Feb. 22, 1966 K. J. MAGNUSSON 3,236,107

TIMING APPARATUS

Filed May 7, 1962 2 Sheets-Sheet 1

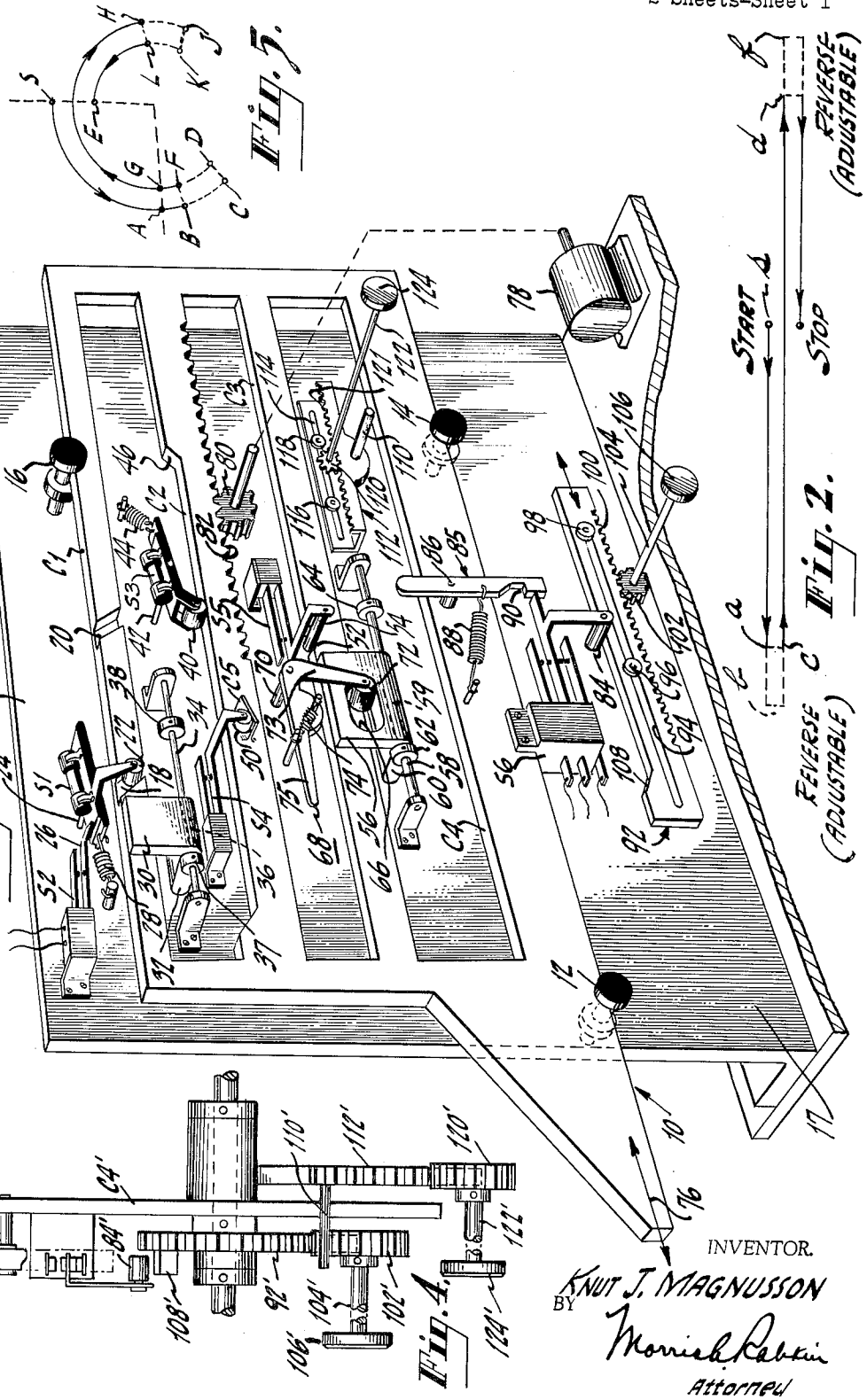


Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

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Filed May 7, 1962 2 Sheets-Sheet 2

