

Nov. 5, 1929.

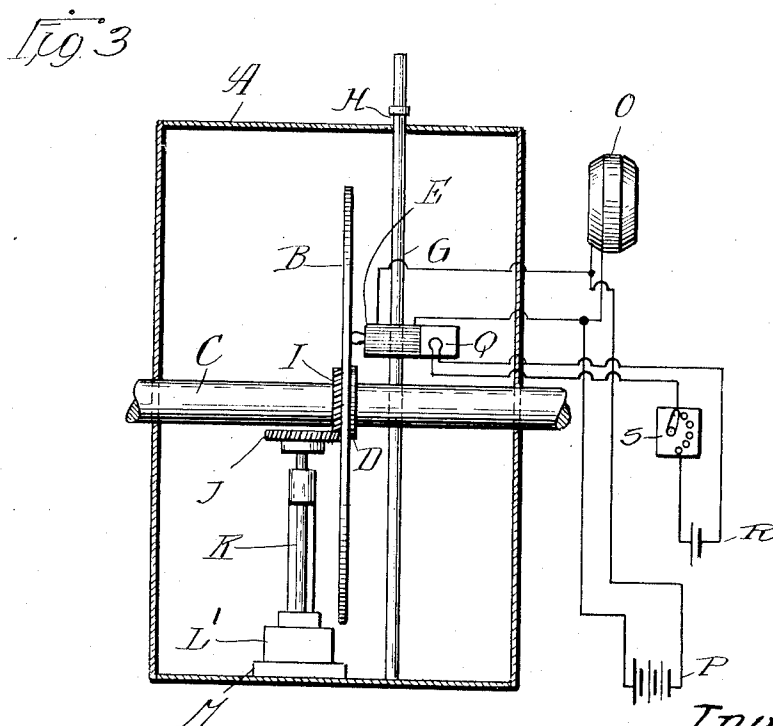
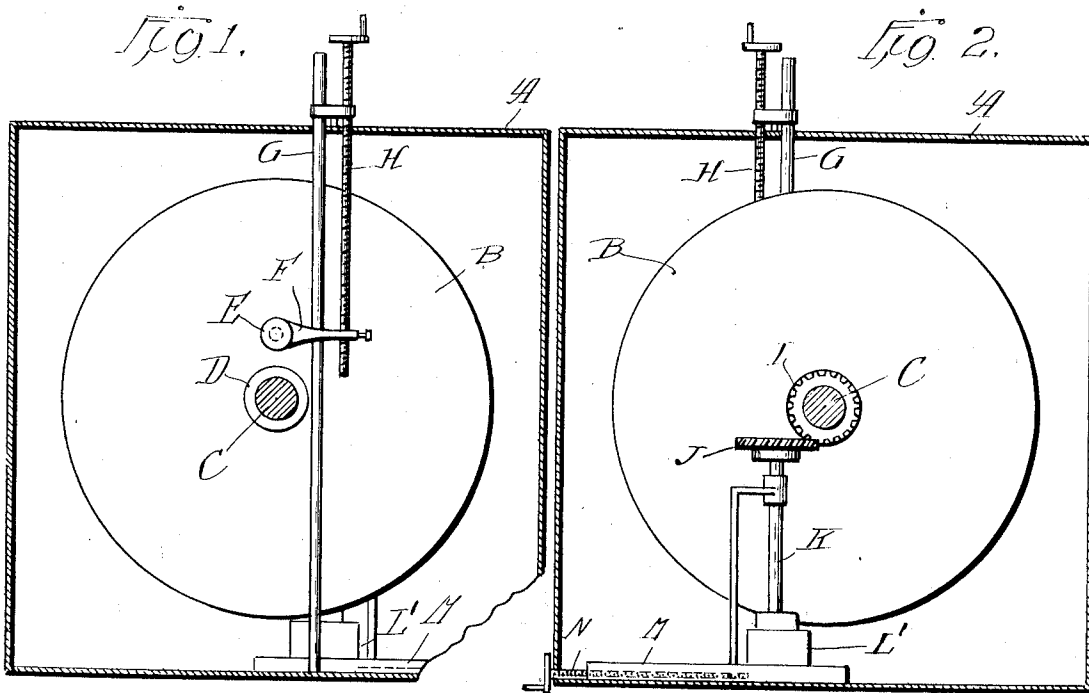
S. M. HULL

1,734,675

METHOD AND APPARATUS FOR REPRODUCING SOUND

Filed Aug. 17, 1927

3 Sheets-Sheet 1



Inventor:
Stanley M. Hull

Nov. 5, 1929.

