Sept. 3, 1940. C. L. OSWALD ET AL 2,213,531

METHOD AND MEANS FOR PRINTING MOTION PICTURE FILMS

Original Filed Oct. 29, 1928 3 Sheets-Sheet 1

Fig. 1

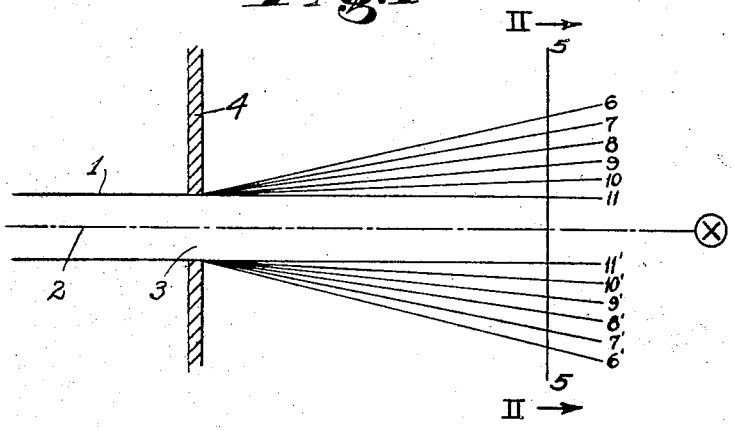


Fig. 2

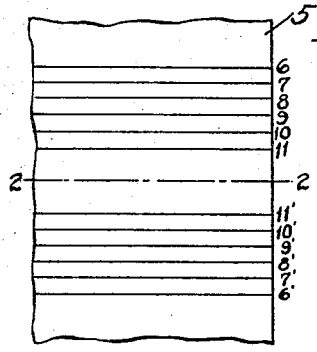


Fig. 3

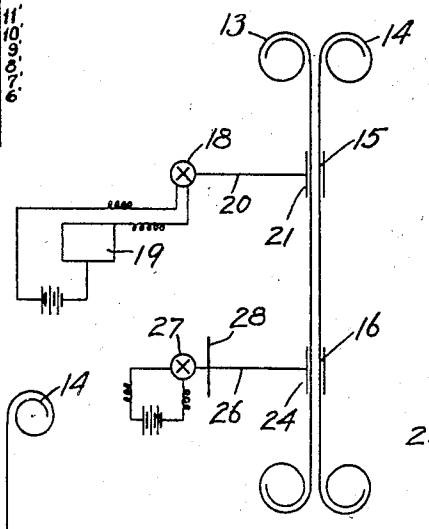


Fig. 5

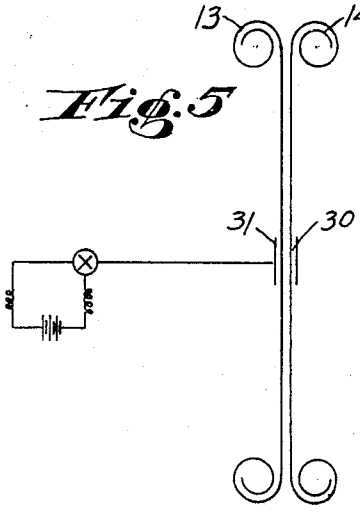
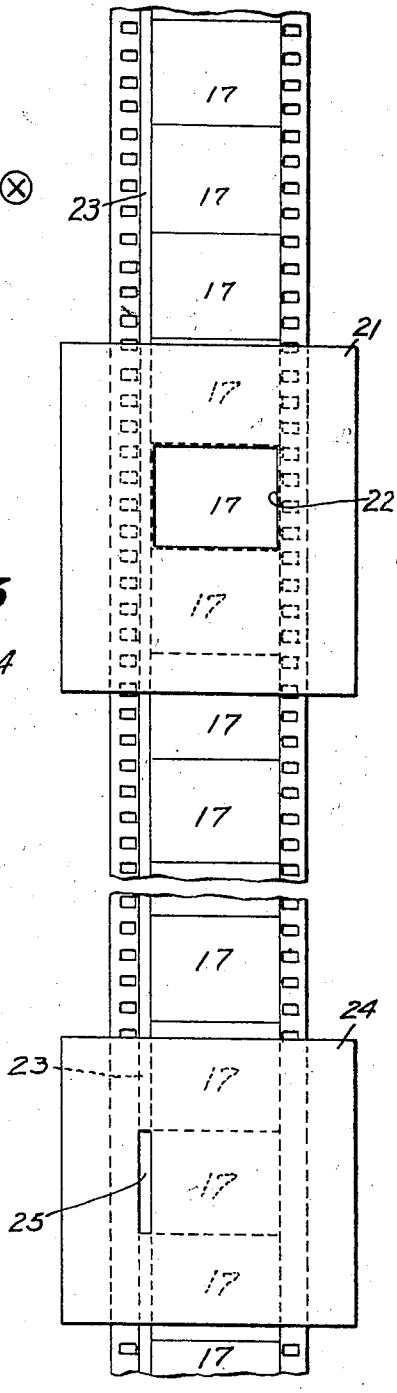


