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TIME DELAY RELAY MECHANISM

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Fig. 1.

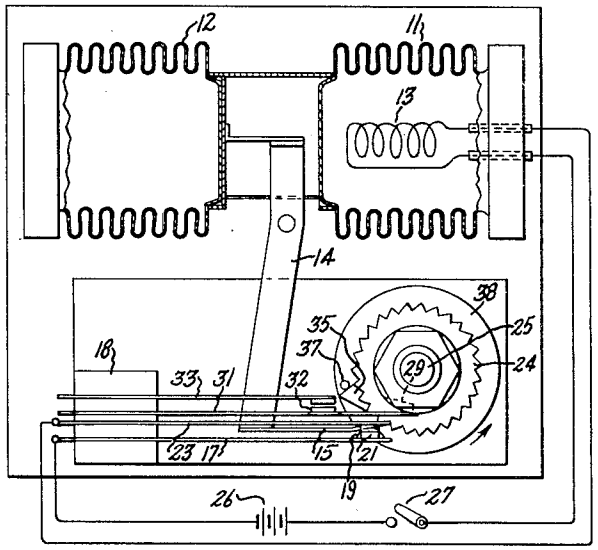
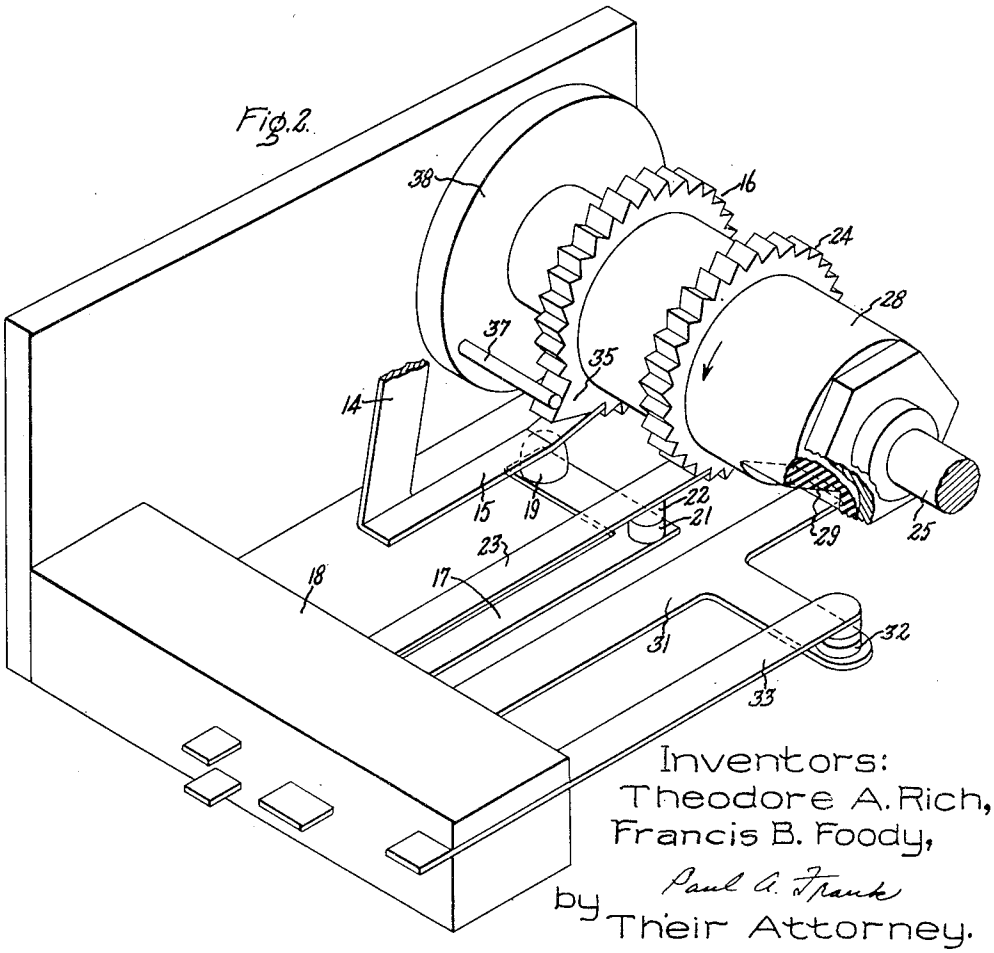


Fig. 2.



