CONTROL APPARATUS FOR ADVANCING WEB OF FILTER MEDIUM THROUGH A FILTERING ZONE

James E. Wooldridge and Oscar A. Wurtenberg, Louisville, Ky., assignors to Continental Air Filters, Inc., Louisville, Ky., a corporation of Delaware
Filed Dec. 3, 1963, Ser. No. 327,679

Claims. (Cl. 55—211)

This invention relates to an improved electrically operated control apparatus for advancing an elongated web of filter medium through a filtering zone in such a manner that interruptions of electrical power will not adversely affect the efficiency of utilization of the filter medium. More particularly, it relates to a control system employing a single timer and a metering means responsive to linear advance of the web.

In our co-pending application, Serial No. 297,317 filed July 24, 1963, now U.S. Patent No. 3,175,775, and assigned to the same assignees as the present invention, there is disclosed a control system employing a single timer in which, when a power failure occurs, the timer promptly resets without completing the timing cycle then in progress. Thus, whenever the power fails and the corresponding resetting of the timer occurs, the timer automatically starts a new time cycle without having advanced the web of filter medium. Accordingly, as soon as power is restored to the system the lapsed time of the previous unfinished cycle is added to the next complete cycle and an insufficient advance of the web results.

Furthermore, when provision is made, as by means of an overload pressure switch, to move the web to relieve an excessive pressure drop thereacross and regardless of the timing cycle, it is important that a new timing cycle be initiated as soon as the emergency web advance ceases. Otherwise, the next normal advance of the web may occur before it is needed and with concomitant wastage of fresh filter medium.

An object of the present invention is to provide an improved control system for automatically operating an air filter under both normal and abnormal operating conditions in such a way as to employ the web filter medium more efficiently than is possible with conventional filters.

Another object is to provide an improved control system for automatically operating an air filter under conditions involving failure of power and wherein the proper amount of filter medium is dispensed despite interruption of operation because of power failure.

A further object is to provide an improved control system for automatically operating an air filter under conditions involving a filtering overload and wherein no wastage of filter medium results as operation is resumed following relief of the overloaded condition.

Other objects and advantages will become more apparent as the description proceeds and when considered in conjunction with the accompanying drawings in which:

FIG. 1 is a partly diagrammatic side elevation view of an air filter with which the present invention may be employed.

FIG. 2 is a detail view of a metering means suitable for use with the present invention, and

FIG. 3 is a wiring diagram illustrating the presently preferred embodiment of a control system employing the principles of the invention.

Referring first to FIG. 1 a suitable filter structure into which this invention may be incorporated preferably is of the type disclosed in U.S. Patent No. 2,848,064 assigned to the same assignee as the present invention. Such a filter includes a generally rectangular frame having a top 10, bottom 11, and side walls, one of which is shown at 12. At the top of the frame an enclosure having side walls, one of which is seen at 13, is arranged. These walls provide a mounting upon which the shaft 14 of a roll 15 of fresh filter medium in the form of a convoluted wound web is mounted. When the web is advanced as a curtain through the filtering zone, it progressively leaves roll 15, passes over a guide idler roller 16, and after passing over the splined idler 17 is then rewound in the form of a roll 18 of spent material. An enclosure at the bottom of the frame, having side walls, one of which is shown at 19, provide means for mounting the shaft 20 of the rewind roll, this shaft being driven in any suitable manner by an electric motor 21. The advancing of the web depends upon the operation of this motor, and it is a purpose of the present invention to cause this motor to operate in such a way that the web is advanced, under both normal and abnormal filter operating conditions, in a manner giving the most efficient usage of the filter medium.

A conventional run-out switch 30 which may be actuated by a plate 34 and upon which the web is engaged to supply roll and arranged to actuate the switch 30 when the exhaustion of the filter medium supply is imminent, is provided. Also, as best shown in FIG. 2, a metering switch 32 (herein for simplicity called the first switch) likewise is provided. A convenient means for operating switch 32 may take the form of a cam 33 attached to a shaft 34 on splined roller 17, the shaft 34 being mounted in the walls of the filter frame adjacent the lower ends of the same. Attached to the shaft 34 in the manner disclosed in the aforementioned Patent No. 2,848,064 is a series of angularly spaced splines 35 adapted to engage with the web and to be moved linearly by the cam with which it is associated. Other arrangements serving the same purpose may, of course, be employed without departing from the scope or intent of the present invention. The shaft 34 and cam 33 accordingly form part of a switch-operating means actuated by linear advance of the web, and the first switch 32 is thus actuated by that switch-operating means.