Fig. 4



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METHOD AND MEANS FOR PRINTING MOTION PICTURE FILMS

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Fig. 6

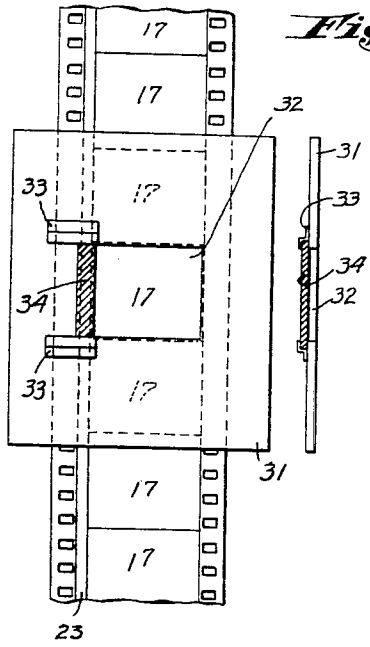


Fig. 7

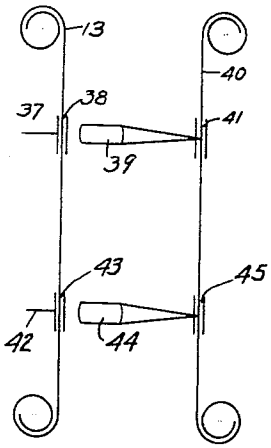


Fig. 8

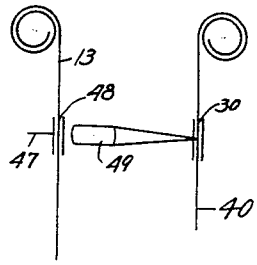


Fig. 10

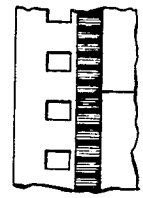


Fig. 9

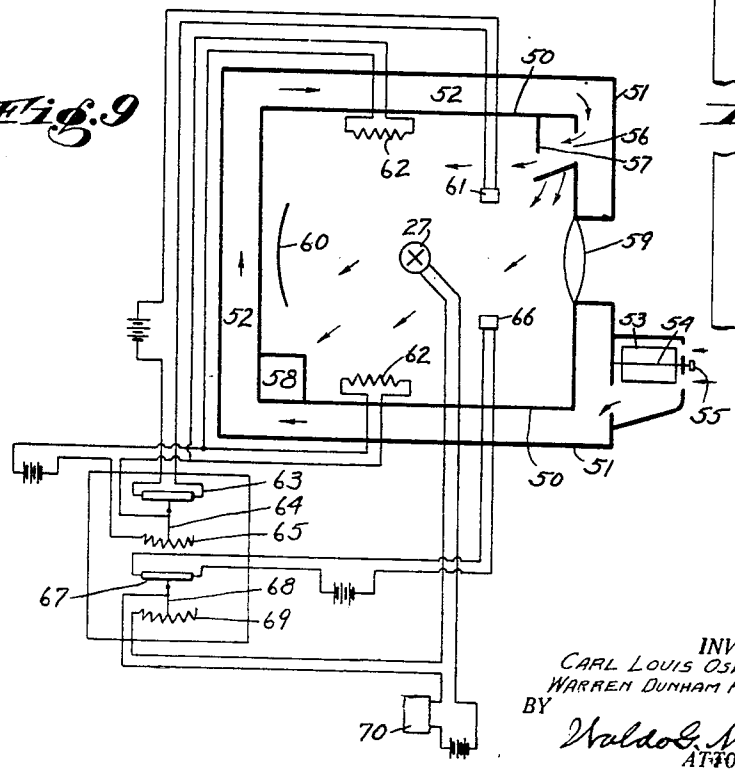
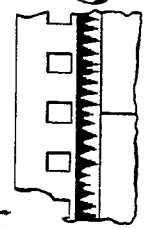


Fig. 11



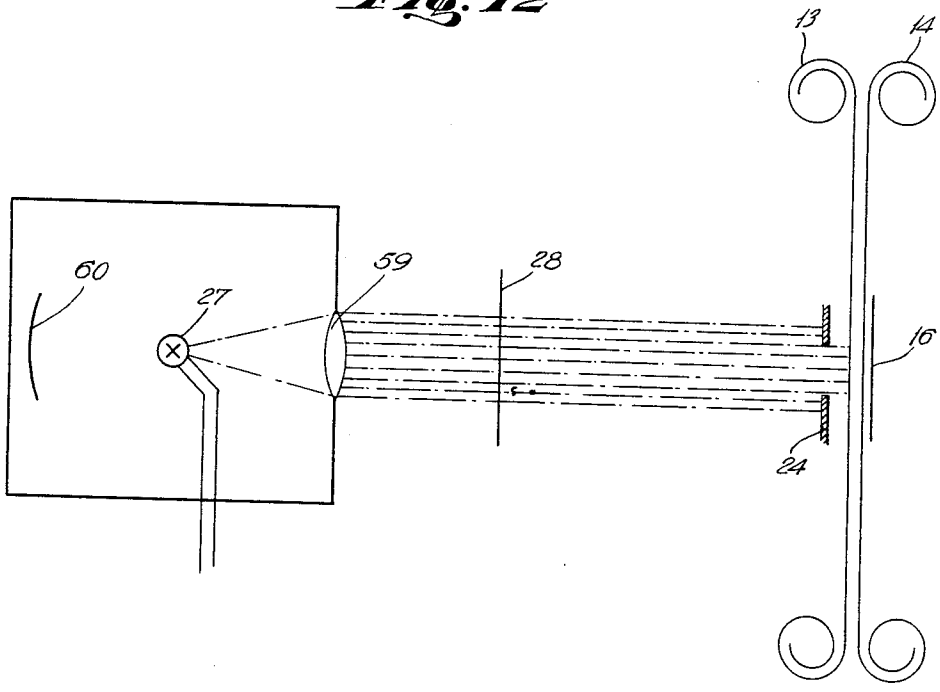
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Fig. 12