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TIME DELAY RELAY MECHANISM

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10 Claims. (Cl. 200—122)

The present invention relates to a time delay relay mechanism.

More specifically, the invention relates to a time delay relay mechanism which is capable of providing precise timing intervals between the time that the mechanism is started and the time at which it is desired that a particular phenomenon occurs, such as closing of the master switch of a controlled device.

There are a number of known time delay relay mechanisms available today which are adapted for general usage on different types of electrical equipment, and which provide some preset timing standard. Such known mechanisms have not been entirely satisfactory, however, in that they cannot be readily adapted for use on different types of equipment requiring varied timing intervals, or for use with widely different types of power supply. Also, the mechanisms heretofore available have been highly subject to pitting and corrosion of parts, or to damage due to shock or vibration, and hence are not entirely reliable in operation. Further, many of the known time delay relay mechanisms are complicated in construction, and expensive to manufacture.

It is therefore one object of the present invention to provide a time delay relay mechanism that can be readily adjusted to provide precise time delays of any desired interval between the time that the mechanism is started, and the time that it is desired a phenomenon occur; and that can be used with a large variety of different types of electrical equipment.

Another object of the invention is to provide an improved time delay relay mechanism wherein pitting of the component parts thereof, and corrosion is reduced to a minimum.

Still another object of the invention is to provide an improved time delay relay mechanism which is not highly subject to failure because of shock or vibration thereof.

A still further object of the invention is to provide an improved time delay relay mechanism having the above set forth characteristic which is simple in construction, and relatively cheap to manufacture.

In practicing the invention a time delay relay mechanism is provided which includes a pawl lever arm having a pawl secured to the end thereof so as to be reciprocally movable by the lever arm. A rotatable ratchet wheel is engaged by the pawl, and is adapted to be rotated by the pawl in a step-by-step fashion. A first resilient contact arm having one end secured to an insulating support in cantilever fashion, and having an insulating spacer and an electrical contact disposed side-by-side on the remaining end thereof, is positioned in a manner such that the insulating spacer element engages and rides upon the pawl. A second resilient contact arm is insulatingly supported in the aforementioned support in a position substantially parallel to the pawl, and has a contact secured thereto which engages the contact on the first contact arm. The second contact arm is frictionally engaged with a ratchet wheel surface similar in configuration to, and aligned, and rotatable in synchronism with

the said rotatable ratchet wheel in a manner such that rotation of the ratchet wheel serves to open and close the electrical circuit through the contact arms and contacts thereof.

Other objects, features and many of the attendant advantages of this invention will be appreciated more readily as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings, wherein like parts are identified with the same reference character, and wherein:

Fig. 1 is a plan view of a time delay relay mechanism constructed in accordance with the present invention, and illustrates the manner in which the mechanism is included in an energizing electrical circuit; and

Fig. 2 is a perspective view of the contact arrangement of the time delay relay mechanism shown in Fig. 1.

