

June 17, 1930.

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1,765,029

SOUND REPRODUCING APPARATUS

Original Filed Sept. 15, 1921

2 Sheets-Sheet 1

Fig. 1

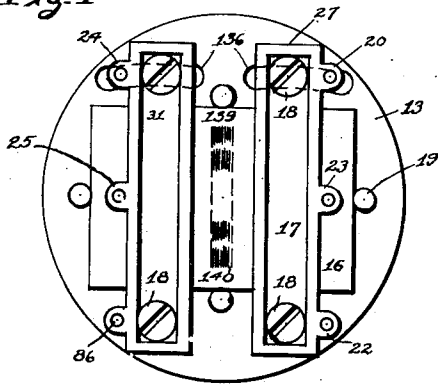


Fig. 2

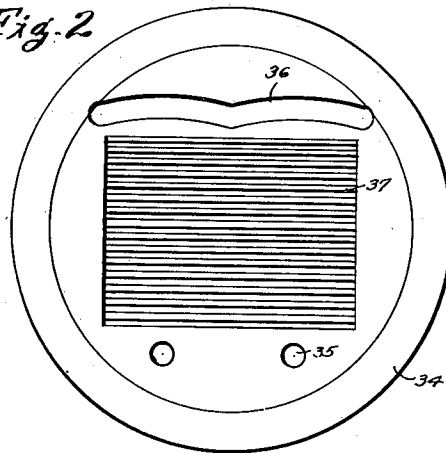


Fig. 3

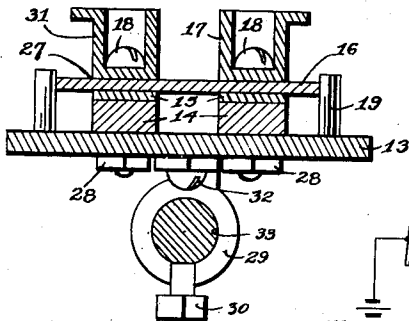


Fig. 4

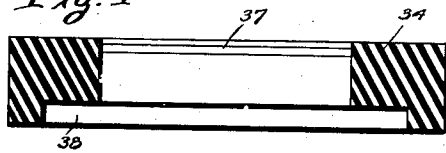


Fig. 6

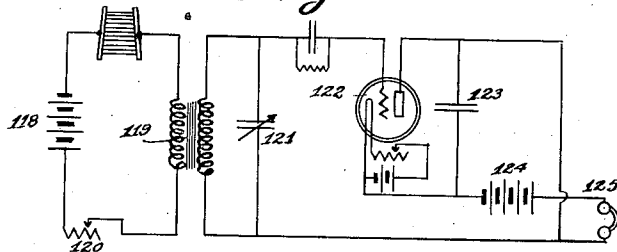


Fig. 5

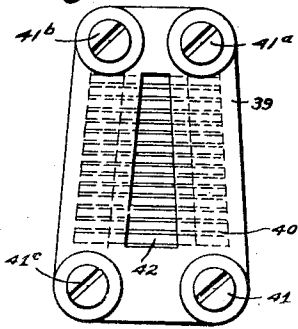


Fig. 7

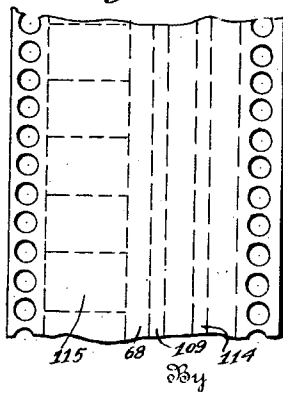
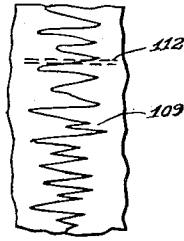


