Aug. 30, 1927. J. TYKOCINSKI-TYKOCINER 1,640,557

METHOD OF AND MEANS FOR TRANSMITTING, RECORDING, AND REPRODUCING SOUND

Filed Feb. 1, 1923 3 Sheets-Sheet 1

Fig. 1

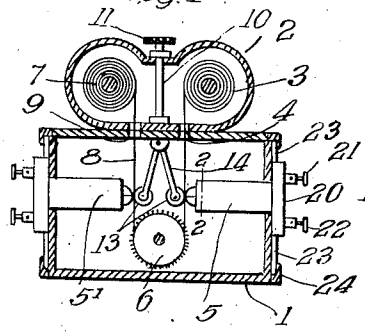


Fig. 2.

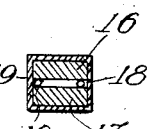
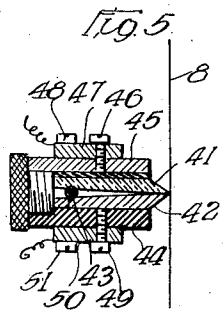


Fig. 5.



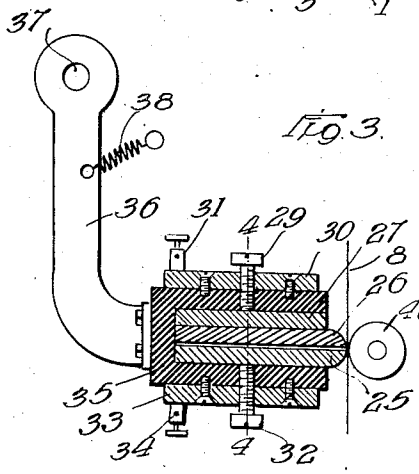


Fig. 3.

Fig. 4.

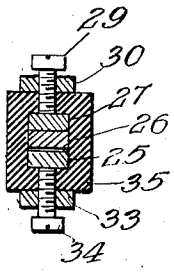


Fig. 6.

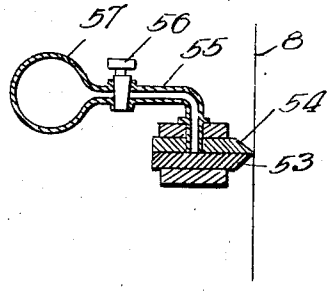


Fig. 7

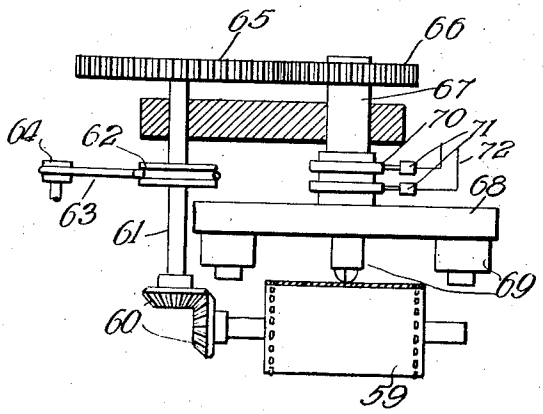
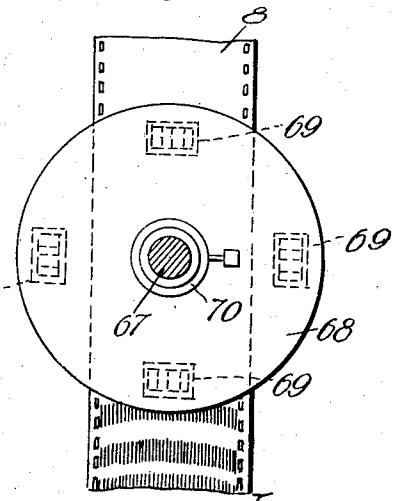


Fig. 8.



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METHOD OF AND MEANS FOR TRANSMITTING, RECORDING, AND REPRODUCING SOUND

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Fig. 9.

