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(54) RANGEFINDER

(71) We, KARL VOCKENHUBER, of 118 Pötzleinsdorferstrasse, Vienna 18, Austria, of Austrian Nationality, and RAIMUND HAUSER, of 2, Goldegg-Gasse, Vienna 4, Austria, of Austrian Nationality, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to rangefinding apparatus such as may be used in conjunction with a camera to find the range of an object to be photographed. The invention is not to be understood as being limited to such use as it has other applications in different fields. However, when used in conjunction with a camera it has the advantage that it is possible to so arrange the rangefinder that should the object to be photographed not lie within the depth of the field of sharp focus, a warning is given.

In accordance with the present invention there is provided range finding apparatus comprising a transmitter energizable to direct along a ranging axis a collimated beam of pulsed electromagnetic radiation produced by a pulsed radiation generator, a receiver having an optical system viewing the ranging axis from one side thereof and arranged to project towards radiation-sensitive transducing means an image of an object located on the ranging axis and irradiated by the beam, an arrangement providing an indication of the range from the transmitter of the object on said ranging axis from the displacement of the object image laterally from the optical axis of the optical system, and a unit operated by the arrangement and providing data relating to the range to the user and/or equipment whose satisfactory operation is dependent on the range and which is associated with the apparatus. Preferably the means are photo-sensitive and filters may be used to produce a beam which is outside of the range of visible light but will nevertheless be reflected back from the object whose range is to be found. It is advantageous to provide the

receiver with a filter also, so that it responds selectively to the frequency of the ranging beam.

The receiver of the invention has the advantage that it can be compact. The sensitivity of the apparatus depends primarily on the distance of the receiver from the transmitter but this does not pose a problem if the apparatus is combined with an instrument such as binoculars or a camera because such devices are normally dimensioned to provide a sufficiently long base line.

The advantage of using a beam of short duration, such as is obtained by pulsing the transmitter, is that only a relatively small amount of power is required. This enables the rangefinding apparatus to be made in portable form if desired. Also the use of a storage enables the range found, to be held and indicated without having to maintain the transmitter in its energized condition.

To ensure that the operation does not depend on environmental conditions, it has proved desirable to measure not the absolute value of the energy, which is incident on the means, but the energy change, which accompanies the emitted pulse. In a preferred embodiment of the invention, a differentiating stage, such as a coupling capacitor, is provided for this purpose between said means and the storage device.

In a preferred embodiment of the invention, the storage includes a bistable switching stage, e.g. a bistable multivibrator, which is shifted from a first state into a second one, when the output signal of a transducing means or a signal derived from said output signal exceeds a predetermined threshold value. If the apparatus operates in the visible range of the spectrum or in the near infrared or ultra-violet ranges, the transmitter preferably consists of a gas discharge lamp. According to another embodiment, the transmitter consists of a luminescent semiconductor diode, e.g. a gallium arsenide diode. These luminescent diodes have extremely small dimensions and a relatively high efficiency. It will be a special

advantage that the light-emitting surface of the diode is extremely small, so that the transmitter rays can be very sharply beamed. Besides, the above-mentioned gallium arsenide diode has the advantage that it emits virtually monochromatic radiation having a wave length of about 900 nanometers, which is in the infrared range.

The invention will now be described in more detail, by way of example, with reference to the accompanying drawings, in which:—

In Fig. 1 a rangefinding apparatus for pulsed operation is diagrammatically illustrated,

Figs. 2, 3 and 4 are block diagrams illustrating ways of utilizing signals produced by a receiver in the rangefinding apparatus shown in Fig. 1,

Fig. 5 shows a detail of part of a circuit shown in block schematic form in Fig. 4,

Figs. 6 and 7 show diagrammatically two further embodiments of rangefinding apparatus as applied to motion pictures or photographic cameras,

Fig. 8 illustrates a modification of the arrangement shown in Fig. 7, and

Fig. 9 shows a preferred arrangement for arranging the receiver with respect to the transmitter.