The time delay relay mechanism comprising the present invention is shown in Fig. 1, and includes a differential bellows arrangement composed of a first flexible bellows 11, and a second flexible bellows 12. The bellows 11 comprises a current sensitive thermal actuating element which expands upon the passage of electric current through a heating coil 13 disposed therein, and which contracts upon the current flow being cut off to the heating coil. The bellows 11 acts in conjunction with the second flexible bellows 12 which serves as a compensating element. The actuating bellows 11 is operatively connected to a pawl lever arm 14 which, as is best shown in Fig. 2 of the drawing has a pawl 15 secured thereto. The pawl 15 is adapted to be reciprocally moved back and forth by the lever arm 14, and the end thereof engages a ratchet wheel 16, best seen in Fig. 2 of the drawings. The ratchet wheel 16 is adapted to be rotated step-by-step by the reciprocally movable pawl 15. Mounted adjacent ratchet wheel 16 is a first L-shaped, resilient, electrically conductive contact arm 17 which is mounted in an insulating mounting support 18 in cantilever fashion with the end of the longer leg portion thereof secured in support 18. Positioned side-by-side on the free shorter leg portion end of the L-shaped contact arm 17 is an insulating spacer element 19 and an electrical contact 21 with the insulating spacer element 19 adapted to engage and ride pawl 15 in the manner shown in Fig. 2 of the drawings. The contact 21 cooperates with a corresponding contact 22 secured to the free end of a second resilient, electrically conductive contact arm in the form of a detent 23 mounted in insulating support 18 in cantilever fashion, and positioned parallel to pawl 15 and immediately beside contact arm 17. The free end of contact arm 23 frictionally engages and is tensioned by a ratchet wheel surface which is similar in configuration to and aligned and rotatable in synchronism with the rotatable ratchet wheel 16. This last mentioned ratchet wheel surface may comprise a second ratchet wheel 24 which is similar in construction to the ratchet wheel 16, and is keyed to a rotatable ratchet hub 28 in common with ratchet wheel 16; or, if desired, a relatively wide single ratchet wheel constructed of an insulating material may be used in place of the two different ratchet wheels shown in the construction in Fig. 2.

Referring again to Fig. 1 of the drawings, the contacts 21 and 22 and the contacts arms 17 and 23 are included in an energizing circuit which is further comprised by the heating coil of the bellows actuating element 11, a source of electrical energy such as the battery 26, and an on-off control switch 27.

When the time delay relay mechanism is initially placed in operation, the end of the pawl 15 and the contact arm 23 engage corresponding teeth on their respective ratchet wheels, and the contacts 21 and 22 are closed so that with control switch 27 closed, there is a closed electrical

circuit supplying the heating coil 13 of the expansible bellows 11. As a result of the application of heating current to the heating coil 13, an inert gas within bellows 11 is heated and expands the bellows. Expansion of the bellows 11 causes the pawl lever arm 14 to move pawl 15 towards ratchet wheel 16, causing ratchet wheel 16 to be rotated counterclockwise, as viewed in Fig. 1. Simultaneously with this action, detent 23 follows the downward movement of pawl 15 due to the fact that the end thereof is engaged by a ratchet wheel tooth which is being moved slowly counterclockwise, and resilient contact arm 17 follows the downward movement of contact arm in the form of a detent 23 due to the fact that contact 21 rests on the contact 22 carried by detent 23. During the forward movement of pawl 15, the insulating spacer 19 clears pawl 15 so as to assure good electrical connection between contact 21 and contact 22. Consequently, the electrical circuit through the contacts is maintained closed during the forward stroke of the pawl. However, because detent 23 is fixedly mounted in the mounting support 18, its end slides relative to the ratchet tooth surface and to pawl 15 until it drops off the tooth and engages the next tooth. At this point, contact arm 17 is prevented from following contact arm 23 because of the engagement of insulating spacer 19 with pawl 15, and the electrical circuit through the contacts 21 and 22 is broken, thus cutting off the supply of heating current to the heating coil 11. The heating coil and inert gas within bellows 11 then cool causing the pawl 15 to be slowly retracted backward until such time that it too drops down to the next succeeding tooth on the ratchet wheel, whereupon the contacts 21 and 22 are again allowed to close due to the face that the contact arm 17 follows the movement of the pawl 15 on the cooling stroke, and the cycle is repeated. During this retracting movement of the pawl 15, the contact arm 23 acts as a detent against the ratchet wheel so as to prevent it being rotated clockwise by the retracting movement of the pawl.

