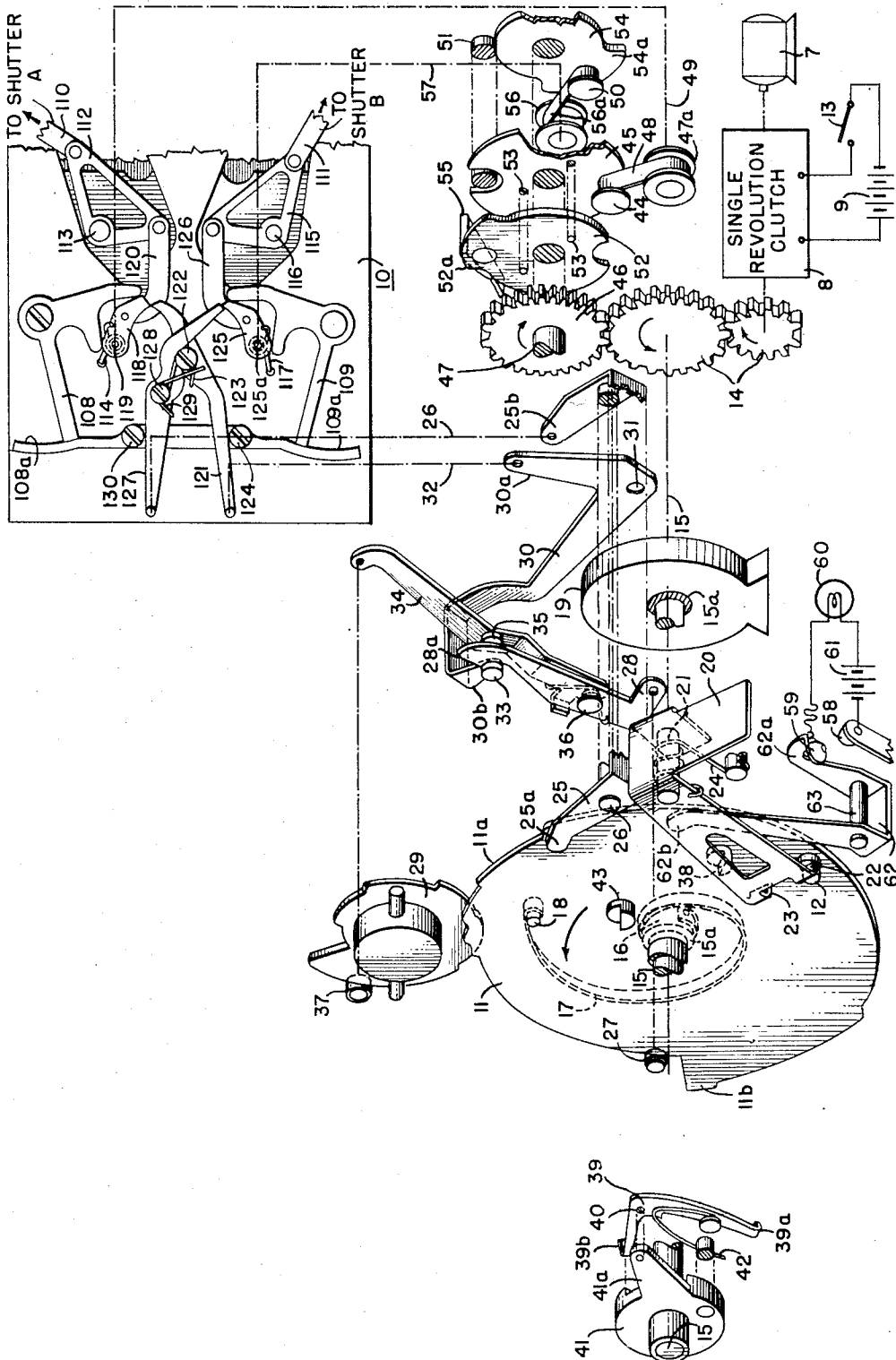


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ADJUSTABLE TIMING SYSTEM

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ADJUSTABLE TIMING SYSTEM

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This invention relates to adjustable timing systems and, while it is of general application, it is particularly suitable for timing a double-bladed shutter of the type described in the co-pending application of Frederick P. Willcox, Serial No. 125,453, filed November 4, 1949, and entitled "Drawer-Type High Speed Inter-Lens Shutter," now Patent 2,691,331, assigned to the same assignee as the present application, and the invention will be specifically described in such an application.

