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L. DE FOREST

METHOD OF AND MEANS FOR CONTROLLING ELECTRIC CURRENTS BY AND
IN ACCORDANCE WITH LIGHT VARIATION

Filed Sept. 18, 1919

2 Sheets-Sheet 1

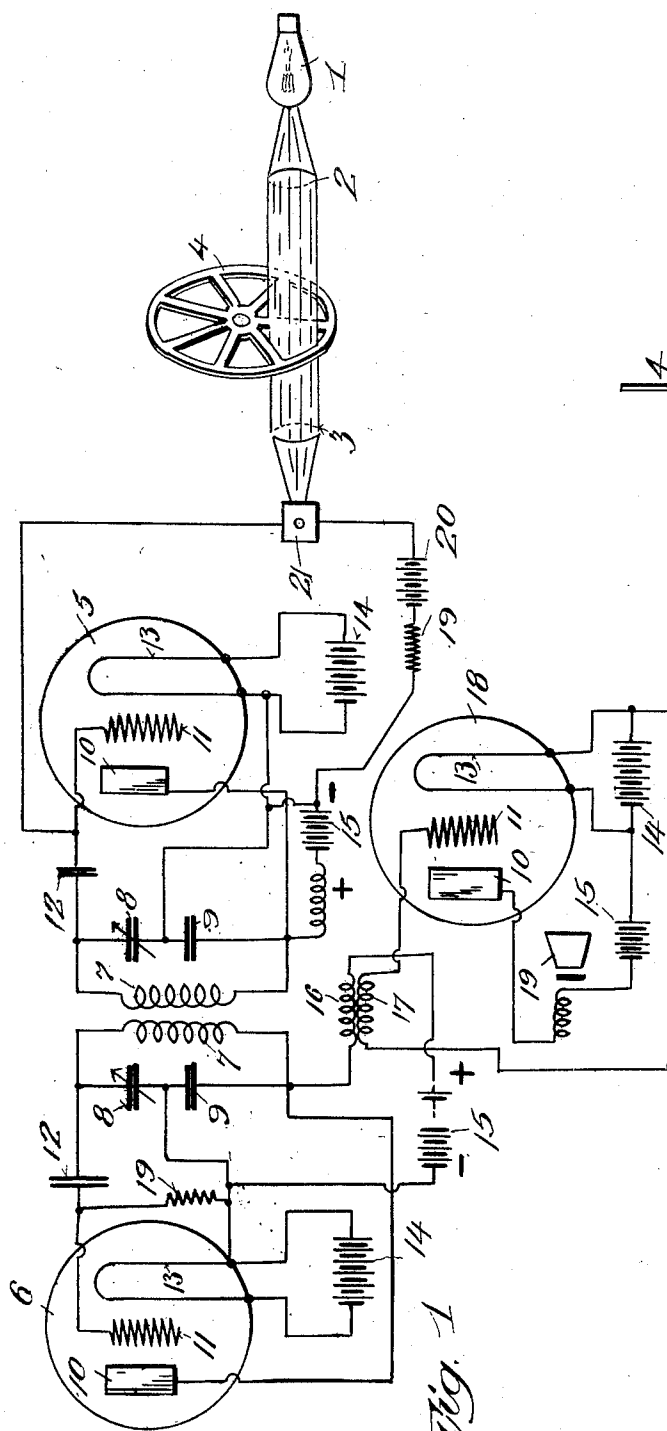


Fig. 1

