

PATENT SPECIFICATION

Application Date : Jan. 21, 1933. No. 2049 / 33.

414,059

Complete Specification Left : May 13, 1933.

Complete Specification Accepted : July 23, 1934.



PROVISIONAL SPECIFICATION.

Production of Cinematographic Effects in Colour and Means therefor.

We, ALBERT GEORGE HILLMAN, British Subject, GEORGE HARMER JOHNSON, British Subject, and COLOURGRAVURE LIMITED, a British Company, all of Victoria House, Vernon Place, Southampton Row, London, W.C. 1, do hereby declare the nature of this invention to be as follows :—

The present invention relates to the production of cinematographic effects in colour and means therefor, and particularly relates to obtaining such effects by optical synthesis of the so-called additive method in which consecutive colour record pictures are simultaneously superposed on the screen, the red picture through a red filter and the green picture through a green filter in the case of a two colour additive process and with the addition of a blue picture through a blue filter in the case of a three colour process.

The object of the present invention is to provide a process in which standard width film and standard picture pull may be employed both in the camera and in the projector, and in which the recurring series of two colour records are taken from the same aspect.

In the process according to the present invention, negatives of records of two colour sensations alternating with each other are photographed by apparatus which may be generally of the usual character for taking cinematographic pictures, but red and green colour filters are employed which are brought into position so that a pair of records of two colour sensations one after the other along the film is simultaneously taken from the same aspect through such colour filters, the arrangement of the optical system and the colour filters being such that during the next exposure period following a shift period in which the film has been advanced an amount corresponding to a single picture pull, that picture of the pair which is the following picture in the direction of motion of the film through the gate, is again exposed with the same aspect through a like colour filter to that through which it was first exposed.

Each colour sensation record is therefore formed by a double exposure from [Price 1s.]

the same aspect, but constitutes a composite photograph as regards motion analysis and each pair of successive colour sensation records is the result of simultaneous exposures from the same aspect recording the same motion phase and periodic exposures from the same aspect but recording such slight different motion phase that in general for normal or slow motion has little or no subversive effect in colour fringing on projection of the positive film made from such negative film on the sheet.

The negative film on which the pictures are taken in the camera is of the panchromatic type and we have found that Kodak's standard super sensitive panchromatic film works well for the purpose of the present invention.

As colour filters for taking the negative film we have found Wratten's standard two colour taking filters to work well, preference being at present had to the red and green filters as now supplied by Kodak Limited of Great Britain to order numbers 28 and 40 A respectively.

For the purpose of taking each pair of the recurring series of two colour sensations from the same aspect, an optical taking system is used in which a pair of paired lenses are employed in combination with a light dividing system in which a branch beam is separated from the entering beam of light by reflectors, the direct beam passing directly through one lens to the focal plane, while the branch beam is reflected to pass through the other lens parallel to the direct beam to the same focal plane.

In practice we have found it advisable not to use a prismatic light dividing system, but for the best results to employ a non-refractive light dividing system, that consisting of appropriately arranged optical flats of stainless steel with appropriate adjustments and lockable settings serving well.

Each colour component of the positive produced from the negative is projected twice and the two pictures superposed on the sheet at any time are each the result of double exposures in the camera from the same aspect, but not identical as re-

gards motion phase, being in fact in this respect two successive phases of an ordinary picture film.

5 It is found however that no objectionable colour fringing steps in in the case of normally active moving subjects at distances from the camera not nearer than nine feet or approximately so when employing a 2" focus lens, and for close up
10 subjects the expedient may be adopted of employing a turret arrangement on the camera by which a lens of longer focal length can be readily substituted for dealing with close up subjects.

15 The following is one way of carrying the present invention into practical effect.

In the camera a tandem two windowed gate and film track are provided to permit simultaneous exposure to be made
20 through the respective red and green filters two paired lenses and a light dividing system providing for the taking of a like picture through each gate.

It is further provided that each picture
25 shall be formed by two exposures, one in each of the two gate windows, the two exposures being separated by a period of time during which the mechanical movements are carried out to make a picture shift after the shutter cover is completed.

30 A diametral sectored opaque shutter rotating in an anti-clockwise direction provides that the time interval between each exposure shall be considerably
35 shorter than if the shutter were to be rotated in a clockwise direction, because in the former case the direction of the film movement along the track in shifting the picture areas from one gate window to the
40 next is opposed to the direction of rotation of the shutter.

The intermittent mechanism employed may be of the usual or approved character giving the standard picture pull so that
45 at the completion of the film shift movement to give a one picture pull, two consecutive picture areas are simultaneously exposed from the same aspect, and when exposure is completed for this picture
50 pull, that exposed area which is the following area in the direction of motion of the film through the gate is transferred, the next shift movement of the film, to the next gate window for a second exposure, whilst the preceding window provides for giving a first exposure again of the next following picture area, the previously double exposed picture passing
55 along the track.

60 The arrangement of the colour filters is such that the cycle of operating two exposures of the same picture area includes the interposition of a like colour filter for each such exposure, e.g., if the
65 exposure through the first window is made

through the red filter the exposure through the second window will be made through the green filter and, after the shift period is completed, the second exposure in the second window, being as it
70 will be of the red record, must again be made through the red filter, and, the first window now being required for photographing a green record, will require the interposition of the green filter.
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This filter shift is synchronised with the picture shift timing of the camera, and for compactness it is convenient to employ an oscillating sector carrying
80 three filters arranged one after the other over the same arc, the middle filter being red and the outside filters being green.

The oscillating motion may be imparted to the filter sector by a crank pin drive from the half speed shutter spindle. This
85 oscillating sector is pivotally anchored at one end remote from the filters to the camera framework and the crank pin drive may be transmitted to such oscillating sector through the medium of a sleeve
90 slidably mounted on a rod by which the sector is pivotally mounted.

During the working of the camera, the filters will be continuously oscillating so that any slight defects in the filters will
95 be smoothed out in the colour records.