The timing system of the invention is particularly suitable for use in a remotely controlled camera, for example, an under-water camera. In the case of an under-water camera used in military work, it is desirable that the timing system be quiet in operation to minimize the chance of detection and to reduce interference with accompanying sound detection apparatus. It is also desirable in the case of remotely controlled cameras that the timing system require a minimum input torque, for example, something less than 1 inch-pound, since such timing systems are usually operated by spring motors in which the size and weight of the motor increase rapidly with torque and power requirements. In addition, it is desirable, in camera applications for making a continuous series of exposures, to provide a timing system in which the timing interval may be adjusted at any time even during the timing cycle, so that it is not necessary to stop the operation of the camera to adjust the exposure time.

It is an object of the present invention, therefore, to provide a new and improved adjustable timing system which obviates one or more of the above-mentioned disadvantages of prior camera exposure timing systems.

It is another object of the invention to provide a new and improved adjustable timing system for camera shutters which is extremely quiet in operation, which requires a minimum input torque and power, and by means of which the exposure time can be adjusted continuously, even during an exposure interval.

It is another object of the invention to provide a new and improved adjustable timing system in which the timing of the system may be adjusted in a number of accurately predetermined discrete steps.

It is a further object of the invention to provide a new and improved adjustable timing system adapted to be actuated by a continuously operating driving means through a resilient connection in which over-stressing of the resilient connection is avoided.

It is a still further object of the invention to provide a new and improved adjustable timing system for camera shutters which is effective also to re-wind the shutter-actuating mechanism of the camera during appropriate portions of the timing cycles.

In accordance with the invention, there is provided an adjustable timing system comprising a movable timing element having a cam surface and normally biased to timing movement, a latch normally restraining the timing element and operable to release the same to initiate a timing cycle, a first controlling member actuated by the timing element and operative to initiate a timing

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operation, a second controlling member actuated by the timing element and operative to terminate a timing operation, one of said controlling members including a cam follower in operative relation to said cam surface and adjustable relative thereto to adjust the timing interval.

Further in accordance with the invention, there is provided in an adjustable timing system including a timing element, an adjustable latch mechanism comprising a latched element having a latch pin, a lever pivotally mounted coaxially with the latch pin when in latched position, and a latch pivotally mounted on said lever, normally engaging the latch pin and disposed to be released by the timing element of the system, such lever being pivotally adjustable to adjust the timing of the release of the latch element.

For a better understanding of the present invention, together with other and further objects thereof, reference is had to the following description taken in connection with the accompanying drawing, while its scope will be pointed out in the appended claims.

Referring now to the drawing, the single figure is an exploded perspective view of an adjustable timing system embodying the present invention and illustrated as applied to a camera shutter of the type described in afore-said copending Willcox application.

Referring now more particularly to the drawing, there is represented an adjustable exposure timing system for a camera shutter of the double-blade type represented schematically at 10 and including a spring-wound shutter-opening mechanism and a spring-wound shutter-closing mechanism, these shutter-actuating mechanisms being described in more detail hereinafter.

The timing system of the invention also includes a movable timing element in the form of a rotatable disc 11 having a radially stepped cam surface 11a and a stop element 12 and normally biased to timing movement or rotation in a counterclockwise direction as viewed in the drawing. The timing system also comprises means including a resilient element for driving the timing element 11. Specifically, this driving means comprises a motor 7 which, through a single-revolution clutch 8 and gearing 14, intermittently drives shaft 15 on which is secured a hub 16. The motor 7 may be of any suitable type, such as a spring motor, while the clutch 8 may also be of a conventional type which rotates the shaft 15 through a single revolution and then disengages the shaft 15 from the motor 7 until tripped mechanically by the timing disc 11 or electrically, as by an electric circuit including a battery or like source 9 and a manually operable push-button switch 13. A spiral spring 17 for driving the timing element 11 and biasing it to timing movement has one end secured to a pin 18 mounted on the disc 11, while the other end is connected to hub 16 so that it is wound by relative movement between the driving shaft 15 and the timing element 11.