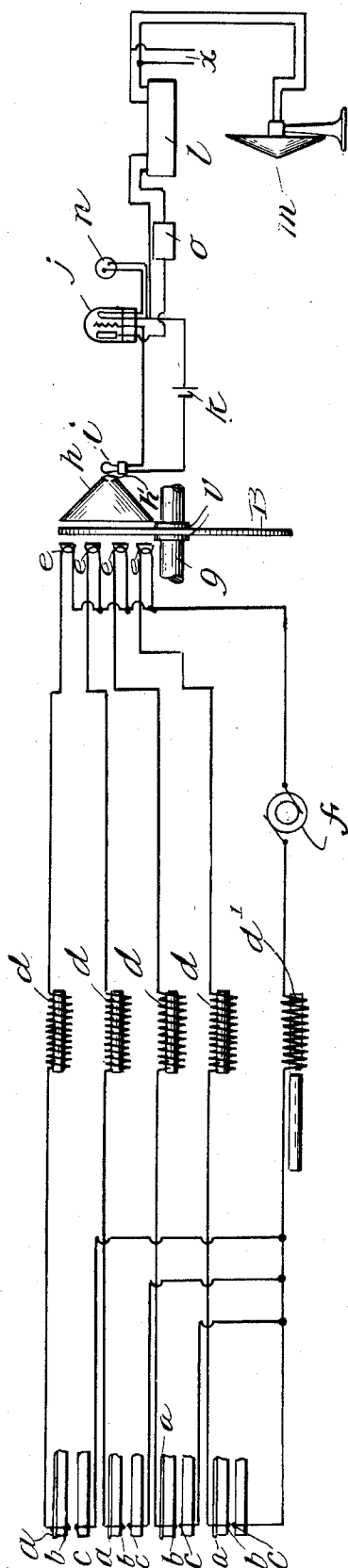
S. M. HULL

1,734,675

METHOD AND APPARATUS FOR REPRODUCING SOUND

Filed Aug. 17, 1927

3 Sheets-Sheet 2



Inventor:
Sidney M. Hull.

Nov. 5, 1929.

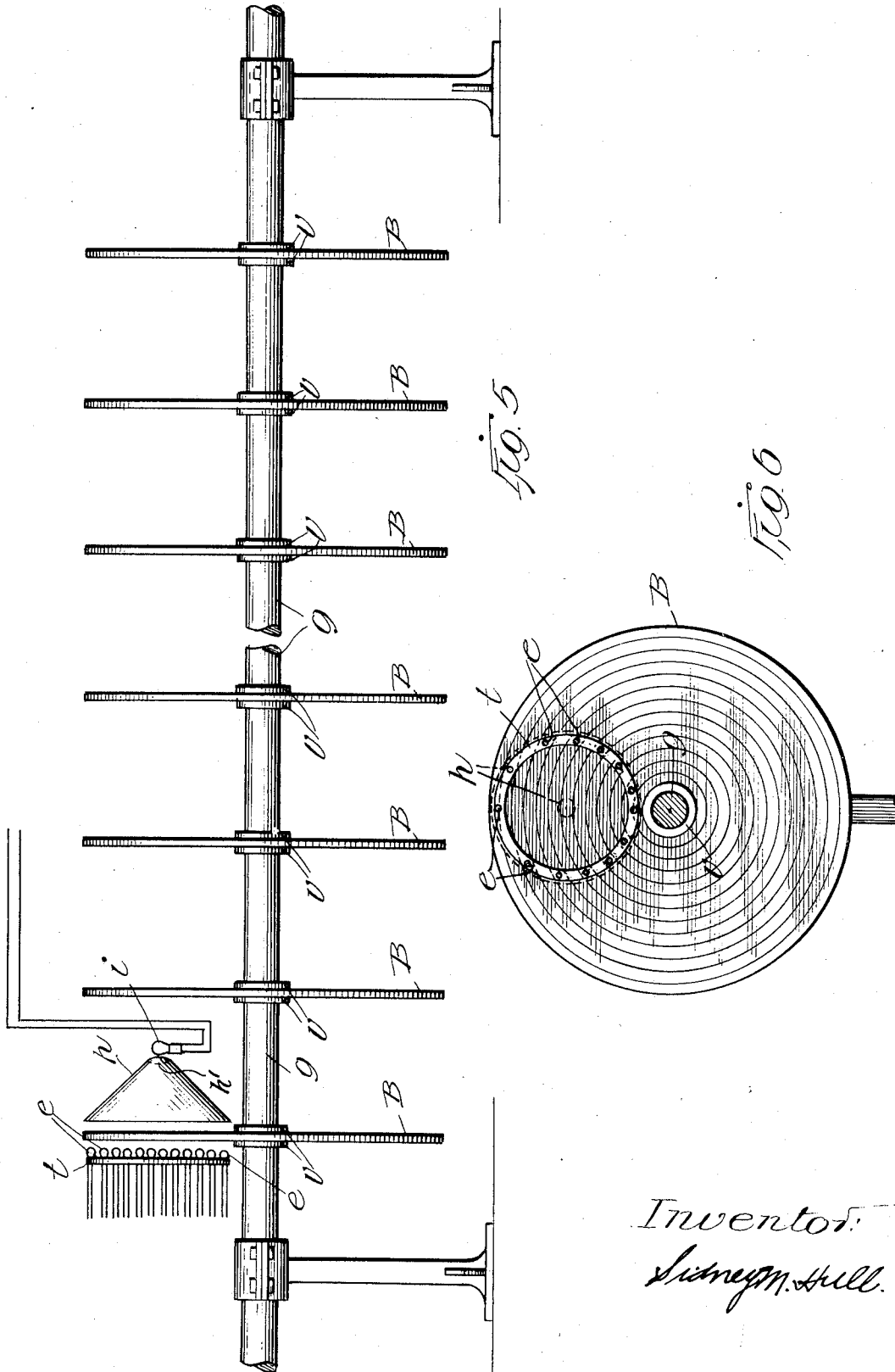
S. M. HULL

1,734,675

METHOD AND APPARATUS FOR REPRODUCING SOUND

Filed Aug. 17, 1927

3 Sheets-Sheet 3



Inventor:
S. M. Hull.