Fig. 8



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2 Sheets-Sheet 2

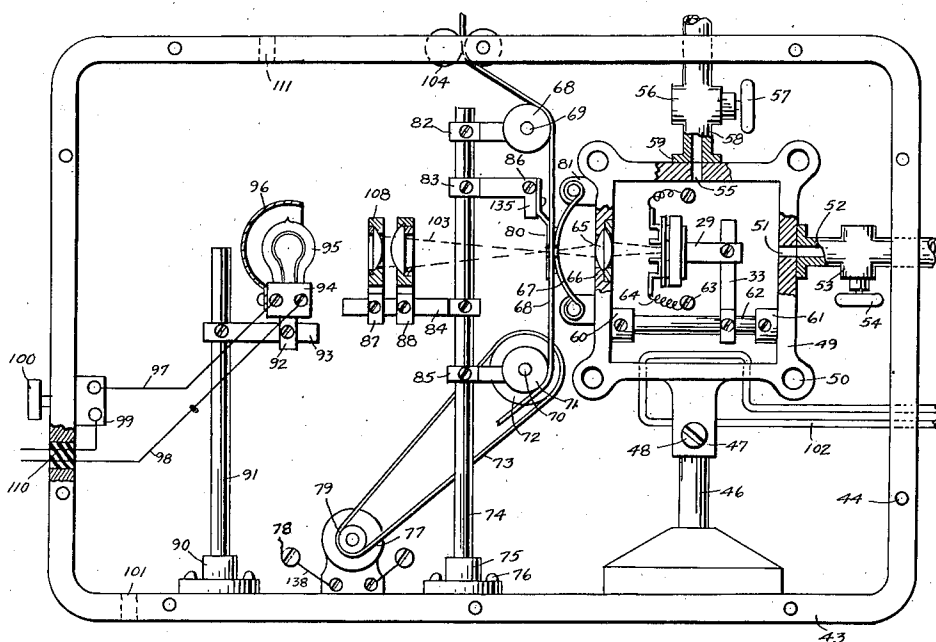


Fig. 9

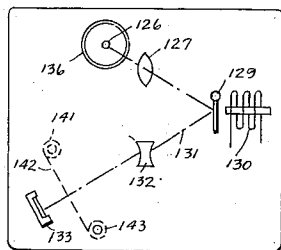


Fig. 10

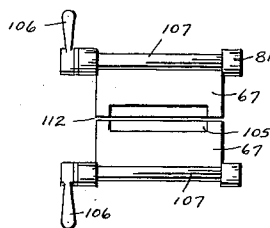


Fig. 11

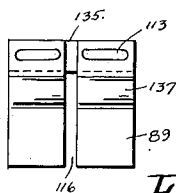


Fig. 12

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SOUND-REPRODUCING APPARATUS

Original application filed September 15, 1921, Serial No. 500,938. Divided and this application filed March 21, 1927. Serial No. 178,516.

My invention relates in general to the variation of electric current by means of a light sensitive resistance changing element.

The present application constitutes a division of my co-pending application on electric current affecting device, Serial No. 500,938, filed September 15th, 1921.

One of the general objects of my invention is to provide a device which may be used to vary current in an electric circuit in synchronism with the movement of a beam of light.

A further object of my invention is to provide a simple device which may vary current in an electric circuit in desired synchronism with a relative movement of a beam of light or other radiant energy of approximately constant area, color, and intensity.

The application has for additional objects the providing of means including a light sensitive cell designed to be affected by the action of energy radiations of approximately constant amount, intensity, or area. The means in addition permit the radiations to impinge on the surface of the said element thereby to vary its resistance in accordance with a desired movement of the said radiations.

Still another object of the invention is to provide means for affecting an electric current so as to electrically reproduce and amplify light recorded sound waves, and to also record the said sound waves in the form of light records in combination with other light records.

Various other objects and advantages of the invention will be in part obvious from an inspection of the accompanying drawings and in part will be more fully set forth in the following particular description of one form of mechanism embodying my invention, and the invention also consists in certain new and novel features of construction and combination of parts hereinafter set forth and claimed.

In the drawings:—

Figure 1 is a plan view of a variable area light sensitive cell.

Figure 2 is a bottom view of a light sensitive variable area cell composed of a plural-

ity of light sensitive resistance changing conductors.

Figure 3 is a vertical sectional view taken at A—A in Figure 1.

Figure 4 is a vertical sectional view taken at B—B in Figure 2.

Figure 5 is a plan view of a fixed area light sensitive cell.

Figure 6 is a diagrammatic view of an amplifying circuit including the light sensitive cell.

Figure 7 is a portion of a light sensitive film such as usually employed in connection with motion picture machines but widened to record one or more sound records in addition to the usual photographs.

Figure 8 shows a greatly enlarged view of a light recorded sound record.

Figure 9 shows a vertical plan and partially sectional view taken through a mechanism containing casing, enclosing a preferred embodiment of the invention mounted on an adjustable support and also means for providing desired light and moving sound records.

Figure 10 is a diagrammatic view of the embodiment of the invention in a simple photophone in combination with a moving film.

Figure 11 is a plan view of a variable area device shown in Figure 10.

Figure 12 is a plan view of the ray limiting device shown in Figure 10.

In the following description and in the claims, parts will be identified by specific names for convenience of expression, but they are intended to be as generic in their application to similar parts as the art will permit.