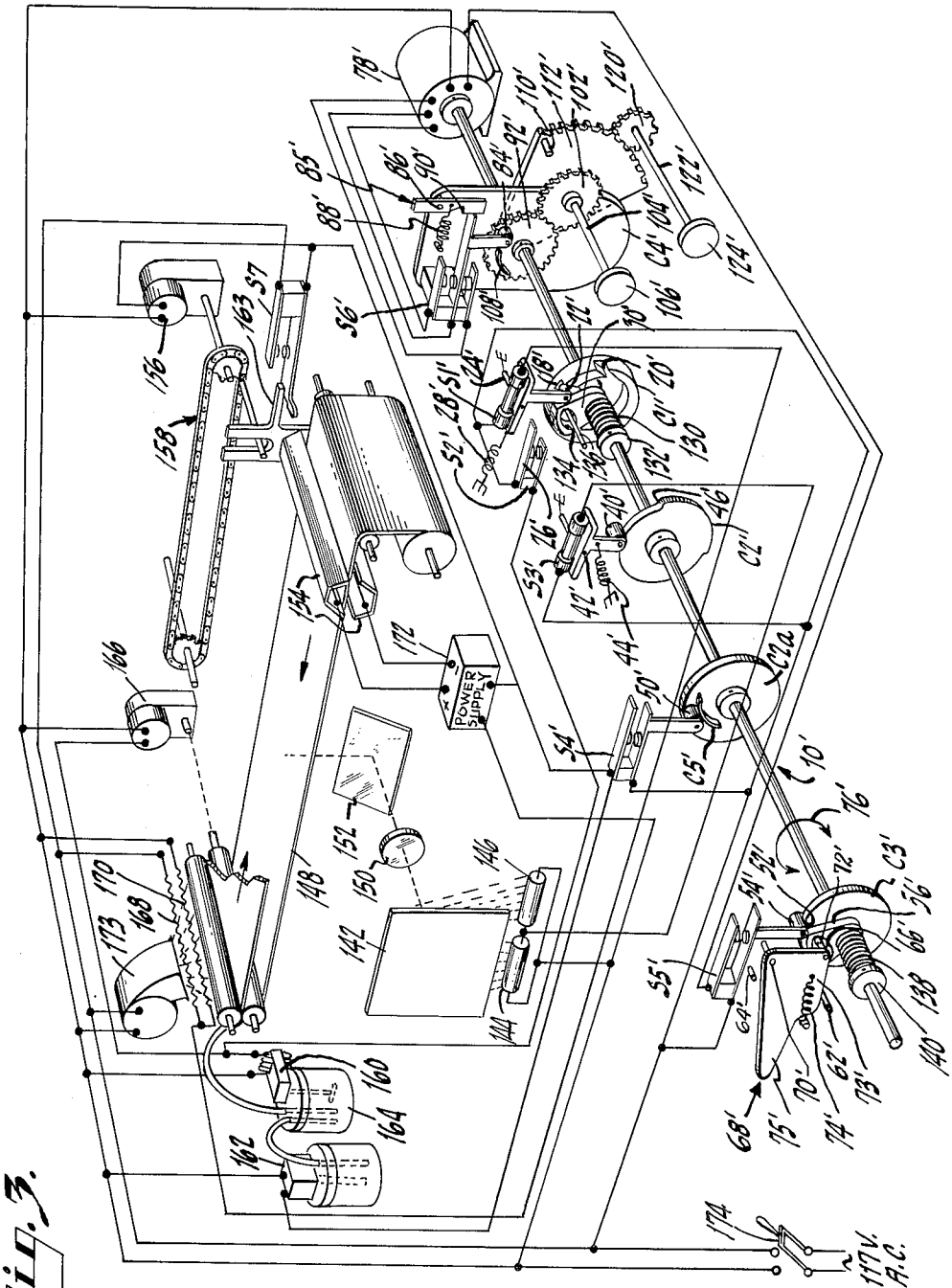


Fig. 3.

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3,236,107

Patented Feb. 22, 1966

3,236,107

TIMING APPARATUS

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Filed May 7, 1962, Ser. No. 192,714
9 Claims. (Cl. 74—3.52)

This invention relates generally to the art of timing mechanisms, and more particularly to improved timing apparatus for controlling the duration of a plurality of functions during a cycle of operation of a process, the time of at least one of the functions being variable. Although by no means limited thereto, the improved timing apparatus of the present invention is particularly useful for timing the functions of electrostatically charging, exposing, printing, and drying an electrophotographic record during an automatic, electrophotographic printing process.

In apparatus of the type for carrying out a plurality of functions, such as in a machine for carrying out an automatic, electrophotographic printing process, it is necessary to control the duration of each of the steps or functions. A single revolution cam or a reciprocating slide cam has been used for this purpose where the duration of each function in the cycle of operation is a predetermined, fixed period of time. Where, however, the duration of one or more of the functions must be varied during each cycle of operation, additional, more complicated mechanisms had to be employed.

It is an object of the present invention to provide improved timing apparatus for controlling the duration of a plurality of functions or steps to be performed by automatic apparatus during one cycle of operation, the time of at least one of the functions or steps being variable for each cycle of operation.

It is another object of the present invention to provide improved timing apparatus for varying the duration of either one or two functions in an automatic process at almost any point in a complete cycle of operation that includes a plurality of functions.

Still another object of the present invention is to provide improved timing apparatus of the type described that is relatively simple in structure, easy to preset and to operate, and highly efficient in use.