UNITED STATES PATENT OFFICE

SIDNEY M. HULL, OF WESTERN SPRINGS, ILLINOIS

METHOD AND APPARATUS FOR REPRODUCING SOUND

Application filed August 17, 1927. Serial No. 213,667.

The sound producing apparatus of my invention is inclusive of a plurality of light varying records, means for furnishing light to said records, the records and light cooperating to furnish differing musical scale tones, means individual to each record for individually controlling the light furnished thereto, and sound producing means subject to and operable by the varied light. In the preferred embodiment of the invention I employ a plurality of individually controlled lamps, each record having a lamp individual thereto and subject to light therefrom and adapted to vary such light in conformity with the record, there being means individual to each lamp for bringing it into and out of cooperative relation with the record individual thereto. The embodiment of the invention herein disclosed I have chosen to call an orchestral organ which is designed to function as a modern organ in churches, theaters, schools and other auditoria, and by reason of its design and construction is readily adaptable to use in smaller spaces, such as residences. Its operation as performed by the operator may be identical with that of the modern pipe organ. The tone-producing possibilities of my organ are far greater than those of a modern instrument, since by suitable choice of stops and other apparatus controlled thereby, the music produced may be identical with that of any pipe organ desired, or as an alternative, all the tones produced may be those of orchestral instruments ranging from those of the double bass viol, through the cello, viola, oboe, horns, etc., to the highest or the shrillest tones of the violin harmonics or flute.

The entire tone-producing mechanism of the orchestral organ may be summed up briefly by stating that the tone produced is developed by allowing light to shine upon and preferably through a suitable image, preferably photographic, of the tone desired on a suitable recording member which is preferably a revolving plate or disc. The light emerging from the image is preferably focused upon a photoelectric cell, which allows an electric current to be transmitted through it in an oscillating or modulated

fashion, the modulations of the current being exactly similar in their amplitude, frequency, and other electric characteristics to the variations of the image on the record disc, which in turn, is preferably the photographic counterpart of the tone from which it was produced. The photoelectric cell current, preferably amplified sufficiently by vacuum tubes in a manner well known to the radio art, actuates a loud speaker or other sound producing mechanism, also well known. As many photographic images are necessary as are the tones desired, while the light corresponding to each tone image is turned on or off in accordance with the keys depressed on the console, and the arrangement of the stops at the time of depression. It is obvious that any reasonable combination of keys, stops, lights and tone-images may be provided or employed.

The invention will be more fully explained in connection with the accompanying drawings which illustrate the preferred equipment. In the drawings, Fig. 1 is a front elevation of the record photographing apparatus, the enclosing casing being shown in section; Fig. 2 is a rear elevation of the apparatus shown in Fig. 1, the casing also being shown in section; Fig. 3 is a side view of the apparatus shown in Figs. 1 and 2, the casing being shown in section; Fig. 4 is an illustration, largely diagrammatic, of a musical instrument equipped in accordance with the invention; Fig. 5 is a view illustrating the preferred mechanical arrangement of a number of recording members, elements pertaining to and complementary to one of these members being illustrated; and Fig. 6 is a face view of one of the recording members with a circular row of lamps in front of the record bearing face thereof.

In Figures 1 to 6 of the accompanying drawings, I have shown in diagrammatic form, the apparatus and arrangement thereof necessary for the execution of the invention fully described in the foregoing specification. In the preparation of these drawings, no attempt has been made to illustrate the mechanical details necessary for the installation of the apparatus since it is obvious that in

the mechanical construction of the apparatus a variety of methods may be employed to accomplish the same end. The illustrations are diagrammatic only and fully demonstrate the principles involved in all the essential features, both as to apparatus and its co-ordination.

Figure 1 shows the front elevation of the apparatus necessary for photographing the single or complex tones desired. A is a light-proof box within which are located a disc B mounted on its axle C and held firmly thereon by the locknut D; a light relay E, mounted by a sliding clamp F on a support G; and a screw adjustment H actuated by the turning of a small hand wheel above the box, for varying the position of the light relay before the disc vertically between the axle and the periphery of the disc B.

Figure 2 represents the rear elevation of the photographic apparatus shown in Figure 1, wherein letters A to H designate the same details as in Fig. 1; L is a specified constant speed motor for rotating the disc B at a number of prescribed constant speeds of rotation, by the worm and spiral gears, J and I respectively. The various speeds of rotation desired may be secured by replacing I and J with other gears of appropriate size and number of teeth, or by substituting therefor any other suitable train of gears necessary. The motor L' is mounted on a sliding base M, whose position is varied by turning the screw adjustment N in order to allow replacement of various sizes of worm and spiral gears.