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UNITED STATES PATENT OFFICE

2,213,531

METHOD AND MEANS FOR PRINTING MOTION PICTURE FILMS

Carl Louis Oswald, New York, N. Y., and Warren Dunham Foster, Washington Township, Bergen County, N. J., assignors, by direct and mesne assignments, to Kinatome Patents Corporation, a corporation of New York

Original application October 29, 1928, Serial No. 315,761. Divided and this application March 21, 1932, Serial No. 600,322. In Great Britain October 26, 1929

22 Claims. (Cl. 95—75)

The present invention relates broadly to the art of recording sound upon light sensitive material and the reproduction of sound therefrom by photo-electrical means, but it will be readily understood that it may be applied to many other uses. Our invention more particularly includes the method and means for the production of duplicate sound records, or positive prints, from a master record or negative, whether or not such sound records are combined or to be combined upon the same film with pictures or used independently thereof or synchronously therewith.

The present application is a division from our co-pending application, Serial Number 315,761, filed October 29, 1928, now Patent No. 1,928,392, September 26, 1933.

A primary object of our invention is the printing upon films from which sound is to be reproduced, of lines or masses which are so clear and distinct, and each portion of which is of such uniform density, that sound waves reproduced from them will be clear, distinct and true.

Another object of our invention is to make possible the reproduction of photographic images in lines or mass formations, representing sounds, which photographic images may be materially smaller than such as now are common in the art. We are able by such means to make use of many more sound images or tone symbols in a given length of film, greatly increasing its tonal time equivalent and range and consequently also greatly augmenting the effectiveness, in a given time period, of combined sound and picture reproduction. Moreover, our invention has particular usefulness in connection with the printing of films for motion picture and phonograph apparatus which employs films of 16 millimeters or 9 millimeters in width or of some other size primarily designed for home use and which are of less than the so-called theatrical standard of 35 millimeters width, whether such films be directly reproduced from negative films of the same size, or reproduced by optical reduction from so-called standard negatives of 35 millimeters width. Obviously upon such smaller films, which, because of economy and other commercial conditions, are now well established for domestic use, the area which is available for the sound image is very much reduced. As a consequence the difficulties which have arisen from ill defined photographic images, representing sound impulses, when these are imprinted upon 35 millimeter film, have been greatly exaggerated when such images have been correspondingly reduced in size for use upon 16 millimeter or other so-called sub-standard film. Our invention makes it possible to reproduce upon 16 millimeter film, for example, as clear and accurate sound images as those which previously have been secured upon 35 millimeter film, and applies with corresponding effect to film of even smaller dimensions.

A principal object of our invention is the reproduction of duplicate copies or prints of combined sound and picture films in which the picture record is printed in accordance with the photographic requirements of the picture and the sound record is printed in accordance with the photographic requirements of the sound record, thus making it possible in a single operation, for example, to print the pictorial portion very soft and with a minimum of contrast and the sound portion very hard and with a maximum of contrast. It will be readily understood that our method of printing may be applied in the duplication of the sound record alone, or of a combined sound and pictorial film.

A further object of our invention is the treatment of the latent sound image by such chemical and physical means, chosen with due regard to the means and methods which had been employed to implant the latent image and the characteristics of the particular photo-sensitive material employed, as will retain in the stable and completed positive sound image the quality imparted by such previous steps in the process.

Other objects, advantages and chartacteristics of our invention are apparent from the following description, the attached drawings and the subjoined claims. Although we are showing one preferred embodiment of each of the several phases of our invention, it will be readily understood that we are not limited to these particular constructions and processes as changes can be readily made without departing from the spirit of the invention or the scope of our broader claims.

In the drawings:

Figure 1 is a diagrammatic representation of diffraction occurring as light passes through an aperture, physical or optical, greatly exaggerated for the purposes of clarity.

Figure 2 is a diagrammatic section along the surface II—II of the film 5 of Figure 1.

Figure 3 shows our invention applied to a film printing machine with separate gates for the pictorial and sound images, severally.

Figure 4 is a diagrammatic representation of the aperture plates of such gates.

Figure 5 shows a printer with a common gate, for both series of images, used in the practice of our invention.