The timing system of the invention also includes a speed-regulating means for limiting the velocity of the timing element 11 to a predetermined value, this means being in the form of a centrifugal brake 19 having a rotatable element driven by the timing element 11 through a sleeve 15a and a stationary braking element. The details of the centrifugal brake 19 are omitted for the sake of clarity since it may be of conventional construction and, per se, forms no part of the present invention.

The timing system of the invention also includes a latch 20 normally restraining the timing element 11 and manually or mechanically operable to release the same to initiate a timing cycle. The latch 20 is mounted on a pivot 21 and includes an inwardly projecting lug 22 normally engaging the stop 12 of the timing element 11. The latch 20 also has a spaced second inwardly project-

ing lug 23 for purposes described hereinafter. Actuation of the latch 20 in a counterclockwise direction about the pivot 21 disengages the lug 22 from the stop 12, permitting it to pass upwardly between the lugs 22, 23 to initiate movement of the timing element 11, as described in detail hereinafter. The latch 20 is provided with a suitable biasing spring 24 which is effective to bias it, upon release, to return it to its initial restraining position.

The timing system also includes a first shutter-controlling member actuated by the timing element 11, specifically, by the stop member 12, which also functions as an actuating element in fixed relation to the timing element 11. The shutter-controlling element described is in the form of a U-shaped crank member 25 pivotally mounted at 26 and including an extending arm 25a in the path of the stop element 12 and in a position to be actuated thereby a substantial interval after the release of the timing element 11 by the latch 20, such that the timing element has reached substantially its maximum velocity as determined by the centrifugal brake 19. The crank 25 has a second extending arm 25b which by a suitable linkage mechanism indicated schematically at 26 is connected to the trip arm 127 of the shutter-actuating mechanism 10 to release the shutter-opening mechanism to initiate a camera exposure, as described hereinafter.

The timing system of the invention also comprises a second shutter-controlling member or assembly including an element actuated by the timing element 11, specifically, a cam follower roller 27 mounted on the end of a crank 28 and disposed in operative relation to the cam surface 11a of the timing element 11. The timing system further comprises means for adjusting the relative position of the shutter-controlling members, specifically, for adjusting the position of the shutter-controlling assembly including the crank 28, to adjust the camera exposure time. This adjusting means comprises means for adjusting the actuating element or crank 28 and its cam follower 27; specifically, it comprises a second cam disc 29 having a series of radial steps related to the radial steps of the cam surface 11a of the timing element 11 for adjusting the cam follower 27 radially relative to the cam surface 11a of the timing element 11.

The second shutter-controlling member which is effective to release the shutter-closing mechanism of the camera includes an adjustable latch mechanism interconnected between the manually adjustable cam 29 and a tripping lever 121 for the shutter-closing mechanism of the shutter-actuating mechanism 10. This adjustable latch mechanism includes a latched element or bell crank 30 pivotally mounted at 31 and having a crank arm 30a connected by a mechanism indicated schematically at 32 to the tripping lever 121. The crank 30 has a second reversely bent crank arm 30b carrying a latch pin 33. The latch mechanism also includes a lever 34 pivotally mounted at 35 coaxial with the latch pin 33 when the crank 30 is in latched position. The crank 28 includes an arm 28a comprising a latch pivotally mounted on lever 34 at 36 and normally engaging the latch pin 33, as shown, the latch arm 28a is disposed to be released from the latch pin 33 by the timing element 11. Specifically, the cam follower 27 mounted on the crank 28 is disposed to be engaged by the cam surface 11a of the timing element 11 to rotate the crank 28 in a clockwise position about its pivot 36 to release the latch pin 33 and the latched crank 30.