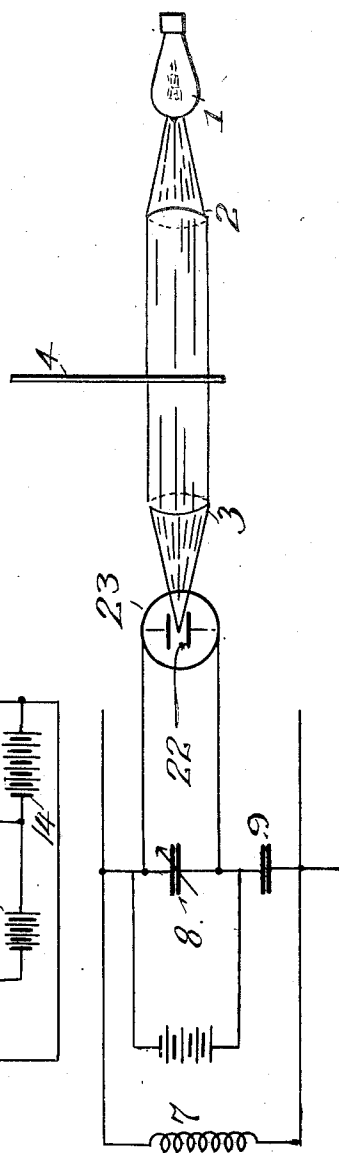


Fig. 2

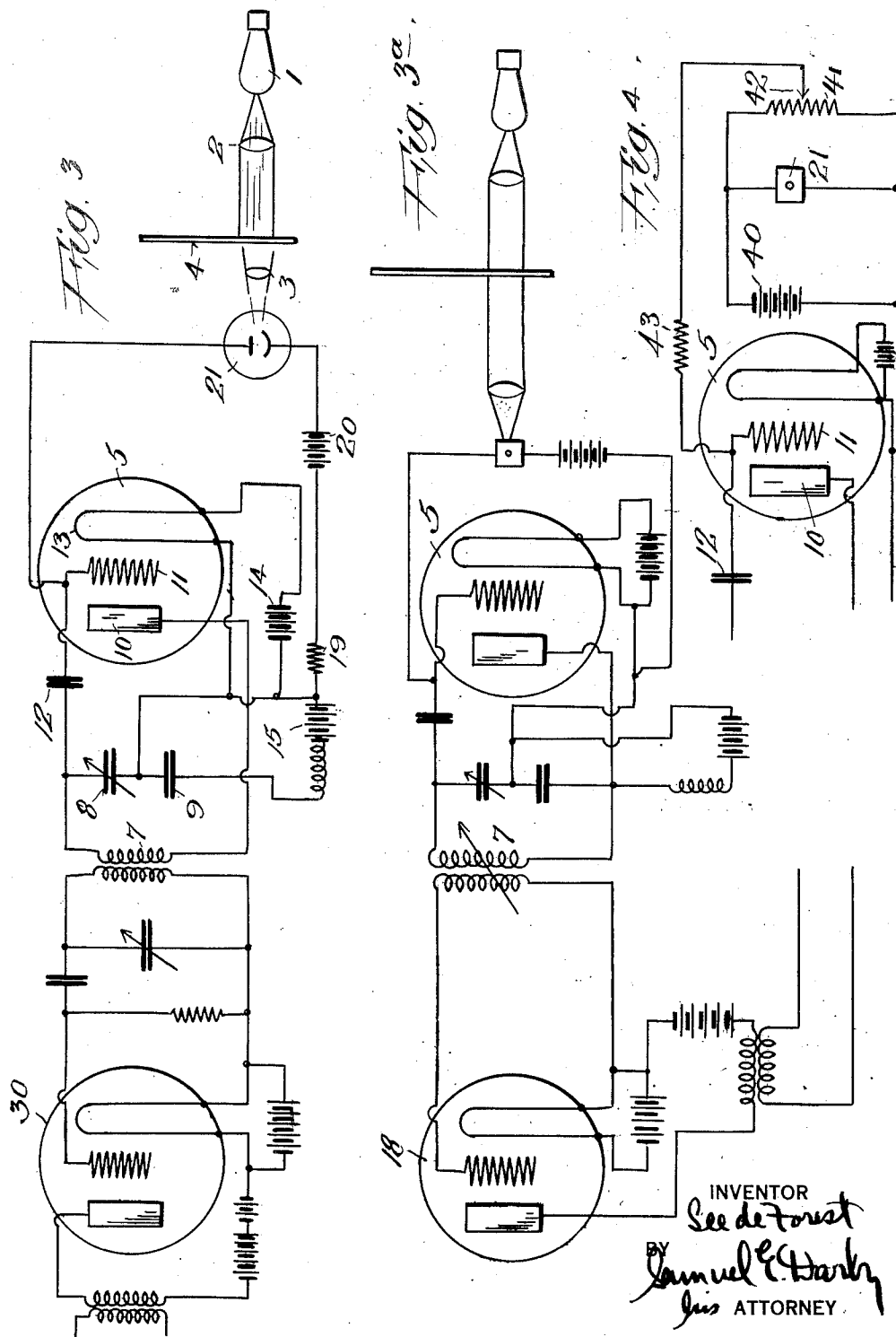
INVENTOR
See de Forest
BY Samuel E. Darby
his ATTORNEY

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2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE.