Referring to the embodiment of my invention as partially disclosed in Figures 1 and 2, there is shown a disc shaped base of fibre or other insulating material 13. Secured to this base 13 by means of suitable screws 18 and nuts 28 are two sets of adjustable resistance terminal holding elements consisting of insulating strips 14, yieldable pads 15 preferably made of felt, contact strips 15 preferably made of lead and the terminal holding strips 17 and 31.

Positioned between the contact strips 15 and 27 is the light affected resistance changing element 16 preferably in the form of a smooth sheet and consisting of selenium.

5 This element 16 is positioned by the locating pins 19. The adjustable terminal holding members 17 and 31 are made of current conducting material of comparatively high or low resistance as desired due to requirements hereinafter described. It is to be noted that 10 each of the terminal members 17 and 31 have a plurality of circuit connection portions as 20, 22, 23, 24, 25 and 26.

A bracket clamp 29 is firmly secured to the 15 base 13 by means of the screws 32 and is adjustably secured to the adjusting post 33 by means of a set screw 30.

The slots 36 in the base 13 are provided so that the terminal members 17 and 31 of 20 Figure 1 may be rotated about the lower screws 18 as a center.

In operation it will be understood that the cell may be included in an electric circuit by any combination of the connecting portions 25 as 20 and 26 so that current will flow in either direction through the element 16 and from one terminal member to the other.

The dotted areas as 139 and 140 shown on the surface of the element 16 (Figure 1) 30 represent portions intercepting light rays. The two portions and the dotted connecting lines may be taken to represent the maximum movement of a beam of light on the exposed active surface of the element 16 while current is flowing through same. It is evident 35 that as long as the terminal strips 17 and 31 are of comparatively low resistance and the light remains approximately constant in area, color, intensity, and position, no appreciable change in resistance of the element 16 40 will occur. If the light be caused to move in effect as indicated in Figure 1 no appreciable change in resistance will occur except due to the low resistance of the terminal holders 17 45 and 31.

However, if one or both of the members 17 and 31 together with the attached parts are rotated from a parallel position in either 50 direction about the lower screws 18 as an axis then the exposed active surface or area of the element 16 can become (say) trapezoidal in form. When the top screws 18 are properly tightened down on the said terminal members 17 and 31 by means of the nuts then suitable contactual relation will be effected by 55 the terminal members 17 and 31 and the element 16 because of the unyielding channel form of the said members.

The relatively soft current conducting contact strips 27 will tend to prevent warping 60 and will be pressed against the surface of the element 16.

Under these conditions it is evident that 65 the total resistance of the element 16 will vary according to the relative position of the

light interception by the element, the form of the active area of the said element, and the combination of circuit connecting portions used to include the element in an electric circuit.

Such action would be in accord with accepted laws of computing resistance values. The action may be further described as follows: 70

If the light is caused in effect to move over 75 the surface of the element 16 in an imaginary straight line from top to bottom (with reference to Fig. 1) then the current change in the circuit of which the element 16 may be a portion will of course be changed accordingly. 80

By causing the terminal member 31 to have a relatively high resistance and the terminal strip 17 to have a relatively low resistance it is evident that the current variation 85 can be affected as desired in magnitude form and frequency. For example if the circuit as shown by Figure 6 includes connecting portion 24 of the high resistance member 31, the said element 16, and connecting portion 90 23 of the low resistance terminal member 17, and the area of the exposed and active surface of element 16 is that of a trapezoid wider at the top than at the bottom (with reference to Fig. 1) the following action will 95 occur. As the light beam is moved in effect over the active surface of the element 16 toward the narrow base of the said trapezoidal area the total resistance of the cell as a unit will decrease. As the light is moved towards 100 the wider base the said total resistance will increase in some proportion to the movement of the light. If the rate of movement of light over the active surface of element 16 is increased the rate of change of resistance will 105 be accordingly accelerated. If the light which may be of constant intensity is oscillated with the speed of voice or any sound waves as desired then the resistance and consequently the current in the circuit of which 110 the element 16 may be a portion will be varied according to the form of the said voice or sound wave.

By employing a light wave of approximately constant intensity, color, area, and 115 oscillation period, the current in the circuit of which the element may be a portion may be still further variably affected by further varying the area and the resistance of the terminal members 17 and 31 and by using different 120 connecting portions of the connecting elements 20 to 26.

If the circuit of which 16 may be a portion includes such connecting portions as 25, 16, and 23 and both of the terminal members 125 are of comparatively high resistance then the change of current in the circuit of which the element 16 is a portion will be at a maximum rate when the light is impinging for an instant in its movement on the surface of the 130

element 16 at approximately the center or in a line connecting the elements 25 and 23 as shown by Figure 1. The change will decrease on movement in effect of light in a direction from the center in either direction.

