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Jordan et al.

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[54] VACUUM-OPERATED TIMING DEVICE WITH SOLENOID-CLOSABLE VENT IN VALVE CHAMBER

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[51] Int. Cl. H01h 35/34, H01h 43/28, H01h 7/02

[58] Field of Search 200/83 R, 83 H, 34

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[57] ABSTRACT

A timing device having a vacuum chamber enclosing a diaphragm which is mechanically connected to a switch in an electric circuit. The vacuum chamber is connected to a source of vacuum through a port controlled by a check valve and also through an adjustable restricted passage which bypasses the port. When vacuum at the source drops below a predetermined level, air is evacuated from the chamber after a delay determined by the selected size of the restricted passage. A vent in the valve chamber wall normally is open to atmosphere and the circuit includes a control device which closes the vent when the circuit is energized.

2 Claims, 5 Drawing Figures

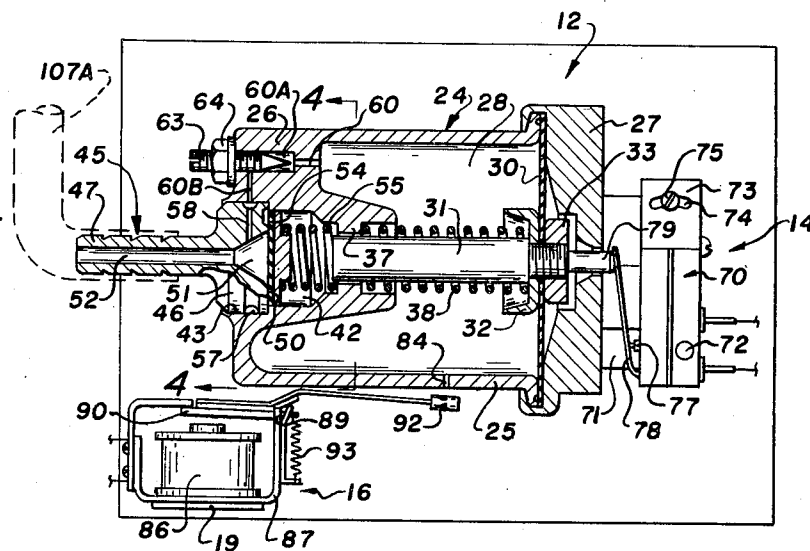


Fig. 1.

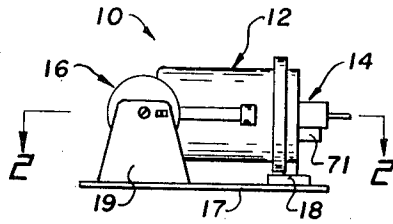


Fig. 3.

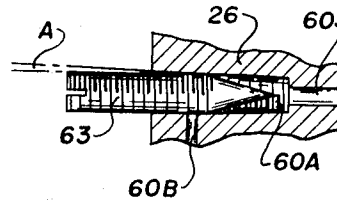


Fig. 2.