The apparatus constituting the rangefinder, which is shown in Fig. 1 gives a measurement in steps. Since it is not required, as a rule, to provide an indication, which is continuous throughout the measuring range, it will be sufficient in general, if the distance is indicated in certain steps. This enables the operation of the transmitter to be pulsed rather than continuous and the power requirement of the transmitter can in consequence be reduced to a fraction of the power which is required for a continuous operation. The transmitter consists of a gas discharge lamp 29, which has associated with it a power supply unit comprising a capacitor 30 and an associated charging device 31. A firing switch is indicated at 32. An image of the electric arc produced by the gas discharge lamp is formed in the object space by the lens 33. The receiver has an optical system formed by a lens 34 and a number of photodiodes 35, which are disposed in the image plane of the lens. It may be desirable to provide filter disc 36' and 37' before the lenses of the transmitter and receiver, respectively. The photodiodes 35 are connected to a data storage device 36, which controls an indicator meter 37. The transmitter and receiver are rigidly mounted. To perform a measurement, the switch 32 is pressed to cause a discharge of the capacitor 30 through the gas discharge lamp 29, so that a defined, relatively small spot or zone of the object 28 is illuminated with a short duration beam of light. An image of this light spot is formed by the lens 34

of the receiver on one of the photodiodes 35. Which of the photodiodes is illuminated depends on the range of the object 28 along the transmitter ranging axis because this range determines the extent to which the image of the object produced by the lens is displaced laterally from the receiver optical axis. If the object 28 is disposed at the intersections of the optical axes of the transmitter and receiver, light will be incident on the photodiode nearest the optical axis of the receiver. If the object 28 is more distant, light will be incident on a photodiode, which is above the optical axis as viewed in Fig. 1. If the object lies before the intersection of the optical axes, the reflected light pulse emitted by the transmitter will be incident on a photodiode which is below the optical axis of the receiver. Since the object 28 has normally a certain illumination, which is due to the ambient light and causes light to be incident on all photodiodes 35, the parameter, which is measured, is not the absolute value of the quantity of light which is incident on the photodiodes, but the change of such quantity with time. The change of the output of the photodiodes 35 is amplified and stored in the data storage device 36. The indicator 37 indicates at any time the result of the last range-finding operation. The switch 32 may be operated by hand. Alternatively, it may be desirable to operate the transmitter intermittently with a pulse train. The frequency of that pulse train will depend on the relative velocity between the rangefinder and the object 28.

Fig. 2 is a block diagram, which represents the data storage device 36. Each photodiode 35 is connected by a coupling capacitor 38 to a bistable switching device 39, which may consist of a multivibrator or of a Schmitt trigger. Each switching stage is connected to a tap of a series connection of resistors 40. When one of the photodiodes 34 is excited by a light pulse, its output will be transmitted by the coupling capacitor 38 to the associated switching stage 39, so that the same assumes its set state, in which it grounds the associated tap of the series connection of resistors 40. The arrangement is such that the photodiode, which is associated with the largest range of distances, connects the smallest resistance, whereas the switching stage, which is associated with the smallest range of distances, bridges the largest resistance. The effective resistance of the series connection of resistors is thus a measure of the distance from the rangefinder to the object. If the distance from the rangefinder to the object 28 is so large that the reflected light is not sufficient to excite a switching stage, the total resistance of the series connection of resistors 40 will be effective. That resistance could be associated e.g. with an infinite distance. For the actual indication of the distance, a resistance-measuring device might be used, which comprises a

measuring instrument 37 carrying a distance scale. Fig. 2 shows diagrammatically an indicating bridge network for a resistance measurement. Any other resistance-measuring circuit

5 may be used, such as a cross-coil instrument. Fig. 3 shows a modification of the circuit, which is shown in Fig. 2. In this embodiment, incandescent bulbs 41 are switched by the switching stage 39. When a light pulse
10 has been emitted, that incandescent bulb 41 is energized, which is associated with the distance range in which the object 28 is disposed. It will be desirable to provide in the power supply part of the storage stage 36 a
15 switch 32a, which is opened for a short time immediately before a new measuring pulse is transmitted. The opening of that switch causes the cancelling of the result of the original measurement. Such switch may consist of a
20 wiping switch coupled to the firing switch 32 (see Fig. 1).

