Aug. 29, 1950 J. E. WOODS 2,520,894

THERMOSTATIC CONTROL DEVICE

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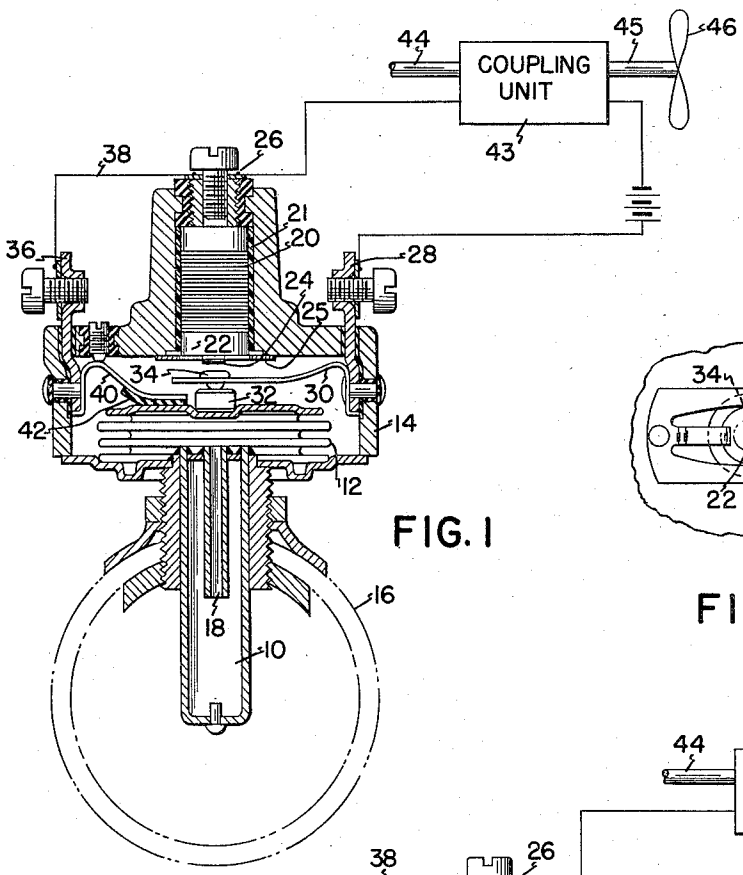


FIG. 1

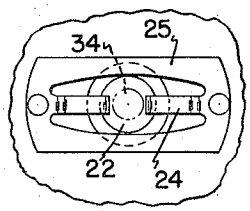


FIG. 3

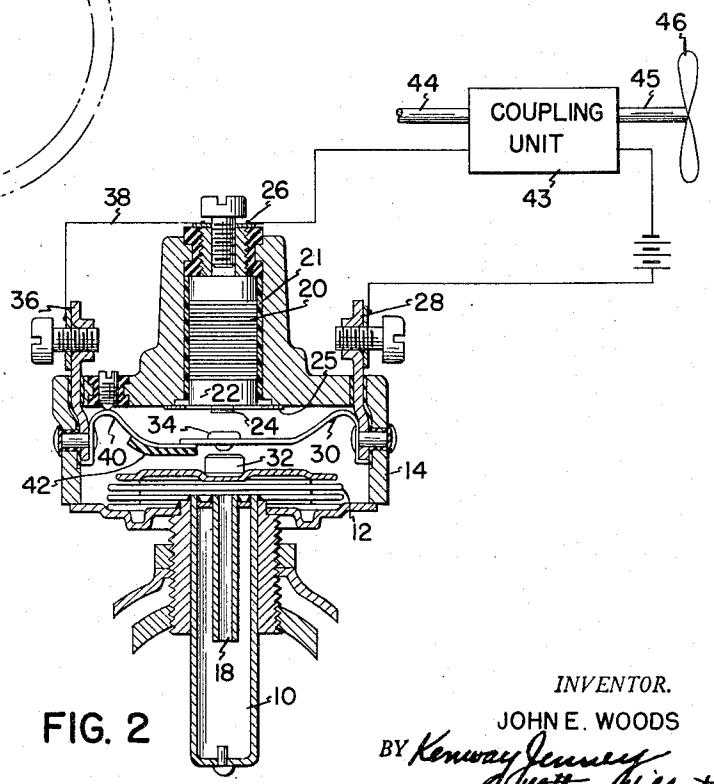


FIG. 2

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THERMOSTATIC CONTROL DEVICE

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1 Claim. (Cl. 201—48)

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The present invention relates to thermostatic control devices and more particularly to thermostatic control devices for controlling the speed of an automotive fan.

The conventional method of driving the fan from the crank shaft through a belt has been found objectionable, since the fan absorbs considerable power at the higher speeds. At high engine speeds, full speed operation of the fan is not necessary because of the ram effect of the vehicle pushing through the air. It has recently been proposed to effect an electromagnetic coupling between the engine and the fan, this coupling being controlled thermostatically whereby the fan is operated at low speed or is cut off altogether when the water is below a certain temperature and at higher speed as the water temperature rises. The electromagnetic coupling may take any form such as a motor-generator or similar system but preferably comprises a variable slip device including a rheostat which is controlled by the thermostatic devices. The preferred rheostat is a carbon pile device. Because of the necessity of applying a pressure to the pile, the bellows preferably has a vapor fill and normally operates with a substantial pressure above atmosphere so that adequate compressive force may be applied to the pile. This means that if the bellows fails or leaks for any reason, the pressure is taken off the pile and the fan will fail to operate.

The principal object of the present invention is to provide improvements in apparatus of this character whereby in the event of failure the system will fail safe, that is, the system will be operated to permit full speed operation of the fan and thereby avoid the danger of overheating.