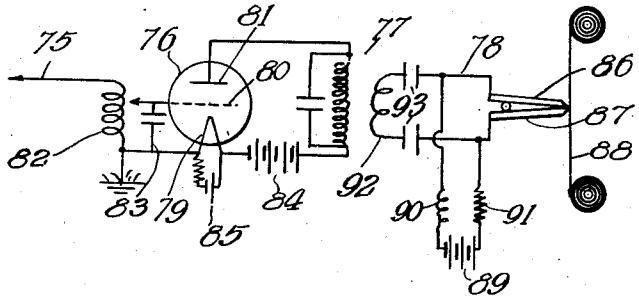
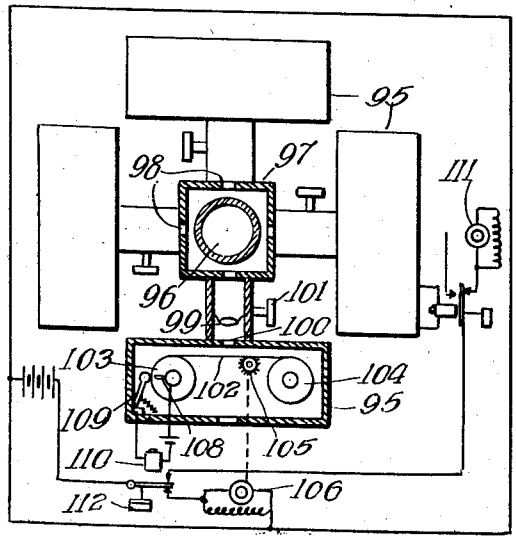


Fig. 10.



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METHOD OF AND MEANS FOR TRANSMITTING, RECORDING, AND REPRODUCING SOUND

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Fig. 13.

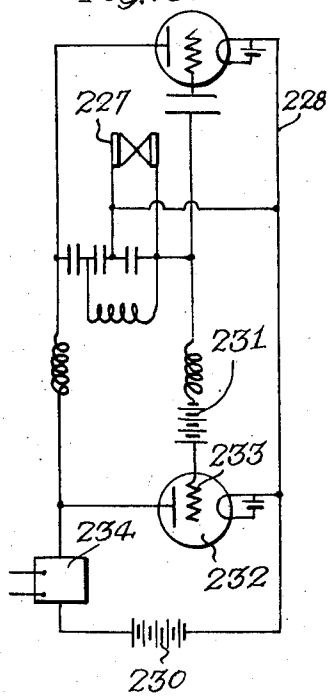


Fig. 11

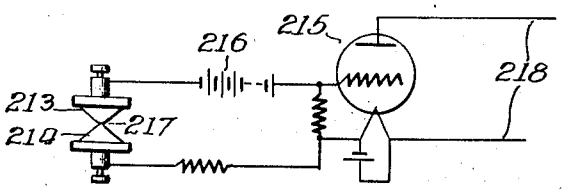
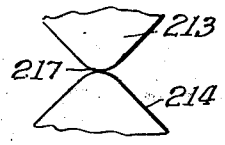


Fig. 12.



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UNITED STATES PATENT OFFICE.

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METHOD OF AND MEANS FOR TRANSMITTING, RECORDING, AND REPRODUCING SOUND.

Application filed February 1, 1923. Serial No. 616,450.

My invention relates to the same general subject-matter as my prior applications, Serial Numbers 565,729, filed June 3, 1922; 565,418, filed June 2, 1922; and 565,419, filed June 2, 1922.

The present application discloses certain improvements and refinements of the apparatus for use in connection with the prior systems disclosed in said applications, and this application discloses among other things, certain specific improvements as follows: first, improvement in the recording camera and recording mechanism to make the recording of sound or variations of audio-frequency or radio-frequency more simple and accurate; second, improvement in the means for transforming vibrations or current variations to variations of light; third, improvement in the means for transforming sound vibrations into variations of current, familiarly termed the telephone transmitter.

Since these improvements all relate to the general subject-matter of transmitting, recording and reproducing sound, I shall describe the same in connection with each other, and in connection with the systems of my prior applications so that those skilled in the art will be able to construct and operate the best form of the invention with which I am familiar at present.

Whereas the improvements which are herein disclosed and claimed are particularly useful in connection with the matter of transmitting, recording and reproducing sound, it is to be understood that the invention is not to be limited to employment in connection with sound, but any phenomenon in which the invention or any part of the same may be useful.

Whereas I have enumerated above certain specific improvements, it will be apparent as the following description proceeds, and as the drawings are examined, that there are numerous other incidental improvements which are not to be lost sight of, but which I intend to claim as a part of my invention.