In Figure 3 is shown the side elevation of the photographic apparatus illustrated in Figures 1 and 2. Herein, the letters A to M designate identical parts of the apparatus shown in Figures 1 and 2. Here, however, the light relay L is shown in a side view with its lamp Q. O is a microphone and P is a suitable source of potential in series in an electrical circuit with the winding in the light relay. R is a suitable source of potential and S is a variable rheostat both of which are placed in series with the lamp Q and are employed for supplying a regulated electrical current to the filament of said lamp.

The light relay L may be of any type but the preferred form is fully described in an article by Franz Aigner in the "Jahrbuch der drahtlosen Telegraphie und Telephonie" for 1923, pages 101-120.

Let it be assumed that the tone images are to be photographically placed on a series of discs B of glass. Each disc may be three feet in diameter, and a quarter of an inch thick, free from optical defects and perfectly plane over its area on both sides, which should be exactly parallel. Each disc is coated with a photosensitive coating, similar to a glass photographic camera plate, projection lantern slide, etc. Each glass disc is

mounted on the horizontal, revolving support C inside the light proof box A. The shaft support may be projected through the side of the box and driven by the suitable constant-speed motor L', either electrically or spring actuated, and so designed that, within a certain range, the disc may be driven at any constant speed desired. Before the disc and mounted on the vertical sliding support G is the light relay E of the type customarily employed in the photographing of sound where the sound vibrations, by means of the microphone O, are transformed into electrical oscillations, which, in turn, either control the intensity of a transmitted beam of light or, by the use of another type of light relay, control the path of a beam of light, both processes serving to expose a photosensitive surface to variations in intensity or path of light, in a manner corresponding to the characteristics of the original sound vibrations. The preferred type of relay is a device by which the intensity of a light affixed thereto is varied in proportion to the variations of an electric current passed through a solenoid winding within the light relay. A stop arrangement is provided whereby the light shining through the light relay, with the glass disc being driven at constant speed, will be allowed to shine upon the surface of the revolving disc for exactly one revolution of said disc. The relay is so supported on the sliding mounting G within the box, that, without opening said box, the relay can be locked in a number of varying positions before the disc. The relay is mounted on the sliding support in a manner customarily employed in photographing sound vibrations and provided with the necessary apparatus for the proper exposure of the sensitized surface.

The microphone O is placed in series with the light relay and the suitable source of current P and the entire sound photography apparatus is ready for use.

Suppose that it is desired to image the tones of a musical instrument such as the cello. The musician sits with his instrument properly placed in front of the microphone, the light relay is adjusted in the box, so that it illuminates a spot on the disc just outside the central mounting (say, three inches from the center of revolution) and the motor is started. As yet the spot before the relay has not been exposed to light since the stop shutting off the light has been kept closed. When the motor has attained constant speed, the musician now plays the lowest tone to be recorded, by bowing his instrument. At the proper moment, with the tone being sounded true and clear, the stop is opened and the light relay exposes an endless annular record concentric with the disc, six inches in diameter, in exact response to the tone vibrations recorded by the micro-

phone. After the disc has rotated through exactly one revolution, the stop is closed, with the result that an annular endless sound record is produced upon the disc. After this first record is produced, the relay is moved half an inch upward and with the next higher tone being played upon the cello, another endless annular record concentric with and immediately surrounding the first is produced in a similar manner. Successive endless annular records of increasing diameter are similarly made until finally the recording member or disc B is completely covered with records of varying diameter and corresponding to the differing tones that were produced by the instrument being recorded. In short, these concentric endless annular records correspond, respectively, to the tones in a chromatic scale so that they may be selected for reproduction in proper sequence to produce music. After the complete exposure to all the desired tones, the disc is taken to a dark room where it is removed from its light proof box and developed in the usual or preferred manner. The result will be a series of concentric endless records, one for each half inch, upon the surface of the disc, and each endless annular record will vary in light and shade, being transparent or opaque, the succession of these light and dark areas on the circular record varying in frequency of occurrence and intensity of transparency, in a manner corresponding exactly to the modulations of the tones correspondingly produced on the cello. Allowing a radial width of one half inch for each record, one octave of twelve tones can be imaged on the disc per six inches of radius, consequently with a diameter of forty-two inches, allowing six inches for mounting on the shaft, three octaves would be photographed. On many instruments, two octaves range would be sufficient, so that thirty inches diameter of disc would be adequate.

The endless annular tone record or lowest pitch is nearest the center of the recording member. Each tone record of higher pitch surrounds the tone records of lower pitch, the tone records increasing in diameter or size in correspondence with the increase in the pitch of the tones, in correspondence with the chromatic scale. It is thus seen that as the tone images progress toward the circumference of the disc, the linear or peripheral speeds thereof increase, with the rotation of the recording member B at uniform speed, in almost the same ratio as the vibration rates of the tones recorded. If desired, the radial spacing of the tone records upon the surface of the disc may be so calculated with respect to both the speed of rotation and frequency of the tone to be photographed, that an exactly integral number of sound vibrations will be photographed in one revolution of the disc.