Figure 6 is a diagrammatic representation of the aperture plate and filter which we may use in such a gate.

Figure 7 shows our invention applied to an optical reduction printer with separate gates, and Figure 8 to a similar printer with a common gate.

Figure 9 shows means employed by us to maintain a light source at a constant temperature and point of incandescence.

Figures 10 and 11 show the sound record portions of photographic films, according to the variable density and variable area systems respectively.

Figure 12 shows diagrammatically the combination of the lamp house of Figure 9 with the printer of Figure 3, the light being shown as projected as parallel light.

In Figure 1 and many of the following drawings, for convenience we show the light as a straight line such as 1. It will be understood that, except as definitely stated, we do not limit ourselves to an optical system of any particular nature. The light may be projected, by any suitable optical system, in the form of parallel, divergent or convergent light.

Throughout the drawings and specifications, like characters apply to like parts.

In carrying out our invention, we employ light of a pre-determined wave length. We select light of that particular rate of vibration which has the photographic qualities which are desirable for the particular result which is to be obtained. For example, when we select light from the visible spectrum, we employ monochromatic light of a selected color or wave length, for the duplication of the photographic image representing the sound wave.

From among the many photographic emulsions which are available, we are not compelled to choose in accordance with the limiting requirements of white light but are enabled to use the photographic emulsion which is best suited to the requirements of the particular conditions then applying and to employ in each instance that particular form of light which will be best suited to the particular emulsion deemed most suitable.

We select the developer for the latent image so implanted upon the selected emulsion by use of light of a selected wave length with due regard both to the particular characteristics of the particular emulsion and its reactions to the selected wave length and also to the peculiar demands of that portion of the film bearing the pictorial image as well as of that portion of the film bearing the sound image, in case both images are implanted upon the same strip. Thus it will be seen that we choose that particular combination of light, emulsion, and developer which will result in the most satisfactory duplication of sound and pictorial images under the given conditions.

In present common practice, polychromatic light, ordinarily spoken of as white light, is employed in apparatus using visible light for the duplication or printing of the films upon which images representing sound are recorded. Even with the use of a better photographic technique than is now common, polychromatic light would still cause many of the difficulties to which reference has already been had and will later be made.

Figure 1 illustrates in a much exaggerated form the edge diffraction which is caused by passing polychromatic light through any small aperture, whether the physical aperture of a slot or the optical or photographic aperture which is discussed below, or over any optically sharp edge. The degree of diffraction which results from passing white light over any edge is directly proportioned to the lengths of the several waves which make up the light. Thus the rays of the longer wave lengths are diffracted to a greater extent than are those which are of lesser amplitude. In Figure 1, 1 represents a beam of polychromatic light of which 2 is the axis.

In this and some of the following drawings, for convenience we show the light as a straight line. This light in passing through the opening 3 in the relatively opaque substance 4 is diffracted in accordance with the wave lengths of its component parts. Thus the infra-red rays 6 and 6' show the maximum diffraction, the visible red rays 7 and 7' the next largest degree of diffraction, the yellow rays 8 and 8' a lesser diffraction, the blue rays 9 and 9' the least amount of diffraction of the visible rays and the ultra violet rays 10 and 10' the least diffraction, the degree of diffraction of the sub-primary colors not being shown.

As these rays of varying wave lengths fall upon the film 5, as is illustrated in Figure 2 of the drawings, in a form exaggerated for clarity, there are transverse bands of the light sensitive emulsion which are subjected to rays of different colors. Every light sensitive emulsion has varying degrees of sensitivity to different colors. As a result of such varying sensitivity, while the portion of the emulsion between the lines 11 and 11' is acted upon with approximate uniformity by the white light, the bands from 10 and 10' to 6 and 6', both inclusive, are acted upon in degrees varying according to the sensitivity to color of the particular photographic emulsion which is being used at the time. As a result all portions of the entire exposed emulsion lying between 11 and 6 and 11' and 6' respectively are lacking in uniform photographic density, the portion between 11 and 11' being more nearly uniform. In other words, the outline being formed is not clear and straight. It is in effect ragged and "muddy." As a result, when a photographic image which is bounded by such an edge is used to actuate a photo-electric cell in the reproduction of sound, what the auditor hears is likewise unclear, "muddy" and blurred. It will be readily recognized that any blurring of a photographic image caused by such diffraction will result in a corresponding blurring of the sound which is reproduced therefrom.

We have found that much of the difficulty in the past blamed generally upon "diffusion," diffraction," and even photographic "grain," is in reality due to the lack of a correct photographic definition caused by fringing colors, which in turn are the result of diffraction as stated above.

The aperture to which reference is made above may be the conventional slot used in certain types of printers or it may be the optical aperture formed by the very image which is being reproduced. As will readily be seen by reference to Figure 10, the lines which make up the sound images according to the variable density system themselves form edged slots of extremely small width which in themselves create difficulties identic with or similar to those created by an aperture physically formed in metal through which light is passed. Similarly, the masses which make up the variable density sound record, as illustrated in Figure 11, are bounded by numerous, minutely-spaced edges which likewise cause dif-

fraction, with its train of difficulties, when subjected to the printing light.

