May 7, 1935. A. C. WATSON 2,000,153

METHOD AND APPARATUS FOR PRODUCING VISUAL EFFECTS

Filed Oct. 20, 1932

FIG. 1.

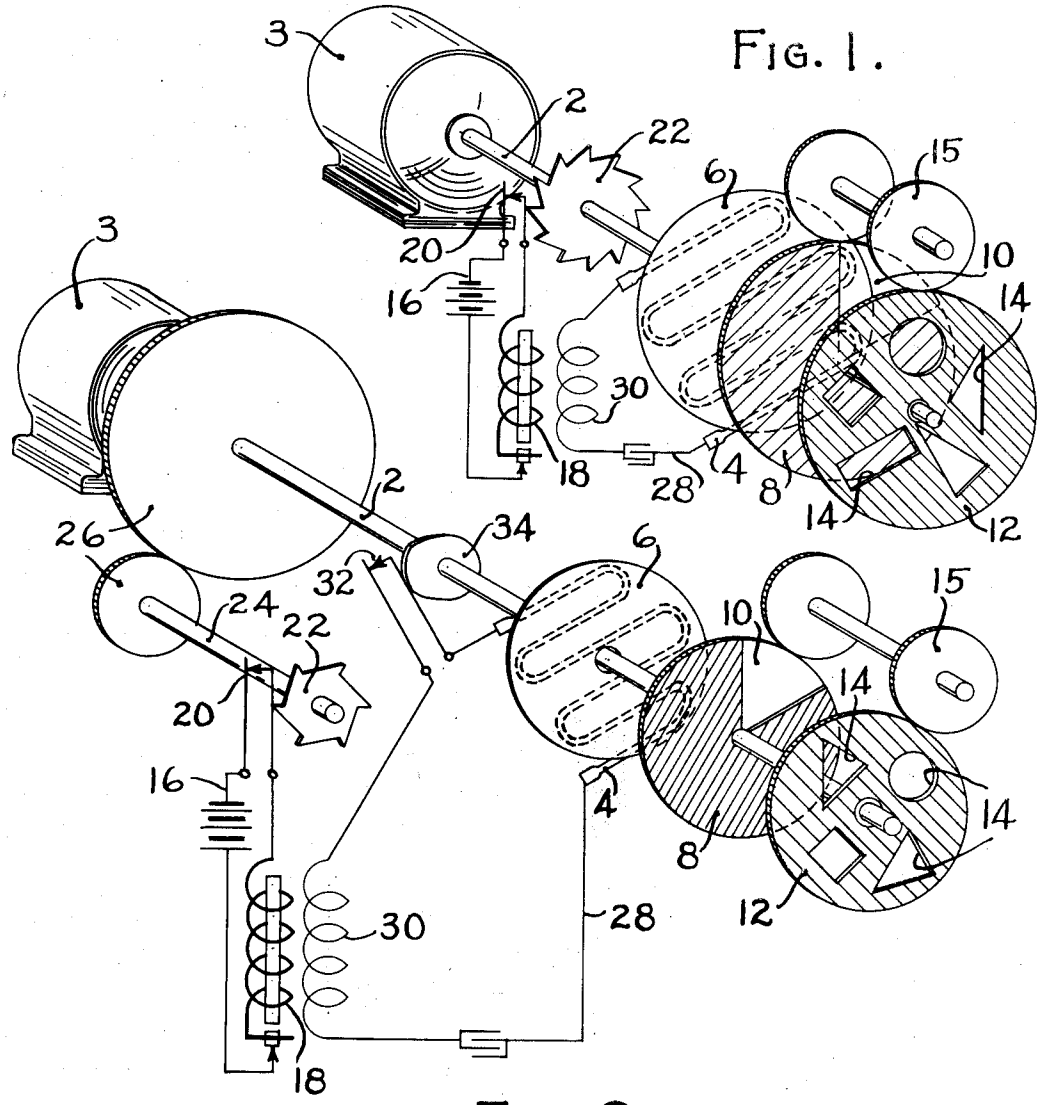


FIG. 2.

