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(54) IMPROVEMENTS IN OR RELATING TO CINEMATOGRAPHIC CAMERAS

(71) We, CANON KABUSHIKI KAISHA, a Japanese Company, of No. 3–30–2, Shimomaruko, Ohta-ku, Tokyo, Japan, 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 cinematographic cameras, and more particularly to an intermittent film advance cinematographic camera having a circuit to control the operation thereof.

It is known to provide a cinematographic camera (cine camera) capable of performing not only "normal" motion picture operation but also special operations such as fade-in and fade-out effects. In conventional cinematographic cameras having such functions, use has been made of an analogue type of control circuit, the complexity of which tends to increase as the required number of specific operating modes is increased. Consequently, when manufacturing small-size cine-cameras, it has been impossible to provide as many operating modes as desired because of the limitations on space in the camera to accommodate the complex control circuits.

Attempts have been made to overcome the above-mentioned drawback of analogue control circuits by employing hard-wired logic circuits in constructing the control circuit. Such a digital type of control circuit, however, gives rise to another problem, that the number of hard-wired logic circuits necessary is increased with an increase in the number of operating modes, as each of the hard-wired logic circuits is designed to perform only one particular sequential operation corresponding to one of the operating modes. This is because it is impossible to pre-design a common circuit portion by which different operating modes can be selectively processed. Thus, the use of a digital circuit also leads to an increase in the complexity of circuit construction, and thus to the camera space required.

On the other hand, the mechanical construction of known cinematographic cameras capable of producing fade-in and fade-out effects is characterised by use of two rotatable shutter blades arranged to vary the relative position of their exposing cut-outs, a variation in the effective opening angle thereof being possible from zero up to a certain value, usually 150°. In a recently developed XL type of camera, however, the shutter opening angle has had to be extended to about 200° at the maximum, thereby making it impossible to have two shutter blades which can also be set to zero degrees of opening. To overcome this problem, one solution is to use three shutter blades arranged to define a single variable opening having a range of 0° to 200°. This proposal has, however, disadvantages such that the control mechanism for these three shutter blades becomes complicated in construction and that a completely different control method from that for two shutter blades must be made, to produce fade effects. As has been mentioned above, however, the control circuit of the camera is itself of the analogue or hard-wired logic type which is incapable of performing a sequential operation in fade-in and fade-out modes, because such operations exceed the capacity of the prior art control circuits.

The principal aim of the present invention is to provide a cinematographic camera which selectively can operate in any one of a number of modes and which employs a processing circuit.

According to this invention, there is provided an intermittent film advance cinematographic camera including: a film transport motor; a shutter for exposing a transported film; a shutter control mechanism co-operative with said film transport motor; a control circuit for controlling at least the driving and stopping operations of said motor; and a multimode processing circuit having a number of pre-programmed operating modes and arranged so as to control said control circuit in accordance with a manually-selected programme, thereby automatically to carry out a required mode of photographic exposing operation.

The programme is preferably stored in a memory circuit, which advantageously is a read-only memory.

It will be appreciated that with a cinematographic camera of this invention, various operating modes can selectively be carried out

using the same control circuit, for the control circuit itself is operated under the control of the programme. By providing the camera with an auxiliary shutter blade independently controllable to adjust the opening of the main shutter, yet more operating modes can be provided in a simple and convenient manner.

By way of example only, one specific embodiment of cinematographic camera constructed in accordance with this invention will now be described, reference being made to the accompanying drawings, in which:—

Figure 1 is a side elevational view of a cinematographic camera constructed in accordance with this invention;

Figure 2 is a perspective view of the camera of Figure 1 but partly broken away to show the arrangement of the basic parts within the camera casing;

Figure 3A is a front view of a shutter control mechanism for the main and auxiliary shutter blades shown in Figure 2;

Figure 3B is a fragmentary horizontal view, partly in section, of the internal construction of the mechanism shown in Figure 2;

Figure 3C is a longitudinal vertical view, partly in section, of the shutter control mechanism and an intermittent film advancing control mechanism shown in Figures 2 and 3A;

Figure 4 is a plan view of the main shutter blade, showing two different examples of arrangement of slits provided therein;

Figure 5A is a schematic electrical circuit diagram, partly in block form, of one embodiment of a control system for a cinematographic camera according to this invention;

Figure 5B is a detailed circuit diagram of part of the system of Figure 5A;

Figure 5C is a table in which the possible combinations of the switch positions of SW1 to SW21 of Figure 5A for various information settings are related to the corresponding combinations of four input signals entered into lines MBADATAØ-L to MBADATA3-L;

Figure 5D is a table in which the conditions of operation of the individual output devices of the camera are related to corresponding combinations of output signals appearing at respective lines MBDATAØ-L to 7-L;

Figure 5E is a table in which the reference numbers representing the individual devices are related to the symbols representing the individual programme instructions;

Figure 6 is a chart showing the co-ordination of operation of the main shutter blade, film pull-down claw and electromagnet 19 shown in Figures 2 and 3 with respect to the phase angle of the main shutter;

Figures 7(*a*), 7(*b*) and 7(*c*) are diagrams showing a process for variation of the shutter opening angle when in a fade-out mode;

Figure 7(*d*) is a diagram showing the variation of the shutter opening angle when in a diaphragm preselection automatic exposure mode;

Figures 8(*a*) and 8(*b*) are diagrams showing a process for increasing the shutter opening angle when in a fade-in mode;

Figures 9A, 9B and 9C are front views of the auxiliary shutter blade respectively in three successive operating positions relative to the picture aperture when in a wipe-in mode;

Figures 10A and 10B are similar views respectively at two successive operating positions when in a wipe-to-lap mode;

Figures 11 is a list of microprocessor instructions;

Figures 12—1 to 12—32 are lists of programme instructions as programmed in a ROM of the CPU in a microcomputer system shown in Figure 5A; and

Figures 13A to 13D are schematic electrical circuit diagrams, partly in block form, of the blocks AD, AD', EXT, LEVEL and MC shown in Figure 5B.

In Figure 1, there is shown a cinematographic camera having a housing 1 with a zoom objective lens barrel 2 attached to the front panel of the housing 1 and a manual release lever 6 extending forwardly of the front panel. On one side of the camera housing 1, there is shown a control panel having arranged thereon a plurality of control knobs including a main switch 5, a mode selecting dial 7, a frame speed selecting dial 8, a time data selecting dial 9 for selective control of a time interval or intervals such as a self-timer operation period, and a shutter opening angle data selecting dial 10. The mode selecting dial 7 is associated with a push button 7*a* arranged coaxially with the dial 7 and upon depression starts the performance of a programme for the selected mode. The time and angle selecting dials 9 and 10 are provided with respective data input push buttons 9*a* and 10*a* arranged coaxially with the dials 9 and 10 to effect entry of the selected data into the CPU, which will be described later. The push buttons 9*a* and 10*a* respectively carry a red and a blue light-emitting diode 9*b* and 10*b*. In order to clear the date entered by the push buttons 9*a* and 10*a*, there is provided a clear push button 11.

Referring to Figures 2 and 3, the internal construction of the camera of Figure 1 includes a first electrical motor or film motor 12 having an output shaft 12*a* transmitting the drive of the motor 12 through a suitable torque buffering spring 14 positioned around the shaft 12*a* to a pinion 13 rotatable on the shaft 12*a*. The pinion 13 drives, through an idler gear 15, a shutter gear 16 which has a main shutter blade 21 fixed on the front surface thereof. On the rear surface of the gear 16 is mounted a cam 16*a* for controlling the intermittent operation of a film driving pull-down plate 17 in front of an aperture 20. The pull-down plate 17 is guided for vertical movement by a pair of pins 41*a* and 41*b* extending from a frame structure 41 of the housing into respective slots provided in the pull-down plate 17 at upper and lower

positions thereof. Mounted on the pull-down plate 17 is a claw pin 17*a* arranged to be brought into driving engagement with one of the perforations of a photographic film 18 when an electromagnet 19 carried by the plate 17 is de-energised. When the electromagnet 19 is energised, an armature 19*a* is attracted against the force of a spring 19*b*, causing the pull-down claw pin 17*a* to be retracted from the perforations against the force of the spring 17*c*.

As shown in Figure 4, the main shutter blade is larger in radius than the drive gear 16 therefor by an amount sufficient to provide an annular zone in which thirty-six slits 21*a* are arranged in an equi-spaced relation, as designated by numerals 0 to 35. The radius of the central circular portion is sufficiently small to clear the aperture 20 (Figure 3A) when the phase of the main shutter blade is from 100 to 280° with respect to an index point A. The main shutter has an initial phase angle of zero degree in the illustrated position, where the slot 21*a* designated zero is placed in registry with the index point A. As the shutter is rotated from this position, each time a slit comes to registration with the index point A, the resulting phase angle is advanced 10° from the just-preceding one. For example, in Figure 4 the aperture starts to be opened when the shutter takes a phase angle of 60°. Then, the shutter continues to be fully open during the range of phase angles of 100° to 280°, and then is fully closed at a phase angle of 320°. This configuration of the main shutter blade, therefore, provides a shutter opening angle of 220°.

Referring again to Figures 2 and 3, in order to detect the angular phase of the aforesaid main shutter 21, there is provided a detector means 22 positioned in alignment with the ring of slits, to detect the 0 slit as the shutter 21 assumes the illustrated position in Figures 3A and 4. A second detector means 23 is provided so as to produce a pulse when the shutter 21 is rotated from the final phase angle to the initial phase angle (i.e. as shown in Figures 3 and 4). In order that the main shutter 21 can be stopped from further rotation in either of two discrete positions, namely, the aperture fully closed or fully open positions, there is provided an arresting means comprising an electromagnet 24 (Mg1), and an engaging shaft 24*a* operable by an armature 24*b* of the electromagnet 24 and arranged parallel to the axis of the idler gear 15 so as to be movable when the electromagnet is energised into selective engagement with either of two arcuate slots 15*a* and 15*b* provided in the idler gear 15. When de-energised, the engaging shaft 24*a* is retracted under the action of a spring 24*c* connected between the housing and the opposite end of the armature 24*b* to that carrying the engaging shaft 24*a*, thereby the engaging shaft 24*a* is disengaged from the slot 15*a* or 15*b* to permit rotation of the main shutter 21. It is of course possible to reverse the operation of the electromagnet 24 and spring with respect to the movement of the engaging shaft 24*a*, to effect an equivalent result to the above.

Drive from the first motor 12 (Figure 2) is also transmitted to a take-up reel of a film magazine 27 through a known slipping clutch and gear train, the latter comprising the pinion 13, the idler gear 15, a worm 15*c* coaxially connected to the idler gear 15 and meshing with a worm wheel 25, and a winding worm wheel 26 meshing with the wheel 25 and fixed on a shaft having an adapter piece (not shown) engageable with a hub (not shown) of the take-up reel of the film magazine 27.

There is provided a second electrical motor or capstan motor 28 having an output shaft on which a worm 30 is fixed. The worm 30 meshes with a worm wheel 29*a* affixed to a capstan 29 against which the film 18, having first and second magnetic sound recording tracks 18*b* and 18*c*, is pressed by a pinch roller 32. In order to detect the rotational phase of the capstan 29, there is provided a magnetic head 31 positioned adjacent the periphery of the worm wheel 29*a* so as to detect variation of magnetic resistance due to the displacement of the teeth of the wheel 29*a*. The pinch roller 32 drives the sound film 18, which has been driven intermittently by the pull-down plate 17, at a constant speed past the position of first and second magnetic recording heads 33*a* and 33*b*, located at a position corresponding to the first and second magnetic recording tracks 18*b* and 18*c*. The pinch roller 32 is pressed on the capstan 29 by electromagnet 34 (Mg3), when the electromagnet 34 is energised. Upon detection of a variation in the slack loop of the film 18 by a loop sensor 35, the speed of either of the first or the second motors 12 and 28 is controlled so as to compensate for the difference between the speed VI of the transport of the film 18 at a point under the sound recording heads 33*a* and 33*b* and the average speed V2 of intermittent advancement of the film 18 driven by the pull-down plate 17. The output of the sensor 35 thus controls the rotational rate of the film motor 12 or the capstan motor 28 so as to maintain a constant film loop under the driving condition. Third and fourth electrical motors for driving the zoom lens 2 and a diaphragm mechanism (not shown) are respectively indicated at 36 and 37.

An auxiliary shutter blade 39 is fixed on the output shaft of a fifth motor 38 which is, in this instance, of the pulse-controlled type (i.e. a stepping motor). The blade 39 has an effective area so configured as to be able fully to cover the aperture or partially to cover the aperture, or to leave the aperture fully uncovered, as shown in Figures 9 and 10. The movement of the blade, corresponding to rotation of the motor, is dependent on the number of pulses supplied to the motor. In order to stop movement of the blade 39 at the initial position for the fully open aperture 20,

there is provided a stop pin 40*a* fixed on the housing to the right of the blade 39 as viewed in Figure 3A. The leftward limit of movement of the blade 39 is controlled by another stop pin 40*b* arranged to be movable in an arcuate slot 101*c* by a linkage having an operating member (not shown) so that the blade 39 when driven into abutment therewith can be stopped either in a fully closed, or in a partly closed position. Instead of using a pulse motor as the fifth motor 38, use may be made of a D.C. motor or the like.

Figures 3A to 3C show the detailed construction of the main shutter and the auxiliary shutter. The electromagnet 24 is fixed to the frame structure 41 fixed to the camera body 1, the engaging shaft 24*a* being slidably supported for axial movement on supporting portion 41*a* and biased by the restoring spring 24*c* away from the idler gear 15. The armature 24*b* is connected to the engaging shaft with some degree of freedom and when the electromagnet is energised it drives the engaging shaft 24*a* against the force of the spring 24*c* to a position in which the shaft can engage with the holes 15*a* and 15*b* in the idler gear.

The electromagnet 19 is also fixed to the frame structure 41. The pull-down plate 17 is guided by the guide pins 41*b*, 41*c* fixed to the frame structure and is driven by the cam 16*a* so as to move up and down in the Y direction. A sleeve having a notched portion 17*b*1 and connected to the pull-down plate 17, slidably mounts the pin 17*a* for axial movement, this pin 17*a* being biased by a restoring spring 17*b* so as to engage with film perforations. The end 19*a*1 of the armature 19*a* of the electromagnet 19 is inserted into the notched portion 17*b*1 of the sleeve 17*b* to engage with the shouldered portion 17*a*1 of the pin 17*a*.

Referring to Figures 5A and 5B, one embodiment of a control circuit for a cinematographic camera according to the present invention is shown, and this includes a microcomputer SMP which may be for example that available from SORD Co. Ltd., under the trade name SMP80/20 and having a CPU (for example, 8080), for performing programmes which will be described in detail later. Various inputs and the control circuit section IOD for controlling the cine camera are shown, these being operatively connected to the microcomputer SMP through eight data bus lines MBADDØ-L to MBDATA7-L, eight address bus lines MBADDØ-L to MBADD7-L for addressing which devices are to receive or produce the output or input data respectively, and two data input and output control lines MB I/O RS-L and MB I/O WS-L at which respective signals of low level appear when data are to be introduced to and produced by the microcomputer SMP respectively. The outputs from a network of switches SW1 to SW21, controlled by a decoder CD40281, and some of the outputs from a binary counter CD4520 are selectively introduced into the data bus lines MBDATA Ø-L to MBDATA 3-L through a data selector CD4019 and through respective NAND gates NANDRO to NANDR3, the gating control input terminals of which are connected by way of a common lead to the signal output line MB I/O RS-L through a NAND gate NANDRS. The remaining outputs from the binary counter CD4520 are introduced to the remaining data input bus lines MBDATA 4-L to MBDATA 7-L through respective NAND gates NANDR4 to NANDR7 the gating control input terminals of which are also connected to the output terminal of NANDRS. The data output bus lines MBDATA Ø-L to MBDATA 7-L are connected through respective inverters IN1 to IN8 to the respective input terminals of six D-type flip-flops CD4035#10, CD4035#11, CD4013#12, CD4013#13, CD4013#14 and CD4013#15 the clock input terminals CL of which are connected to the respective output terminals of AND gates A#10 to A#14. One of the input terminals of the AND gates are connected to the respective output terminals 0 to 5 of the decoder CD40281, and their other input terminals are connected by way of a common lead to the output write signal line MB I/O WS-WS-L through an inverter IN17. The first three address bus lines MBADDØ-L to MBADD2-L are connected through respective inverters IN9 to IN11 to input terminals A, B and C of the decoder CD40281. The fourth terminal MBADD3-L is connected through inverters IN12 and INS1 to one input terminal of an AND gate ANDSR1 and also through inverter IN12 to one input terminal of an AND gate ANDSR2, the output terminals of these AND gates being connected to the data selector CD4019. The other input terminals of ANDSR1 and ANDSR2 are connected to the output terminal of an AND gate AND MB2 to which is also connected, through an inverter, an input terminal D of the decoder CD40281. ANDMB2 has two input terminals one of which is connected through an inverter IN13 to MBADD4-L and the other of which is connected to an output terminal of an AND gate ANDBM1. It is to be noted here that the symbols CD4019, CD40281, CD4013, CD4035 and CD452 are the type numbers of the corresponding integrated circuit devices available from the Radio Corporation of America (RCA).

The outputs Q0 to Q3 of CD4035#10 are connected to respective light-emitting diodes LED0 to LED3, and the outputs Q0 and Q1 of CD4013#13 are connected to respective light-emitting diodes LEDT and LEDD. The outputs Q0 to Q3 of CD4035#11 are connected at Q0 to an electronic switch for the electromagnet 24 (Mg1) of Figures 1 to 3, and at Q1 and Q2 to a control circuit for the film motor 12 (EM). This control circuit includes seven transistors TF1 to TF7 arranged so that when signals of high level appear at Q1 and Q2, TF1 and TF7 are turned on and therefore TF2,

TF3 and TF5 are turned off while TF4 and TF6 are turned on to drive the motor EM for forward rotation; when signals of high and low levels appear at Q1 and Q2 respectively, TF1 is turned on while TF7 is turned off, thus all the other transistors are turned off to stop the motor EM; and when signals of low level appear at Q1 and Q2, TFi and TF7 are turned off, then TF4 and TF6 are turned off, and then TF2, TF3 and TF5 are turned on to drive the motor EM for reverse rotation. The outputs Q0 and Q1 of CD4013#12 are connected to a control circuit PS-ILD-1 for the pulse motor 38 (PM), available from Japan Pulse Motor Co. Ltd. When high and low level signals appear at Q0 and Q1 respectively. PS-ILD-1 drives the motor PM for rotation in a counter-clockwise direction; when low and high level signals appear at Q0 and Q1 respectively, the direction of rotation is reversed; and when both signals are of low level, the drive is stopped.

A light-emitting diode LEDP1, a photo-transistor PT1 and a transistor TrP1 constitute the shutter phase detector means 22, while a light-emitting diode LEDP2, a photo-transistor PT2 and a transistor TrP2 constitute the initial shutter phase detector means 23. The outputs of these means 22 and 23 are connected respectively to clock and reset input terminals CLOCK and RESET of a binary counter CD4520. The first six outputs 0 to 5 of the binary counter CD4520 are selectively combined by a NOR gate NOR2, and two AND gates ANDD1 and ANDD2 to set and reset a flip-flop FF' by the outputs of ANDD1 and ANDD2 respectively. The output of FF' is connected to an electronic switch Tr for the electromagnet 19.

Switches SW1 and SW2 are arranged to co-operate with the aforementioned manual release lever 6 in such a manner that upon depression to a first release position, SW1 is turned on, and, upon further depression to a second position, SW2 is turned on while SW1 remains in the ON state. SW3 is turned on when the button 7*a* is pushed down. SW4 is turned on when the button 11 is pushed down. A combination of the switched positions of SW5 to SW8 is dependent upon the selected mode on the dial 7. A combination of the switched positions of SW9 to SW11 depends upon the selected frame frequency on the dial 8. A combination of the switched positions of SW12 to SW15 is dependent upon the selected time on the dial 9. A combination of the switched positions of SW16 to SW19 is dependent upon the selected shutter opening angle on the dial 10. SW20 and SW21 are turned on when the buttons 9*a* and 10*a* are pushed down respectively.

The first four NANDs R0 to R3 are selectively receptive of the outputs not only from SW1 to SW21 through the data selector CD4019 but also from AND gates AA1 to AA12 shown in Figure 5B. EXT is a light measuring circuit responsible to the level of brightness of a scene being photographed to produce an analogue output which is then converted to a digital output by an analogue-to-digital converter AD. The converter AD has four ouput terminals connected respectively to one of the inputs of AND gates AA1 to AA4, the other inputs of which being connected by way of a common lead to terminal 8 of the decoder CD40281. LEVEL is a circuit for producing a digital output representative of a predetermined constant and constructed from a number of switches as shown in Figure 13B. Circuit LEVEL has four output terminals connected respectively to one of the inputs of AND gates AA5 to AA8, the other inputs of which being connected by way of a common lead to terminal 9 of the decoder CD40281. Output terminal 10 of CD40281 is connected both to the set input S of a flip-flop FFL and to one input of each of the AND gates AA9 to AA12, the other inputs of which being connected respectively to the output terminals of an analogue-to-digital converter AD'. The input terminal of the converter AD' is connected to the common connection between a resistor and a capacitor C1, the output from the light measuring circuit EXT being supplied to the resistor. Connected across the capacitor C1 is a transistor Tra having its base connected to the output terminal $\bar{Q}$ of the flip-flop FFL. The reset terminal R of FFL is connected to the output terminal of a comparator MC having input terminals connected to LEVEL and AA9 to AA12.

An example of the light measuring circuit EXT is shown in Figure 13A. This includes a photo-cell SPCC such as SPC connected across two input terminals of an amplifier AmSP1, and a diode DSD connected in the feedback network of AmSP1, the parts SPCC, DSD and AmSP1 constituting a logarithmic converter. SvR is a variable resistor for setting film speed information. AmSP2 and AmSP3 are operational amplifiers connected in series with each other and with the logarithmic converter and SvR, so that the brightness information and the film speed information are combined to produce a light value.

An example of the A-to-D converter of Figure 5B is shown in Figure 13C, and includes a number of comparators COMPA, inverters IN, AND gates AND and an encoder ECD. The arrangement and construction of these components of a converter are known in the art as a parallel comparison AD converter. An example of the comparator circuit of Figure 5B is shown in Figure 13D, and includes Exclusive-OR and NOR gates constituting a coincidence detecting circuit, of known construction.

Before consideration is given to the operation of the cinematographic camera with the control circuit of the invention, a programme usable in this embodiment of the invention will be explained in connection with Figures 12–1 to 12–32 for the various sub-routines. The

instructions listed in Figures 12–1 to 12–32 are written in a read only memory (ROM) within the CPU, and the addresses of the instructions are advanced in the same order as the statement numbers in Figures 12–1 to 12–32. In this Specification, hexadecimal (hex) numbers are indicated by square brackets; viz hexadecimal 06 is shown by [06]. In the drawings, however, such numbers are indicated by a 'hash'; viz hexadecimal 06 is shown as #06.

** Start sub-routine **

This sub-routine covers Statements Nos. 501 to 504 inclusive.

MVI A, [06] : Transfer a digital value representative of [06] to the accumulator.

OUT CONT 1 : Write on the address lines MBADDs Ø-L to 7-L a digital value representative of [11].

Hence, MBADD lines Ø-L and 4-L only become low with a high level output at terminal 1 of the decoder CD40281, and line MB I/O WS-L becomes low. This causes and AND gate A#11 to go high so that a pulse is applied to the clock terminal of the D-type flip-flop CD4035#11. At the same time, the content [06] of the accumulator is fed to the data lines MBDATAs Ø-L to 7-L with the result that only lines 1-L and 2-L become low to apply high signals to the input terminals P1 and P2 of the D-type flip-flop CD4035#11. Therefore, an output appearing at the terminals Q1 and Q2 of CD4035#11 actuates the film motor 12 (EM) for forward drive rotation.

** Stop Sub-routine **

This sub-routine covers statements Nos. 505 to 511.

MVI A,[03] : Transfer a digital value representative of [03] to the accumulator.

OUT CONT1 : Likewise as in the start sub-routine, a pulse is applied to the clock terminal of the D-type flip-flop CD4035#11, and also the content [03] of the accumulator is fed to the data lines with only Ø-L and 1-L going low to apply high level signals to the input terminals P0, P1 of CD4035#11, with the result that an output appearing at terminals Q0 and Q1 energises the electromagnet 24 and also stops the motor 12.

CALL MS5 : Perform a sub-routine MS5, to be described later, so that the aforesaid state is maintained for 5 milliseconds.

MV1 A, [02] : Transfer a digital value representative of [02] to the accumulator.

OUT CONT1 : Likewise as in the start sub-routine, a pulse is applied to the clock terminal of CD4035#11, and the content [02] of the accumulator is fed to the data lines with only 1-L going low to apply a high level signal to the input terminal P1 of CD4035#11 with the result that an output appearing at only terminal Q1 maintains the motor 12 stopped and de-energises the electro-magnet 24.

Thus, the motor 12 gets stopped and maintained in this state, while the electromagnet 24 is supplied with a current for 5 milliseconds to actuate the plunger 24*a*, to arrest the rotating shutter. After the motor 12 and the main shutter blade 21 have been stopped, the electromagnet 24 is again de-energised to save an electrical energy consumption, which otherwise would wastefully be used.

** Reverse Sub-routine **

This sub-routine covers statements Nos. 512 to 515.

MVI A,[00] : Transfer a digital value representative of [00] to the accumulator.

OUT CONT1 : Likewise as in the start sub-routine, a pulse is applied to the clock terminal of CD4035#11, and the content [00] of the accumulator is fed to the data lines. As all the data lines go high, all the input signals to CD4035#11 are low, and all the levels appearing at terminals Q0 to Q2 are low with the result that the motor 12 is driven for rotation in a reverse direction.

** Pulse Motor Open (PMO) Sub-routine **

This sub-routine covers statements Nos. 516 to 519.

MVI A,[10] : Transfer the digital value representative of [10] to the accumulator.

OUT CONT2 : Produce the digital output representative of [12] to the address lines MBADDs Ø-L to 7-L, so only 1-L and 4-L become low to apply a signal of high level to the input terminal B of the decoder CD40281. Thus only output terminal 2 of CD40281 produces a high level output signal and this is applied to one of the input terminals of the AND gate A#12. On the other hand, MB I/O Ws-L goes low so that the inverter IN17 produces a high level signal which is then applied to the other input terminal of A#12. The output of A 12 therefore goes high, applying a clock pulse to the D-type flip-flop CD4013#12. Further, the content of the accumulator, that is, [10] is fed to the data lines MBDATAs Ø-L to 7-L with only the 4-L line going low, to apply a high level signal from the inverter IN5 to the input terminal P0 of CD4013#12, which in turn produces a high level signal at the terminal Q0 thereof. This signal is fed to the input terminal Q0 of the pulse motor control circuit PS-ILD-1, thereby the pulse motor 38 is driven by one step in a counter-clockwise direction.