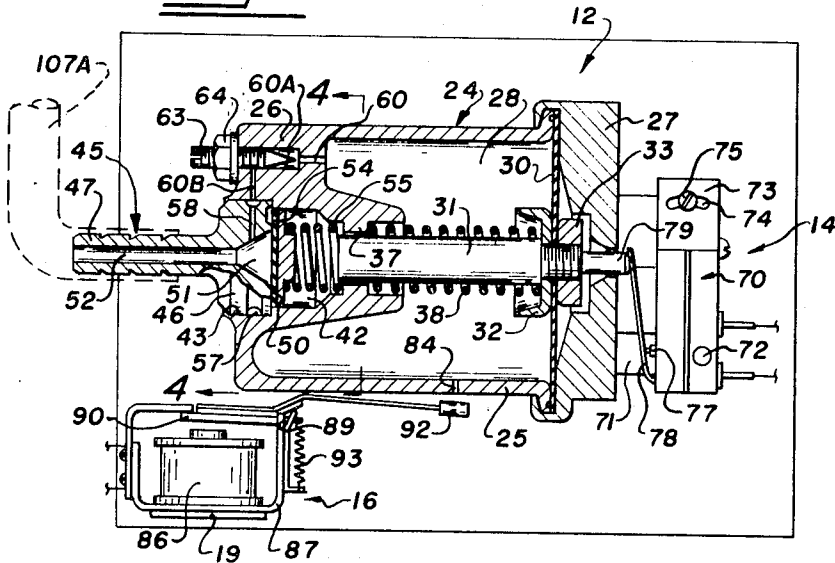


Fig. 5.

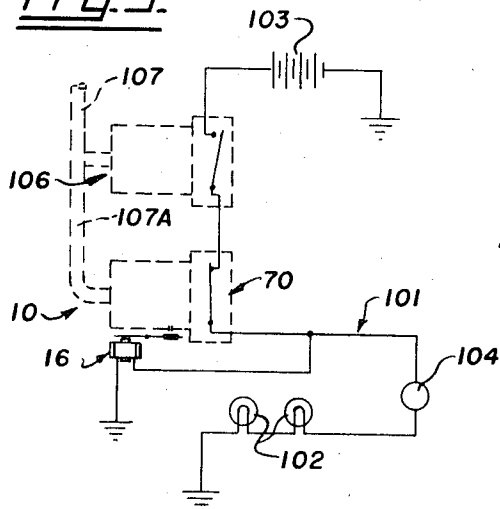
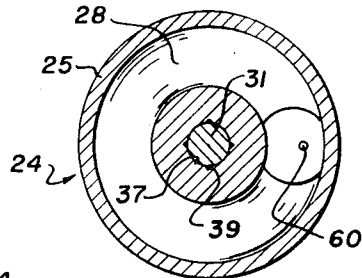


Fig. 4.



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VACUUM-OPERATED TIMING DEVICE WITH SOLENOID-CLOSABLE VENT IN VALVE CHAMBER

Our invention relates to improvements in a vacuum operated, delayed action timing device for controlling an electric circuit.

In our U.S. Pat. No. 3,466,410 issued Sept. 9, 1969, we disclosed a vacuum operated timer switch arrangement which is particularly intended for use in operating warning lights at the rear of a car. The purpose of such lights is to warn the drivers of following cars that the vehicle equipped with the warning lights is slowing down. The timer switch of our prior patent was shown, by way of example, operating in conjunction with a second vacuum operated speed change indicator switch as described in our prior U.S. Pat. No. 3,363,075 issued on Jan. 9, 1968. Both these switches were shown connected to a common source of vacuum, in this instance, the intake manifold of a car. Whenever the vehicle so equipped decelerates and a predetermined level of vacuum is developed in the intake manifold, the indicator switch operates to close the warning light circuit. Should the car be descending a long hill, the operating level of vacuum will be maintained for a lengthy period and this would keep the warning lights which might confuse the drivers of the following cars as to whether the leading car was actually slowing down or merely proceeding at a constant but slower speed. This was intended to be remedied by the timer switch which, after a suitable delay, opens the circuit previously closed by the speed change indicator switch.

Such an arrangement of switches works well under nearly all circumstances with one possible exception. It may happen that the vehicle so equipped has been running at or near idling speed for a lengthy period immediately prior to descending the long hill. As a result, the vacuum chamber of the timer switch will be evacuated of nearly all its air and therefore the switch will be open and the circuit broken. If the car then starts to descend the long hill and builds up speed even at a low throttle setting, the driver will take his foot off the accelerator but the rear warning lights will not come on since the circuit is broken by the timer switch. This difficulty can be overcome if the driver will accelerate so as to recharge the vacuum chamber with air but, since a car is already accelerating on the hill, he probably will not want to increase his speed still further.

