United States Patent [19]

Hovey

[11] **3,874,347**

[45] **Apr. 1, 1975**

[54] **SHUTTER-FAN SYSTEM**

[76] Inventor: **Gordon Elmer Hovey**, 2378 Holly Ln., Ottawa, Ontario, Canada K1V 7P1

[22] Filed: **May 1, 1973**

[21] Appl. No.: **356,141**

[52] **U.S. Cl.** **123/41.12**, 123/41.05

[51] **Int. Cl.** **F01p 7/02**

[58] **Field of Search** 123/41.12, 41.05

[56] **References Cited**

UNITED STATES PATENTS

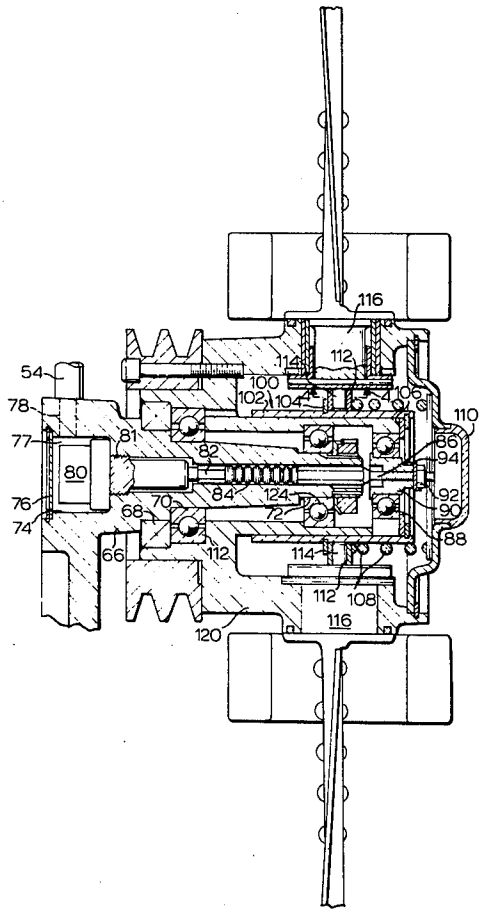
2,169,121	8/1939	Coy	123/41.12
2,225,209	12/1940	Dewey	123/41.12
2,284,938	6/1942	Allen	123/41.12
2,351,203	6/1944	Hanson	123/41.12
2,437,810	3/1948	Earley et al	123/41.12
2,472,728	6/1949	Sanders	123/41.12
2,479,668	8/1949	Brandon	123/41.12
2,734,493	2/1956	Findley	123/41.12
2,957,459	10/1960	Tauschek	123/41.12
3,177,852	4/1965	Elmer	123/41.12
3,265,047	8/1966	Elmer	123/41.12

Primary Examiner—Manuel A. Antonakas
Assistant Examiner—Daniel J. O'Connor

[57] **ABSTRACT**

A vehicle coolant system incorporating a shutter-fan capable of restricting the passage of air through the radiator section of the system until a predetermined coolant temperature at the engine inlet is achieved, the opening of the shutter-fan to an air impelling condition then being effected by a thermally actuated unit exposed to engine coolant at inlet conditions.

