

Jan. 28, 1941.

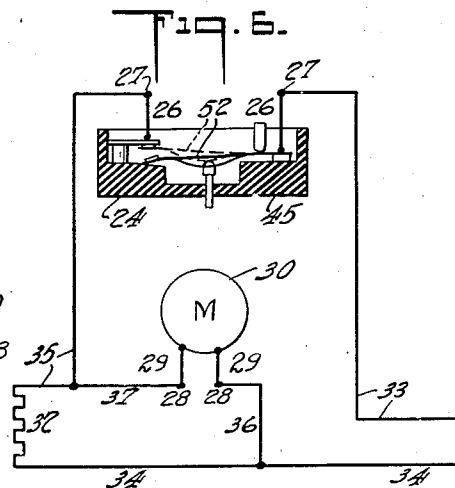
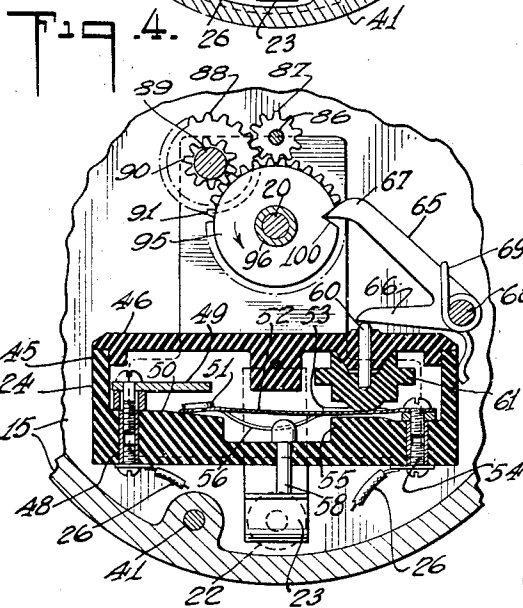
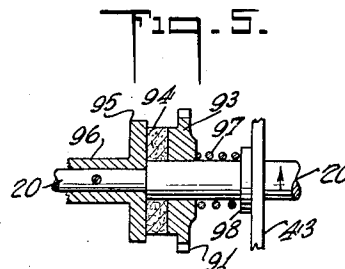
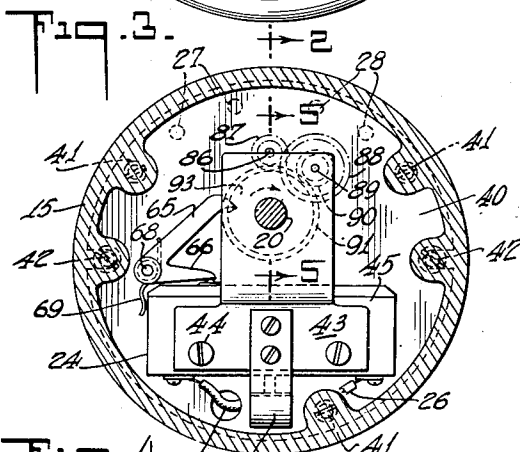
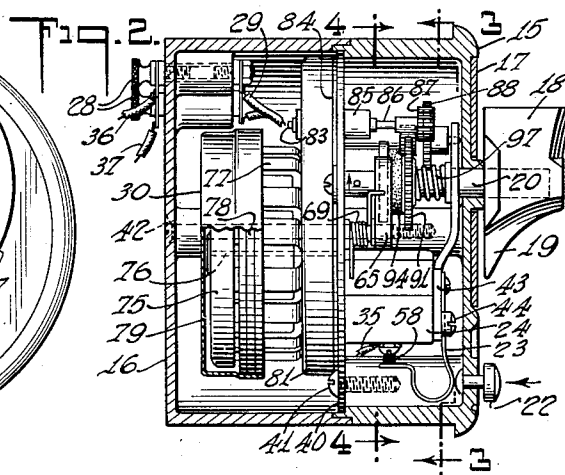
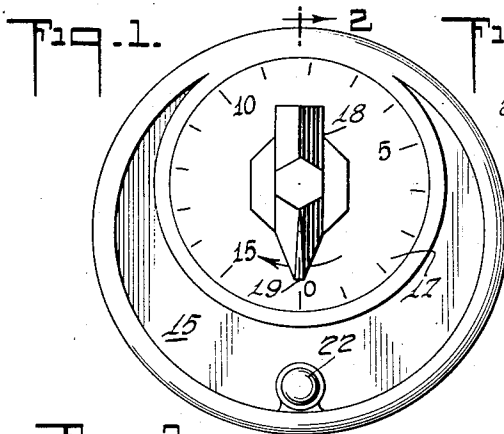
R. F. KNIGHT