LEE DE FOREST, OF NEW YORK, N. Y., ASSIGNOR, BY MESNE ASSIGNMENTS, TO DE FOREST PHONOFILM CORPORATION, OF JERSEY CITY, NEW JERSEY, A CORPORATION OF DELAWARE.

METHOD OF AND MEANS FOR CONTROLLING ELECTRIC CURRENTS BY AND IN ACCORDANCE WITH LIGHT VARIATION.

Application filed September 18, 1919. Serial No. 324,685.

To all whom it may concern:

Be it known that I, LEE DE FOREST, a citizen of the United States, residing at New York, in the county and State of New York, have made a certain new and useful Invention in Methods of and Means for Controlling Electric Currents by and in Accordance with Light Variation, of which the following is a specification.

This invention relates to a method of and means for controlling electric currents, and is particularly directed to the control thereof by and in accordance with light variations.

The object of the invention, broadly stated, is to provide means for controlling, effecting, generating or altering electric currents by and in accordance with light variations.

Further objects of the invention will appear more fully hereinafter.

The invention consists substantially in the construction, combination, location and relative arrangement of parts together with the method involved and the circuitual arrangements employed in accordance therewith, all as will be more fully hereinafter set forth, as shown by the accompanying drawings, and finally pointed out in the appended claims.

Referring to the drawings,—

Fig. 1 is a diagrammatic view of a system embodying my invention.

Fig. 2 is a detail view of a modified arrangement of a portion of the system shown in Fig. 1.

Fig. 3 is a similar view of a modified arrangement.

Figs. 3^a and 4 are similar views showing circuitual modifications.

The same part is designated by the same reference characters wherever they occur throughout the several views.

My present invention is directed to the control of electric currents by and in accordance with variations of light. The useful applications of a system of this nature are many, one of which being the reproduction of photographically recorded sounds for sound reproduction purposes, for example, in phonographs, talking moving pictures, etc., the specific uses forming the subject matter of copending applications. I do not

desire to limit my present case to any particular use, for this reason I have diagrammatically illustrated the principles involved, and it will be apparent to those skilled in the art how the useful applications of the invention with or without modification in details must logically follow.

In Fig. 1 I show a source of light 1 which directs its rays through suitable lenses 2, 3, between which is located a screen, revolving shutter, or the like, 4. In the case of reproduction of sounds from a photographically obtained record thereof, the shutter 4 may be substituted by the film having the photographically obtained sound record thereon as illustrated diagrammatically in Figs. 2, 3 and 3^a. I employ two oscillating audions 5 and 6 with their associated circuits, electrically associated with each other.

Each of the oscillating audions, or oscillations, generates in the usual manner, oscillating currents, which may be of either high or low frequency, as desired. The oscillating audion circuits selected for the purpose of illustration are now well known in the radio art, and may be briefly described as, in this instance, as an oscillating circuit, including an inductance 7 and condensers 8 and 9, connected in parallel, which circuit connects the plate electrode 10 with the grid electrode 11 of the audion 6, through the usual stopping condenser 12. A tap connection is provided from the oscillating circuit to the filament electrode 13, and the filament electrode is lighted from a current source 14, all as is well known and practiced in the art. Likewise a circuit is provided in the usual manner from the oscillating circuit to the filament electrode 13 including the usual B-battery, or current source 15. This last circuit, however, in accordance with my present invention, includes one coil 16 of a transformer, the other coil 17 of which is included in the input or grid-filament circuit of an audion amplifier 18, the output or plate-filament circuit of which includes an electro responsive device 19, for example, a telephone receiver, loud speaking horn, or the like. The circuits of oscillating audions 5 are essentially the same, and the two oscillating audions are inductively associated with each other through the coils 7. I prefer to provide a high resistance leak path 19 be-

tween the grid and filament electrodes of audions 6, and in a similar grid-filament circuit of oscillating audion 5 I provide in addition to the resistance 19, a source of current 20 and a light sensitive device 21 through which the system is controlled. The light sensitive device, which may be a photo-electric, selenium cell, or the like, is positioned adjacent the lens 3, and in alignment therewith to be affected by the light coming from source 1, as permitted by the shutter, film, screen, or the like, 4.

By means of the foregoing arrangement a beat note is set up by interference between the two frequencies generated by the audions 5 and 6. The pitch or intensity of this beat note is altered by the amount of resistance in the grid-filament leak path of either oscillation. The beat note or current set up as above explained in the plate or output circuit of oscillation 6 is amplified, if desired or necessary, by the audion amplifier 18, and detected, or made audible through the telephone receiver or loud speaking horn 19 in the output circuit thereof.