5 Claims, 4 Drawing Figures



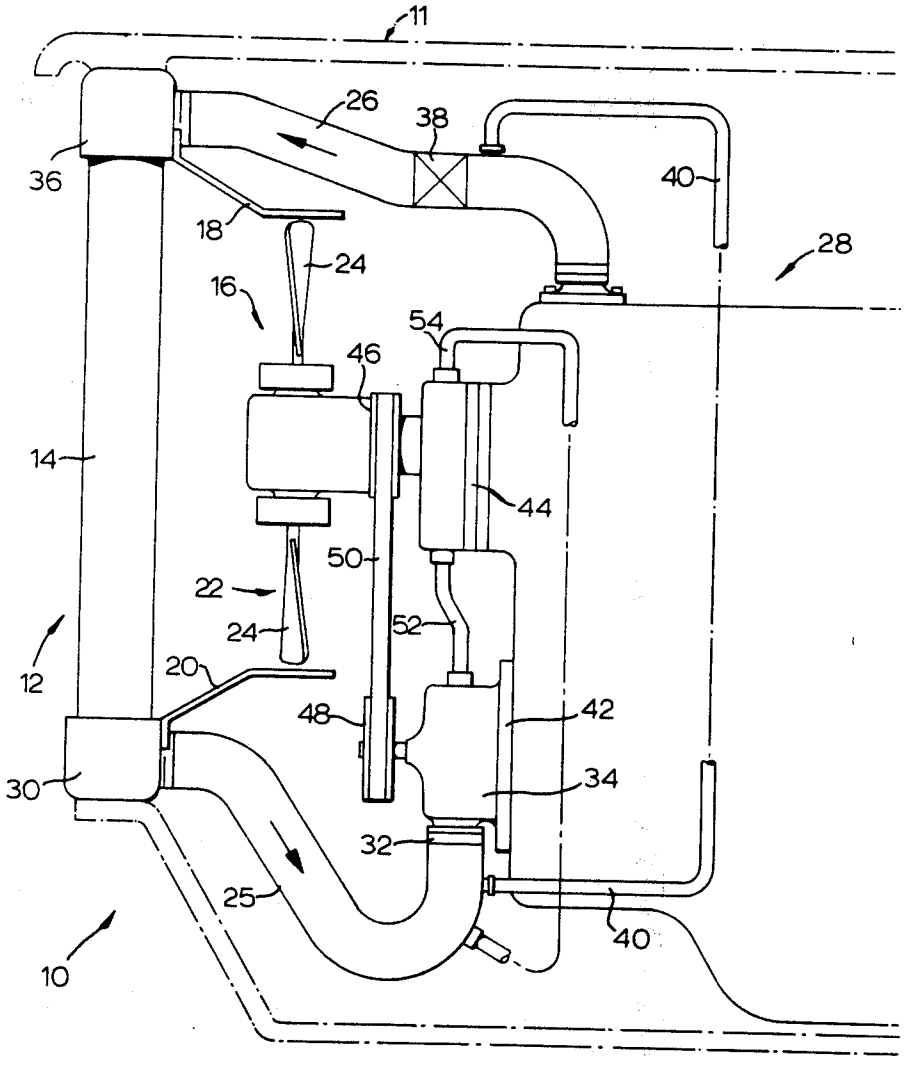

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FIG. 1.

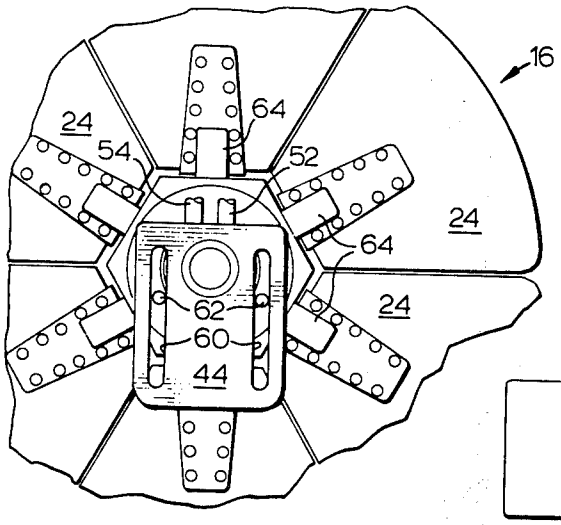


FIG.2

FIG.3.

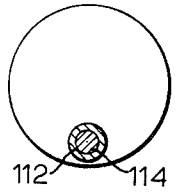


FIG.4.

SHUTTER-FAN SYSTEM

This invention is directed to a coolant system and in particular to a thermally operable shutter-fan to regulate the temperature of coolant fluid in relation to the system.

In the operation of vehicles under environmental conditions, of extreme cold, such as in the Arctic, problems arise concerning the suitable regulation of engine operating temperatures and in particular, the control of the temperature differential between outlet and inlet engine coolant.

The cylinder head temperature of internal combustion engines is generally regulated by the operation of a coolant-sensitive circulation-inhibiting thermostat located in the engine coolant outlet, by means of which the circulation of the coolant under thermo-siphon and water pump forces from the engine to the engine radiator is restricted or substantially prevented until a desired minimum coolant temperature at the engine outlet is achieved. The regulation of coolant flow including inflow from the radiator is usually controlled by restricting circulation at the engine coolant outlet. As is well known in the art, such operation may be readily effected using the well known type of wax-filled thermostate in the engine coolant outlet. However, one problem that arises is the question of temperature difference between the engine inlet and outlet temperatures of the coolant. If incoming coolant at an ambient temperature of 10°F. in the radiator is admitted to an engine equipped with a 180°F. winter thermostat, then the coolant temperature differential across the engine is 170°F. A wide temperature differential of this order leads to a number of problems including reduced engine reliability, serviceability, and severely increased levels of harmful engine emmissions.

