June 18, 1957 J. BALL ET AL 2,796,528

PHOTO TIMER

Filed Sept. 9, 1954 4 Sheets-Sheet 1

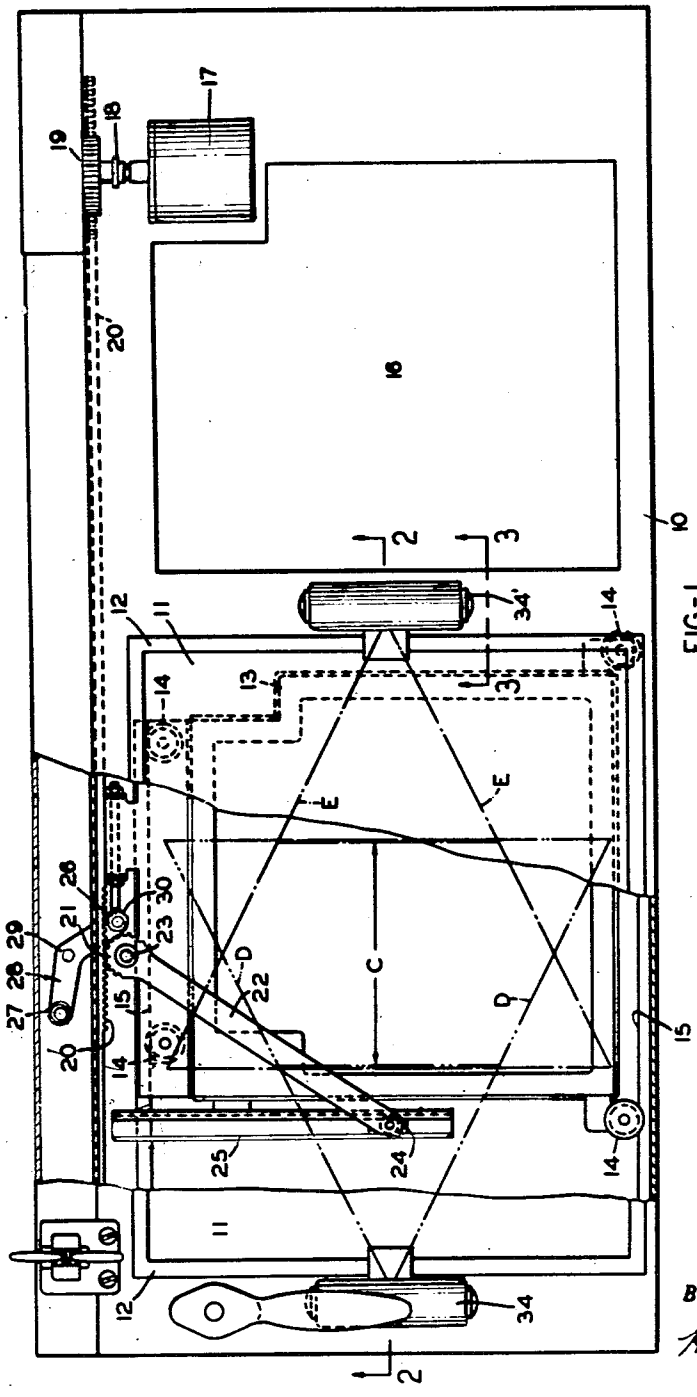
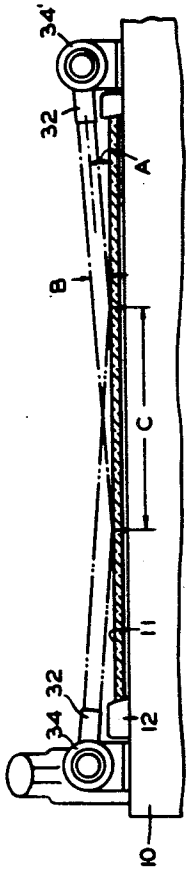