The crank pin drive provides for an accelerated motion of the filters over two opposing 90° motions of the crank, the end motions being considerably retarded
100 over the other two opposing 90° motions, such retarded motions corresponding to the shutter exposure positions. There being three filters and two gate windows, two filters being like in colour and separated
105 by another unlike in colour, say two green filters separated by a red filter and carried by the oscillating sector and moving in timed relationship with the picture shift and shutter opening, there is always
110 one filter in the inoperative position when exposure takes place, preceding in one exposure the first exposure window and being at the next exposure in advance of the second exposure window.
115

Cinematographic cameras of the character in general use do not provide sufficient space to run a rotating filter of the disc type having concentric coloured bands, and consequently oscillating mechanism of the character above described enables the present invention to be readily adapted to present day cameras. The
120 oscillating principle further favourably reduces friction troubles and eliminates the slide guides which a rectilinear reciprocating motion would require. The present invention is however not to be regarded as limited to any particular
125 method of interposing the colour filters at 130

the proper time. If desired a band of alternate colour filters travelling with the film or in or on the film itself may be used both in taking and projecting.

- 5 A camera substantially as above described will produce an alternating monochrome rendering of colour selections on standard film from which a direct positive can be printed in the usual manner.
- 10 For the purpose of identifying the respective colour records, the camera will conveniently and advantageously contain means to expose on the margins of the film or one of the frames an identity
- 15 mark that will only be exposed to every other picture, and if this identity mark is

exposed, say to the red record in the camera, the negatives will then contain a master key to be in turn printed on the positives. As this identity mark will always refer to the red record, the joining of the positives will then be an easy matter; titles and leads would be treated in a like manner and the threading of the projector will be done with the aid of this identity mark to position the red record with respect to the red filter.

Dated this 21st day of January, 1933.

HYDE & HEIDE,

2, Broad Street Buildings,
Liverpool Street, London, E.C. 2,
Patent Agents for the Applicants.

COMPLETE SPECIFICATION.

Production of Cinematographic Effects in Colour and Means therefor.

- 30 We, ALBERT GEORGE HILLMAN, British Subject, GEORGE HARMER JOHNSON, British Subject, and COLOURGRAVURE LIMITED, a British Company, all of Victoria House, Vernon Place, Southampton Row, London, W.C. 1, do hereby declare the nature of this invention and in what
- 35 manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

- 40 The present invention relates to cinematograph cameras for producing colour sensation records suitable for subsequent reproduction on the screen by optical synthesis or the so-called additive method in which consecutive colour record images are simultaneously superposed, the red
- 45 image through a red filter and the green image through a green filter.

- 50 The present invention relates to a camera suitable for the production on a negative band of colour constituent images (negatives) forming a continuous series, in which each negative (except the extreme negatives of the band) is exposed with the preceding negative, and also with the following negative, the exposures in each case being to the same
- 55 beam which is divided by appropriate means whereby parallax effects are eliminated or considerably reduced, the process for the production of such negatives forming the subject of our co-pending application No. 2608 of 1934 (Serial No. 414,065). Cameras according to this invention have the advantage that standard width film and standard picture pull can be used.

- 60 Negative films produced by such method for two colour cinematography require that red and green filters be employed which are brought into position so that a pair of records of two colour sensations

one after the other along the film is taken from the same aspect through such colour filters, the arrangement of the optical system and the colour filters being such that during the next exposure period following a shift period in which the film has been advanced an amount corresponding to a single picture pull, that picture of the pair which is the following picture in the direction of motion of the film through the gate, is again exposed with the same aspect through a like colour filter to that through which it was first exposed.

65 The positive band produced from such a negative is projected by optical superposition on the sheet of the colour constituent positives each through its corresponding colour screen, the positive band between projections being so moved onward, and the colour screening of the projection beams being so changed, that each constituent is projected through the same or a like colour screen first with the constituent positive image preceding it and next with the constituent positive which follows it along the length of the film.

70 Inasmuch as each image is thus projected first with the image preceding it and then with the following image it is of first importance that the images produced on the negative band shall be evenly spaced along the length of the band, for any departure from this condition will prevent accurate registration of the colour constituent positives on the screen and will result in double images and/or colour fringing, and this coupled with the difference in motion phase which has to be tolerated in each image produced as a result of exposure and re-exposure will preclude satisfactory exhibition with good

definition and without colour fringing of the picture on the sheet.

For this reason the optical taking system must be capable of fine adjustment, must include positive and precise means for effecting adjustment to ensure the necessary accurate spacing of the image areas along the film, and must be such as to produce image areas of unvarying size.

The use of prismatic light-dividing systems for the purpose of the present invention is open to many objections, among which may be mentioned the difficulty of securing together the prism elements by an adhesive in the necessary accurate relationship, the aptitude of the elements to suffer relative displacement by the softening of the adhesive, the lack of any power of adjustment of the elements with respect to each other, and the liability which is always present in systems involving a mass of glass for extraneous or "ghost" images and images of unequal size to be produced. Adjustment of the image positions along the film by the lenses without other means of adjustment is very difficult to accomplish as the comparatively large lens unit does not lend itself to being finely adjusted and locked in the adjusted position whilst ensuring that image areas of equal size are produced.

The present invention broadly consists in a cinematograph camera for producing two or more colour constituents from the same aspect of view through a multiple windowed gate and in which the film is moved on to an extent permitting a re-exposure of the same picture area through the same or a like colour filter, having an optical light beam dividing and directing system composed of plane non-refracting reflectors and co-operating matched lenses through which the component beams are transmitted to a common focal plane at least one the reflectors being rotatably mounted about an axis parallel to the plane of the film in the gate and having fine adjusting means for rotating it and provision for maintaining it in a desired set position.

The location of the pivots must of course be performed with great care, but this can be effected by the skilled craftsman by known methods on the optical bench. The critical operation of securing the position of the images accurately in relation to the length of the film is then effected by a fine screw adjustment of a rotatable mirror, which permits of extremely sensitive manipulation and is capable of being readily locked in the desired adjusted position as determined by photographic tests.