Figures 3 to 8 inclusive illustrate diagrammatically the application of our invention to printing or duplicating apparatus in such manner that the difficulties to which attention is directed above are minimized.

The negative film 13 and the positive film 14 may be fed in any manner well known in the art as through the two separate printing gates 15 and 16. The portion of the film which bears the pictorial representation 17 is exposed in the usual manner in the gate 15. The intensity of the light source 18 is varied in any well known manner by the light control unit which is diagrammatically represented as 19. Thus, as is common in motion picture printing, due allowance is made for under-exposed and over-exposed scenes. The light 20 from the source 18 strikes the aperture plate 21, as is clearly shown in Figure 4 of the drawings, and passes through the aperture 22 which restricts the area of exposure to the pictorial portion 17 of the film and completely masks the sound record portion shown as 23.

In the gate 16 is an aperture plate 24 with an opening 25 which is carefully restricted to the area 23 of the sound recording portion of the film. The light 26 from the source 27 passes through the filter 28 and illuminates this aperture and effects the necessary exposure. The filter 28 may be of any desired characteristics.

The exact filter to be used will depend upon the photographic characteristics of the emulsion selected for the positive film. It will be readily understood that with the use of any monochromatic light all of the area of the film which is exposed or illuminated at the same instant will be of practically uniform density. For example, if we elect to employ light of approximately 4000 Angstrom units, we will use a filter 28 adapted to prevent the passage of all light other than such as will register between 9 and 9', inclusive, as shown in Figures 1 and 2. The image so created upon the film will have sharp demarcation along the lines separating band 9 from band 8 and band 9' from band 8'. That is, each illuminated or exposed area will be clearly and sharply defined and its photographic edges clearly made. Irrespective of the type of monochromatic light employed, the sharpness of differentiation will be increased over such as obtained with polychromatic light and the "raggedness" caused by the use of such light largely eliminated. It should be noted, however, that the relative excellence of the result will depend upon the selection of the wave length particularly appropriate to the photographic emulsion selected. In recent practice, in order to overcome difficulties caused by the so-called "grain" of the emulsion, relatively slow emulsion, such as, for example, those of 120 according to the rating of Hurter and Driffield, have been recommended for sound films. By the use of photographically active wave lengths, such as for example those in the vicinity of 4000 Angstrom units, we secure with such a slow emulsion in a relatively short period of exposure the same results as others secure in a much longer and hence impractical period of exposure.

It will be understood that instead of using rays of one wave length only, we may employ rays of a group of related wave lengths, as the isolation of a single wave length of light is extremely difficult practically.

For purposes entirely different from those embraced within or pertinent to our invention, it has been proposed to employ visible colored images for use in connection sound records. We do not use colored images as part of or in carrying out our invention, since we do not rely on the particular color of the image in carrying out our invention. We use what is ordinarily known as a colored light, but the latent images produced thereby, when rendered stable and visible by development, may be what are known as black and white. They have none of the characteristics, requirements or purposes of colored images or photography. It will therefore be understood by those skilled in the art, that our invention does not require the use of the special and expensive films and apparatus, which have been proposed to be used for purposes different from our own, nor are we limited by the many photographic and practical difficulties associated with the use of so-called colored films, although our invention may be applied, if desired, to films which are printed in colors. When reference in this specification or in the claims which are a part hereof is made to "black-and-white" films, it is understood that such terminology is used with the meaning common in the motion picture art. Such "black-and-white" films may be colored by tinting or toning or any other similar process, whether carried on as supplementary to the regular development and fixing or otherwise. Moreover, the term may be used to include films which are made upon a base which is colored or tinted, provided the emulsion used thereon is one of those ordinarily associated with the making of black-and-white images if used with an ordinary white or gray base.

The type of printing apparatus which is illustrated in Figures 5 and 6 is useful under certain conditions, as for instance in printing from duplicate negatives which have already been "timed" (that is, in the pictorial parts reduced to a condition of uniform density).

We make use of a common gate 30 for printing of both the sound images 23 and the pictorial images 17 at the same time. As is illustrated in Figure 6, in the front plate 31, we may provide an aperture 32 sufficiently large to expose both images. Into a suitable holder, such as the pieces of bent metal 33 attached to the plate 31 in any suitable manner, the filter 34 covering the portion 23 carrying the sound images may be slipped, this filter being of any desired characteristics as to color and density to produce the monochromatic light desired, in cooperation with the particular negative and with the particular emulsion of the positive, to produce the exact photographic results which are desired. Thus the constant polychromatic light illuminates the pictorial portion and selected rays from the same light source illuminate the sound-recording portion.

Our invention is of particular usefulness in printing sound record positive films by the process known in the motion picture art as that of optical reduction, as, for instance, when a negative of 35 millimeters in width is optically projected to form a positive of some smaller size, say 16 or 9 millimeters in width. This reduction in size together with the consequent increase in photographic and other difficulties makes the use of monochromatic light particularly valuable.