Fig. 4 is a circuit diagram showing another modification of the embodiment of Fig. 1. A transmitter 42 is connected by a main switch
25 43 to a power source, not shown. The transmitter comprises a firing switch 44, which is ganged to a switch 45 included in the circuit of the measuring and storage unit. The photodiodes 35 are included in the input circuit of
30 respective amplifiers 46, which, just as in the above-described embodiment, are connected by respective coupling capacitors 38 to bistable multivibrators 48. The multivibrators 48 cooperate with a controller 49
35 which has a resistor chain similar to that shown in Figure 2 and which includes in its output circuit a motor 50 and a relay 51. The multivibrators 48 having a quiescent state which, they assume initially when the supply
40 voltage is applied. This arrangement has the following mode of operation:

When the ignition switch 44 is operated, the contact 45 is closed first to energize the
45 amplifiers 46, the multivibrators 48 and the controller 49. The contact 32 (Figure 1) is then closed to initiate the flash. Depending on the position of the object 28, one of the photodiodes 35 is excited to shift the associated multivibrator to its operative position.
50 The new resistance value of the resistor chain caused by such action is then compared in the controller 49 with a setting, which corresponds to the position of the motor 50. If that position is in agreement with the
55 measured value, the motor 50 and the relay 51 will remain deenergized, so that the amplifiers, multivibrators and controller are deenergized, when the switch 44 is released. The measured value will in most cases fail to
60 correspond to the position of the motor 50. Depending on the direction of the deviation, the motor will be energized to operate in one sense of rotation or the other. The motor 50 will be operated until a feedback device indi-
65 cates that the position of the motor corre-

sponds to the measured value. The relay 51 remains excited as long as the motor is energized. The normally open contact 52 of the relay 51 connects the amplifiers 46, multi-
70 vibrators 48 and controller 49 to the source of power regardless of the position of switch 44 and will not interrupt the circuit until the motor 50 has reached the position corresponding to the object distance.

Fig. 5 is a basic circuit diagram of the arrangement just described. The photodiode
75 35 is connected to the base of a first transistor stage 53, the collector circuit of which is coupled by the capacitor 47 to the bistable multivibrator, comprising two transistors 54,
80 55. In known manner, the collector circuit of one transistor is connected by a resistor to the base circuit of the other. A diode 56 connects the multivibrator to a tap of the series connection of resistors 40. As in Fig. 2, that
85 series connection is included in a Wheatstone bridge, which contains in its other arms the resistors 57, 58 and 59. The resistors 57 and 58 have fixed values. The resistor 59 is adjustable by the motor 50. A differential amplifier
90 connected across the diagonal of the bridge comprises two transistors 60 and 61. The motor 50 and the relay 51 are included in the output circuit of the transistors 60 and 61. The motor 50 may be connected to an indi-
95 cating instrument or to a mechanism for focusing a lens assembly of a camera.

It will be desirable to form the photodiodes 35, the preamplifier 53, the coupling capaci-
100 tor 47 and the multivibrator 54, 55 on a common support, preferably a semiconductor crystal, by an integrated circuit technique. The individual stages may constitute separate
105 integrated circuits, alternatively, all stages may be combined in one such circuit, which may include also the differential amplifier 60, 61, if desired.