2,230,191

INTERVAL TIMING DEVICE

Filed Nov. 18, 1937

2 Sheets-Sheet 1



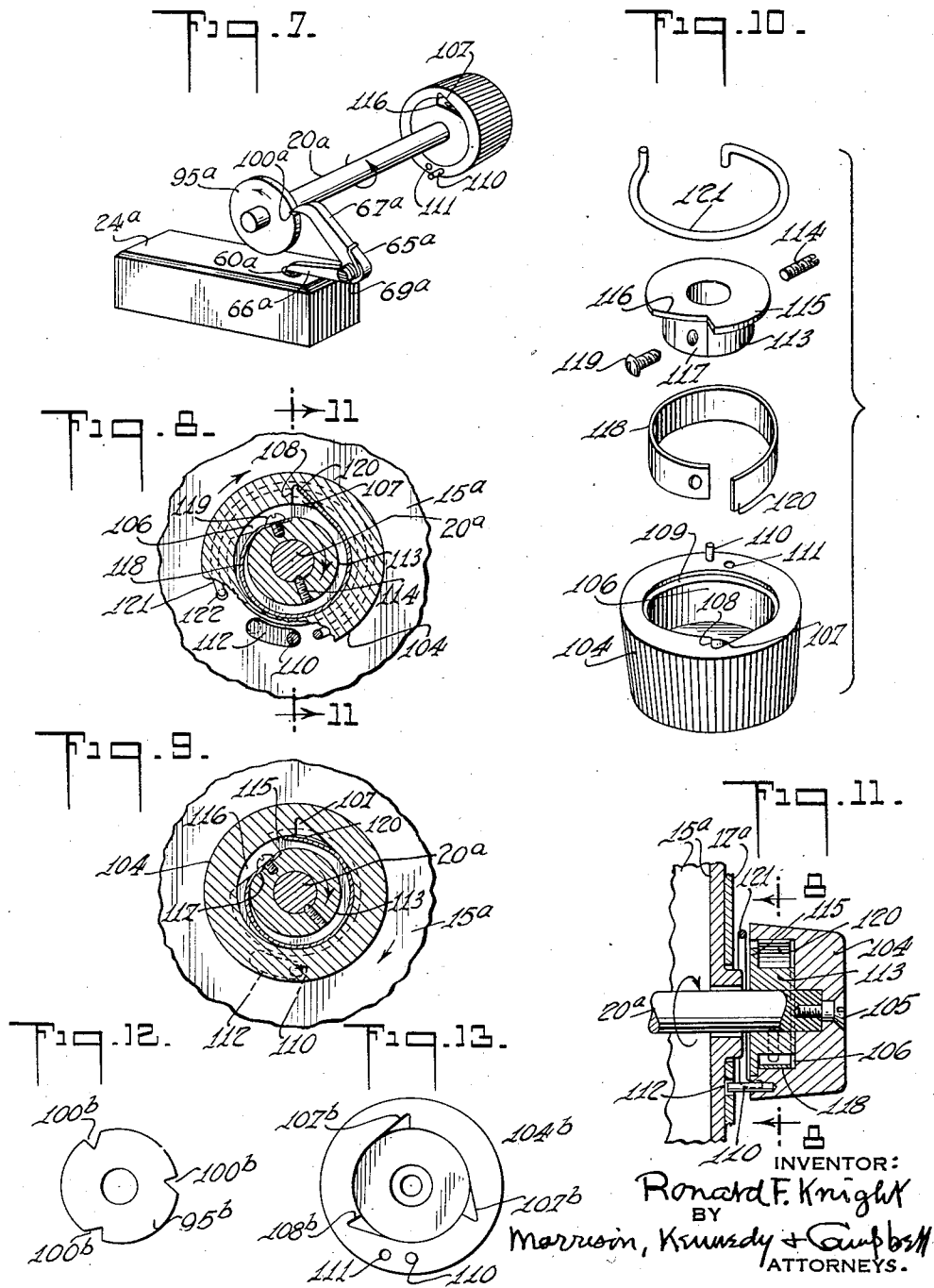
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Jan. 28, 1941.