FIG-1

FIG-2




INVENTORS
JACK BALL &
JOHN J. RUSSELL

BY

Hyde, Meyer, Baldwin & Doran

ATTORNEYS

June 18, 1957 J. BALL ET AL 2,796,528

PHOTO TIMER

Filed Sept. 9, 1954 4 Sheets-Sheet 2

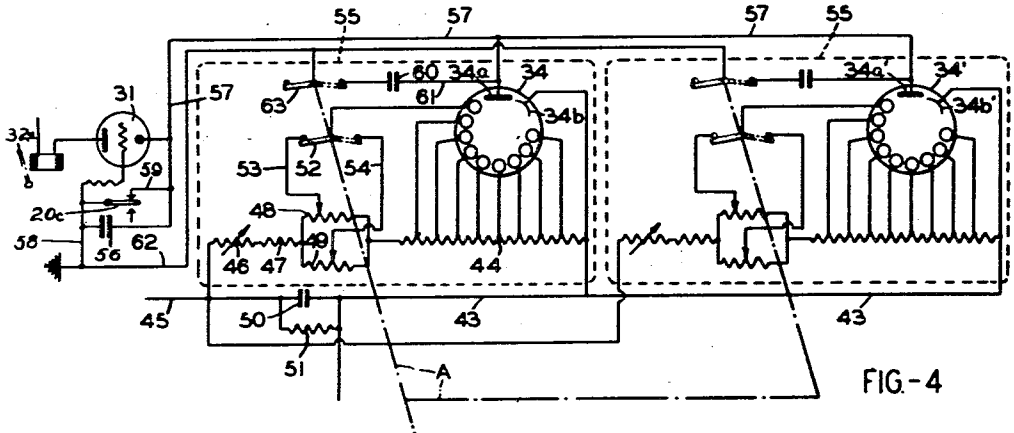



FIG.-4

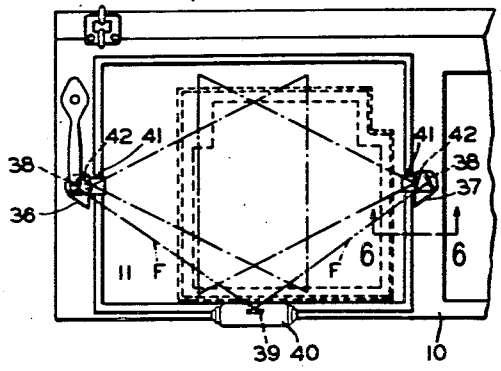



FIG.-5

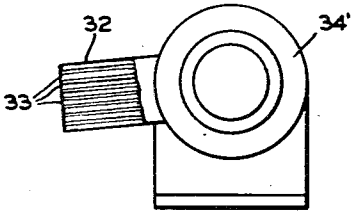



FIG.-3

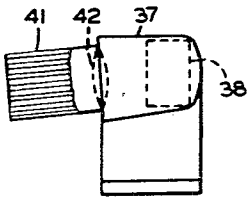



FIG.-6


*INVENTORS*
JACK BALL &
JOHN J. RUSSELL

*BY*

Hyde, Meyer, Ballou & Dorsey

ATTORNEYS

June 18, 1957 J. BALL ET AL 2,796,528

PHOTO TIMER

Filed Sept. 9, 1954 4 Sheets-Sheet 3

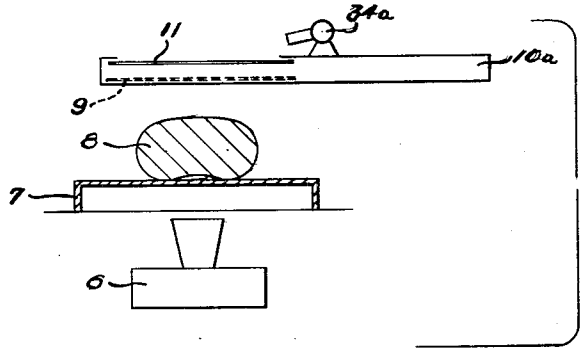



FIG-7

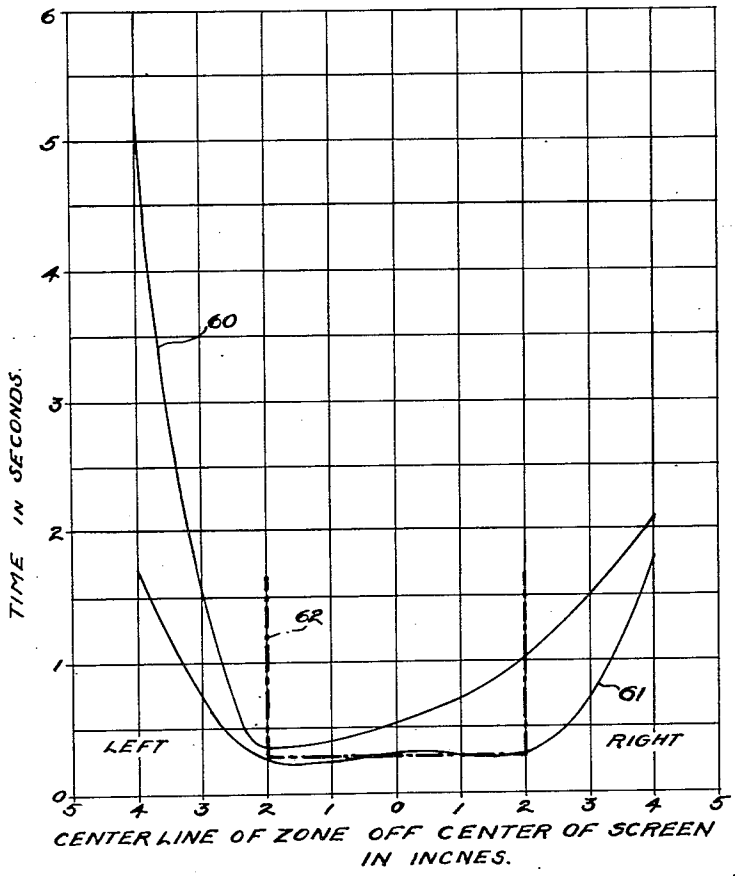



FIG-8

INVENTORS.
JACK BALL &
JOHN J. RUSSELL

BY
Hyde, Mayer, Baldwin & Doran
ATTORNEYS

June 18, 1957 J. BALL ET AL 2,796,528

PHOTO TIMER

Filed Sept. 9, 1954 4 Sheets-Sheet 4