Cam 33 includes equally spaced peripheral recesses into which the cam follower may fall in order to actuate the switch 32 following a predetermined amount of angular travel of the cam, and between these recesses peripheral cam lobes of equal length are provided with the result that equal increments of web length are advanced through the filtering zone each time the switch 32 is operated, as later to be described. As an example, in many usages increments of web advance in the order of one inch are sufficient.

Referring now to FIG. 3, the improved control system of the invention includes an electrical return line 35 connected to ground or to neutral and a supply line 36 in which a conventional fan interlock and fused disconnect switch 37 is arranged. The run-out switch 30 is located in line 36 and is movable between a closed position as when a suitable supply of filter medium is present on roll 15 and an open position, as when the supply on that roll approaches exhaustion. In its open position switch 30 contacts terminal 38 and through conductor 39 establishes a circuit through warming lamp 40. It will be understood that the opening of switch 30, which in some installations may not occur more frequently than once each six months or longer, is not regarded as an abnormal operating condition in the sense as defined herein.

The invention employs a self-resetting timer 41 which preferably is of the 24-hour range type although timers with longer or shorter time ranges may be used. As will later appear, the restarting of this timer, after it has reset itself, is delayed until switch 32 re-establishes the circuit to the timer motor. By way of illustration and not of limitation, this timer may comprise the type CSF
Timer Model J3195 made by the Industrial Timer Corporation, Parsippany, New Jersey; or the modified Haydon Reset Acrotimer Series BR adapted for non-resetting upon power failure. Such a timer includes a timer motor 42 and a timer circuit switch 44 of a single pole-double throw type and which alternately is moved by the coil to a relay-de-energizing position in contact with abutment 45 and by the timer motor mechanism to a relay-energizing position in contact with terminal 46. The movement of the timer switch 44 to the relay-energizing position constitutes a resetting of the timer and occurs only upon energization of the timer coil 43 when using the types of timer herein disclosed.

As in the copending application the timer possesses the advantage of being capable of operating with substantially any selected time setting between zero and 1440 minutes (when a 24-hour timer is used) and without the necessity of maintaining at hand a stock of gear racks. With the time range flexibility thus provided, the necessity for having at hand more than one cam 33 for the splined idler also is eliminated. Concomitantly, the need for two timers in cascade is avoided and yet the assurance that the motor will advance a uniform distance each time the motor 21 is energized through the timer, is still retained.

For the purpose of energizing motor 21 through the timer, a pair of conventional relays 47 and 48 (such as the RDM Type 84 and herein called first and second relays) are employed, the respective coils 49 and 50 thereof closing the respective relay switches 51 and 52 upon energization of the proper relay coil.

Conventional elements of the improved control comprise an optional media saver switch 60 in line 36 and which is under the influence of a conventional pressure responsive device 61 (FIG. 1). This switch normally remains in open position against an abutment 62 so long as a selected pressure differential, for example, about 0.3 inch water pressure, exists between the upstream and downstream sides of the filter curtain. Such a condition indicates that the filtering load is so small that no web movement is required and thus the normal operation of timer 41 would use up filter medium unnecessarily. When, however, the media saver switch 60 is moved to its closed position upon terminal 63, the intended action of the timer becomes possible. A normally open manual push button 64 is provided for emergency use or for use in adjusting the filter after replenishment by a new roll of medium.

A further control element which may be employed efficiently with the present invention includes an overload pressure switch 65 under the influence of a separate pressure device 66. This switch is movable between a normal inactive position in contact with abutment 67 and wherein it exerts no influence upon the web and the timer, and an active position in contact with terminal 68 in which it establishes an overriding circuit to each of the first relay coil 49 and to the timer coil 43.

The establishment of this overriding circuit occurs when a pressure drop (or resistance to flow) of a predetermined value occurs across the web curtain, as may sometimes occur with a sudden increase of dust or the like, and as used herein the establishment of the overriding circuit is considered an abnormal operating condition in the same sense as an unexpected power failure.