Our improved vacuum operated timing device corrects this small but important defect found in our earlier switch arrangement by providing a valve chamber which has a normally open vent to atmosphere. Thus the chamber cannot be evacuated during periods when the engine is run at low speeds. The device has control means for closing the normally open vent, the means operating automatically the moment the indicator switch is actuated to close the circuit. An adjustment on the device enables the timed interval of its operation to be adjusted and because the control means acts instantly as described, this time interval is not extended and a particularly precise degree of control is then made possible.

In drawings which illustrate a preferred embodiment of the invention,

FIG. 1 is a side elevation of a vacuum controlled timing device,

FIG. 2 is an enlarged horizontal section taken on the line 2—2 of FIG. 1,

FIG. 3 is a schematic view of a metering screw,

FIG. 4 is a transverse section taken on the line 4—4 of FIG. 2, and

FIG. 5 is a wiring diagram showing the timing device in a typical condition of use.

Referring to the drawings the numeral 10 indicates generally a timing device which is shown to comprise a vacuum unit 12, switch means 14, and control means 16. The device 10 conveniently can be mounted on a baseplate 17, the unit 12 which carries the switch means 14 being provided with a transversely extending mounting stand 18, and the control means 16 being supported by a bracket 19.

As shown best in FIG. 2, the vacuum unit 12 comprises a casing 24 which has a cylindrical wall 25, a left end wall 26, a

right end closure 27, with a vacuum chamber 28 being defined therebetween. A diaphragm 30 is clamped between the cylindrical wall 25 and the end closure 27 to extend across the vacuum chamber 28 and seal off that end of the unit.

Diaphragm 30 is secured to a centrally disposed stem 31 by means of a cup 32 and a clamping nut 33. The inwardly projecting end wall 26 of the casing is shaped to provide a bearing 37 in which the inner end of the stem 31 is slidably mounted. A compression spring 38 is interposed between the bearing 37 and the cup 32 to urge the diaphragm 30 towards the end closure 27. In FIGS. 3 and 4, it will be noted the bearing 37 is provided with a number of longitudinally extending passages 39 which allow air to pass between said bearing and stem 31.

To the left of the bearing 37 (FIG. 2) the end wall 26 is counterbored to provide a valve chamber 42 and a recess 43. The recess 43 houses an adapter 45 having a cylindrical head 46 and an outwardly projecting tube 47. Head 46 is suitably secured against withdrawal from the recess 43 and the inner face of said head is shaped to provide a valve seat 50 and a port 51. Tube 47 has a bore 52 which communicates with the port 51. A disc-type check valve 54 is held against the seat 50 by a compression spring 55, this spring butting against the inner end of the bearing 37. The head 46 is provided with a peripheral groove 57 as well as with a radial aperture 58 which connects said groove to the port 51.

The casing end wall 26 is drilled to provide a restricted passage 60 having portions 60A and 60B, which passage places vacuum chamber 28 in communication with port 51 through the groove 57 and aperture 58. A metering screw 63 is threaded into the enlarged portion 60A of the restricted passage 60, the screw being locked into adjusted position by means of a nut 64. The threads on the screw 63 and/or the mating threads within portion 60A of the restricted passage 60 are shaped to provide a clearance which progressively increases towards the tip of said screw. As shown schematically in FIG. 3, this clearance is provided by removing the crests of the internal threads so that these threads taper inwardly to a slight extent. This provides a clearance indicated by the letter A and this clearance is exaggerated in FIG. 3 for purposes of illustration. Thus, when the meter screw 63 is advanced, it serves to restrict the passage 60 and when retracted, the amount of restriction is correspondingly reduced. This arrangement provides a much finer degree of adjustment than could be achieved by a conventional needle valve for example.