As the auxiliary shutter 39 is left in an operative position where the aperture is fully closed, said one step of the pulse motor 38 causes the auxiliary shutter 39 to be moved to an operative position where the aperture 20 is uncovered laterally by one half of the aperture area thereof, as shown in Figure 9B. Upon a further step of the pulse motor 38 in the same direction, the aperture is fully opened, as shown in Figure 9C.

** Pulse Motor Close (PMC) Sub-routine **

This sub-routine covers statements Nos. 520 to 523.

MVI A,[20] : Transfer the digital value representative of [20] to the accumulator.

OUT CONT2 : Likewise as in the PMO sub-

routine, CD4013#12 is given one clock pulse, while the content [20] of the accumulator is fed to the data lines so only the 5-L line goes low. A high level signal is transmitted by IN6 to the P1 output terminal of CD4013#12 which in turn produces a high level signal at the output terminal Q1. As a result, low and high level signals are applied to the input terminals Q0 and Q1 of the pulse motor control circuit PS-ILD-1 respectively, thereby causing the pulse motor 38 to rotate one step in a clockwise direction.

As the auxiliary shutter 39 is initially set in a position where the aperture 20 is fully open as shown in Figure 9C, said one step of the pulse motor 38 causes the auxiliary shutter 39 to cover one half the area of the aperture 20. A further one step of the pulse motor 38 results in the entire closure of the aperture 20.

** Pulse Motor Stop (PMSTOP) Sub-routine **

This sub-routine covers statements Nos. 524 to 527.

MVI A,[00] : Transfer the digital value representative of [00] to the accumulator.

OUT CONT2 : Likewise as in the PMO sub-routine, CD4013#12 is addressed, while the content [00] of the accumulator is fed to the data lines. As all the data lines become high, all the outputs of IN1 to IN8 go low, so that CD4013#12 produces low level output signals at Q0 and Q1, which are applied to the input terminals Q0 and Q1 of the pulse motor control circuit PS-ILD-1 to terminate the driving of the pulse motor 38.

** Pulse Motor Open Set (PMOST) Sub-routine **

This sub-routine covers statements Nos. 529 to 537.

MVI B,3 : Transfer the digital value representative of decimal 3 to B register.

MVI A,[10] : Transfer the digital value representative of [10] to the accumulator.

OUT CONT2 : Likewise as in the PMO sub-routine, CD4013#12 is addressed, while the content [10] of the accumulator is fed to the data line so that the pulse motor 38 is rotated one step in the counter-clockwise direction.

CALL MS05 : Perform a MS05 sub-routine, which will be described later, to maintain the aforesaid state for 0.5 millisecond.

CALL PMSTOP : Perform the aforementioned PMSTOP sub-routine to stop the pulse motor 38.

CALL MS5 : Perform a MS5 sub-routine, to be described later, to maintain the aforesaid state for 5 milliseconds.

DCR B : Subtract 1 from the content of the B register. Thereafter, the content of B register becomes 2. By such substraction, all the condition flip-flops, except the carry, are affected.

JNZ PMOST1 : Jump to an address denoted by the branch name PMOST1 when the aforesaid DCR B results in that the zero flip-flop is 0. As the aforesaid DCR B leads to the B register having a content 2, the zero flip-flop is 0 so that a jump to the address denoted by PMOST1 is effected, to perform again the aforesaid programme. The B register becomes 0 and thus the zero flip-flop changes state when the aforesaid programme has been repeated 3 times, and thus the pulse motor 38 is caused to perform three steps in the same counter-clockwise direction; the auxiliary shutter is set in this way to the initial position where the aperture is fully open.

** Pulse Motor Close Set (PMCST) Sub-routine **

This sub-routine covers statements Nos. 538 to 547.

MVI B,3 : Transfer the digital value representative of decimal 3 to the B register.

MVI A,[20] : Transfer a digital value representative of [20] to the accumulator.

OUT CONT2 : Perform the programme of the PMC sub-routine together with the aforementioned MVI A,[20] to result in one clockwise step of the pulse motor 38.

CALL MS05 : Perform the MS05 sub routine to maintain the aforesaid state for 0.5 millisecond.

CALL PMSTOP : Perform the PMSTOP sub-routine to stop the pulse motor 38.

CALL MS5 : Perform the MS5 sub-routine to maintain the aforesaid state for 5 milliseconds.

DCR B : Subtract 1 from the content of the B register, as in the PMOST sub-routine.

JNZ PMCST1 : jump to the address denoted by the branch name PMCST1 except when the content of the B register is 0, thereby to perform again aforesaid programme.

In this way, the pulse motor 38 is driven three steps in the clockwise direction to set the auxiliary shutter in the aperture-closed position.

** Display Sub-routine **

This sub-routine covers statements Nos. 548 to 551.

MOV A,E : Transfer the content of the E register to the accumulator.

OUT DISP1 : Produce to the address lines MBADDs Ø-L to 7-L the digital output representative of [10]. As only the 4-L line goes low, all the inputs A to D of the decoder CD40281 become low so that only output terminal 0 of CD40281 produces a high level signal, which is applied to one of the input terminals of the AND gate A#10, to the other input terminal of which is applied a high level signal from IN17 because a low level signal is applied to IN17 from MB I/O WS-L. The output of A#10 is applied to the clock terminal ofthe D-type flip-flop CD4035#10. On the other hand, the content of the accumulator is transmitted through the data lines to the input terminals P0 to P3 of CD4035#10, with the resulting output signals from the terminals Q0 to Q3 of CD4035#10 depending upon the content of the accumulator and being displayed by the light-emitting diodes LEDs 0 to 3 respectively.

** Time Set (TSET) Sub-routine **

This sub-routine covers statements Nos. 562 to 572.

MVI A,[40] : Transfer the digital value representative of [40] to the accumulator.

OUT DISP2 : Produce the digital output representative of [13] to the address lines MBADDs Ø-L to 7-L. As only Ø-L, 1-L and 4-L become low, CD40281 receives high level signals at the input terminals A and B, and then produces a high level output signal at 3 which is applied to the AND gate A#13 to one input terminal thereof. To the other input terminal of A#13 is applied a high level signal from IN17, as a low level signal is applied thereto from MB I/O WS-L. The output of A#13 is applied to the clock terminal of the D-type flip-flop CD4013#13. On the other hand, the content [40] of the accumulator is fed to the data lines, so only 6-L becomes low. This signal, after being inverted, is applied to the input terminal P0 of CD4013#13, which in turn produces an output at Q0, thereby illuminating the light-emitting diode LEDT.

CALL MS500 : Perform sub-routine MS500, which will be described later, to maintain LEDT illuminated for 500 milliseconds.

MVI A,[00] : Transfer the digital value representative of [00] to the accumulator.

OUT DISP2 : Likewise as in the aforementioned OUT DISP2, a high level signal is applied to the clock terminal of CD4013#13, while the content of the accumulator is fed to the data lines. As the content of the accumulator is [00], all the data lines go high with the application of low level signals to both of the input terminals P0 and P1 of CD4013#13, thereby turning off the light-emitting diode LEDT;

CALL MS500 : Perform sub-routine MS500, to be described later, so that LEDT is turned off for 500 milliseconds.

IN DATASET : Produce to the address lines the digital value representative of [15]. As only 4-L, 2-L and Ø-L lines go low, the decoder CD40281 receives through IN9 and IN11 high level signals at its input terminals A and C, and then produces a high level signal at the output terminal 5. On the other hand, MB I/O RS-L goes low, causing the NANDRS gate to produce a high level signal which is applied to one input terminal of each NAND gates NANDR0 to NANDR7. At this time, as the address lines Ø-L, 2-L and 4-L provide low level signals, and the output of the ANDMB1 gate is applied to one input terminal of the AND gate ANDMB2, the ANDMB2 produces a high level output which is applied to one terminal of each of ANDSR1 and ANDSR2. As the other input terminal of ANDSR1 is connected through the inverter INS1 to the address line 3-L, only ANDSR1 produces a high output. For this reason, a high level signal is applied to input terminal Ka of the data selector CD4019, so that only signals appearing at the input terminals A1 to A4 of the selector are permitted to enter the NANDs NANDR0 to NANDR7. On the other hand, at only output terminal 5 of the decoder CD40281 there appears a high level output, so that a digital value, depending upon the switched positions of the data setting switches SW20 and SW21, are selected for entry through the data input terminals A4 and A3 to the accumulator. As mentioned before, when the push button 9*a* is depressed, SW20 in closed, causing NANDR0 to produce a low level signal and causing the other NANDs to produce high level signals. In this way, a digital value representative of [01] enters the accumulator.

CPI [01] Compare the content of the accumulator with [01]. When the content of the accumulator is coincident with [01], the zero flip-flop is set. Now assuming that the push button 9*a* was depressed, the content of the accumulator was [01] and thus CPI [01] leads to the setting of the zero flip-flop.

JNZ TSET : Jump to the address denoted by the branch name TSET when the zero flip-flop is not set. When the push button 9*a* was depressed, the zero fli-flop is set. Thus, with sub-routine comes to end.

In conclusion, the light-emitting diode LEDT continues to flash until the push button 9*a* is depressed to set a desired time value selected on dial 9.

** Degree Set (DEGSET) Sub-routine **

This sub-routine covers statements Nos. 573 to 582.

MVI A,[80] : Transfer the digital value representative of [80] to the accumulator.

OUT DISP2 : Likewise as in the aforementioned TSET sub-routine, a high level signal is applied to the clock terminal of CD4013#13, while the content [80] of the accumulator is fed to the data lines. As only 7-L data line goes low, CD4013#13 receives a high level input signal at the input terminal P1 and then illuminates the light-emitting diode LEDD.

CALL MS500 : Perform sub-routine MS500, to be described later, to maintain LEDD illuminated for 500 milliseconds.

MVI A,[00] : Transfer the digital value representative of [00] to the accumulator.

OUT DISP2 : Likewise as in the aforementioned OUT DISP2, the light-emitting diode LEDD is turned off.

CALL MS500 : Perform sub-routine MS500 to maintain the LEDD turned off for 500 milliseconds.

IN DATASET : Likewise as in the aforementioned TSET sub-routine, a digital value dependent upon the switched positions of SW20 and SW21 are transmitted through the input terminals A4 and A3 of the selector CD4019 and the NAND gates to the accumulator. When the push button 10*a* is depressed to close SW21, only data line 1-L goes low and thus the digital value representative of [02] enters the accumulator.

CPI [02] : Compare the content of the accumulator [02]. Likewise as in the aforemen-

tioned CPI instruction, the conditions of the zero flip-flop is determined. If the push button 10*a* was depressed, the zero flip-flop is set.

JNZ DEGSET : Terminate operation of this sub-routine when the zero flip-flop is set; otherwise, jump to the address corresponding to branch DEGSET. In this way, the light-emitting diode LEDD continues to flash until the push button 10*a* is depressed.

** Time One Set (T1SET) Sub-routine **

This sub-routine covers statements Nos. 603 to 613.

CALL TSET : Perform the aforementioned TSET sub-routine to flash LEDT until the push button 9*a* is depressed. Upon depression of the push button 9*a*, the following instructions are performed.

IN TIME : Provide the digital value representative of [13] to the address lines, so only Ø-L, 1-L and 4-L go low. As IN9 and IN10 produce high level signals which are applied to the input terminals A and B of the decoder CD40281, only at output terminal 3 of CD40281 is a high level signal for selection of SWs 12 to 15. As IN13 produces a high level signal which is transmitted through ANDMB2 and ANDSR1 to the input terminal Ka of the selector CD4019, and MB I/O RS-L produces a low level signal which, after being inverted by NANDRS, is applied to NANDR0 and NANDR3 and a digital value dependent upon the switched positions of SWs 12 to 15 and representative of a desired value of time selected by the dial 9, are transferred through the selector CD4019 and NANDR0 to NANDR3 to the accumulator.

DCR A : Subtract the digital value representative of decimal 1 from the content of the accumulator.

MOV B,A : Transfer the content of the accumulator to B register.

MVI A,[01] : Transfer the digital value representative of [01] to the accumulator.

RLC : Shift the content of the accumulator left one bit. As the accumulator contained the digital value representative of [01], the resulting new content of the accumulator is the digital value representative of [02].

DCR B : Subtract the digital value representative of a decimal 1 from the content of the accumulator.

JNZ T1SET1 : Proceed to the following instructions when the DCR B results in setting the zero flip-flop, otherwise jump to the address denoted by the branch T1SET1.

Hence, the subtraction of 1 from the time data selected by the dial 9 is repeated until the time data become zero, and therefore [01] is shifted to left by the number of repetitions. For example, let us now assume that the dial 9 was operated to select 1 second, [04] enters the accumulator as can be seen from Figure 5C. By DCR A, [03] can be obtained. The number of times by which the subtraction of [01] from [03] is repeated until [00] results is three so that the content of the accumulator – that is, [01] – is shifted left three bits: the resulting content is [08] which, in the following step MOV H,A is transferred to a H register. In this way, when a time interval of 1 second is set, this time information is stored in the form of a digital value representative of [08] in the H register. In other words, in this embodiment of the present invention, [01] provides 125 milliseconds, so that [08] provides 125 x 8 = 1000 milliseconds. In general, if a time data in question is X, the content of the H register is in the form of 125xX.

** Time One and Two Set (T12SET) Sub-routine **

This sub-routine covers statements Nos. 583 to 602. CALL TSET; IN TIME; DCR A; MOV B,A; MVI A,[01]; RLC; DCR B; JNZ T12SET; and MOV H,A are performed so that the first set time information is stored in the H register, as in the aforementioned sub-routine T1SET. In the next place, CALL TSET; IN TIME; DCR A; MOV B,A; MVI A,[01]; RLC; DCR B; JNZ T12SET2 are performed to process the subsequently set time information, as in the aforementioned T1SET sub-routine. By MOV L,A, the content of the accumulator resulting from the processing of the time information is transferred to a L register. In conclusion, when two values of time are required for a single operating mode, a first required value of time is stored in the H register, while the second required value of time is stored in the L register.

** Degree One and Two Set (D12SET) Sub-routine **

This sub-routine covers statements Nos. 614 to 620.

CALL D1SET : Perform sub-routine D1SET (Degree One Set).

** Degree One Set (D1SET) Sub-routine **

This sub-rotuine covers statements Nos. 621 to 628.

CALL DEGSET : Perform the aforesaid DEGSET sub-routine with the result that the light-emitting diode LEDD is flashed until the push button 10*a* is depressed.

IN DEG : Provide the digital value representative of [14] to the address lines, so only 2-L and 4-L go low. The inverters IN11 produces a high level signal which is applied to the input terminal C of the decoder CD40281, giving a high level output at terminal 4 only of CD40281, for selection of the angular degree setting switches SWs 16 to 19. The inverter IN13 produces a high level signal which is applied to one input of ANDMB2, the other input receiving a high level signal from ANDMB1. ANDMB2 then produces a high level signal which is applied to ANDSR1 and ANDSR2. As the 3-L line is high, only ANDSR1 produces an output which is applied to the input terminal Ka of the selector CD4019, so that the input terminals A1 to A4 are gated on, while MB I/O RS-L produces a

low level signal which is converted by NANDRS to a high level signal, gating on NANDR0 to NANDR7. Thus, a digital value output representative of a desired value of shutter opening angle, selected by the dial 10 and dependent upon the switched positions of SWs 16 to 19, is transmitted through the data lines to the accumulator.

CPI [00] : Compare the content of the accumulator with the digital value representative of [00]. If the content of the accumulator is coincident with [00], the zero flip-flop is set; i.e. to binary state "1". Such a situation occurs only when the dial 10 is set in a position for the "Auto" mode, as can be seen from Figure 5C.

JN AA : Jump to the address denoted by branch AA when the zero flip-flop is set, otherwise perform the following instructions. Thus, except for the "Auto" mode, the following instructions are performed.

CALL DEGA : Perform sub-routine DEGA.

** Degree A (DEGA) Sub-routine **

This sub-routine covers statements Nos. 629 to 653.

CPI [01] : Compare the content of the accumulator with [01]. If the content of the accumulator is coincident with [01], the zero flip-flop is set to "1".

JZ A5 : Jump to the address denoted by branch A5 when the zero flip-flop is set to "1"; otherwise perform the following instructions.

CPI [02] : Compare the content of the accumulator with [02]. Upon coincidence, set the zero flip-flop to "1".

JZ A7 : Jump to the address denoted by branch A7 when the zero flip-flop is set to "1"; otherwise perform the following instructions.

CPI [03] : Compare the content of the accumulator with [03]. Upon coincidence, set the zero flip-flop to "1".

JZ A9 : Jump to the address denoted by branch A9 when the CPI [03] results in the setting of the zero flip-flop to "1"; otherwise perform the following instructions.

CPI [04] : Compare the content of the accumulator with [04]. Upon coincidence, set the zero flip-flop to "1".

JZ A11 : Jump to the address denoted by branch A11 when the CPI [04] results in the setting of the zero flip-flop to "1"; otherwise perform the following instructions.

CPI [05] : Compare the content of the accumulator with [05]. Upon coincidence, set the zero flip-flop to "1".

JZ A13 : Jump to the address denoted by branch A13 when the CPI [05] results in the setting of the zero flip-flop to "1"; otherwise perform the following instructions.

CPI [06] : Compare the content of the accumulator with [06]; Upon coincidence, set the zero flip-flop to "1".

JZ A15 : Jump to the address denoted by branch A15 when the CPI [06] results in the setting of the zero flip-flop to "1"; otherwise perform the following instructions.

CPI [07] : Compare the content of the accumulator with [07]. Upon coincidence, set the zero flip-flop to "1".

JZ A17 : Jump to the address denoted by branch A17 when the CPI [07] results in the setting of the zero flip-flop to "1"; otherwise perform the following instructions.

CPI [08] : Compare the accumulator with [08]. Upon coincidence, set the zero flip-flop to "1".

JZ A19 : Jump to the address denoted by branch A19 when the CPI [08] results in the setting of the zero flip-flop to "1"; otherwise perform the following instructions.

CPI [09] : Compare the content of the accumulator with [09]. Upon coincidence, set the zero flip=flop to "1".

JZ A21 : Jump to the address denoted by branch A21 when the CPI [09] results in the setting of the zero flip-flop to "1"; otherwise perform the following instructions.

CPI [0A] : Compare the content of the accumulator with [0A]. Upon coincidence, set the zero flip-flop to "1".

JZ A23 : Jump to the address denoted by branch A23 when the CPI [0A] results in the setting of the zero flip-flop to "1"; otherwise perform the following instructions.

CPI [0B] : Compare the content of the accumulator with [0B]. Upon coincidence, set the zero flip-flop to "1".

JZ A25 : Jump to the address denoted by branch A25 when the CPI [0B] results in the setting of the zero flip-flop to "1"; otherwise perform the following instructions.

MVI A,27 : Transfer the digital value representative of decimal 27 to the accumulator.

The DEGA sub-routine achieves the entry of the shutter opening angle data in the form of hexadecimal numbers selectively into the accumulator and the performance of the programme of the selected one of the addresses denoted by the branch A5, A7, A9, A11, A13, A15, A17, A19, A21, A23 and A25, which depend upon the selected angle data. The programme of the various branches are:

A5: MVI A,5; JMP DEGA1
A7: MVI A,7; JMP DEGA1
A9: MVI A,9; JMP DEGA1
A11: MVI A,11; JMP DEGA1
A13: MVI A,13; JMP DEGA1
A15: MVI A,15; JMP DEGA1
A17: MVI A,17; JMP DEGA1
A19; MVI A,19; JMP DEGA1
A21: MVI A,21; JMP DEGA1
A23: MVI A,23; JMP DEGA1
A25: MVI A,25; JMP DEGA1

The MVI instruction transfers to the accumulator a digital value representative of the same decimal number as the numeral given to the branch, and is followed by the JMP instruction to jump to the address denoted by the branch DEGA1. Hence, stored in the accumu-

lator is the digital value representative of a decimal number corresponding to the selected shutter opening angle, and then the programme of the address denoted by the branch DEGA1 is performed. As the DEGA1 instruction is identical to a RET (Return) instruction of the DEGA sub-routine, the CALL DEGA instruction is followed by the STA DEG1M instruction.

** Degree One Set (D1SET) Sub-routine ** (Continued)

STA DEG1M : Store the content of the accumulator in a first memory area addressed by [41F1].

RET : Return to the CALL DEGSET instruction preceded by the CALL D1SET of the D12SET sub-routine.

** D12SET Sub-routine ** (Continued)

The CALL DEGSET instruction is followed by IN DEG and CALL DEGA instructions in sequence with the result that the light-emitting diode LEDD is flashed until the push button 10*a* is depressed as in the aforementioned D1SET sub-routine. Upon depression of the push button 10*a*, the selected angle data enters the accumulator.

STA DEG2M : Store the content of the accumulator in a second memory area addressed by [41F2].

Hence, the first selected opening angle data is stored in the first memory area addressed by [41F1], and the subsequently selected opening angle data is stored in the second memory area addressed by [41F2]. Thus, data of two opening angles are recorded.

** Time One (T1) Sub-routine **

This sub-routine covers statements Nos. 552 to 556.

MOV B,H : Transfer the content of the H register to the B register.

CALL MS125 : Perform sub-routine MS125, which will be described later, to provide a time interval of 125 milliseconds.

DCR B : Subtract the digital value representative of decimal 1 from the content of the B register. As the time data X is set in the form of 125X 9y the T1SET sub-routine, this instruction performs a calculation defined by X-1. At the time when the content of the B register becomes zero, therefore, the duration of a time interval corresponding to the selected time data is terminated.

JNZ T1 : Jump to the address denoted by branch T1 when the zero flip-flop has not yet been set to "1". When the DCR B results in the occurrence of zero in the content of B register, the zero flip-flop is set to "1", so as to proceed to the following instruction.

In consequence, by the number of times necessary to reduce the content of the B register to zero, the MS125 sub-routine is repeated to provide a time interval equal to 125 times the content of the B register, in milliseconds. For example, when [08] – representative of one second – was stored in the B register, the DCR B instructed is repeated eight times to obtain one second, based on the formula 125 x 8 = 1000 milliseconds.

** Time Two (T2) Sub-routine **

This sub-routine covers statements Nos. 557 to 561.

MOV B,L : Transfer the content of the L register to the B register.

The subsequent procedure is similar to that of the T1 sub-routine. The time is produced on the basis of the time data memorized in the L register.

** Shutter Sub-routine **

This sub-routine covers statements Nos. 471 to 500.

IN PHASE : Provide a digital output representative of [18] to the address lines, so only 4-L and 3-L go low. Inverter IN12 produces a signal of binary level "1" which is applied to ANDSR2, and at the input terminal Kb of the selector CD4019 a signal of level "1" appears so that digital information appearing at the B input terminals of CD4019 is permitted to pass therethrough; that is, the output of the binary counter CD4520 is selected to enter the accumulator of the CPU.

The binary counter CD4520 is operated to count the number of pulses supplied from the light-emitting diode LEDP1, a pulse being generated each time a slit of the main shutter blade 21 comes into alignment therewith. Therefore, the number of pulses counted by CD4520 represents the phase angle of the shutter 21 and is written in the accumulator by the IN PHASE instruction. The main shutter blade 21 is provided with thirty six slots angularly spaced by 10°. As the counting starts from the time when a pulse is applied from the resetting circuit 23 to the RESET terminal of the binary counter CD4520, the phase angle from the initial position can be determined by multiplying the number of pulses counted by a factor of 10.

CPI [00] : Subtract [00] from the content of the accumulator. If the result is zero, the zero flip-flop is set to "1".

JNZ SHUTTER : Jump to the address denoted by branch SHUTTER except when the CPI [00] results in the setting of the zero flip-flop to "1". If such setting occurs, the following address instruction is performed.

Until the zero flip-flop is set to "1", therefore, the procedure comdrising the steps IN PHASE; CPI [00] and JNZ SHUTTER repeats. Upon occurrence of zero in the CPI [00] step – that is, upon attainment of the initial phase angle of the shutter shown in Figure 4 – the photo-diode PT2 receives light from the light-emitting diode LEDP2 of Figure 5A to produce a pulse which is applied to the RESET terminal of CD4520. Only when the resetting of CD4520 is established, the following MVI B,2 instruction gets performed. Before the shutter arrives at the initial position, therefore, the performance of the subsequent programme is inhibited from starting.

MVI B,2 : Transfer the digital value representative of decimal 2 to the B register when the shutter has reached the initial position as shown in Figure 4.

IN PHASE : Detect the actual phase angle of the shutter as in the aforesaid IN PHASE instruction.

ANI [01] : AND the content of the accumulator with [01]. If the content of the accumulator is an odd number, the zero flip-flop is prevented from being set to "1".

JZ STR1 : Jump to the address denoted by branch SRT1 when the aforesaid ANI [01] step results in the setting of the zero flip-flop to "1"; otherwise perform the following address instruction.

For this reason, only when the content of the accumulator is an odd number, the following address instruction gets performed. When the content is an even number, the steps of IN PHASE, ANI [01] and JN STR1 are repeated. In other words, after the phase of the shutter is set to "0", the programme of the address corresponding to the statement No. 474 and those that follow is performed. Until the shutter rotates 10° from the initial position to effect application of one pulse to the binary counter CD4520, the performance of the following programme is inhibited from starting. After the shutter has rotated 10°, the following programme is performed.

CALL PMC : Call the aforementioned PMC sub-routine and perform this sub-routine with the result that the auxiliary shutter is turned in such a direction as to close the aperture as the pulse motor is moved one step.

IN PHASE : Introduce the actual phase of the shutter into the accumulator as in the aforementioned IN PHASE.

ANI [01] : AND the content of the accumulator with [01] as in the aforesaid ANI [01]. When the content of the accumulator is an even number, the zero flip-flop is set to "1". This occurs after the phase of the shutter has advanced from 10° to 20°.

JNZ STR2 : Jump to the address denoted by branch STR2 when the zero flip-flop has not yet been set to "1"; otherwise perform the following address instruction.

Until the shutter advances 20° in phase, therefore, IN PHASE; ANI [01]; and JNZ STR2 are repeatedly performed. Upon advancement to 20°, CALL PMSTOP is performed.

CALL PMSTOP : Perform the aforementioned PMSTOP sub-routine with the result that the energisation of the pulse motor is stopped.