Having thus described the several elements of a typical system, the advantages of the invention will be noted from the following description of operation thereof. With the timer 41 being set for the desired time interval and the web having come to rest from its last previous movement, a circuit is made from line 36 through conductor 70, first switch 32, terminal 71, conductor 72, timer motor 42 which now is beginning to accrue time, and conductor 73 to return line 35. The de-energized timer coil 43 thus exerts no action on timer switch 44 which at this time is resting upon abutment 45 and breaking any circuit to the coil 50 of the second relay. When, however, the accrued time upon the timer motor reaches the value for which the timer is adjusted, the timer switch 44 is moved into contact with terminal 46 whereupon a temporary circuit is made from line 36, conductor 74, switch 44, terminal 46, conductor 75, coil 50 of the second relay 48 and conductor 76 to return line 35. Energizing of relay coil 50 closes the relay switch 52 and a circuit is made from line 36, conductor 77, closed relay switch 52, roll-driving motor 21 and conductor 78 to return line 35.

As this occurs, the motor 21 drives the rewinding roll 18 causing the web to advance and to effect a rotation of cam 33 serving as the switch-operating means for first switch 32. Rotation of the cam immediately switches 32 into contact with its second position upon terminal 80 whereupon the following events simultaneously occur. The timing motor circuit through conductor 72 is interrupted and the timing motor comes to rest in readiness for its next timing cycle; a circuit is established from line 36, conductor 70, switch 32, terminal 80, conductor 81, conductor 82, timing coil 43, and conductor 83 to return line 35, thus energizing the timer coil, and a shunt circuit is established from conductor 84, coil 49 of the first relay and conductor 85 to return line 35.

As soon as the relay coil 49 is energized another shunt circuit is established from conductor 81, conductor 86, relay switch 51, conductor 87, roll-driving motor 21 and conductor 78 to return line 35. This shunt circuit through conductor 65, conductor 74, coil 50 of the first relay will be maintained until the first switch 32 interrupts the same upon satisfaction of the proper amount of web advance under normal operating conditions, or until the overriding circuit, later to be described, from the overload switch 66 interrupts the same upon satisfaction of the proper amount of web advance under abnormal operating conditions. In either event, however, immediately upon energization of timer coil 43 and following the energization of coil 50 of the second relay 48, the timer coil acts to reset the timer by moving timer switch 44 away from terminal 46 and against abutment 45. This action, of course, de-energizes the second relay 48 but by this time the first relay 47 is closed to continue the supply of current to the roll-driving motor. After the proper amount of web has been advanced, first switch 32 returns to its normal first position upon terminal 71 and power again is supplied to the timer motor which then begins its next timing cycle.

Assuming now that the timer motor has accumulated an amount of accrued time equal to a small fraction of the time between normal shifts of its timing switch 44, and a sudden power failure occurs. In this event the timing motor 42 comes to rest, but the remainder of the system remains unchanged. When power is restored, the timing motor again turns and continues to accumulate time until its timing cycle is completed and a normal advance of web follows. On the contrary, had the timer rest itself upon power interruption, it would not have caused any advance of partially used filter medium. The unfinished time cycle, therefore, would have been added to the next full time cycle and an insufficient advance of the medium would have resulted.

Assuming further that the timer motor has accumulated an amount of accrued time equal to a fraction of the time between normal shifts of its timing switch 44 and a sudden heavy filtering load is imposed on the curtain which causes the overload switch 65 to move to its active position upon terminal 68. As this occurs, an emergency and overriding circuit is made from line 36, conductor 90, switch 65, conductor 81, conductor 84, coil 49 of the first relay and conductor 85 to return line 35. This circuit causes relay switch 51 to close and the roll-driving motor 21 to turn thus to relieve the overloaded condition and the motor will continue to turn until the first switch 32 is again restored to its normal first position following the interruption of this overriding circuit. However, it will be seen that so long as the overriding circuit is in
effect the timing coil 43 is energized and holds the timer switch 44 upon abutment 45. Thus, when the first switch 32 reaches its normal first position following the emergency advancement of the web, a new timing cycle will begin with a clean web in position in the filtering zone and no accrued time will be present on the timer. Accordingly, the time accrued prior to the overload will have been expended during the described correction of the abnormal operating condition and no unnecessary wastage of filter medium will occur when the normal operation again resumes.