If desired, each reflector can be rotat-

ably mounted and provided with fine adjusting means, but if one of the reflectors is accurately secured by means within the knowledge of the skilled craftsman, the correct relationship of the image areas along the length of the film can be attained by providing the other reflector only with a means of fine adjustment.

A further important advantage of the present invention is that it can be used in conjunction with lenses of short focal length, e.g., 50 mm. or 24 mm., as now commonly used in cinematography, since no correcting block is required between the objective and the film such as is generally used in conjunction with prism systems.

A feature of the invention consists in the use of an oscillating sector carrying three filters arranged one after the other over substantially the same arc, the outside filters being of like colour, and preferably the oscillating motion is transmitted to the filter sector by a crank pin drive from the half speed shutter spindle conveniently through the medium of a sleeve slidably mounted on a pivoted rod on which the sector is mounted.

Such a filter changing device will effectively withstand continuous operation and is admirably suited to modern camera design.

In order that the present invention may be the more readily understood, reference is hereinafter made to the constructional form illustrated in the accompanying drawings, in which:—

Fig. 1 is a side elevation of a camera according to the present invention, and Fig. 2 is a front view thereof with the panel carrying the optical system removed. Fig. 3 is a front view with the panel in position.

Fig. 4 shows a piece of standard size film which can be used for the negative and positive pictures.

Figs. 5 to 8 show the shutter and the moving filter carrier in four successive positions representing 90° angular displacements of the shutter shaft.

Fig. 9 is a side sectional elevation of the panel carrying the optical system, and Figs. 10 and 11 are rear and side views of the optical system casing.

Fig. 12 shows a modification of the optical system hereinafter referred to.

Fig. 13 is a diagrammatic view showing a retarded and accelerated motion of the filters.

The negative film on which the pictures are taken in the camera should be of the panchromatic type and we have found that Kodak's standard super sensitive panchromatic film works well.

As colour filters for taking the negative

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film we have found Wratten's standard two colour taking filters to work well, preference being at present had to the red and green filters as now supplied by Kodak Limited of Great Britain to order numbers 28 and 40 A respectively.

For the purpose of taking each pair or sequence 1, 2 Fig. 4 of the recurring sequences of two colour sensations from the same aspect, a non-refractive light dividing optical taking system is employed such as is illustrated in Fig. 9 in combination with a pair of paired lenses 3, 4, the light dividing system causing a branch beam to be separated from the entering beam of light 5 by reflectors 6, 7, the direct beam passing directly through the medially apertured reflector 6 and one lens 3 to the focal plane, while the branch beam is reflected by the imperforate reflector 7 to pass through the other lens 4 parallel to the direct beam to the same focal plane.

Optical flats 6, 7 of stainless steel are preferred. The mirrors are rotatably mounted about axes 34, 35 and are rotated by small amounts by the adjusting screws 36, 37 against springs 38, 39 pressing behind each reflector. This mounting allows the mirrors to be rocked away from the screws for cleaning purposes, against the springs which cause the mirrors to return to correct position when released.

Any suitable provision is employed for locking the adjusting screws, e.g., set screws engaging them. The adjustment on the optical bench for parallelism of the pivots can be effected by mounting the pivots, viz., pointed screws 51, in appropriately operated slides 52 which are released for sliding by slackening screws 53 and 54. 55 are lock-nuts. Similar slides to those shown in Fig. 11 are arranged at the other side of the casing but operate in a direction perpendicular to the slides shown.

In the camera 8 a tandem two windowed gate 9, 9¹ and film track 10 are provided to permit simultaneous exposure to be made through the respective red and green filters 11, 12 (12¹), the two paired lenses 3, 4 and the light dividing system 6, 7 providing for the taking of a like picture through each window 9, 9¹.

To provide that each picture shall be formed by two exposures, one in each of the two gate-windows 9, 9¹, the two exposures being separated by a period of time during which the mechanical movements are carried out to make a picture shift after the shutter cover is completed, a diametral sectored opaque shutter 13 serves well which looking at the front of the camera rotates in an anti-clockwise

direction (where the shutter is mounted as shown at the right of the gate) so as to provide that the time interval between each exposure shall be considerably shorter than if the shutter were to be rotated in a clockwise direction, because in the former case the direction of the film movement along the track 10 in shifting the picture areas 1, 2 from one gate window 9 to the next 9¹ is opposed to the direction of rotation of such shutter.

The intermittent mechanism employed may be of the usual or approved character giving the standard picture pull so that at the completion of the film shift movement to give a one picture pull, two consecutive picture areas 1, 2 are simultaneously exposed from the same aspect, and when exposure is completed for this picture pull, that exposed area 1 which is the following area in the direction of motion of the film 14 through the gate 9, 9¹ is transferred in the next shift movement of the film, to the next gate window 9¹ for a second exposure, whilst the preceding window 9 provides for giving a first exposure of the next following picture area, the previously double exposed picture passing along the track.

The arrangement of the colour filters 11, 12 (12¹) is such that the cycle of operating two exposures of the same picture area includes the inter-position of a like colour filter for each such exposure, e.g., if the exposure through the first window 9 is made through the red filter 11 (see Fig. 5) the simultaneous exposure through the second window will be made through the green filter 12 and, after the shift period is completed the second exposure in the second window 9¹, being as it will be of the red record, must again be made through the red filter 11, and the first window 9 now being required for photographing a green record, will require the inter-position of the green filter 12¹, (see Fig. 7).

This filter shift is synchronised with the picture shift timing of the camera, and for compactness it is convenient to employ an oscillating sector 15 carrying three filters arranged one after the other over substantially the same arc, the middle filter 11 being red and the outside filters 12, 12¹ being green.