The lever 34 carries a cam follower roller 37 disposed to engage the cam surface of cam 29 so that manual adjustment of the cam 29 rotates the lever 34 about its pivot 35 to adjust the position of the cam follower 27 relative to the timing element and thus adjust the timing of the release of the crank 30 and the release of the shutter-closing trip lever 121. As men-

tioned above, the radial steps of the cam 29 and those of the cam surface 11a of timing element 11 are related to each other in the direct ratio of the lever arm of the cam follower 37 with respect to the pivot 35 and the lever arm of the cam follower 27 with respect to the pivot 36.

In order to provide a time exposure, the timing element 11 is provided with a stop element 38 disposed upon rotation of the timing element to engage the lug 23 of latch 20 before the timing element 11, through the cam follower 27, actuates the shutter-controlling member or crank 30 when the relative positions of the cam follower 27 and the arm 25a of the shutter-controlling member 25 have their maximum relative adjustment, that is, when the cam follower 27 is adjusted to its maximum radial setting, so that operation of the timing element is arrested upon the engagement of the stop 38 and the lug 23. Under these conditions, a second manual release of the latch 20 is required to terminate the time exposure of the camera, as described in more detail hereinafter.

Since the timing element 11 is driven intermittently by the motor 7, clutch 8, and shaft 15 through the biasing spring 17, if for any reason the movement of the timing element 11 were arrested, as by the jamming of the shutter-controlling members, etc., the biasing spring 17 would be over-wound or over-stressed. To avoid this consequence, there is provided a tripping element for the latch 20 driven directly by the drive shaft 15. This tripping element is in the form of a crank 39 pivotally mounted at 40 on an arm 41a of a hub 41 secured to shaft 15.

The crank 39 has a tripping arm 39b and an actuating arm 39a which is biased clockwise to inoperative position by a spring 42, but is operable by the timing element 11 to tripping position in a predetermined relative position of the driving shaft 15 and of the timing element 11, thereby to avoid over-winding the spring 17. Specifically, in case the shaft 15 tends to advance too far relative to the timing element 11, so as to over-stress the spring 17, an actuating pin 43 of the timing element 11 engages the arm 39b of the tripping assembly moving the crank 39 counterclockwise about its pivot 40 and moving the tripping arm 39a into engagement with the lug 23 of latch 20 to trip the same and release the timing mechanism 11, which then completes another cycle of operation while the shaft 15 is completing the next cycle of rotation.

The timing system of the invention also includes lost-motion driving connections from the shaft 15 for winding one of the shutter mechanisms during one portion of the timing cycle and for winding the other shutter mechanism during another portion of the timing cycle. An understanding of the winding of the shutter mechanisms will be aided by a description of the shutter-actuating mechanism 10, which is essentially the same as that described in the aforesaid Willcox Patent 2,691,331 and is identical to that illustrated and described in the copending application of Irving W. Doyle, Serial No. 340,557, filed March 5, 1953, and assigned to the same assignee as the present application. For ease of comparison, the several elements of the shutter-actuating mechanism 10 are identified by the same reference numerals as in the aforesaid copending Doyle application, increased by 100 to avoid duplication herein.

The shutter-actuating mechanism 10 includes two independently operable shutter-actuating elements 110, 111 which may, for example, be connected to two independently operable shutters A and B arranged in cascade in the optical system of the camera, for example, the sets of shutter blades 28 and 30 of the aforesaid copending Willcox application. It will be assumed that shutter B actuated by the element 111 is initially in aperture-closing position and that shutter A actuated by element 110 is in aperture-opening position. There is

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provided means for biasing the element 110 to aperture-closing position including a crank 112 mounted on a pivot 113. There is also provided means for biasing the element 111 to aperture-opening position comprising a crank 115 mounted on a pivot 116.