Fig. 6 illustrates the use of the novel range-
finder in a cinematographic camera. The
110 objective assembly of the camera consists of a prime lens 62 and an auxiliary lens 63 having a variable magnification. A front lens element 64 of the auxiliary lens 63 is axially movable to focus the optical system. A partially reflect-
115 ing prism 65 is disposed between the prime lens 62 and the auxiliary lens 63. Part of the light, which passes through the auxiliary lens 63 is deflected by the prism 65 into a viewfinder 66. A rotating shutter 68 is disposed
120 between the prime lens 62 and an exposure aperture 67 and covers the latter as the film is advanced. A contact roller 70 is carried by a shaft 69 of the rotating shutter 68 and cooperates with stationary contacts 71 to connect the same as the film is advanced and the
125 exposure aperture is covered. The transmitter and receiver are disposed on the opposite sides of the optical axis of the lens 62. The transmitter includes a lens 72, a luminescent diode 73, particularly a gallium arsenide
130

diode, disposed in the image plane of the lens 72 and has an associated power supply unit 74. A firing switch for the transmitter is designated 75. The receiver comprises a lens 76 and photodiodes 77 disposed in the image plane of the lens 76 and controlling a data storage device 78. The photodiodes have a special sensitivity, which is selected to match the transmitter. Silicon photodiodes are desirable for use with gallium arsenide diodes, because they have a maximum sensitivity in the infrared range. The data storage device controls by means of a Wheatstone bridge 79 a motor 80 in the manner described above. The motor 80 displaces the front lens element 64 of the objective assembly in an axial direction. For a feedback of the existing focus setting, the front lens element is connected to a variable resistance 81 of the bridge 79. Where a luminescent diode 73 is used, which emits light that would result in a response of the film, it is preferred to synchronize the light pulses with the operation of the shutter 68 of the camera, so that no light pulse will be emitted, unless the shutter 68 covers the exposure aperture. For this purpose, the switch consisting of the contact roller 70 and the stationary contacts 71 is included in the ignition circuit of the transmitter. Because the object space includes normally a large number of objects at different distances, an area is defined in the viewfinder in known manner, which corresponds to the measuring field of the rangefinder. The ignition switch 75 may be manually operable or may be automatically controlled at a certain pulse frequency, which may be adjustable, if desired. The size of the light-receiving areas of the photodiodes 77 is selected to match the range, in which the depth of field of the camera lens is most critical. This means that the object distance range corresponding to the width of the light-receiving surface must be smaller than the depth of field, when the camera is set to the most critical values of the focal length and stop. The use of luminescent diodes rather than a gas discharge lamp in the transmitter has the advantage that a relatively low fed voltage is sufficient. Besides, the dimensions of that transmitter element are much smaller than those of comparable other light sources, so that the formation of an exact image is particularly facilitated. Gallium arsenide diodes emit light, which has only a very small band width, so that it is virtually monochromatic, and this light is in the infrared range so that persons and animals in the object space will not become aware of the rangefinding operation. Reference is also made to the relatively high efficiency of gallium arsenide diodes and to the fact that they are highly suitable for pulsed operation.

In photographic and cinematographic operations it is often not necessary for the operator to know the absolute value of the

object distance. Automatic focusing is sometimes inconsistent with an optimum composition of the image. In this case apparatus may be employed and which is diagrammatically indicated in Fig. 7, which indicates to the user of the rangefinder, whether the object is disposed in the zone of depth of field of an objective assembly comprising a lens 82, Fig. 7, a focusing device 83, a zooming device 84 and means 85 for adjusting a diaphragm 86 associated with the lens. Devices for adjusting the setting of the components 82—86 are coupled to a depth-of-field calculator 87, which may consist of a mechanical calculating mechanism or an electric calculating circuit. The depth-of-field calculator 87 controls a pinion 88, which adjusts two racks 89 and 90 in opposite senses. Each of the two racks 89 and 90 carries a photodiode 91 and 92. The two photodiodes are so adjusted by the depth-of-field calculator 87 that they correspond respectively to the spaces disposed outside of the zone of depth of field. The photodiode 92 is associated with the space before the zone of depth of field and the photodiode 91 with the space which succeeds the zone of depth of field. The diode 91 or 92 will receive a light pulse during the measurement if the object is outside of the zone of depth of field. This deviation is indicated by suitable signalling means.