In the accompanying drawings which form a part of the present specification;

Figure 1 illustrates a vertical longitudinal section of a recording device for recording variations of current upon a photographic film by means of variations of light produced by the discharge between two adjacent plates;

Fig. 2 is a cross-section on the line 2—2 of Fig. 1, showing the arrangement of the plates for producing the electrical discharge;

Fig. 3 is a longitudinal section thru a modified form;

Fig. 4 is a transverse section taken on the line 4—4 of Fig. 3 showing the arrangement of the electrodes;

Fig. 5 is a similar section of a modification in which the plates are made convergent towards the point of recording;

Fig. 6 is a modified form in which the electrodes are operated in an atmosphere which will promote actinic activity;

Fig. 7 is a transverse section; and

Fig. 8 is a front elevation of a recording device having a plurality of recording electrodes for making transverse arcuate records on the recording film;

Fig. 9 is a diagram of a system for recording discharges from closely spaced electrodes generated by audio-frequency or radio-frequency current;

Fig. 10 illustrates partially in section a front view of a recording camera having a plurality of magazines for making successive records of incoming signals;

Fig. 11 illustrates diagrammatically a further form of telephone transmitter dependent upon the variation of discharge between two electrodes by disturbances in the air caused by sound waves;

Fig. 12 is a fragmentary elevational view of the electrode shown in Fig. 11; and Figure 13 is a diagram of a system in which variations of capacity are combined with variations of conductivity in an inertia-less telephone.

Referring now to Figures 1 to 9 inclusive, I have shown means for securing actinic discharges which may be varied in accordance with telephonic, telegraphic or radio current, by a discharge between plates separated by a distance of microscopic magnitude. These plates with the minute gaps between them provide a clear, sharp line of light which is high in actinic properties, and I place the edges of the plate directly

in contact with the film upon which the record is to be made. While I shall describe the plate as in contact with the film, it is to be understood that the contact is not necessary for any reason other than to secure as close proximity between the source of actinic activity and the recording film or plate as possible.

In Figure 1 I have shown an improved form of recording camera which comprises a light tight box 1 provided with a suitable magazine 2 for feeding a roll of film 3 through a slot 4 in the magazine and in the box 1 past a suitable generator 5 of actinic activity over the feeding drum 6 and back onto a receiving roll 7 in the magazine 2. The film, after passing the actinic source 5 may be passed in front of a second source 5′ or any other number of such sources for making parallel records upon the film 8. After the film 8 passes a second recording means 5′ it passes up through a suitable slot 9 in the case 1 and in the magazine 2, and is wound upon the receiving drum or roll 7. The magazine 2 is adapted to be secured on top of the box 1 by means of a removable connection such as indicated by the stud 10 and knurled nut 11.

Within the box 1, I provide a pair of rollers 13 which are provided with a pivotal mounting upon swinging arms 14, these arms being held apart by a spring 15 between them which has the effect of pressing the rollers 13 against the inner side of the film 8 and thence holding said film in contact with the recording devices 5 and 5′. Any suitable means may be provided in conjunction with the feeding drum 6 and the supply roll 3 and take-up roll 7 for feeding the film past the recording devices 5 and 5′ preferably at a uniform rate of speed.

In the present case the recording devices 5 and 5′ are mounted stationarily upon the box 1 and the rollers 13 are movable to press the film into contact with said recording devices. Obviously the reverse effect may be secured by having the recording devices movable and the rollers or other supporting means back of the film, stationary. Such an arrangement is shown in Figure 3.

The recording devices 5 and 5′ shown in Figure 1 comprise two metallic or other conducting plates 16 and 17 separated by a microscopic gap secured by interposing threads of quartz, hard glass, mica, enamel, or any other suitable insulating material. This insulating material is illustrated between the electrodes 16 and 17 at 18, but the same has been shown of exaggerated thickness.

The plates 16 and 17 with the separator 18 are held together in an insulating cover 19 which has a suitable boss 20 on the exterior bearing the binding posts 21 and 22 and extending arms 23 which are turned under the spring clamping members 24 much on the order of a bayonet slot connection. The turning of the arms 23 under the clamps 24 brings the gap between the plates 16 and 17 at right angles to the line of the film 8 so that a suitable record may be made upon the film.

The width of the electrodes 16 and 17 is chosen to correspond to the width of record which it is desired to make on the film 8. If, as in my prior embodiment shown in my prior applications the film is to record both moving picture images and a sound record. the width of these plates will be made relatively small so that the margin which is devoted to the sound record may be relatively narrow.

Insulating material 18 instead of being disposed transversely across the width of the plates 16 and 17 may be laid longitudinally along the edge only.