Briefiy, the improved timing apparatus of the present invention comprises a plurality of cam means adapted to move initially in one direction from a starting point, then reverse and move in the opposite direction past the starting point, and then reverse again and move back to the starting point. In one embodiment of the present invention, the cam means include a slide cam assembly having a plurality of slide cams for controlling a plurality of devices by cam followers which ride on the cam surfaces. The slide cam assembly is coupled to a reversible motor for reciprocal movement thereby first in one and then in the other of two opposite directions. The reversible motor is started by pushing a slide member under a cam follower to raise the latter from a groove in one cam surface to close a motor starter switch. The slide member is held adjacent to the slide cam assembly by friction, and the motion of the slide member is limited in a manner to prevent the cam follower from falling into the groove (to open the motor starter switch) until the slide cam assembly has moved through a complete cycle of operation. The distance of travel of the slide cam assembly in either direction from its starting point is determined by a pair of limit means that are positioned to trip a motor reversing switch fixed to the cam slide assembly to reverse the direction of movement of the slide cam assembly. At least one of the pair of limit means is made movable to vary the slide cam assembly travel time, whereby to vary at least one function responsive to the movement of the slide cam assembly.

In another embodiment of the present invention, the cam means include a plurality of rotary cams fixed to a rotatable shaft. Slide members are disposed in frictional engagement with selected cams for limited movement therewith to prevent some cam followers from falling into grooves in certain cam surfaces during certain periods in a complete cycle of operation. Adjustable timing of a function during a cycle of operation is accomplished by adjustable limit means that are disposed to actuate the motor reversing switch, whereby to reverse the reversible motor that drives the rotary cams. Thus, by initiating a variable function before the cams are reversed, and by terminating the variable function after the cams have been reversed, the duration of the variable function is made adjustable.

The novel features of the present invention, both as to its organization and method of operation, as well as additional objects and advantages thereof, will be more readily understood from the following description, when read in connection with the accompanying drawings in which parts of one of two embodiments of the invention are designated by the same reference characters as corresponding parts of the other embodiment of the invention, with the exception that the corresponding reference characters of this other embodiment are primed, and in which:

FIG. 1 is a view, in perspective, of improved timing apparatus employing a slide cam assembly in accordance with the present invention;

FIG. 2 is a schematic diagram illustrating the direction of movement of the slide cam assembly of FIG. 1 during one cycle of operation;

FIG. 3 is a perspective view of another embodiment of improved timing apparatus in accordance with the present invention, this embodiment employing an assembly of rotating cams and being shown with its timing apparatus associated with automatic, electrophotographic printing equipment, parts of which are shown schematically;

FIG. 4 is a fragmentary side view of a portion of the rotating cams illustrated in FIG. 3, showing adjustable means for limiting the rotation of the cams; and

FIG. 5 is a schematic diagram illustrating the direction of movement of the rotating cams of FIG. 3 during one cycle of operation.

Referring, now, to FIG. 1, there are shown cam means in the form of a slide cam assembly **10**. This assembly is formed with a plurality of substantially parallel slide cams C1 . . . C4. The cam assembly **10** is mounted for reciprocating movement between lower rollers **12** and **14** and an upper roller **16** mounted on a panel **17**.

The cam C1 is formed with two, parallel, spaced-apart grooves **18** and **20**. The cam follower **22** of a mercury switch S1 is disposed within the groove **18** when the cam assembly **10** is in its starting position. The switch S1 is fixed to the stationary panel **17** by means of a pivot **24** on which the switch S1 is free to rotate. A switch S2 is fixed to the stationary panel **17** by any suitable means. The switch S2 is normally open and has a lower, spring-biased member **26** that is disposed to contact a portion of the switch S1 when the latter is closed, whereby to close the switch S2. The switch S1 is biased normally in an open position by a spring **28** which is connected between the switch S1 and the stationary panel **17**.

Means are provided to prevent the cam follower **22** from going into the groove **18** during certain periods of the reciprocating travel of the cam assembly **10**. To this end, a slide member **30** is mounted in frictional engagement with the cam C1 for limited movement with the cam assembly **10**. The slide member **30** is formed with a relatively heavy, elongated boss **32**. A shaft **34** is disposed within a hole **36** in the boss **32**, and the shaft

34 is anchored to and spaced from the stationary panel 17 so that the slide member 30 can move along the shaft 34 with the movement of the cam assembly 10. The shaft 34 has stop means 37 and 38 fixed thereto to limit the movement of the slide member 30 between them. The boss 32 is relatively heavy and tends to cause the slide member 30 to rotate (in a counter-clockwise direction, looking at FIG. 1) about the shaft 34, thereby causing a frictional engagement between the slide member 30 and the cam C1. Alternatively, spring means (not shown) could be used to obtain this frictional engagement. It will now be understood that the slide member 30, being in frictional contact with the cam assembly 10, can move along with the slide member 10 between the stops 37 and 38 in either direction.

The cam follower 40 of a mercury switch S3 is adapted to ride on the surface of the cam C2. The switch S3 is fixed to the stationary panel 17 by means of a pivot 42 on which the switch S3 is free to rotate. The switch S3 is biased normally in an "off" position by means of a spring 44. The cam assembly 10 is formed with a cam C5 fixed to the side of the cam C2. A normally open switch S4 is fixed to the stationary panel 17. The cam follower 50 of the switch S4 is adapted to close the switch S4 when the cam follower 50 rides up on the cam C5.