Other features of the invention consist of certain novel features of construction, combinations and arrangements of parts hereinafter described and particularly defined in the claim.

In the accompanying drawings Fig. 1 is a sectional elevation of the preferred system according to the present invention; Fig. 2 is a sectional elevation showing operation upon loss of liquid from the thermostatic system; and Fig. 3 is a detail view of the pile-supporting spring.

The construction shown in Fig. 1 comprises a bulb 10 and an expansible chamber indicated as a bellows 12, the latter being enclosed in a metal casing 14. The tube 10 is adapted to be clamped within some part of water circulating system of the vehicle, preferably within the lower hose connection indicated at 16. A capillary tube 18 connects the bulb 10 with the interior of the bellows 12. The bulb, tube and bellows are completely filled with a liquid having a negligible vapor pressure at ordinary air temperatures and a considerable vapor pressure at the temperature at which the fan is to be operated. For example, the fill may comprise a water-alcohol mixture having at, say 175° F. sufficient vapor pressure to effect full useful expansion of the bellows.

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Received in the upper part of the casing 14 is a pile of carbon disks 20 forming a carbon pile resistor of conventional form. The disks are insulated from the casing by a sleeve 21. At the bottom of the pile there is arranged a plunger 22 held in place by spring fingers 24 on a plate 25. The fingers 24 hold the carbon pile under a small initial compression. The top of the pile presses against a contact having a terminal 26. A terminal 28 mounted in the casing has a spring arm 30 overlying the center of the bellows. The bellows has a thrust member 32 normally engaging a button 34 on the spring. The top of the button 34 is adapted, upon expansion of the bellows, to engage the plunger 22 in the space between the fingers 24.

Since the vapor pressure of the fill is small at non-operating temperatures, the liquid serves as a stop to limit contraction of the bellows. Thus, no mechanical internal stop is required. Therefore, under non-operating conditions, that is, when the motor vehicle is not in operation, the bellows assumes the position shown in Fig. 1, the button 34 being then out of contact with the pile. For reasons to be explained later, the length of the bellows in the non-operating condition of Fig. 1 is greater than the "free length" of the bellows; in other words, the bellows is initially filled with sufficient liquid to expand it to a length somewhat greater than its free length.

In case of a leak which causes the liquid to drain out of the bellows, the present invention provides a fail-safe arrangement. To this end there is provided a third terminal 36 mounted on but insulated from the casing and having a direct wire connection 38 to the terminal 26. Extending inwardly from the terminal 36 is a bowed contact spring 40 which normally bears against the upper part of the bellows but is insulated therefrom by a pad 42. The spring 40 is free to follow the bellows upon an expansive movement, but if the liquid drains out of the bellows due to a leak, the bellows contracts to the "free length" position of Fig. 2, and the member 40 does not follow it, whereby contact is then made between the spring 30 and the spring 40. This establishes a shunt around the resistor 20, by reason of the connection 38.

As shown in Fig. 1 the system includes a cou-

pling unit designated generally at **43**. The crank shaft **44** of the engine is connected through the coupling unit to the fan shaft **45** to drive the fan **46**. The coupling unit is here shown in purely diagrammatic form because it may comprise any type of device for variably driving the crank shaft. For example, it may comprise an electrical generator-motor unit, the motor speed being controlled by the resistor **20** in series with the armature. A simpler form of device is the usual electromagnetic slip coupling arrangement whereby as the flux is varied by the change of current the fan shaft is more or less tightly coupled to the driving shaft **44**. In any event, regardless of the exact form of the electromagnetic coupling, it will be understood that an increase of pressure on the pile produces an increase in speed of the fan driven by the crank shaft.

In operation, as the engine is started up from its cold condition, the button **34** is out of contact with the diaphragm **24**. The fan is then shut down. This makes for a quick rise in water temperature to the desired value. Up to about 150°, the vapor pressure is negligible and the condition of the bellows is determined by the liquid fill. Since the change in volume of the liquid up to about 150° is relatively small, there is no substantial change in the bellows. As the temperature increases to a predetermined value, say 160°, the expansion of the bellows brings the button **34** into contact with the plunger **22**. As the temperature increases, the further expansion of the bellows effects further compression of the pile, so that minimum resistance is preferably reached at about 175°.

At sustained high engine speed where the ram effect is adequate to provide substantial cooling, the water temperature tends to drop, thereby relieving the pressure on the carbon pile and thus diminishing the fan speed or even cutting out the fan altogether. It will be noted that in the condition of Fig. 1 and as heretofore stated, the bellows length is somewhat greater than its free length but it is prevented from collapsing to its free length by the liquid fill.

In the event of a leak the bellows contracts to its free length as shown in Fig. 2, thereby allowing the spring **30** to engage the contact **40** and establish the short-circuit connection **38** around the resistor. This causes the fan to operate at full speed. This is the "fail-safe" condition, which insures full speed fan operation and prevents overheating of the engine in the event of bellows failure.

It will be understood that the invention is not limited to the particular elements herein shown, but may employ other forms. For example, the bellows **12** is representative of expansible chambers, which may take other forms such as diaphragms, capsules and the like, and the carbon pile resistor is representative of pressure-responsive circuit control devices as will be understood by those skilled in the art.

Having thus described the invention, I claim:

In a thermostatic control system for an automotive fan, a thermostat to be responsive to the temperature of the circulating water including a bellows filled with liquid to hold the bellows normally at a length greater than its free length, a pressure-responsive variable resistor actuated by expansion of the bellows due to vapor pressure, a spring member pressing against the bellows, a contact member normally bearing against but insulated from the bellows and normally out of contact with the spring member, the contact member being out of engagement with the bellows if the bellows collapses to its free length due to loss of liquid, whereby said spring member then engages said contact member, and a shunt for the resistor established by the engagement of said spring and contact members.

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