In the photographing of a tone by the above method, the speed of revolution and the constancy of that speed are preferably made essential factors. In general, the linear or peripheral speed of the recording areas of surface which pass before the light relay should only be the minimum speed at which the light vibrations, as they are projected onto the disc, will not superimpose upon each other. In other words, the critical speed is that speed at which, when the image is developed on the plate, the recorded vibrations of the highest frequency will be drawn out laterally, or, in this case, circumferentially, to produce a vibration record.

The manner of taking photographic records of tones produced by any selected musical instrument or instruments or sounds produced by other sound producing instrumentalities may be in accordance with the process hitherto described. The invention, however, is not to be limited to any peculiar form of record nor to any peculiar process of making such records, excepting that such records are produced by the action of sound or are copies, replicas, or reproductions thereof.

In Figure 4 we leave the photographic apparatus and illustrate in turn the complete diagrammatic set-up for the reproduction of the tones photographed with the apparatus shown in Figs. 1 to 3, in response to the depression of keys at a keyboard. *a* designates a plurality of keys connected in series, through a plurality of choke coils *d*, with a plurality of lamps *e* wherein each key is electrically connected through its individual choke coil to its individual lamp. A common source of potential *f* and a common variable choke *d'* are connected in series with the key-lamp circuits in such a way that the potential source *f* supplies electrical energy to any or all of the lamps in response to the depression of the keys corresponding to said lamps. The variable choke coil *d'* is connected mechanically in any suitable manner to a foot pedal at the console in order that the operator, by depressing the pedal, may cause the core of the said choke coil to be withdrawn therefrom and thus increase the amperage and, in turn, the brilliancy of the light produced by the lamps *e*. Obviously, the effect of operation of the choke coil *d'* is to vary, as desired, the intensity of the illumination to vary the musical tones. The adjustable choke coil, which is common to the records, is used where the lamps are supplied with alternating current; obviously other instrumentalities could be employed. The choke coils *d* are adjusted during installation of the apparatus to provide suitable equalization in the intensities of the lights produced by the said lamps. If the source of potential *f* is alternating in character, *d* and *d'* may be choke coils, but if direct cur-

rent is used, d and d' would necessarily be direct current resistances of suitable construction. b and c are electrical contacts for closing the electrical circuits between the keys and the lamps in order that the lamps may light in response to depression of the keys.

B is the disc carrying upon its surface the more or less transparent, endless circular photographs of the desired tones. It is mounted upon an axle g to which it is firmly secured by the two collars $v-v$. A single lamp e is placed directly in front of each corresponding tone photograph and when a particular key is depressed, the light from the corresponding lamp is projected through the photograph of the corresponding tone and is reflected by the cone-shaped mirror h with a convergent lens at its apex, upon the anode of the photoelectric cell i . If desired, individual lenses may be used in place of the cone mirror. When in operation, of course, the disc B is being rotated by a suitable motor and drive (not shown) at the identical speed at which it was rotating when the photographs which it carries were produced.

In response to the variation of light thrown upon it by the lamps e , the photoelectric cell i transmits the current produced by the source of potential k in an oscillating manner, identical with the original electrical oscillations produced by the microphone O in Fig. 3. The vacuum tube j with its "A" battery n and "B" battery o amplifies the oscillating current transmitted by the photoelectric cell i and in turn, is connected with the input leads of the amplifying unit l . The amplifier l amplifies the current from the vacuum tube j sufficiently to operate the loud speaker m , which reproduces the combination of tones desired. If desired, the vacuum tube j may be omitted and the photoelectric cell i connected directly through the battery k to the input terminals of the amplifier l . The manner of electrically connecting the photoelectric cell, vacuum tube and loud speaker, and the specifications therefor are matters of common knowledge and need not be described here. It is important to note, however, that both the amplifier l and the loud speaker m should be so constructed that they will best amplify and reproduce sounds over a limited range of frequency corresponding to the tones whose photographs are used in the reproduction of said tones through the said amplifier and loud speaker.

Figure 5 illustrates the distribution of discs carrying tone photographs of tones within one limited range of frequency and wherein all photographs were taken at one constant speed. In the final assembly of the complete instrument, a plurality of such shafts, with their appropriate discs, are mounted parallel to one another and are so

geared together that one constant speed motor will produce rotation of all the discs at the respective speeds at which the photographs were produced on each disc. t represents a support for the lamps e and, naturally, a set of lamps, as shown in Figure 4, would be provided in front of each disc, while behind each disc would be located the cone-shaped mirror and photoelectric cell with its circuit as shown in detail in Figure 4. In the final assembly the source of potential k would supply current to a plurality of photoelectric cells and the circuits from said cells would be grouped in parallel and connected to an amplifier and loud speaker designed particularly for the limited range of frequency within which would fall the frequencies of all tones used in connection with said amplifier and loud speaker.

Figure 6 illustrates the method of distributing and supporting the lamps e in front of the discs B in order that the light from each lamp may strike the side of the cone-shaped mirror h at the same angle and will thus have an equal share of effect in the activation of the photoelectric cell i . e represents the backs of the individual lights which are arranged on a circular support t in front of the disc in such a manner that each lamp is located directly in front of one circular tone image on the disc. The dotted lines representing the cone-shaped mirror and lens h are drawn in to show the relative sizes of the mouth of the cone and the diameter of the circle of lamps; the cone is slightly larger than the support t so that all light projected forward through the disc will impinge just within the mouth of the cone on the slanting side thereof.

