photo electric cells whereby the combined effects of the photo electric cells may be impressed upon the circuits of an electron discharge device.

A further object of this invention is to provide a balanced circuit arrangement of photo electric cells in a circuit of an electron discharge device.

Other objects and features of this invention will be apparent from the following specification and the appended claims to those skilled in the art to which this invention pertains.

In accordance with this invention, a plurality of photo electric cells of the selenium type or of the potassium sodium hydride type are connected in a balanced circuit arrangement which is connected into the input circuit of an electron discharge device. In the arrangement of this invention employing a pair of photo electric cells for the reproduction of a sound or similar record one of the cells is exposed to the positive of that record while the other cell is exposed to the negative of the same record. The resistance of one of the cells is thus caused to decrease upon its exposure to light rays from the sound record, whereas the resistance of the other cell is caused to increase. In the arrangement employing four photo electric cells the resistance or electron emission is caused to increase in two of them and decrease in the other two at a given instant.

This invention will be more clearly under-

stood from the specification and the drawings in which, briefly,

Fig. 1 illustrates one embodiment of this invention;

Fig. 2 illustrates another embodiment;

Fig. 3 shows sections of sound record bearing strips;

Fig. 4 illustrates a modified form of arrangement embodying this invention, and

Fig. 5 shows a detail view of a modification employed in accordance with an arrangement similar to that illustrated in Fig. 4.

Reference numerals 1 and 2 of Fig. 1 of the drawings designate photo electric cells connected into a Wheatstone bridge circuit arrangement, together with variable resistance units 3 and 4. The units 3 and 4 may be in the form of variable impedance units or choke coils. In cases where a high frequency source of current supply is employed in place of the direct current source 5, choke coils having a frequency characteristic such that they present an impedance of substantial magnitude to the high frequency current used are preferably employed. The photo electric cells 1 and 2 may be of the annealed selenium type in cases where the source 5 is of a direct current or low radio frequency current type; however, in cases where maximum fidelity of reproduction of the sound record from the record bearing strips 7 and 9 is desired, and where the source 5 is of a high frequency current type, the alkali or alkali hydride cathode type of cell, which is well known in the art of sound reproduction, is preferably employed. Because of the small currents that the cells are required to pass in the arrangement herein disclosed, cells of the selenium type may be satisfactorily employed without harmful fatigue.

Light sources 6 and 8 are positioned adjacent to the sound record bearing strips 7 and 9, respectively. The strip 7 which is moved past the photo electric cell 1 and modulates the light rays passing from the source 6 passing to this cell and the strip 9 modulates the light passing from the source 8 to the cell 2.

The sound record bearing strips 7 and 9 are a negative and a positive, respectively, as

illustrated in Fig. 3 by sections *b* and *a* of sound record bearing strips. The resistance of the cell 1 is thus caused to increase in accordance with the sound record, whereas the resistance of the cell 2 is caused to decrease in accordance with the sound record. It is, of course, understood that the strips *a* and *b* of Fig. 3 are the positive and the negative, respectively, of the same sound waves.

The control or grid electrode and the cathode of the electron discharge device 10 are connected to the equipotential points of the balanced bridge circuit. A "C" battery or source of grid biasing potential is connected in series with the cathode and the bridge circuit. Where the resistance of the photo electric cells 1 and 2 and the resistance units 3 and 4 is of the proper magnitude for the particular type of electron discharge device employed it is not necessary to employ a "C" battery.

An amplifier 11 consisting of one or more electron discharge devices is connected to the output circuit of the device 10 for amplifying sound modulated electrical energy impressed upon the circuits of the device 10 thru the operation of the bridge circuit and the record bearing strips 7 and 9 associated therewith. A sound reproducing device or loud speaker 12 is connected to the output circuit of amplifier 11.

In Fig. 2 an arrangement in which photo electric cells 14, 15, 16 and 17 are employed in a balanced circuit is illustrated. Light sources 19 and 20 are provided adjacent to the sound record bearing strips 21 and 22, respectively. One of the strips, for example 21, bears a negative sound record corresponding to record *b* of Fig. 3, while the other strip, that is, strip 22, bears a positive sound record corresponding to record *a* of Fig. 3.

The photo electric cells 14 and 15 are thus caused to decrease in resistance in accordance with the sound record, while the photo electric cells 16 and 17 are caused to increase in resistance in accordance with the sound record. The balance of the bridge is thus caused to be unbalanced in accordance with the sound record and a pulsating potential applied to the control or grid electrode of the electron discharge device 23. An amplifier 24 consisting of one or more electric discharge devices or other suitable electrical oscillation amplitude increasing devices is connected to the output circuit of the device 23. A sound reproducing device 25 is connected to the output circuit of the amplifier 24.