Fig. 8 shows a modification of the arrangement that has been described hereinbefore. The pinion 88 of the depth-of-field calculator 87 operates two racks 93, 94 to adjust two stop blades 95 and 96, which precede a photodiode 97 and a photoconductor, respectively. The stop blades 95 and 96 are so controlled that their edges correspond to the limits of the zone of depth of field. If the object is disposed outside the depth of field, an image of the light spot formed by the transmitter 73 on the object will be formed on the stop blade 95 or 96. A suitable alarm device can be operated, when the receiver fails to receive a signal.

In the arrangement of the optics of the transmitter and receiver as shown in Fig. 9, an image of a transmitter 100 is formed by a lens 101 on an object 102 to be measured. The image of the irradiated object is formed by a lens 103 on the receiver. To ensure the formation of sharp images of the particular objects, regardless of their distance, a plane 104 in which the transducers are disposed is inclined relative to the optical axis of the transmitter in accordance with Scheimpflug's conditions. The plane 104 is defined in known manner by the intersection 105 of the main plane of the lens of the receiver and the plane, which contains the several objects of which sharp images are to be formed. That plane thus includes the optical axis of the transmitter.

Where photoconductors are used as photo-

electric transducers, a large useful signal will be obtained, if each photoconductor is included in a voltage divider circuit, which comprises a second resistor that consists also of a photoconductor which receives light from the environment of the lens. Where non-linear photoelectric transducers are used, they will preferably be operated at their optimum operating points. To eliminate the influence of the illumination of the object by the ambient light, the receiver is preferably preceded by a dimmer, which is controlled by a photovoltaic cell, a photoconductor or the like and by which a diaphragm or a neutral wedge preceding the photoelectric transducer is adjusted so that the average of the luminous flux falling on the photoelectric transducers is constant. Such a dimmer may be designed like the automatic diaphragm control device, which is known in photographic and cinematographic cameras. Where the novel rangefinder is used in combination with photographic or cinematographic lenses, it will be desirable to arrange the receiver, to receive light passing through the lens, or to use reflecting means, whereby the light required for the receiver is deflected out of the path of light passing through the lens. If the receiver of the rangefinder or the beam-splitting mirror succeeds the diaphragms of the lens, the average quantity of the light, which is incident on the photoelectric transducer of the receiver will be constant regardless of the illumination of the object by the ambient light.

The invention is not restricted to the examples, which have been described hereinbefore. In addition to photography, cinematography and television, the invention may be used also for geodetic surveying instruments, as well as for sighting and tracking devices. Besides, the novel device may be used for a measurement of altitude in known instrument landing operations.

Various lasers may be used rather than the transmitters described hereinbefore, ruby lasers and CO₂ lasers being particularly desirable, because they have a favourable frequency range.

WHAT WE CLAIM IS:—

1. Range finding apparatus comprising a transmitter energizable to direct along a ranging axis a collimated beam of pulsed electromagnetic radiation produced by a pulsed radiation generator, a receiver having an optical system viewing the ranging axis from one side thereof and arranged to project towards radiation-sensitive transducing means an image of an object located on the ranging axis and irradiated by the beam, an arrangement providing an indication of the range from the transmitter of the object on said ranging axis from the displacement of the object image laterally from the optical axis of the optical system, and a unit operated by the arrange-

ment and providing data relating to the range to the user and/or equipment whose satisfactory operation is dependent on the range and which is associated with the apparatus.

2. Apparatus as claimed in Claim 1, in which the means are photo-sensitive.

3. Apparatus as claimed in Claim 1 or Claim 2, in which the arrangement includes a row of radiation-sensitive transducers forming said means and extending in a direction such that they are selectively irradiated at different object range zones along the axis, and electrical connections connecting respective transducers to the unit which is constructed as a storage.

4. Apparatus as claimed in Claim 3, in which the electrical connections includes pre-amplifiers.

5. Apparatus as claimed in Claim 3 or Claim 4, in which the electrical connections include differentiating elements.

6. Apparatus as claimed in Claim 5, in which the elements comprises capacitors.

7. Apparatus as claimed in any one of Claims 3 to 6, in which the connections respectively extend to bistable switches in the storage and which respond to an electrical output of an associated transducer according a threshold value by being switched from a first stable state to a second stable state.