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2 Sheets-Sheet 2



UNITED STATES PATENT OFFICE

2,230,191

INTERVAL TIMING DEVICE

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5 Claims. (Cl. 161—1)

This invention relates to interval timing devices, referring to means of an electrical character for turning on or off a switch or similarly controlling other operations. The invention is of the class wherein is combined a switch and a time measuring means such as a synchronous drive motor and control means cooperating with the motor and the switch to afford the automatic determination of time intervals for various purposes. A common commercial application of such devices is to control or limit the period of operation of cookers, flatirons or other heaters, in order to turn on the heat, or turn it off, or both, in any desired manner, whether for operating or safety or other purposes. The device however is adaptable for controlling various other electrical or non-electrical operations, among which may be mentioned radio reception, illumination, fluoroscope operation, and various electrical appliances whether or not embodying a driven electric motor.

The general object of the present invention is to afford a constant-speed motor-operated interval timing device of the class referred to which will be efficient, reliable and convenient in use, and sturdy, simple and compact in structure. A further object is to render such a device trouble-free or foolproof and of long life and small upkeep expense. A particular object is to provide for the ready manual setting of the device to afford a predetermined period of operation; and in one form the manual setting being automatically accompanied by the actual starting of the controlled operation and the running of the interval. Further objects and advantages will be pointed out in the following description of illustrative embodiments of the invention or will be understood by those conversant with the subject.

In the accompanying drawings
Fig. 1 is a front exterior view of an interval timing device embodying the present invention.

Fig. 2 is a central fore-and-aft section taken on the line 2—2 of Fig. 1, looking from the left.

Fig. 3 is a front elevation of certain interior parts and a cross section of the housing on the line 3—3 of Fig. 2.

Fig. 4 on an enlarged scale is a rear elevation of certain parts taken on the line 4—4 of Fig. 2.

Fig. 5 is a vertical sectional view of certain details taken on the line 5—5 of Fig. 3, looking from the left.

Fig. 6 is a diagram of a convenient mode of wiring pertaining to the embodiment shown in Figs. 1 to 5.

Fig. 7 is a perspective view of a second or modified

embodiment limited to a showing of certain mechanical parts, those not shown to be considered as corresponding with Figs. 1 to 5.

Fig. 8 is a transverse sectional view of certain details taken on the line 8—8 of Fig. 11, looking from the front.

Fig. 9 is a view similar to Fig. 8 showing the parts in a different stage or position.

Fig. 10 is an exploded perspective view of the components characterizing the second embodiment.

Fig. 11 is a fore-and-aft vertical section view taken on the line 11—11 of Fig. 8, looking from the left.

Figs. 12 and 13 are rear elevations showing certain parts with further modifications of structure.

Referring first to certain of the exterior and the main interior elements, the device hereof is shown as compactly accommodated within a housing or case, comprising a front housing portion or half 15 and a rear half 16, these being assembled into a cylindrical box-like form of suitable depth. On the face of the front housing half 15 is conveniently arranged a graduated disk or dial 17, its markings for example indicating the number of minutes of interval to which the device may be manually set. In front of the dial is a finger piece or knob 18 of convenient shape, having a pointer or index 19 cooperating with the scale marked upon the dial. The setting knob is shown mounted at the front end of a shaft 20 which may be referred to as the timing shaft, being subject not only to the manual setting referred to, but to the time controlled operation of the device.

Another exterior feature is the operating member or button 22 mounted in a hole in the front wall of the housing so that it can be actuated or pressed inwardly at will, its interior end engaging a connecting member in the form of a spring strip 23 so shaped and disposed as to cause the operation of a switch 24, preferably of the snap type as will be more fully described.