The insulating material may be omitted from between the electrodes by making one of the electrodes of a semi-conductive material such for example as polished agate. Thus in the form of recording device shown in Figure 3, I have provided a lower metallic electrode 25 and an upper semi-conducting electrode 26 which in this case is made of polished agate placed directly in contact on its lower side with the upper face of the electrode 25. The upper side of the agate electrode 26 is silvered in order to secure as good contact as possible between said agate contact and the upper metallic plate 27 which upper plate is connected through a suitable contact screw 29 and plate 30 with the binding post 31. The lower electrode 25 is connected through a similar contact screw 32 and plate 33 with binding post 34. The plate 27 and electrodes 26 and 25 are held in a suitable clamping frame 35 of insulating material, this clamping frame being in turn mounted upon a swinging arm 36 which is pivoted at 37 and is held by means of the spring 38 yieldingly in contact with the film 8 which film is in contact upon its back side with the supporting roller 40. This roller 40, like the rollers 13 in Figure 1 is preferably faced with a yielding material such as a soft rubber face.

It is well known that a discharge in air has high actinic activity, and I take advantage of this fact in these forms of recording device. There is an extremely thin film of absorbed air of about 1/100 of a millimeter embedding the particles at the surface of the agate plate 26 and electrode 25, even in spite of the direct contact between these parts. I have found that if the potential impressed upon the air film between these electrodes is larger than a certain value, to wit, approximately 100 to 150 volts, a visible corona-like discharge is started which discharge emits strongly ac-

tinic rays of a bluish, violet and ultra-violet color. This discharge is confined to a very narrow bundle of sharp definition and of limited dimensions, which dimensions correspond to the thickness of the layer between plates and to the width of the electrodes. I have found that if currents of varying amplitude are superposed upon the continuous current which serves to sustain the discharge, the intensity of the actinic rays varies accordingly and consequently the density of the photographic image of the light sensitive layer on the film or plate.

By means such as above described, it is possible to record accurately and definitely upon a sensitive film, the variations of current to be recorded. In fact, the definition is so sharp and the action is so much confined to the particular point of recording that a number of records may be made in close proximity to each other upon the same film as indicated for example in Figure 1 where two records are being made upon the film 8.

The character of the discharge may be varied by mechanical arrangement of the electrodes or plates, or by introducing a different medium between them.

In Figure 5, I have shown an arrangement of the plates 41 and 42 which are of agate and of metal respectively so as to secure a concentrated discharge at the extreme tips of these electrodes immediately in contact with the film 8.

The plate 41 is of agate and the plate 42 is of metal and the two are separated at the inner ends by a piece of insulating material 43 which causes the plates to converge and contact at their outer tips where a concentrated discharge is secured. These plates are mounted in a suitable holder of insulating material 44 as previously described in connection with Figure 3, and the agate plate 41 is maintained in good electrical contact with the metallic plate 45, which in turn through the contact screw 46 and plate 47 is connected to the binding screw 48 leading to one terminal of the recording circuit. The metallic electrode 42 is similarly connected to a contact screw 49, plate 50 and binding screw 51 with the other side of the recording circuit.

I have found that it is possible to secure discharges in very thin layers so that the intensity of the emitted actinic rays can be recorded on a sensitized surface directly in contact with electrodes by employing a plate of dielectric material between metallic electrodes instead of a semi-conductive electrode. Thus, with two metallic electrodes and a dielectric layer between them, two layers of air are formed, one along each plane of the dielectric in contact with the metallic plate, and these two layers of air emit actinic rays of varying intensity when the device, which really forms a condenser, is traversed by audio-frequency or radio-frequency currents which may be modulated by sound, by a telegraph key or the like. Thus signals either in the shape of sound or in the shape of telegraphic signals or the like may be received from a distant radio station, from a telephone transmitter or any other means designed to create variations of current to be recorded.

The actinic properties of discharges between electrodes of the above described types can be intensified by the use of material between the plate which will augment the actinic character of the discharge. For example, a thin film of fluorescent substance placed between the semi-conductive and the conductive electrodes will increase the actinic discharge with a given amplitude of current variation. Under the action of ionic bombardment such a film of fluorescent material becomes luminous in proportion to the current delivering the ions. This fluorescent light added to the direct luminosity of the discharge increases the photographic action upon the sensitized recording film or strip. The fluorescent substance can be used at the same time as an insulator to conductive electrodes such as shown in Figures 1 and 2.