The surface of the cam C3 is formed with a depression or groove 52 therein. When the cam assembly 10 is in its starting position, the spring-biased cam follower 54 of a normally open switch S5 is adapted to rest within the groove 52, thereby leaving the switch S5 in "open" position. The switch S5 is fixed to the stationary panel 17 by any suitable means.

A slide member 56 is held in frictional engagement with the cam C3 by means similar to that providing frictional engagement between the slide member 30 and the cam C1. Thus, a shaft 58 is disposed within a hole 59 in a relatively heavy, elongated boss 60 of the slide member 56 to provide movement of the slide member 56 in a direction parallel to the direction of motion of the cam assembly 10. The motion of the slide member 56 is limited between limit stops 62 and 64 fixed adjacent to the respective ends of the shaft 58. The shaft 58 is attached to the stationary panel 17 by any suitable spacing means.

Means are provided to move the slide member 56 under the cam follower 54 to raise the latter and to close the switch S5 when it is desired to start the cam assembly 10 moving, as will be hereinafter described. To this end, the slide member 56 is formed with an opening 66 in its side. A starting lever in the form of a bell crank 68 is pivoted to the stationary panel 17 by means of a pivot pin 70 on which the bell crank 68 can rotate. A pin 72, fixed adjacent to the end of one arm 73 of the bell crank 68, extends into the opening 66 in the slide member 56. The other arm 75 of the bell crank 68 is biased upwardly by means of a spring 74. It will now be understood that the slide member 56 can be moved toward the stop 64 by depressing the arm 75 of the bell crank 68 against the spring tension of the spring 74, whereby the upper surface of the slide member 56 will raise the cam follower 54 and close the switch S5.

The cam assembly 10 is adapted to be reciprocated in the directions indicated by the double pointed arrow 76. A reversible motor 78 is provided for this purpose. The shaft of the motor 78 is coupled to a pinion 80 which, in turn, is coupled to a rack 82 on the lower surface of the cam C2. The reversible motor 78 is of the split-phase type and is adapted to be reversed by means of a single pole-double throw switch S6 which is fixed to the lower portion of the cam assembly 10. The middle movable contact of the switch S6 is spring biased normally against the lower, fixed contact. A cam follower 84 is fixed to the movable contact of the switch S6 to move the movable contact against the upper, fixed contact when the cam follower 84 is raised by cam means shortly to be described.

A latch 85 is pivotally mounted to the side of the cam C4 by a pin 86 on which the latch 85 can rotate. The lower portion of the latch 85 is biased toward the cam follower 84 by means of a spring 88 secured to the latch below the pin 86. The latch 85 is formed with a latching toe 90 that is adapted to retain the movable contact of the switch S6 against the upper contact when the cam follower 84 is raised by the aforementioned cam means.

Limit means are provided to limit the movement of the cam assembly 10. Thus, an adjustable slide cam 92 is mounted for movement with respect to the slide cam assembly 10. The slide cam 92 is formed with an elongated slot 94 for receiving therein a pair of pins 96 and 98 fixed to the stationary panel 17. The lower edge of the slide cam 92 is formed with a rack 100 that engages a pinion 102 for moving the slide cam 92 to a desired position. The pinion 102 may be rotated manually, for example, by means of a shaft 104 and a knob 106 thereon. The upper surface of the slide cam 92 is formed at one end with a cam riser 108 for raising the cam follower 84 of the switch S6 to reverse the motor 78. Thus, the slide cam 92 functions as variable limiting means for the travel of the cam assembly 10 to the left, as viewed in FIG. 1.

The cam assembly 10 can be limited in its motion to the right by limiting means comprising a pin 110 fixed to a rack member 112. The rack member 112 is formed with an elongated opening 114 through which a pair of pins 116 and 118 extend. The pins 116 and 118 are fixed to the stationary panel 17. A pinion 120 is coupled to the rack 121 of the rack member 112 for moving the pin 110 to a desired position. The pinion 120 is rotated by means of a shaft 122 one end of which has a knob 124 fixed to it. Thus, the rack member 112 functions as variable limiting means for the travel of the cam assembly 10 to the right, as viewed in FIG. 1.

The operation of the improved timing apparatus shown in FIG. 1 will now be described. The slide cam assembly 10 is adapted to be driven by the reversible motor 78, first to the left and then to the right past its starting position, looking at FIG. 1. Before finally stopping, the cam assembly 10 is reversed once more and moves to the left until it reaches its starting position, where it stops. This cycle of operation is started by pressing down on the arm 75 of the bell crank 68. This action causes the slide member 56 to slide to the right, raising the cam follower 54 and closing switch S5. This action starts the motor 78. The cam assembly 10 is driven to the left by means of the rack 82 and pinion 80 until the cam follower 84 on the motor reversing switch S6 strikes the cam riser 108 on the slide cam 92. The latch 85 latches the switch S6 in its new position, and the direction of rotation of the motor 78 reverses. The cam assembly 10 thus reverses its direction of motion and moves to the right until the upper part of the latch 85 strikes the pin 110. This restores the switch S6 to its original position and reverses the motor 78 once more. The cam assembly 10 now moves to the left until the cam follower 54 on the switch S5 drops into the groove 52 on the cam C3 and the motor 78 stops.