As shewn the oscillating motion is imparted to the filter sector 15 by a crank pin drive 16 from a shutter spindle 17 revolving at half the normal speed which in an ordinary black and white camera is one revolution for one picture shift. But this speed of the shutter may if desired be retained in which case the crank pin drive could be derived from a half speed secondary shaft. This oscillating sector 15 is

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pivotally anchored at one end 18, remote from the filters, to the camera framework, and the crank pin drive 16 is preferably transmitted to such oscillating sector 15 through the medium of a sleeve 19 slidably mounted on a rod 20 by which the sector 15 is pivotally mounted.

During the working of the camera, the filters will be continuously oscillating so that any slight defects in the filters will be smoothed out in the colour records.

The crank pin drive 16 provides for an accelerated motion of the filters over two opposing 90° motions 21, 22 of the crank, the end motions being considerably retarded over the other two opposing 90° motions, such retarded motions corresponding to the shutter exposure positions. There being three filters 11, 12 (12¹) and two gate windows 9, 9¹ two filters 12, 12¹ being like in colour and separated by another 11 unlike in colour, in the example shewn two green filters 12, 12¹ separated by a red filter 11 and carried by the oscillating sector 15 and moving in timed relationship with the picture shift and shutter opening, there is always one filter in the inoperative position when exposure takes place, preceding in one exposure the first exposure window 9 and being at the next exposure in advance of the second exposure window 9¹.

Figs. 5 to 8 represent respectively four successive positions of the shutter 13 and the sector 15 produced by successive 90° angular displacements of the rotating shutter spindle, Figs. 5 and 7 showing the position of the parts during exposure after approximately one-half of the retarded movement has been made, and Figs. 6 and 8 the positions during film shifts.

The drive of the rotating shutter shaft 17 and for the claw mechanism for imparting an intermittent movement to the film may be derived from the usual spring motors, the common toothed wheel 23 being geared up to the motors in the usual way. This wheel 23 drives toothed wheels 24, 25 which are related to the claw mechanism in well known manner such mechanism being not shown in the drawings since it forms no part of the present invention. The drive of the shutter shaft 17 from the wheel 23 is through a toothed wheel 26, and another 27 on the shaft 28 which carries a toothed wheel 29 meshing with another wheel 30 on a shaft 31 which carries a bevel wheel 32 engaging with a bevel wheel 33 on the shutter spindle 17.

The reflector 6 of the light dividing system depicted in Fig. 9 is provided with a single central aperture, but if desired,

to permit the system to operate over a greater range of stops and to minimise parallax a reflector 40, see Fig. 12 may be employed provided with multiple perforations 41 the axes of which may be inclined in one direction to favour one half of the picture area and the walls of which may be locally relieved or diminished through the thickness of the material to the reflecting face in another direction to favour the other half and thereby facilitate the passage of inclined rays and the effective illumination of the marginal portions of the picture area as described and claimed in the co-pending application Serial No. 404,307 dated 12th April, 1932, of two of the present applicants. In order that the axes of the holes may be inclined to the optical axis the mirror is rotated slightly from the position it is to occupy in use (see the full line position (Fig. 12) to the dotted line position, the drilling tool being horizontal. The mirrors are rotatably mounted and screw-adjusted against springs as described in relation to Fig. 9.

Cinematographic cameras of the character in general use do not provide sufficient space to run a rotating filter of the disc type having concentric coloured bands whereas the oscillating mechanism of the character above described can be readily adapted to present day cameras. The oscillating principle further favours the slide guides which a rectilinear reciprocating motion would require. The present invention is however not to be regarded as limited to any particular method of interposing the colour filters at the proper time. If desired alternating colour filters in or on a band travelling with the film or in or on the band itself may be used both in taking and projecting.

A camera substantially as above described will produce an alternating monochrome rendering of colour selections on standard film from which a direct positive can be printed in the usual manner.

For the purpose of identifying the respective colour records, the camera will conveniently and advantageously contain means to expose on the margins of the film or one of the frames an identity mark that will only be exposed to every other picture, and if this identity mark is exposed, say to the red record in the camera, the negatives will then contain a master key to be in turn printed on the positives. As this identity mark will always refer to the red record, the joining of the positives will then be an easy matter; titles and leads would be treated in a like manner and the threading of the

projector will be done with the aid of this identity mark to position the red record with respect to the red filter.

5 It is found that in general no objection-
able colour fringing steps in in the case
of normally active moving subjects when
employing a 2" focus lens, but for close
up subjects the expedient may be
10 adopted of employing a turret arrange-
ment on the camers by which a lens of
longer focal length can be readily substi-
tuted for dealing with close up subjects.

15 Having now particularly described and
ascertained the nature of our said inven-
tion and in what manner the same is to
be performed, we declare that what we
claim is :—

1. A cinematograph camera for produc-
ing two or more colour record images from
20 the same aspect of view through a mul-
tiple windowed gate and in which the film
is moved on to an extent permitting a re-
exposure of the same picture area
25 through the same or a like colour filter,
having a light beam dividing and direct-
ing system composed of plane non-refract-
ing reflectors and co-operating matched
lenses through which the component
30 beams are transmitted to a common focal
plane, the reflectors being mounted for
rotation relatively to one another about an
axis or axes parallel to the plane of the
gate, fine adjusting means being provided
35 for effecting rotation whereby to cause
even spacing of the images in the direc-
tion of the length of the film and provi-
sion is made for maintaining the reflect-
ors in the desired adjusted relationship.

2. A camera as in claim 1 in which the
40 rotation of the reflector is effected by a
fine screw action against a spring resist-
ance.

3. A camera as in claim 2 wherein the
reflector or reflectors can be rotated
45 against the spring for example for clean-
ing purposes without disturbing the posi-
tion of adjustment.

4. A camera as in claim 1, 2 or 3, in
which the colour filter control of re-ex-
50 posures of the same picture area is effected
by an oscillating sector carrying three
filters arranged one after the other over
substantially the same arc, the outside
filters being of like colour.