Inventor

ARTHUR C. WATSON

By

Attorney

Patented May 7, 1935 2,000,153

UNITED STATES PATENT OFFICE

2,000,153

METHOD AND APPARATUS FOR PRODUCING VISUAL EFFECTS

Arthur C. Watson, Marietta, Ohio

Application October 20, 1932, Serial No. 638,825
In France October 20, 1931

6 Claims. (Cl. 40—52)

The present invention relates to a method and apparatus for producing visual effects and particularly to the production of such effects of the type resulting from the application of the stroboscopic principle.

The so-called persistency of vision, as is well known, requires a certain minimum frequency of retinal stimulation to produce a continuous sensation free from flicker. This frequency is usually referred to as the "critical frequency", and relates to that frequency at which periods of greater and less visual stimulation succeed each other with sufficient rapidity and with the definite regularity necessary to produce continuous visual sensation by means of the so-called "retinal lag" or "after image" which bridges the gap between successive stimulations.

It is also well known that for obtaining maximum brilliance of sensation a light stimulus of a given physical intensity must have a certain minimum duration in order to overcome the inertia of the retina or optic nerve. This minimum duration varies, of course, with the condition of rest or fatigue which characterizes the eye of the observer in any given case. It is also well known that within very short intervals (probably about one-fifth second) to secure a visual sensation of a given brilliance the physical stimulus may be shortened in duration provided its intensity is increased; and vice versa if its intensity is decreased its duration must be increased. This relationship appears to be quite regular in said brief intervals and is generally believed to be such as may be formulated as follows: Within said such brief intervals time and intensity are exactly interchangeable. This is generally known as the "reciprocity law".

It is also well known that with variations in the intensity of a visual stimulus there are corresponding variations in the intensity or brilliance of the sensation and that these two corresponding series vary in general in accordance with the so-called Fechner-Weber law according to which if a series of visual intensities is in arithmetic progression the corresponding series of stimulus intensities is in geometric progression.

It is obvious therefore that if within certain limitations the time and intensity of a visual stimulus are interchangeable (to secure a given intensity of sensation) then within said limitations the Fechner-Weber law applies to duration as well as to intensity.

Combining the above two principles, it is seen, first, that up to a certain duration a light of a given physical intensity will produce a visual sensation which increases in intensity or brilliance as the exposure continues until a duration has been reached (probably about a fifth of a second at a medium degree of retinal adaptation) beyond which brilliance of sensation does not increase no matter how long the stimulus may continue; and second, that the rate of increase of the brilliance conforms to the typical curve for the Fechner-Weber law.

The present invention is based on the discovery that in the case of an intermittent substantially instantaneous light of such frequency as permits its use under the conditions outlined in this discussion the increase of intensity of sensation should be represented by a steeper curve than that which represents the increase of intensity of a continuous light. In other words, if a given continuous stimulus "x" produces its maximum brilliance of sensation after a given duration of time "y"; and if an intermittent stimulus "x'" produces its maximum brilliance of sensation after a duration of "y" time; then if the two stimuli be cut off after the same fractional part of the time "y" the stimulus "x'" will have produced a sensation brilliance nearer to its maximum than will the stimulus "x". Or, stating it more generally, during its initial stages an intermittent stimulus (of a suitable frequency with respect to the requirements for smooth continuous sensation) advances toward its maximum sensation intensity more rapidly than a continuous stimulus having a similar possible maximum of sensation intensity.

It should be added that the effects of this principle are the more noticeable as the ratio of the nonstimulation interval to the stimulation interval is increased. Of course the cycles of stimulation and nonstimulation may be such that for instance, the light is applied to the eye for, say one ten-thousandth of a second and the light is cut off from the eye for one-hundredth of a second whereas in another instance the light is applied for one or two hundredths of a second and the light cut off from the eye for one or two thousandths of a second. In the latter case the effect will be less markedly different from that characteristic of continuous light than it would be in the former case. But in any case where clean-cut brief intervals are interjected in the stimulation process the efficiency of the stimulus, all thing considered, is increased provided the whole sequence is such as to come within the requirements for smooth continuous sensation.