The slide member 56 is held frictionally in contact with the cam C3, and it travels with the cam assembly 10 between the fixed limit stops 62 and 64. When the cam assembly 10 first moves to the left, the slide member 56 is pushed to the left as far as the stop 62 will allow. Having reached the stop 62, the slide member 56 now slips with respect to the cam assembly 10 as the latter continues to move to the left. When the motor 78 is reversed and the cam assembly 10 moves to the right, the slide member 56 also moves to the right, as far as the stop 64 will allow, and prevents the cam follower 54 on the switch S5 from dropping into the groove 52. It is noted that the slide member 56 slips with respect to the cam assembly 10 when the latter continues to move and the slide member 56 has

reached the stop 64. When the motor 78 is reversed once more and the cam assembly 10 moves to the left, it drags the slide member 56 to the left, as far as the stop 62 will allow, thus uncovering the groove 52. The cam follower 54 on the switch S5 can now drop into the groove 52 so that the switch S5 will open and the motor 78 and cam assembly 10 will stop.

During the first part of the cycle, the cam rise 46 of the cam C2 tilts the mercury switch S3 which, in turn, closes an electrical circuit, shown in FIG. 3 and described more fully hereinafter, to perform a desired function. The switch S3 remains closed until the cam assembly 10 reverses its direction of motion, as when the cam follower 40 on the switch S3 is lowered from the cam rise 46 to open the switch S3. The length of time that the switch S3 remains closed is determined by the distance that the cam assembly 10 travels to the left. This distance is easily adjusted by the knob 106. The switches S1 and S2 control other functions which are explained hereinafter. These switches are normally "open" before the cam assembly 10 moves to the left. The switches S1 and S2 close when the cam assembly 10 returns to the right, and the cam follower 22 of the switch S1 slides through the groove 20 to the top surface of the cam C1. The switches S1 and S2 open again only when the cycle of operation is completed and the cam assembly 10 stops.

The slide member 30 cooperates with the switch S1 in the same manner as the slide member 56 cooperates with the switch S5. Thus, the slide member 30 covers the groove 18 when the slide assembly 10 moves to the left. During this time, the cam follower 22 of the switch S1 rides on the lower surface of the cam C1, and the switch S1 remains "open." When the slide assembly 10 moves to the right, the cam follower 22 rides through the groove 20 and onto the upper surface of the cam C1, closing the switch S1 (and the switch S2). The cam follower 22 rides over the upper edge of the slide member 30 when the cam assembly moves to the right. The groove 18 is exposed to the cam follower 22 only when the cam assembly 10 is reversed a second time and moves to the left again.

Referring, now, to FIG. 2, the direction of motion of the cam assembly 10 is shown for one full cycle of operation. It is noted that the path traveled by the cam assembly 10 in either direction from the starting point can be varied, as indicated by the dashed lines by manipulating the knobs 106 and 124 to vary the time of reversal of the cam assembly 10. Thus, the shortest path (and time) of travel of the cam assembly 10 to the left is shown by the path *sa*. The longest path in this direction is shown by the path *sab*. The shortest and longest paths of travel of the cam assembly 10 to the right are shown by the paths *cd* and *cdf*, respectively.

Referring, now, to FIG. 3, there is shown another embodiment of the improved timing apparatus of the present invention, this embodiment employing a rotary cam assembly 10' instead of the slide cam assembly 10. Since the functions and operations of the rotary cams and associated parts shown in FIG. 3 are substantially similar to those of the slide cams and associated parts shown in FIG. 1, the same reference numerals will be used to designate corresponding parts in both FIGS. 1 and 3 except for a prime after each reference numeral in FIG. 3. Also, motion to the left by the cam assembly 10 is analogous to a counter-clockwise rotation by the cam assembly 10', and motion to the right by the cam assembly 10 is analogous to a clockwise rotation of the cam assembly 10'. The slide cam 92, in FIG. 1, and rack member 112, in FIG. 1, perform the same functions as a movable cam member 92' and a segment gear member 112', respectively, in FIG. 3.

In FIG. 3, cams C1', C2', C3' and C4' are fixed to the shaft of a reversible motor 78'. A cam C5' is fixed to a cam C2*a*, the latter being also fixed to the shaft of the motor 78'. It is noted that though the cams C2' and C2*a* are shown as two separate cams, they may actually be combined as an integral member. A slide member 30' comprises a metal sheet mounted loosely for rotation on the shaft of the motor 78'. The slide member 30' is held in frictional engagement with the cam C1' by means of a spring 130 and a collar 132 mounted on the shaft of the motor 78', the spring 130 being compressed between the slide member 30' and the collar 132. The rotary slide member 30' is formed with an opening 134 therein. A pin 136, fixed to stationary means (not shown), extends into the opening 134 to limit, over a predetermined arc, the rotation of the slide member 30 resulting from the latter's frictional engagement with the cam C1'.

