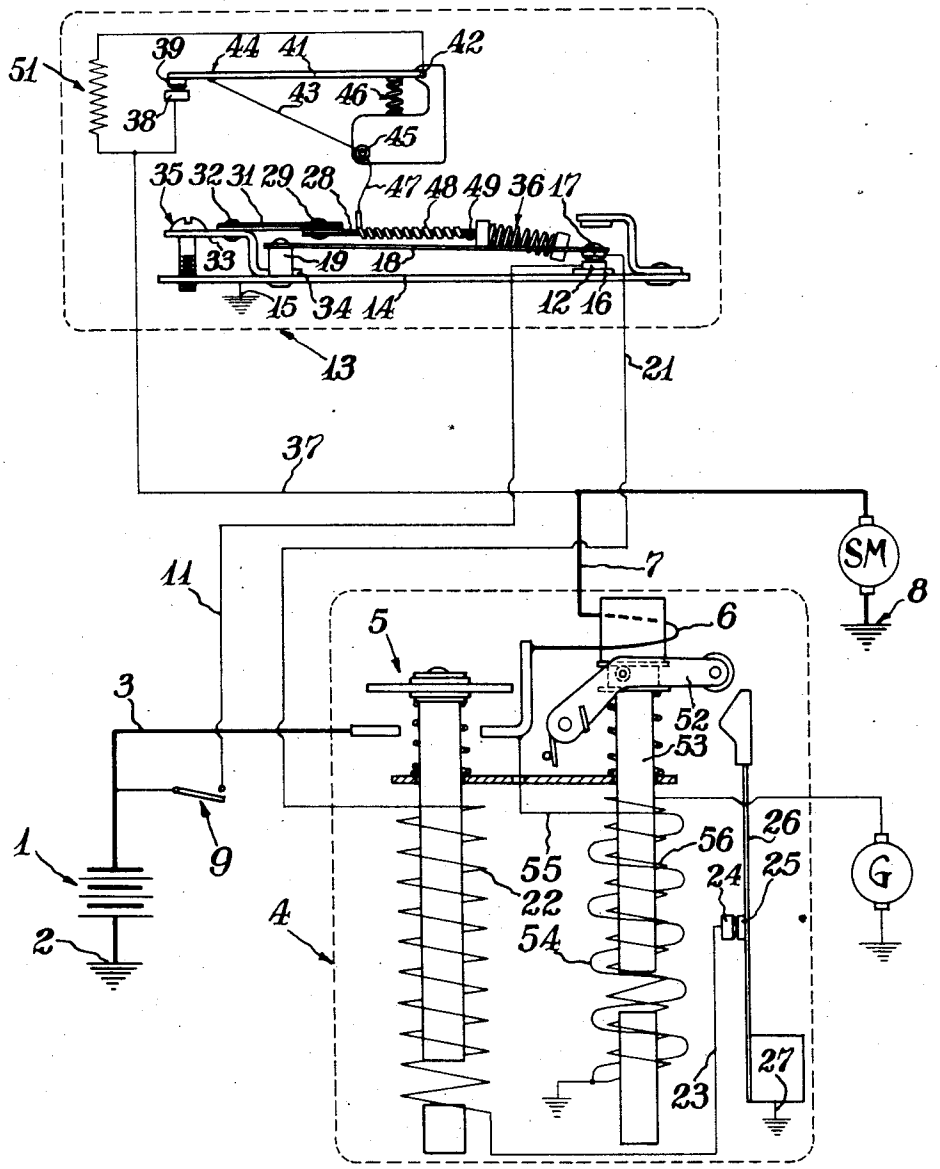
Oct. 20, 1942. M. H. ELKIN 2,299,215

CRANKING TIME LIMITER FOR ENGINE STARTERS

Filed Nov. 14, 1940



Witness:
Burr W. Jones

INVENTOR.
BY Manuel H. Elkin
Clinton S. Janes
ATTORNEY.

Patented Oct. 20, 1942

2,299,215

UNITED STATES PATENT OFFICE

2,299,215

CRANKING TIME LIMITER FOR ENGINE STARTERS

Manuel H. Elkin, Elmira Heights, N. Y., assignor to Bendix Aviation Corporation, South Bend, Ind., a corporation of Delaware

Application November 14, 1940, Serial No. 365,683

9 Claims. (Cl. 200—122)

The present invention relates to a cranking time limiter for engine starters and more particularly to a compensated thermostatic control for interrupting cranking of an engine after a predetermined time.

In devices for interrupting the cranking operation of an internal combustion engine when it fails to start, various devices have been utilized in attempts to secure uniformity of operation under varying conditions of battery charge, ambient temperature, stiffness of the engine, etc. Those which have approached closely the desired regulation, however, have in general been subject to the disadvantages of expensive, bulky and fragile construction, and limited scope of adjustment.