Therefore the oscillations of the current change will be double and the rate of oscillation of the light beam if the circuit includes the ends of the high resistance terminals because of such variation would twice be of zero value and twice a maximum for each oscillation of light. Hence the form and frequency of the current in the circuit of which the element 16 may be a portion may be varied at will according to my invention.

By changing the form and area of the element 16 or a plurality of such elements coactively associated to form in effect a single unit, the specific resistance of the members, the intensity, area and color of the light, etc. unlimited current variations in form, magnitude, and frequency may be obtained when the element 16 is a portion of an electric circuit having a source of power, and the light is moved in effect over the exposed surface of the said elements. It is understood that any form of radiant energy may be substituted for the light.

The insulating base 13 is held by the clamp 29 as previously described and by moving 29 (clamp) about the support 33 the angle of incidence of the light against the surface of the element 16 may be varied as well as the relative position of the said element and therefore the form of the current variation may be additionally changed for any given light oscillation to any desired extent.

By affecting the movement of the said light, its intensity, color, and area the said form will of course be still further affected.

In Figure 2 we have an embodiment of the invention which employs a plurality of light sensitive resistance changing conductors 37 arranged in parallel and separately insulated by positioning same in the moulded form 34 preferably made of bakelite. This form is provided with holes 35 designed to receive lower screws 18 and is also provided with radial openings 36 arranged to receive upper screws 18 of Figure 1.

The element 16 and the pins 19 in Figure 1 may be replaced by the form 34 and conductors 37 of proper dimensions to fit over the base 13.

When the terminal members 17 and 31 are rotated and secured as previously described we again form a trapezoidal area or a rectangular one as desired but any area will be composed of a plurality of light sensitive conductors 37 in parallel both physically and electrically.

Accepted laws regarding conductance and resistance of current conductors disposed in parallel electrically indicate that any change of resistance in one or more of the conduc-

tors varies a total conductance and hence resistance of the said conductors. Hence if we affect the resistance of one of the wires 37 as shown in Figure 2 we will affect the total resistance of the circuit of which they may be a part when placed on the said insulating base in Figures 1 and 2 as described above.

Of course if the wires 37 were all of the same electrical length and consequently of the same resistance then affecting any one of the said wires to change its resistance to the same extent would also affect the total resistance to the same extent but when the area is trapezoidal in form each wire or conductor 37 has a different resistance value than an adjacent one.

In other words we will have a tapering resistance and the movement of the said light in a given direction across the said conductors will vary the resistance of each conductor to approximately the same extent, but will vary the total resistance in proportion to the extent of its movement in either direction or the number of wires or conductors it affects.

The conductors 37 may be arranged in any desired combination of sizes, lengths and specific resistance in order to secure certain desired results. For example they may be arranged so as to secure a variation according to the sine law.

In Figure 5 we have a fixed light affected resistance changing cell composed of a plurality of preferably tellurium conductors 42 having portions moulded into an insulating form 39 preferably of bakelite. The conductors 42 are connected electrically by means of connecting strips 40 shown in dotted lines and which end in contactual relation with the terminal posts 41 which constitute means for introducing the said cell into an electric circuit as shown in Figure 6.

Figure 6 consists of a diagrammatic view of an organization of circuit means for varying current by means of the resistance change in conductors 37 in Figure 2.

In Figure 6 these light sensitive wires properly connected are designated as a cell 117 in series with a source of current 118, variable resistance 120, and a winding of transformer 119. The remainder of the organization consists of a conventional amplifying set including a vacuum tube having a filament 122, and the necessary condensers 121, batteries 124, receiver 125, etc. It is understood that any suitable arrangement for amplifying current may be used in connection with the cell 117. The circuit organization shown on Figure 6 is merely a diagrammatic form of one circuit to show an embodiment of my invention.

I have hereinbefore described the effect of a relative movement of the beam of light used in one form of my invention, and I will

also describe one form of means for causing in effect the said relative movement of light also included in one embodiment of my invention.

It is admitted that causing a reflected beam of light to oscillate due to the vibrations of a diaphragm magnetically actuated or otherwise is old in the art. It is also old to cause the said beam to affect the resistance of a selenium cell or other light affected substances. In addition the art reveals methods of recording the oscillations of a beam of light on a moving photographic surface. Means for amplifying current variation are also found in the art.

My invention requires the use of one or more of the above known means more or less improved and arranged to cooperate with the elements shown by Figures 1, 2 and 3 and other means hereinafter described for a complete embodiment.