The shutter-actuating mechanism also includes a pair of releasable latches individually restraining the biased shutter-actuating elements 110 and 111 from movement. The latch for the element 110 includes a latch element in the form of a crank 118 secured to a pivot shaft 119 and connected to the crank 112 by a link 120 pivotally connected at either end to the elements 118 and 112. Crank 118 is biased for clockwise rotation by means of spring 114. The latch for the element 110 also includes a latch element 121 pivotally mounted at 122, biased for counterclockwise rotation by a spring 123, and resting against a stop pin 124. One end of the latch element 121 engages the tip of the latch crank 118, as illustrated.

The latch for the shutter-actuating element 111 includes a latch element in the form of a crank 125 secured to a pivot shaft 125a and connected to the crank 115 by means of a link 126 pivotally connected at either end to the latch element 125 and the crank 115. Crank 125 is biased for counterclockwise rotation by means of spring 117. This latter latch also includes a latch element 127 pivoted at 128, biased for clockwise rotation by a spring 129, and resting against a stop pin 130. Cranks 118 and 125 co-operate with pivoted snubbers 108 and 109, respectively, engaging arcuate friction elements 108a and 109a, respectively, for cushioning the final ranges of movements of the latch mechanisms.

The lost-motion driving connections from the driving shaft 15 to wind the springs 114, 117 and their associated shafts 119 and 125a, respectively, include a first crank pin 44 secured to a disc 45 and connected to be driven directly by the shaft 15 through gearing 14, 46, the gear 46 and the disc 45 being secured to a common shaft 47. There is provided a one-way driving connection from the crank pin 44 to the shaft 119 of the "A" shutter-actuating mechanism to re-wind the spring 114. This one-way driving connection includes a spring-biased pulley 47a on which is wound an inelastic element, such as a flexible steel tape 48. The pulley 47a, through a suitable drive shaft or equivalent mechanism 49, has a one-way driving connection, such as a ratchet and pawl connection, to the shaft 119 of the shutter-actuating mechanism.

The winding mechanism includes a second crank pin 50 having a 180° lost-motion driving connection to the shaft 47 and thus to the shaft 15. This lost-motion driving connection is in the form of a pin 51 secured to a spring disc 52 which, in turn, is secured to the disc 45 by rivets 53, or the like. Normally the pin 51 is disposed adjacent the outer periphery of a disc 54 journaled on the shaft 47 and carrying the crank pin 50. The relationship of the parts is such that after approximately 180° of rotation of the disc 45, the pin 51 engages a projecting sector 54a of disc 54, thereafter driving it in a clockwise direction with the disc 45. After approximately 350° of rotation of disc 45, an extending sector 52a of spring disc 52 engages a stationary cam or ramp 55 which deflects the spring disc 52 to disengage the pin 51 from the disc 54 so that the latter is free to return to its initial position in a reverse direction. There is also provided a one-way driving connection from the crank pin 50 to the shaft 125a of the "B" shutter-actuating mechanism to rewind the spring 117. Specifically, the crank pin 50 is connected through an inelastic element, such as a steel tape 56a, to drive a spring-biased pulley 56 which, through suitable one-way driving mechanism 57, is connected to the shaft 125a to rewind the spring 117.

The timing system of the invention also includes a flash-control circuit closed by the timing element 11

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in advance of the actuation of the first shutter-controlling member 25. This circuit includes a stationary contact 58 and a movable contact 59 connected in circuit with a suitable flashlamp 60 and a suitable source of energy, schematically represented as a battery 61. The movable contact 59 is mounted on a U-shaped crank 62 mounted on a pivot shaft 63 and having one crank arm 62a on which the contact 59 is mounted and a second crank arm 62b disposed in the path of movement of stop element 12 somewhat in advance of the point at which the stop 12 engages the arm 25a of the controlling member for the shutter-opening actuating mechanism, so that energy of the flashlamp 60 is effective to cause that lamp to reach maximum illumination at approximately the initiation of the camera exposure.