In Fig. 2, in place of the selenium or photo-electric cell 21, I show a small condenser 22, preferably in a partially exhausted glass vessel 23 filled with an ionizable gas, the said condenser being in shunt to the condenser 8 of the oscillating circuit of the oscillation 5. In this arrangement the light from the source 1 is directed to the condenser 22, and the capacity of this condenser will be varied according to the quality and degree of light falling thereon from the source 1. The changes in capacity thus produced by light variations causes corresponding changes in the frequency of oscillations in the circuit of the oscillation 5, and these changes can be detected with or without amplification by the beat method above explained.

In Fig. 3 I show a modification of the system thus far described, which consists essentially, in employing but one oscillation system, and modulating, by means of the light, the oscillating currents generated by the oscillation, detecting the modulated oscillations, and reproducing the same in the form of sound by means of the telephone receiver, loud speaking horn, or the like. In this instance, the coil 7 of oscillation 5 is inductively associated with the input circuit of the usual audion detector 30, or it may be connected directly to the input circuit of the first audion 18 of a series of multi-stage amplifiers, in a manner well understood in the art and as illustrated in Fig. 3^a. In Figure 3 I have illustrated the device 21 in the grid-filament leak path of the oscillation 5, as a photo-electric cell, but I wish it to be understood that I do not desire to be limited to any particular type or style of light sensitive device.

In Fig. 4 I show another method of connecting the light sensitive device 21 to the grid leak of an audion 5 which may or may not be in an oscillating state. Here a polarizing battery 40 is connected around the device 21, as is also a potentiometer resistance 41 from which a sliding contact 42 leads off to the grid electrode 11 of the audion 5. A "ballast" resistance 43 is connected in this last lead as shown. By this arrangement I am enabled to obtain an exceedingly sensitive adjustment and consequent efficient control of the modulating or beat effect produced by the light variations.

Many other modifications will occur to those skilled in the art without departing from the spirit and scope of my invention as defined in the claims.

Therefore, what I claim as new and useful, and of my own invention, and desire to secure by Letters Patent, is,—

1. The combination with a plurality of oscillations and their associated circuits, electrically associated with each other, and each generating undamped oscillating currents, means controlled by light rays for altering the frequency of the oscillations generated by one of said oscillations.

2. The combination with a plurality of oscillations and their associated circuits, electrically associated with each other, and each generating undamped oscillating currents, means controlled by light rays for altering the frequency of the oscillations generated by one of said oscillations, and means for detecting the alterations so made.

3. The combination with a plurality of oscillations and their associated circuits, electrically associated with each other, and each generating undamped oscillating currents of different frequency, and a light sensitive device included in one of the circuits of one of said oscillations for altering by and in accordance with light rays the frequency of the oscillations generated thereby.

4. The combination with a plurality of oscillations and their associated circuits, electrically associated with each other, and each generating undamped oscillating currents, of different frequency, and a light sensitive device included in one of the circuits of one of said oscillations for altering by and in accordance with light rays the frequency of the oscillations generated thereby, and means for detecting the alterations so made.

5. The combination with a plurality of oscillations and their associated circuits, electrically associated with each other, and each generating undamped oscillating currents of different frequency, and a light sensitive device included in the grid circuit of one of said oscillations for altering by and in accordance with light rays the frequency of the oscillations generated thereby.

6. The combination with a plurality of

oscillations and their associated circuits, electrically associated with each other, and each generating undamped oscillating currents of different frequency, and a light sensitive device included in the grid circuit of one of said oscillations for altering by and in accordance with light rays the frequency of the oscillations generated thereby, and means for detecting the alterations so made.

7. The combination with an audion, of a light sensitive device included in a circuit connecting the grid and filament electrodes of said audion, and a source of current included in said circuit and shunted around said device.

8. The combination with an audion, of

a light sensitive device included in a circuit connecting the grid and filament electrodes of said audion, and a potentiometer included in said circuit and shunted around said device.

9. The combination with an audion, of a light sensitive device included in a circuit connecting the grid and filament electrodes of said audion, a source of current and a potentiometer included in said circuit and each shunted around said device.

In testimony whereof I have hereunto set my hand on this 12th day of September, A. D., 1919.

LEE DE FOREST.