From the terminals of the snap switch 24 extend wires 26, shown also in the diagram Fig. 6, these extending to terminals or binding posts 27 preferably at the back side of the housing. There is preferably also a second pair of such terminals 28 having connection by wires 29 with a driving motor 30 of predetermined speed, preferably an electric motor of the synchronous type, thus operating as a time measuring means. If another kind of motor is employed, as clockwork, the wires 29 will lead to a magnet controlling the

motor. Referring further to the wiring diagram, this shows the controlled load 32, for example in the form of a cooker or heater. Wires 33 and 34 are shown supplying current for the device and for the operation of the load. As an example, the supply wire 33 is shown connected to one of the switch wires 26, the other switch wire being connected by a wire 35 to the load 32, which also is connected to the other supply wire 34. One of the wires 29 of the motor 30 is shown connected by wire 36 with the supply wire 34, the other motor wire 29 being connected by wire 37 with the wire 35. By this arrangement the switch 24 controls completely the disclosed circuits, with which it is in series. The circuits containing respectively the motor 30 and the load 32 are preferably in parallel. The motor as well as the load are thus cut off by the switch at the end of the timed operation, terminating all consumption of current. When the motor is in parallel not only with the load but also with the switch then the motor may continue running, in cases where so desired.

Referring to the construction of the interior parts of the device the switch 24 and motor 30 are shown both mounted upon a circular plate or cross wall 40 which is clamped firmly between the housing parts and constitutes a partition affording a motor chamber and a chamber for the switch and control parts. The wall 40 is shown attached to bosses on the housing front half 15 by means of screws 41, and screws 42 are indicated connecting the rear to the front housing half. By removing these several screws, and detaching the knob 18, the entire interior mechanism is removable, being carried on the middle wall or disk 40, upon which it may be assembled before enclosing in the housing. The wall 40 may be considered as part of the frame of the device, and this is supplemented by a front frame wall or plate 43 fixedly mounted for convenience at the front side of the switch 24 by screws 44.

The switch 24 may be of various kinds, being shown as a well known type of switch known as a snap switch, wherein the movable contact is adapted to spring into place, open or closed, with a snap action. A snap switch 24 is shown for convenience substantially like that illustrated in United States Patent No. 1,960,020 of May 22, 1934, which may be referred to for details of structure and operation; it being understood that other types of switch may be employed within the purposes of the present invention. The switch 24 is shown in exterior views in Figs. 2 and 3 and its interior in Figs. 4 and 6. It has a housing 45 of insulating material as Bakelite, with a cover 46 of the same material. Mounted on the housing, as by a sleeve 48 is a fixed contact 49, spaced somewhat from an insulating abutment 50. The movable contact piece 51 is adapted to shift across between the contact 49 and the abutment 50, this being a single contact switch, suitable for certain uses. The movable contact is formed at the extremity of a swingable carrier 52, shown for convenience in the form of a spring, with one end mounted on a metallic base or plate 53 which in turn is fixedly mounted by a sleeve 54 upon a boss or abutment 55. The plate 53 may be of U-shape, with the carrier 52 swinging between its sides, and the ends of the sides may be notched to receive the free ends of a pair of stressed springs 56 which extend between the base 53 and the free end of the carrier 52. This known arrangement of carrier and operating spring affords the so-called over-center action by which

the carrier and the contact 51 are held yieldingly in either of their two positions, as shown by full and dotted lines in Fig. 6, it being only necessary to press lightly in either direction, beyond a certain central position, when the contact will snap across to its opposite position.

A snap switch as thus described is operable by means of a snap pin or member, which may be termed a trigger, being usually in the form of a pin or plunger, mounted to press the contact or carrier away from either position toward the other, so that a very light movement of the snap member or trigger causes a reliable reversal of the switch. In the embodiment shown there are two triggers or pins. The first is the pin or plunger 58 sliding through the lower wall of the switch housing, so that by pressing up on the pin the switch will snap into closed position. The pin 58 is arranged to be thrust upwardly by the connecting member or spring 23 already mentioned, actuated by the exterior button 22. Therefore, when the switch 24 is open, as shown, it remains so until the button 22 is manually operated to close the switch thereby starting the operation of the synchronous motor 30 and the load or heater 32.