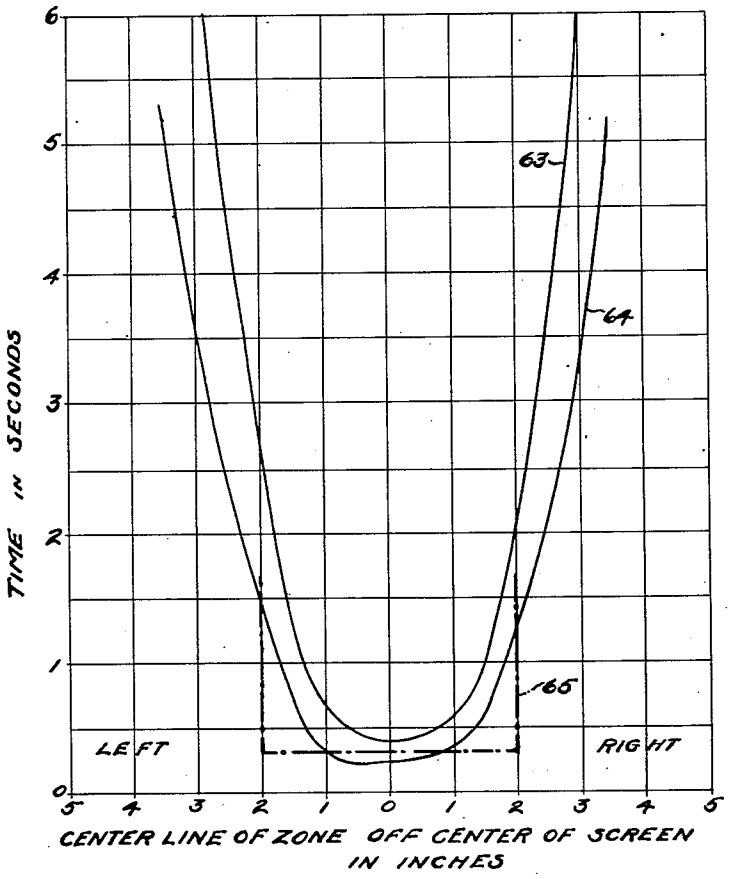



FIG-9

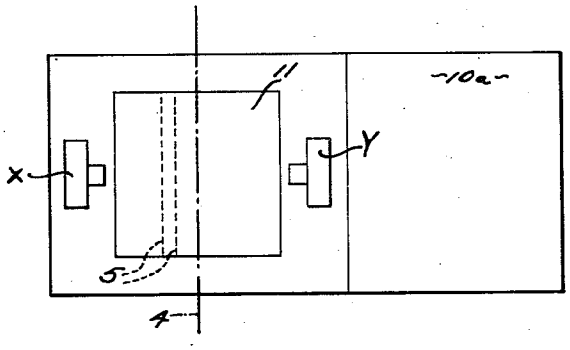



FIG-10

INVENTORS.
JACK BALL &
JOHN J. RUSSELL

BY
Hyde, Myers, Baldwin & Doran
ATTORNEYS

United States Patent Office 2,796,528 Patented June 18, 1957



2,796,528

# PHOTO TIMER

Jack Ball, Cleveland, Ohio, and John J. Russell, Greenville, S. C., assignors to Picker X-Ray Corporation, Waite Manufacturing Division, Inc., Cleveland, Ohio, a corporation of Ohio

Application September 9, 1954, Serial No. 454,954

6 Claims. (Cl. 250—95)

This invention relates to improved means sensitive to the luminosity of an image on a fluorescent screen and useful for controlling a timing period in a photographic process.

This application is a continuation-in-part of our co-pending application Serial No. 116,112, filed September 16, 1949, now abandoned.