DCR B : Subtract 1 from the content of the B register.

As mentioned before, at this time, the content of the B register is 2 so that the DCR B results in 1 being the new content of the B register. If the DCR B results in the occurrence of 0, the zero flip-flop is set to "1". Because the new content of the B register is 1, the zero flip-flop is not yet sent to "1".

JNZ STR1 : Jump to the address denoted by branch STR1 when the zero flip-flop has not yet been set to "1"; otherwise perform the following address instruction.

As the zero flip-flop is not set to "1", the programme of statements Nos. 476 to 484 for the branch STR1 is again performed so that the auxiliary shutter advances two steps. When the main shutter has a phase of 40°, the aperture is fully closed, and then the following programme starts to be performed. It is to be noted that the main shutter starts to uncover the aperture at a phase of 60° and then reaches the aperture fully open position at a phase of 100°. In the above mentioned procedure, therefore, the auxiliary shutter reaches the aperture fully closed position before the main shutter starts to uncover the aperture.

IN PHASE : Introduce the actual phase angle of the shutter into the accumulator.

SUB E : Subtract the content of the accumulator from the content of the E register. When the subtraction results in zero, the zero flip-flop is set to "1".

JNZ STR3 : Jump to the address denoted by branch STR3 if the zero flip-flop is not set to "1"; otherwise perform the following address instruction.

Until the phase of the main shutter comes to coincidence with the phase stored in the E register, therefore, IN PHASE, SUB E and JNZ STR3 are repeatedly performed. When the main shutter has reached a phase equal to that stored in the E register at a time during the maintenance of the auxiliary shutter in the aperture fully closed position, the following programme is performed.

MVI B,2 : Transfer 2 to the B register.

IN PHASE : Introduce the phase of the shutter into the accumulator.

ANI [01] : AND the content of the accumulator with [01] as in the aforesaid ANI [01]. When the content of the accumulator is an even number, the zero flip-flop is set to "1".

As the content of the E register is an odd number, when the shutter has reached a phase advanced by 10° from that stored in the E register, the ANI [01] results in the setting of the zero flip-flop to "1".

JNZ STR4 : Jump to the address denoted by branch STR4 when the zero flip-flop is set to "0"; otherwise perform the following address instruction.

Until the phase of the shutter is advanced 10° from that stored in the E register, therefore, IN PHASE, ANI [01], and JNZ STR4 are repeatedly performed. Upon advancement of 10° from the phase stored in the E register, the following instruction is performed.

CALL PMO : Perform the aforementioned PMO sub-routine with the result that the auxiliary shutter is operated to open the aperture.

IN PHASE : Introduce the phase of the shutter into the accumulator as in the aforesaid

IN PHASE.

ANI [01] : As in the aforesaid ANI [01], when the phase of the shutter is advanced by 10° more, in other words by 20° from the phase stored in the E register, the zero flip-flop is not set to "1".

JZ STR5 : Jump to the address denoted by branch STR5 when the zero flip-flop is set to "1", otherwise perform the following address instruction.

Until the shutter is advanced by 20° from the phase equal to that stored in the E register, therefore, IN PHASE, ANI [01] and JZ STR5 are repeatedly performed. Upon advancement of 20° from the phase of the E register, the following CALL PMSTOP instruction is performed.

CALL PMSTOP : Perform the aforementioned PMSTOP sub-routine with the result that the power supply to the pulse motor is stopped.

DCR B : Subtract 1 from the content of B register. When the subtraction results in 0, the zero flip-flop is set to "1".

JNZ STR4 : Jump to the address denoted by branch STR4 when the zero flip-flop is not set to "1", otherwise perform the following address instruction.

As the initial content of the B register is 2, the DCR B results in the production of 1 based on the calculation: $2 - 1 = 1$, so that the instructions beginning with IN PHASE of statement No. 490 of branch STR4 and terminating at JNZ STR4 of statement No. 499 are again performed, resulting in the setting of the zero flip-flop to "1". Thereafter, the following RET instruction is performed.

Hence, the pulse motor is driven two steps. When the main shutter has advanced by 40° from the phase of the E register, the auxiliary shutter is set to open fully the aperture.

** 0.5 Milliseconds (MS05) Sub-routine **

This sub-routine covers statements Nos. 678 to 681.

MVI C, [40] : Transfer [40] to the C register.

DCR C : Subtract 1 from the [40] in the C register.

JNZ MS05A : When the DCR C results in the setting of the zero flip-flop to "1", the following address instruction is performed, otherwise the instruction of the address denoted by branch MS05A is performed.

As the calculation of [40] − 1 = 63 (decimal), DCR C and JNZ MS05A are therefore performed 64 times before the following address or RET instruction is performed to terminate the programme. As a result, an interval of time obtained by the computation is 0.5 millisecond.

** 5 Millisecond (MS5) Sub-routine **

This sub-routine covers statements Nos. 682 to 688.

MVI C, [0A] : Transfer [0A] to the C register.

MVI D, [40] : Transfer [40] to the D register.

DCR D : Subtract 1 from [40] in the D register.

JNZ MS5B : If the DCR D does not result in 0, the instruction of the address denoted by branch MS5B is performed. After DCR D and JNZ MS5B are performed 64 times, the following instruction is performed.

DCR C : Subtract 1 from the content of the C register. The result is 9.

JNZ MS5A : If the result of the DCR C is not zero, jump to the address of branch MS5A to perform the programme beginning with MVI D, [40]. After the DCR C and JNZ MS5B are repeated 10 times, the following RET instruction is performed to obtain 5 milliseconds.

** 500 Milliseconds (MS500) Sub-routine **

This sub-routine covers statements Nos. 696 to 704.

MVI C, [FF] : Transfer [FF] to the C register.

MVI D, [7F] : Transfer [7F] to the D register.

DCR D : Subtract 1 from the content of the D register.

JNZ MS500B : If the above DCR D does not result in zero, the instruction of the address denoted by branch MS500B is performed. Hence, the DCR D and JNZ MS500B are repeated [7F] times, before the following instruction is performed.

DCR C : Subtract 1 from the content of the C register.

JNZ MS500A : If the above DCR C does not result in zero, the instructions of the addresses beginning with the branch MS500A are performed. Hence, the DCR instruction is performed [FF] x [7F] times to obtain 500 milliseconds.

** 125 Millisecond (MS125) Sub-routine **

This sub-routine covers statements Nos 689 to 695.

MVI C, [80] : Transfer [80] to the C register.

MVI D,[7F] : Transfer [80] to the D register.

DCR D : Subtract 1 from [7F] in the D register.

JNZ MS125B : If the results of the DCR D is not zero, the instruction of the address of the statement number for branch MS125B is performed. Hence, the instructions of the DCR D to JNZ MS125B are performed [7F] times before the following instruction is performed.

DCR C : Subtract 1 from [80] in the C register.

JNZ MS125A : If the result of the above DCR C is not zero, the instructions beginning with branch MS125A are performed. Hence, the instructions MVI D, [7F] to JNZ MS125B are performed [80] times to obtain 125 milliseconds.

The various operating modes of the cinematographic camera to this invention will next be described.

(1) Normal (NORMAL) mode:

The operator will first turn the mode setting dial 7 to place an index mark cut thereon in registry with a symbol NORM, and then turn the main switch 5 to place an index mark cut thereon in registry with a symbol ON. The CPU is thereby rendered operative to start performance of a programme written in the ROM with the memory addresses corresponding to statement No. 21 and those that follow.

The statement No. 21 (hereinafter abbreviated as Stm. 21) involves an instruction designated IN with an operand designated MODE and, upon performance, provides digital signals representative of [11] (i.e. hexadecimal 11) appearing at respective address lines MBADDs Ø-L to 7-L, so only Ø-L and 4-L lines go low. Inventors IN9 and IN13 apply high level signals to input terminal A of decoder CD40281 and ANDMB2 respectively. The performance of Stm. 21 for the instruction IN with the operand MODE (which will be hereinafter abbreviated as IN/MODE) also causes the production of a low level signal appearing at line MB I/O RS-L. This signal is inverted by NANDRS to a high level signal which is applied to one input terminal of each of the NAND gates R0 to R7 so that these NAND gates produce inverted signals to those entered. The address line MBADD goes high, and this is applied through inverters IN12 and INS1 to one input terminal of gate ANDSR1, and as the output of ANDMB2 is high, said gate ANDSR1 also goes high so that the data selector CD4019 is operated to pass to NANDs R0 to R3. Further, as the decoder CD40281 only produces an input signal at terminal 1, only those switches which are connected to the output terminal 1 of CD40281 are rendered effective. In this way, digital signals representing the switched positions of SWs 5 to 8 are introduced through NANDs R0 to R3 to the accumulator. In the case of the NORMAL mode, upon setting of dial 7 to the corresponding position, all SWs 5 to 8 remain open, so the digital signals fed to the data lines MBDATAs Ø-L to 7-L represent [00] which is stored. Thereafter, Stm. 22 CPI/[00] is performed and then followed by Stm. 23 JZ/NORM. When the content of the accumulator is [00], Stm. 23 is followed by Stm. 52 for addresses denoted by a branch NORM.

The above performance of Stm. 21 IN/MODE leads to the entry of [00] in the accumulator, and therefore a programme of Stms. 51 to 68 is to be performed. Upon Stm. 52 CALL/PMOST, the sub-routine PMOST is performed with the result that the auxiliary shutter of Figure 2 is set to the initial position as shown in Figure 3A, where the aperture is fully open with respect to the auxiliary shutter. Upon Stm. 53 IN/RL, digital signals representative of [10] are fed to the address lines MBADDs Ø-L to 7-L with only 4-L going low so that all the inputs A to D of the decoder are low, and so that only output terminal 0 of the decoder produces a high level signal. In a similar manner to that described in connection with Stm. 21 IN, digital signals dependent upon the switched positions of SWs 1 to 4 are caused to enter the accumulator. Let us now assume that the manual release 6 is actuated to the second position, then SWs 1 and 2 are in the ON states. This leads to the entry of [03] in the accumulator. Upon operation of Stm. 54 CPI/[03], the content of the accumulator is compared with [03]. If the result is "0", the zero flip-flop is set to "1". Upon Stm. 55 JNZ/MRM with the setting of the zero flip-flop to "1", Stm. 56 CALL/START follows. Alternately, assuming that the release 6 is not yet depressed to the second position, then the zero flip-flop is not set to "1", so that the performance of Stm. 55 JNZ/NRM results in a jump to the address denoted by branch NRM.

When the lever 6 has been advanced to the second position, the performance of Stms. 501–504 START sub-routine starts to drive the film motor 12 in a forward direction, with the simultaneous initiation of the taking of a first normal motion picture frame. Upon Stm. 57 IN/RL of branch NORM2, identical to that of branch NORM1, a digital value depending upon the switched positions of SWs 1 to 4 are written in the accumulator. Upon Stm. 58 SUI/[02], subtraction of [02] from the content of the accumulator is performed. If the content of the accumulator is less than [02] – in other words, if the lever 6 is released – the carry flip-flop is set to "1" so that Stm. 59 JP/NORM2 is followed by Stm. 60 IN/PHASE. So long as the lever 6 remains depressed to the second position SW1 and SW2 are left ON to enter [03] into the accumulator, so that Stm. 58 SUI/[02] results in the maintenance of the carry flip-flop reset at "0". Upon Stm. 59 JP/NORM2, therefore, the programme of Stms. 57–59 starts again to be performed. Thus, rotation of the film motor 12 continues until the lever 6 is released.

When the trigger 6 is released from the second position to the first, or further from the first position to the unactuated position, SW2 is, or both SW1 and SW2 are, opened respectively, and Stm. 57 IN/RL results respectively in the entry of [01] or [00] into the accumulator. Upon Stm. 60, as mentioned before, a digital value representative of the actual phase of the main shutter 21 is transferred from the counter CD4520 to the accumulator. Upon Stm. 61 CPI/34, the content of the accumulator is compared with 34. When the content of the accumulator is in coincidence with the digital value representative of 34, the zero flip-flop is set to "1". If so, Stm. 62 JNZ/Z1 is followed by Stm. 63 CALL/STOP.

The binary counter CD4520 counts the number of pulses beginning with the first pulse which occurred when the shutter 1 had rotated 10° from the initial phase position of Figure 4. Therefore, only when the shutter 21 has

rotated 340° from the initial position, Stm. 63 is rendered effective, causing the shaft 24*a* of Figure 3a to engage in the first arcuate slot 15*a* near or at the leading edge thereof. After a further slight rotation of the gear 15, the trailing edge of the slot 15*a* abuts the shaft 24*a*, thereby arresting the shutter 21 in its initial phase position as shown in Figures 3A and 4, while the energisation of the film motor is terminated.

Upon Stm. 64 MVI/B,[00], [00] is entered into the B register. Upon Stm. 65 IN/MODE, as mentioned before, digital signals from SWs 5 to 8 are entered into the accumulator. In the subsequent Stm. 66 CMP/B, the content of B register is compared with the content of the accumulator. If these contents are coincident with each other, the zero flip-flop is set to "1". Otherwise, if the content of B register is smaller than the content of the accumulator, the carry flip-flop is set to "1". Upon Stm. 67 JZ/NORM1, with the setting of the zero flip-flop to "1", Stm. 67 is succeeded by Stm. 53 for branch NORM1. With the alternate setting of the zero flip-flop, Stm. 67 is succeeded by Stm. 68 JMP/INITI1. If the mode setting dial 7 is unchanged in position during the above-mentioned exposure operation, as Stm. 65 IN/MODE results in the entry of [00] into the accumulator, and Stm. 66 results in the setting of the zero flip-flop to "1", the programme beginning with Stm. 53 is performed. When the lever 6 is actuated again, a next normal motion picture sequence starts. If the dial 7 is moved from the NORM position, Stm. 68 JMP/INITI1 is followed by Stm. 24 for the entry of the selected mode information.

During the process of taking a normal motion picture sequence, the film advancing mechanism operates in such a manner that the phase angle of the main shutter 21 is sensed by the binary counter CD4520, because the CD4520 counts the number of pulses caused by the slits 21*a* passing the detector means 22. When the number of pulses counted is 6, an actuating signal is applied through ANDD1 to the flip-flop FF′, thereby turning transistor Tr on to energise the electromagnet 19. When the number of pulses counted is 25, a deactuating signal is applied through ANDD2 to FF′ to reset the latter. As a result, the period of actuation of the electromagnet 19 is controlled in accordance with the phase angle of the shutter, ranging from 60 to 250°. As shown in Figure 6, the main shutter moves through a range of angles from 60 to 320° to open at least in part the area of the aperture 20, while the pull-down claw pin 17*a* is retracted by the energised electromagnet 19 out of engagement with the perforations 18*a* of the film 18. Further, the pull-down plate 17 remains stationary over 200° during the rotation of the shutter. When the electromagnet 19 is de-energised at shutter phase 250°, the claw pin 17*a* is permitted to engage in one of the perforations, but remains stationary until the shutter assumes a 320° phase. During a rotational angle of 320° to 60°, therefore, one cycle of claw operation is completed with the film 18 advanced one frame past the aperture 20.

The above-described control process will change the sequence of branches before the actuation of lever 6 is depressed to the second position, as follows. By Stm. 55 JNZ/NRM, a jump to Stm. 712 shown by the branch name, NRM occurs. Upon Stm. 712 MVI/B, [00] the digital value representative of [00] is transferred to B register. Upon Stm. 713 IN/MODE, the digital value corresponding to the mode selected by the dial 7 is transferred to the accumulator. Upon Stm. 714 CMP/B, the digital value representative of [00] entered in B register is compared with the digital value representative of the selected mode entered in the accumulator. When the selected mode is NORMAL, the zero flip-flop is set to "1", so that Stm. 715 JZ/NORM1 is succeeded by Stm. 53 IN/RL. Alternately, when the selected mode is not NORMAL, Stm. 715 is succeeded by Stm. 716 JMP/NORM3, then by Stm. 68 JMP/INITI1, and then by Stm. 24. Accordingly, when the index on dial 7 is left in registry with NORMAL, the camera operates to take a normal motion picture. When the dial 7 is turned to select any mode other than the normal mode, the push button 7*a* must be depressed to start an exposure operation in the selected mode.

(2) Diaphragm preference mode (DIAPHRAGM)

This mode makes possible the automatic adjustment of the shutter opening angle in accordance with the level of brightness of an object being photographed, so that correct exposure can be always effected when taking normal motion picture frames.

At first, the mode setting dial 7 is turned to place the index in registry with a symbol SHI, and then the main switch 5 is turned ON, thereby rendering the CPU operative to start performance of Stm. 21 IN/MODE. In the SHI position, only SW5 of the mode setting switches SW5 to SW8 is turned on to provide the digital value representative of [01] to data 4ines MBDATAs Ø-L to 3-L, as shown in Figure 5C, and which are written in the accumulator. Upon Stm. 22 CPI/[00], the content of the accumulator is compared with [00]. As the content of the accumulator is [01], the zero flip-flop is not set to "1" so that Stm. 23 JZ/NORM is succeeded by Stm. 24 CPI/[01]. Upon Stm. 24, the zero fli-flop is set to "1", so that Stm. 25 JZ/DIAPHRAGM is succeeded by Stm. 70 CALL/PMOST. The performance of the PMOST sub-routine results in the setting of the auxiliary shutter to the initial open position. Upon Stm. 71 IN/RL, as mentioned before, the switched positions of SW1 and SW2 are written in the accumulator. Upon Stm. CPI/[01], the content of the accumulator is compared with

NORM is succeeded by Stm. 24 CPI/[01]. Upon Stm. 24, the zero fli-flop is set to "1", so that Stm. 25 JZ/DIAPHRAGM is succeeded by Stm. 70 CALL/PMOST. The performance of the PMOST sub-routine results in the setting of the auxiliary shutter to the initial open position. Upon Stm. 71 IN/RL, as mentioned before, the switched positions of SW1 and SW2 are written in the accumulator. Upon Stm. CPI/[01], the content of the accumulator is compared with [07]. If the content of the accumulator is not [07], the zero flip-flop is not set to "1". Only SW1 and SW2 of switches SW1 to SW4 are arranged to co-operate with the manual release lever 6, so tha actuation of lever 6 cannot achieve the entry of any small number than [03]. Upon Stm. 73 JNZ/SBRI with "0" condition of the zero flip-flop, there is a jump to Stm. 717 MVI/B,[01] with which branch SBRI begins. This branch SBRI contains Stms. 717 MVI/B,[01], 718 IN/MOD, 719 CMP/B, 720 JZ/DIAPHRAGM 1 and 721 JMP/DIAPHRAGM 4 which are identical to Stms. 712 to 716 respectively, except that instead of transferring [00] into B register, [01] is transferred, and that when the selected mode is not the diaphragm preference mode, Stm. 721 JMP/DIAPHRAGM 4 is succeeded by Stm. 89 JMP/INITI2 which is then succeeded by Stm. 26 CPI/[02] with which branch INITI2 begins. When the mode setting dial 7 is left in the position for the diaphragm preference mode, Stm. 720 JZ/DIAPHRAGM 1 is succeeded by Stm. 71 IN/RL with which branch DIAPHRAGM 1 begins. So long as the dial 7 remains in the position for the diaphragm preference mode, therefore, the performance of Stm. 71 IN/RL, Stm. 72 CPI/[07] and Stm. JNZ/SBRI are repeated.

When the push button 7*a* is depressed at a time during the reptition of the performance of Stms. 71 to 73, switch SW3 is closed so that with the lever 6 depressed to the second position, Stm. 71 IN/RL results in the entry of [07] into the accumulator. Upon Stm. 72 CPI/[07], the zero flip-flop is set to "1". Now first, Stm. 73 JNZ/SBRI is succeeded by Stm. 74 CALL/START. In conclusion, only when the depression of the lever 6 to the second position and the depression of the programme start button 7*a* occur, the performance of the programme for the diaphragm preference mode starts. Upon Stm. 74 CALL/START, the aforementioned START sub-routine results in the film motor 12 starting in the forward direction.

Upon Stm. 75 IN/EXT, in a similar manner to that described in connection with the IN instruction, the digital value representative of [20] corresponding to the operand EXT is applied to the address lines MBADDs Ø-L to 7-L. As only one MBADD line 5-L becomes low, ANDMB2 produces an output signal of "0" level which, after being inverted, is applied to the D input terminal of the decoder $CD40281$, while all the other input terminals A to C of the decoder receive "0" level signals, causing only output terminal 8 of $CD40281$ to produce a "1" level output signal. This signal actuates the AND gates AA1 to AA4 of Figure 5B to pass digital signals from the analogue-to-digital converger AD to data lines MBDATAs Ø-L to 3-L and therefrom to the accumulator, representative of a proper exposure value. In this instance, this is a proper shutter opening angle, dependent upon the level of brightness of the object as photo-electrically sensed by SPCC of Figure 13A and the sensitivity of the film set on the variable resistor SvR. Upon Stm. 76 MOV/E,A, the content of the accumulator is transferred to the E register. Upon Stm. 77 CALL/SHUTTER, when the main shutted 21 has rotated 40° from the initial phase position, the auxillary shutter 39 is driven to close fully the aperture 20 and maintain this state. When the shutter 21 has advanced 40° from the phase entered in E register, the auxiliary shutter 39 is set fully open with respect to the aperture 20. By this, the phase of the main shutter stored in E register, in other words the object brightness level, is made use of in controlling the shutter opening angle.

Assuming that E register stores a decimal number 11 which corresponds to a shutter opening angle of 160°, when the main shutter has rotated 40° from the initial phase position, the auxiliary shutter 39 reaches the aperture fully closed position as shown by dashed lines in Figure 7 (d). When the main shutter assumes a phase of 110°, this is detected. When the phase of the main shutter becomes 120°, the pulse motor 38 is driven one step to turn the auxiliary shutter 39 counter-clockwise by one step, thus starting to open the picture aperture. Further rotation of the main shutter to 140° is accompanied by counter-clockwise movement of the auxiliary shutter 39 to uncover the picture thereof. At 140°, the pulse motor 38 is further driven by one more step. When the main shutter has reached 150°, the auxiliary shutter fully uncovers the aperture 20.

When the object brightness level is increased from the above, Stms. 75 and 76 enter a larger decimal number than 11 into the E register so that the auxiliary shutter 39 starts to open the aperture 20 after a corresponding time delay from the moment the main shutter has assumed a phase of 120°, with the resulting shutter opening angle being made smaller.

After the performance of Stm. 77, a succession of Stms. 78 IN/RL, 79 SUI/[02] and 80 JP/DIAPHRAGM 2 is performed, which is identical to that of Stms. 57 to 59m so that, so long as the lever 6 is depressed, a programme of Stms. 75 to 80 is repeatedly performed to take a normal motion picture sequence with automatic adjustment of the shutter opening angle in accordance with the object brightness level.

When the lever 6 is released Stm. 81 IN PHASE follows. Upon Stm. 83 JNZ/Z2, when the main shutter 21 has reached 340° as mea-

sured from the initial phase position, there occurs a jump to Stm. 84 CALL/STOP in a similar manner to that described in connection with the NORMAL mode, so that the main shutter 21 gets stopped at the final phase position coincident with the initial phase. Then, the programme proceeds in performance with Stm. 85 to 88, 85 MVI/B,[01], 86 IN/MODE, 87 CMP/B and 88 JZ/DIAPHRAGM 1, which are identical to Stms. 64 to 67 respectively. When the mode setting dial 7 is left in SHI position, Stm. 88 is succeeded by Stm. 71 with which the branch DIAPHRAGM 1 begins, so that when the lever is actuated again, the camera is rendered operative to take a second normal motion picture sequence in the diaphragm preference mode. If the dial 7 is moved from the SHI mode, Stm. 88 is succeeded by Stm. 89 JMP/INITI2 which is then succeeded by Stm. 26 for the entry of the selected mode.

(3) Memo Motion (MM) mode:–

This mode performs a succession of single frame operations with each intervening time period previously set to a desired value. The operator first turns the mode setting dial 7 to place the index in registry with a symbol MM, and then throws the power switch, thereby rendering the CPU operative with the performance of Stm. 21 IN/MODE. In the MM position of the dial 7, only SW6 of SWs 5 to 8 is closed to enter the digital value representative of [02] through the respective lines MBDATAs Ø-L to 3-L to the accumulator, as shown in Figure 5C. Upon Stm. 22 CPI/[00], the zero flip-flop is set if the content of the accumulator is [00]. Now, Stm. 22 compares [02] with [00], so that the zero flip-flop remains un-set, causing Stm. 23 JZ/NORM to be succeeded by Stm. 24 CPI/[01]. This succession continues until the performance of the last CPI instruction in said succession sets the zero flip-flop to "1". Upon the JZ instruction of the next statement following that CPI instruction which caused the zero flip-flop to be set, the programme branches to that point indicated on the same line as the effective JZ instruction statement. The content of the accumulator is [02], so Stm. 26 CPI/[02] sets the zero flip-flop and Stm. 27 JZ/MM, jumps to Stm. 91 whereat the Memo Motion (MM) branch begins. Upon Stm. 91 CALL/PMOST, the pulse motor 38 is set to the initial open position. Upon Stm. 92 CALL/T1SET, the aforementioned T1SET sub-routine is performed to effect intermittent lighting of LEDT until the push button 9*a* is depressed to enter a digital value into H register representative of the time value selected by dial 9. Let us now assume that the selected value of time is 1 second, then the digital value representative of [08] is stored in the H register, as has been mentioned before. Upon Stm. 91 IN/RL, a digital value depending upon the switched positions of SW1 and SW2 co-operative with the lever 6 are written in the accumulator. Upon Stm. 94 CPI/[07], the content of the accumulator is a value other than [07], the zero flip-flop is not set to "1", but when at [07], the flip-flop is set. Only SW1 and SW2 of SWs 1 to 4, however, are operated by the lever 6 to derive one of the numbers [00] and [03]. Hence, it is impossible to set the zero flip-flop. Upon Stm. 95, the "0" condition of the zero flip-flop is detected, causing a jump to Stm. 722 with which the branch MMB begins. This branch MMB is comprised of Stms. 722 MVI/B,[02], 723 IN/MODE, 724 CMP/B, 725 JZ/MMI and 726 JMP/MM3, which are identical to the aforementioned stms. 712 to 716. Although a detailed description is omitted, instead of transfer of [00] to the B register, there is a transfer of [02]. If the selected mode is not MM mode, Stm. 726 JMP/MM3 is succeeded by Stm. 110 JMP/INITI3 which is then succeeded by Stm. 28. Thus, the selected mode is scanned. Alternately when the mode setting dial 7 is left unchanged in the MM position, Stm. 725 JZ/MM1 is succeeded by Stm. 93 with which the branch MM1 begins. So long as the dial 7 is in the MM position, therefore, a number of successive cycles of Stms. 93 IN/RL, 94 CPI/[07] and 95 JNZ/MMB are repeated. When the push button 7*a* is depressed at a time during the repetition of the performance of Stms. 93 to 95, SW3 is closed. With the lever 6 depressed to the second position, therefore, the depression of the push button 7*a* realises simultaneous closure of SWs 1 to 3, causing a digital value representative of [07] to enter the accumulator when Stm. 93 is ON. Upon Stm. 94, the content of the accumulator is compared with [07] to result in the setting of the zero flip-flop to "1", and Stm. 95 JNZ/MMB is succeeded by Stm. 96 CALL/START. As described above, unless the lever 6 is depressed to the second position and the push button 7*a* is depressed, the MM code programme will not be performed.