In one form of my invention I employ a beam of light and a continuously moving photographic film to produce the oscillating light ray as hereinbefore described. By the use of my invention in connection with one or more of the above known means a great improvement is made in the practical and useful recording reproduction and amplification of light and sound records.

When the invention is used in connection with a current amplifier as shown by Figure 6 the device is admirably suitable for use in connection with a talking and moving picture machine and it will be described in connection with such a device, but it will be readily appreciated that the invention is not so limited, but may be utilized wherever an electric current may be affected to electrically record, reproduce and amplify desired waves of light or sound.

Referring to Figure 7, I shows a portion of a film 68 sufficient in width to include the usual conventional picture space 115 and also additional spaces 109 and 114 designed to receive and record a plurality of light recorded sound records as line 109 of Figure 8. It is obvious that two or more films may be employed. One film may be employed for the picture records 115 and separate films for the said sound records 109 and 114.

In Figure 8 is shown a magnified portion 109 of the light recorded sound record assumed to be found in the spaces 109 and 114 of the film shown by Figure 7. The record portion or section of 109 included between the dotted lines 112 of Figure 8 will permit the light to pass through the film because of the transparency of the light affected portion of the said film 68. Hence as the film 68 is moved infinitesimal portions of the sinuous line 109 moving between the lines 112 will for a given instant permit the light to pass through a given portion. The result in effect will be a beam of light moving or oscillating

similar to the said sinuous sound record line 109.

If this moving beam of light is permitted to pass beyond the said film 68 and to impinge on the surface of the said element 16 as shown in Figure 1 or conductors 37 as shown in Figure 2 and previously described, then the sound or energy waves represented by the sinuous line 109 in Figure 8 will be electrically reproduced in proper synchronism and amplified as desired as shown in Figure 6.

In Figure 9 there is shown a mechanism containing casing 43 provided with an air tight cover (not shown) fastened to the said casing by suitable screws which fit into the drillings 44. This casing contains a support rod 46 having a heavy slidable base 45. Mounted on the said rod 46 is a second smaller casing 49 designed to resist pressure both inside and out and adjustably supported to the said rod 46 by means of a set screw 47 and a clamp 48 attached to the casing 49. An air tight cover (not shown) closes 49 and is fastened to same by means of bolts passing through the openings 50. Openings 51 and 55 are designed to admit gas, air, etc. into the said casing or remove same by means of the pipes 58 and 62, valves 53 and 56, and handwheels 54 and 57. These openings may also be used to create a vacuum formed by the enclosure of the casing 49. A system of circulating pipes 102 are designed to bring heated or cooled liquid or gas to the interior of the casing 40 and thereby raise or lower the temperature of its interior and any elements positioned therein. Adjustably mounted on adjusting post 33 is a light affected resistance changing cell as shown in one embodiment of my invention by Figures 1, 2 or 5. The post 33 is in turn adjustably secured to the horizontal rod 62 by the sliding clamp of post 33. The rod is further securely fastened to projections of the casing 49 by means of set screws 61.

The cell is suitably connected to an external circuit of which it may be a portion by means of the insulated conductors 64 and insulated terminals 63 passing through the walls of the casing 49 so as to make same airtight under pressure or vacuum.

A suitable lens 65 is desirably positioned in a desirable opening of the casing 49 so as to prevent cracking of the said lens due to pressure of the bolted element 66 which holds the said lens 65 in its desired position.

Also contained in the interior of the enclosure formed by the mechanism casing 43 is a portion or all of a movable previously exposed and developed record film as shown by Figure 7 properly guided and positioned by the actuating wheels 68 and 71. These wheels are adjustably mounted on shafts 69 and 70 respectively adjustably positioned by clamp collars 82 and 85 on supporting posts

74. The post 74 is securely seated in an extension hub 75 of the base plate 76 which is securely fastened to the wall of the mechanism containing casing 43. If desired the film may be entirely contained in the enclosure formed by casing 43 by simply replacing the wheels 68 and 71 by suitable reel spools. In either case the film 68 may be actuated by motor 77, pulley 79, belt 73, and power wheel 72 attached to 71 by means of rotatable shaft 70.

Suitable power may be delivered to the motor 77 by means of conductors 138 suitably connected to insulated terminals 78 and an external source of power. The supporting post 74 may be rotated in the seat formed in the flange 75.

Integral with and projecting from the casing 49 are two support ears designed to properly support and position the shafts 107 shown in Figure 111. These shafts 107 have winged projections 67 and manually movable handles 106. The shafts 107 are formed about tight fitting pins turning in the openings of the ears 81 of Figure 9 so as to be stationary except when moved by the adjusting handles 106 or by other suitable means. Due to these area varying elements the space as indicated by dotted lines 112 on Figure 8 and included between the dotted lines may be varied as required by rotating the shafts 107 by the handles 106. It should be noted that the dotted lines 112 are really the edges 112 of the element 67 shown in Figure 11. Rays portions 105 are designed to cause the film 68 to move smoothly and closely over the elements 67 and to permit fine adjustment due to the possible thinness of the material used.