An object of the present invention is to provide apparatus for use above the body of a patient being examined for timing an X-ray photograph of a selected portion of the patient's anatomy. For this purpose a movable film tray is positioned above the body of the patient with a fluorescent screen over the picture-taking position of the film in the tray and with the upper surface of the screen at all times exposed to the clear vision of an operator standing by the patient. The X-ray tube is positioned below the body of the patient with the rays directed upwardly through the body and impinging on the under side of the fluorescent screen in the usual manner so that the X-ray image appears on the screen as it will appear on an interposed film when a picture is to be taken. Our invention includes a photoelectric light-sensitive device secured to one side of the screen in a low position to receive light rays from the screen at a flat angle, the position of the light-sensitive device being such that the upper surface of the screen is always clearly exposed to the vision of the operator. It results from this arrangement that the operator may view the anatomy of the patient and select that portion which he desires to photograph, then center that selected portion so that its image is in the center of the fluorescent screen, then move the film tray to exposure position of the film and time the X-ray photograph utilizing the output of the photoelectric light-sensitive device to terminate the exposure with the assurance that he is getting that period of exposure which will give him the best definition on the film. Such a photoelectric light-sensitive device may be used with or without a collimator but the device works better with a collimator so that the light is transmitted to the photoelectric device more accurately limited to a selected luminous area of the screen. While a single photoelectric light-sensitive device positioned as herein described will operate fairly well, we find that two of these devices positioned on opposite sides of the fluorescent screen provide a more accurate timing means.

Another object of the present invention is to provide light-sensitive means subject to the luminosity effect of an image on a fluorescent screen as observed from opposite sides thereof so as to average the light effects over a large portion of the entire image whereby a light area of the image which is nearer to one of the luminosity responsive devices will be farther away from the luminosity responsive device on the opposite side of the image, thus averaging the total light effect and obtaining a more accurate value for photographic timing purposes.

In one form of our invention, two photoelectric cells are positioned respectively on opposite sides of the image



in position to receive light rays from a large area of the image and the electrical output of the two photoelectric cells is totalized or averaged for timing purposes.

In another form of our invention, the luminosity effect from the opposite sides of the image is focused by means of mirrors simultaneously from two mirrors on to a single photoelectric cell, thus averaging the light effect from opposite sides of the image in a single cell, the output of which is utilized in a timing circuit.

Another object of the present invention is to do away with the errors which occur by timing an X-ray photograph where the timing value is determined from one side only of the image.

Still another object of the present invention is to do away with cumbersome movable light-sensitive devices which have to be moved over the image in the screen for operative purposes and thus are sensitive to the particular spot on which the light-sensitive device happens to be focused and which is undesirable because of the wires connected to the device which have to be bent back and forth each time, together with the undesirability of having the vision of the operator obstructed.

Other objects and advantages of our invention will be apparent from the accompanying drawings and description and the essential features will be summarized in the appended claims.

In the drawings,

Fig. 1 is a top plan view of a frame equipped with a fluorescent screen and a movable cassette or film holder and equipped with that form of our device which requires two photoelectric cells;

Fig. 2 is a fragmental sectional view taken along the line 2—2 of Fig. 1;

Fig. 3 is a fragmental sectional view enlarged taken along the line 3—3 of Fig. 1 and partly broken away to more clearly show the construction;

Fig. 4 is a diagrammatic view of a portion of an electrical timing circuit for use with the device of Figs. 1, 2 and 3;

Fig. 5 is a top plan view of the left-hand portion of Fig. 1 to somewhat smaller scale and showing a modified form of our device using mirrors;

Fig. 6 is a fragmental sectional view enlarged taken along the line 6—6 of Fig. 5;

Fig. 7 is a diagrammatic view illustrating the position of the X-ray tube, the body of the patient, the film and the fluorescent screen;

Fig. 8 is a graph showing the results obtained utilizing one or two photoelectric devices without a collimator;

Fig. 9 is a similar graph showing the results using one photoelectric device or two devices together with a collimator; while

Fig. 10 is a diagrammatic view of the fluorescent screen and photoelectric devices illustrating how the graphs of Figs. 8 and 9 were made.

Our invention is useful for photo-timing an X-ray photograph or for timing an ordinary photograph of an X-ray image on a fluorescent screen. In either case, the parts to be photographed are viewed as an image on a fluorescent screen and some measure of the luminosity of the image must be utilized for timing purposes. One common device for photo-timing a picture under these conditions, consists in the use of a photo-sensitive tube which is moved to a central position of the picture when it is desired to time an exposure. One of the difficulties of this device is that the photo-tube is in the way for viewing the screen when it is moved to a position over the screen, and furthermore the device has high voltage wires connected to it, which have to be bent back and forth each time the phototube is placed in position or

pushed out of the way. Another difficulty with this type of timing is the great difference in the effect depending upon whether the phototube is focused over a dark shadow such as the spine would make or over a brighter spot such as light tissue would make. This is particularly noticeable where a patient has been fed bismuth which, of course, provides a very dark spot, and if the phototube were placed over such a spot, a very dark picture would result.