Upon Stm. 96 CALL/START, the aforementioned START sub-routine is performed to start forward rotation of the film motor 12. As the film motor 12 rotates, the actual phase of the main shutter 21 is sensed by IN/PHASE. When the phase as sensed has become 340° from the initial phase position, there occurs a jump to Stm. 100 CALL/STOP by CPI 34, JNZ/K1. By the aforementioned STOP sub-routine the main shutter gets stopped after the completion of one revolution. In other words, based on the programme of Stms. 96 CALL/START to 100 CALL/STOP, the film motor 12 is operated to drive the main shutter through a rotation from the initial phase of 0° position to the first 340° phase position, and rotation of the shutter is stopped when the initial phase is regained. During this single cycle of shutter operation, a first single frame is exposed.

Upon Stm. 101 CALL/T1, the T1 sub-routine of Stms. 552 to 556 is performed to generate a time delay based on the time data stored in the H register. As the required time

value time is 1 second, after the main shutter has been maintained stationary in the 360° phase position for 1 second, Stms. 101 IN/RL, 103 SUI/[02] and 104 JP/MM2 are performed, these being identical with Stms. 57 to 59 of the NORMAL mode. So long as the lever 6 is depressed, Stm. 104 is succeeded by Stm. 96 CALL/START (branch name MM2), thus starting a second cycle of the programme of Stms. 96 to 104, with the result that a second frame is exposed. In such a manner, the time period between successive single frame exposures can be adjusted to a desired value by the dial 9.

When the lever 6 is released, Stm. 105 CALL/STOP is rendered effective to terminate a particular continuous series of single frame exposures. Thereafter, in a manner similar to that shown in connection with Stms. 64 to 68 for the NORMAL code, there occurs a succession of Stms. 106 MVI/B,[02], 107 IN/MODE, 108 CMP/B and 109 JZ/MM1. If the selected mode is left unchanged from the MM mode, Stm. 109 is succeeded by Stm. 93 so that upon a second actuation of the lever, the camera starts to operate again in the MM mode. If a different mode has been selected, Stm. 109 is succeeded by succeeded by Stm. 93 so that upon a second actuation of the lever, the camera starts to operate again in the MM mode. If a different mode has been selected, Stm. 109 is succeeded by Stm. 110 JMP/INITI3 which is then succeeded by Stm. 28 with which the branch INITI3 begins.

The MM mode has been explained in connection with an intervening time period of 1 second. It is of course possible to vary the time period over the wide range of values avaiable on the control panel shown in Figure 1.

(4) Indent Work Sampling (IWS) mode:

This mode enables four successive single frames to be taken separated by a pre-set time interval, followed by another desired time interval after which the next succession of four single frame exposures are made.

At first, the mode setting dial 7 is turned to select symbol IWS, and then the main switch is closed, thereby rendering the CPU operative and the performance of Stm. 21 IN/MODE for the entry of the switched positions of SWs 5 to 8 into the accumulator. The dial 7 is in IWS position where SW5 and SW6 are simultaneously closed to derive the digital value representative of [03] to the data lines MBDATAs Ø-L to 3-L as shown in Figure 5C. Upon Stm. 22 CPI/[00], the content of the accumulator is compared with [00], to determine the condition of the zero flip-flop as has been mentioned before. As the accumulator contains [03], the zero flip-flop is not set. The programme proceeds through Stm. JZ/NORM, Stm. 24 CPI/[01] and so on until the zero flip-flop is set to "1". The next JZ instruction following the CPI instruction which caused the zero flip-flop to be set starts performance of a succession of statements for the branch the name of which is given in the effective JZ instruction. As the content of the accumulator for the IWS mode is [03], the performance of Stm. 28 CPI/[03] results in the setting of the zero flip-flop and Stm. 29 JZ/IWS is therefore to start the Indent Work Sampling sub-routine beginning at Stm. 112. Upon Stm. 112 CALL/PMOST, the aforementioned PMOST sub-routine is performed to set the auxiliary shutter in the initial open position. Upon Stm. 113 CALL/T12SET, the aforementioned T12SET sub-routine is performed with the result that a digital value representative of a time value first selected by the dial 9 is stored in the H register, and then a digital value representative of another time value selected by the dial 9 is stored in the L register. Let us now assume that the first and second selected times are 1/4 and 1 second respectively, the aforementioned T12SET sub-routine transfers to the accumulator [02] (the hexadecimal number corresponding to 1/4 second), dependent upon the switched positions of SWs 12 to 15. Upon Stm. 586 DCR/A, the content of the accumulator is reduced to [01]. Upon Stm. 587 MOV/B,S, the [01] is transferred to the B register. Upon Stm. 588 MVI/A[01], [01] is transferred to the accumulator. Upon Stm. 589 RLC, the content of the accumulator becomes [02]. Upon Stm. 590 DCR/B, the content of the B register becomes [00]. Upon Stm. 951 JNZ/T12SET followed by Stm. 592 MOV/H,A, the [02] in the accumulator is transferred to the H register.

[08] is transferred to the L register for the 1 second delay in the following manner. Upon Stms. 593 to 594, a value representative of [04] is transferred to the accumulator. Upon Stm. 595 CDR/A, the content of the accumulator becomes [03]. Upon Stm. 596 MOV/B,A, the [03] is transferred to the B register. Upon Stm. 597 MVI/A,[01], [01] is transferred to the accumulator. Upon Stm. 598 RLC, DCR/B, the content of the B register becomes [02]. Upon Stm. 600 JNZ/T12SET2, there is a jump to Stm. 598 RLC. This jump is repeated two more times until the content of the B register becomes [00]. Finally, the content of the accumulator is [08] which is transferred to the L register.

After the entry of the time data into the H and L registers has been completed, Stm. 113 CALL/T12SET is succeeded by Stm. 114 MVI/D,4 to transfer the digital value representative of decimal 4 into the D register. Upon Stm. 115 IN/RL, the switched positions of SW1 and SW2 co-operative with the lever 6 are written in the accumulator. Upon Stm. 116 CPI/[07], the content of the accumulator contains [07] is the zero flip-flop set to "1" but as only SW1 and SW2 co-operate with lever 6, the accumulator can contain only [00] or [03], and the zero flip-flop is not set. Upon Stm. 117 JNZ/IWSB, the "0" condition of the zero flip-flop is detected, causing a jump to Stm. 727 with

which the branch ISWB begins. This branch IWSB comprises Stms. 727 MVI/B,[03], 728 IN/MODE, 729 CMP/B, 730 JZ/IWSI, and 731 JMP/IWS4 which are identical with the aforementioned Stms. 712 to 716. Although a detailed description is omitted, instead of transferring [00] to B register, there is a transfer of [03]. If the selected mode is not IWS mode, Stm. 731 JMP/IWS4 is succeeded by Stm. 136 JMP/INITI4 which is then succeeded by Stm. 30 (represented by the branch name INITI4). Thus, the selected mode is scanned. Alternately when the mode setting dial 7 is left unchanged from the IWS position, Stm. 730 JZ/IWS1 is succeeded by Stm. 115 IN/RL with which the branch IWS begins. So long as the dial 7 is in IWS position, therefore, a number of cycles of Stms. 115 IN/RL, 116 CPL/[07] and 117 JNZ/IWSB sequence are repeated. When the push button 7*a* is depressed during the repetition of such cycles, SW3 is closed. With lever 6 depressed to the second stroke, therefore, the depression of the push button 7*a* effects simultaneous closure of three switches SW1 to SW3, causing the digital value representative of [07] to enter the accumulator on Stm. 115. Upon Stm. 116 CPI/[07], the content of the accumulator is compared with [07] to result in the setting of the zero flip-flop to "1", and then Stm. 117 JNZ/IWSB is succeeded by Stm. 118 CALL/START. As has been indicated above, when the depression of the lever 6 to the second position and the depression of the push button 7*a* occur together, the IWS programme is performed.

Upon Stms. 118 to 123, which are identical with Stms. 96 to 101 for the MM mode, a first single frame operation takes place. Based on the time data stored in H register, for 1/4 second the main shutter is maintained stationary in the aperture fully closed position. At the termination of 1/4 second, Stm. 124 DCR/D subtracts 1 from 4 with the resulting content of the D register becoming a digital value representative of decimal 3. Upon Stm. 125 JNZ/IWS2, the condition of the zero flip-flop is detected. When the condition of the zero flip-flop as detected is "1", the following statement, namely Stm. 126 CALL/T2, is rendered effective. Or otherwise, the programme beginning with Stm. 118 is performed again. As indicated just above, the new content of the D register is 3 so that the zero flip-flop is prevented from being set to "1", causing a second performance of the programme beginning with Stm. 118, with the result that a second single frame operation is performed. After the duration of 1/4 second from the closure of the aperture by the main shutter, Stms. 124 CDR/D and 125 JNZ/IWS2 are performed. Until the zero flip-flop is set to "1" by the JNZ instruction, a number of repetitions of the programme of Stms. 118 to 125 are performed. As mentioned just above, the initial content of D register is decimal 4 so that there are 4 repetitions. A fourth operation of Stm. 125 is succeeded by Stm. 26 CALL/T2. As a result, only after four single frame exposures have taken place at intervals of 1/4 second, the statement CALL/T2 is performed.

Upon Stm. 126 CALL/T2, the aforementioned sub-routine T2 is performed with the result that the film motor and the shutter are maintained stationary, with the aperture fully closed, for the time interval previously stored in L register. The time interval stored in L register is in the above example [08], corresponding to 1 second, so that the aforementioned MS125 sub-routine is performed eight times before the zero flip-flop is set to "1", by the DCR instruction of the T2 sub-routine. In this way, a continuous time interval of 1 second based on the calculation: 125 x 8 = 1000 milliseconds, is obtained.

After the four single frame exposures at intervals of 1/4 second have been completed and then after a further 1 second, counting from the termination of the last single frame exposure, Stm. 127 MVI/D,4 starts to perform with the result that digital value representative of decimal 4 is transferred again to the D register. As Stms. 128 IN/RL, 129 SUI/[02] and 130 JP/IWS2 are identical with Stms. 57 to 59 for the NORMAL mode, provided the lever 6 is still fully depressed, a number of repetitions of the programme beginning with Stm. 118 CALL/START (represented by the branch name IWS2) and terminating at Stm. 130 are performed. In this way a number of cycles each having 4 exposures at preset intervals followed by a preselected interval are performed. The present interval is sored in the H register (in this example, corresponding to 1/4 second) and the preselected interval is stored in the L register (in this example, corresponding to 1 second).

When lever 6 is released, Stm. 131 CALL/STOP is rendered effective to terminate the taking of a particular picture frame sequence made in the Indent Work Sampling mode. Thereafter, in a manner similar to that shown in connection with Stms. 64 to 68 for NORMAL mode, there occurs a succession of Stms. 132 MVI/B,[03], 133 IN/MODE, 134 CMP/B and 135 JZ/IWS1. If the selected mode is left unchanged from IWS mode, Stm. 135 JZ/IWS1 is succeeded by Stm. 115 (represented by the branch name IWS1) so that upon a subsequent actuation of lever 6, the camera starts to operate in the IWS mode. If a different mode from the IWS mode is selected, Stm. 135 is succeeded by Stm. 136 JMP/INITI4 which is then succeeded by Stm. 30, and thus, the newly selected mode is scanned.

(5) Work Sampling (WS) mode:

This mode repeats a number of cycles of motion picture operations with each cycle lasting for a desired time, the cycles being spaced from each other by a preset time. The mode setting dial 7 is first turned to the WSP position, and then the main switch is closed, there-

by rendering the CPU operative with the performance of Stm. 21 which effects the entry of the information representative of the switched positions of SWs 5 to 8 into the accumulator. In WSP position, only SW7 is closed to give a value representative of [04] to lines MBDATAs Ø-L to 3-L as shown in Figure 5C; thus the accumulator stores [04]. Upon Stm. 22 CPI/[00], the content of the accumulator is compared with [00] to determine the condition of the zero flip-flop, as mentioned before. The instant comparison concerns [04] and [00], so that the zero flip-flop is not set to "1".

The programme proceeds as has been described until the zero flip-flop is set and the next following JZ instruction branches to the statement at which the selected mode programme begins. As the content of the accumulator for the WS mode is [04], Stm. 30 CPI/[04] causes the zero flip-flop to be set to "1", and Stm. 31 JZ/WS causes a jump to Stm. 138, at which the branch "Work Sampling" begins. Upon Stm. 138 CALL/PMOST, the auxiliary shutter is set to the initial open position. Upon Stm. 139 CALL/T12SET, as explained in connection with IWS mode, a first required time value set by the dial 9, is entered into the H register, and a second required time value, also set by the same dial 9, is entered into the L register. Now assuming that the first and second required values of time are 1/4 and 1 second respectively (as described in the IWS mode), the contents of the H and L registers are [02] and [08] respectively.

Upon Stm. 140 IN/RL, the switched positions of SW1 and SW2, controlled by lever 6, are written in the accumulator. Upon Stm. 141 CPI/[07], the content of the accumulator is compared with [07]. If the content of the accumulator is different from [07], the zero flip-flop is prevented from being set to "1" but the flip-flop is set to "1" when the accumulator coincides with [07].

As only SW1 and SW2 of switches SW1 to SW4 are controlled by lever 6, only [00] and [03] are possible, so that Stm. 141 CPI/07 fails to set the zero flip-flop. Upon Stm. 142 JNZ/WSB, the "0" condition of the zero flip-flop is detected, causing a jump to Stm. 732, at which the branch WSB begins. This branch comprises Stms. 732 MVI/B[04], 733 IN/MODE, 734 CMP/B, 735 JZ/WS1 and 736 JMP/WS3, which are identical with Stms. 712 to 716 for the NORMAL branch. Although a detailed explanation of these statements is omitted, note should be made of the following. Instead of transferring [00] to the B register, [04] is transferred thereto. If a newly selected mode is different from the WS mode, Stm. 136 JMP/WS3 is succeeded by Stm. 158 JMP/INITI5 which is then succeeded by Stm. 32, at which the selected mode scanning programme begins. If the mode setting dial 7 is left unchanged from the WS mode position, Stm. 735 JZ/WS1 is succeeded by Stm. 140 IN/RL at which the branch WS1 begins. This WS1 branch is performed repeatedly until the push buton 7*a* is depressed. Upon depression of button 7*a*, the programme for the WS mode beginning with Stm. 143 CALL/START commences.

After the aforementioned START subroutine is performed, starting the film motor at the frame frequency, Stm. 144 CALL/T1 is rendered effective to control the period of actuation of the film motor, to establish one cycle of motion picture operation based on the stored time data – in this instance, 1/4 second stored as [02] in the H register. At the termination of the duration of the 1/4 second, Stms. 145 IN/PHASE, 146 CPI/34, 147 JNZ/K3 and 148 CALL/STOP are rendered effective to stop the main shutter in the initial phase position.

Upon Stm. 149 CALL/T2, the aforementioned T2 sub-routine is performed to maintain the main shutter stationary in the aperture closed position for 1 second, based on the time data stored as [08] in the L register. In other words, by the programme beginning with Stm. 143 CALL/START and terminating at Stm. 149 CALL/T2, a motion picture sequence is performed for 1/4 second, according to the time data stored in the H register, and subsequently the exposure operation is stopped for 1 second, according to the time data stored in the L register. After the completion of Stm. 149 CALL/T2, there occurs a sequence of Stm. 150 IN/RL, 151 SUI/[02] and 152 JP/WS2 which are identical with Stms. 57 to 59 for the NORMAL mode. So long as the lever 6 remains depressed, a number of repetitions of the programme to take the corresponding number of motion picture sequences, while controlling the first and second time intervals in the manner mentioned above.

When the lever 6 is released, Stm. 152 JP/WS2 is succeeded by Stm. 153 CALL/STOP. After that, Stms. 154 MVI/B,[04], 155 IN/MODE, 156 CMP/B, 157 JZ/WS1 and 158 JMP/INITI5, which are identical with Stms. 64 to 68 for the NORMAL mode, are repeatedly performed in sequence. If the mode setting dial 7 is maintained at WSP and when the lever 6 is actuated again the programme beginning with Stm. 140 takes place If the dial 7 is set to a position different from the WSP position, the mode scanning programme takes place.

(6) Self Timer mode:

This mode delays the start of a motion picture sequence by a preset time interval and limits the duration of the motion picture sequence to a preselected time interval. The operator first turns the mode setting dial 7 to place the index in registry with a symbol ST, and then turns on the main switch. The accumulator thereby stores a value represenative of [05] which is then discriminated in the manner as has been described above in connection with any of the previously-mentioned modes. Thus, upon Stm. 32 CPI/[05], the zero flip-flop is set to "1", and Stm. 33 JZ/ST causes a jump to

Stm. 160 CALL/PMOST. The aforementioned PMOST sub-routine sets the auxiliary shutter to the initial open position. Upon Stm. 161 CALL/T12SET, the T12SET sub-routine of Stms. 583 to 602 is performed to effect the entry of a first and second required time value into the H and L registers respectively. Let us now assume that the first and second required time values are 8 and 1 second respectively, then the T12SET sub-routine enters a value in the accumulator dependent upon the switched positions of SWs 12 to 15 for 8 seconds, this being [07]. Upon the DCR/A, the content of the accumulator is reduced to [06], but instead the content of H register – namely [01] – is shifted left one bit. This precedure repeats itself six times until the content of the accumulator becomes [00] with the result that the final content of the H register is [40], which corresponds to decimal 64. On the other hand, entered into the L register is a value representative of [08], as in either the IWS or WSP modes.

When the lever 6 is depressed to the second position and when the push button 7*a* is depressed, a succession of Stms. 162 IN/RL, 163 CPI/[07] and 164 JNZ/STB is further succeeded by Stm. 165 CALL/T1. If the push button 7*a* is not yet depressed, Stm. 164 JNZ/STB is succeeded by Stm. 737 with which the branch STB begins. This branch comprises Stms. 737 MVI/B,[05]; 738 IN/MODE; 139 CMP/B; 740 JZ/ST1 and 741 JMP/ST2. If a new mode different from the ST mode is selected, this new mode is scanned. If however the mode setting dial 7 remains in the ST mode, a number of repetitions of the programme beginning with Stm. 162 and terminating at Stm. 740 are performed until the push button 7*a* is depressed.

Upon depression of the push button 7*a* at a time during the course of repetitions of said programme, Stm. 165 CALL/T1 starts to perform, cusing the T1 sub-routine to repeat the MS125 sub-routine 64 times, based on the digital value of decimal 64 stored in the H register. At the termination of the duration of 125 milliseconds x 64 = 8 seconds, Stm. 166 CALL/START starts to dive the film motor so as to take a motion picture sequence. In other words, after the elapse of 8 seconds from the time at which the push button 7*a* is depressed, the taking of the motion picture sequence starts. Upon Stms. 167 CALL/T2 to 171 CALL/STOP, the aforesaid motion picture sequence continues to take place for 1 second, as this time value is stored in the L register. After the elapse of 1 second, the particular motion picture sequence is terminated. Thus, the start of the particular motion picture sequence is delayed by a time set in the H register, and the period of duration of the particular motion picture sequence is for a time set in the L register.

After the completion of the particular motion picture sequence, the programme beginning with Stm. 172 is performed so that, in a manner similar to that described in connection with the NORMAL mode, further depression of the lever 6 causes the camera to operate in the ST mode, provided that the mode setting dial 7 remains in the ST position. If a new mode is selected different from the ST mode, the mode scaning programme is rendered effective.

(7) Time Exposure One (TE1) mode:

This mode takes a continuous series of single frame exposures with each exposure of a long duration, previously selected, while the times between the successive exposures are adjusted to a value previously preselected. The operator first turns the mode setting dial 7 to place the index in registry with a symbol TE1, and then turns the main switch, thereby causing the accumulator to store the digital value representative of [06], which is then discriminated in such a manner as will be appreciated from the foregoing description. Upon Stm. 34 CPI/[06], therefore, the zero flip-flop is set to "1", and Stm. 35 JZ/TE1, causes a jump to Stm. 178 CALL/PMOST. The aforementioned PMOST sub-routine sets the auxiliary shutter to the initial open position. Upon Stm. 179 CALL/T12SET, the T12SET sub-routine of Stms. 583 to 602 is performed to effect the entry of a first and second required time value into the H and L registers respectively. Let us now assume that the first and second required values of time are 8 and 1 second respectively, then the T12SET sub-routine enters a values in the accumulator dependent upon the switched positions of SWs 12 to 15 for 8 seconds, this being [07]. Upon the DCR/A, the content of the accumulator is reduced to [06], but instead the content of H register – namely [01] – is shifted left one bit. This procedure repeats itself six times until the content of the accumulator becomes [00] with the result that the final content of the H register is [40], which corresponds to decimal 64. On the other hand, a value representative of [08] is entered into the L register, as described above.

In performance of Stms. 180 IN/RL; 181 CPI/[07]; and 182 JNZ/TE1B, only when the depression of the push button 7*a* occur simultaneously can Stm. 183 CALL/T1 succeed. If the push button 7*a* is not depressed, Stm. 182 JNZ/TE1B is succeeded by Stm. 742 with which the branch TE1B begins. This branch contains Stms. 752 MVI/B,[06]; 143 IN/MODE; 745 CMP/B; 745 JZ/TE11; and 746 JMP/TE14. As explained in connection with the above modes, when a new mode different from the TE1 mode is selected, this mode is scanned so as to be effective. If the mode setting dial 7 remains in the TE1 position, the programme of Stms. 180 to 182 and 742 to 745 are repeated until the push button 7*a* is depressed.

Upon depression of the push button 7*a* during the repetitions of said programme, Stm. 183 CALL/START with the aforesaid START sub-routine is performed, to start the film

motor for forward rotation. Upon Stms. 184 IN/PHASE; 185 CPI/16; and 186 JNZ/TE12, the main shutter is permitted to advance through an angular distance of 160° from the initial phase position. When the shutter has advanced 160°, Stm. 187 CALL/STOP is performed, causing the aforementioned STOP subroutine to energise the electromagnet 24, thereby the shaft 24*a* engages the second arcuate slot 15*b* (Figure 3A), and simultaneously the film motor is stopped. By inertia, the main shutter 21 rotates further to assume a phase of 180°, and is then held in the position where the aperture 20 is fully open starting the exposure of a first frame. This state is maintained for 8 seconds by Stm. 188 CALL/T1.

At the termination of 8 seconds, Stm. 189 CALL/START with the START sub-routine starts the film motor again. Upon Stms. 190 IN/PHASE; 191 CPI/34; 191 JNZ/K5; and 192 CALL/STOP, the main shutter gets stopped in a position coincident with the initial phase position, so completing the first frame exposure, the exposure time corresponding to the time value set in the H register. Upon Stm. 194 CALL/T2 with the aforementioned T2 subroutine, this state of the main shutter is maintained for 1 second, as this time value is set in the L register. As a result, by the programme of Stms. 183 to 194, the camera is operated in TE1 mode to make a single frame exposure of a preset duration followed by a wait of a preselected duration.

So long as the lever 6 remains depressed, as detected by Stms. 195 to 197, namely 195 IN/RL; 196 SUI/[02] and 197 JP/TE13, which are identical with Stms. 57 to 59 for the NORMAL mode, a number of repetitions of the programme of Stms. 183 to CALL/START to 197 JP/TE13 are performed to make a continuous series of single frame exposures.

When the lever 6 is released, Stm. 197 JP/TE13 is succeeded by Stm. 198 CALL/STOP. After that, Stms. 199 MVI/B,[06]; 200 IN/MODE; 201 CMP/B; 202 JZ/TE11 and 203 JMP/INITI7, which are identical with Stms. 64 to 68 for the NORMAL mode, are performed repeatedly in this order. When the mode setting dial 7 is maintained in the TE1 position, and when the lever 6 is actuated again, the camera is again operated in the TE1 mode. When the dial 7 is set to a position different from the TE1 position, the mode scanning programme is performed.

(8) Time Exposure Two (TE2) mode:

This mode makes a continuous series of single frame exposures while controlling the exposure time in accordance with the brightness level of an object being photographed. The operator first turns the mode setting dial 7 to place the index in registry with a symbol TE2, and then turns the main switch, thereby causing the accumulator to store a value [07], which is then discriminated in such a manner as will be appreciated from the foregoing description.

Upon Stm. 36 CPI/[07], the zero flip-flop is set to "1", andStm. 37 JZ/TE2, causes a jump to Stm. 205 CALL/PMOST, which sets the auxiliary shutter to the initial open position.

Upon Stms. 206 IN/RL; 207 CPI/[07], and 208 JNZ/TE2B, only a simultaneous occurrence of the depression of the lever 6 to the second position and the depression of the push button 7*a* leads to start an exposure operation in the TE2 mode by the programme beginning with Stm. 209. If the push button 7*a* is not yet depressed, Stm. 208 JNZ/TE2B is succeeded by Stm. 747 with which the branch TE2B begins. This branch contains Stms. 747 MVI/B,[07]; 748 IN/MODE; 749 CMP/B; 750 JZ/TE21 and 751 JMP/TE25. As explained in each of the heretofore described modes, when a new mode is selected which is different from the TE2 mode, this new mode is scanned so as to be effective. If the mode setting dial 7 is permitted to remain in the TE2 position, a number of repetitions of the programme of Stms. 206 to 208 and 747 to 750 are performed until the push button 7*a* is depressed.