The switch means generally indicated at 14 is shown in FIG. 2 to comprise a normally closed microswitch 70 which is mounted on a bracket 71 carried by the casing 24 for swinging movement about a vertical pivot pin 72. An extension 73 of switch 70 is provided with an arcuate slot 74 and the bracket 71 has a locking screw 75 which projects upwardly through this slot. Switch 70 has a spring-pressed operating plunger 77. A leaf spring 78 is carried by switch 70 to extend across the plunger 77, the free end of said spring being engaged by outer end 79 of the diaphragm stem 31.

The cylindrical wall 25 of the vacuum unit 12 is provided with a vent 84 which connects the vacuum chamber 28 to atmosphere and this vent is adapted to be opened and closed by the means 16 of the present timing device. In FIG. 2, the vent control means generally indicated at 16 is shown to comprise a solenoid 86 which is mounted within a substantially U-shaped frame 87, the frame being suitably secured to the bracket 19. Mounted on the frame 87 for rocking movement about a vertical pivot 89 is an armature 90 which extends alongside the casing 24 of the unit 12. One end of the armature 90 is positioned over the solenoid 86 and the opposite end thereof is fitted with a stopper pad 92 which is aligned with the vent 84. A tension spring 93 is connected to the armature 90 and the frame 87 normally to hold the stopper pad 92 off the casing 24 so that the vent 84 remains open.

Referring now to FIG. 5, this diagram shows the timing device 10 connected into a series circuit generally indicated at 101 whereby to control the operation of a pair of rear warning lights 102. For this purpose, the circuit 101 would include the

battery 103 of the vehicle and may also be provided with a flasher 104 to operate the lights 102 intermittently. The timing device 10 is connected by the circuit 101 to a normally open speed change indicator switch indicated generally at 106 and shown diagrammatically in FIG. 5 only. Switch 106 is the vacuum-operated vehicle speed change indicator switch described in detail in our U.S. Pat. No. 3,363,075. Switch 106 is connected by a length of hose 107 to a source of vacuum, which in this instance, is the intake manifold (not shown) of the vehicle. A branch 107A of the hose 107 extends to the timing device 10 and is connected to the tube 47 of the adapter 45 as shown best in FIG. 2.

The normally closed microswitch 70 is adjusted to select a predetermined level of vacuum at which said switch will operate. To carry out such an adjustment, the screw 75 is backed off a few turns and the microswitch 70 is swung about the pivot pin 72 to dispose said switch at a suitable angle relative to the end closure 27, whereupon the locking screw 75 is again tightened. At this time, the leaf spring 78 is in contact with the end 79 of the stem and continues to hold the plunger 77 in closed position. It is then necessary for the stem 31 to move a selected distance before the microswitch 70 will open. To bring about the required movement of the stem 31, the diaphragm 30 must flex a corresponding distance and this distance is determined by the level of vacuum within the chamber 28. Thus, it is possible to set the timing device 10 so that it will respond only to a predetermined level of vacuum. This vacuum level normally is quite high to ensure that the microswitch 70 is not operated by minor fluctuations in the level of vacuum.

The metering screw 63 is also adjusted as required to control the length of time needed to evacuate the chamber 28 through the restricted passage 60. When the screw 63 is advanced as far as it will go into the passage 60, only a very slight clearance is provided between the male and female threads of these two parts. This reduces the restricted passage 60 to a minimum with a result that quite a long time is required to evacuate the chamber 28. By backing off the screw 63 a partial turn, the clearance between the threads can be increased very slightly and the period required for air within the chamber 28 to flow through the restricted passage 60 is shortened accordingly. Thus, the period of delay before which the switch 70 will open is readily controlled within extremely fine limits by means of the metering screw 63.

Assuming the vehicle fitted with the assembly shown in FIG. 5 is moving along the road, the driver occasionally will lift his foot off the accelerator to cause a buildup of vacuum in the intake manifold. If the manifold vacuum rises to a predetermined level, switch 106 is actuated to cause the warning lights 102 to go on. This warns the driver of a following car that the leading car is decelerating so that he can adjust his speed accordingly. When the accelerator of the leading vehicle is again depressed, the vacuum drops below the predetermined level and the switch 106 opens to turn off the lights 102. Thus, the rear warning lights are operated solely by the switch 106 at this time.