Another manner of photo-timing such pictures is the provision of a photoelectric tube or cell along one side of the fluorescent screen and directed toward the image on the screen. This is a satisfactory arrangement except that it does not average the light over the entire screen, but has a greater effect from the areas lying close to the phototube rather than from the areas farther away. The effect of the light of the image on the phototube follows the inverse square law and therefore the image areas nearer to the phototube give a much greater effect.

For instance, if it is desired to take a picture through one-half of the human body, if the phototube is toward the center of the body, then the dark portion of the body image will be nearer the phototube and the image farther away from the phototube may have a certain amount of "splash" where the view extends outside the confines of the body itself, giving a very bright spot on the screen distant from the phototube and therefore, the darker portion of the body nearer the phototube will control and one will obtain a dark picture. On the other hand, if the phototube is near one side of the body looking toward the center, then any "splash" will be close to the phototube and the darker portion of the body image will be farther away from the phototube. In this case, the timer will cut off the exposure tube quickly and a light print will develop.

Another manner of photo-timing an X-ray photograph is to place the X-ray tube above the patient with the fluoroscopic screen and film beneath the patient. With this arrangement, the operator cannot move the fluorescent screen around and observe the image until he obtains the exact portion of the anatomy which he desires to photograph.

We have chosen to show our invention in combination with a frame **10** which carries a fluorescent screen **11** in a binding frame **12** and mounted by means not shown for movement to various positions relative to the body of the patient to be observed. A cassette or film tray **13** is mounted by means of rollers **14** for movement along parallel tracks **15** either to a photographing position as shown in Fig. 1 or to a loading and unloading position in the area **16**. For moving the tray **13** back and forth, a motor **17** is provided which through a slip clutch connection **18** drives a pinion **19** meshing with a rack **20** which in turn meshes with a mutilated gear **21** formed on one end of an arm **22** which is oscillatable about a fixed pivot **23** connected with the main frame **10**. At the opposite end of lever **22** it has a pivotal engagement with a shoe **24** which is slidable in a slotted frame **25** which is rigidly carried and is a part of the tray **13**. Movement of the rack **20** thus oscillates arm **22** to carry the tray **13** from loading to photographic position and back again. The particular device shown in the drawings is a spot film arrangement with stop members **26** and **27** carried by arm **28** which is pivotally mounted at **29** on the main frame and is movable by means of a handle not shown. A V-shape stop **30** adjustably mounted on the tray **13** engages the stop **26** in the position shown in Fig. 1 so that the tray can move no farther toward the left. The slip clutch arrangeemnt **18** provides a safe manner of stopping at any desired point, the motor **17** being arranged to overdrive until a stop member is reached. In this particular device, the tray **13** may be set to take a picture for each of its four quarters or for the left half or the right half or for the upper half or for the lower half or for the entire area of the screen. The particular arrangement of the main frame **10** and the movements of the tray **13** have no special bearing on the present invention and are only shown to illustrate one embodiment thereof.

In the form of our invention shown in Figs. 1 to 4 inclusive, a photoelectric cell **34** is mounted in fixed position on the frame **10** at the left-hand side of the fluorescent screen **11**. A single photoelectric cell may be used for our purpose as hereinafter set forth, but better results are obtained with two cells, which is the preferred form of our invention. Preferably, therefore, a second photoelectric cell **34'** is mounted in fixed position on the frame **10** at the right-hand side of the fluorescent screen as shown in Figs. 1 and 2. As shown in Fig. 2, these photoelectric cells extend a very short distance above the level of the frame, approximately one and one-half inches, so that they are entirely out of the way and are not obstructing the view of the operator. As clearly shown in Fig. 2, the angle A between the beam of light coming from the image on the fluorescent screen toward each of the photoelectric cells is very flat, not substantially over ten degrees. It results from this construction that a very shallow beam of depth B thus intercepts a wide area of width C on the fluorescent screen. In other words, the light beams coming from the image toward each of the photoelectric cells is derived from a very large area of the fluorescent screen **11**. Preferably, the openings to the photoelectric tubes are provided with devices **32** for collimating the light entering the cell openings. As shown in Fig. 3, this comprises a plurality of plates **33** parallel to the axis of the photoelectric cell **34** or **34'**, and this insures that the beams of light directed to cells **34** and **34'** come from substantially the same exact area. In other words, the two beams overlap for the width of the image indicated at C in Figs. 1 and 2. The rays from each cell converge along the broken lines as shown in Fig. 1. The rays toward the cell **34** converge along the dot-dash lines D and converge toward the cell **34'** along the dot-dash lines E. Thus, except for the outer corners as shown in Fig. 1, the light beams moving toward cells **34** and **34'** come from substantially the same area of the fluorescent screen and come from quite a large area thereof so that there is no specialized effect from a particularly light or dark spot of the image on the screen. It will be obvious that a light spot of the image nearer tube **34'** will have a strong effect there but will have a weak effect on the tube **34**. Thus, the luminosity effects from opposite sides of the image are averaged.