5. A camera as in claim 4, in which
55 the oscillating motion is transmitted to
the filter sector by a crank pin drive from
the half speed shutter spindle.

6. A camera as in claim 5, in which the
60 crank pin drive is transmitted to the
oscillating sector through the medium of a
sleeve slidably mounted on a pivoted rod
on which the sector is mounted.

7. A camera as in any claim 1—6, hav-
ing a diametral sectored opaque shutter
65 which exposes the picture areas succes-
sively and is connected to rotate so that
the edges of the apertures are moving at
the moment when they effect the ex-
70 posures, in a direction contrary to that in
which the band moves through the camera
so that the re-exposure of each negative
commences before the exposure of the suc-
ceeding negative.

8. A camera substantially as herein de-
75 scribed or shown for the purpose of pro-
ducing cinematographic effects in colour.

Dated this 11th day of May, 1933.

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2, Broad Street Buildings,
Liverpool Street, London, E.C. 2,
Patent Agents for the Applicants.

Fig. 1.

[This Drawing is a reproduction of the Original on a reduced scale.]

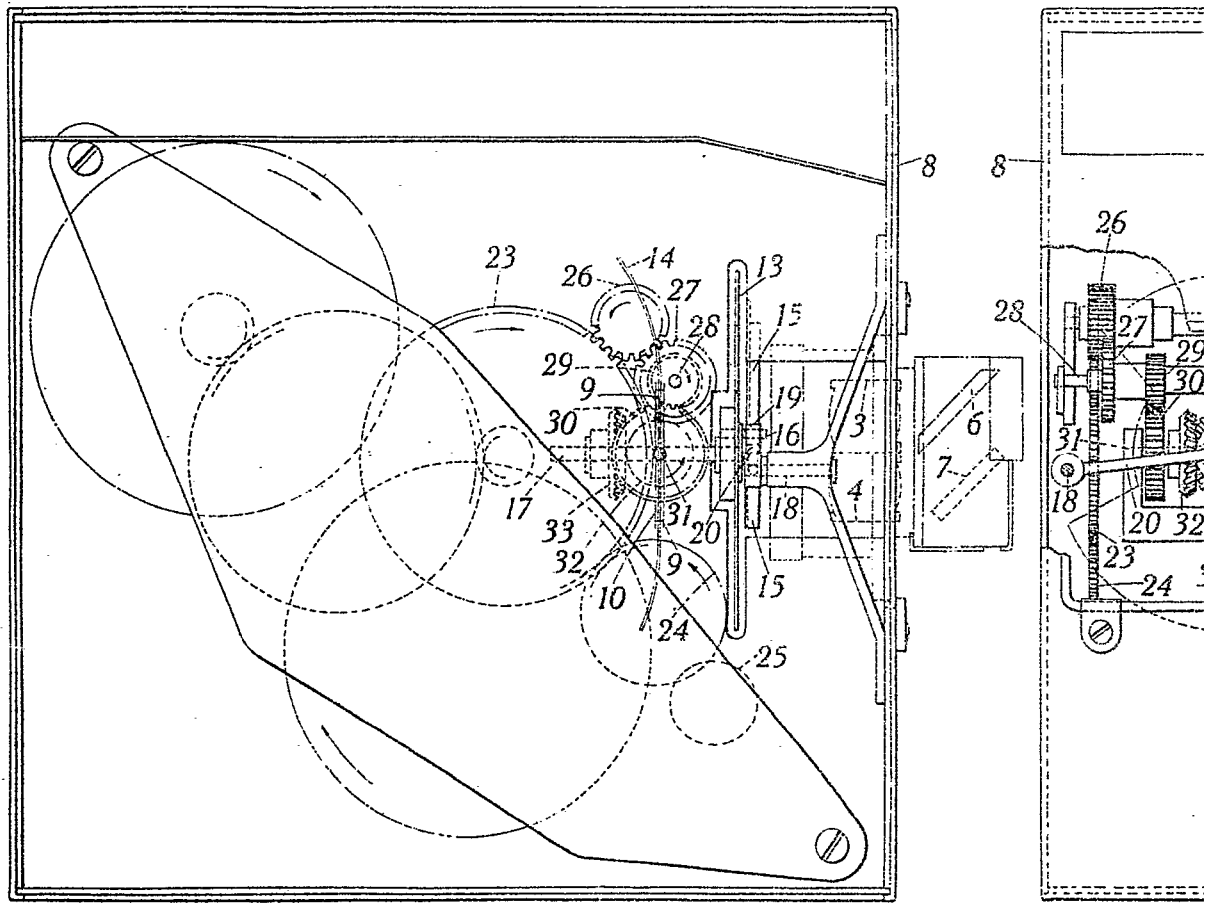


Fig. 2.

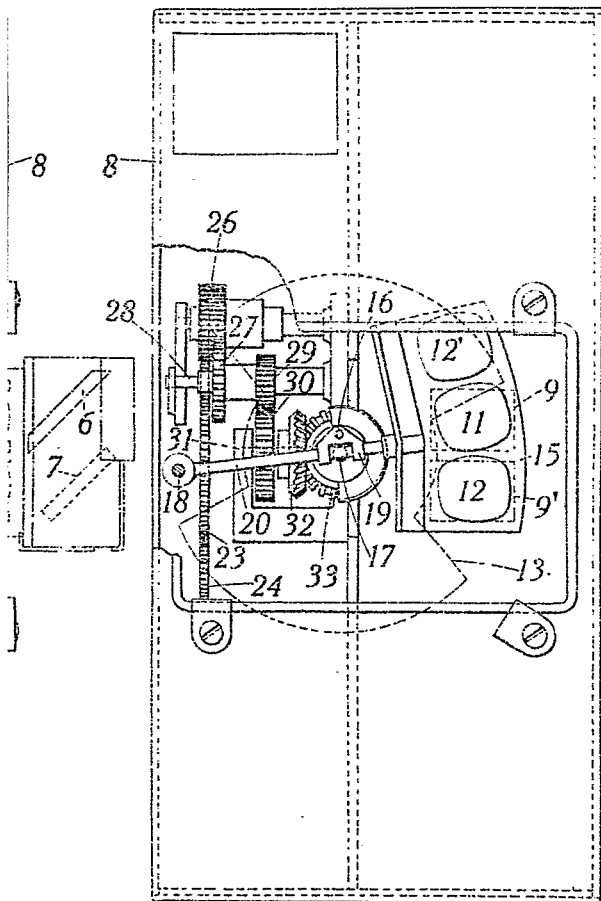


Fig. 3.