It is believed that the operation of the adjustable timing system of the invention will be clear from the foregoing description. However, in brief, the continuously operating motor 7 drives the shaft 15 a single revolution through the clutch 8, which then disengages the shaft from the motor 7. The trip latch 20 is operated manually counterclockwise to initiate the operation of the timing disc 11 and a camera exposure. The disc 11, under torque by the spring 17, commences rotation and rapidly accelerates to a final velocity determined by the setting of the centrifugal brake 19. Shortly thereafter, the stop element 12 engages the arm 25a of crank 25 which actuates the trip arm 111 of the shutter-actuating mechanism. It will be assumed that shutter A connected to the actuating element 110 is initially open and that the crank 112 is biased to actuate it to aperture-closing position and that the shutter B connected to the element 111 is in aperture-closing position and biased by the spring 117 to aperture-opening position. Under these conditions, actuation of the trip lever 127 releases the latch 127, 125 so that biasing spring 117 collapses the toggle formed by crank 125 and link 126 and rotates the crank 115 counterclockwise to actuate the shutter mechanism 111 to aperture-opening position. This, of course, initiates a camera exposure.

A predetermined interval of time later, depending upon the setting of the manual timing disc 29, one of the radial steps of the cam surface 11a engages the cam follower 27 and rotates the crank 28 clockwise to release the latch pin 33, thereby permitting the crank 30 to move in a clockwise direction and actuate the trip arm 121 to release the latch 121, 118. Thereupon the spring 114 actuates the crank 118, collapsing the toggle comprising elements 118, 120 and operating the shutter mechanism 112 to aperture-closing position, thus completing the camera exposure. In the event the clutch 8 is connected to be tripped by the timing disc 11 upon completion of a timing cycle, as described, the timing mechanism will effect a series of exposures in succession. If the clutch is tripped manually, as by the manual switch 13, each exposure is initiated by first closing the switch 13 and then tripping the latch 20.

Adjustment of the camera exposure time is effected by manual rotation of the cam disc 29 operating through the cam follower 37 and its associated pivoted lever 34 to adjust the cam follower 27 radially with respect to the cam surface 11a of the timing disc 11. It is clear from the configuration of the timing disc 11 that the angle of rotation through which it moves before one of its cam steps engages the cam roller 27 is dependent upon the radial positioning of the roller 27 relative to the timing disc. By appropriate configuration of the stepped disc 11, any desired number of discrete exposure times may be secured.

In case it is desired to effect a time exposure, the cam roller 27 is adjusted to its maximum outward position in which it is engaged only by the trailing step 11b of the timing element. However, before such engagement, the stop element 38 secured to the timing disc engages the lug 23 of the latch 20 to arrest motion of the disc 11.

The camera exposure is then completed by a second operation of the latch 20, permitting the stop 38 to pass between the lugs 22 and 23 of the latch and to permit the trailing cam portion 11b to engage the cam roller 27 to actuate the shutter-closing mechanism, as described above.

In the event that the latch 20 or its associated mechanism should jam so that the timing disc 11 is not released, continuous operation of the motor 7 and the drive shaft 15 would tend to over-wind the spring 17. This is avoided by the auxiliary tripping mechanism described; that is, the crank 39 continuously driven by the shaft 15 is actuated by engagement with the element 43 and is effective to trip the latch 20, as described above, in time to prevent over-winding of the spring 17.

The adjustable timing system of the invention has the advantage also that it is capable of re-winding the shutter mechanism 10 during appropriate portions of the timing cycle. In the relative positions of the parts illustrated in the drawing, it is assumed that both springs 114 and 117 are unwound. Rotation of the shaft 15 effects clockwise rotation of the disc 45, rotating the pulley 47 through the tape 48 and winding the spring 114 by means of the shaft 119 connected to the shaft 49 of the pulley 47. This winding takes place during 180° of rotation of the disc 45 and, during the succeeding 180° rotation the spring-biased pulley 47 returns to its initial position, its one-way driving connection to shaft 49 permitting disengagement from shaft 119. After 180° rotation of the disc 45, the pin 51 carried by the spring disc 52 engages the extending sector 54a of the disc 54 which carries the crank pin 50 and similarly actuates the pulley 57 through the steel tape 56a, the pulley 56 being connected by a shaft 57 or suitable mechanism to the shaft 125a to re-wind the spring 117. This re-winding is effected during rotation of the disc 45 from 180° to 350°, at which point the extending sector 52a of the spring disc 52 engages the cam or ramp 55 and disengages the pin 51 from the disc 54, permitting it to return to its initial position illustrated under the influence of the biasing spring of the pulley 56, at the same time disengaging the shaft 125a.