The problems encountered in operating an engine in such fashion under this type of climatic condition are aggravated by the extreme heat losses which take place directly from the engine block, due to large losses of heat by radiation and convection from the engine external surfaces, within the engine compartment. Such radiation and convection losses are directly affected by the flow of cold ambient air to the engine compartment due to wind, the motion of the vehicle, or the operation of the vehicle engine fan. Even the use of an electrically controlled fan of the prior art does not provide effective control of conditions within the engine compartment or tend to modify compartment conditions sufficiently.

The present invention provides a shutter-fan assembly for use with a temperature modifying system such as a vehicle engine cooling system, comprising; assembly mounting means for mounting the assembly in spaced relation with a radiator portion of the temperature modifying system; a rotor assembly attached in rotatable relation with the mounting means, having a substantially circular array of blades extending outwardly therefrom, at least some of the blades being moveable from a first flow obturating shutter condition to a second blowing position; thermally responsive means to move the moveable blades from one position to the other position, and means to rotate the rotor assembly whereby in operation when in the blade second position the assembly functions as a fan.

In the case of air cooled motors many of the benefits of the subject shutter-fan may be obtained by suitable installation.

The present invention further provides a method of operating a coolant circuit for an engine fluid coolant system having a fluid coolant suplied at a low temperature to the engine and a shutter-fan to regulate the passage of gaseous coolant in cooling relation with the system, including the steps of operating the engine to provide power therefrom; circulating coolant through the engine in cooling relation therewith; blending coolant from the radiator with coolant circulating in the engine; maintaining the shutter-fan in a substantially closed condition to impede the passage of coolant fluid in cooling relation through the radiator while permitting an increase in the temperature of coolant within the radiator and entering the engine from the radiator, sensing the thermal condition of blended coolant entering the engine, and regulating the shutter-fan accordingly in an opening sense on attaining predetermined coolant inlet conditions to promote predetermined engine operating conditions.

In the case of engines having liquid coolant circuits using the subject shutter-fan, the circulation of cooling air through the core of the radiator due to fan action is controlled, and the admission of cold air into the engine compartment is restricted.

In operating an engine by providing a regulated cooling thermal gradient in addition to benefits such as improved oil circulation, reduced thermal gradients and reduced thermal stresses, accelerated engine warm up and reduced crank case condensation, to name but a few, a further significant advantage is achieved in the case of vehicles having partially or completely enclosed engine compartments in that by controlling fan action the air temperature within the engine compartment is permitted to rise relatively rapidly to that associated with temperature conditions. The warmer engine compartment thus provides warmed combustion air, leading to enhanced performance in terms of fuel vaporization and improved fuel economy, with the achievement of exhaust temperatures even approaching design values and corresponding improvements in efficiency and reliability.

A major advantage of the shutter fan herein disclosed is the ease with which it may be installed in a vehicle without the need of expensive structural alterations or modifications to the vehicle, as may be entailed in alternative systems.

A further and not inconsiderable factor is the accelerated provision of a sufficient heat source for heating the interior of the associated vehicle, when required.

The present invention provides a shutter-fan having a controlling actuator responsive to the temperature of coolant within the vehicle engine. The use of a dynamically energized shutter within the protected confines of the engine compartment lends an assurance of dependable operation under conditions where other forms of shutter are liable to jam or malfunction. According to the invention a wax containing element having a change-of-state characteristic at a selected temperature may be used to power the shutter-fan from a blade-closed to a blade-open position. Thus, if a wax containing unit having a wax which liquifies at approximately 170°F. is connected in blade controlling relation with at least some of the blades of the shutter-fan, then on achievement of the selected temperature of 170°F. the

coolant at the engine inlet, which temperature is transmitted to the wax element by appropriate local coolant circulation, the wax element expands, to cause operation of the device from the closed "shutter" condition to an open "Fan" condition.

It is contemplated that instead of being direct acting, the temperature responsive element may operate in controlling relation with an independently powered servo system. However, it has been found that direct fan blade actuation may be achieved in the manner taught, to provide a simple and reliable system.

A further characteristic of the present invention is the use of a pre-loaded resilient linkage in the mechanism to facilitate the setting up and adjustment of the blade control linkages, which controls the opening and closure of the fan blades.

Certain embodiments of the present invention are described reference being made to the accompanying drawings, wherein;

FIG. 1 is a schematic side view of an engine installation incorporating a shutter-fan according to the present invention;

FIG. 2 is a partial view of the shutter-fan assembly in elevation, as seen from the rear or engine side, and

FIG. 3 is a sectional side view of the shutter-fan assembly.