An electrical connection between photoelectric cells **34** and **34'** so as to average out the results and to utilize this result in a timing circuit is illustrated in Fig. 4. The view of Fig. 4 is intended to be incorporated in the timing circuit shown and claimed in the copending application Serial No. 785,664 of Jack Ball and Edward B. Graves for Photoelectric Timer for X-Ray Apparatus, filed November 13, 1947, now Patent No. 2,541,187, granted February 13, 1951, to which reference may be had for a more complete description. It will be noted that the left-hand portion of Fig. 4 is exactly like a similar part of the drawings in the above mentioned Patent No. 2,541,187 wherein a photoelectric cell **34** is shown in a broken line box indicated as **55**. The right-hand portion of Fig. 4 is a complete duplication of the left-hand portion and any parts thereof may be referred to with reference characters having the suffix "prime." The photoelectric tubes **34** and **34'** are illustrated as being of the type shown in United States Patent No. 2,231,697 granted February 11, 1941, to V. K. Zworykin et al. The cathodes **34*b*** and **34*b'*** of the present application are intended to be the equivalent of the cathode **5** of the above mentioned Zworykin et al. patent. It will be noted that whereas, in the above mentioned Ball et al. patent, the termination of a photographic exposure depends upon the firing of the trigger tube **31** responsive to the output from a single

photoelectric cell 34, the timer circuit when connected according to the teachings of Fig. 4 and the above mentioned Ball et al. patent connects in parallel the plates 34*a* and 34*a'* of the two phototubes by means of the connector 57. It is well known to fire a trigger tube when a connected condenser has collected sufficient electrons from an anode such as 34*a* of cell 34. The present invention supplies means for charging such a condenser 56 responsive to the average luminosity of substantially the entire screen by connecting anodes 34*a* and 34*a'* in parallel.

A trigger tube 31 is shown as of the cold cathode tube. The plate 31*a* of this tube is connected through relay 32 having an armature 32*a* the purpose of which is to open a set of contacts and terminate the X-ray exposure responsive to the timing apparatus herein disclosed.

A phototube of the above mentioned Zworykin type is diagrammatically shown at 34. This tube has a plate 34*a*, a cathode 34*b* and a plurality of dynodes. Suitable taps on resistor 44 supply the dynodes with proper voltage all except the last one. This last dynode is connected to switch 52, which, in the full line position shown in the drawings, engages contact 52*a* for radiography. The series resistor 46 is used as a calibrator. The phototube units are sent out fully assembled including the parts within the broken line 55. By adjusting the resistor 46, each phototube unit may be adjusted to the same sensitivity so as to give identical output.

A capacitor 56 is provided for collecting the electrons from the anode 34*a* of the phototube until a sufficient charge is collected to fire the trigger tube 51. This condenser is connected with line 57 which in turn connects the anode 34*a* of the phototube with the cathode of the trigger tube. The other side of the condenser is grounded through line 58. The capacitor 56 is normally short-circuited through line 59 and switch 20*c* until an exposure starts. At that time, the switch 20*c* opens and the capacitor begins to collect a charge. By proper selection of the capacity of the capacitor 56, the potential to which it is charged in order to fire the trigger tube, and the sensitivity of the phototube, an exposure may be terminated when a recording film has been properly exposed. The capacitor 56 and the trigger tube 31 are so selected and arranged as to take care of the output from the two photoelectric cells 34 and 34' as here shown, or from one cell if connected as in Patent No. 2,541,187, so as to terminate the X-ray exposure after the film has been properly exposed.

Certain refinements will occur to those skilled in this art in order to make the above device operate properly. In the first place, each of the cells 34 and 34' will be separately focused on the same area, lighted in the same manner, and each of the phototube units will be adjusted to the same sensitivity so as to give identical output for identical input. This is done by adjusting the resistor 46 for cell 34 and by adjusting the equivalent resistor for the cell 34'.