8. Apparatus as claimed in claim 7, in which each transducer, the electrical connection associated with it and the associated bistable switch are formed as an integrated circuit.

9. Apparatus as claimed in claim 7 or claim 8, in which each bistable switch operates to connect one end of an electrical resistance chain to a unique tapping point in the chain, and the value held in the storage is a function of the electrical resistance of the chain portion which is not shunted out by operation of a switch.

10. Apparatus as claimed in claim 9, in which the chain is connected in one arm of an electrical measuring circuit.

11. Apparatus as claimed in claim 10, in which the measuring circuit is constructed as a bridge.

12. Apparatus as claimed in claim 11, in which the bridge includes a balancing resistor controlled by the setting of a focussing assembly of a camera objective which is adjusted by the value stored in the storage.

13. Apparatus as claimed in claim 12, in which the focussing assembly setting is adjusted by a motor which is mechanically coupled to the balancing resistor to alter its setting in a direction which restores the bridge balance, the motor being connected across one pair of diagonal terminals of the bridge which is energized by a voltage applied across the other pair of diagonal terminals.

14. Apparatus as claimed in claim 13, in which a differential amplifier circuit has input



electric transducers, a large useful signal will be obtained, if each photoconductor is included in a voltage divider circuit, which comprises a second resistor that consists also of a photoconductor which receives light from the environment of the lens. Where non-linear photoelectric transducers are used, they will preferably be operated at their optimum operating points. To eliminate the influence of the illumination of the object by the ambient light, the receiver is preferably preceded by a dimmer, which is controlled by a photo-voltaic cell, a photoconductor or the like and by which a diaphragm or a neutral wedge preceding the photoelectric transducer is adjusted so that the average of the luminous flux falling on the photoelectric transducers is constant. Such a dimmer may be designed like the automatic diaphragm control device, which is known in photographic and cinematographic cameras. Where the novel rangefinder is used in combination with photographic or cinematographic lenses, it will be desirable to arrange the receiver, to receive light passing through the lens, or to use reflecting means, whereby the light required for the receiver is deflected out of the path of light passing through the lens. If the receiver of the rangefinder or the beam-splitting mirror succeeds the diaphragms of the lens, the average quantity of the light, which is incident on the photoelectric transducer of the receiver will be constant regardless of the illumination of the object by the ambient light.

The invention is not restricted to the examples, which have been described hereinbefore. In addition to photography, cinematography and television, the invention may be used also for geodetic surveying instruments, as well as for sighting and tracking devices. Besides, the novel device may be used for a measurement of altitude in known instrument landing operations.

Various lasers may be used rather than the transmitters described hereinbefore, ruby lasers and CO₂ lasers being particularly desirable, because they have a favourable frequency range.

WHAT WE CLAIM IS:—

1. Range finding apparatus comprising a transmitter energizable to direct along a ranging axis a collimated beam of pulsed electromagnetic radiation produced by a pulsed radiation generator, a receiver having an optical system viewing the ranging axis from one side thereof and arranged to project towards radiation-sensitive transducing means an image of an object located on the ranging axis and irradiated by the beam, an arrangement providing an indication of the range from the transmitter of the object on said ranging axis from the displacement of the object image laterally from the optical axis of the optical system, and a unit operated by the arrange-

ment and providing data relating to the range to the user and/or equipment whose satisfactory operation is dependent on the range and which is associated with the apparatus.

2. Apparatus as claimed in Claim 1, in which the means are photo-sensitive.

3. Apparatus as claimed in Claim 1 or Claim 2, in which the arrangement includes a row of radiation-sensitive transducers forming said means and extending in a direction such that they are selectively irradiated at different object range zones along the axis, and electrical connections connecting respective transducers to the unit which is constructed as a storage.