The other trigger or plunger 60 is adapted for automatic or timed operation by means of a lever 65 to be later described. The pin 60 extends slidably through the switch cover 46, being accessible from the exterior, its interior end carrying, or actuating, an insulating block 61, this block having its lower portion shaped and positioned so that when depressed by the pin it thrusts downwardly on the contact carrier 52, thus moving it beyond the balanced or dead center position, until the switch snaps open. By the described arrangement, when the snapping member 60 is pressed downwardly this opens the switch and circuits; and later when the pin 60 is released the switch may be closed, but does not actually close until the manual operation of the pin 58 by the exterior button 22. As will be further explained therefore, in this form, two manual operations are necessary, first the setting of the index 19 on the dial 17 to predetermine the interval, which at the same time releases the pin 60, and thereupon the pressing of the button 22 to close the switch and circuits, thus energizing the load 32 and at the same time energizing the motor 30 which measures off the predetermined time interval for which the device has been set.

The lever 65 for operating the switch plunger or trigger 60 is shown as comprising a lower arm 66 adapted to bear down on the pin to open the switch. The other arm of the lever constitutes a dog or follower 67 and cooperates with a notched actuator disk or cam 95 turning with the timing shaft 20 as will be further described. The lever 65 is mounted on a short fixed stud 68 projecting frontwardly from the frame disk 40 and located preferably so that the arm 66 constitutes a radius at right angles to the movement of the pin 60, while the dog arm 67 extends at an upward slant. Surrounding the stud 68 is a coil spring 69 having its rear end anchored or held by a fixed part, as the end of the switch housing, as Fig. 3 shows, and its front end contacting the upper side of the lever. The spring is placed under initial circular tension affording a tendency for the lever always to swing downwardly and with sufficient force to depress the pin 60 and cause it to throw the switch into open position.

The driving motor 30 is a predetermined or constant speed electric motor, or electrically gov-

erned motor, preferably a synchronous motor, therefore giving drive with the regularity of clockwork. It is preferably a self-starting synchronous motor of a slow-speed kind well known on the market. The motor is sufficiently shown in Fig. 2, comprising a rotor or disk 75 mounted upon a free turning shaft 76. Connected with the usual frame 77 of such a motor are the usual rings 78, and jammed upon these is a protecting cap or cover 79. The motor shaft 76 extends into a sealed gear box 81, often marketed along with the motor as a unit, and containing reduction gearing not necessary to show, by which the rotation of the shaft 76 is transmitted with a large ratio of reduction to the final or drive shaft 83, the end of which projects frontwardly from the gear box. The driving of the present invention starts with this drive shaft 83, which passes through the front wall 84 of the gear box and turns in a bearing block 85 that may be mounted on the wall 84.

The frame wall 40 is perforated for the accommodation of the bearing 85 and drive shaft 83, and in front of the wall is a continuation shaft 86 integral with or coupled to the shaft 83. For further transmission and speed reduction the front end of the shaft 86 carries a pinion 87 from which suitable gearing is driven which may be selected or changed to deliver to the timing shaft a relatively low and constant desired rate of rotation, depending upon the time interval to be effected. Thus, engaging the pinion 87 is a larger gear 88 mounted on a shaft 89 turning in walls 40 and 43 and which shaft carries also a pinion 90. The pinion 90 engages a larger gear 91, formed as the periphery of a disk 93 surrounding the timing shaft or spindle 20 somewhat to the rear of the frame wall 43 and adapted, during operation, to transmit steady or synchronous rotation to the shaft.

The gear disk 93 is connected to drive the timing shaft, not positively, but through a slip device or friction means which is best shown in Figs. 2 and 5, as follows. Adjacent to the rear of the disk 93, which is rotated by the motor, is shown a friction piece or disk 94, which may consist of any known friction material such as cork. This friction disk or washer 94 is between the disk 93 in front and a disk or flange 95 to the rear. As will appear this is the notched actuator disk or cam already referred to. The disk 95 is mounted to turn with the timing shaft 20, having for this purpose a sleeve 96 fixed to the shaft. In order to create frictional pressure there is shown, in front of the disk 92, a compression spring 97, being in the form of a helical spring surrounding the shaft 20, and confined between the disk 93 and the wall 43 or a flange 98 formed on the shaft adjacent to the wall. It therefore appears that normally, during the operation of the motor and gearing, the final gear 91 operates through the friction device to turn the shaft 20 at the predetermined speed, this drive being through the non-positive or friction device which therefore permits the shaft 20 to be preliminarily turned and set, as manually, to any desired position determined by the movement of the index 19 over the dial 17. There is therefore a maximum timing period corresponding with one complete rotation of the timing shaft, but by the described manual setting this period may be reduced to any desired shorter period by means of the setting knob 18, in accordance with the purposes of this invention.