As illustrated herein, the various lamps e are individually controlled by the keys a whereby the lamps may be caused to glow to project light upon the records or may be caused to cease to glow according to the position of the keys. Obviously, however, other means may be employed for preventing or permitting light to pass from the lamps to the records. The claims mention "sound producing apparatus", this expression being used in a broad sense to be inclusive of a sound receiver which may be located in the neighborhood of the recording member and lamps or which may be widely separated therefrom and operated by broadcasting.

If an organ with fifty stops is desired, fifty discs B will be prepared from the original tone photographs by printing from the originals, in exactly the manner of printing a picture from a photographic negative. These discs and the lamps e are now divided into groups, according to the speed at which the photographs were taken and each group of discs is mounted on one or more horizontal shaft supports G . The discs are placed about eighteen inches to two feet apart along the

shafts, and the various shafts are geared together so that, when driven by a constant speed motor, the discs on each shaft will revolve at exactly the same speed at which they revolved when the tones were being photographed. The lamps referred to may be either small filament lamps or they may be small "glim" lamps of the type of the well known neon ionization lamp. The lamps should be very responsive to the application or disconnection of current from them, since the entire success of the operation may depend upon the immediate response of the light to the depression of the keys at the console. The ionization lamp is more suited to this purpose than any other type, since it is instantaneous in its response and moreover, has a very low current consumption.

If we presume that in the production of the original tone images, one note may have been played louder than others on either the same instrument, or in comparison with the proper intensity of the tones of other instruments, this difficulty is easily overcome. It is only necessary to introduce the proper amount of resistance into the lamp-key circuit, to reduce the intensity of the illumination produced by the lamp for this tone, and the difficulty is solved. In this way, it might be said that the organ is voiced.

The use of alternating current in the key-lamp circuits for flashing the lamps before the tone images is advantageous also, since by its use, simple choke coil impedances could be employed for varying the current strengths of the various circuits, and consequently, the intensity of illumination produced by the lamps. In this way, either a change in the number of turns in the coil or the insertion or withdrawal of the core (even in slight amounts) would constitute an easy method of light intensity control, in instances where variations in the tone intensity of any tone, or combination of tones, by manual or stop, is desired. The lamps are in a circular support on one side of the axis of the recording member, the lamps pertaining to immediately adjacent rows being on opposite sides of such circular row. It will be apparent that the endless records of individual musical scale tones and the light furnishing means are relatively movable in a direction and to an extent enabling the light to move along the records and throughout their lengths to enable the production of continuous tones during the relative movement of the light and records.

What I claim is:

1. In a sound producing apparatus, the combination with a recording member which has a plurality of differing and differently located substantially endless light varying records of individual musical scale tones; of means for furnishing light to all of said records to be varied thereby; means indi-

vidual to each record for individually controlling the light furnished thereto; and sound producing means subject to and operable by the varied light, the records and the light furnishing means being relatively movable in a direction and to an extent enabling the light to move along the records and throughout their lengths to enable the production of continuous tones during the relative movement of the light and records.

2. In a sound producing apparatus, the combination with a recording member which has a plurality of differing and differently located substantially endless light transmitting light varying records of individual musical scale tones; of means for furnishing light to all of said records to be varied thereby; means individual to each record for individually controlling the light furnished thereto; and sound producing means subject to and operable by the varied light, the records and the light furnishing means being relatively movable in a direction and to an extent enabling the light to move along the records and throughout their lengths to enable the production of continuous tones during the relative movement of the light and records.

3. In a sound producing apparatus, the combination with a recording member which has a plurality of differing and differently located substantially endless light varying records of individual musical scale tones; of means for furnishing light to all of said records to be varied thereby; means individual to each record for individually controlling the light furnished thereto; an electrically operated sound producing receiver; an operating electrical circuit for said receiver and inclusive of a source of current; and means sensitive to light in controlling relation to said circuit and subject to the light that is varied by the records, the records and the light furnishing means being relatively movable in a direction and to an extent enabling the light to move along the records and throughout their lengths to enable the production of continuous tones during the relative movement of the light and records.

4. In a sound producing apparatus, the combination with a recording member which has a plurality of differing and differently located substantially endless light transmitting light varying records of individual musical scale tones; of means for furnishing light to all of said records to be varied thereby; means individual to each record for individually controlling the light furnished thereto; an electrically operated sound producing receiver; an operating electrical circuit for said receiver and inclusive of a source of current; and means sensitive to light in controlling relation to said circuit and subject to the light that is varied by

the records, the records and the light furnishing means being relatively movable in a direction and to an extent enabling the light to move along the records and throughout their lengths to enable the production of continuous tones during the relative movement of the light and records.