Upon depression of the push button 7*a* during the course of repetitions of the aforesaid programme, Stm. 209 IN/LEVEL is performed. Now the operated LEVEL applies to the address lines MBADDs Ø-L to 7-L; only Ø-L and 5-L thereby go low. This leads to only input terminals A and D of decoder CD40281 going high, causing CD40281 to produce an output of "1" at output terminal 9. This output is applied to AND gates AA5 to AA8 of Figure 5B, through which binary data representative of a predetermined value set in LEVEL circuit are introduced to the accumulator, in a manner similar to that in which the aforesaid IN instruction is performed. Upon Stm. 210 MOV/E,A, the content of the accumulator is transferred to the E register. Upon Stms. 211 to 215, which are identical with Stms. 183 to 187, the main shutter is driven but then arrested in a 180° phase position, where the aperture 20 is fully open. Next, Stm. 216 IN/ICC is performed, this operand ICC applying [22] to the address lines MBADDs Ø-L to 7-L in a similar manner to that in which the just mentioned IN instruction is performed; only 1-L and 5-L go low. As the input terminals B and D of decoder CD40281 receive "1" signals, decoder CD40281 produces a "1" output at terminal 10, thereby the AND gates AA9 to AA12 are gated on and the flip-flop FFL is set from "1" to "0" condition at $\bar{Q}$ output, simultaneously turning OFF transistor Tra. The light measuring circuit EXT produces an output proportional to the brightness level of the object, which output is integrated by the capacitor C1. The integrated output on the capacitor C1 is converted by the analog-to-digital converter AD′ to a digital output which is loaded into the accumulator. Upon Stm. 217 SUB/E, the reference value in the E register is compared with the output of AD′, and on coincidence the zero

flip-flop is set to "1", so that the programme can proceed to Stm. 219 CALL/START. If coincidence is not attained, a sequence of instructions with Stms. 216 to 218, designated by the branch TE23, is carried out repeatedly.

When coincidence has been attained, in other words, when the output of the capacitor C1 has attained the reference level dependent upon the output of the LEVEL circuit of Figure 5B, Stm. 219 CALL/START is carried out. After the time interval corresponding to the output of the light measuring circuit EXT, the main shutter starts, to be rotated from the 180° phase position to the 360° phase position, at which the main shutter will be stopped by the next sequence of the instructions with Stms. 220 IN/PHASE; 221 CPI/34; 222 JNZ/K6; and 223 CALL/STOP. It is to be noted here that the occurrence of coincidence of the C1 output with the LEVEL output leads to the production of an output from the comparator, and this causes the flip-flop FFL to be reset to the initial state, so that the capacitor C1 is discharged ready for the next cycle of single frame operation.

So long as the lever 6 is depressed, as detected by the instructions of Stms. 224 IN/RL; 225 SUI/[02]; and 226 JP/TE24, which are identical with Stms. 57 to 59 for the NORMAL mode, a number of cycles of single frame operation are performed to take a continuous series of single exposures while controlling the exposure time in accordance with the object brightness level, the number of cycles corresponding to the number of repetitions of the programme of Stms. 211 CALL/START to 226 JP/TE24, designated by the branch T24. When the lever 6 is released, Stm. 226 JP/TE24 is followed next by Stm. 227 MVI/B,[07]. In a similar manner to that in whicht the programme for the NORMAL mode is carried out, the camera is then ready for a further operation in the TE2 mode, provided that the mode setting dial 7 remains unchanged from the TE2 position. Upon displacement of the dial 7 from the TE2 position, the mode-scanning programme is started.

(9) Fade-in (FI) mode:

The mode setting dial 7 is first turned to place the index in registry with a symbol FI, and then the main switch is turned, thereby writing the FI mode in the accumulator, and the mode discriminating operation is performed in a manner similar to that described in any of the heretofore described modes. The symbol FI causes [08] to be loaded in the accumulator and Stm. 38 sets the zero flip-flop to "1". Stm. 39 JZ/FI, therefore, causes a jump to Stm. 233 CALL/PMOST with which the branch FI begins and which sets the auxiliary shutter to the initial open position. Upon Stm. 234, CALL/D12SET, with the D12SET sub-routine of Stms. 615 to 619, two kinds of opening angle data selected by the dial 10 are stored in respective memory locations addressed by [41F1] and [41F2] respectively. As shown in Figure 5C, there are available 12 values of shutter opening angle in 20° steps, which are selected one at a time by the dial 10, the selected value depending upon the particular combination of the switched positions of SWs 16 to 19 co-operative with the dial 10. The first and second data of the opening angles set in this order represent degrees of initial and final angles, at which a fade-in effect respectively starts and terminates.

After such setting of the opening angle data has been performed, a sequence of instructions with Stms. 235 IN/RL; 236 CPI/[07]; and 237 JNZ/FIB is carried out. As in any of the heretofore described modes, only when the depression of the lever 6 to the second position and the depression of the push button 7*a* occur simultaneously, can an exposure operation with fade-in effect be carried out by a sequence of instructions beginning with Stm. 238. If the push button 7*a* is not yet depressed, Stm. 237 JNZ/FIB is followed next by Stm. 752 at which the branch FIB begins. This branch FIB contains 752 MVI/B,[08]; 753 IN/MODE; 754 CMP/B; 755 JZ/FI1 and 756 JMP/FI4. As explained in each of the heretofore described modes, when a new mode is selected from the FI mode, this new mode is rendered effective. When the mode setting dial 7 is left unchanged from the FI mode position, the programme of Stms. 235 to 237 and 752 to 755 is repeatedly carried out until the push button 7*a* is depressed.

Upon depression of the push button 7*a* during the process of carrying out the just-mentioned programme, Stm. 238 LDA/DEG1M; in other words, the opening angle data stored in [41F1] is loaded in the accumulator. Upon Stm. 239 MOV/E,A, the opening angle data in the accumulator is transferred to the E register. Upon Stm. 240 CALL/START, the aforementioned START sub-routine is carried out. By this, the film motor is driven in the forward direction. Upon Stm. 241 MVI/D,6, a value representative of decimal 6 is set in the D register. Upon Stm. 242 CALL/SHUTTER, the aforementioned SHUTTER sub-routine is carried out.

Now assuming that the first and second values of the shutter opening angle entered by the aforementioned D12SET sub-routine are 0° and 220° respectively, then decimal numbers 27 and 5 are stored in [41F1] and [41F2] respectively. When the main shutter 21 of Figure 3A has rotated from the initial phase of 40°, the auxiliary shutter 39 fully covers the aperture. When the main shutter 21 has reached a phase of 280°, in other words, when the aperture 20 starts to be closed by the main shutter 21, the pulse motor 38 is driven through one step in the direction to open the aperture 20. During the turning movement of the auxiliary shutter 39 to the aperture half-open position, however, the main shutter moves from 280° to 300°. Then the pulse motor 38 is further

driven through more one step to open fully the aperture, while the main shutter is advanced to 320° at which the aperture is fully closed. In total, therefore, the entire area of the aperture is covered by either or both of the auxiliary shutter and the main shutter during the period when the main shutter moves from 60° to 320°, as can be seen from Figure 8(a) where the ordinate represents the proportion of the aperture which is open to the entire area thereof, and the abscissa represents the phase angle of the main shutter. In other words, the initiation of aperture opening operation of the auxiliary shutter is controlled in accordance with the data stored in the memory location [41F1] by the SHUTTER sub-routine. As the data stored in [41F1] is, in this instance, 27, the auxiliary shutter starts to open the aperture at a time when the main shutter has arrived at a phase of 280°. The selection of 27 as the first opening angle data leads to the maintenance of a closed aperture during the first complete revolution of the main shutter.

After a first frame exposure has been completed, the SHUTTER sub-routine is followed by Stm. 243 DCR/D which subtracts 1 from 6 in the D register. The result of the subtraction is discriminated by Stm. 244 JNZ/F12. If not 0, the branch F12 is repeatedly carried out. In this instance, the necessary number of repetitions of the branch F12 is 6, so that the first six frames are not exposed to light, as the aperture is maintained closed. Thereafter, upon Stm. 245 DCR/E, subtraction of 1 from the content of the E register, in this instance from 27, is carried out with the resulting content of the E register being 26. Next, CALL/DISPLAY1 is carried out to display the content of the E register by the light-emitting diodes LEDs 0 to 3 of Figure 5(A). Upon Stm. 247 LDA/DEG2M, the content of the memory location addressed by DEG2M or [41F2] is loaded to the accumulator. As the opening angle data stored in [41F2] was assumed to be 5, the resulting content of the accumulator becomes 5. Upon Stm. 248 SUB/E, the content of the accumulator is subtracted from the content of the E register with a result: 26–5 = 21. Stm. 249 JNZ/F15, detects whether or not the result of SUB/E is zero. If not zero, the instruction of the address denoted by the branch F15 is carried out. In this way, a number of repetitions of the programme of Stms. 241 to 249 are carried out, until the content of the E register comes into coincidence with the opening angle set in [41F2].

Because the result of the SUB/E is not zero, the just mentioned programme is carried out again. At this time, however, as the content of the E register was decreased from 27 to 26, performance of the SHUTTER sub-routine causes the pulse motor to be driven when the main shutter has rotated to a phase of 270°, so that the resulting opening angle defined by the auxiliary shutter and the main shutter is wider by 10° than that for which the first six frame exposures were made, as shown by dashed line B in Figure 8(b). With a new opening angle of 10°, the next six frame exposures are made. To take a motion picture sequence with fade-in effect, the initiation of the operation of the auxiliary shutter is caused to be progressively earlier with respect to the phase angle of the main shutter, with the resulting opening angle being increased by 10° for every six frame exposures, as shown by a sequence of dashed sloping lines A to V in Figure 8(b). When the final performance of SUB/E occurs with a result of zero, in other words, when the opening angle is widened to an angle narrower by 10° than the angle set in [41F2], Stm. 249 JNZ/F15 is followed next by Stm. 250 CALL/SHUTTER. In this instance, after the opening angle has reached 210°, Stm. 250 CALL/SHUTTER is carried out to make six more frame exposures with the widest opening angle of 220°, which was entered as [05] in [41F2] as shown by a sloping line in W in Figure 8(b). Thus, operation of the auxiliary shutter is controlled to increase the shutter opening angle from a first value of angle record stored in [41F1] to a second value of angle stored in [41F2], in discrete steps of variation separated by 10° from each other for each six frame exposures.

After the completion of the last frame exposure with the widest opening angle dependent upon the data stored in [41F2], Stm. 251 IN/RL is carried out, thereby writing the states of switches SW1 and SW2 of Figure 5(A) in the accumulator, as mentioned before. Upon Stm. 252 SUI/[02], the content of the accumulator is reduced by [02]. So long as the lever 6 remains depressed to the second position, the content of the accumulator written by IN/RL is [03], so that the sign flip-flop is not set. Upon Stm. 253 JP/F13, the instruction of the address denoted by the branch F13 is carried out. Until the lever 6 is released from the second position, a number of repetitions of the programme of Stms. 250 CALL/SHUTTER; 251 IN/RL; 252 SUI/[02]; and 253 JP/F13 are carried out with the result that the particular motion picture sequence with fade-in effect is followed by a continuous series of the corresponding number of frame exposures with the opening angle dependent upon the data stored in [41F2], and remaining unchanged therethrough. When the lever 6 is released, Stm. 251 IN/RL results in the entry of [00] or [01] into the accumulator. Upon Stm. 253 JR/F13, Stms. 254 IN/PHASE to 257 CALL/STOP succeed in sequence. When the main shutter nears to the position equivalent to the initial phase position, the film motor is stopped, and a current is allowed to flow through the solenoid of electromagnet 24 for 5 milliseconds to drive the shaft 24*a* into engagement with the first arcuate slot 15*a*.

After that, upon Stm. 258 MVI/B,[08], a

[08] is written in the B register. Upon Stm. 259 IN/MODE, as mentioned before, the states of switches SW5 to SW8 are written in the accumulator. Upon Stm. 260 CMP/B, the content of the accumulator is compared with the content of the B register and when the contents are equal, the zero flip-flop is set to "1". When the content of the B register is smaller than that of the accumulator, the carry flip-flop is set to "1". Upon Stm. 261 JZ/F11, the condition of the zero flip-flop is detected. When the zero flip-flop was set to "1", the instruction of Stm. 235 denoted by the branch FI1 is carried out. Otherwise, Stm. 261 JZ/FI1 is followed next by Stm. 262 JMP/INITI9. If the mode setting dial 7 is not moved out of registry with the FI mode during the above mentioned process of exposure operation, Stms. 259 IN/MODE and 260 CMP/B select the programme beginning with Stm. 235 of the branch FI1 to be carried out, because the FI mode provides [08] as mentioned before. A subsequent depression of the lever 6 will lead to the start of another motion picture sequence with fade-in effect. If the dial 7 is operated to select a new mode different from the FI mode, the programme of the mode set by the JMP/INITI9 instruction is carried out.

In operating the camera in the fade-in mode, it is possible to vary the length of that portion of the film which is to be exposed with the fade-in effect by selecting the initial and final degrees of the variable opening angle as desired. Further, in order to vary the intensity of the image in a linear relation to the number of frames exposed with fade-in effect, the equispaced arrangement of slits 21*a* shown in Figure 4 may be modified so as to be spaced by progressively larger angular distances. For example, the spacing may be proportional to the logarithms of angles in radians, as indicated by dotted lines in Figure 4.

(10) Fade-out (FO) mode:

The mode setting dial 7 is first turned to place the index in registry with a symbol FO, and then the main switch is turned, thereby writing the selected FO mode in the accumulator, and the mode discriminating operation is performed in a manner similar to that described in any of the heretofore described modes. The symbol F0 causes [09] to be loaded to the accumulator and Stm. 40 sets the zero flip-flop to "1". Stm. 41 JZ/F0, therefore, causes a jump to Stm. 264 CALL/START with which the branch F0 begins and which sets the auxiliary shutter to the initial open position. Upon Stm. 265 CALL/D12SET with the D12SET sub-routine of Stms. 615 to 619, two kinds of opening angle data selected by the dial 10 are stored in respective memory locations addressed by [41F1] and [41F2] respectively. As shown in Figure 5(C), there are available 12 values of shutter opening angle in 20° steps, which are selected one at a time by the dial 10, the selected value depending upon the particular combination of the switched positions of SW16 to SW19 co-operative with the dial 10. The first and second data of the opening angles set in this order represent degrees of initial and final angles, at which a fade-out effect respectively starts and terminates.

After such setting of the opening angle data has been performed, a sequence of instructions with Stms. 266 IN/RL; 267 CPI/[07]; and 268 JNZ/FOB is carried out. As in any of the heretofore described modes, only when the depression of the lever 6 to the second position and the depression of the push button 7*a* occur simultaneously, can an exposure operation with fade-out effect be carried out by a sequence of instructions beginning with Stm. 269. If the push button 7*a* is not yet depressed, Stm. 268 JNZ/FOB is followed next by Stm. 757 with which the branch FOB begins. This branch FOB contains 757 MVI/B,[09]; 758 IN/MODE; 759 CMP/B; 760 JZ/FO1; and 761 JMP/FO4. As explained in each of the heretofore described modes, when a new mode is selected different from the FO mode, this new mode is rendered effective. When the mode setting dial 7 is left unchanged from the FO mode position, the programme of Stms. 266 to 268 and 757 to 760 is repeatedly carried out until the push button 7*a* is depressed.

Upon depression of the push button 7*a* during the process of carrying out the just mentioned programme, Stm. 269 LDA/DEG1M is carried out so that the content of the memory location [41F1] is addressed by DEG1M; in other words, the opening angle data stored in [41F1] is loaded in the accumulator. Upon Stm. 270 MOV/E,A, the opening angle data in the accumulator is transferred to the E register. Upon Stm. 271 CALL/START, the aforementioned START sub-routine is carried out. In this, the film motor is driven in the forward direction. Upon Stm. 272 MVI/D,6, a value of decimal 6 is set in the D register. Upon Stm. 273 CALL/SHUTTER, the aforementioned SHUTTER sub-routine is carried out.

Now assuming that the first and and second values of the shutter opening angle entered by the aforementioned D12SET sub-routine are 220° and 160° respectively, then decimal numbers 5 and 11 are stored in [41F1] and [41F2] respectively. When the main shutter 21 of Figure 3A has rotated from the initial phase of 0° to a phase of 40°, the auxiliary shutter 39 fully covers the aperture. When the main shutter 21 of Figure 3A has rotated from the initial phase of 0° to a phase of 40°, the auxiliary shutter 39 fully covers the aperture. When the main shutter has advanced by more than 10°, reaching a phase of 50°, this is detected. When the main shutter has reached a phase of 60°, in other words, when the aperture 20 starts to be opened, the pulse motor is driven by one step to turn the auxiliary shutter in a counterclockwise direction to open the aperture 20 to

a point at which laterally half the entire area of the picture gate 20 is uncovered by the auxiliary shutter 39. When the main shutter further advances to a phase of 80°, the pulse motor is further driven by more than one step. When the main shutter reaches a phase of 100°, in other words, when the aperture is fully opened with respect to the main shutter, the auxiliary shutter is also moved completely clear of the aperture 20 so that the aperture 20 is fully open to an image-forming light beam.

Whilst the main shutter is operated to open the aperture at least in part over a range of 60 to 280° in phase angle, operation of the auxiliary shutter is controlled in such a manner that when the main shutter is in the range of 0 to 40° in phase angle, in other words, when the aperture is fully covered by the main shutter, the auxiliary shutter also fully covers the aperture; when the main shutter reaches a phase of 60° to start uncovering the aperture, the auxiliary shutter uncovers the aperture by half the entire area thereof; and when the main shutter reaches a phase of 100°, in other words, when the aperture is fully uncovered by the main shutter, the auxiliary shutter also fully uncovers the aperture. Thus, the auxiliary shutter is entirely removed from the aperture when the main shutter is uncovering the aperture, thereby a first frame exposure is made with a maximum possible opening angle of 220° of the main shutter as will be seen from Figure 7(a) wherein the main shutter covers and uncovers the aperture as indicated by the solid lines, while the auxiliary shutter covers and uncovers the aperture as indicated by the dashed lines. The auxiliary shutter covers the aperture over the same time interval as the main shutter, to prevent the auxiliary shutter from effecting the first exposure.

After the first frame exposure has been completed, the SHUTTER sub-routine is followed by Stm. 274 DCR/D which subtracts 1 from 6 in the D register. The result of the subtraction is discriminated by Stm. 275 JNZ/FO2. If not 0, the branch FO2 is repeatedly carried out. In this instance, the necessary number of repetitions of the branch FO2 is six so that the first six frames are exposed with the same opening angle of 220°. Thereafter, upon Stm. 276 INR/E, addition of 1 to the content of the E register is carried out, in this instance to 5 with the resulting content of the E register being increased to 6. Next, Stm. 277 CALL/DISPLAY1 is carried out to display the new content of E register by the light-emitting diodes LEDs 0 to 3 of Figure f(A). Upon Stm. 278 LDA/DEG2M, the content of the memory location addressed by DEG2M, i.e. [41F2], is loaded to the accumulator, thereby the opening angle data stored in [41F2] is transferred to the accumulator. As the opening angle data stored in [41F2] was assumed to be 11, the resulting content of the accumulator becomes 11. Upon Stm. 279 SUB/E, the content of the E register is subtracted from the content of the accumulator to obtain a result: $11 - 6 = 4$. Stm. 280 JNZ/FO5, detects whether or not the result of SUB/E is zero. If not zero, the instruction of the address denoted by the branch FO5 is carried out. In this way, a number of repetitions of the programme of Stms. 272 to 280 are carried out, until the content of the E register comes into coincidence with the opening angle set in [41F2].

Now because the result of the SUB/E is not zero, the just mentioned programme is carried out again. At this time, however, as the content of the E register was increased from 5 to 6, performance of the SHUTTER sub-routine causes the pulse motor to be driven when the main shutter has rotated to a phase of 70°, so that the resulting opening angle defined by the auxiliary shutter and the main shutter is narrower by 10° than that for which the first six frame exposures were made, being equal to 210° as shown by the dashed line in Figure 7(b). With a new opening angle of 210°, the next six frame exposures are made. To take a motion pixture sequence with fade-out effect, the start of the operation of the auxiliary shutter is caused to be delayed by a progressively longer time with respect to the phase angle of the main shutter with the resulting opening angle being decreased by 10° for every six frame exposures. When the final performance of SUB/E occurs with a result of zero, in other words, when the opening angle is narrowed to an angle equal to the data set in [41F2], Stm. 280 JNZ/FO5 is followed by Stm. 281 CALL/SHUTTER. In this instance, after the opening angle has reached 160°, Stm. 281 CALL/SHUTTER is carried out to make six more frame exposures with the narrowest opening angle of 160° which was entered as [11] in [41F2] as shown in Figure 7(c). Thus, operation of the auxiliary shutter is controlled to decrease the shutter opening angle from a first value of angle stored in [41F1] to a second value of angle stored in [41F2], in discrete steps of variation separated by 10° from each other for each six frame exposures.

After the completion of the last frame exposure with the narrowest opening angle dependent upon the data stored in [41F2], Stm. 282 IN/RL is carried out, thereby writing the state of switches SW1 and SW2 of Figure 5(A) in the accumulator, as mentioned before. Upon Stm. 283 SUI/[02], the content of the accumulator is subtracted by [02]. So long as the lever 6 remains depressed to the second position, the content of the accumulator written by IN/RL is [03], so that the sign flip-flop is not set. Upon Stm. 284 JP/FO3, the instruction of the address denoted by the branch FO3 is carried out. Until the lever 6 is released from the second position, a number of repetitions of the programme of Stms. 281 CALL/SHUTTER; 282 IN/RL; 283 SUI/[02] and 284 JP/FO3 are carried out with the result that the particular

motion picture sequence with fade-out effect is followed by a continuous series of the corresponding number of frame exposures with the opening angle dependent upon the data stored in [41F2], and remaining unchanged therethrough. When the lever 6 is released, Stm. 282 IN/RL results in the entry of [00] or [01] into the accumulator. Upon Stm. 284 284 JR/RO3, Stms. 285 IN/PHASE to 288 CALL/STOP succeed in sequence. When the main shutter nears to the position equivalent to the initial phase position, the film motor is stopped, and a current is allowed to flow through the solenoid of electromagnet for 5 milliseconds to drive the shaft 24*a* into engagement with the first arcuate slot 15*a*.

Upon Stm. 289 MVI/B,[09], [09] is written in the B register. Upon Stm. 290 IN/MODE, as mentioned before, the states of switches SW5 to SW8 are written in the accumulator. Upon Stm. 291 CMP/B, the content of the accumulator is compared with the content of the B register and when the contents are equal, the zero flip-flop is set to "1". When the content of the B register is smaller than that of the accumulator the carry flip-flop is set to "1". Upon Stm. 292 JZ/FO1, the condition of the zero flip-flop is detected. When the zero flip-flop was set to "1", the instruction of Stm. 266 denoted by the branch FO1 is carried out. Otherwise, Stm. 292 JZ/FO1 is followed by Stm. 293 JMP/INITI10. If the mode setting dial 7 is not moved out of registry with the FO mode during the above mentioned process of exposure operation, Stms. 290 IN/MODE and 291 CMP/B select the programme beginning with Stm. 266 of the branch FO1 to be carried out because FO mode provides [09], as mentioned before. A subsequent depression of the lever 6 will lead to the start of another motion picture sequence with fade-out effect. If the dial 7 is operated to select a new mode different from the FO mode, the programme of the mode set by the JMP/INITI10 instruction is carried out.

It will be understood from the foregoing that the length of that portion of the film which is to be exposed with fade-out effect can be varied by suitable selection of the initial and final values of the variable opening angle. By a similar modification to the arrangement of the slits 21*a* to that described in connection with the FI mode, the intensity of the imaging light can be varied in a linear manner over the entire length of that portion of the film which is exposed with fade-out effect.

(11) Overlap (OL) mode:

The mode setting dial 7 is first turned to place the index in registry with a symbol OL, and then the main switch is turned, thereby writing the OL mode in the accumulator, and the mode discriminating operation is performed in a similar manner to that described in any of the heretofore described modes. Now, when the OL mode is selected by the dial 7, [OA] is loaded in the accumulator, and Stm. 42 CPI/[OA] is carried out to effect the setting of the zero flip-flop to "1". Upon Stm. 43 JZ/OL, therefore, there occurs a jump to Stm. 295 CALL/PMOST with which the branch OL begins. This branch OL covers Stms. 295 CALL/PMOST to 311 JNZ/OL5 which are identical with Stms. 264 to 280 for the FO mode. Branch OL is thus carried out to take a motion picture sequence with the fade-out effect in discrete steps of a decrease in the shutter opening angle from a previously selected value to a value larger by 10° than another previously selected value of angle, each step occurring for the taking six frame exposures in sequence; Stm. 311 JNZ/OL5 is followed by a sequence of Stms. 312 IN/PHASE to 315 CALL/STOP so that the main shutter and the film motor are stopped in the position equivalent to the initial phase position. Thereafter, Stms. 316 IN/RL; 317 SUI/[02] and 318 JP/OL3 are carried out to permit this state to be maintained so long as the lever 6 remains depressed.

When the lever 6 is released, the next Stm. 319 LDA/DEG1M is carried out. The memory location addressed by DEG1M is loaded to the accumulator, this being the opening angle data for the start of the fade-out effect stored in [41F1]. Upon Stm. 320 MOV/E,A, the content of the accumulator is transferred to the E register. Upon Stm. 321 CALL/PMOST, the aforementioned PMOST sub-routine is carried out to turn the auxiliary shutter 39 in a clockwise direction to close the aperture. Upon Stm. 322 CALL/REV, the aforementioned REVERSE sub-routine is carried out to drive the film motor 12 in the reverse direction, thereby rewinding the film. Upon Stm. 323 MVI/D,6, a transfer of 6 to the D register occurs. Upon Stms. 324 IN/PHASE; 325 CPI/[00] and 326 JNZ/OL4, the main shutter is rotated counter-clockwise (as viewed in Figure 3A) to the initial phase position at which the film has been rewound by a length corresponding to one frame. Upon Stms. 327 IN/PHASE; 328 CPI/[00] and 329 JZ/K11, the main shutter is further rotated counter-clockwise causing the film to be rewound by one more frame. During this time, Stm. 330 DCR/D is carried out to subtract 1 from the content of the D register. This procedure is repeated until the subtraction results in zero. When the result is zero, Stm. 332 INR/E is permitted to follow, for otherwise the branch OL4 of Stms. 324 to 331 is carried out again. Now, because of the fact that the initial content of the D register was 6, the rewinding of the film by a length corresponding to the sum of six picture frames is required to set the zero flip-flop to "1" by carrying out Stm. 330 DCR/D. When the zero flip-flop is set to "1", Stm. 331 JNZ/OL4 is followed by Stm. INR/E which adds 1 to the content of the E register. Upon Stm. 333 LDA/DEG2M, the opening angle data for the finish

of fade-out effect is transferred to the accumulator. Upon Stms. 334 SUB/E and 335 JNZ/K12, the content of the E register is subtracted from the content of the accumulator, and when the content of the E register has come to coincidence with the content of the accumulator, the zero flip-flop is set to "1". When the condition of the zero flip-flop is "1", the programme beginning with Stm. 336 is carried out. Otherwise, the branch K12 of Stms. 323 to 335 is carried out repeatedly until the result of the SUB/E is zero. At the end, the film has been rewound to the point at which the fade-out was commenced.