A slide member 56' is loosely mounted for rotation on the shaft of the motor 78', and it is held in frictional engagement with the cam C3' by means of a spring 138 and a collar 140 mounted on the shaft of the motor 78', the spring 138 being compressed between the slide member 56' and the collar 140. The pin 72' of a bell crank 68' extends into an opening 66' in the slide member 56' to limit the rotation of the latter over a predetermined arc. The motion of the bell crank 68' is also limited by means of stop pins 62' and 64' on opposite sides of the arm 73' of the bell crank 68'.

A cam riser 108' is mounted on the cam member 92' which, in turn, is loosely mounted for rotation on the shaft of the motor 78'. The cam member 92' is formed with external teeth that mesh with a pinion 102'. A knob 106', fixed to the pinion 102' through a shaft 104', is adapted to move the cam member 92' to vary the length (and time) of travel of the cam assembly 10' in a counter-clockwise direction, as shown in FIG. 4.

A pin 110' is mounted on the segment gear member 112' which, in turn, is mounted loosely for rotation on the shaft of the motor 78'. The gear member 112' is adapted to be rotated by a pinion 120' which, in turn, is adapted to be turned by a knob 124' coupled to the shaft 122', as shown in FIG. 4.

The timing apparatus comprising the cam assembly 10' is described herein, for illustrative purposes, in connection with the operation of a plurality of functions in apparatus for performing automatically various operations in an electrostatic printing process. Since the electrostatic printing apparatus shown in FIG. 3, with the exception of the timing apparatus therefor, does not form a part of the instant invention, the electrostatic printing apparatus will not be described in detail. A letter 142, for example, to be reproduced by the electrostatic printing process is illuminated by two lamps 144 and 146. The reflected image of the letter 142 is focused onto a portion of a web of an electrophotographic record 148 by means of a lens system represented by a single lens 150 and a mirror 152. A double, electrostatic charging unit 154 is adapted to move, with the aid of guide rails (not shown), across a portion of the record member 148 to charge the latter electrostatically. The charging unit 154 is moved forth and back by means of gear reduction motor 156 and the chain drive assembly 158. A pump 160 pumps liquid developer to a manifold (not shown). A replenisher pump 162 maintains the correct level and density of the liquid developer in a main developer container 164. The record web 148 is driven by a gear reduction motor 166 through a shaft and appropriate rollers. Fusing of the developer is accomplished by a heater comprising two heating elements 168 and 170. A blower 173 directs the heat from the heating elements 168 and 170 to the record web 148. A high voltage power supply 172 energizes the charging unit 154.

The operation of the timing apparatus comprising the cam assembly 10' will now be described. Closing a main switch 174 to a source of conventional A.-C. voltage starts the blower 173 and connects the heaters 168 and 170 in series for "stand-by" heat. Depressing the starter arm 75' of the bell crank 68' closes the switch S5', starts the reversible motor 78', and causes the cam assembly 10' to

rotate in a counter-clockwise direction as viewed in FIG. 3. The switch S4' is then closed momentarily by the cam riser C5' to pass current momentarily to the circuits for the high voltage power supply 172, the motor 156, and the replenisher pump 162. A switch S7, normally held open by supporting means 163 for the charging unit 154, takes over the function of the switch S4' as soon as the charging unit 154 starts moving to the left, looking at FIG. 3. When the charging cycle is completed, the switch S7 is opened by the charging unit supporting means 163. It is noted that the switch S4' could control both the starting and the stopping of the charging unit 154, but the switch S7 provides more accurate means for stopping the charger unit 154. The cam riser C5' on the cam C2*a* is shaped so that it does not actuate the switch S4' during the clockwise rotation. Next, the lamps 144 and 146 are turned "on" when the switch S3' is actuated by the cam riser 46' on the cam C2'. When the cam follower 84' of the switch S6' is engaged by the cam riser 108' on gear member 92', the latch 85' locks the switch S6' in its new position, and the cam assembly 10' reverses its direction of rotation, moving now in a clockwise rotation.

The lamps 144 and 146 are turned "off" when the cam riser 46' restores the switch S3' to the "off" position. At this point, the cam follower 22' of the switch S1' moves through the groove 20' to the upper surface of the cam C1'. The switch S1' then tilts to the "on" position and shorts the heater element 168, thus putting full voltage on the heater 170 to provide maximum heat. The switch S1' mechanically closes the switch S2' which, in turn, starts the record drive motor 166 and the motor of the developer pump 160.

The cam assembly 10' continues its clockwise rotation until the stop pin 110' releases the latch 85', and the switch S6' resets itself to its normally biased position. The motor 78' now reverses once more and rotates in a counter-clockwise direction. The cycle of operation is completed when the cam assembly 10' returns to its start position, that is, when the switch S1' tilts back to its "open" position and the switch S2' opens also. The cam follower 54' on the switch S5' now drops into the groove 52' in the cam C3', the switch S5' opens, and the reversible motor 78' stops.