FIG. 4 is a top view of a blade boss **116** showing bushings **112** and cam spindles in off-centered relation.

Referring first to FIG. **1**, the engine and cooling system assembly **10** is shown beneath the hood **11** of a vehicle. The coolant system **12** comprising a radiator **14** in combination with a subject shutter-fan **16.** The radiator **14** is provided with air baffles **18,20** which form a coolant flow passage **22** within which is located the blades **24** of shutter-fan **16.**

The radiator **14** is connected by bottom hose **25** and top hose **26** to the engine **28,** the bottom hose **25** connecting the bottom tank **30** of the radiator with the inlet **32** of the coolant pump **34.**

The radiator top hose **26** extends from the engine **28** to the radiator top tank **36,** having a thermostat **38** located therein, in accordance with usual automotive practice.

A thermal bypass **40** connects the engine adjacent the coolant outlet with the pump inlet **32,** to permit local circulation during warm-up.

While the pump **34** is shown separated from the block of the engine, being carried by extension **42** of the engine crankshaft it will be understood that this is primarily for illustrative purposes. Similarly, the circulation by-pass **40** in practice is often located within the engine block, while the thermostat **38** also is usually located internally within the engine, usually on top of the block.

The shutter-fan **16** is shown attached by mounting bracket **44** to the front of the engine, and has a pulley **46** in driven relation with engine pulley **48,** driven by the engine crankshaft. A fan belt **50** connects the two pulleys.

An inlet connection **52** and outlet connection **54** connect the shutter-fan assembly with the engine coolant circuit, to provide engine coolant at engine inlet temperature from the pump **34** to the shutter-fan actuator assembly.

Turning to FIG. **2** the shutter-fan mounting bracket **44** is shown, having recess walls **60** defining slots to receive mounting bolts **62.** The blades **24** are shown in their fully closed position, forming a substantially closed shutter. In the closed shutter position blade balance weights **64** extend substantially normal to the plane of the blades **24.** The balance weights **64** serve to off-set a shift in the blade center of gravity, on movement to an open position. Thus the balance weights provide a substantially constant center of gravity to each blade assembly.

Turning to FIG. **3,** the mounting bracket **44** includes a boss **66** extending normally thereto, having progressively reduced portions **68, 70, 72** on which are mounted the bearings which support the rotor assembly.

Within the bracket **44** internal walls **74** together with cover plate **76** define a fluid sensing chamber **77** coaxial with the boss **66,** having coolant passages **78** connecting with the respective coolant inlet and outlet connections **52,54.**

A thermostat actuator **80** is located within the fluid sensing chamber **77,** being secured at **81** by threaded attachment means. The actuator **80** or lower element has a presser spindle **82** extending forwardly therefrom (rightwardly as illustrated) in pressing relation with a resilient loading device **84** comprising a plurality of Belleville washers arranged in pairs in back-to-back relation to form a compression spring. The resilient washer arrangement **84** in turn presses against a push rod **86** having a thrust bearing **88** mounted thereon by way of a threaded carrier **90** secured in adjustable relation to the push rod **86** by way of a lock nut **92** which in turn is secured by a locking tab **94.**

A slide sleeve assembly **100** comprises a sleeve portion **102** having an outer collar **104** and an inner collar **106.**

The inner collar **106** is held in forward thrusting relation by the thermostatic actuator **80** acting on push rod **87** and the thrust bearing **88** working against a coil spring **108.** The spring **108** is compressed between an end housing **110** of the rotor assembly and a series of bushings **112** mounted on respective cam spindles **114** which are attached in off-centered relation with the respective blade bosses **116.** The blade bosses **116** are rotatably mounted on a cylindrical body portion **120** of the rotor assembly by suitable anti-friction thrust bearings to permit ready rotation of the blades about the radially extending polar axes of their respective bosses **116.**

The rotor body portion **120** is rotatably mounted by way of bearings **122, 124** on the portions **70, 72** of bracket boss **66.**

In operation at low temperatures the shutter-fan blades are held in a closed condition by the coil spring **108** which acts in compression between the end housing **110** and bushings **112.**

The bushings **112** are mounted on cam spindles **114.** Each shutter blade **24** has a boss portion **116** about the main axis of which the blade **24** rotates. Each blade boss **116** has a spindle **114** extending axially therefrom and positioned eccentrically from the boss main or polar axis to provide a turning moment to the blade, under the action of spring **108** on the forward side and collar **104** acting against the rearward side of the spindle bushings **112.**

Upon start-up of the engine **28** in a cold condition, the engine coolant circulates inwardly from the pump **34** into the engine block, and recirculates back to the pump inlet by way of the circulation by-pass **40.** The

shutter fan blades **24** remain in a closed, substantially air flow blocking condition during engine warm-up, thereby substantially precluding entry of cold air through the radiator **14** and past the fan into the engine compartment.