The character of the gas between electrodes or between the semi-conductive electrode and the metallic plate electrode may be varied as illustrated for example in Figure 6. In this case the semi-conductive electrode 53 and the metallic electrode 54 are polished and are in close contact. This space between these electrodes is connected by means of a tube 55 and valve 56 with a container 57 holding a suitable gas such as neon, helium, hydrogen and the like, traces of which alone are sufficient to enrich the spectrum of the discharge between the plates 53 and 54 with spectral lines of shorter wave length. Since these plates are polished and are in close contact with each other, the gas consumption is unappreciable.

The space between such space or electrodes may be made more active in actinic effect by lowering the atmospheric pressure upon the layer of gas between these plates. Thus, for example, a small vacuum pump might be connected to the tube 55 for withdrawing air from between the plates to reduce the pressure at that point. The pump may be driven independently of the film feeding means, or it may be connected to the same mechanism which drives the film 8, so that the effect will be produced when the film is moved.

The pressure between the plates such as 53 and 54 may be reduced to a few millimeters of mercury and the actinic effect of the discharge is greatly enhanced with a lowering of voltage required to maintain

the discharge. If desired the recording device including the plates 53 and 54 may be placed in a sealed glass tube for maintaining a constant gas pressure in the space between the plate. Also if desired the entire mechanism may be placed under reduced pressure.

Where it is desired to employ the entire face of the recording strip for recording variations of current corresponding to sound, telegraphic signals, wireless oscillations or the like, the mechanism shown in Figures 7 and 8 may be employed. This mechanism is of the same general character as that shown in Figures 1, 2, 11 and 12 of my copending application, Serial Number 565,418.

In the present case the sensitized film 8 is fed over a feeding drum 59 which is driven by means of suitable gears 60 and shaft 61. This shaft is preferably driven by a pulley 62, belt 63 and driving pulley 64 which may be driven by any suitable motor. The shaft 61 is also connected though suitable gears 65 and 66 to the shaft 67 of the recording plate 68. This recording plate carries a number of record making devices 69 in this case shown as 4 in number of the character described in connected with Figures 1 to 6 inclusive. These record making devices comprise electrodes separated by a minute gap as previously described, and are placed symmetrically about the spindle 67, and in such position that the forward ends of the plates will just ride over the surface of the record film 8 as the spindle 67 is revolved. These record making devices 69 are all connected in parallel through a pair of slip-rings 70 and brushes 71 to a suitable circuit 72 which circuit has impressed thereupon the variations of current to be recorded. It will be observed that the record extends across the width of the film 8 as indicated at the lower portion of Figure 8. This is secured by having one set of record making electrodes come into register with the active portion of the film at substantially the same time that the preceding set of record making electrodes leaves the active surface of the film. Any desired degree of overlapping may be secured.

If desired the slip-rings 67 may, instead of being complete rings, be commutator sections and connected to the respective recording devices 69 so that as these recording devices come into register with the active part of the film 8, they may be switched into circuit and out of circuit so as to make the corresponding record upon the film 8. The arcuate record across the film is a curved path, the components of which are the rotary motion of the record making devices 69 and the forward motion of the film 8. If desired, the recording devices 69 may be connected in series or parallel as above mentioned, and if it is desired to confine the record to a particular portion of the film, a suitable screen may be used and this screen may prevent the making of a record upon any part other than that desired. A thin screen may also be provided to insure the successive action of the recording devices without overlapping. It will be understood that in the form shown in Figures 7 and 8, four arcuate records will be made for each revolution of the spindle 67.

In my previous application above referred to, I have described various methods of influencing discharges by means of audio-frequency and radio-frequency currents.

In Figure 9 I have shown the application of the same principle to the above described discharges, for recording radio-telegraphic or radio-telephonic messages.

The wire 75 is connected or otherwise coupled to an antenna or loop aerial, or to a wired radio system so that variations of current corresponding to radio-frequency or audio-frequency are impressed upon the circuit including the thermionic amplifier 76 and are then impressed through the transformer 77 upon the recording circuit 78. The amplifier 76 may comprise the usual amplifying thermionic tube having the hot cathode 79, the plate 80 and the grid 81, as is well understood by those skilled in the art, the grid and cathode respectively being connected across a variable number of turns of the coil 82 with the condenser 83 in parallel. The plate circuit is provided with a suitable source of electromotive force 84 and the cathode 79 is heated by current from a suitable source 85. The recording circuit 78 comprises the electrodes or plates 86 and 87 of the type disclosed in connection with Figures 1 to 7 inclusive, these plates or electrodes providing a suitable discharge between them in contact with the film 88.