Adjustable clamp 83 attached to and supported by rod 74 by means of a set screw in turn adjustably positions clamp 86 which supports the light limiting members 80 by means of bracket 135 as shown on Figure 12. The slots 113 permit the movable members 80 to be moved relative to each other in order to vary the width of the space 116 formed by such movement. The members 80 are preferably designed to be yieldable due to the curved portion 137 and the said portion may be formed so as to give suitable pressure against the film 68.

Also adjustably supported by supporting rod 74 is lens rod 84 in turn adjustably supporting clamped members 87 and 88 ending in lens holders 108 in which are suitably mounted condenser lenses 89. A third support rod 91 also secured to the casing 43 by means of floor flange 90 and suitable bolts is used for supporting the source of light 95, reflector 96, socket 94, and socket clamp 92 attached to adjusting rod 93 by a set screw.

Openings having insulating bushings 110 admit current conductors 97 and 98 which supply a variable current to the filament of

light source 95 due to the variable rheostat 99 and the handle 100.

Openings 101 and 111 are also provided in the wall of the casing 43 to permit desired ventilation.

It is assumed that the film 68 may be a portion of film used in a conventional motion picture machine but designed to receive a film similar to that shown on Figure 7 or perhaps two separate films as hereinbefore mentioned. In such an event two or more sets of pulleys 104 may be used to guide the film 68 in or out of the casing 43.

The operation of the elements shown on Figure 9 may be described as follows:

Desired light is produced by passing current of proper strength through the filament of light source 95. This light is suitably collected by the condensers 89 when properly adjusted and caused to converge as light rays 103 which may focus at a point adjacent the surface of the film 68. The light limiting members 80 prevent the ray from impinging on the film 68 except on a desired area, as for instance the maximum width of the record 109 as shown on Figure 7.

The opening 112 formed by the space between the edges of the variable aperture member 67 shown on Figure 11 may be considered at right angles to the adjustable opening 116 between the light limiting members 80 of Figure 112. Hence if the film 68 was removed the light would be permitted to pass through the rectangular opening formed by the two said spaces overlapping each other. But in operation the film 68 is moving between the said members 80 and 67 and only the light affected sound record portion as 109 of Figure 8 will permit light to pass through the said film 68. One dimension is fixed by the opening and the other dimension will vary with the width of the said film record 109. Assuming that the record 109 of Figure 8 may be represented for the sake of description by a sinuous line of approximately constant width it is evident that the transparent portion included in the said area will in effect reciprocate at right angles to the direction of movement of the said film 68.

It is of course obvious that the record need not be of constant width and that the transparent portion may increase in both directions at right angles to the motion of the film 68. In this case the amount of light falling on the elements 16 of Figures 1, 2 and 5 would not be of constant amount. But it is evident that the form of the element could be so arranged that the current variation of the circuit of which the elements 16 may be a portion would be a faithful reproduction of the light record.

It is also evident that the portion of light passing through the said transparent portion 109 of film 68 due to the said reciprocation in effect of the transparent portion will in

effect become a similar oscillating beam of light passing on to lens 65 in diverging lines.

The lens 65 is assumed to be of such suitable form as to cause the light rays 103 to again converge and impinge on the surface of the light affected resistance changing element 16 as shown on Figures 1, 3 and 5, and hereinbefore described as according to my invention.

By adjusting the relative positions of condenser lenses 89 it is apparent that the point of focus may be varied with respect to the surface of the film 68.

In addition the adjusting means 33 supporting the cell will allow movement relative to the lens 65 and thereby vary the intensity and area of the light rays 103 at the instant of impinging of the said light rays on its active area. In some operations it will be possible to eliminate the lens 65 and permit the light rays 103 to strike the cell directly after passing through the film 68. By rotating the cell in a horizontal plane about the supporting post 33 the light rays 103 may be permitted to impinge on the surface of the elements 16 at an angle. By employing all the adjusting means hereinbefore described many variations of the effect of the light on the said surface of the elements 16 may be obtained. Hence the resistance of the light affected element 16 may be varied and the current of the circuit of which it may be a portion also varied and these variations amplified as indicated by the diagrammatic connections as shown by Figure 6. In addition this variation may be effected faithfully in synchronism with the moving sound records 109 as recorded on a moving film 68, and by means of a suitable receiver 125 reproduced into audible sound waves in synchronism with picture records relatively positioned on the said film 68.