As has been pointed out, in the case of a succession of very brief flashes of light which come within the requirements of the "critical frequency", the intensity of sensation will increase with every repetition of the stimulus up to a certain point beyond which no increase in intensity of sensation occurs no matter how often the stimulus is repeated just as a continuous light appears no brighter after say, a fifth of a second or less, no matter how long it persists. In the case of the succession of brief flashes, when that number of flashes has been experienced which brings the sensation up to or approximately up to its potential maximum, a point or number of repetitions has been reached which may conveniently be called "the critical frequency for brilliance" just as the other frequency is called "the critical frequency for sensation."

In summary it may be said that the phrase "substantially instantaneous" light is used as meaning a light of very brief duration and of exceedingly short onset and cessation such that there is no observable fringe of waxing and waning intensity; and furthermore, it is intended that each cycle shall consist of a relatively long rest or dark interval followed by a period of shorter rest intervals separated by rapid flashes; and further that this total of brief flashes, brief rest intervals and longer rest intervals (which total constitutes the said cycle) must altogether be accomplished within the requirements of the "critical frequency", namely, within a period which is generally regarded as being about one-sixteenth of a second. In practice these instantaneous flashes may suitably be of any range of duration from a fraction of a one-thousandth of a second up to not more than two one-hundredths of a second

$$\left(\frac{2}{100}\right)$$

and the brief rest intervals may be of about the same duration.

More particularly, my object is to move in front of a diffused source of light, forming a light surface, an opaque disc having an opening through which the light can pass. As the disc rotates rapidly, each portion of its surface will appear to be illuminated at all times because of the retinal lag. As a matter of fact, however, each portion of the area will be illuminated during only a small portion, say one-sixth, of each cycle, thus giving long rest periods when the eye is fixed on any particular part of the area. The rotating disc thus gives the effect of a continuously illuminated area, although each portion is actually lighted during a part only of each cycle by rapid intermittent flashes. Thus the eye is rested without any appreciable difference in the sensation obtained. Thus without moving the source of light the desired effect can be secured.

It is a further purpose of the present invention to combine the above described principle with a well known principle of stroboscopy according to which two rotating discs provided with apertures and moving at slightly different rates of speed in front of a source of light of intermittent and substantially instantaneous character may be used to produce a changing size or shape of visual image of the aperture, single or multiple according as the light flashes regularly once or several times during each revolution of the disc, and with the same or approximately the same position of the aperture at the moment of each flash of light. In the embodiment of these two principles as represented by this feature of the invention, it is essential that one of the discs (which we may call the primary disc) shall have an aperture or apertures wide enough to expose any given point on the luminous surface behind it a length of time sufficient for a plurality of successive flashes of light, such plurality being the minimum to conform to the requirements of the "critical frequency for brilliance" as described above. It is also desirable that the light of the intermittent source shall be diffused over a surface, for example of frosted glass, immediately behind the primary disc.

The secondary disc must have a variety of apertures or variously translucent patterns, one system of such patterns for each of the apertures in the primary disc.

The result of the above combination is to produce a circular or disc-like area of luminous patterns which are continuously changing in true kaleidoscopic fashion, and which are, in all or at least in many parts, of that high degree of brilliancy referred to above under the principle of the "critical frequency of brilliance."

Two forms of apparatus suitable for carrying out my invention are shown in the accompanying drawing which illustrates diagrammatically such devices.

In the drawing:

Fig. 1 shows diagrammatically one form of apparatus for practicing the invention.

Fig. 2 shows a modified form utilizing the stroboscopic principle.