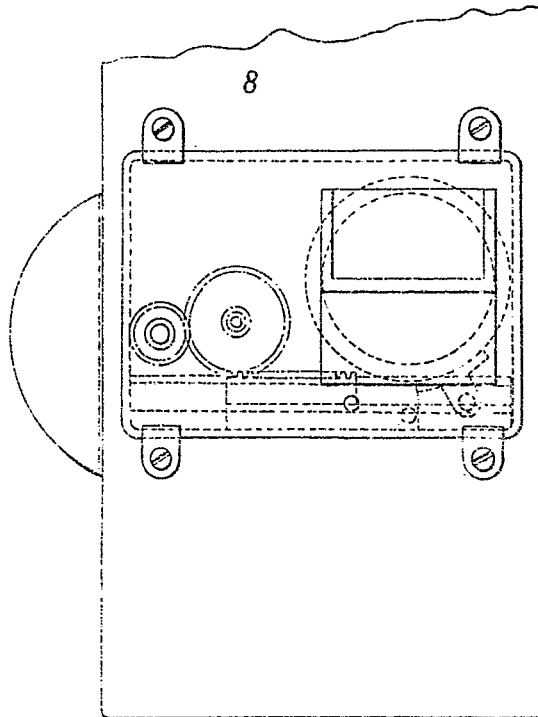


Fig. 4.

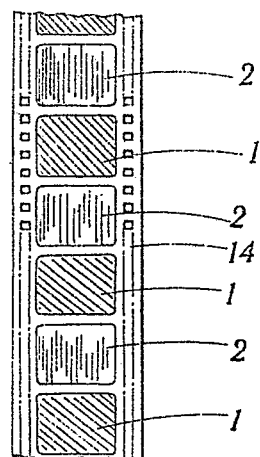


Fig. 3.

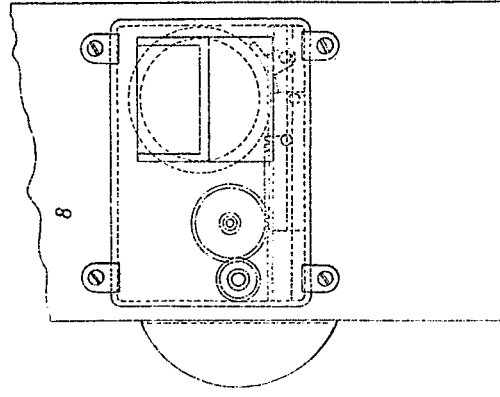


Fig. 2.

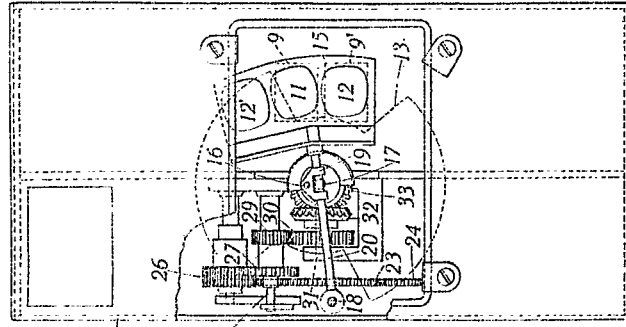


Fig. 1.

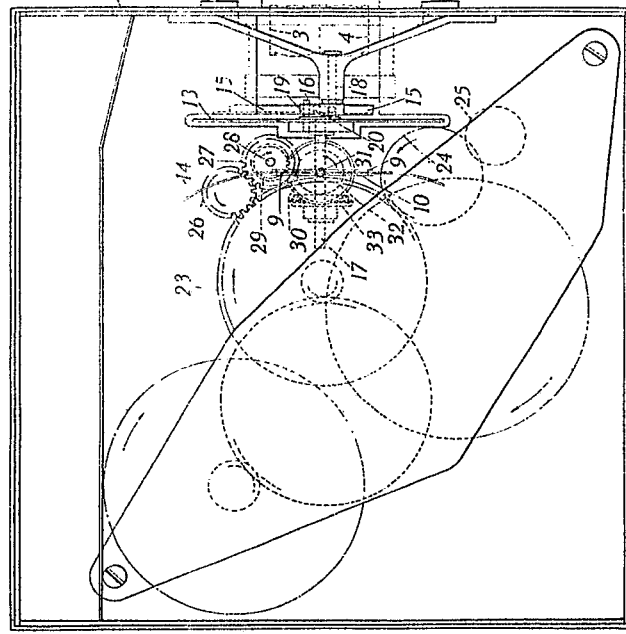
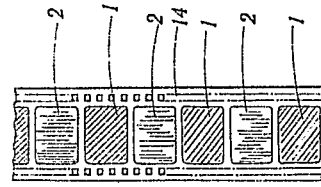


Fig. 4.



[This Drawing is a reproduction of the Original on a reduced scale.]

Fig. 5.