Now assuming that a fade-out is to be effected with variation of the shutter opening angle from 220° to 180°, upon instructions of Stms. 300 to 311, a continuous series of six frame exposures are made four times with a stepwise variation of 10° in the opening angle from 220 to 190°, so that 4 x 6 = 24 frames are made with the fade-out effect. Therefore, upon Stms. 319 to 335, the rewinding of six frames for each 10° interval from 220 to 190° is performed – thus 4 times. When the film has been rewound by 24 frames based on the formula: 6 x 4 = 24, a sequence of Stms. 336 IN/PHASE; 337 CPI/34; 338 JNZ/K13 and 339 CALL/STOP are performed to stop the film motor with the shutter in the initial phase position.

When the lever 6 is depressed to the second position simultaneously with the depression of the push button 7*a* again, as detected by carrying out Stms. 340 IN/RL; 341 CPI/[07] and 342 JNZ/OL41, the aforesaid PMOST sub-routine is selected by Stm. 343 CALL/PMOST, and carried out to set the auxiliary shutter to the initial open position. Upon Stms. 344 to 363, which are identical with Stms. 239 to 257 for FI mode, that particular motion picture sequence which has been taken with fade-out effect is now re-exposed with a fade-in effect while the shutter opening angle is varied from the second angle data stored in the memory location [41F2] addressed by DEG2M, to the first angle data stored in the memory location [41F1] addressed by DEG1M. After the completion of the taking of the particular overlapped motion picture sequence, the shutter is maintained stationary in the aperture closed position, while the instructions of Stms. 364 MVI/B,[OA]; 365 IN/MODE; 366 CMP/B; 367 JZ/OL1; and 368 JMP/INITI11 are carried out in sequence. As for the programme of the NORMAL mode, a second of actuation of the release lever 6 followed by the depression of the push button 7*a* will lead to another start of the OL mode of the camera operation, provided that the mode setting dial 7 has not been moved from the OL mode position. If however the mode setting dial 7 has not been moved to select a new mode, the mode scanning programme starts.

It is to be noted again that the use of a modified arrangement of the slits 21*a* so the angular spacing follows a geometrical progression is particularly preferable on this overlap mode, because the total intensities of the overlapped exposures will then be made uniform.

(12) Wipe-in mode:

In this mode, the exposure operation is made with the picture aperture fully closed for a previously selected time interval, and thereafter exposures are made through an area which gradually is increasing from zero to the maximum. The mode setting dial 7 is first turned to place the index in registry with a symbol WI, and then the main switch is turned, thereby writing the WI mode in the accumulator, and the mode discriminating operation is performed in a manner similar to that described in any of the heretofore described modes. Now, when the WI mode is selected by the dial 7, [OB] is loaded in the accumulator and Stm. 44 is carried out to set the zero flip-flop to "1". Upon Stm. 45 JZ/WI, therefore, there occurs a jump to Stm. 370 CALL/PMCST with which the branch WI begins and which sets the auxiliary shutter to the aperture closed position, as shown in Figure 9(A). Upon Stm. 371 CALL/T1SET, the aforementioned T1SET sub-routine is carried out to set a time data in the H register. Now assuming that the selected time data is 1 second, [06] is transferred to the H register as mentioned before. Upon the simultaneous depression of the lever 6 to the second position and the depression of the push button 7*a* as detected by carrying out Stms. 372 IN/RL; 373 CPI/[07]; and 374 JNZ/WIB, an exposure operation in wipe-in mode starts to be performed by a sequence of instructions beginning with Stm. 375. If the push button 7*a* is not yet depressed, Stm. 374 JNZ/WIB is followed next by Stm. 767 with which the branch WIB begins. This branch WIB contains 767 MVI/B.[OB]; 768 IN/MODE; 769 CMP/B; 770 JZ/WI1; and 771 JMP/WI4. As has been explained in each of the heretofore described modes, when a new mode different from WI mode is selected this new mode is rendered effective. If the mode setting dial 7 is left unchanged from WI mode position, the programme of Stms. 372 to 374 and 767 to 770 is repeatedly carried out until the push button 7*a* is depressed.

Upon depression of the push button 7*a* during the steps of the just mentioned programme, Stm. 375 CALL/START is carried out by the START sub-routine causing the film motor to start rotating. As the auxiliary shutter has been operated to close fully the aperture 20, no exposure is made. Upon Stm. 376 MVI/D,2, a value of decimal 2 are transferred to the D register. Upon next Stm. 377 CALL/PMO, the pulse motor is driven for rotation in a direction to open the picture gate, thereby the auxiliary shutter half-opens the aperture, as shown in Figure 9B. Upon Stm. 378 CALL/MS5, this state is maintained for 5 milliseconds by the MS5 sub-routine. Upon Stm. 379 CALL/PMSTOP, the power supply to the pulse motor

38 is stopped by the PMSTOP sub-routine. Upon Stm. 380 CALL/T1, an exposure operation is performed for 1 second by the T1 sub-routine, with the auxiliary shutter half opened. Thereafter, upon Stm. 381 DCR/D, a subtraction of 1 from the content of the D register is performed. If the subtraction results in zero, Stm. 382 JNZ/WI2 is followed by Stm. 382 IN/RL. If not zero, the programme of Stms. 377 to 380 is carried out repeatedly until the DCR/D results in zero. Now, the content of the D register was 2 so that after the programme of Stms. 377 to 380 has been carried out two times, the instructions of Stm. 383 and those that follow are carried out. Accordingly, after an exposure operation has been performed with an aperture as shown in Figure 9B for 1 second the pulse motor is driven by one more step causing the auxiliary shutter to open fully the aperture as shown in Figure 9C and a further exposure operation is performed for 1 second. Then, the programme beginning with Stm. 383 is carried out. In such a manner, the aperture is half open for the first 1 second exposure, and thereafter in the fully open state for a second 1 second exposure; thereby the film is first exposed over half the entire area thereof, and then exposed over the entire area thereof.

After the wipe-in exposure operation has been performed as described, the programme of Stms. 383 IN/RL to 385 JPWI3 is carried out. As in the instructions of Stms. 57 to 59 for the NORMAL mode, so long as the lever 6 remains depressed, the programme of Stms. 383 IN/RL to 385 JP/WI3 for the branch WI3 is carried out repeatedly to continue exposing with a fully open aperture. When the lever 6 is released, the JP instruction of Stm. 385 proceeds to the CALL/STOP of Stm. 389, and the STOP sub-routine is carried out to terminate the exposure operation. Thereafter, the instructions of Stms. 390 to 349 are carried out so that if the mode setting dial is left in the WI mode position, a second of actuation of the release starts an exposure operation in WI mode, while if the dial 7 has been displaced from the WI position, the mode scanning programme is carried out. This procedure is similar to that for the NORMAL mode.

(13) Wipe-out (WO) mode:

In this mode, the exposure operation is made while the picture aperture is first fully opened for a previously selected time interval and then gradually decreased to zero. The mode setting dial 7 is first turned to place the index in registry with a symbol WO, and then the main switch is turned, thereby writing the WO mode in the accumulator, and the mode discriminating operation is performed in a manner similar to that described in any of the heretofore described modes. Now, when the WO mode is selected by the dial 7, [OC] is loaded in the accumulator, and Stm. 46 CPI/[OC] is carried out to set the zero flip-flop to "1". Upon Stm. 47 JZ/WO, therefore, there occurs a jump to Stm. 396 CALL/PMOST with which the branch WO begins and which sets the auxiliary shutter to the initial aperture open position. Upon Stm. 397 CALL/T1SET, the aforementioned T1SET sub-routine is carried out to set a desired time data in the H register. Now assuming that the selected time data is 1 second, [06] is transferred to the H register as mentioned before. Upon the simultaneous depression of the lever 6 to the second position and the depression of the push button *7a* as detected by carrying out Stms. 398 IN/RL; 399 CPI/[07] and 400 JNZ/WOB, Stm. 401 CALL/START follows to start an exposure operation in the WO mode. If the push button *7a* is not yet depressed, Stm. 400 JNZ/WOB is followed next by Stm. 772 with which the branch WOB begins. This branch contains 772 MVI/B,[OC]; 773 IN/MODE; 774 CMP/B; 775 JZ/WO1; and 776 JMP/WO3. As has been explained in each of the heretofore described modes, when a new mode different from WO mode is selected, this new mode is rendered effective. If the mode setting dial 7 is left unchanged from WO mode position, the programme of Stms. 398 to 400 and 772 to 775 is repeatedly carried out until the push button *7a* is depressed.

Upon depression of the push button *7a* during the steps of the just mentioned programme, Stm. 401 CALL/START is carried out to start an exposure operation. Thereafter, upon Stm. 402 MVI/D,2, a transfer of a value representative of decimal 2 to the D register occurs. Upon the next Stm. 403 CALL/PMC, the aforementioned PMC sub-routine is carried out to set the auxiliary shutter in a position where the apenture is open over a half of its entire area. Upon Stms. 404 CALL/MS5 and 405 CALL/PMSTOP, the power supply to the pulse motor is stopped, as in WI mode. Thereafter, upon Stm. 406 CALL/T1, this state (where the aperture is half closed) is maintained for 1 second, while permitting the exposure operation to proceed. Upon Stms. 407 DCR/D and 408 JNZ/WO2, which are identical with Stms. 381 and 382 for WI mode, there occurs a number of jumps to Stm. 403 until the result of the DCR/D is zero. Now the content of the D register was 2, so that after an exposure operation has been performed with the half closed aperture for the first 1 second and with the fully closed aperture for a second 1 second, Stms. 409 IN/PHASE to 412 CALL/STOP are carried out to stop the main shutter in the position equivalent to the initial phase position. After that, the instructions of Stms. 413 to 417 are carried out so that if the mode setting dial 7 is left unchanged from the wipe-out mode position, a second of actuation of the lever 6 starts an exposure operation in the WO mode, while if the dial 7 is displaced from the WO position, the mode scanning programme is carried out. The procedure is similar

to that for the NORMAL mode.

As a result, by a succession of exposure operations the first one of which is performed for 1 second with the half closed aperture and the second one of which is performed with the fully closed aperture for 1 second, picture images are first formed on film frames only over half the area of each frame, and then no picture images are formed on subsequent film frames; thus a picture sequence is taken in the WO mode.

(14) Wide Lap (WL) mode:

This mode makes wipe-out exposure and then a wipe-in exposure over the same portion of the film. Prior to making a wipe lap exposure, an operating member (not shown) is manipulated so that the stop pin 40*b* (Figure 3A) is moved from the normal position (shown in Figure 9) to the left, reaching the position shown in Figure 10. Here, the stop pin 40*b* is held in abutment against the left-hand end of the arcuate slot 101*c*. Then, the mode setting dial 7 is turned to place the index in registry with a symbol WL, and the main switch is turned, thereby writing the WL mode in the accumulator and the mode discriminating operation is performed in a manner similar to that described in any of the heretofore described modes. Now, when the WL mode is selected by the dial 7, [OD] is loaded in the accumulator, and Stm. 48 CPI/[OD] is carried out to set the zero flip-flop to "1". Upon Stm. 49 JZ/WL, therefore, there occurs a jump to Stm. 419 CALL/PMOST with which the branch WL begins and which sets the auxiliary shutter to the initial aperture open position. Upon Stm. 420 CALL/T1SET, the aforementioned T1SET sub-routine is carried out to set a desired time data in the H register. Upon simultaneous depression of the lever 6 to the second position and the depression of the push button 7*a* as detected by carrying out Stms. 421 IN/RL; 422 CPI/[07]; and 423 JNZ/WLB, Stm. 424 CALL/START follows to start an exposure operation in the WL mode. If the push button 7*a* is not yet depressed, Stm. 423 JNZ/WLB is followed by Stm. 777 with which the branch WLB begins. This branch WLB contains Stms. 777 MVI/B, [OD]; 778 IN/MODE; 779 CMP/B; 780 JZ/WL1; and 781 JMP/WL7. As has been explained in each of the heretofore described modes, when a new mode different from WL mode is selected, this new mode is rendered effective. If the mode setting dial 7 is left unchanged from WL mode position, the programme of Stms. 421 to 423 and 777 to 780 is repeatedly carried out until the push button 7*a* is depressed.

Upon depression of the push button 7*a* during the steps of the just mentioned programme, Stm. 424 CALL/START is carried out to start an exposure operation, while the aperture is fully open. Upon Stm. 425 CALL/T1, the exposure operation is permitted to proceed for a time interval dependent upon the time data stored in the H register. The subsequent Stms. 426 to 436 are identical with Stms. 402 to 412 for the wipe-out mode, so that a continuous succession of exposure operations are made with a variation in the open aperture area from the fully open state through half open to the fully closed state.

When the lever is released as detected by Stms. 437 IN/RL; 438 SUI/[02] and 439 JP/WL3, a programme beginning with Stm. 440 is carried out. This programme comprises instructions of Stms. 440 MVI/D,3; 441 CALL/REV; 442 CALL/T1; 443 DCR/D and 444 JNZ/WL4. Upon Stm. 440 MVI/D,3, a transfer of 3 to the D register occurs. Upon 441 CALL/REV, the film motor is driven for rotation in the reverse direction to rewind the film for a time interval which is controlled by the next Stm. 442 CALL/T1. At the termination of this time interval, Stm. 443 is carried out to subtract 1 from the content of the D register. When the result of DCR/D as detected by the next Stm. 444 JNZ/WL4 is not zero, the sequence of the instructions of Stms. 442 to 444 is carried out again. This procedure repeats until the DCR/D results in zero. Now, the content of the D register was 3, so that after the CALL/T1 has been repeated 3 times, the result of the DCR/D becomes zero, to start a programme of Stms. 445 IN/PHASE to 448 CALL/STOP. As a result, the rewinding of the film takes place for a time interval equal to 3 times the selected time data. This means that the film is rewound to that frame at which the wipe-out exposure operation began.

When the lever 6 is actuated the second time, as detected by Stms. 449 IN/RL; 450 CPI/[03]; and 451 JNZ/WL5, Stm. 452 CALL/START is carried out to start driving the film motor for rotation in the forward direction. Upon Stm. 453 CALL/T1, an exposure operation is performed with the aperture fully closed for the time interval T1. Subsequently, Stms. 454 to 460, which are identical with Stms. 376 to 382 of the wipe-in mode except that the CALL/PMO is replaced by the CALL/PMC, are carried out with the result that the auxiliary shutter assumes the position shown in Figure 10A to open one half of the aperture while an exposure operation is performed for the time interval T1, and then takes the position shown in Figure 10B where the aperture is fully open to perform a subsequent exposure operation again for the time interval T1. Thereafter, Stms. 461 IN/PHASE; 462 CPI/34; 463 JNZ/K19; and 464 CALL/STOP are carried out to stop the main shutter in the position equivalent to the initial phase position.

In summary, for the first time interval, an image of a first scene is formed on the film through the fully open aperture as shown in Figure 9C; for the second time interval, images of the first scene and a second scene (which is different from the first scene) are formed on the film along the same length thereof but on

areas laterally separated as these images are projected through the respective areas of the aperture as shown in Figures 9B and 10A; and for the third time interval, only the second scene is photographed through the fully open aperture shown in Figure 10B, on that portion of the film which was run past the fully closed aperture shown in Figure 9A. As a result, the first scene is wiped out from right to left as viewed in Figures 9 and 10, and at the same time the second scene is wiped in from the same direction.

After the competion of the wipe lap exposure operation, Stms. 464–1 CALL/PMO; 464–2 CALL/MS5; 464–3 CALL/PMSTOP; and 465 CALL/PMOST are carried out in sequence with the result that the auxiliary shutter is set to the initial open position. Upon Stms. 466 MVI/B,[OD]; 467 IN/MODE; 468 CMP/B; 469 JZ/WL1 and 470 JMP/INITI14, a second of actuation of the release lever 6 followed by the depression of the push button 7*a* will lead to the camera starting in the WL mode provided that the mode setting dial 7 is left unchanged from the WL mode position. Otherwise, if the mode setting dial 7 has been turned from the WL position to select a new mode, the mode scanning programme starts.

It will be seen from the foregoing that the cinematographic camera of this invention is controlled by the use of a microprocessor and an associated programme. Although this programme is described as written in ROM, it is of course possible to write this programme in RAM (random access memory). Furthermore, the use of a programme in controlling the cinematographic camera makes it possible selectively to perform a wide variety of operating modes while nevertheless preserving a relatively simple control circuit.

WHAT WE CLAIM IS:–

1. An intermittent film advance cinematographic camera including: a film transport motor; a shutter for exposing a transported film; a shutter control mechanism co-operative with said film transport motor; a control circuit for controlling at least the driving and stopping operations of said motor; and a multi-mode processing circuit having a number of pre-programmed operating modes and arranged so as to control said control circuit in accordance with a manually-selected programme, thereby automatically to carry out a required mode of photographic exposing operation.

2. A cinematographic camera according to claim 1, wherein said programme is stored in a memory circuit.

3. A cinematographic camera according to claim 2, wherein said memory circuit is a read-only memory.

4. A cinematographic camera according to any of claims 1 to 3, wherein the manually-selected programme corresponding to an operating mode for photographic exposure is selected by a mode selecting programme.

5. A cinematographic camera according to claim 4, wherein there is provided a manually operable mode selecting means for selecting a photographic mode and for forming a signal corresponding to the selected mode, said processing circuit being arranged to carry out said mode selecting programme in response to said signal.

6. A cinematographic camera according to any of claims 1 to 5, wherein an auxiliary shutter is provided to open and close a picture aperture independently of the shutter (main shutter) controlled by said shutter control mechanism.

7. A cinematographic camera according to claim 6, wherein both the main shutter and the auxiliary shutter are controlled by said control circuit under instructions from the processing circuit, the auxiliary shutter being actuated only at a predetermined phase of the main shutter dependent upon the selected exposure operation.

8. A cinematographic camera according to any of the preceding claims, wherein manually-operable release means are provided, said programme operating to detect the manual actuation of the release means and then to effect the required control to drive said film transporting motor.

9. A cinematographic camera according to claim 8, wherein the termination of the actuation of the release means is detected by a step in said programme whereafter a stop signal is applied to the control circuit to stop the driving of said film transport motor.

10. A cinematographic camera according to claim 9, wherein phase detecting means are provided for detecting the phase of the shutter, said programme operating to produce said stop signal when the shutter assumes the phase at which the aperture is closed.

11. A cinematographic camera according to claim 6, or any claim appendent thereto, wherein a light measuring circuit is provided for producing an output corresponding to the brightness of an object to be photographed, the auxiliary shutter being actuated under the control of said programme to close the aperture on the basis of the output of said light measuring circuit.

12. A cinematographic camera according to any of the preceding claims, wherein time information setting means are provided for setting time information into the processing circuit, the film transport motor being actuated under the control of said programme for a set time interval whereafter the motor is stopped.

13. A cinematographic camera according to any of claims 1 to 11, wherein means are provided for setting first and second time informations into the processing circuit.

14. A cinematographic camera according to claim 13, wherein the control circuit is controlled by the programme to perform a number of single frame exposure operations, each successive single frame exposure operation follow-

ing the preceding operation by said pre-set first time interval, whereafter the second time interval elapses before the next series of single frame exposures occurs.

15. A cinematographic camera according to claim 13, wherein the control circuit is controlled by the programme to actuate the film transport motor after the elapse of said first pre-set time interval, the motor being actuated for said second pre-set time interval.

16. A cinematographic camera according to claim 13, wherein the control circuit is controlled by the programme to actuate the film transport motor for a time equal to the first pre-set time, whereafter the motor is stopped for a time equal to the second pre-set time.

17. A cinematographic camera according to claim 13, wherein the control circuit is controlled by the programme to hold the shutter in a phase at which the aperture is open for the first pre-set time, and then to hole the shutter in a phase at which the aperture is closed for the second pre-set time.

18. A cinematographic camera according to any of the preceding claims, wherein a light measuring circuit is provided for producing an output corresponding to the brightness of an object to be photographed, the control circuit operating under the control of the programme to hold the shutter in a phase at which the aperture is open for a time corresponding to the output of said light measuring circuit, the film transport motor being stopped, during such time.

19. The cinematographic camera according to any of the preceding claims, wherein the shutter comprises a rotatable blade and there is provided an opening angle control circuit for controlling the angle of the shutter for which the aperture is open.

20. A cinematographic camera according to claim 19, wherein the opening angle control circuit is controlled by the programme so as to reduce the angle over which the shutter is open as a film is transported and exposed.

21. A cinematographic camera according to claim 19, wherein the opening angle control circuit is controlled by the programme so as to increase the angle over which the shutter is open as a film is transported and exposed.

22. A cinematographic camera according to claim 19, wherein the opening angle control circuit is controlled by the programme so that in a first period of transport of the film by the film transport motor the angle over which the shutter is open is reduced as the film is transported and exposed, and in a second period of transport of the film the angle over which the shutter is open is increased as the film is transported and exposed, the film transport motor being driven for reverse rotation to rewind the film between the first and second periods whereby the same length of film is exposed twice, once with decreasing opening angle and then with increasing opening angle.

23. A cinematographic camera according to any of claims 19 to 22, wherein said shutter has a fixed opening angle, and an auxiliary shutter is provided and which is controlled by the opening angle control circuit to decrease the effective opening angle of the said shutter.

24. A cinematographic camera according to claim 23, wherein said auxiliary shutter comprises a blade movable across the picture aperture by means of a motor under the control of the opening angle control circuit.

25. A cinematographic camera according to claim 25, wherein said motor is a pulse controlled stepping motor.

26. A cinematographic camera substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

27. A method of controlling a cinematographic camera according to any of claims 1 to 26 and substantially as hereinbefore described.

28. A method of operating a cinematographic camera according to claim 1, in which method the processing circuit follows a series of steps defined in a programme so as to control the control circuit, whereby the film transport motor and shutter are operated to perform a selected exposure operation on a film.

29. A method according to claim 29 in which the processing circuit reads the programme from a read-only memory.

30. A method according to claim 28 or claim 29, in which the cinematographic camera has an auxiliary shutter and means to sense the brightness of an object being filmed, the programme including instructions for the processing circuit to assess the correct exposure time taking into account the film speed and the object brightness and to cause the control circuit to actuate the auxiliary shutter in conjunction with the main shutter thereby correctly to expose the film.

31. A method of operating a cinematographic camera according to claim 28 and substantially as hereinbefore described with reference to the accompanying drawings.

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Agents for the Applicants.