As will be seen, our improved control system is flexible in its functioning and is adapted both for long periods of normal operation and for short periods of abnormal operation without unnecessary expenditure of filter medium. Having thus described the invention and its various advantages, it is intended that the appended claims are to cover such changes and modifications of that invention as come within the true spirit and scope of the same.

What is claimed is:

1. In a control apparatus for advancing a web of filter medium in an air filter having a rewind roll for storing the spent web fed through a filtering zone and a motor for driving said roll, the improvement comprising an electrical system for efficiently utilizing the web during abnormal operating conditions and including; a switch-operating means actuated in dependence upon linear advance of said web, a first switch actuated by said means and movable between a normal first position and a second position, first and second relays having separate circuits for respectively energizing said roll-driving motor, and a self-resetting timer for timing the successive normal advances of said web and comprising, a timing motor, a timer switch movable between a position energizing said second relay and a position de-energizing said second relay, and a timer coil adapted upon energization to move said timer switch from said relay-energizing position to said relay-de-energizing position and to reset said timer; and an overload pressure switch for establishing emergency circuit to said roll-driving motor, upon attainment of a predetermined pressure drop across said web, said pressure switch being movable between a normal inactive position having no influence upon said relays and timer coil and an active position establishing an overriding circuit to each of said first relay and said timer coil, whereby upon movement of said pressure switch to said active position said timer coil is energized to reset said timer and to hold said timer in reset condition regardless of the position then occupied by said first switch, said first switch upon movement to its second position normally energizing said timer coil and said first relay and de-energizing said timer motor and upon movement to its first position normally energizing said timer motor and de-energizing said timer coil and said first relay, whereby upon failure of power during occupancy of said first position by said first switch the timer will retain the time accrued thereon at the occurrence of said power failure thus to utilize the web efficiently during both normal and abnormal operating conditions.

2. Apparatus as defined in claim 1 wherein the de-energizing of said second relay opens one circuit to said roll-driving motor after said first relay has closed another circuit to said roll-driving motor thereby to enable said first switch to effect the stopping of said roll-driving motor as said first switch later moves to its normal first position.

3. Apparatus as defined in claim 1 wherein said switch-operating means is rotatable and includes a cam serving to actuate said first switch periodically, each of the intervals between successive movements of said first switch to its first position corresponding to the prior advance of said web by a uniform linear amount.

4. In a control apparatus for advancing a web of filter medium in an air filter having a rewind roll for storing the spent web fed through a filtering zone and a motor for driving said roll, the improvement comprising an electrical system for efficiently utilizing the web during abnormal operating conditions and including; a switch-operating means actuated in dependence upon linear advance of said web, a first switch actuated by said means and movable between a normal first position and a second position, first and second relays having separate circuits for respectively energizing said roll-driving motor; a self-resetting timer for timing the successive normal advances of said web and comprising a timing motor, a timer switch movable between a position energizing said second relay and a position de-energizing said second relay, and a timer coil adapted upon energization to move said timer switch from said relay-energizing position to said relay-de-energizing position and to reset said timer; and an overload pressure switch for establishing emergency circuit to said roll-driving motor, upon attainment of a predetermined pressure drop across said web, said pressure switch being movable between a normal inactive position having no influence upon said relays and timer coil and an active position establishing an overriding circuit to each of said first relay and said timer coil, whereby upon movement of said pressure switch to said active position said timer coil is energized to reset said timer and to hold said timer in reset condition regardless of the position then occupied by said first switch, said first switch upon movement to its second position normally energizing said timer coil and said first relay and de-energizing said timer motor and upon movement to its first position normally energizing said timer motor and de-energizing said timer coil and said first relay, whereby upon failure of power during occupancy of said first position by said first switch the timer will retain the time accrued thereon at the occurrence of said power failure thus to utilize the web efficiently both during normal and during abnormal operating conditions.

No references cited.

ORIS L. RADER, Primary Examiner.

T. B. O'IKE, Assistant Examiner.