As already stated the disk 95 is formed with a

portion or notch 100 cooperating with the switch opening lever 65, as best shown in Fig. 4, wherein the shaft 20 and disk 95 turn counterclockwise. The notch 100 is formed preferably with a radial entrance, and the dog or follower 67 of the lever is so formed that it can drop instantaneously from the periphery into the notch at the end of the time interval, as shown. By the action of the spring 69 this control movement of the lever causes the depression of the switch trigger or pin 60 and thus snaps open the switch, breaking the circuit, terminating the control operation, and at the same time discontinuing the rotation of the driving motor 30, so that through the stopping of the motor all parts come to complete inaction when the spring movement of the follower 67 is brought about by the final rotary travel of the disk and notch.

In resetting and restarting the timing device, it is only necessary to turn the knob 18 to a desired position, for example around clockwise to the number 10 on the dial. This single manual operation performs two functions. The notch 100 has a fairly steep exit or outward incline, as Fig. 4 shows, so that the switch lever 65 is immediately lifted, releasing the pin 60 and thus potentially opening the switch or setting it to be opened. At the same time the selective turning of the knob and index cuts down the full period of the interval, for example from 15 to 10 minutes, the notched disk being turned with the shaft during this adjustment, so that when rotation is commenced the following interval of operation will be for the predetermined or reduced period, as 10 minutes. With a suitable switch 24 this manual operation of setting the knob and pointer might at the same time reverse the switch and thereby actually start the controlled operations as well as the rotation of the gearing. In the embodiment of Figs. 1 to 6 however, as already explained, a second manual operation is necessary to effect the actual starting, namely the pressing of the front button 22, operating through elements 23 and 58 to snap over the switch to its closed position. This combination permits the operator at leisure to turn the knob and predetermine the interval, and then, when ready, press the button 22 to start operations, which continue until the shaft and disk have completed rotation to the point where the notch 100 comes under the lever dog 67, permitting the spring 69 to operate the lever and the switch pin 60 to open the switch and discontinue all operations.

The need of pressing the starting button 22 after setting the knob may be dispensed with by pushing in and locking the button to hold the spring connector 23 under stress, this being weaker than spring 69, so that the lift of lever 65 closes and its depression opens the circuit. It may be arranged to have a prolonged interval, greater than that corresponding to one turn of the notched disk 95, namely, by an automatic guard rendering the notch inoperative for one or more turns, such as a latch to hold raised the lever 65 until a master control cam, e. g. on shaft 89, releases it. The disclosed switch and circuits are such that at the end of the interval the controlled circuit is opened or broken, but manifestly, by special switch or relay or otherwise, a circuit might be closed rather than opened, or one circuit opened and another closed. Or by placing the motor in parallel to the switch, e. g. by connecting the wire 37 of Fig. 6 between point 28 and wire 33, while button 22 is locked in, the motor can be kept running as long as desired, 75

affording successive cycles of closed and open load circuits.

In lieu of securing the button 22 in depressed position so that the setting of the timing shaft or spindle may also close the switch and start the motor, there may be used a switch type which is self closing and is held open only by the plunger 60 and lever 65, so that operations start with the setting action, and the interval can be varied at will as before.

The modification shown in Figs. 7 to 11 may have its general parts correspond largely with Figs. 1 to 6. Only enough of these parts are disclosed for explaining the modifications of structure and operation. Part of the front housing 15^a appears in Figs. 8, 9 and 11, including the dial 17^a, which is formed with a slot 112 and hole 122 for purposes to be explained. The timing shaft or spindle 20^a is to be understood as driven as before, from a constant speed motor, through reduction gearing, and with a slip coupling permitting the shaft to be turned relatively to the gearing, and thereafter by the gearing. A modified snap switch 24^a is shown having an exteriorly accessible plunger or trigger 60^a for its operation by the arm 66^a of an operating member or lever 65^a pressed by spring 69^a to cause switch operation, and having a follower or dog 67^a adapted to engage the cam or notch portion 100^a of a disk or flange 95^a on the timing shaft.