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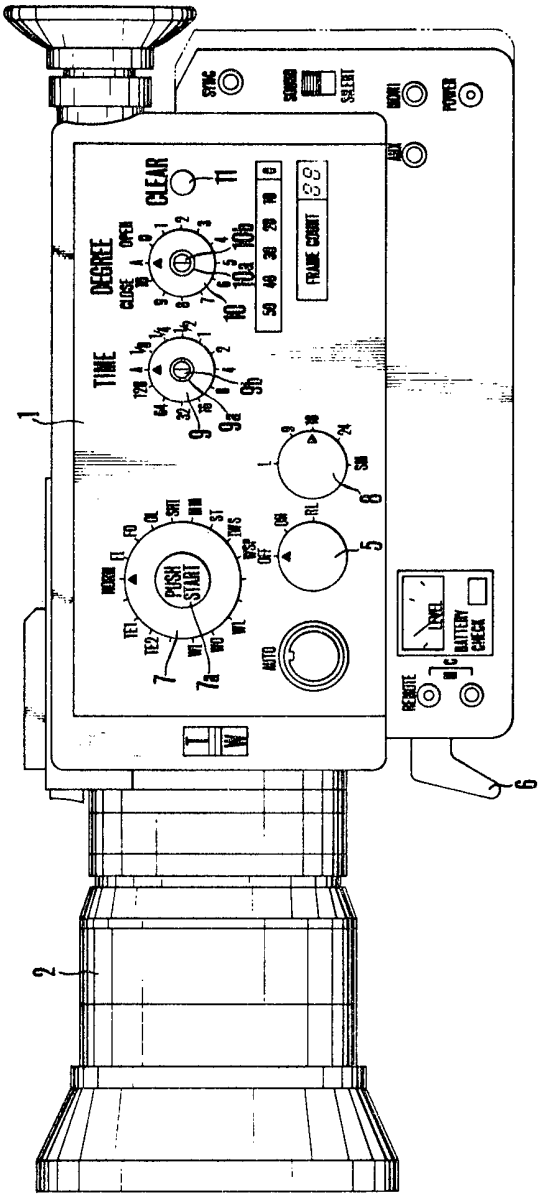
Sheet 1

FIG.1



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Sheet 2

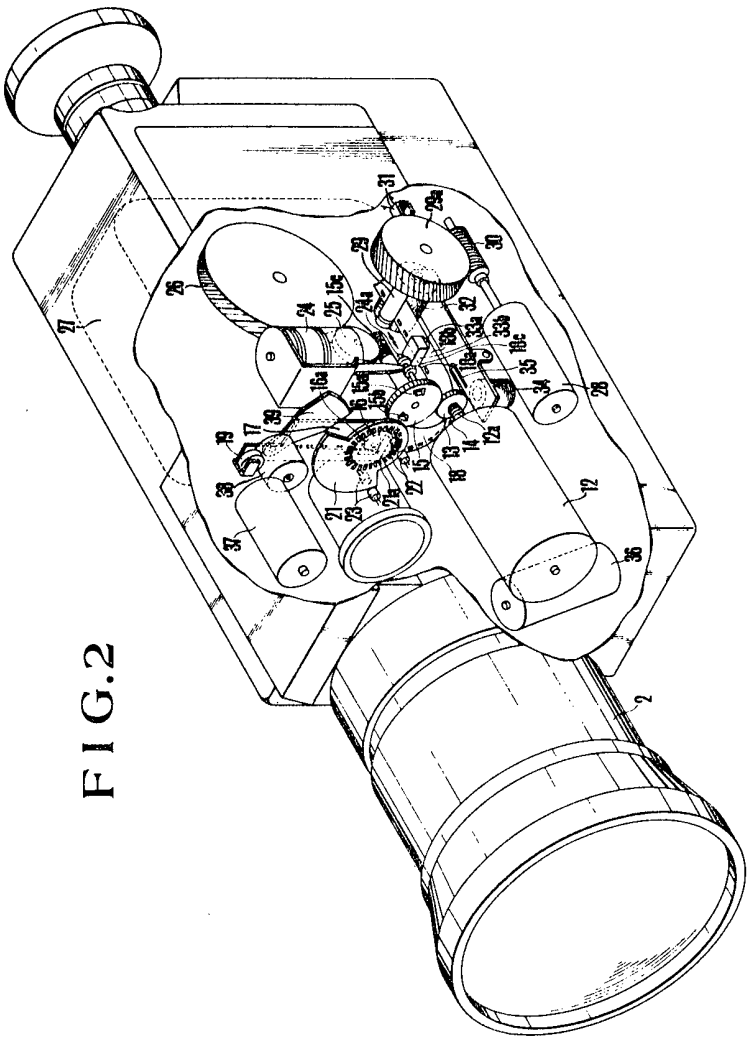

FIG.2

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Sheet 3

FIG.3A

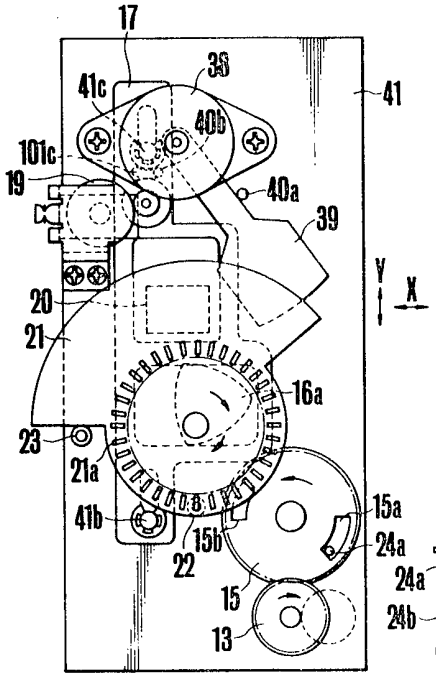

FIG.3C

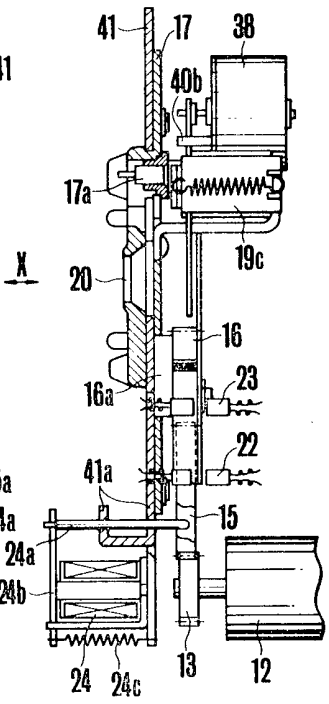

FIG.3B

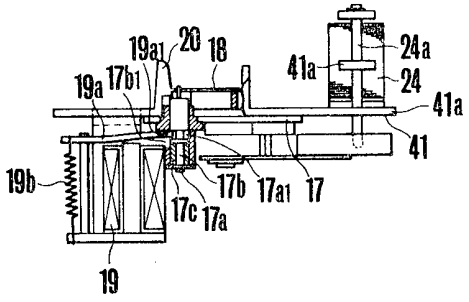

FIG.4

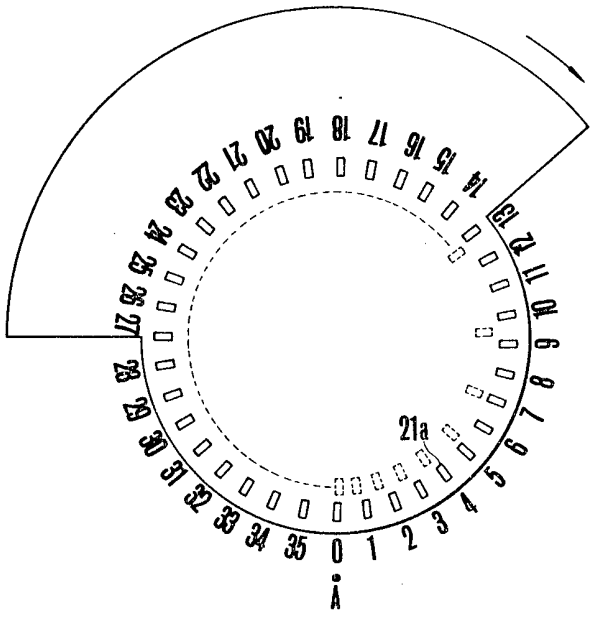

FIG.5e

IN		OUT		
HEX	PROGRAM INSTRUCTION	HEX	PROGRAM INSTRUCTION	DEVICE
# 10	R L	# 10	DISP 1	L E D
# 11	MODE	# 11	CONT 1	Mg1,FILM MOTOR
# 12	F P S	# 12	CONT 2	PULSE MOTOR
# 13	TIME	# 13	DISP 2	L E D
# 14	DEG	# 14	CONT 3	M g 2
# 15	DATA SET	# 15	CONT 4	M g 3
# 18	PHASE	# 16	CONT 5	
# 20	EXT	# 17	CONT 6	
# 21	LEVEL			
# 22	I C C			

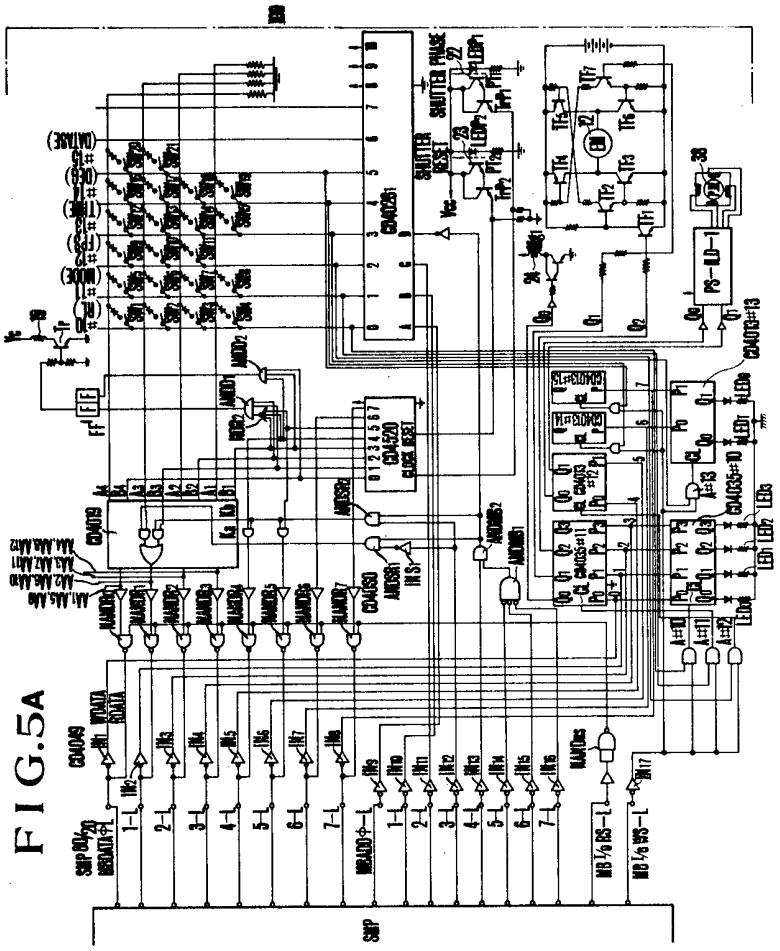

FIG.5A

FIG.5B

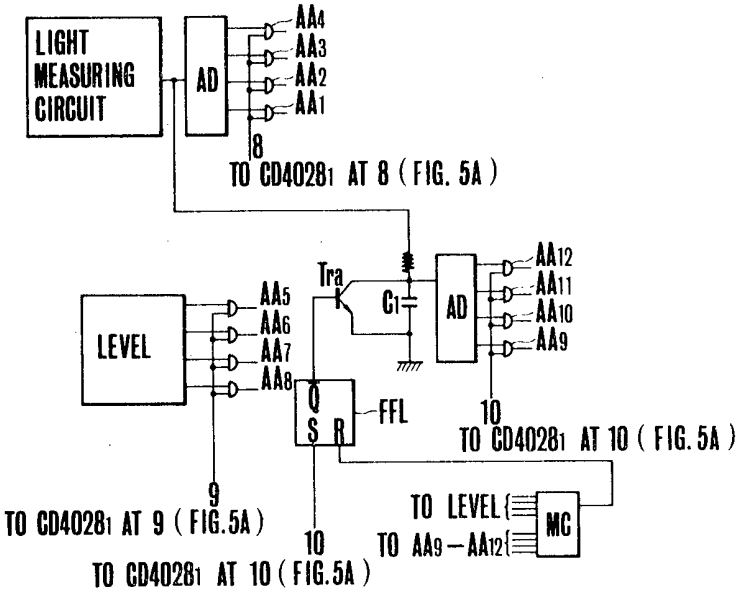
LIGHT MEASURING CIRCUIT
AD
AA4
AA3
AA2
AA1
8
TO CD4028₁ AT 8 (FIG. 5A)
Tra
C1
AD
AA12
AA11
AA10
AA9
LEVEL
AA5
AA6
AA7
AA8
Q
S R
FFL
10
TO CD4028₁ AT 10 (FIG. 5A)
9
TO CD4028₁ AT 9 (FIG.5A)
10
TO CD4028₁ AT 10 (FIG.5A)
TO LEVEL
TO AA9 – AA12
MC

FIG.5c

	MBOATAD+3-1				# 10 (RL)				# 11 MODE								# 12 FPS	# 13 TIME								# 14 DEG								# 15 DATASET		
HEX	3	2	1	0	SW 1	SW 2	SW 3	SW 4	SW 5	SW 6	SW 7	SW 8		SW 12	SW 13	SW 14	SW 15		SW 16	SW 17	SW 18	SW 19			SW 20	SW 21	
#0	H	H	H	H	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	NORM	OFF	OFF	OFF	OFF	1	OFF	OFF	OFF	OFF	AUTO				
#1	H	H	H	L	ON	OFF	OFF	OFF	ON	OFF	OFF	OFF	DIAPHRAGM	ON	OFF	OFF	OFF	9	ON	OFF	OFF	OFF	220°		ON	OFF	TIME
#2	H	H	L	H					OFF	ON	OFF	OFF	MM	OFF	ON	OFF	OFF	18	OFF	ON	OFF	OFF	200°		OFF	ON	DEG
#3	H	H	L	L	ON	ON	OFF	OFF	ON	ON	OFF	OFF	IWS	ON	ON	OFF	OFF	24	ON	OFF	OFF	OFF	180°				
#4	H	L	H	H					OFF	OFF	ON	OFF	WS	OFF	OFF	ON	OFF	SW	OFF	ON	ON	OFF	160°				
#5	H	L	H	L					ON	OFF	ON	OFF	ST		ON	OFF	ON		ON	OFF	ON	OFF	140°				
#6	H	L	L	H					OFF	ON	ON	OFF	TE1		OFF	ON	ON		OFF	ON	ON	OFF	120°				
#7	H	L	L	L	ON	ON	ON	OFF	ON	ON	ON	OFF	TE2		ON	ON	ON		ON	ON	ON	OFF	100°				
#8	L	H	H	H					OFF	OFF	OFF	ON	FI		OFF	OFF	OFF		OFF	OFF	OFF	ON	80°				
#9	L	H	H	L					ON	OFF	OFF	ON	FO						ON	OFF	OFF	ON	60°				
#A	L	H	L	H					OFF	ON	OFF	ON	OL						OFF	ON	OFF	ON	40°				
#B	L	H	L	L					ON	ON	OFF	ON	WI						ON	ON	OFF	ON	20°				
#C	L	L	H	H					OFF	OFF	ON	ON	WO						OFF	OFF	ON	ON	0°				
#D	L	L	H	L					ON	OFF	ON	ON	WL														
#E	L	L	L	H																							
#F	L	L	L	L																							

FIG.5d

MBADD0~7 HEX DATA	OPERATION OF OUTPUT DEVICE			MBDATA 0 ~ 7								
				HEX	7	6	5	4	3	2	1	0
# 10	LED DISPLAY (SHUTTER PHASE)			# 00~#0F	H	H	H	H	L	L	L	L
# 11	Mg 1 DE-ENERGIZED	FM (FILM MOTOR) STOP		# 02	H	H	H	H	H	H	L	H
	〃	FORWARD DIRECTION		# 06	H	H	H	H	H	L	L	H
	〃	REVERSE DIRECTION		# 00	H	H	H	H	H	H	H	H
	ENERGIZED	STOP		# 03	H	H	H	H	H	H	L	L
	〃	FORWARD DIRECTION		# 07	H	H	H	H	H	L	L	L
# 12	PULSE MOTOR	STOP		# 00	H	H	H	H	H	H	H	H
	〃	CLOCKWISE DIRECTION		# 20	H	L	H	H	H	H	H	H
	〃	COUNTER CLOCKWISE DIRECTION		# 10	H	H	L	H	H	H	H	H
# 13	LED		ON	# 30	H	L	L	H	H	H	H	H
			OFF	# 00	H	H	H	H	H	H	H	H
# 14	TIME DATA LED		ON	# 40	H	L	H	H	H	H	H	H
			OFF	# 00	H	H	H	H	H	H	H	H
# 15	OPENING ANGLE DATA LED		ON	# 80	L	H	H	H	H	H	H	H
			OFF	# 00	H	H	H	H	H	H	H	H

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FIG.6

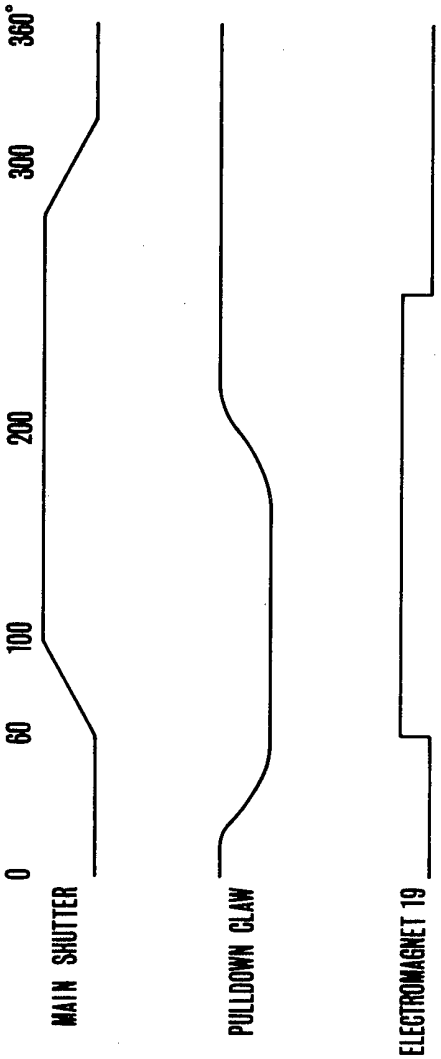

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FIG.7 (a)

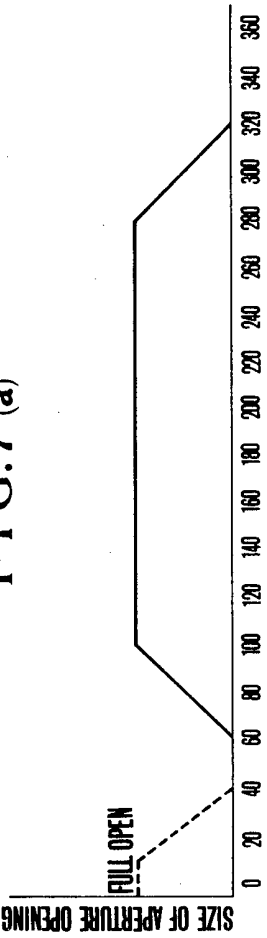


FIG.7 (b)

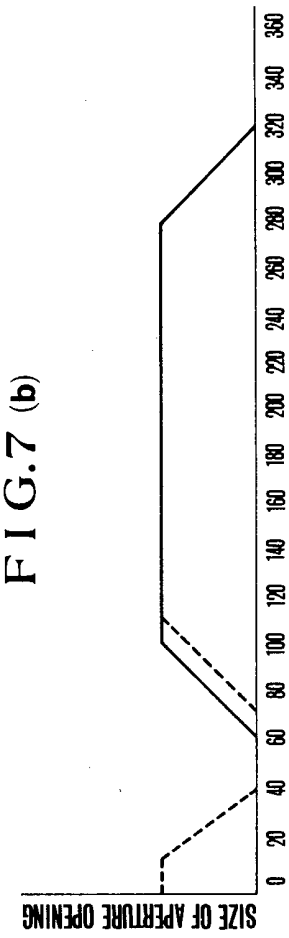


FIG.7 (c)

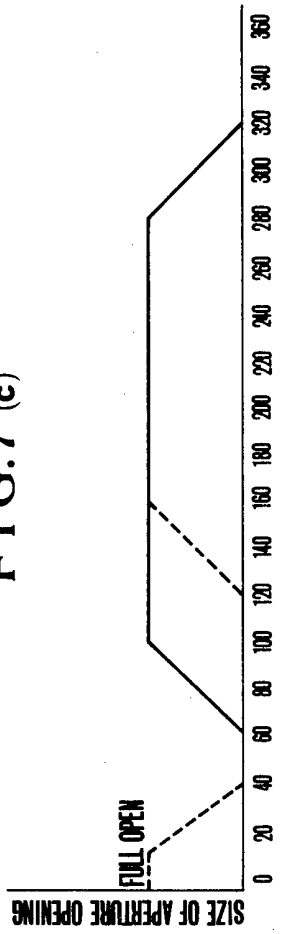

SIZE OF APERTURE OPENING
FULL OPEN
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360

FIG.7 (d)

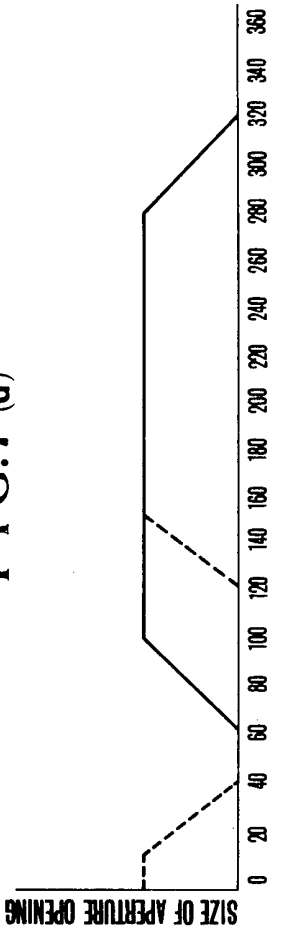

SIZE OF APERTURE OPENING
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360

FIG.8 (a)

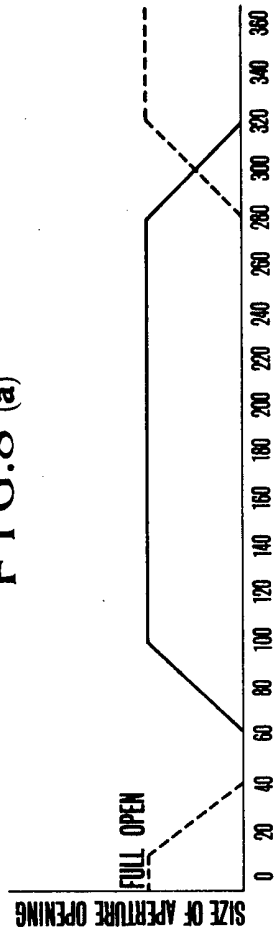

SIZE OF APERTURE OPENING
FULL OPEN
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360

FIG.8 (b)

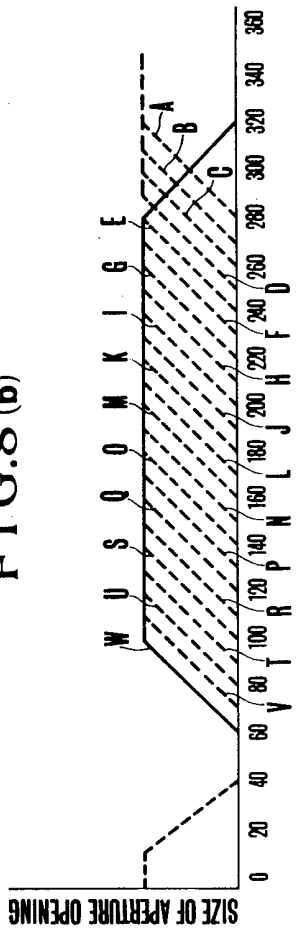

SIZE OF APERTURE OPENING
A
B
C
W U S Q O M K I G E
V T R P N L J H F D
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360

FIG.9

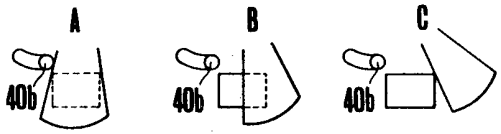
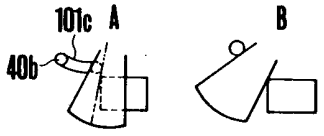


FIG.10



1588264 COMPLETE SPECIFICATION

47 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 14

FIG.11

INSTRUCTION SYMBOL	OPERAND	INSTRUCTION CODE											CONTENT & MEANING OF OPERATION ACCORDING TO INSTRUCTION	EFFECT ON CARRY FLIP-FLOP
		FIRST BITE									SECOND BITE	THIRD BITE		
M O V	A.E	7B			1	1	1	0	1	1			TRANSFER 8 BITS DATA IN REGISTER E TO REGISTER A	
M O V	E.A	5F	0	1	0	1	1	1	1	1			" A " E	
M O V	L.A	6F			1	0	1	1	1	1			" A " L	
M O V	H.A	67			1	0	0	1	1	1			" A " H	
M V I	A	3E			1	1	1				8 BITS DATA		SET 8 BITS DATA OF SECOND BITE IN REGISTER A	
M V I	B	06	0	0	0	0	0	1	1	0	"		" B	
M V I	D	16			0	1	0				"		" D	
I N R	E	1C	0	0	0	1	1	1	0	0			ADD +1 TO DATA IN REGISTER E	
D C R	A	3D			1	1	1						ADD −1 TO DATA IN REGISTER A	
D C R	B	05			0	0	0						" B	
D C R	D	15	0	0	0	1	0	1	0	1			" D	
D C R	E	1D			0	1	1						" E	
D C R	H	25			1	0	0						" H	
D C R	L	2D			1	0	1						" L	
S U B	E	93	1	0	0	1	0	0	1	1			SET IN REGISTER A DIFFERENCE BETWEEN DATA IN REGISTERS A AND E.	EFFECTIVE
S U I		D6	1	1	0	1	0	1	1	0	8 BITS DATA		SET IN REGISTER A DIFFERENCE BETWEEN 8 BITS DATA OF SECOND BITE AND DATA IN REGISTER A.	EFFECTIVE
A N I		E6	1	1	1	0	0	1	1	0	8 BITS DATA		SET IN REGISTER A LOGIC PRODUCT OF 8 BITS DATA OF SECOND BITE AND DATA IN REGISTER A.	EFFECTIVE
C P I		FE	1	1	1	1	1	1	1	0	8 BITS DATA		COMPARE 8 BITS DATA OF SECOND BITE AND DATA IN REGISTER A. CONTENT OF REGISTER A UNCHANGED.	EFFECTIVE
R L C		07	0	0	0	0	0	1	1	1			SHIFT DATA IN REGISTER A TO LEFT BY 1 BIT. ADVANCE A_7 AND A_0 TO CARRY F/F. AM · 1 → AM	
S T A		32	0	0	1	1	0	0	1	0	8 BITS DATA	8 BITS DATA	MAKE THIRD BINARY WORD UPPER ADDRESS AND SECOND BITE LOWER ADDRESS. TRANSFER DATA IN REGISTER A TO MEMORY ADDRESS.	
O U T		D3	1	1	0	1	0	0	1	1	8 BITS DATA		SEND I/O DEVICE CODE DENOTED IN SECOND BITE TO ADDRESS BUS AND DATA IN REGISTER A TO DATA BUS.	
I N		DB	1	1	0	1	1	0	1	1	8 BITS DATA		SEND I/O DEVICE CODE DENOTED IN SECOND BITE TO ADRESS BUS AND DATA AT DATA BUS TO REGISTER A.	
J M P		C3	1	1	0	0	0	0	1	1	8 BITS DATA	8 BITS DATA	JUMP TO MEMORY ADDRESS FOR THIRD BITE MADE UPPER ADDRESS AND SECOND BITE LOWER ADDRESS.	
J N Z		C2	1	1	0	0	0	0	1	0	"	"	JUMP TO MEMORY ADDRESS FOR THIRD BITE MADE UPPER ADDRESS AND SECOND BITE LOWER ADDRESS WHEN DATA IN REGISTER IS NOT 0.	
J Z		CA	1	1	0	0	1	0	1	0	"	"	JUMP TO MEMORY ADDRESS FOR THIRD BITE MODE UPPER ADDRESS AND SECOND BITE LOWER ADDRESS WHEN DATA IN REGISTER A IS 0.	
J P		F2	1	1	1	1	0	0	1	0	"	"	JUMP TO MEMORY ADDRESS FOR THIRD BITE MADE UPPER ADDRESS AND SECOND BITE LOWER ADDRESS WHEN DATA IN REGISTER A IS POSITIVE.	
CALL		CD	1	1	0	0	1	1	0	1	"	"	JUMP TO MEMORY ADDRESS FOR THIRD BITE MADE UPPER ADDRESS AND SECOND BITE LOWER ADDRESS.	
R E T		C9	1	1	0	0	1	0	0	1				
L D A		3A	0	0	1	1	1	0	1	0	8 BITS DATA	8 BITS DATA	TRANSFER DATA IN MEMORY ADDRESS FOR THIRD BITE MADE UPPER ADDRESS AND SECOND BITE LOWER ADDRESS TO REGISTER A.	