In operation the bridge circuit including photo electric cells 14, 15, 16 and 17 is properly balanced so that the points thereof connected to the grid electrode and cathode of the electron discharge device 23 are of equal potential. In balancing the bridge circuit the light sources 19 and 20 are energized and light rays impinging upon the surfaces of

cells 16 and 17 are caused to pass thru a piece of substantially clear film strip such as used to record sound vibrations. The light rays passing to the cells 14 and 15 are caused to pass thru a piece of fully exposed and developed strip bearing no record. This may, however, be reversed and the cells 16 and 17 exposed to light passing thru a fully exposed and developed strip, as will be seen from the complete description of this invention. In order to obtain this balance, variable resistance units are sometimes necessarily connected in series with the photo electric cell in at least two legs of the bridge circuit. The light sources 19 and 20 being energized, the record bearing strips 21 and 22 are moved past light admitting windows of the photo electric cells adjacent to the respective strips 21 and 22. Since the strip 21 bears a negative sound record, the resistance of the cells 16 and 17 will increase, while the resistance of the cells 14 and 15 will decrease in accordance with the sound record. The four arms of the bridge circuit are thus caused to vary in resistance in accordance with the sound vibrations of the record. This is more readily seen from a reference to Fig. 4 of the drawings, wherein photo electric cells *a*, *b*, *c* and *d* of the alkali or alkali hydride, or alkali alloy cathode type are illustrated. The cells *a* and *d* are exposed to the light rays modulated by, for example, the negative sound record. The resistance, that is, the electron emission of these cells, will increase in accordance with the sound record. For example, when the intensity of the sound recorded increases the emission of the cells *a* and *d* increases. The cells *b* and *c* are exposed to light rays modulated by the positive sound record. The emission of the cathodes of these cells increases as the intensity of the sound recorded increases.

As the emission of the cells *a*, *b*, *c* and *d* is varied, the potential drop across each of them is varied, although it is seen that the potential across them as a unit is the same; that is, it is equal to the potential of the source 26. The potential of the points to which the control electrode and the cathode of the electron discharge device 27 is connected either increases or decreases with respect to the control electrode of the electron discharge device, depending upon whether the potential drop across the photo electric cells *b* and *c* is caused to decrease or increase, respectively.

A source 29 of grid electrode biasing potential is connected in series with a choke coil 28 to the grid electrode of the device 27. A condenser 28a is connected between the bridge circuit and the cathode of the device 27 in cases where the source of potential 29 causes an excessive current to flow thru the photo electric cells.

In Fig. 5 a detail view of a photo electric

cell 30 of the electron emission cathode type shunted by a variable capacity 31 is shown. This arrangement has been found to be desirable in cases where the source corresponding to the direct current source 26 is replaced by a high frequency source. The photo electric cells *a, b, c* and *d* of Fig. 4 each have a small electrostatic capacity, and it has been found rather difficult to obtain four cells having the same capacity and resistance or capacity and resistance bearing a ratio to each other so that the bridge circuit made up of these cells is relatively easily balanced. At least one of the legs of the bridge circuit is provided with small variable condenser connected in parallel with the photo electric cell and a variable resistance connected in series with the cell in cases where it is difficult to obtain cells having characteristics which permit a balanced circuit to be readily obtained.

It is, of course, understood that this invention may be employed for simultaneously reproducing more than one different sound record where it is desired to reproduce the combined effects of these different sound records.

It will be observed that various modifications of this invention may be made without departing from the spirit and scope thereof; and that, therefore, I do not desire to limit this invention to the exact details as set forth in the foregoing specification except in so far as they are defined by the appended claims.

What I claim and desire to secure by Letters Patent of the United States is:

1. In photo electric cell circuits, the combination of a balanced circuit, each of the arms of said balanced circuit having a photo electric cell associated therewith and means for exposing alternate ones of said photo electric cells to different sound records.

2. In light sensitive cell circuits, the combination of a plurality of light sensitive cells, electron discharge device means, connections between said cells and said electron discharge device, and means for exposing one of said cells to a negative sound record and another of said cells to a positive sound record.

3. In sound reproducing apparatus, the combination of a pair of sound record bearing strips, one of said strips bearing a negative sound record, the other of said strips bearing a positive sound record, a balanced circuit, and a plurality of light sensitive cells associated with said balanced circuit, selected ones of said cells being exposed to light rays modulated by said negative sound record bearing strip, others of said cells being exposed to light rays modulated by said positive sound record bearing strip.

4. In sound reproducing apparatus, the combination of sound record bearing strips each bearing a different sound record, a plu-

ality of photo electric cells connected into a balanced circuit, an electron discharge device, and connections between electrodes of said electron discharge device and said photo electric cells, selected ones of said photo electric cells being exposed to light rays modulated by different ones of said sound record bearing strips.

5. In sound reproducing apparatus, the combination of a pair of sound record bearing strips, a balanced circuit, each leg of said balanced circuit having a photo electric cell associated therewith, means for exposing an alternately connected pair of said photo electric cells to light modulated by the sound record of one of said strips and the other pair of said cells to the light rays modulated by the sound record of the other of said strips, and electron discharge device means, said electron discharge means being connected to said balanced circuit for increasing the amplitude of sound modulated electric currents derived from said circuit.

6. In light sensitive cell circuits the combination of a balanced circuit, light sensitive cell means connected into said balanced circuit, means for exposing said light sensitive means to both a positive and a negative sound record, and electron discharge device means associated with said balanced circuit.

7. In light sensitive cell circuits the combination of light sensitive cell means, electron discharge device means, connections between said light sensitive cell means and said electron discharge device, and means for exposing said light sensitive cell means simultaneously to a negative and a positive sound record.

8. In light sensitive cell circuits the combination of a plurality of light sensitive cells connected into a balanced circuit and record bearing means for exposing one of said light sensitive cells to corpuscular radiations of increasing magnitude and simultaneously exposing another of said light sensitive cells to corpuscular radiations of decreasing magnitude.

9. In combination, a pair of sound records, one of said sound records being an inverted duplicate of the other of said sound records, means associated with said sound records for the reproduction thereof simultaneously, and electron discharge device means connected to said first mentioned means.

In testimony whereof I affix my signature.
BEN J. CHROMY.