The switch 24^a is preferably a quick opening and closing, or snap switch, differing however from the switch 24 in that it has only a single operating plunger or trigger 60^a. In this form the contained leaf spring contact has only one normal position, and is preferably normally closed, so that when shifted across to open position it is self-returning to closed position. The lever 65^a then, through the switch plunger displaces the contact to open position, that is, when the lever is in initial position, as shown in Fig. 7. When the shaft and notched disk are turned sufficiently to throw the lever arm 67^a out of the disk notch, this releases the plunger 60^a, allowing the switch to close and the motor-driven operation to commence. While in the first embodiment the manual starting movement of the shaft may be continued to a variable point, to vary the interval of operation, in the modification of Figs. 7 to 11 this facility is eliminated, and on the contrary the device is arranged to afford always a fixed operating interval. There is shown at the front or exterior end of the shaft 20^a a manual starting knob or handle 104, but this is restricted in such a way that it can only advance the shaft by a short or minimum extent, sufficient however to swing the lever 65^a and put the motor operation into effect. The knob 104 is separate or loose from the shaft and is representative of any exterior member or handle which is operative only to give the short initial or starting rotation by which the motor drive is put into effect, the operation thereupon continuing always for a predetermined operative period of time.

Referring to the details of the second embodiment the starting member or handle 104 is shown in the form of an oscillating knob, mounted for convenience at the front end of the timing shaft, namely by a shouldered screw 105 which leaves the knob loose upon the shaft. The starting knob 104 is hollow, having a concentric chamber 106 in which is accommodated the shaft and other parts to be described. At one side the annular

rear rim of the knob is formed with a notch 107, presenting at one side a shoulder 108 adapted through a pawl 118 to cause starting rotation of the shaft when the knob is turned in the same clockwise direction of rotation. The knob also, near its rear side, has a slight angular shoulder 109 to receive a flange 115 to be described. The knob rear rim carries also a limiting pin or projection 110 for restricting the manual movement to a short extent of rotation, and at a convenient point a hole 111 in which to anchor one end of a spring 121. The knob limiting pin 110 is shown engaged in a short slot 112 formed in a fixed part, as the dial 17^a, so that the knob movement is strictly limited to a short turn, as will be apparent from Fig. 8, only just about sufficient to cause the disk 95^a to lift the lever 65^a and permit the closing of the switch 24^a.

Cooperating with the knob or handle 104 so described are certain parts on the timing shaft. A collar 113 is shown mounted fast upon the shaft by an attaching screw 114. The collar is accommodated within the chamber 106 of the knob and at its rear side has an outward flange 115 adjacent to the knob shoulder 109. The flange 115 is shown formed with a gap or notch 116, this being present only for construction purposes, giving access for the machining of a flat seat 117 on the periphery of the collar to receive a spring or pawl 118.

The knob notch 107 and the shaft collar spring or pawl 118 constitute a one-way clutch, by which the notch shoulder 108 may push clockwise on the spring pawl and thereby advance the collar and shaft, but can not turn them reversely. The one-way clutch between the knob and the shaft, permitting only a limited advance motion of the latter by the manual operation of the former, is only illustrative of other one-way devices that may be used, that which is shown being compact, convenient and efficient. Instead of a simple spring pressed pawl, the pawl spring 118 is shown as an elongated volute or spiral spring, attached at its inner end to the collar seat 117 by the screw 119 and extending thence around the collar, within the knob chamber, until the somewhat straightened free end 120, pressing frictionally against the annular wall of the knob, the extreme end being thus adapted to enter the notch 107 as shown in Fig. 8.

When therefore the knob 104 is turned clockwise to the extent permitted by the slot 112 the notch shoulder 108 thrusts endwise against the spring pawl end 120, first taking up any slack as the spring is pressed against the knob chamber wall, and then communicating a clockwise thrust or rotation to the collar and shaft, to the extent necessary to start the automatic operation. A desirable supplemental device consists of a knob retracting spring 121, conveniently bringing the knob back to initial position when manually released, so that it is in readiness for a subsequent starting action. The spring 121 is shown as a circular spring having bent ends, one of which enters the hole 111 in the knob and the other of which enters a similar hole 122 formed in the housing front wall or dial 17^a, appearing in Fig. 8.