5. In a sound producing apparatus, the combination with a plurality of substantially endless light varying records; of means for furnishing light to said records, the records cooperating with the light in furnishing differing individual musical scale tones; means individual to each record for individually controlling the light furnished thereto; and sound producing means subject to and operable by the varied light, the records and the light furnishing means being relatively movable in a direction and to an extent enabling the light to move along the records and throughout their lengths to enable the production of continuous tones during the relative movement of the light and records.

6. The sound producing apparatus of claim 1 wherein the light furnishing means is inclusive of a plurality of individually controlled lamps each record having a lamp individual thereto.

7. The sound producing apparatus of claim 2 wherein the light furnishing means is inclusive of a plurality of individually controlled lamps each record having a lamp individual thereto.

8. The sound producing apparatus of claim 3 wherein the light furnishing means is inclusive of a plurality of individually controlled lamps each record having a lamp individual thereto.

9. The sound producing apparatus of claim 4 wherein the light furnishing means is inclusive of a plurality of individually controlled lamps each record having a lamp individual thereto.

10. The sound producing apparatus of claim 5 wherein the light furnishing means is inclusive of a plurality of individually controlled lamps each record having a lamp individual thereto.

11. In a sound producing apparatus, the combination with a recording member which has a plurality of differing and differently located light varying musical scale tone records; of means for furnishing light to all of said records to be varied thereby; means individual to each record for individually controlling the light furnished thereto; and sound producing means subject to and operable by the varied light, wherein the records are in the form of substantially concentric endless rings of differing diameters and the records and light furnishing means are relatively rotatable on an axis that substantially contains the common center of said records to enable the light to move along the records.

12. In a sound producing apparatus, the combination with a record member which has a plurality of differing and differently located light varying musical scale tone records; of means for furnishing light to all of said records to be varied thereby; means individual to each record for individually controlling the light furnished thereto; and sound producing means subject to and operable by the varied light, wherein the light furnishing means is inclusive of a plurality of individually controlled lamps, each record having a lamp individual thereto and subject to light therefrom, and wherein the records are in the form of substantially concentric endless rings of differing diameters and the records and the lamps are relatively rotatable on an axis that substantially contains the common center of said records to enable the light from the lamps to move along the records, the lamps being circularly disposed on one side of the aforesaid axis.

13. In a sound producing apparatus, the combination with a recording member which has a plurality of differing and differently located light varying musical scale tone records; of means for furnishing light to all of said records to be varied thereby; means individual to each record for individually controlling the light furnished thereto; and sound producing means subject to and operable by the varied light, wherein the light furnishing means is inclusive of a plurality of individually controlled lamps, each record having a lamp individual thereto and subject to light therefrom, and wherein the records are in the form of substantially endless rings of differing diameters and the records and the lamps are relatively rotatable on an axis that substantially contains the common center of said records to enable the light from the lamps to move along the records, the lamps being arranged in a circular row on one side of the aforesaid axis, the lamps pertaining to immediately adjacent records being in opposite sides of the circular row of such lamps.

14. The sound producing apparatus of claim 1 wherein means, in addition to the light controlling means, are provided for varying the intensity of the tones.

15. The sound producing apparatus of claim 2 wherein means, in addition to the light controlling means, are provided for varying the intensity of the tones.

16. The sound producing apparatus of claim 3 wherein means, in addition to the light controlling means, are provided for varying the intensity of the tones.

17. The sound producing apparatus of claim 4 wherein means, in addition to the light controlling means, are provided for varying the intensity of the tones.

18. The sound producing apparatus of claim 5 wherein means, in addition to the

light controlling means, are provided for varying the intensity of the tones.

19. The sound producing apparatus of claim 11 wherein means, in addition to the light controlling means, are provided for varying the intensity of the tones.

20. The sound producing apparatus of claim 12 wherein means, in addition to the light controlling means, are provided for varying the intensity of the tones.

21. The sound producing apparatus of claim 13 wherein means, in addition to the light controlling means, are provided for varying the intensity of the tones.

22. The sound producing apparatus of claim 1 wherein means, common to the records and in addition to the light controlling means, are provided for varying the intensity of the tones.

23. The sound producing apparatus of claim 2 wherein means, common to the records and in addition to the light controlling means, are provided for varying the intensity of the tones.

24. The sound producing apparatus of claim 3 wherein means, common to the records and in addition to the light controlling means, are provided for varying the intensity of the tones.

25. The sound producing apparatus of claim 4 wherein means, common to the records and in addition to the light controlling means, are provided for varying the intensity of the tones.

26. The sound producing apparatus of claim 5 wherein means, common to the records and in addition to the light controlling means, are provided for varying the intensity of the tones.

27. The sound producing apparatus of claim 11 wherein means, common to the records and in addition to the light controlling means, are provided for varying the intensity of the tones.

28. The sound producing apparatus of claim 12 wherein means, common to the records and in addition to the light controlling means, are provided for varying the intensity of the tones.

29. The sound producing apparatus of claim 13 wherein means, common to the records and in addition to the light controlling means, are provided for varying the intensity of the tones.