It is an object of the present invention to provide a novel cranking time limiter which is accurate and reliable in operation, simple and economical in construction, and readily adjustable throughout a wide range of actuating conditions.

It is another object to provide such a device in which a compensated thermostatic controlling device is heated during the cranking operation at a constant rate irrespective of variations in battery voltage over a wide range.

Further objects and advantages will be apparent from the following description taken in connection with the accompanying drawing which illustrates semi-diagrammatically one preferred form of the invention.

In the drawing there is illustrated a starting system comprising a battery 1 grounded at 2 and connected by a lead 3 to a commercial form of automatic starter control indicated generally by the numeral 4.

This starter control includes a magnetic starting switch 5 which is arranged to connect the starting circuit lead 3 through a single turn magnetic coil 6 to a lead 7 running to the starting motor SM which is grounded at 8 to complete the starting circuit.

A control circuit for actuating the magnetic switch 5 is illustrated comprising a manual switch 9 adapted to connect the starting circuit lead 3 to a lead 11 which is connected to a fixed contact 12 in a cranking time limiting device indicated generally by numeral 13. Contact 12 is mounted on a fixed frame 14 which is grounded as indicated at 15, but the contact 12 is insulated therefrom as indicated at 16. A movable contact 17 is mounted on the free end of a flat bifurcated spring 18, the opposite end of which is fixed as indicated at 19 to the frame 14 while being insulated therefrom. A lead 21 connects the movable contact 17 with the coil 22 of magnetic switch 5, the opposite end of the coil 22 being grounded through a lead 23, fixed contact 24 and movable contact 25 mounted on a pendulous vibrator 26 which is grounded as indicated at 27 to complete the control circuit for the starting switch.

Thermostatic means for controlling the contact 17 is provided in the form of a thermostatic blade 28 which is attached at one end as indicated at 29 to a second shorter thermostatic blade 31 which in turn is attached at 32 to a bracket 33 which is fixed to the frame 14 as indicated at 34 and is adjustable by suitable means such as shown at 35. Thermostatic blade 28 is arranged with the component thereof having the higher coefficient of expansion on the upper side thereof so that a rise in temperature causes the blade to bend downwardly. Thermostatic blade 31 is oppositely arranged and is so proportioned that like changes in temperature of the two blades compensate each other so that as long as the blades are at the same temperature, the free end of the blade 28 is maintained substantially static.

A compression spring connection 36 is mounted in the space between the furcations of the spring mount 18 for movable contact 17 and arranged to connect the free end of the spring mount to the free end of the thermostatic blade 28. Spring device 36 is mounted under compression whereby it normally presses the movable contact 17 into engagement with the fixed contact 12 as illustrated.

Means for heating the thermostatic blade 28 during the cranking operation is provided in the form of a heating circuit comprising a lead 37 connecting the starting motor lead 7 to a fixed contact 38 in the cranking time limiter device. A movable contact 39 mounted on the free end of a contact arm 41 having a pivotal mounting 42 is normally maintained in engagement with the fixed contact 38 by means of a tension element 43. This tension element is here illustrated in the form of a wire of thermally expansive material attached as indicated at 44 adjacent the free end of the arm 41 and having a fixed insulated anchorage 45 adjacent the pivotal mount of the arm 41. The wire 43 is placed under sufficient tension to hold the contact 39 against the fixed contact 38 when the wire is cold, but when the wire is heated, it is arranged to expand sufficiently to permit contact 39 to move out of engagement with contact 38 under the influence of a spring 46 acting on the arm 41.

The thermally expansive wire 43 is connected

by a lead 47 to a heating element 48 coiled around the thermostatic blade 28 and grounded on the blade as shown at 49 in order to complete the heating circuit through the frame 14 to the ground at 15. A resistor 51 is shunted around the contacts 38, 39 in order to reduce arcing of these contacts and to make the heating effect of the element 48 somewhat more uniform than would otherwise be the case.

The starter control is provided with means for opening the control circuit contacts 24, 25 when the engine starts including a lever 52 actuated by a plunger 53 under the influence of a solenoid 54 connected by a lead 55 to the starting motor side of the starting switch 5. A holding coil 56 energized by the engine-driven generator G operates to maintain contacts 24, 25 open as long as the engine is self-operative.