The operation of the second form may be as follows, Figs. 7 and 8 indicating the initial position with the switch held open by the lever 65^a. The operator may now turn the knob clockwise to the extent of the slot 112, which affords a limit both to the advancing and return movements of the knob. The notch shoulder 108 pressing the

pawl spring 118 causes it to expand against the knob chamber wall, followed by the bodily turning of the spring and the shaft collar with the knob. This limited movement is so determined that it will rotate the disk 95^a sufficiently to force the switch lever 65^a out of the disk notch, thus closing the circuits and starting the automatic operation. Having performed this function it now becomes inoperative, and the operator is without power to modify the automatic operation, which proceeds for the desired interval, until automatic stoppage. During the operation any manual oscillation of the knob will merely cause idle play of the shoulder 108. In the meanwhile the shaft, collar and spring pawl are rotated steadily through the interval. Fig. 9 shows them in an advanced position, having nearly completed the full rotation or interval, the pawl spring being about to come to the knob notch, the completion of the rotation restoring the parts to the position shown in Figs. 7 and 8. Only now has the operator power to cause a repeat of operations. Moreover a new operation can only be started if the knob has been allowed to return to initial position. The device is thus proof against mishandling, since if the knob should be purposely jammed or locked in its advanced position, the operations will not continue at the end of one cycle, but will necessarily stop as described. Manifestly the knob must be returned to initial position in order to permit the pawl spring 118 to snap back into the notch 107. The operator therefore must be present and intentionally operate the knob for a repeat operation. This arrangement is important with certain control actions, for example in the timing of fluoroscopes, wherein a definite time limit is requisite, and repetition of cycle undesirable, except by the intentional resetting of the device.

The device of Figs. 7 to 11 may be advantageously modified in the manner indicated in Figs. 12 and 13, where a quite short interval is desired. This consists in providing the disk 95^b with a plurality of notches 100^b, and correspondingly forming the knob 104^b with a series of notches 107^b. Three such notches in each member being shown it follows that each operation is shortened to about one-third of the interval of the full cycle of a complete rotation of the timing shaft.

In all disclosed embodiments the starting or setting movement of the manual knob or handle and timing shaft is in the same direction, as clockwise, as the continued motor driven advance of the shaft; the handle starts the advance, the motor completes it for the predetermined interval. In the disclosed relation of the switch operating lever and its controller or notched disk the former acts also as a pawl holding positively the disk and shaft against wrong or reverse rotation,

compelling the setting or starting operation to be in the advancing direction of timing travel of the parts. The stoppage at the end of the interval is brought about not by any mechanical obstruction but by reason of the timed stoppage of the driving motor and gearing as the lever drops into the disk notch and thus opens the switch. The slip device or friction 93—94—95 therefore needs to function only for and by reason of the manual starting operation.

I claim:

1. An interval timing device for a circuit having a load or operation to be timed, said device having a switch adapted to be connected in series with the load, a constant-speed motor connected in series with the switch, and a switch-operating timing shaft rotated through slip drive from the motor; in combination with a controller disk rotated by the shaft, a switch actuating lever movable between opening and closing positions and when thrown to second position causing initial closing of the switch and when restored to opening position causing opening of the switch, said disk being so constructed and related to said lever that the initial advance rotation of the disk causes the throw of the lever and the final advance rotation of the disk after a fixed interval causes the restoration of the lever, and manual setting means for initially advancing the shaft only sufficiently to cause the disk to throw the lever and to a fixed setting position to predetermine a fixed time interval; said setting means comprising a knob loose on the shaft, means limiting the knob's rotation, and means whereby the limited knob rotation turns the shaft the initial amount to swing the lever, close the switch and start the interval; whereby when the switch is so initially closed, the motor drive of the shaft is caused for the predetermined fixed interval, with accompanying energizing of the load circuit, until, at the fixed interval end, the disk rotation restores the lever to open finally the switch and terminate motor drive and circuit energizing.

2. A timing device as in claim 1 and wherein is a one-way clutch device between the shaft and knob.

3. A timing device as in claim 1 and wherein is a one-way clutch device between the shaft and knob, with a single point of engagement, whereby the knob is rendered inoperative until the interval has elapsed and the rotation stopped in initial position.

4. A timing device as in claim 1 and wherein is means to return the knob to its zero position.

5. A timing device as in claim 1 and wherein is means to return the knob to its zero position, and to prevent repetition unless and until the knob has been returned to initial position before a new operation.

RONALD F. KNIGHT. 60