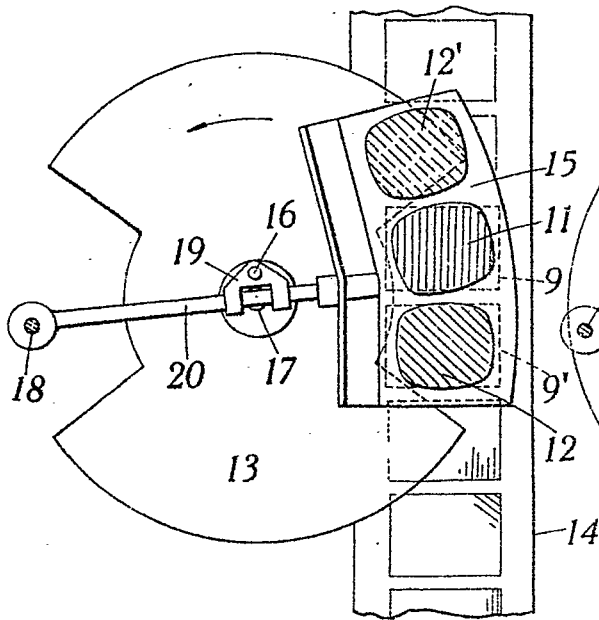


Fig. 6.

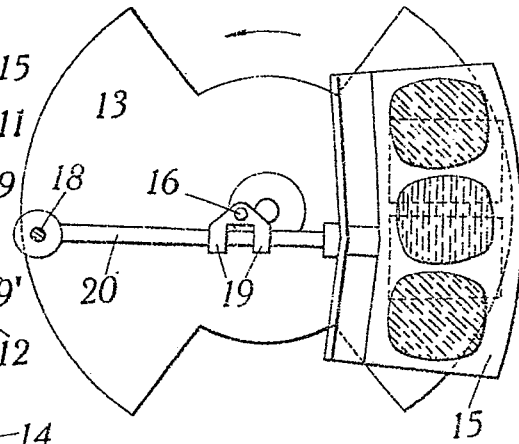


Fig. 7.

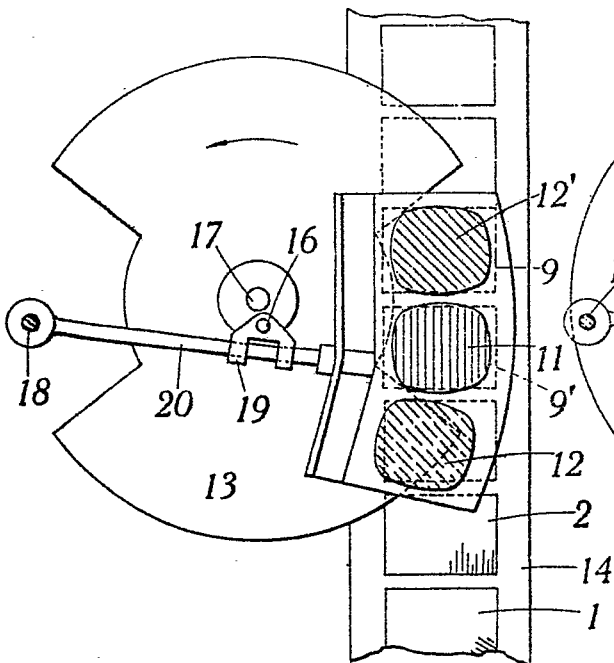
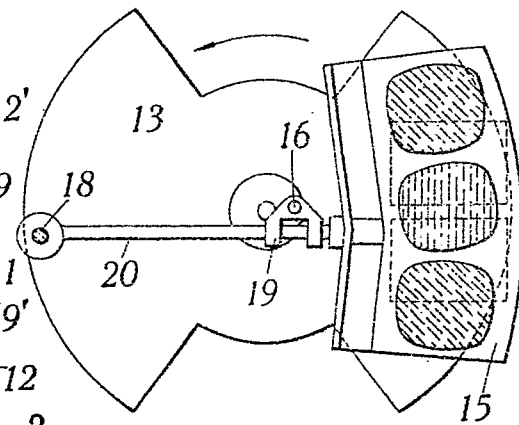


Fig. 8.



[This Drawing is a reproduction of the Original on a reduced scale.]

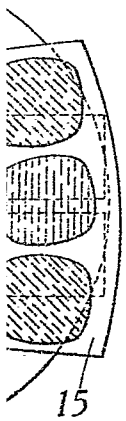
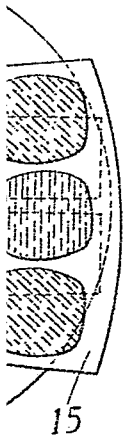


Fig. 9.

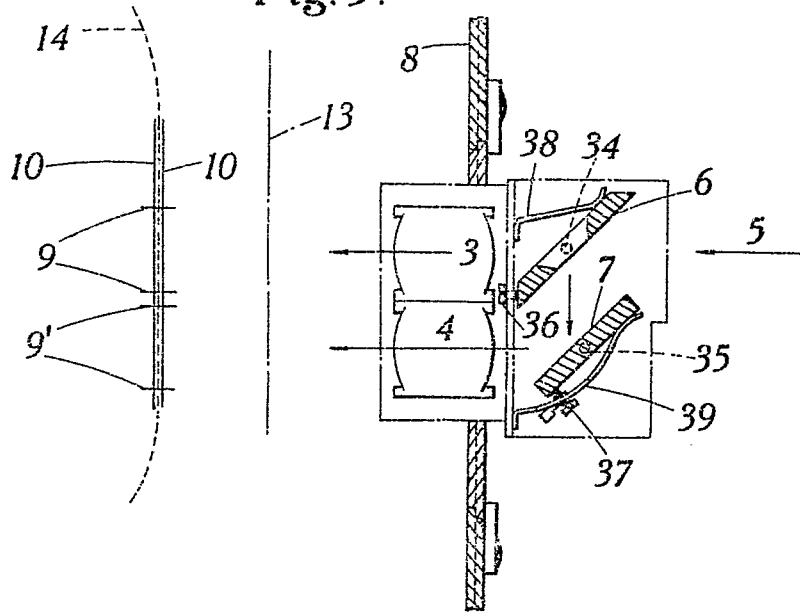


Fig. 10.