In the operation of the device, closure of the manual switch 9 completes the control circuit from battery 1 through lead 11, thermostatic contacts 12, 17, lead 21, coil 22, lead 23, vibrator contacts 24, 25 to the ground at 27. Starting switch 5 is thereby closed by the action of coil 22, whereupon the starting circuit is closed through lead 3, starting switch 5, lead 7 and starting motor SM to the ground at 8, and cranking of the engine is initiated. At the same time, the heating circuit is completed from the starting motor lead 7 through lead 37, contacts 38, 39, thermally expansive wire 43, lead 47, heating element 48 and ground connections 49, 15. The current traversing the heating circuit causes the thermostatic element 43 to heat up rapidly and expand, thereby opening contacts 38, 39. The heating effect of the element 48 is thus momentarily reduced by the introduction of the resistance 51 in the heating circuit, but the consequent cooling off of the element 43 draws the contact 39 against the contact 38, whereupon the full battery voltage is again applied to the heating element 48. The opening and closing of contacts 38, 39 as controlled by the thermally expansive element 43 causes the heating effect of the element 48 to be substantially constant irrespective of wide variations in the voltage of the battery. In other words, if the battery is fully charged, the element 43 is heated rapidly and the contacts 38, 39 are opened quickly and maintained open for a large proportion of the time. On the other hand, if the battery is low, the element 43 does not heat up so quickly and contacts 38, 39 remain closed a larger proportion of the time. It will be understood that contact 38 may be made adjustable in any suitable manner in order to adapt the device to various installations.

After the engine becomes self-operative in the normal manner, the counter-E. M. F. of the starting motor due to the release of the cranking load, causes the coil 54 to overcome the effect of the single turn coil 6 on the plunger 53 whereby contacts 24, 25 are opened and starting switch 5 deenergized, after which the vibrator contacts are maintained open by the generator-actuated coil 56. If the engine fails to start after a predetermined time, however, the heating effect of the element 48 on the thermostatic blade 28 causes it to bend down until its free end is below the spring 18, whereupon the pressure of the spring 36 is exerted in an upward direction on the spring 18, causing the contact 17 to be moved up out of engagement with contact 12 and the cranking operation is thereby interrupted. Inasmuch as the heating of the element 48 is controlled, as above pointed out, by means of the action of the thermally expansive element 43 on the contacts 38, 39, it will be appreciated that the time of cranking may be quite precisely regulated by means of the adjustment 35 of the thermostatic control, irrespective of wide variations in ambient temperature, battery voltage and cranking load.

Although but one embodiment of the invention has been shown and described in detail, it will be understood that other embodiments are possible and various changes may be made in the design and arrangement of the parts without departing from the spirit of the invention as defined in the claims appended hereto.

What is claimed is:

1. In a cranking time limiter for internal combustion engines, a control switch, thermostatic means for actuating the switch, means for heating the thermostatic means during the cranking operation, and means for periodically reducing the application of heat to the thermostatic means.

2. In a cranking time limiter for internal combustion engines, a control switch, thermostatic means for actuating the switch, electrical means for heating the thermostatic means during the cranking operation, and means for periodically reducing the flow of current to the heating means, so arranged that an increase in voltage of the heating current causes a corresponding reduction in the duration of the heating periods.

3. In a cranking time limiter for internal combustion engines, a control switch, thermostatic means for actuating the switch, means for heating the thermostatic means during the cranking operation, and means controlled in accordance with the energy of the heating means for periodically reducing the application of heat to the thermostatic means so as to maintain the average heating effect substantially constant.

4. In a cranking time limiter for internal combustion engines, a control circuit, a thermostatic switch for opening the control circuit after a predetermined time of cranking, and heating means for the thermostatic switch including an electrical heating circuit energized during the cranking operation, and means controlled by the voltage of the source of electricity for periodically reducing the flow of electricity in the heating circuit so as to maintain the average heating effect substantially constant.

5. In a cranking time limiter for internal combustion engines, a control switch, thermostatic means for actuating the switch, and a circuit for the thermostatic means including a pair of contacts and a thermally expansive wire controlling said contacts.

6. In a cranking time limiter for internal combustion engines, a control switch, thermostatic means for actuating the switch, and a heating circuit for the thermostatic means including a pair of contacts and a thermally expansive wire in series with said contacts for controlling the same.

7. A cranking time limiter for internal combustion engines including a control switch, thermostatic means for opening the switch, and an electrical heating circuit for the thermostatic means energized during the cranking operation, said heating circuit including a pair of contacts biased to open position, and a thermally expansive wire normally drawing the contacts closed, said wire being so arranged that heating thereof

by the heating current causes it to expand and allow the contacts to open.

8. In a cranking time limiter for internal combustion engines, a starter control circuit including a movable contact, thermostatic means for moving the contact, and a heating circuit for the thermostatic means including a pair of contacts biased to open position, a thermally expansive conductor normally holding said pair of contacts closed, and a resistor in shunt with said pair of contacts, said conductor being so constituted and arranged that passage of a predetermined heating current therethrough causes it to expand and permit the pair of contacts to open, and said resistor being of such value as to then so reduce the current as to cause the conductor to contract and close the pair of contacts.

9. In combination with the starting system of an internal combustion engine including a source of energy, control means therefor including a thermostatic switch, a heating circuit for the thermostatic switch including a pair of contacts, and means for periodically opening and closing said contacts in such manner as to maintain the heating effect of the heating circuit substantially constant irrespective of variations in the voltage of the source of electrical energy.

MANUEL H. ELKIN.