As is diagrammatically illustrated in Figure 7 of the drawings, the light 37 may be passed through the gate 38, the portion 17 of the standard or large sized negative 13 which bears the pictorial image, the optical element 39 which

may be a lens of any proper characteristics, which reduces the beam of light through the convergence of its rays, and on the positive film **40**, which is of 16 millimeter or some other desired width, less than that of the negative **13**, which passes through the gate **41**. Similarly, the monochromatic light **42** passes through the gate **43**, the portion **23** of the negative **13** which bears the images representing the sound, the optical element **44**, and, through convergence of the rays, falls upon the positive film **40** in the gate **45**, imprinting thereon a suitable smaller image than that of **17**. Or, since duplicate large sized negatives of uniform density are often used as the basis for small-sized positives, the single gate device, previously described above, may be used, as is diagrammatically illustrated in Figure 8. In such case, the light **47** passes through the gate **48** and the optical element **49** and converges upon the smaller-sized positive film **40** in the gate **30**, which may be of the type illustrated in Figure 6 and previously described. Before reaching the sound-recording portion of the film, however, the polychromatic light passes through a filter **34** in the plate **31** as is illustrated in Figure 6 and described above.

According to one preferred embodiment of our invention, we employ ultra violet light instead of visible monochromatic light. Ultra violet light possesses the advantages which we have stated for monochromatic light in the visible spectrum and in addition shows less diffraction than any of the wave lengths of the visible spectrum and is furthermore extremely active photographically. In carrying out our invention by means of the use of ultra violet light, we employ any suitable light source encased in quartz, or a light source which will emit visible and ultra violet light under normal atmospheric conditions, such as, for example, the electric arc and the so-called Nernst lamp.

Attention is specifically directed to the fact that we use ultra violet rays, which are invisible, to produce a latent image which is later rendered visible and thereafter utilized with visible light and in the same manner as images originally produced by visible light.

It will of course be understood that while for most purposes we prefer concurrently to expose the positive film to both the sound and pictorial images, each may be exposed separately.

To secure improved and stable duplication or printing of sound record films, the theoretically constant light source may be maintained at a point which is actually constant, or approximately constant, as is illustrated, for example, in Figure 9 of the drawings. As has been pointed out above, one set of difficulties caused by the fluctuations of the light sources is removed by the use of monochromatic light. A further embodiment of our invention prevents material change in light intensity.

A common cause of change in intensity of the theoretically constant light source is found in temperature changes which decrease or increase the degree of incandescence of the light element. The common expedient of warming the light source by turning on the current in advance of its use does not meet the difficulties caused by later changes in temperature caused by conditions which later develop. We have found that the opening of a door or window in a room in which apparatus is being used will change the visible characteristics of the light. The means shown for example in Figure 9 definitely controls the heat of the theoretically constant light source.

In one embodiment of our invention, we may place the light source **27**, which for example may be an incandescent globe of any desired type, in a chamber as for example one with double walls such as **50** and **51**, if desired, with an air space **52** between them. Fresh air is forced into this chamber **52** by a fan **53** rotative upon a shaft **54** to which is attached a pulley **55**, and such air takes the direction shown by the arrows in Figure 9. The pulley **55** may be driven in any desired way, not shown. Through the opening **56** past the baffle plate **57** the fresh air is directed into the inner lamp chamber. The wall **50** being preferably of a heat conductive material, the fresh air, while considerably cooler than the body of air in the chamber, is not of a temperature sufficiently low to cause a drop in the incandescence of the lamp. The heated air leaves the chamber through the vent **58** in the top, which is protected by baffle plates, not shown, as is well known in the projection art, to prevent the escape of objectionable light.

Under some conditions the fan **53** may be dispensed with, sufficient circulation of air being obtained by the heat generated within the chamber.

Light is passed from the source **27** through the optical element **59** which may form the window, as it were, of the lamp chamber. Such optical element may be a plate of plane glass or quartz, merely to complete the enclosure of the chamber, or it may be a suitable condensing lens or filter. A mirror or other reflecting surface **60** may be provided.

In order positively to maintain the lamp **27** at a given point of incandescence by holding the temperature of the chamber at a predetermined point, a thermostatic element **61** may be provided which, through an appropriate electrical means, controls the amount of current which is permitted to flow into the heating units **62** which may be placed within the chamber.

The thermostatic control of the circuits of the heating units **62** may be accomplished in any of various well known ways. For example, the thermostatic element **61** may be in circuit with the magnetic element **63** which determines the movement of the wiper arm **64** so that it places more or less of the resistance **65** in circuit with the heating elements **62**, thus determining their activity.

It will be understood that we do not limit ourselves to this type of control unit and refer to it merely for purposes of illustration.

In order to compensate for changes in incandescence of the light source which might be brought about by changes in the temperature of the lamp chamber, or lamp house as it is generally termed in the motion picture art, we may regulate the amount of current reaching the lamp in accordance with the temperature of the immediate vicinity of the lamp. Such means may be employed independently of the heat maintaining means just described, or in conjunction therewith. For simplicity, we illustrate this phase of our invention in Figure 9, which also illustrates such heat maintaining means.