Due to the adjusting means herein described the amplitude, frequency, pitch and therefore overtones and harmonics of the audible vibrations produced by the said receiver 125 may be produced and varied relative to the sound waves recorded on the sound record 109 on the said moving film 68. In other words the original sound waves may be reproduced by the receiver 125 so distorted that they may be unrecognizable, or distorted records 109 on the said moving film 68 may be so corrected by the hereinbefore described adjustments and variations as to be similar to the original sound waves. In other words we may first record the true waves so as to be distorted and then correct same so as to be reproduced in the receiver 125 as faithful reproductions of the original sound waves.

Figure 10 indicates a diagrammatic assembly of the elements required for amplifying current waves by an embodiment of my invention as shown in Figure 5. It also indicates a method of recording sound records on

a movable film as 68. A source of light 126 is suitably placed in a reflecting enclosure 136 so formed as to emit a beam of light 128. A lens 127 is employed to concentrate the beam on a preferably hinged diaphragm 129 actuated preferably by a suitable magnetic core in turn actuated by winding 130, but of course, the said diaphragm 129 may be vibrated or actuated by any other desired means. The said beam 128 is therefore reflected by the reflecting armature or diaphragm 129 as an oscillating beam of light 131 through lens 132. The lens 132 may be arranged to change the color of the moving beam 131 and focus it on the moving light wave recording means 142. When suitably enclosed as shown and described in Figure 9 this record or so called film 142 will be affected by the movement of the said beam 131 to indicate its oscillating movement thereby when suitably treated as known in the art.

Or the record receiving film 142 may be removed and a light affected resistance changing element 133 more specifically shown by Figure 1 may be positioned in the path of the said oscillating beam 131. It is understood that the light affected element 133 forms a portion of an electric circuit as shown by Figure 6. By changing the form of the said element 133 the current in the circuit of which 133 may be a portion may be affected variably with reference to the movement of the said diaphragm 129 and hence the current in the windings 130. In other words the current in the circuit of which 133 is a portion, (as in Figure 6) may be decreased as the current in winding 130 increases, or any instantaneous relation between the current changes in the winding 130 and the element 133 may be obtained by suitable design and adjustment according to my invention. It should also be evident that if the said film 142 is bent or curved at the time the record is received that the variation of the record from the true light oscillation may be rectified by a suitable design of the element 133. It is also to be noted that the film 68 as shown in Figure 9 may have been previously used as the film 142 to record the record being used to affect the cell shown in Figure 9.

This embodiment of my invention is shown and described merely to indicate one of the many possible applications of my invention. It is evident that by proper design the cell including an element 16 may be employed in organizations constituting such devices as an oscillator, rectifier, detector, relay, a photo electric condenser, a photo electric impedance, voltage regulator, amplifier, and in fact any device depending on the variation of current for its proper action.

While I have shown and described and have pointed out in the annexed claims certain novel features of my invention it will be understood that various changes in the form

and details of the device illustrated, such as providing means for multiplying a number of elements 16 in co-operative arrangements may be made.

5 It is also evident that there are many ways of combining the talking and moving picture records in the same film or in separate films to properly work along the lines of conventional moving picture apparatus.

10 It should be further evident that a plurality of light sources as 95, means for attaching the device to a moving picture machine providing elements with curved surfaces, etc. could have been shown.

15 It should be still further obvious that various other changes, omissions and substitutions in the particular form of invention illustrated and in its operation may be made by those skilled in the art without departing from the spirit of my invention.

20 Having thus described my invention I claim:

1. In a device of the class described, a light source of constant intensity, means to select
25 a light beam of constant area of cross section from said source, a light-sensitive member comprising a plurality of electrical paths, each of a different resistance when illuminated by said constant beam, and means to cause
30 said constant beam to act successively upon successive ones of said paths whereby to determine the resistance of said light-sensitive cell according to the paths selected.

2. In a device of the class described, a light
35 source of constant intensity, means to select a light beam of constant area of cross-section from said source, a sensitive member responding in electrical resistance according to the illumination thereon and comprising a plural-
40 ity of electrical paths which each has a different resistance from that of the other paths when illuminated by said constant beam, and means to cause said beam to impinge on a
45 selected path whereby to determine the electrical resistance across said member.

3. In a device of the class described, means for producing a light beam of constant quantity, a light-sensitive member responding by electrical resistance when illuminated and
50 comprising a plurality of electrical paths, each responding by a different electrical resistance when illuminated by said beam, means to cause said constant beam to impinge upon a selected one of said paths so that the
55 light-sensitive member will vary correspondingly in its total resistance, and means to adjust the ratios of the relative resistances of said paths.