30. In a sound producing apparatus, the combination with a recording member which has a plurality of differing and differently located substantially endless light varying records of individual musical scale tones; of means for furnishing light to all of said records to be varied thereby; means individual to each record for individually controlling the light furnished thereto; sound producing means subject to and operable by the

varied light, the records and the light furnishing means being relatively movable in a direction and to an extent enabling the light to move along the records and throughout their lengths to enable the production of continuous tones during the relative movement of the light and records; and means, in addition to the light controlling means, to vary the intensity of the tones, said tone varying means being in controlling relation to the light furnished to the records.

31. In a sound producing apparatus, the combination with a recording member which has a plurality of differing and differently located substantially endless light transmitting light varying records of individual musical scale tones; of means for furnishing light to all of said records to be varied thereby; means individual to each record for individually controlling the light furnished thereto; sound producing means subject to and operable by the varied light, the records and the light furnishing means being relatively movable in a direction and to an extent enabling the light to move along the records and throughout their lengths to enable the production of continuous tones during the relative movement of the light and records; and means, in addition to the light controlling means, to vary the intensity of the tones, said tone varying means being in controlling relation to the light furnished to the records.

32. In a sound producing apparatus, the combination with a recording member which has a plurality of differing and differently located substantially endless light varying records of individual musical scale tones; of means for furnishing light to all of said records to be varied thereby; means individual to each record for individually controlling the light furnished thereto; an electrically operated sound producing receiver; an operating electrical circuit for said receiver and inclusive of a source of current; means sensitive to light in controlling relation to said circuit and subject to the light that is varied by the records, the records and the light furnishing means being relatively movable in a direction and to an extent enabling the light to move along the records and throughout their lengths to enable the production of continuous tones during the relative movement of the light and records; and means, in addition to the light controlling means, to vary the intensity of the tones, said tone varying means being in controlling relation to the light furnished to the records.

33. In a sound producing apparatus, the combination with a recording member which has a plurality of differing and differently located substantially endless light transmitting light varying records of individual musical scale tones; of means for furnishing light to all of said records to be varied thereby;

means individual to each record for individually controlling the light furnished thereto; an electrically operated sound producing receiver; an operating electrical circuit for said receiver and inclusive of a source of current; means sensitive to light in controlling relation to said circuit and subject to the light that is varied by the records, the records and the light furnishing means being relatively movable in a direction and to an extent enabling the light to move along the records and throughout their lengths to enable the production of continuous tones during the relative movement of the light and records; and means, in addition to the light controlling means, to vary the intensity of the tones, said tone varying means being in controlling relation to the light furnished to the records.

34. In a sound producing apparatus, the combination with a plurality of substantially endless light varying records; of means for furnishing light to said records, the records cooperating with the light to furnish differing individual musical scale tones; means individual to each record for individually controlling the light furnished thereto; sound producing means subject to and operable by the varied light, the records and the light furnishing means being relatively movable in a direction and to an extent enabling the light to move along the records and throughout their lengths to enable the production of continuous tones during the relative movement of the light and records; and means, in addition to the light controlling means, to vary the intensity of the tones, said tone varying means being in controlling relation to the light furnished to the records.

35. In a sound producing apparatus, the combination with a recording member which has a plurality of differing and differently located light varying musical scale tone records; of means for furnishing light to all of said records to be varied thereby; means individual to each record for individually controlling the light furnished thereto; sound producing means subject to and operable by the varied light, wherein the records are in the form of substantially concentric endless rings of differing diameters and the records and light furnishing means are relatively rotatable on an axis that substantially contains the common center of said records to enable the light to move along the records; and means, in addition to the light controlling means, to vary the intensity of the tones, said tone varying means being in controlling relation to the light furnished to the records.

36. In a sound producing apparatus, the combination with a recording member which has a plurality of differing and differently located light varying musical scale tone records; of means for furnishing light to all of said records to be varied thereby; means

individual to each record for individually controlling the light furnished thereto; sound producing means subject to and operable by the varied light, wherein the light furnishing means is inclusive of a plurality of individually controlled lamps, each record having a lamp individual thereto and subject to light therefrom, and wherein the records are in the form of substantially concentric endless rings of differing diameters and the records and the lamps are relatively rotatable on an axis that substantially contains the common center of said records to enable the light from the lamps to move along the records, the lamps being circularly disposed on one side of the axis; and means, in addition to the light controlling means, to vary the intensity of the tones, said tone varying means being in controlling relation to the light furnished to the records.

37. In a sound producing apparatus, the combination with a recording member which has a plurality of differing and differently located light varying musical scale tone records; of means for furnishing light to all of said records to be varied thereby; means individual to each record for individually controlling the light furnished thereto; sound producing means subject to and operable by the varied light, wherein the light furnishing means is inclusive of a plurality of individually controlled lamps, each record having a lamp individual thereto and subject to light therefrom, and wherein the records are in the form of substantially endless rings of differing diameters and the records and the lamps are relatively rotatable on an axis that substantially contains the common center of said records to enable the light from the lamps to move along the records, the lamps being arranged in a circular row on one side of the aforesaid axis, the lamps pertaining to immediately adjacent records being in opposite sides of the circular row of such lamps; and means, in addition to the light controlling means, to vary the intensity of the tones, said tone varying means being in controlling relation to the light furnished to the records.

SIDNEY M. HULL.