The compound lever mechanism between the cam roller 27 and the cam 37 engaging the manually adjustable cam disc 29 has the advantage that movement of the crank 28 to unlatch the crank 30 is the same irrespective of the adjustment of the lever 34 by the cam 29. This is due to the fact that the latch pin 33 engaged by the latching arm 28a of the crank 28 is coaxial with the pivot 35 of the lever 34, together with the fact that the crank 28 is pivoted at 36 on the lever 34 and the fact that the arm 28a and the lever 34 are normally maintained in axial alignment. This ensures that the trip-out time of the crank 28 remains constant and independent of the setting of either the manual cam disc 29 or the timing cam disc 11.

While there has been described what is at present considered to be the preferred embodiment of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and it is, therefore, aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. An adjustable timing system comprising: a movable timing element having a radially stepped cam surface and normally biased to timing movement; a latch normally restraining said timing element and operable to release the same to initiate a timing cycle; a first controlling member independent of but actuated by said timing element in a predetermined position thereof and operative to initiate a timing operation; a second controlling member including a cam follower in operative relation to said cam surface and operative to terminate a timing operation;

tion; and a second cam for adjusting said cam follower radially relative to said cam surface to adjust the timing interval, said second cam having a series of radial steps related to the radial steps of said first cam.

2. An adjustable timing system comprising: a movable timing element having a stop element and normally biased to timing movement; a latch normally restraining said timing element and operable to release the same to initiate a timing cycle; a first controlling member independent of but actuated by said timing element and operative to initiate a timing operation; a second controlling member actuated by said timing element and operative to terminate a timing operation; and means for adjusting the relative position of said members to adjust the timing interval, said stop element engaging said latch before said timing element actuates said second member when the relative position of said members has its maximum adjustment, whereby the timing interval is terminated by a second manual release of said latch.

3. An adjustable timing system comprising: a movable timing element having a cam surface and a stop element and normally biased to timing movement; a latch normally restraining said timing element, manually operable to release the same to initiate a timing cycle, and biased to return to its restraining position; a first controlling member independent of but actuated by said timing element in a predetermined position thereof and operative to initiate a timing operation; and a second controlling member including a cam follower in operative relation to said cam surface and operative to terminate a timing operation, said second member being adjustable relative to said cam surface to adjust the timing interval and said stop element engaging said latch before said cam follower actuates said second member when said second member has its maximum adjustment, whereby the timing interval is terminated by a second manual release of said latch.

4. An adjustable timing system comprising: a movable timing element normally biased to timing movement; a first latch normally restraining said timing element and operable to release the same to initiate a timing cycle; a first controlling member actuated by said timing element and operative to initiate a timing operation; a second controlling member operative to terminate a timing operation and having a latch pin; a lever pivotally mounted coaxially with said latch pin when in latched position; and a second latch pivotally mounted on said lever, normally engaging said latch pin and releasable by said timing element to release said second member, whereby pivotal adjustment of said lever is effective to adjust the timing interval.

5. An adjustable timing system comprising: a movable timing element having a cam surface and normally biased to timing movement; a first latch normally restraining said timing element and operable to release the same to initiate a timing cycle; a first controlling member actuated by said timing element and operative to initiate a timing operation; a second controlling member operative to terminate a timing operation and having a latch pin; a lever pivotally mounted coaxially with said latch pin when in latched position; and a second latch pivotally mounted on said lever, normally engaging said latch pin and having a cam follower in operative relation to said cam surface, whereby pivotal adjustment of said lever is effective to adjust the timing interval.

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