FIG.12-1

STATEMENT NO.	NAME OF BRANCH	INSTRUCTION	OPERAND	
STMT	SOURCE STATEMENT			
1	RL	EQU	#10	RELEASE SW
2	MODE	EQU	#11	MODE SW
3	FPS	EQU	#12	FRAMES/SEC DATA SW
4	TIME	EQU	#13	TIME DATA SW
5	DEG	EQU	#14	DEGREE DATA SW
6	PHASE	EQU	#18	SHUTTER PHASE PULSES
7	DATASET	EQU	#15	TIME, DEG DATASET SW
8	DISP 1	EQU	#10	DISPLAY 1
9	CONT 1	EQU	#11	CONTROL 1
10	CONT 2	EQU	#12	CONTROL 2
11	DISP 2	EQU	#13	DISPLAY 2
12	CONT 3	EQU	#14	
13	CONT 4	EQU	#15	
14	CONT 5	EQU	#16	
15	CONT 6	EQU	#17	
16	EXT	EQU	#20	QUANTITY OF EXPOSURE
17	LEVEL	EQU	#21	EXPOSURE LEVEL SETTING
18	DEG1M	EQU	#41F1	INITIAL DEG MEMORY
19	DEG2M	EQU	#41F2	END DEG MEMORY
20		ORG	#4200	
21	INITIAL	IN	MODE	
22		CPI	#00	
23		JZ	NORM	NORMAL = 0
24	INITI 1	CPI	#01	
25		JZ	DIAPHRAGM	DIAPHRAGM PREFERENCE=#01

FIG.12-2

STATEMENT NO.	NAME OF BRANCH	INSTRUCTION	OPERAND	
26	INITI 2	CPI	#02	
27		JZ	MM	MEMO MOTION =#02
28	INITI 3	CPI	#03	
29		JZ	IWS	INDENT WORK SAMPLING =#03
30	INITI 4	CPI	#04	
31		JZ	WS	WORK SAMPLING =#04
32	INITI 5	CPI	#05	
33		JZ	ST	SELF TIMER =#05
34	INITI 6	CPI	#06	
35		JZ	TE 1	TIME EXPOSURE1 =#06
36	INITI 7	CPI	#07	
37		JZ	TE 2	TIME EXPOSURE2 =#07
38	INITI 8	CPI	#08	
39		JZ	FI	FADE IN=#08
40	INITI 9	CPI	#09	
41		JZ	FO	FADE OUT=#09
42	INITI 10	CPI	#0A	
43		JZ	OL	OVER LAP=#0A
44	INITI 11	CPI	#0B	
45		JZ	WI	WIPE IN =#0B
46	INITI 12	CPI	#0C	
47		JZ	WO	WIPE OUT=#0C
48	INITI 13	CPI	#0D	
49		JZ	WL	WIPE LAP=#0D
50	INITI 14	JMP	INITIAL	

FIG.12-3

STATEMENT NO.	NAME OF BRANCH	INSTRUCTION	OPERAND
51	•NORMAL•		
52	NORM	CALL	PMOST
53	NORM 1	IN	RL
54		CPI	#03
55		JNZ	NRM
56		CALL	START
57	NORM 2	IN	RL
58		SUI	#02
59		JP	NORM 2
60	Z 1	IN	PHASE
61		CPI	34
62		JNZ	Z 1
63		CALL	STOP
64		MVI	B, #00
65		IN	MODE
66		CMP	B
67		JZ	NORM 1
68	NORM 3	JMP	INITI 1
69	•DIAPHRAGM PREFERENCE•		
70	DIAPHRAGM	CALL	PMOST
71	DIAPHRAGM 1	IN	RL
72		CPI	#07
73		JNZ	SBRI
74		CALL	START
75	DIAPHRAGM 2	IN	EXT

FIG.12-4

STATEMENT NO.	NAME OF BRANCH	INSTRUCTION	OPERAND
76		MOV	E, A
77		CALL	SHUTTER
78		IN	RL
79		SUI	#02
80		JP	DIAPHRAGM
81	Z2	IN	PHASE
82		CPI	34
83		JNZ	Z2
84		CALL	STOP
85		MVI	B, #01
86		IN	MODE
87		CMP	B
88		JZ	DIAPHRAGM 1
89	DIAPHRAGM	JMP	INITI 2
90	·MEMO MOTION·		
91	MM	CALL	PMOST
92		CALL	T1SET
93	MM 1	IN	RL
94		CPI	#07
95		JNZ	MMB
96	MM 2	CALL	START
97	K1	IN	PHASE
98		CPI	34
99		JNZ	K1
100		CALL	STOP

FIG.12-5

STATEMENT NO.	NAME OF BRANCH	INSTRUCTION	OPERAND
101		CALL	T1
102		IN	RL
103		SUI	#02
104		JP	MM2
105		CALL	STOP
106		MVI	B, #02
107		IN	MODE
108		CMP	B
109		JZ	MM 1
110	MM 3	JMP	INITI 3
111	*INDENT WORD SAMPLING*		
112	IWS	CALL	PMOST
113		CALL	T12SET
114		MVI	D, 4
115	IWS 1	IN	RL
116		CPI	#07
117		JNZ	IWSB
118	IWS 2	CALL	START
119	K2	IN	PHASE
120		CPI	34
121		JNZ	K2
122		CALL	STOP
123		CALL	T1
124		DCR	D
125		JNZ	IWS 2

FIG.12-6

STATEMENT NO.	NAME OF BRANCH	INSTRUCTION	OPERAND
126		CALL	T2
127		MVI	D, 4
128		IN	RL
129		SUI	#02
130		JP	IWS 2
131		CALL	STOP
132		MVI	B, #03
133		IN	MODE
134		CMP	B
135		JZ	IWS 1
136	IWS 4	JMP	INITI 4
137	•WORK SAMPLING•		
138	WS	CALL	PMOST
139		CALL	T12SET
140	WS 1	IN	RL
141		CPI	#07
142		JNZ	WSB
143	WS 2	CALL	START
144		CALL	T1
145	K3	IN	PHASE
146		CPI	34
147		JNZ	K3
148		CALL	STOP
149		CALL	T2
150		IN	RL

FIG.12-7

STATEMENT NO.	NAME OF BRANCH	INSTRUCTION	OPERAND
151		SUI	#02
152		JP	WS 2
153		CALL	STOP
154		MVI	B, #04
155		IN	MODE
156		CMP	B
157		JZ	WS 1
158	WS 3	JMP	INITI 5
159	·SELF TIMER·		
160	ST	CALL	PMOST
161		CALL	T12SET
162	ST 1	IN	RL
163		CPI	#07
164		JNZ	STB
165		CALL	T1
166		CALL	START
167		CALL	T2
168	K4	IN	PHASE
169		CPI	34
170		JNZ	K4
171		CALL	STOP
172		MVI	B, #05
173		IN	MODE
174		CMP	B
175		JZ	ST 1

FIG.12-8

STATEMENT NO.	NAME OF BRANCH	INSTRUCTION	OPERAND
176	ST 2	JMP	INITI 6
177	•TIME EXPOSURE1•		
178	TE 1	CALL	PMOST
179		CALL	T12SET
180	TE 11	IN	RL
181		CPI	#07
182		JNZ	TE1B
183	TE 13	CALL	START
184	TE 12	IN	PHASE
185		CPI	16
186		JNZ	TE 12
187		CALL	STOP
188		CALL	T1
189		CALL	START
190	K5	IN	PHASE
191		CPI	34
192		JNZ	K5
193		CALL	STOP
194		CALL	T2
195		IN	RL
196		SUI	#02
197		JP	TE 13
198		CALL	STOP
199		MVI	B, #06
200		IN	MODE

FIG.12-9

STATEMENT NO.	NAME OF BRANCH	INSTRUCTION	OPERAND
201		CMP	B
202		JZ	TE 11
203	TE 14	JMP	INITI 7
204	•TIME EXPOSURE 2•		
205	TE 2	CALL	PMOST
206	TE 21	IN	RL
207		CPI	#07
208		JNZ	TE2B
209		IN	LEVEL
210		MOV	E, A
211	TE 24	CALL	START
212	TE 22	IN	PHASE
213		CPI	16
214		JNZ	TE 22
215		CALL	STOP
216	TE 23	IN	ICC ICC=#22
217		SUB	E
218		JNZ	TE 23
219		CALL	START
220	K6	IN	PHASE
221		CPI	34
222		JNZ	K6
223		CALL	STOP
224		IN	RL
225		SUI	#02

FIG.12-10

STATEMENT NO.	NAME OF BRANCH	INSTRUCTION	OPERAND
226		JP	TE 24
227		MVI	B, #07
228		IN	MODE
229		CMP	B
230		JZ	TE 21
231	TE 25	JMP	INITI 8
232	·FADE IN·		
233	FI	CALL	PMOST
234		CALL	D12SET
235	FI 1	IN	RL
236		CPI	#07
237		JNZ	FIB
238		LDA	DEG1M
239		MOV	E, A
240		CALL	START
241	FI 5	MVI	D, 6
242	FI 2	CALL	SHUTTER
243		DCR	D
244		JNZ	FI 2
245		DCR	E
246		CALL	DISPLAY 1
247		LDA	DEG2M
248		SUB	E
249		JNZ	FI5
250	FI 8	CALL	SHUTTER

FIG.12-11

STATEMENT NO.	NAME OF BRANCH	INSTRUCTION	OPERAND
251		IN	RL
252		SUI	#02
253		JP	FI 3
254	K7	IN	PHASE
255		CPI	34
256		JNZ	K7
257		CALL	STOP
258		MVI	B, #08
259		IN	MODE
260		CMP	B
261		JZ	F11
262	FI 4	JMP	INITI 9
263	·FADE OUT·		
264	FO	CALL	PMOST
265		CALL	D12SET
266	FO 1	IN	RL
267		CPI	#07
268		JNZ	FOB
269		LDA	DEG1M
270		MOV	E, A
271		CALL	START
272	FO 5	MVI	D, 6
273	FO 2	CALL	SHUTTER
274		DCR	D
275		JNZ	FO 2

FIG.12-12

STATEMENT NO.	NAME OF BRANCH	INSTRUCTION	OPERAND
276		INR	E
277		CALL	DISPLAY 1
278		LDA	DEG2M
279		SUB	E
280		JNZ	FO5
281	FO 3	CALL	SHUTTER
282		IN	•RL
283		SUI	#02
284		JP	FO3
285	K8	IN	PHASE
286		CIP	34
287		JNZ	K8
288		CALL	STOP
289		MVI	B, #09
290		IN	MODE
291		CMP	B
292		JZ	FO1
293	FO 4	JMP	INITI 10
294	•OVER LAP•		
295	OL	CALL	PMOST
296		CALL	D12SET
297	OL 1	IN	RL
298		CPI	#07
299		JNZ	OLB
300		LDA	DEG1M

FIG.12-13

STATEMENT NO.	NAME OF BRANCH	INSTRUCTION	OPERAND
301		MOV	E, A
302		CALL	START
303	OL 5	MVI	D, 6
304	OL 2	CALL	SHUTTER
305		DCR	D
306		JNZ	OL 2
307		INR	E
308		CALL	DISPLAY 1
309		LDA	DEG2M
310		SUB	E
311		JNZ	OL 5
312	K9	IN	PHASE
313		CPI	34
314		JNZ	K9
315		CALL	STOP
316	OL 3	IN	RL
317		SUI	#02
318		JP	OL 3
319		LDA	DEG1M
320		MOV	E, A
321		CALL	PMCST
322		CALL	REV
323	K12	MVI	D, 6
324	OL 4	IN	PHASE
325		CPI	#00

FIG.12-14

STATEMENT NO.	NAME OF BRANCH	INSTRUCTION	OPERAND
326		JNZ	OL 4
327	K11	IN	PHASE
328		CPI	*00
329		JZ	K 11
330		DCR	D
331		JNZ	OL 4
332		INR	E
333		LDA	DEG2M
334		SUB	E
335		JNZ	K 12
336	K13	IN	PHASE
337		CPI	34
338		JNZ	K 13
339		CALL	STOP
340	OL 41	IN	RL
341		CPI	*07
342		JNZ	OL 41
343		CALL	PMOST
344		LDA	DEG2M
345		MOV	E, A
346		CALL	START
347	OL 10	MVI	D, 6
348	OL 5	CALL	SHUTTER
349		DCR	D
350		JNZ	OL 5

FIG.12-15

STATEMENT NO.	NAME OF BRANCH	INSTRUCTION	OPERAND
351		DCR	E
352		CALL	DISPLAY 1
353		LDA	DEG1M
354		SUB	E
355		JNZ	OL 10
356	OL 6	CALL	SHUTTER
357		IN	RL
358		SUI	#02
359		JP	OL 6
360	K 14	IN	PHASE
361		CPI	34
362		JNZ	K 14
363		CALL	STOP
364		MVI	B, #0A
365		IN	MODE
366		CMP	B
367		JZ	OL 1
368	OL 7	JMP	INITI 11
369	•WIPE IN•		
370	WI	CALL	PMCST
371		CALL	T1SET
372	WI 1	IN	RL
373		CPI	#07
374		JNZ	WIB
375		CALL	START

FIG.12-16

STATEMENT NO.	NAME OF BRANCH	INSTRUCTION	OPERAND
376		MVI	D, 2
377	WI 2	CALL	PMO
378		CALL	MS 5
379		CALL	PMSTOP
380		CALL	T 1
381		DCR	D
382		JNZ	WI 2
383	WI 3	IN	RL
384		SUI	#02
385		JP	WI 3
386	K 15	IN	PHASE
387		CPI	34
388		JNZ	K 15
389		CALL	STOP
390		MVI	B, #0B
391		IN	MODE
392		CMP	B
393		JZ	WI 1
394	WI 4	JMP	INITI 12
395	•WIPE OUT•		
396	WO	CALL	PMOST
397		CALL	T1SET
398	WO 1	IN	RL
399		CPI	#07
400		JNZ	WOB

FIG.12-17

STATEMENT NO.	NAME OF BRANCH	INSTRUCTION	OPERAND
401		CALL	START
402		MVI	D, 2
403	WO 2	CALL	PMC
404		CALL	MS 5
405		CALL	PMSTOP
406		CALL	T 1
407		DCR	D
408		JNZ	WO 2
409	K 16	IN	PHASE
410		CPI	34
411		JNZ	K 16
412		CALL	STOP
413		MVI	B, #0C
414		IN	MODE
415		CMP	B
416		JZ	WO 1
417	WO 3	JMP	INITI 13
418	•WIPE LAP•		
419	WL	CALL	PMOST
420		CALL	T1SET
421	WL 1	IN	RL
422		CPI	#07
423		JNZ	WLB
424		CALL	START
425		CALL	T 1

FIG.12-18

STATEMENT NO.	NAME OF BRANCH	INSTRUCTION	OPERAND
426		MVI	D, 2
427	WL 2	CALL	PMC
428		CALL	MS 5
429		CALL	PMSTOP
430		CALL	T 1
431		DCR	D
432		JNZ	WL 2
433	K 17	IN	PHASE
434		CPI	34
435		JNZ	K 17
436		CALL	STOP
437	WL 3	IN	RL
438		SUI	#02
439		JP	WL 3
440		MVI	D, 3
441		CALL	REV
442	WL 4	CALL	T 1
443		DCR	D
444		JNZ	WL 4
445	K 18	IN	PHASE
446		CPI	34
447		JNZ	K 18
448		CALL	STOP
449	WL 5	IN	RL
450		CPI	#03

FIG.12-19

STATEMENT NO.	NAME OF BRANCH	INSTRUCTION	OPERAND
451		JNZ	WL 5
452		CALL	START
453		CALL	T 1
454		MVI	D, 2
455	WL 6	CALL	PMC
456		CALL	MS 5
457		CALL	PMSTOP
458		CALL	T 1
459		DCR	D
460		JNZ	WL 6
461	K 19	IN	PHASE
462		CPI	34
463		JNZ	K 19
464		CALL	STOP
464-1		CALL	PMO
464-2		CALL	MS 5
464-3		CALL	PMSTOP
465		CALL	PMOST
466		MVI	B, *0D
467		IN	MODE
468		CMP	B
469		JZ	WL 1
470	WL 7	JMP	INITI 14
471	••SHUTTER••		
472	SHUTTER	IN	PHASE
473		CPI	*00
474		JNZ	SHUTTER
475		MVI	B, 2

FIG.12-20

STATEMENT NO.	NAME OF BRANCH	INSTRUCTION	OPERAND
476	STR 1	IN	PHASE
477		ANI	#01
478		JZ	STR 1
479		CALL	PMC
480	STR 2	IN	PHASE
481		ANI	#01
482		JNZ	STR 2
483		CALL	PMSTOP
484		DCR	B
485		JNZ	STR 1
486	STR 3	IN	PHASE
487		SUB	E
488		JNZ	STR 3
489		MVI	B, 2
490	STR 4	IN	PHASE
491		ANI	#01
492		JNZ	STR 4
493		CALL	PMO
494	STR 5	IN	PHASE
495		ANI	#01
496		JZ	STR 5
497		CALL	PMSTOP
498		DCR	S
499		JNZ	STR 4
500		RET	

FIG.12-21

STATEMENT NO.	NAME OF BRANCH	INSTRUCTION	OPERAND
501	··START··		
502	START	MVI	A, #06
503		OUT	CONT 1
504		RET	
505	··STOP··		
506	STOP	MVI	A, #08
507		OUT	CONT 1
508		CALL	MS 5
509		MVI	A, #02
510		OUT	CONT 1
511		RET	
512	··REV··		
513	REV	MVI	A, #0
514		OUT	CONT 1
515		RET	
516	··PMO··		
517	PMO	MVI	A#10
518		OUT	CONT 2
519		RET	
520	··PMC··		
521	PMC	MVI	A#20
522		OUT	CONT 2
523		RET	
524	··PMSTOP··		
525	PMSTOP	MVI	A, #0

FIG.12-22

STATEMENT NO.	NAME OF BRANCH	INSTRUCTION	OPERAND
526		OUT	CONT 2
527		RET	
528	••PMOST••		
529	PMOST	MVI	B, 3
530	PMOST 1	MVI	A, #10
531		OUT	CONT 2
532		CALL	MS 05
533		CALL	PMSTOP
534		CALL	MS 5
535		DCR	B
536		JNZ	PMOST 1
537		RET	
538	••PMCST••		
539	PMCST	MVI	B, 3
540	PMCST 1	MVI	A, #20
541		OUT	CONT 2
542		CALL	MS 05
543		CALL	PMSTOP
544		CALL	MS 5
545		DCR	B
546		JNZ	PMCST 1
547		RET	
548	••DISPLAY1••		
549	DIAPLAY 1	MOV	A, E
550		OUT	DISP 1

FIG.12-23

STATEMENT NO.	NAME OF BRANCH	INSTRUCTION	OPERAND
551		RET	
552	••T 1••		MOVB, H
553	T 1	CALL	MS 125
554		DCR	B
555		JNZ	T 1
556		RET	
557	••T 2••		MOVB, L
558	T 2	CALL	MS 125
559		DCR	B
560		JNZ	T 2
561		RET	
562	••TSET••		
563	TSET	MVI	A, #40
564		OUT	DISP 2
565		CALL	MS 500
566		MVI	A, #00
567		OUT	DISP 2
568		CALL	MS 500
569		IN	DATASET
570		CPI	#01
571		JNZ	TSET
572		RET	
573	DEGSET	MVI	MVIA, #80
574		OUT	DISP 2
575		CALL	MS 500

FIG.12-24

STATEMENT NO.	NAME OF BRANCH	INSTRUCTION	OPERAND
576		MVI	A, #00
577		OUT	DISP 2
578		CALL	MS 500
579		IN	DATASET
580		CPI	#02
581		JNZ	DEGSET
582		RET	
583	..T12SET..		
584	T12SET	CALL	TSET
585		IN	TIME
586		DCR	A
587		MOV	B, A
588		MVI	A, #01
589	T12SET1	RLC	
590		DCR	B
591		JNZ	T12SET
592		MOV	H, A
593		CALL	TSET
594		IN	TIME
595		DCR	A
596		MOV	B, A
597		MVI	A, #01
598	T12SET2	RLC	
599		DCR	B
600		JNZ	T12SET2

FIG.12-25

STATEMENT NO.	NAME OF BRANCH	INSTRUCTION	OPERAND
601		MOV	L, A
602		RET	
603	••T1SET••		
604	T1SET	CALL	TSET
605		IN	TIME
606		DCR	A
607		MOV	B, A
608		MVI	A, #01
609	T1SET 1	RLC	
610		DCR	B
611		JNZ	T1SET 1
612		MOV	H, A
613		RET	
614	••D12SET••		
615	D12SET	CALL	D1SET
616		CALL	DEGSET
617		IN	DEG
618		CALL	DEGA
619		STA	DEG2M
620	D12SET 1	RET	
621	••D1SET••		
622	D1SET	CALL	DEGSET
623		IN	DEG
624		CPI	#00
625		JZ	AA

FIG.12-26

STATEMENT NO.	NAME OF BRANCH	INSTRUCTION	OPERAND
626		CALL	DEGA
627	DISET 1	STA	DEG1M
628		RET	
629	..DEGA..		
630	DEGA	CPI	#01
631		JZ	A5
632		CPI	#02
633		JZ	A7
634		CPI	#03
635		JZ	A9
636		CPI	#04
637		JZ	A11
638		CPI	#05
639		JZ	A13
640		CPI	#06
641		JZ	A15
642		CPI	#07
643		JZ	A17
644		CPI	#08
645		JZ	A19
646		CPI	#09
647		JZ	A21
648		CPI	#0A
649		JZ	A23
650		CPI	#0B

FIG.12-27

STATEMENT NO.	NAME OF BRANCH	INSTRUCTION	OPERAND
651		JZ	A 25
652		MVI	A, 27
653	DEGA 1	RET	
654	••DEGREE DECORD SECTION••		
655	A5	MVI	A, 5
656		JMP	DEGA 1
657	A7	MVI	A, 7
658		JMP	DEGA 1
659	A9	MVI	A, 9
660		JMP	DEGA 1
661	A11	MVI	A, 11
662		JMP	DEGA 1
663	A13	MVI	A, 13
664		JMP	DEGA 1
665	A15	MVI	A, 15
666		JMP	DEGA 1
667	A17	MVI	A, 17
668		JMP	CEGA 1
669	A19	MVI	A, 19
670		JMP	DEGA 1
671	A21	MVI	A, 21
672		JMP	DEGA 1
673	A23	MVI	A, 23
674		JMP	DEGA 1
675	A25	MVI	A, 25

FIG.12-28

STATEMENT NO.	NAME OF BRANCH	INSTRUCTION	OPERAND
676		JMP	DEGA1
677	..TIME INTERVAL SUBROUTINE..		
678	MS05	MVI	C, #40
679	MS05A	DCR	C
680		JNZ	MS05A
681		RET	
682	MS5	MVI	C, #0A
683	MS5A	MVI	D, #40
684	MS5B	DCR	D
685		JNZ	MS5B
686		DCR	C
687		JNZ	MS5A
688		RET	
689	MS125	MVI	C, #80
690	MS125A	MVI	D, #7F
691	MS125B	DCR	D
692		JNZ	MS125B
693		DCR	C
694		JNZ	MS125A
695		RET	
696	MS500	MVI	C, #FF
697	MS500A	MVI	D, #7F
698	MS500B	DCR	D
699		JNZ	MS500B
700		DCR	C

FIG.12-29

STATEMENT NO.	NAME OF BRANCH	INSTRUCTION	OPERAND
701		JNZ	MS500A
702		RET	
703	DE	NOP	
704		RET	
705	••AA•		
706	AA	MVI	A, 5
707		STA	DEG1M
708		MVI	A, 27
709		STA	DEG2M
710		JMP	D12SET1
711	••MODE SELECT BRANCHES••		
712	NRM	MVI	B, #00
713		IN	MODE
714		CMP	B
715		JZ	MORM1
716		JMP	NORM3
717	SBRI	MVI	B, #01
718		IN	MODE
719		CMP	B
720		JZ	DIAPHRAGM 1
721		JMP	DIAPHRAGM 4
722	MMB	MVI	B, #02
723		IN	MODE
724		CMP	B
725		JZ	MM 1

FIG.12-30

STATEMENT NO.	NAME OF BRANCH	INSTRUCTION	OPERAND
726		JMP	MM 3
727	IWSB	MVI	B, #03
728		IN	MODE
729		CMP	B
730		JZ	IWS 1
731		JMP	IWS 4
732	WSB	MVI	B, #04
733		IN	MODE
734		CMP	B
735		JZ	WS 1
736		JMP	WS 3
737	STB	MVI	B, #05
738		IN	MODE
739		CMP	B
740		JZ	ST 1
741		JMP	ST 2
742	TE1B	MVI	B, #06
743		IN	MODE
744		CMP	B
745		JZ	TE 11
746		JMP	TE 14
747	TE2B	MVI	B, #07
748		IN	MODE
749		CMP	B
750		JZ	TE 21

FIG.12-31

STATEMENT NO.	NAME OF BRANCH	INSTRUCTION	OPERAND
751		JMP	TE 25
752	FIB	MVI	B, #08
753		IN	MODE
754		CMP	B
755		JZ	FI 1
756		JMP	FI 4
757	FOB	MVI	B, #09
758		IN	MODE
759		CMP	B
760		JZ	FO 1
761		JMP	FO 4
762	OLB	MVI	B, #0A
763		IN	MODE
764		CMP	B
765		JZ	OL 1
766		JMP	OL 7
767	WIB	MVI	B, #OB
768		IN	MODE
769		CMP	B
770		JZ	WI 1
771		JMP	WI 4
772	WOB	MVI	B, #0C
773		IN	MODE
774		CMP	B
775		JZ	WO 1

FIG.12-32

STATEMENT NO.	NAME OF BRANCH	INSTRUCTION	OPERAND
776		JMP	WO 3
777	WLB	MVI	B, #OD
778		IN	MODE
779		CMP	B
780		JZ	WL 1
781		JMP	WL 7
782		END	

FIG. 13A

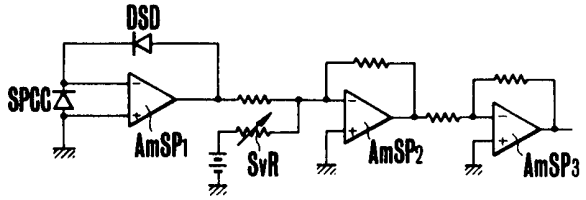


FIG. 13B

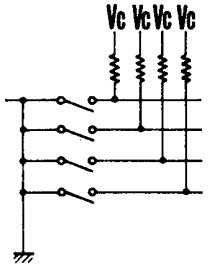


FIG. 13C

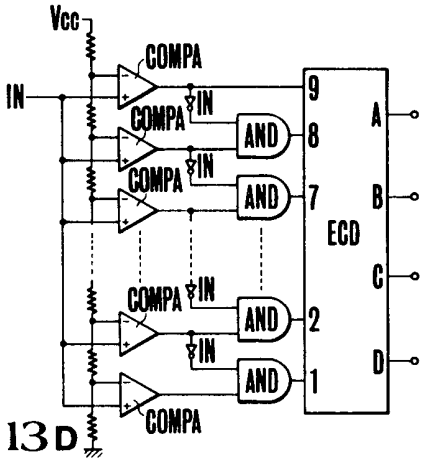


FIG. 13D