The upper part of ratchet hub 28 comprises an insulating cam surface having a flat depression 29 formed therein. Disposed over the depression 29 is the end of a third contact arm 31 which is likewise secured to the mounting support 18 in cantilever fashion and has a contact, indicated at 32, secured to an integral arm thereof. The contact 32 engages a similar contact connected to the end of a fourth contact arm 33 likewise secured in mounting post 18 in cantilever fashion. Arm 31 is flexible and its sprung force is directed against hub 28. The end is thus restrained against vibration for the arm 33 is sufficiently rigid to be unaffected by vibration forces.

From an examination of the arrangement shown in Fig. 2, it can be appreciated that after a certain number of cycles of operation of the pawl 15 which results in opening and closing the contact arms 21 and 22 a predetermined number of times, the ratchet wheels 16 and 24, and ratchet hub 28 will be rotated into a position such that the end of contact arm 31 drops into the depression 29 in the ratchet hub. This action results in closing the contact 32 on its counterpart, and establishing a closed electrical circuit through contact arms 31 and 33. At all other times, the end of the contact arm 31 is held from engagement with the contact on the contact arm 33. Hence, upon contact arm 31 dropping into the depression 29, the contacts on arms 31 and 33 become intimate, resulting in energization of the circuit to be controlled by the time delay relay mechanism.

If at the time that the contact arm 31 drops into depression 29, it is desired that the relay mechanism be de-energized and not continue on cycling through each step of the ratchet wheel, an enlarged tooth 35, best seen in Fig. 2 of the drawings, may be formed on the ratchet wheel 16. With this arrangement, it can be appreciated that upon the pawl 15 coming into engagement with the ratchet tooth 35, the pawl will not be drawn back sufficiently through the action of the expansible bellows 11 alone, to allow the end of the pawl to go to the next succeeding tooth on the ratchet wheel. Hence, the contacts 21 and 22 will remain open, and the mechanism will be rendered inoperative. If the large tooth 35 then is aligned with the depression 29 in the cam surface 28, de-energization of the time delay relay can be made to occur simultaneously or shortly thereafter with the closing of the contacts 32 of the master control circuit.

From the foregoing discussion, it can be readily appreciated that the invention provides a relatively simple time delay relay mechanism which can be inexpensively manufactured. Because the heating and cooling time of the bellows 11 is exactly reproducible from cycle to cycle of operation of the relay, each movement of the ratchet wheel requires a predetermined period of time so that by controlling the number of movements of the ratchet wheel, precise time delay intervals can be obtained. Also, because the resilient contact arms are tensioned by the ratchet wheels, the tooth to tooth movement of the end of the contact arm over the ratchet wheel is positive, resulting in a clean snap-action break so that pitting and corrosion of the contact does not occur. Also tensioning of the contact arms prevents damage by shock or vibration, and reliable operation of the mechanism is assured.

In order to provide a standard for adjusting the length of delay interval provided by the time delay relay, a timing pin, best seen in Fig. 2 of the drawing is provided which is mounted on a timing ring 38. The timing pin 37 is adapted to engage the back or steep portion of the enlarged tooth 35 of the ratchet wheel so that by adjusting the position of the timing pin 37 relative to the tooth 35 the interval of time delay provided by the relay can be readily controlled. Hence, by simply rotating timing ring 38 and then rotating shaft 25 until tooth 35 abuts against timing pin 37, the number of cycles, and thus the delay time, may be selected.

From the foregoing description, it can be appreciated that the present invention provides a time delay relay mechanism that can be easily adjusted to provide precise time delay of any desired interval between the time that the mechanism is started and the time that it is desired a controlled device or circuit be activated. The mechanism can be used with a large variety of different types of equipment as a control element, and by reason of its design, pitting or corrosion of the parts thereof is reduced to a minimum, hence reliable operation of the mechanism is assured. In addition to these characteristics, the mechanism is simple in design and relatively inexpensive to manufacture.