The apparatus mentioned so far utilizes two photoelectric cells and totalizes the output of the two cells electrically in order to obtain an average result from the image on the fluorescent screen. The modification shown in Figs. 5 and 6 averages the luminosity effect observed from each side of the image by simply adding together the light rays as they effect a single photoelectric cell. All of the parts of Fig. 5 are understood to be the same as those described in connection with Fig. 1 except those now about to be described. Positioned in fixed relationship to the frame 10 on opposite sides of the fluorescent screen 11, we provide housings 36 and 37. In each of these housings there is a mirror 38 so positioned as to receive light rays from the image on the fluorescent screen and to reflect these rays parallel to the dot-dot-dash lines F of Fig. 5 to the cathode 39 of a photoelectric cell 40 which is mounted on the frame 10. The cathode 39 is of a similar character to that previously described at 34*b* and 34*b'*. Collimating devices 41 exactly equivalent to the devices 32 are positioned in front of each of the mirrors 38 to provide parallel rays of light coming from the fluorescent screen toward each mirror and limiting the area covered by the rays of light going in opposite directions to the same width of image as indicated at C in Figs. 1 and 2 in connection with the first form of our device. If necessary or desirable, a lens 42 may be positioned between each device 41 and the associated mirror 38 so as to converge all of the stray rays of light onto the mirror 38.

The operation of the device of Figs. 5 and 6 should now be apparent. The phototube 40 takes the position of the photoelectric cell 34 as shown in the above mentioned Ball et al. patent. The cathode 39 takes the place of the cathode 34*b* of the Ball et al. patent. The output equivalent to 34*a* of the photoelectric cell 40 is directed to a trigger tube such as shown at 31 in the Ball et al. patent to produce a timing operation. The necessary corrections can be made to take care of the light coming from two sources toward the cathode 39 in the present instance, but it will be obvious to those skilled in this art how this may be done so as to utilize the photo-timing circuit of the Ball et al. patent.

Referring to Fig. 7, a preferred arrangement of our device is shown wherein an X-ray tube 6 is positioned beneath a table 7 upon which the body 8 of a patient lies. The film tray 10*a* is movably positioned over the patient in the usual manner with the fluorescent screen 11 over the picture-taking position of the film 9 which is movable in the tray as previously described. A single photoelectric cell 34*a* may be positioned as shown in Fig. 7 or two cells 34 and 34' may be positioned on the tray as illustrated in Figs. 1 and 2.

It is obvious that the arrangement diagrammatically illustrated in Fig. 7 has great advantages from the point of view of the medical practitioner or operator utilizing the device. Using fluoroscopy, the operator moves the tray 10*a* to a position where the fluorescent screen 11 is over the body of the patient 8. The X-rays cause the usual image of the body parts to appear on the screen 11 and the operator may select that portion which he desires to photograph very accurately in the middle portion of the screen 11. He will then slide the film 9 from the loading position indicated at 16 in Fig. 1 to the position beneath the screen 11 as indicated in Fig. 7, it being understood that the X-ray tube is meanwhile deenergized. The tube is then energized to take a photograph making use of a timer such as we have herein described under the control of a single phototube 34*a* or a pair of phototubes 34 and 34'. This arrangement has great advantages for taking a selected picture at the right exposure and is better than any previously known arrangement to the best of our knowledge.

In order to investigate the effectiveness of one or two photoelectric devices with or without collimators, we set up a device as diagrammatically illustrated in Fig. 10. The fluorescent screen 11 was set up to receive an image as illustrated in Fig. 7. Photoelectric cells X and Y were set up on opposite sides of the fluorescent screen as taught hereinabove and arranged so that one or both of these cells could be utilized for timing purposes as hereinabove described. All of the screen 11 was blocked off so far as visible light was concerned by means of tape or fiber board leaving exposed only a one inch strip as indicated between the broken lines 5 of Fig. 10. The light sensitive devices X and Y were focused primarily upon a space 4 inches by 4 inches square in the middle of the screen 11.

Referring now to Fig. 8, with the open strip 5 of Fig. 10 positioned centrally on the center line 4, that is, with one-half inch of the open strip on each side of the center line, with a given image and a given setting of all of the values in the control circuit shown in Fig. 4, the timer was tripped at approximately 0.55 second and this is the point plotted on line 60 of Fig. 8 at the abscissa marked

zero which corresponds to the center line 4 of Fig. 10. For the curve 60 only the photocell X was utilized without any collimator. A series of such exposures was made leaving the exposed strip 5 of Fig. 10 in various positions to the left and right of the center line 4 of Fig. 10, the number of inches being indicated as ordinates in Fig. 8. For instance, with the center of strip 5 two inches to the left of the center line, a timing period of approximately 0.35 second was obtained which is also plotted on curve 60. On the other hand, when the strip 5 was centered two inches to the right of the center line (on the side away from the photocell X) the timer was tripped at about 1.05 seconds which appears at the ordinate "2" at the right-hand side of the ordinate "0" in Fig. 8. At a position four inches to the left of the center line the timing interval became 5.25 seconds and at four inches toward the right of the center line, the timing period became approximately 3.0 seconds as plotted on the curve 60 of Fig. 8.