4. Apparatus as claimed in Claim 3, in which the electrical connections includes pre-amplifiers.

5. Apparatus as claimed in Claim 3 or Claim 4, in which the electrical connections include differentiating elements.

6. Apparatus as claimed in Claim 5, in which the elements comprises capacitors.

7. Apparatus as claimed in any one of Claims 3 to 6, in which the connections respectively extend to bistable switches in the storage and which respond to an electrical output of an associated transducer according to a threshold value by being switched from a first stable state to a second stable state.

8. Apparatus as claimed in claim 7, in which each transducer, the electrical connection associated with it and the associated bistable switch are formed as an integrated circuit.

9. Apparatus as claimed in claim 7 or claim 8, in which each bistable switch operates to connect one end of an electrical resistance chain to a unique tapping point in the chain, and the value held in the storage is a function of the electrical resistance of the chain portion which is not shunted out by operation of a switch.

10. Apparatus as claimed in claim 9, in which the chain is connected in one arm of an electrical measuring circuit.

11. Apparatus as claimed in claim 10, in which the measuring circuit is constructed as a bridge.

12. Apparatus as claimed in claim 11, in which the bridge includes a balancing resistor controlled by the setting of a focussing assembly of a camera objective which is adjusted by the value stored in the storage.

13. Apparatus as claimed in claim 12, in which the focussing assembly setting is adjusted by a motor which is mechanically coupled to the balancing resistor to alter its setting in a direction which restores the bridge balance, the motor being connected across one pair of diagonal terminals of the bridge which is energized by a voltage applied across the other pair of diagonal terminals.

14. Apparatus as claimed in claim 13, in which a differential amplifier circuit has input

terminals connected to said one pair of bridge terminals and output terminals connected to the motor.

5 15. Apparatus as claimed in any one of the preceding claims 3 to 13, in which the value stored in the storage is displayed by a meter.

10 16. Apparatus as claimed in any of the preceding claims, mounted on a camera and having synchronizing equipment preventing operation of the transmitter while the camera shutter is open.

15 17. Apparatus as claimed in claim 16, having a focussing assembly for the camera objective and a source of current connectable through a switch to energize the transmitter simultaneously with or shortly after energization of the receiver, the switch opening the energization circuits of the transmitter and receiver when the setting of the focussing assembly agrees with a value stored in the unit which is constructed as a storage.

20 18. Apparatus as claimed in claim 1, constructed as a camera having an objective assembly and a depth of field calculator which computes from settings of a focussing device, a zooming device and a diaphragm adjusting device, a separation distance to be applied to two elements which are associated with said means and so control its response that in the event of the object not falling within the depth of field of the assembly, as determined by the settings of the devices, a warning indication is given by the unit.

35 19. Apparatus as claimed in claim 18, in which the two elements comprise stop blades separable across the active face of an irradiation-sensitive transducer by a distance depending, respectively, on the limits of the depth of field.

20. Apparatus as claimed in claim 19, in which the transducer is a photo-sensitive device having its active surface lying in the image plane of the receiver optical system, and the stop blades are moved in respective opposite senses by a rack-and-pinion drive from the calculator.

21. Apparatus as claimed in claim 18, in which the two elements respectively comprise separable members carrying radiation-sensitive transducers, respectively, which each responds to the incidence thereof of radiation from the optical system by initiating generation of said warning indication.

22. Apparatus as claimed in claim 21, in which the two elements respectively comprise photo-sensitive devices separable from one another by a rack-and-pinion drive from the calculator.

23. Apparatus as claimed in any of the preceding claims, in which the receiver optical system includes an optical filter for selective transmission of the radiation frequency of the transmitter beam.

24. Apparatus as claimed in claim 15, in which the transmitter comprises a second optical system for projecting a light beam generated by a pulsed semi-conductor, light-generating diode providing the radiation generator.

25. Apparatus as claimed in claim 24, in which the diode is a Gallium-Arsenide diode.

26. Apparatus as claimed in claim 1, arranged and adapted to operate substantially as described with reference to the accompanying drawings.

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