In order to sustain the discharge through the electrodes 86 and 87 to overcome the initial insensitivity, inertia of the photographic material on the plate 88, a source of direct current 89 in series with a suitable inductance 90 and resistance 91, is connected to the plates 86 and 87 in parallel with the secondary 92 of the transformer 77. The direct current from the source 89 is kept out of the transformer coil by means of suitable condensers 93 and the inductance 91 serves to keep the variations of current to be recorded from discharging through the supply circuit of the battery or other source 89. While I have shown the recording device as consisting of two electrodes or plates 86 and 87 which are of the type previously described, it is to be understood that other forms of discharge tubes, arc lamps and the like may be supplied instead. Such sources of varying light may be employed with or

without an optical system by the provision of a narrow slit in contact with the film, this slit being suitably illuminated by the luminous discharges which are varied in accordance with the current variations to be recorded.

Instead of employing a source of direct current 89, the feeding circuit may be operated upon radio-frequency, and a suitable oscillating circuit may maintain the discharge at electrodes 86 and 87. The above described arrangement for recording sounds or messages or other signals may be employed at the transmitting station as well as the receiving station, and may be employed in connection with wire telegraphy and telephony as well as radio-telegraphy and telephony.

The recording of signals with an apparatus such as indicated in Figure 9 may be performed at a very high rate of speed. If the resolving power of finely grained standard photographic emulsion is taken as the basis of calculating a permissible speed of recording, it will be found to be possible theoretically to record about 50,000 words per minute employing a velocity of about 1 meter per second for the movement of the photographic strip.

Speeds of from 15,000 to 30,000 words per minute are practically possible. At this enormous speed it is necessary to provide means for changing quickly from one recording strip to another.

In Figure 10 I have shown more or less diagrammatically a means for permitting a record to be made upon successive films by providing a plurality of magazines such as 95 about a suitable discharge tube 96. The single modulated source of light 96 is enclosed in a suitable box or holder 97, having a plurality of slits 98 and objectives 99 grouped about the box 97 and adapted to be in register with the shutters 100 of the respective magazines 95. The objectives 99 are adjustable by means of suitable thumb screws 101 so as to throw the image of the slits 98 upon the recording film 102, this film being sent from one spool such as 103 upon another spool 104 past the shutter opening 100.

The film 102 is fed by means of the driving wheel 105 driven by a suitable motor 106. The supply roll 103 is provided with a contact 108 and a stationary contact 109 is adapted to contact therewith when the film is substantially exhausted from the roll 103. This pair of contacts closes the circuit for the relay 110 which operates to throw into the circuit the feeding motor 111 for the next magazine film 95 and thus start said motor 110 before the circuit of the motor 116 is broken. For this purpose a slow acting armature is provided for the relay 110 as by means of the dash pot 112. Thus, after one film is substantially spent, the operating motor for the next one is started and thus the films are employed one after the other to make a record of the variations of light of the source 96.

Any desired number of films within limit may be thus exposed one after the other by means of a chain controlling circuit such as above illustrated. In each case the next motor in advance is started before the circuit of the particular motor is opened. Thus a slightly overlapping record may be secured and none of the signals will be lost.

It will also be apparent that the film magazines 95 may be distributed along the tube instead of around the same if desired. It is not necessary to have a single source of light where a series of films are to be exposed as the discharge devices such as shown in Figures 1 to 9 inclusive may be employed, and if desired, a number of these devices may be connected in series or connected in parallel and the films started in succession by means of the chain circuit above illustrated or other suitable means. If desired, the circuits of the various discharge devices may also be switched on in succession by means of a circuit similar to that above described and illustrated.

In the description thus far given, I have mentioned only the actinic properties of the discharge, and in connection with it the use of photographically sensitive material on the recording strip or roll. According to my further investigations, I find that it is possible to utilize chemical, thermal and electrical properties of the discharges and to record the variations of current not only upon photographic material but upon specially prepared strips, rolls, discs or cylinders, or any other suitable surface. For instance, I find that ozone is abundantly formed by the above described discharge devices in quantities depending upon the current passing through the gap. It is, therefore, possible to make records on a film or vapor which may be painted with a dye which is easily bleached by ozone. Any other suitable substance which may be decomposed or acted upon by ozone may be employed.