As shown in the drawing, there is provided a shaft 2 driven at a constant speed, for example, 16 revolutions per second, by motor 3. Near the axis of this shaft I provide a source of instantaneous light such as a Neon tube 4. In front of this tube and around the shaft is arranged a fixed disc 6 of a material capable of diffusing the light from the neon tube 4, for instance, of milk glass, white wax or the like. Mounted on the shaft 2 in front of the disc 6 is an opaque disc 8 having a cut out 10. This disc rotates at a high enough speed to satisfy the requirements set out above, for instance at a rate of 16 revolutions per second. The lamp 4 is connected in a secondary circuit 28 having a coil 30 which is eneregized by coil 18 of the primary circuit 16 which includes a source of current and a switch 20. This switch is closed a number of times during each revolution by a wheel 22 mounted on the shaft 2, so that the light is operated intermittently. In front of the disc 8 is arranged a secondary mask or disk 12 rotatably mounted on the shaft also of opaque material and having cut out sections 14 of any desired shape to form a pattern. This secondary disc may be, however, formed of a translucent material having different portions thereof of varying transparent colors. Gearing 15 serves to drive the disc 12 at a speed slightly different from that of disc 8, for instance, at 16½ revolutions per second.

The operation and effect of this construction should be clear. As the opaque disc rotates, succeeding portions of the intermittently illuminated surface 6 become visible. Because the apparatus is arranged to satisfy the critical requirements for frequency and brilliance, the result will be a sensation equivalent to that of an illuminated disc. As a matter of fact, this sensation will be intensified by the periods of rest

as the eye looks at any particular point. It is obvious that the pattern of disc 12 placed in front of the disc 8 will appear to be illuminated at all times.

Fig. 2 shows a similar device operating on the stroboscopic principle. In this form, the shaft 2, motor 3, light 4, plate 6, and disc 8 are similar to those described above. In front of the disc 8 is arranged a secondary mask or disc 12 rotatably mounted on the shaft also of opaque material and having cut out sections 14 of any desired shape to form a pattern. This secondary disc may be, however, formed of a translucent material having different portions thereof of varying transparent colors. Gearing 15 serves to drive the disc 12 at a speed slightly different from that of disc 8, for instance, at 16½ revolutions per second. The neon tube 4 is stationary and the disc 6 is likewise preferably immovable. As the discs 8 and 12 rotate on the same axis at slightly different speeds, this construction will produce the well known stroboscopic action.

In order to control and energize the neon tube, a circuit is provided including a primary portion 16 which contains a source of current and a suitable coil as at 18. This primary circuit is made and broken rapidly by a switch 20 which is controlled by a toothed wheel 22 mounted on a shaft 24 driven by the shaft 2 through gearing 26 at a relatively high speed. It will be noted that the primary circuit is thus made and broken a considerable number of times during each revolution of the shaft 2. The secondary circuit 28 includes a coil 30 adjacent the coil 18 and energized thereby. This secondary circuit is connected to the lamp 4 and includes a switch 32 which is closed during a period of each rotation of the shaft 2 by a cam 34. As shown, since the disc 8 moves with the shaft 2, the tube 4 can be energized only during that portion of the rotation of the shaft when the opening 10 is near the top side of the disc 8.

It will be obvious from the foregoing that the light 4 will give relatively long rest periods caused by the opening of the switch 32 and other periods, during which the switch 32 is closed, of relatively short dark periods and rapid intermittent flashes caused by the opening and closing of the switch 20. During the portion of each revolution in which the cut out 10 is at the top, this will be illuminated by rapid flashes separated by relatively short rest portions. As the disc 12 is turning at a speed slightly greater than that of the disc 8, the pattern openings 14 will gradually change shape in the known manner. As one of these pattern openings passes out of the range of the cut out 10, another opening will take its place and continuous kaleidoscopic action will thus take place.