However, if the car is descending a long hill, the high level of vacuum will be maintained for a sufficiently long period to bring the timing device 10 into operation as well as the switch 106. The indicator switch 106 operates as described above to close the circuit 101 and, at the same time, completes the aforesaid series circuit to energize the solenoid 86 and close the vent 84. Thus a volume of air is trapped within the chamber 28 and must be evacuated therefrom before the normally closed switch means 14 will open. The first sudden rise in vacuum above the predetermined level causes the check valve 54 to close and seal off the port 51. Air within the chamber 28 then flows through the restricted passage 60, thence into the peripheral groove 57, and through the aper-

ture 58 to the port 51. In this manner, the chamber 28 is evacuated over a period which is determined by the setting of the screw 63. The level of vacuum within the chamber 28 eventually rises to a point where the diaphragm 30 will flex sufficiently to move the stem 31 endwise the required distance to operate the microswitch 70. Microswitch 70 is opened when the leaf spring 78 swings towards the enclosure 27 a distance sufficient to allow the spring-pressed plunger 77 move outwardly so as to open said microswitch. Thus, the timing device 10 opens the circuit 101 which previously had been closed by the switch 106 and, in so doing, turns off the warning lights 102. It will be noted that once the valve 54 reopens, as occurs when intake manifold pressure rises to a level sufficient to overcome the pressure of the spring 55, the vacuum within the chamber 28 is relieved almost immediately through the passages 39. The switch 70 of the timing device is then returned to its normally closed position without delay so as not to interfere with any subsequent operation of the switch 106. Thus, the switch 106 will control the circuit 102 during normal operation of the car and the timing device 10 will come into operation only if intake manifold pressure is maintained at a predetermined high level for a selected length of time.

As previously mentioned, the solenoid 86 is energized the moment switch 106 is closed. This serves to snap the stopper pad 92 against the casing wall 25 so as to close off the vent 84. The timing device 10 then operates as above described without atmospheric air entering the vacuum chamber 28. As soon as the switch 106 is reopened, the circuit 101 is broken and the solenoid 86 is deenergized to open the vent 84 and allow atmospheric air to flow into the vacuum chamber 28. This air is trapped within the vacuum chamber 28 the next time the solenoid 86 is energized and it is the controlled flow of this air through the restricted passage 60 which sets the time interval for the reopening of the circuit 101.

From the foregoing it will be apparent we have provided a timing device which will operate accurately even if the level of vacuum at the source is only slightly above the level required to actuate the device. Such a condition could cause the device 10 to operate prematurely but, by providing the casing 24 with the vent 84 and said device with the control means 16 for closing said vent at the appropriate moment, there is no likelihood of the present timing device interfering with the normal operation of the circuit in which it is connected. The timed interval set for the opening of the microswitch 70 always remains the same regardless of the speed of the engine immediately prior to the moment when the rear warning lights are turned on.

We claim:

1. A timing device comprising a casing having a vacuum chamber, a diaphragm mounted in the casing to seal off one end of the vacuum chamber, switch means included in an electric circuit, means operatively connecting the diaphragm to the switch means, said casing having a port connecting the vacuum chamber to a source of vacuum, a check valve mounted in the casing to open and close the port, said check valve closing the port in response to a predetermined level of vacuum at the source, said casing having a restricted passage connecting the vacuum chamber to the port and a vent normally open to atmosphere, and control means in the electric circuit adapted to be actuated by energization of said circuit to close the vent whereby the vacuum chamber is evacuated through the restricted passage and over a selected period of time at the end of which the diaphragm is flexed and the switch means is actuated.

2. A timing device as claimed in claim 1, in which said control means comprises a solenoid connected into the electric circuit, an armature mounted on the solenoid to extend alongside the casing, and a stopper pad on the free end of the arm to close the normally open vent.

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