A thermostatic element **66** may be provided which controls the amount of current which is permitted to flow into the light source **27**. As is later set out in further detail, such control is exercised within restricted limits. The thermo-

static control of the circuit supplying the source 27 may be accomplished in any of various well known ways. For example, the thermostatic element 66 may be in circuit with the magnetic element 67 which determines the movement of the wiper arm 68 so that it places more or less of the resistance 69 in circuit with the light source 27. The range within which the current reaching the lamp is permitted so to fluctuate is very small. When a light source, particularly an incandescent light source, is operated reasonably near its point of optical efficiency, a relatively small fluctuation in the current reaching such source will have relatively great effect in the intensity of its light output. It will be understood that since uniformity and not intensity is desired, it is preferable to burn the lamp at a point well below that at which injury to the filament is likely. We prefer that the maximum current permitted to reach the lamp by the resistance 69 be sufficiently restricted so that even when the filament is cold such maximum current will not be dangerous to the life of the filament.

As an additional safeguard, to prevent overloading of the circuit supplying the light source, we may place in such circuit an automatic circuit breaker, 70, or other similar device, or the light source 27 may be fed direct from a battery or the like. This control element will positively prevent any amount of current, over the predetermined maximum, reaching the light source 27.

In those cases in which the heating elements and the means for the control of the circuit of the light source are jointly used, it will be readily understood that the usefulness of the latter means generally will be greater in the early stages of any period of operation. After the temperature of the lamp chamber has been brought to the desired point, it will generally be so maintained by the heating elements alone.

It will be readily understood by those skilled in the art that the joint operation of these two means involves no conflict. From the time of beginning operation until the temperature of the lamp chamber reaches the predetermined point, the thermostatic element 61 will operate gradually to increase the amount of resistance 65 in circuit with the heating elements 62 and so render them less and less active. From that point onwardly, the fluctuations of current in the circuit feeding the heating elements 62 will be such as are necessary to maintain that predetermined point of temperature. It is understood that the ventilating device such as heretofore described when the heating units 62 are entirely inactive will prevent the temperature of the chamber from reaching a point higher than the predetermined point.

When operations begin, all resistance 69 will be out of the circuit feeding the light 27, it if desired being protected against overloading as by the element 70. As the temperature of the chamber increases, the amount of such resistance 69 in circuit with the light source 27 gradually increases until the entire amount is in circuit when the temperature reaches the predetermined point. Should such temperature rise still further, as is not contemplated owing to the above-described ventilating system, there would be no change in the amount of such resistance 69 in circuit. Should such temperature fall, the amount of resistance 69 would be decreased until the light source 27 receives the entire amount of current delivered from the line as through the protective device 70. The range of the resistance 69, it will be understood, is carefully limited in accordance with the closely limited range in which current fluctuations occur.

If desired, the above described device may be used with the light source which prints the pictorial portion of the film, such device being particularly useful in connection with the use of a duplicate negative which has already been "timed," although capable of useful combinaion with an automatic or other light regulating device such as is commonly used in motion picture printing.

It will thus be apparent that the method and construction above described provide extremely simple means for the faithful and pleasing duplication of films, particularly sound records of the film phonograph or "talking movie" type.

Other advantages have been referred to throughout the specification from which it becomes apparent that different embodiments of the invention may be made within the scope of the inventive disclosure hereof.

We claim:

1. A method for printing from a negative sound record to a positive which consists of moving a negative and a positive in cooperative and overlying relation and passing monochromatic light through said negative and upon said positive.

2. The method of printing films which comprises providing a negative film bearing thereupon images representing sound, passing monochromatic light through such images and upon a light sensitive film thereby securing latent images the boundaries of which are clear and distinct owing to the absence of diffraction or chromatic dispersion and rendering the latent images so produced stable and visible.

3. The method of printing films which comprises providing a negative film bearing thereupon black-and-white images representing sound, continuously passing monochromatic light of substantially constant color characteristics through such images and upon a light sensitive film thereby securing latent images the boundaries of which are clear and distinct owing to the absence of diffraction or chromatic dispersion, and rendering the latent images so produced stable and visible in the form of black and white visible images.

4. A method for printing from a negative sound record to a positive which consists of moving a negative and a positive in cooperative and overlying relation and passing light of relatively short wave length through said negative and upon said positive.

5. The method of printing films which comprises providing a negative film bearing thereupon images representing sound, passing light of approximately 4000 Ångstrom units through such images and upon a light sensitive film, and rendering the latent images so produced stable and visible.

6. The method of printing films which comprises providing a negative film bearing thereupon images representing sound, passing light which consists substantially entirely of ultra violet rays through such images and upon a light sensitive film, and rendering the latent images so produced stable and visible.

7. The method of printing films which comprises providing a negative film bearing thereupon black-and-white images representing sound, pass-

ing light of approximately 4000 Ångstrom units through such images and upon a light sensitive film, and rendering the latent images so produced stable and visible in the form of black and white visible images.

8. The method of printing films which comprises providing a negative film bearing thereupon black-and-white images representing sound, passing light which consists substantially entirely of ultra violet rays through such images and upon a light sensitive film, and rendering the latent images so produced stable and visible in the form of black and white visible images.