The slide members 30' and 56', in FIG 3, cooperate with the rotary cams C1' and C3', respectively, in substantially the same manner as the slide members 30 and 56, in FIG. 1, cooperate with the slide cams C1 and C3, respectively. Thus, to start a cycle of operation, slide member 56' is pushed to the right, or clockwise, by depressing the arm 75' of the bell crank 68', whereupon the cam follower 54' of the switch S5' is raised, and the switch S5' is closed. The cam follower 54' will be prevented from riding into the groove 52' in the rotary cam C3' by the slide member 56' until all of the rotary cams have rotated first to the left, (i.e., counter-clockwise), then to the right (clockwise), and then to the left again to their starting positions. Thus, the cam follower 54' returns to the groove 52' at the end of the cycle of operation.

The slide member 30' moves across the groove 18' during the counter-clockwise rotation of the cam C1'. The slide member 30' covers the groove 18' when the cam C1' reverses and rotates in a clockwise direction, the groove 18' being uncovered by the slide member 30' only when the cam C1' is reversed again and rotates in a counter-clockwise direction to its original starting position.

Referring, now, to FIG. 5, the directions of rotation of the cam assembly 10' are shown schematically. In a typical cycle of operation, a fixed point on any of the rotary cams starts at a point S and ends at a point E, the points E and S being superimposed on each other in space but being shown displaced from each other in FIG. 5 for the sake of clarity. In the electro-photographic system illustrated in FIG. 3, the following functions are performed by the timing apparatus during the first counterclockwise travel of the cam assembly 10', between the starting point S and a point A:

(1) The high voltage power supply 172 is connected to the charging unit 154.

(2) The charging unit 154 is caused to move back and forth to charge the record 148.

(3) The replenisher pump 162 is operated.

The lamps 144 and 146 are turned on during the time period represented by the distance A B C D F G. The shortest time possible for this function is the time represented by the travel distance A B F G. This time can be made variable, however, by the adjustment of the knob 106', which varies the time at which the motor 78' reverses. Thus, the exposure time, controlled by the lamps 144 and 146, can be varied by starting the timing period of the exposure function before the reversal of the cam assembly 10' and ending the exposure time period after the cam assembly 10' has reversed.

The time represented by the movement of the cam assembly 10' between the points G and E is the time during which the following functions are controlled:

(1) The record drive motor 166 is turned "on."

(2) The motor for the developer pump 160 is turned "on."

(3) The high-heat heater element 170 is turned "on," the low-heat heater element 168 and 170 being "on" during the time period S A B C D F G.

It is noted that the duration of the last three functions can be made variable by the adjustment of the knob 124' which controls the movement of the limit pin 110', thereby controlling the time at which the motor 78' changes from a clockwise rotation to a counter-clockwise rotation.

From the foregoing description, it will be apparent that there has been provided improved timing apparatus for controlling a plurality of functions, some of which are variable in time. While only two embodiments of the improved timing apparatus of the invention have been illustrated and described, various other embodiments thereof, as well as various components useful therein, will, no doubt, readily suggest themselves to those skilled in the art. Hence, it is desired that the foregoing shall be considered merely as illustrative and not in a limiting sense.

What is claimed is:

1. In a system wherein a plurality of functions are performed in timed sequence during a cycle of operation and wherein the duration of at least one of said functions is variable to thereby vary the duration of said cycle, timing apparatus comprising, in combination,

(a) cam means movable from a starting point and effective to initiate said one function and towards said starting point effective to terminate said one function in the course of such movement,

(b) means for causing said cam means to go through said movement to thereby effect said functions, and

(c) means for varying the extent of said movement from said starting point to thereby vary the duration of said one function and thus the duration of said cycle.

2. In a system wherein a plurality of functions are performed in timed sequence during a cycle of operation and wherein the duration of at least one of said functions is variable to thereby vary the duration of said cycle, timing apparatus comprising, in combination,

(a) reciprocatory cam means movable successively first in one and then in the other of two opposite directions with respect to a starting point and effective to initiate said one function when said reciprocatory means moves through a predetermined point in one direction from said starting point and to terminate said one function when said reciprocatory means moves through said point in the opposite direction of movement thereof in the course of such movement,

(b) means for causing said reciprocatory cam means to go through said movement to thereby effect said functions, and

(c) means for varying the point at which said reciprocatory means is caused to change its direction of said movement to thereby vary the duration of said one function and thus the duration of said cycle.

3. In a system wherein a plurality of functions are performed in timed sequence during a cycle of operation and wherein the duration of at least one of said functions is variable to thereby vary the duration of said cycle, timing apparatus comprising, in combination,

(a) reciprocatory cam means movable from a starting position, first in one direction to a second position, then in the opposite direction through said starting position and beyond to a third position, and then in said one direction again back to said starting position, said means being effective to initiate said one function when said means moves away from said starting position and to terminate said one function when said means moves towards said starting position in the course of such movement,

(b) means for causing said reciprocatory cam means to go through said movement to thereby effect said functions, and

(c) means for varying the location of at least one of said second and third positions to thereby vary the duration of said one function and thus the duration of said cycle.