Other modifications and variations of the present invention will be suggested to those skilled in the art in the light of the above teachings. It is therefore to be understood that changes may be made herein which are within the full intended scope of the invention as defined by the appended claims.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. A timing switch contact arrangement including in combination a reciprocally movable pawl, a rotatable ratchet wheel engaged by said pawl and adapted to be rotated by said pawl in a step-by-step fashion, a pair of flexible conductive contact arms positioned adjacent said ratchet wheel and having contacts secured thereto adapted to engage each other, a ratchet wheel surface similar in configuration to and aligned and rotatable in synchronism with said rotatable ratchet wheel with one of said contact arms frictionally engaging said last-mentioned ratchet wheel surface, and an electrical insulating spacer secured to the remaining one of said contact arms and designed to engage and ride upon said pawl, said contacts being opened and closed by the rotation of said ratchet wheel and ratchet wheel surface, which rotation is caused by the movement of said pawl.

2. A timing switch including in combination a current sensitive thermal actuating element, a lever arm operatively connected to said actuating element and adapted to be moved thereby and having a pawl secured to the end thereof, a rotatable ratchet wheel engaged by said pawl and adapted to be rotated by said pawl in a step-by-step fashion, a pair of flexible conductive contact arms mounted adjacent the ratchet wheel and having contacts secured thereto adapted to engage each other and to be included in the energizing circuit of said current sensitive thermal actuated element, a ratchet wheel surface similar in configuration to and aligned and rotatable in synchronism with said rotatable ratchet wheel, with one of said contact arms frictionally engaging said last-mentioned ratchet wheel surface, and an electrical insulating spacer secured to the remaining contact arm and designed to engage and ride upon said pawl, said energizing circuit being opened and closed by said contacts as said ratchet wheel and ratchet wheel surface are rotated by the motion of said pawl.

3. A timing switch contact arrangement including in combination a reciprocally movable pawl, a rotatable ratchet wheel engaged by said pawl and adapted to be rotated by said pawl in a step-by-step fashion, a ratchet wheel surface similar in configuration to and aligned and rotatable in synchronism with said rotatable ratchet wheel, a pair of flexible conductive contact arms mounted adjacent said ratchet wheel with one of said contact arms frictionally engaging said last-mentioned ratchet wheel surface, an electrical insulating spacer secured to the remaining contact arm and designed to engage and ride upon said pawl, said contact arms having contacts secured thereto which are adapted to be normally closed upon said pawl and said first-mentioned contact arm engaging aligned teeth in their respective ratchet wheel surfaces and to be opened upon said pawl and said first-mentioned contact arm engaging non-aligned teeth on the respective ratchet wheel surfaces, said contacts being opened and closed by the rotation of said ratchet wheel and ratchet wheel surface, which rotation is caused by the movement of said pawl.

4. A timing switch including in combination a current sensitive thermal actuating element, a lever arm operatively connected to said actuating element and adapted to be moved thereby, a pawl secured to said lever arm, a rotatable ratchet wheel engaged by said pawl and adapted to be rotated by said pawl in a step-by-step fashion, a ratchet wheel surface similar in configuration to and aligned and rotatable in synchronism with said rotatable ratchet wheel, a pair of flexible conductive contact arms mounted adjacent said ratchet wheel with one of said contact arms frictionally engaging said last-mentioned ratchet wheel surface, an electrical insulating spacer secured to the remaining contact arm and designed to engage and ride upon said pawl, said contact arms having contacts secured thereto which are adapted to be normally closed upon said pawl and said first-mentioned contact arm engaging aligned teeth in their respective ratchet wheel surfaces and to be opened upon said pawl and said first-mentioned contact arm engaging non-aligned teeth on the respective ratchet wheel surfaces, said contacts being included in the energizing circuit of said current sensitive thermal actuated element.