Utilizing two photocells X and Y, the experiments were repeated moving the open strip 5 of Fig. 10 to various positions on each side of the center line 4 and plotting the timing periods as abscissa on curve 61 of Fig. 8 at various positions on opposite sides of the center line indicated at zero. It will be seen that this gave a fairly flat curve between 2 inches to the left and 2 inches to the right of center as compared to the same portion of curve 60 which sloped upwardly toward the right. It is assumed that an ideal curve would be approximately like that shown in dot-dash line at 62 in Fig. 8 where the timing period would remain constant over the 4 inch distance desired from 2 inches to the left of center line to 2 inches to the right thereof, and on either side thereof the timing would go to infinity. It will be seen that the two photocells working together producing curve 61 of Fig. 8 come closer to producing this ideal response than does the single phototube X, the results of which are plotted on curve 60.

The same experiments were repeated with a collimator in each of the photocells X and Y and the results are plotted in Fig. 9. Curve 63 of Fig. 9 shows the results using a single phototube X with a collimator as illustrated in Fig. 3 and curve 64 are a similar set of experiments moving the open strip 5 as previously described to left and right of the center line indicated at zero. In this case each of the cells X and Y had a collimator similar to that shown in Fig. 3. The ideal type of curve is again indicated at 65 in dot-dash lines.

Comparing Fig. 9 with Fig. 8, it will be seen that the collimator more closely restricts the field observed by the photocell so that the curves 63 and 64 curve upwardly more sharply on each side of the center line, and the curve 64 more closely approximates the ideal type of curve 65 than any other combination which we have tried.

What we claim is:

1. In X-ray apparatus involving a planar fluorescent screen having thereon an image of unevenly distributed luminosity, the combination therewith of two devices positioned so as to be responsive to the luminosity of substantially the same area of said screen, said devices being located on opposite sides of said image and sufficiently adjacent the plane of said fluorescent screen so that the light rays from said image approach said devices at a flat angle not substantially over ten degrees, and photoelectric cell means operatively associated with both of said devices connected to average the luminosity effects from said two devices.

2. The combination of claim 1 wherein said devices comprise two photoelectric cells positioned respectively on opposite sides of said image, and a timing circuit connecting the output of said photoelectric cell means in parallel.

3. The combination of claim 1 wherein said devices comprise two mirrors positioned respectively on opposite sides of said image at an angle to receive light rays therefrom, and said photoelectric cell means comprises a single photoelectric cell having a cathode positioned to receive light rays simultaneously from both of said mirrors, and a timing circuit responsive to the electrical output of said cell.

4. Apparatus for use above the body of a patient being examined for timing an X-ray photograph of a selected portion of the patient's anatomy and comprising a movable film tray having a fluorescent screen over the picture-taking position of said film in said tray and with the upper surface of said screen exposed to the vision of an operator standing by the patient, an X-ray tube below the body with its rays directed upwardly whereby the X-ray image appears on said screen as it will appear on an interposed film, a photoelectric light-sensitive device operatively connected with said screen at one side thereof and in position to receive light rays from said screen at a flat angle not substantially greater than ten degrees, said device positioned to leave the upper surface of said screen exposed, a collimator positioned between said device and said screen arranged to collimate the light transmitted to said device to thereby more accurately limit the luminous area of the screen from which light rays impinge on said device, X-ray exposure time terminating means, and the electrical output of said device operatively connected with said time terminating means.

5. Apparatus for use above the body of a patient being examined for timing an X-ray photograph of a selected portion of the patient's anatomy and comprising a movable film tray having a fluorescent screen over the picture-taking position of said film in said tray and with the upper surface of said screen exposed to the vision of an operator standing by the patient, an X-ray tube below the body with its rays directed upwardly whereby the X-ray image appears on said screen as it will appear on an interposed film, a photoelectric light-sensitive device operatively connected with said screen at one side thereof and in position to receive light rays from said screen at a flat angle not substantially greater than ten degrees, said device positioned to leave the upper surface of said screen exposed, X-ray exposure time terminating means, and the electrical output of said device operatively connected with said time terminating means.

6. The combination of claim 4 including two of said photoelectric light-sensitive devices positioned on opposite sides of said fluorescent screen, and the electrical outputs of said devices connected in parallel circuit with said time terminating means.

UNITED STATES PATENTS

**References Cited** in the file of this patent

| | | |
|---|---|---|
| 2,486,866 | Morgan et al. | Nov. 1, 1949 |
| 2,666,145 | Eversole et al. | Jan. 12, 1954 |
| 2,668,913 | Goldfield et al. | Feb. 9, 1954 |