4. In apparatus of the type wherein a reciprocating cam has a cam surface formed as a groove, and wherein a device has a cam follower that rides on said cam, said device being actuated to one of two predetermined conditions when said cam follower rides into said groove, the combination therewith of

(a) a slide member having an edge adapted to be disposed adjacent to a portion of said cam, and

(b) means mounting said slide member in frictional engagement with said cam for movement therewith over a limited path of reciprocation, means coupled to said slide member to move it at will beneath said cam follower to actuate said device to the other of said conditions, whereby said cam follower is prevented by said edge of said slide member from riding into said groove until a predetermined point in the cycle of reciprocation of said cam.

5. In apparatus of the type wherein a reciprocation cam has a cam surface formed as a depression, and wherein a device has a cam follower that rides on said cam, said device being actuated to a predetermined condition when said cam follower rides into said depression, said reciprocating cam moving, in one cycle of operation, along a path in one direction from a starting point, then in an opposite direction past the starting point, and then in said one direction back to said starting point, the combination therewith of

(a) a slide member having an edge adapted to be disposed adjacent to a portion of said cam, and

(b) means mounting said slide member in frictional engagement with said cam for movement therewith over a limited portion of said path, said slide member being movable beneath said cam follower whereby said cam follower is prevented by said edge of said slide member from riding into said depression until substantially the end of the cycle of reciprocation of said cam.

6. In apparatus of the type wherein a reciprocating cam has a cam surface formed as a depression, and wherein a device has a cam follower that rides on said cam, said device being actuated to a predetermined condition when said cam follower rides into said depression, said reciprocating cam moving, in one cycle of operation, along a path in one direction from a starting point, then in the opposite direction past the starting point, and then in said one direction back to said starting point, the combination therewith of

(a) a slide member having an edge adapted to be disposed adjacent to a portion of said cam,

(b) means mounting said slide member in frictional engagement with said cam for movement therewith over a limited portion of said path, and

(c) means to move said slide member manually beneath said cam follower in the beginning of said cycle whereby to prevent said cam follower from riding into said depression until the end of said cycle of operation, said slide member being adapted to slip with respect to said cam when said slide member reaches an end of said limited portion of said path and said cam continues to move.

7. In apparatus of the type wherein a reciprocating slide cam has a cam surface formed as a depression, and wherein a device has a cam follower that rides on said cam, said device being actuated to a predetermined condition when said cam follower rides into said depression, and said reciprocating cam moving, in one cycle of operation, along a path in one direction from a starting point, then in an opposite direction past the starting point, and then in said one direction to said starting point, the combination therewith of

(a) a slide member having an edge adapted to be disposed substantially coplanarly with a portion of said cam,

(b) means mounting said slide member in frictional engagement with said cam for movement therewith over a limited portion of said path, and

(c) limit means disposed on said mounting means to limit the movement of said slide member and to cause said slide member to slip with respect to said cam when said slide member reaches said limit means and said cam continues along its path of reciprocation.

8. In apparatus of the type wherein a rotary cam is mounted on a shaft for reciprocative rotation therewith, said shaft being rotatably mounted on a support, said cam having a surface formed as a depression, a device having a cam follower that is adapted to ride on said cam to actuate said device into a predetermined condition when said cam follower rides into said depression, said reciprocating cam moving, in one cycle of operation, along a path in one direction from a starting point, then in an opposite direction past said starting point, and then in said one direction to said starting point, the combination therewith of

(a) a slide member loosely mounted on said shaft,

(b) means disposing said slide member in frictional engagement with said cam, said slide member having an edge of substantially the same radial curvature as said cam, and

(c) limit means mounted on said support and cooperating with said slide member to limit the movement thereof with respect to said support over a portion of said path, said slide member being adapted to rotate with said cam in both directions of reciprocation of said cam between the limits set by said limit means.

9. In apparatus of the type wherein a rotary cam is mounted on a shaft for reciprocative rotation therewith, said shaft being rotatably mounted on a support, said cam having a surface formed as a depression, a device having a cam follower that is adapted to ride on said cam to actuate said device into a predetermined condition when said cam follower rides into said depression, said reciprocating cam moving, in one cycle of operation, along a path in one direction from a starting point, then in an opposite direction past said starting point, and then in said one direction to said starting point, the combination therewith of

(a) a slide member loosely mounted on said shaft,

(b) means disposing said slide member in frictional

engagement with said cam, said slide member having an edge of substantially the same radial curvature as said cam,

(c) limit means mounted on said support and cooperating with said slide member to limit the movement thereof with respect to said support over a portion of said path, said slide member being adapted to rotate with said cam in both directions of reciprocation of said cam between the limits set by said limit means, and

(d) means to move said slide member adjacent to said depression to raise said cam follower when said cam is stationary.

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