Another property of the discharge device heretofore described is the heat evolved. To utilize this property the recording material may be made slightly humid or moist. The variations of temperature radiating from the discharge device causes the recording material to be dried to varying degree dependent upon the variations of current along the path of the record which is acted upon by the discharge device. The record therefore assumes a varying hygroscopical property. The record thus treated may be dusted with a suitable colored powder as, for example, graphite, and it will then show the variations of current as variations of the shade of record thus produced.

Finally the varying differences of potential acting upon the electrodes and the gaps between them may be used to produce electrochemical and mechanical changes in the material which is used for recording. For example, a powdered strip of paper moving in proximity to the discharge shows distinct changes in the distribution of particles. Even if a bare strip is moved in contact with the discharge device, it will exhibit dielectric polarization which does not disappear at once, and a strip thus treated may be dusted immediately after it has passed the electrodes and the varied distribution will then make a record of the current variations which produced the dielectric polarization.

In Figures 11 and 12, I have indicated how a modification of the method of recording of current variations by means of luminous discharges through an adsorbed gas film can be reversely applied as an improved method of transforming sound into current variations for telephonic or the like purposes. In this case I provide two electrodes 213—214 which are preferably convex surfaces such as would be provided by a rounded pyramid or cone or by hemispherical or semi-cylindrical electrodes.

These electrodes may be one or both made of semi-conductive material such as agate, lithographic stone or a dielectric medium impregnated with a small amount of conductive material. One or the other electrode may be made of metal if desired. These electrodes are in contact with each other and are connected to an amplifying device such as the thermionic tube 215, being connected to the grid circuit thereof.

The potential of the battery 216 which is impressed upon the electrodes 213—214 is high enough to cause a visible corona-like discharge in the place of contact between the electrodes. This contact is relatively imperfect and serves more to concentrate the discharge than to form a genuine contact between them. The discharge current passing the contact 217 is varied in accordance with the compression and rarefactions of the air produced by sound. This tends to vary the input potential on the amplifying tube 215 with a resulting variation on the output circuit 218. The output circuit may in turn be connected to a modulator of a radio transmitter or to translating or transmitting devices, or it may be connected to a luminous discharge tube, the luminosity of which is to be varied in accordance with sound.

It will be obvious at once that instead of employing direct current from the battery 216 the discharge electrodes 213 and 214 may be excited by a source of oscillating current, the variation in air pressure then serving to influence the resistance and capacity of the circuit to vary the amplitude of the oscillation of the circuit. As a matter of fact, both methods may be employed at the same time.

Figure 13 shows how the effect of variations of capacity can be combined with the variations of conductivity in an inertia-less telephone transmitter such as illustrated in Figures 11 and 12. The transmitter 227 in this case is connected to the radio-frequency circuit 228 which circuit is maintained in oscillation by the oscillating tube 229, so that with variation of capacity of the transmitter 227, the frequency of the circuit 228 will vary, thereby producing corresponding variations of current from the battery 230 which supplies the plate current for the tube 229. The transmitter 227 is also connected to the battery 231 which supplies the current for the transmitter discharge and for the amplifying tube 232. Variations of conductivity of the transmitter 227 will change the potential of the grid 233 and cause additional variations of the plate currents supplied by the battery 230 for the tube 232. These supply current variations caused by changes both of capacity and of conductivity of the transmitter are then amplified in the usual way by the amplifier 234.

I further wish to call attention to the fact that in exciting the sound-actuated condensers such as are shown in Figure 13, it is advantageous to use not only radio-frequency of oscillations but also ultra-radio-frequencies of the order of magnitude of from 10,000,000 to 200,000,000 cycles per second.

It will now be apparent from the above specification and drawings that I have made certain improvements in the apparatus employed in the complete system of my prior applications above referred to, and I have not shown these individual elements as assembled into a complete sound and picture recording or reproducing or transmitting system since it will be apparent from my prior applications how the individual elements of the present application are to be employed or may be employed. I do not wish, however, to limit the use of the individual elements which I have disclosed and described to use in only the particular situations prescribed by my prior applications but intend that they may be used generally wherever found suitable for employment.

I claim:—

1. In combination, a plurality of elements physically in contact with each other and separated by a gap of molecular dimension, and means for creating a discharge of high actinic value between said elements.