9. The method of making a photographic print of a film upon which appear small and contiguous images representing sound and pictorial images which consists of passing monochromatic light through said sound images and upon a predetermined portion of a light sensitive film thereby securing images the boundaries of which are relatively clear and distinct and passing polychromatic light through said pictorial images and upon another predetermined portion of said light sensitive film.

10. The method of printing films which comprises concurrently passing polychromatic light through a portion of a film which portion bears stable pictorial images thereupon and upon one portion of a light sensitive film and passing monochromatic light through another portion of said first mentioned film which portion bears stable images representing sound thereupon and upon a portion of said second film other than such first mentioned portion thereof and concurrently rendering stable and visible the latent images so produced upon both of such portions of said second mentioned film.

11. The method of duplicating a film bearing thereon pictorial images and images representing sound which comprises passing polychromatic light through such pictorial images and monochromatic light through such sound images and upon different portions of a light sensitive film thereby creating latent images, maintaining said monochromatic light relatively constant throughout the printing operation, and thereafter rendering said latent images stable and visible.

12. The method of printing films which comprises passing polychromatic light through one portion of a film bearing stable images thereupon and upon one portion of a light sensitive film, varying the actinic effectiveness of said light in accordance with the pictorial requirements of the successive pictorial images thereby producing latent images of maximum and consistent pictorial effectiveness, and passing monochromatic light through another portion of said first mentioned film bearing stable images thereupon and upon another portion of said second mentioned film maintaining said monochromatic light substantially constant, said monochromatic light producing a series of sound images the boundaries of which are clear and distinct owing to the absence of diffraction or chromatic diffusion, and concurrently rendering stable and visible the latent images so produced upon both such portions of said second mentioned film.

13. The method of printing films which comprises concurrently passing polychromatic light through one portion of a film which portion bears stable pictorial images thereupon and upon one portion of a light sensitive film and passing light of approximately 4000 Ångstrom units through another portion of said first mentioned film which portion bears stable images representing sound thereupon and upon a portion of said second mentioned film different from that upon which said first mentioned light impinges and concurrently rendering stable and visible the latent images so produced upon both of such portions of said second mentioned film.

14. The method of duplicating a film bearing thereon stable pictorial images and stable images representing sound which consists of concurrently moving said film and a light sensitive film in cooperative relation with each other, providing a source of light, passing light from said source through such pictorial images and upon a predetermined portion of said light sensitive film, passing light from such source through such images representing sound and upon another predetermined portion of said light sensitive film, and intercepting all of the rays of such light except those which vibrate at a predetermined rate before they reach such second mentioned predetermined portion of said light sensitive film thereby securing sound images the boundaries of which are clear and distinct owing to the absence of diffraction or chromatic dispersion.

15. An apparatus for printing from a negative sound record to a positive comprising a wall having an opening therein past which a negative and positive move in overlying relation, a source of light, means for causing rays of light from said source to pass through said opening, and means for limiting such light to ultra violet.

16. An apparatus for printing from a negative sound record to a positive comprising a wall having an opening therein past which a negative and positive move in overlying relation, a source of light, means for causing rays of light from said source to pass through said opening, and means for limiting such light to light of approximately 4000 Ångstrom units.

17. An apparatus for printing from a negative sound record to a positive comprising a wall having an opening therein past which a negative and positive move in overlying relation, a source of light, means for causing rays of light from said source to pass through said opening in a direction normal to the negative, and means between the source of light and the negative which is opaque to rays of light of comparatively long wave length.

18. An apparatus for printing from a negative sound record to a positive comprising a wall having an opening therein past which a negative and positive move in overlying relation, a source of light, means for causing rays of light from said source to pass through said opening in a direction normal to the negative, and means permitting only rays of light of comparatively short wave length to pass to the negative from said source.

19. An apparatus for printing from a negative sound record to a positive comprising an opaque wall having an opening therein past which the negative and positive are adapted to move in overlying relation, a source of a line of light, means for causing the rays of light emanating from said source to pass through said opening in a direction substantially perpendicular to the negative, and means between the source of light and the negative for cutting out all the longer wave length rays of light.

20. An apparatus for printing from a negative sound record to a positive comprising a wall having an opening therein past which a negative and

positive move in overlying relation, a source of light the rays of which project through said opening, means for causing rays of light from said source to impinge on negative in a direction normal to the negative, and means between the source of light and the negative which is opaque to rays of light of comparatively long wave length.

21. An apparatus for printing from a negative sound record to a positive comprising a wall having an opening therein past which a negative and positive move in overlying relation, a source of light the rays of which project through said opening, means for causing rays of light from said source to impinge on negative in a direction normal to the negative, and means permitting only rays of light of comparatively short wave length to pass to the negative from said source.

22. An apparatus for printing from a negative sound record to a positive comprising an opaque wall having an opening therein past which the negative and positive are adapted to move in overlying relation, a source of light the rays of which project through said opening, means for causing rays of light from said source to impinge on negative in a direction normal to the negative, and means between the source of light and the negative for cutting out all the longer wave length rays of light.

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