In order to produce the action sought for in the present invention, and to take advantage of the principles expressed above, the speed of the disc 8 and the width of the opening or cut out 10 must be such that during the movement of the opening 10 across any part of the source of light there will be a sufficient time for a plurality of successive flashes of the intermittent light source, the number of such flashes being at least the minimum for the "critical frequency for brilliance" as described above. In other words, during the stimulating portion of the cycle or rotation of the shaft, that is, the period during which the light 4 is illuminated and is sending stimuli through the cut out 10, there must be sufficient flashes to reach the desired brilliance.

It is quite obvious that instead of providing a single cut out portion a number of such portions could be provided which would then produce a plurality of stroboscopic figures at various points around the disc 12. It is likewise obvious that only a single figure need be provided in the disc 12 if desired.

It will be noted that the use of a diffusing disc is very important in order to give a light surface as the source. In addition, it is vital that the source of light be interrupted a plurality of times during that portion of each revolution of the disc 8 in which the opening 10 is passing any given point on the disc 6.

While I have described herein one embodiment of my invention, I wish it to be understood that I do not intend to limit myself thereby except within the scope of the appended claims.

I claim:

1. A method which consists in causing substantially instantaneous intermittent illuminations throughout an area, cutting off the illumination from a constantly changing portion of such area and cutting off a constantly changing portion of the remaining illumination, the space between successive illuminations and the duration thereof being sufficient to satisfy the requirements for critical frequency for continuous visual sensation and also for the critical frequency for brilliance and producing visual effects of appreciable duration.

2. A method of treating substantially instantaneous light, which comprises interrupting said light cyclically by relatively long periods of darkness, interrupting each period of illumination between such long periods of darkness a plurality of times by relatively short periods of darkness, and cutting off during such periods of illumination a portion of the light, such portion varying from cycle to cycle, whereby a stroboscopic effect is obtained, the frequency and duration of such periods of illumination and short periods of darkness being sufficient to satisfy the requirements for critical frequencies for sensation and brilliance.

3. A method which consists in causing substantially instantaneous intermittent illuminations throughout a stationary surface or area, interposing and moving in front of said surface or area a mask with an open or cut out section or sections, causing said mask to travel along a periodic path in rapid succession through repetitive cycles satisfying the critical frequency for continuous visual sensation and the critical frequency for brilliance, producing visual effects of appreciable duration, interposing a second mask or a variously translucent screen between said light and first mask and the observer, and moving said second mask or screen in the same direction as the first mask and at a slightly different speed therefrom to modify said visual effects.

4. The treatment of a substantially instantaneous stationary source of light which comprises diffusing the light, intermittently interrupting the light to produce regular instantaneous flashes each of a duration less than one fiftieth of a second, each flash followed by a rest interval of less than one fiftieth of a second, obscuring the flashing light for intermittent periods and exposing the flashing light for periods of shorter duration than the obscured periods, said exposure periods occurring rapidly enough

to satisfy the requirements for critical frequency for continuous visual sensation.

5. The treatment of a substantially instantaneous stationary source of light which comprises diffusing the light, intermittently interrupting the light to produce alternating flashes and rest intervals of a rapidity sufficient to satisfy the requirements for critical frequency for brilliance, and intermittently obscuring the flashing light to produce alternating periods of lightness and darkness succeeding each other at a rate sufficient to satisfy the requirements for critical frequency for continuous visual sensation.

6. Apparatus of the class described, comprising a stationary source of substantially instantaneous light, a diffusing screen in front of said light, a rotatable disc member in front of said screen, the major portion of said disc member being opaque and the minor portion of said disc being pervious to light, means for intermittently flashing said light at a rate sufficient to satisfy the requirements for critical frequency for brilliance, a second rotatable disk member in front of said screen and adjacent said first disk member, said second disk member having a plurality of variously shaped apertures, means for rotating said first disc at a speed high enough to satisfy the requirements for critical frequency for continuous visual sensation and means for rotating said second disk at a slightly different rate of speed from said first disk.

ARTHUR C. WATSON