2. In combination, a plurality of elements physically in contact with each other and electrical means for creating an actinic discharge between the said elements which is confined intermediate the elements and

which although relatively small in volume is sharply defined and of a variable actinic value, said discharge being adapted to cause a proportional amount of ozone to be formed.

3. In combination, a plurality of elements physically in contact with each other and electrical means for creating an actinic discharge between the said elements which is sharply defined intermediate the elements and which although relatively minute in size is of a high actinic value, said discharge being adapted to radiate heat of variable temperatures.

4. In combination a pair of plates separated by a minute air film, and an electric circuit subject to variations of potential connected to said plates for creating a varying electrical discharge between said plates, one of said plates comprising a relatively poor conductor.

5. In combination a pair of metallic plates separated by a minute air film, an electric circuit subject to variations of potential for creating a varying electrical discharge between said plates and threads of insulating material separating said plates to establish the gap.

6. In combination a pair of plates separated by a microscopic gas film, an electric circuit subject to variations in potential connected to said plates and creating a varying electrical discharge between said plates corresponding to the variations of potential and means for varying the fluid pressure between said plates to control the electrical discharge between said plates.

7. In combination a pair of plates separated by a microscopic gas film, an electric circuit connected to said plates subjecting them to differences of potential for creating a varying electric discharge between them varying in accordance with said variations of potential a recording surface and means for causing relative movement between said surface and said plates and a fluid connection for the gap between the plates for controlling the fluid in said gap.

8. In combination a pair of plates separated by a microscopic gas film, means to space said plates out of parallel with each other to concentrate the actinic effect, and an electric circuit connected to said plates and subjecting them to variations of potential for creating an electric discharge between them said discharge having an actinic effect.

9. In combination a photosensitive film, a source of actinic effect comprising a minute gas film, electrodes defining said film, said electrodes being maintained substantially in contact with said film and means for impressing variations of current upon said electrodes for varying the intensity of the discharge at said film.

10. In combination, a pair of plates physically in contact with each other, said plates providing a gap of molecular dimension, and means for creating an electrical discharge of high actinic value between said plates.

11. In combination, a pair of plates in physical contact, an electric circuit subject to variations of potential connected to said plates for creating a varying electrical discharge between said plates, one of said plates comprising a relatively poor conductor.

12. In combination, a pair of plates in physical contact, but providing an electrical gap of molecular dimensions, means for maintaining an electrical discharge of high actinic value between said plates, and means for conducting said plates into contact with each other.

13. In combination, a pair of plates in physical contact, an electric supply circuit for maintaining an electrical discharge of high actinic value between said plates, and means for varying said discharge in accordance with variations of current flow.

14. In combination, a pair of plates in physical contact, an electric supply circuit for maintaining an electrical discharge of high actinic value between said plates, and means for varying said discharge in accordance with variations of current flow, and clamping means for pressing said plates together.

15. In combination, a pair of plates in physical contact, an electrical circuit subject to variations in potential, said circuit being connected to said plates and creating a varying electrical discharge between said plates, and means for varying the gas pressure between said plates.

16. In combination, a pair of plates in physical contact, means for maintaining an electrical discharge between the plates, and means for supplying gas of a desired character between the plates to control the character of the discharge.

17. In combination, a pair of plates separated by a gap of molecular dimensions only, means for creating an electrical discharge in said gap between the plates, and means for supplying a gas which will enhance the actinic effect of said discharge.

18. In combination, a pair of plates physically in contact, means to separate the plates at one end to concentrate the actinic effect, and an electric circuit connected to said plates and subjecting them to variations of potential for creating an electric discharge between them, said discharge having an actinic effect.

19. In combination, a pair of plates having a layer of fluorescent material between them, an electric circuit connected to said plates and subjecting them to differences of

potential for creating a varying electrical discharge between the plates, said fluorescent material being excited by said electric discharge between the plates.

20. In combination, a plurality of elements physically in contact with each other and separated theoretically by a gap of molecular dimension, means for creating a variable discharge of high actinic value between said elements, and means responsive to said discharge adapted to be associated with said elements to record variations in the actinic discharge, said discharge, although relatively small in size being sharply defined and relatively close to said last mentioned means, said elements being so proximate to said recording means as to prevent diffusion of said actinic discharge.

In witness whereof, I hereunto subscribe my name this 26th day of January, 1923.

JOSEPH TYKOCINSKI-TYKOCINER.