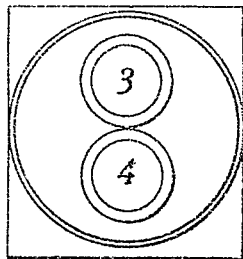


Fig. 11.

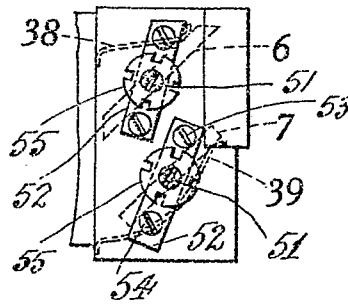


Fig. 12.

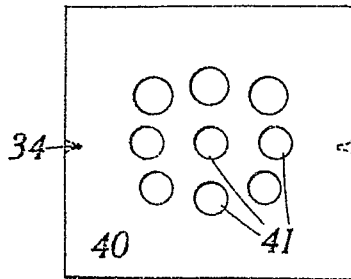
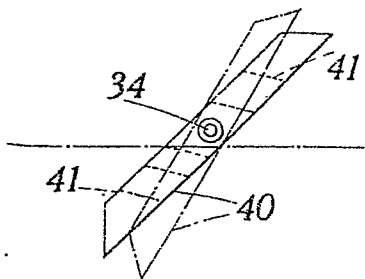
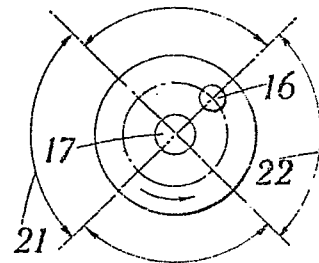
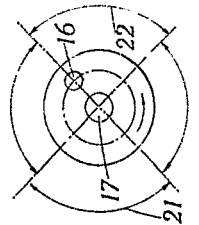
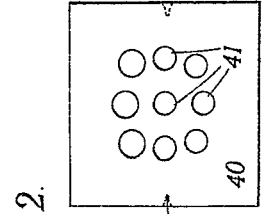
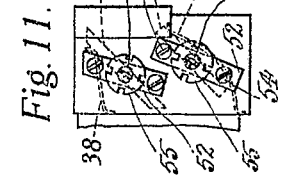
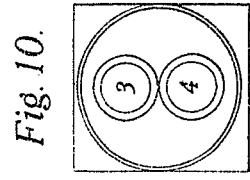
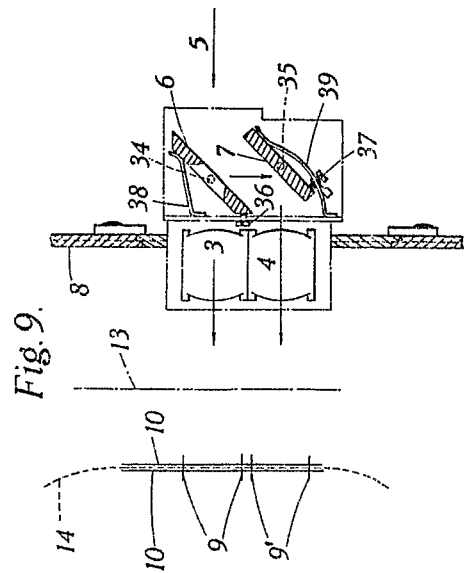
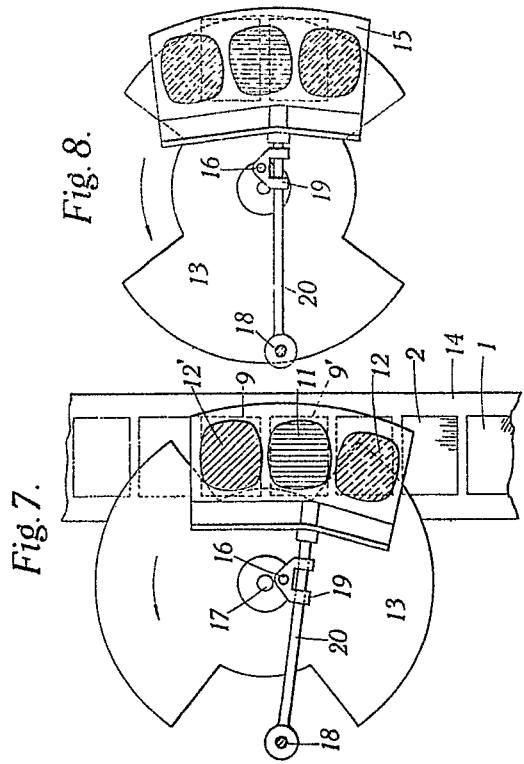
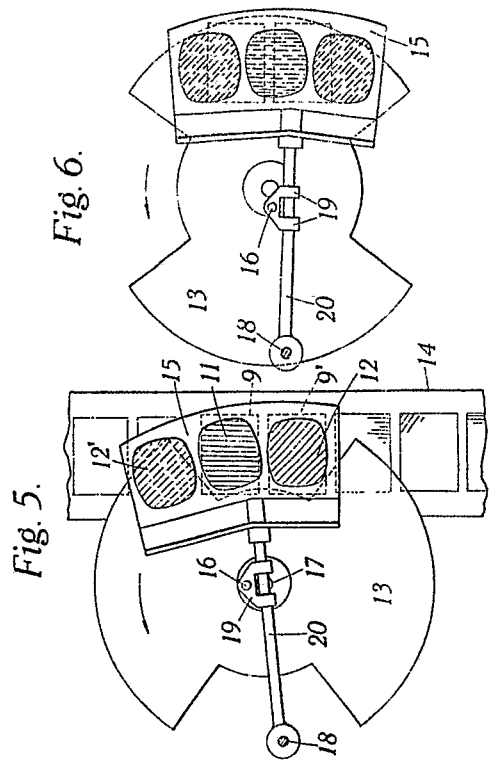


Fig. 13.





[This Drawing is a reproduction of the Original on a reduced scale.]