5. A timing switch including in combination a current sensitive thermal actuating element, a lever arm operatively connected to said actuating element and adapted to be moved thereby, a pawl secured to said lever arm, a rotatable ratchet wheel adapted to be rotated by said pawl in a step-by-step fashion and having an enlarged tooth thereon, a ratchet wheel surface similar in configuration to and aligned and rotatable in synchonism with said rotatable ratchet wheel, a pair of flexible conductive contact arms mounted adjacent said ratchet wheel with one of said contact arms frictionally engaging said last-mentioned ratchet wheel surface, an electrical insulating spacer secured to the remaining contact arm and designed to engage and ride upon said pawl, said contact arms having contacts secured thereto which are adapted to be normally closed upon said pawl and said first-mentioned contact arm engaging aligned teeth in their respective ratchet wheel surfaces and to be opened upon said pawl and said first-mentioned contact arm engaging non-aligned teeth on the respective ratchet wheel surfaces with both of said contacts being included in the energizing circuit of said current sensitive thermal actuated element, a timing pin adapted to engage the back end of said enlarged tooth on the first-mentioned ratchet wheel to provide a means for gauging the number of step-by-step movements of the ratchet wheel prior to said enlarged ratchet tooth engaging said pawl whereupon step-by-step rotation of the ratchet wheel is discontinued, and an adjustable timing ring having said pin secured thereto for adjusting the angular position at which said pin engages said enlarged tooth.

6. A timing switch contact arrangement including in combination a reciprocally movable pawl, a rotatable ratchet wheel engaged by said pawl and adapted to be rotated by said pawl in a step-by-step fashion, a first resilient contact arm having one end thereof secured in an insulating support in cantilever fashion and having an insulating spacer and a contact disposed side-by-side on the free end thereof, said insulating spacer element engaging and riding upon said pawl, and a second resilient contact arm mounted on said insulating support in cantilever fashion in a position substantially parallel to said pawl, a ratchet wheel surface similar in configuration to and aligned and rotatable in synchronism with said rotatable ratchet wheel, the free end of said second contact arm being frictionally engageable with said last-mentioned ratchet wheel surface, and having a contact secured thereto which is tensioned into engagement with the contact on said first contact arm upon said pawl and said second contact arm engaging aligned ratchet wheel teeth in their respective ratchet wheel surfaces, said contacts being disengaged upon said pawl and said second contact arm engaging non-aligned teeth in their respective ratchet wheel surfaces.

7. A timing switch including in combination a current sensitive thermal actuating element, a lever arm operatively connected to said actuating element, a pawl secured to the end of said lever arm so as to be reciprocally movable thereby, a rotatable ratchet wheel engaged by said pawl and adapted to be rotated by said pawl in step-by-step fashion, a first resilient contact arm having one end thereof secured in an insulating support in cantilever fashion and having an insulating spacer and a contact disposed side-by-side on the free end thereof, said insulating spaced element engaging and riding upon said pawl, and a second resilient contact arm mounted on said insulating support in cantilever fashion in a position substantially parallel to said pawl, a ratchet wheel surface similar in configuration to and aligned and rotatable in synchronism with said rotatable ratchet wheel, the free end of said second contact arm being frictionally engageable with said last-mentioned ratchet wheel surface, and having a contact secured thereto which is tensioned into engagement with the contact on said first contact arm upon said pawl and said second contact arm engaging aligned ratchet wheel teeth in their respective ratchet wheel surfaces, said contacts being disengaged upon said pawl and said second contact arm engaging non-aligned teeth in their respective ratchet wheel surfaces and being included in the energization circuit of said current sensitive thermal actuating element.