4. In a device of the class described, a light
60 source of constant intensity, a light-sensitive member comprising a plurality of electrical paths which each differ in electrical resistance and are connected electrically in multiple, a film being for its major portion opaque and
65 having a light-transmitting zig-zag line there-

on, means for passing said film opposite said light-sensitive member, a shutter having a slot of constant width and disposed between said source of light and said cell and adjacent said film so that the light from said source is trans-
70 mitted through said zig-zag track and said slot to said sensitive member and encounters the one of said paths determined by the point of intersection of said zig-zag track with said slot, whereby the total resistance across said
75 cell is determined by the response of said selected path to the illumination.

5. In a device of the class described, a light-sensitive member comprising a plurality of substantially parallel electrical paths connected electrically in multiple and each differ-
80 ing in electrical resistance in response to a constant quantity of light, a film having an opaque portion lengthwise thereof with a zig-zag light-transmitting track
85 thereon, a source of light of constant intensity, a light-obscuring shutter member located between said source and said light-sensitive member, and having a slot therein extending
90 substantially parallel to the direction of said paths, and means for passing said film when opposite said light-sensitive member in a direction perpendicular to the direction of said light paths, so that said slot and track acting in conjunction permit the passage of a
95 single light beam of constant quantity from said source to a portion of said light-sensitive member selected by the point of intersection of said slot and path.

6. In a device of the class described the
100 combination of a mechanism containing casing having openings for the passage of air, gases, liquids, and electric conductors, and designed to exclude light, means contained in the said casing comprising a source of
105 light, means comprising a movable photographic film, means comprising a light sensitive cell contained in a second pressure resisting casing positioned in the space formed by the first named casing, means for adjust-
110 ing, supporting, ventilating, heating, and cooling same, means comprising suitable lenses also contained in the same space and arranged so as to concentrate portions of the said light on desired portions of the said
115 cell.

7. In a device of the class described, the combination of a plurality of light affected conductors having different normal resistance values, means for adjustably varying the
120 effective resistance of said conductors in desired progression and at a desired rate, and placing same in a circuit in parallel electrically, and means for maintaining the above
125 said means in a suitable gas and admitting an oscillating beam of light of approximately constant intensity to the said effective portions of the said conductors.

8. A photophone comprising a light susceptible resistance-changing element having
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predetermined differing resistances when light of approximately constant intensity and area falls upon different predetermined portions thereof, means for producing light of constant intensity, a film having a light recorded sound wave record thereon comprising a light-transparent strip of uniform width but varying position along the length of the film, and means cooperating with said film to cause a beam of constant area from said source to fall upon portions of said element determined by the respective positions of the sound wave record on said film.

9. In a device of the class described, the combination of a light affected resistance changing cell having a resistance portion, a light affected resistance changing portion comprising a plurality of light affected conductors of various lengths and resistance values arranged electrically in parallel, a second resistance portion, means for introducing the above named portions in an electric circuit organization, and means to produce a beam of light of approximately constant intensity and area while excluding all other light, and to cause a change of position of said beam whereby to affect a predetermined one of said conductors according to the position of the light.

10. In a device of the class described, the combination of two resistance portions constituting contact members and holders, a light affected portion consisting of a plurality of light sensitive conductors, means for adjusting the said holders so as to secure the said conductors whereby they may be introduced into an electric circuit in parallel electrically, and their respective resistances varied, a pressure resisting container surrounding said holders and conductors, and means to produce a beam of light of approximately constant intensity and area and to cause said beam to be projected upon successively predetermined conductors whereby to vary the total resistance across said cell.

11. In a device of the class described, the combination of a light susceptible cell composed of a plurality of conductors connected electrically in parallel and arranged so that the resistance of the successive conductors varies in a desired progression, means for producing a beam of light of approximately constant intensity and area and causing the beam to be projected upon the said conductors, and means to move said beam relative to said conductors whereby to vary to total resistance in proportion to said movements.

12. In a device of the class described, the combination of a light susceptible cell composed of a plurality of conductors connected electrically in parallel and arranged so that the resistance of the successive conductors varies in a desired progression, means for producing a beam of light of approximately constant intensity and area and causing the

beam to be projected upon the said conductors, means to move said beam relative to said conductors whereby to vary the total resistance in proportion to said movements, and means for excluding all other light from the surface of the said conductors except the said beam.

Signed at New York, in the county of New York and State of New York this first day of March A. D. 1927.

HOWARD J. MURRAY.