8. A timing switch contact arrangement including in combination a reciprocally movable pawl, a rotatable ratchet wheel engaged by said pawl and adapted to be rotated by said pawl in a step-by-step fashion, a first L-shaped resilient contact arm having the end of the longer leg portion thereof secured in an insulating support in

cantilever fashion and having an insulating spacer and a contact disposed side-by-side on the free shorter leg end portion thereof, said insulating spacer element engaging and riding upon said pawl, and a second resilient contact arm mounted on said insulating support in cantilever fashion in a position substantially parallel to said pawl, a ratchet wheel surface similar in configuration to and aligned and rotatable in synchronism with said rotatable ratchet wheel, the free end of said second contact arm being frictionally engageable with said last-mentioned ratchet wheel surface, and having a contact secured thereto which is tensioned into engagement with the contact on said first contact arm upon said pawl and said second contact arm engaging aligned ratchet wheel teeth in their respective ratchet wheel surfaces, said contacts being disengaged upon said pawl and said second contact arm engaging non-aligned teeth in their respective ratchet wheel surfaces.

9. A timing switch including in combination a current sensitive thermal actuating element, a lever arm operatively connected to said actuating element, a pawl secured to the end of said lever arm so as to be reciprocally movable thereby, a rotatable ratchet wheel engaged by said pawl and adapted to be rotated by said pawl in a step-by-step fashion, a first L-shaped resilient contact arm having the end of the longer leg portion thereof secured in an insulating support in cantilever fashion and having an insulating spacer and a contact disposed side-by-side on the free shorter leg end portion thereof, said insulating spacer element engaging and riding upon said pawl, and a second resilient contact arm mounted on said insulating support in cantilever fashion in a position substantially parallel to said pawl, a ratchet wheel surface similar in configuration to and aligned and rotatable in synchronism with said rotatable ratchet wheel, the free end of said second contact arm being frictionally engageable with said last-mentioned ratchet wheel surface, and having a contact secured thereto which is tensioned into engagement with the contact on said first contact arm upon said pawl and said second contact arm engaging aligned ratchet wheel teeth in their respective ratchet wheel surfaces, said contacts being disengaged upon said pawl and said second contact arm engaging non-aligned teeth in their respective ratchet wheel surfaces and being included in the energization circuit of said current sensitive thermal actuating element.

10. A timing switch including in combination a current sensitive thermal actuating element, a lever arm operatively connected to said actuating element, a pawl secured to the end of said lever arm so as to be reciprocally movable thereby, a rotatable ratchet wheel keyed to a rotatable ratchet hub and adapted to be engaged and rotated by said pawl in a step-by-step fashion, a first L-shaped resilient contact arm having the end of the longer leg portion thereof secured in an insulating support in cantilever fashion and having an insulating spacer and a contact disposed side-by-side on the free shorter leg end portion thereof, said insulating spacer element engaging and riding upon said pawl, and a second resilient contact arm mounted on said insulating support in cantilever fashion in a position substantially parallel to said pawl, a ratchet wheel surface similar in configuration to and aligned and rotatable in synchronism with said rotatable ratchet wheel, the free end of said second contact arm being frictionally engageable with said last-mentioned ratchet wheel surface, and having a contact secured thereto which is tensioned into engagement with the contact on said first contact arm upon said pawl and said second contact arm engaging aligned ratchet wheel teeth in their respective ratchet wheel surfaces, said contacts being disengaged upon said pawl and said second contact arm engaging non-aligned teeth in their respective ratchet wheel surfaces, and being included in the energization circuit of said current sensitive thermal actuating element, an enlarged tooth formed on said rotatable ratchet wheel, a cam surface formed on said rotatable ratchet hub and having a discontinuity thereon in axial alignment with said enlarged tooth, a third pair of resilient contact arms mounted in cantilever fashion and having the free ends thereof engaging the cam surface formed on said ratchet post, electrical contacts secured to said contact arms and adapted to be normally closed, said contacts being adapted to open upon the free ends of said contact arms engaging the discontinuity in said cam surface, a timing pin adapted to engage the back end of said enlarged tooth on the first-mentioned ratchet wheel to provide a means for gauging the number of step-by-step movements of the ratchet wheel prior to said enlarged ratchet tooth engaging said pawl whereupon step-by-step rotation of the ratchet wheel is discontinued, and an adjustable timing ring having said pin secured thereto for adjusting the position at which said pin engages said enlarged tooth.

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