With the circulation thermostat **38** closed there is virtually no flow of coolant between the engine **28** and the radiator **14.**

When the coolant contacting the normal circulation thermostat **38** achieves a sufficient temperature to initiate opening of the thermostat **38,** then some hot liquid coolant flows by way of top hose **26** into the radiator **14,** and a corresponding mass of cold water from the bottom of radiator **14** is drawn by way of the bottom hose **25** through the pump **34** into the engine.

The coolant recirculating in by-pass **40** mixes with radiator coolant flowing in from bottom hose **25.** The temperature of coolant passing through pump **34** being modified accordingly.

If ambient conditions permit, the flow of heated coolant through the radiator will become sufficient to raise the temperature of coolant leaving pump **34** and entering the engine to the desired predetermined operating temperature. The condition of engine ingoing coolant is conveyed to the sensing chamber **77** by connection **52** from the discharge of pump **34.**

On reaching the predetermined temperature, the thermostat power element **80** within the sensing chamber **77** commences operation, the wax contents thereof expanding to produce forward motion of the pressure spindle **82.** This motion is transferred by the belleville washers **84** into forward motion of the push rod **86.**

The axially slidable push rod **86,** together with the carrier **90** moves forward, carrying the thrust bearing **88** with it. The outer race portion of bearing **88** pushes against the inner collar **106** of the rotating sleeve assembly **100,** to move the sleeve assembly **100** forward (to the right, as illustrated). This motion causes the sleeve outer collar **104** to be displaced forward axially, thereby moving the cam spindles **114** forwardly against the compressive force exerted by the spring **108.**

Displacement of the cam spindles **114** axially causes rotation of the blade bosses **116,** to move the blades **24** from a closed to an opening position.

Upon such movement the shutter-fan ceases to prevent a flow of air through the radiator **14,** and the fan blades **24** cause air to flow through the radiator in accordance with the degree of blade opening.

It is not considered that the location of the wax element **80** in the assembly is critical and other locations are contemplated.

It will be understood that the subject arrangement is suitable for inward or outward aspirating fans.

In addition to controlling engine conditions during start-up, it will be understood that the shutter-fan system provides continuous protection during the operation of the engine. Thus, in the case of a vehicle hauling through mountainous terrain, on making descent down a hill, when windage cooling increases due to increased vehicle speed, and the rate of heat generation also markedly diminishes, the shutter-fan responds to the condition of the inlet coolant, and will thus tend to close-down somewhat, or even close right off to the shuttered condition.

While the illustrated embodiment shows blades in side by side relation, when closed, the blade edges can be made so as to overlap at this condition.

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

1. A shutter-fan assembly for use with a temperature modifying system, comprising: assembly mounting means for mounting the assembly in spaced relation with a temperature modifying system; a rotor assembly attached in rotatable relation with said mounting means, having a substantially circular array of blades extending outwardly therefrom, at least some of said blades being moveable from a first obturating position to a second, blowing position; thermally responsive means to move the moveable blades from one said position to the other said position, and means to rotate said rotor assembly whereby in operation when in said second blade position the assembly functions as a fan said blades being individually supported on anti-friction mountings for movement between said positions, each blade having a cam spindle off-set from the blade axis of movement, said thermally responsive means including a temperature sensitive pushing element in thermal contact with coolant inlet conditions to the engine, push rod means connected thereto for displacement axially within said rotor assembly, and anti-friction thrust means connecting said push rod means with said blade spindles to accurately position said blades in response to changes in length of said pushing element produced by temperature change in said coolant, said push rod means including a resilient loading device to provide pre-determined pre-load to the push rod means.

2. The assembly as claimed in claim **1** in combination with a temperature modifying system having a radiator section, a coolant gas circulation path therethrough including a restricted path portion in facing cooperating relation with said rotor assembly, said rotor blades when in said first position serving to restrict passage of said coolant gas through said circulation path.

3. The combination according to claim **2** wherein said temperature modifying system comprises a vehicle coolant system.

4. The combination according to claim **3** wherein said vehicle coolant system comprises a propulsive engine of the vehicle connected in liquid coolant circulating relation with said radiator section, said shutter fan assembly being mounted rearwardly of said radiator section, said gas circulation restricted path portion comprising a portion of casing confining said gas circulation path, having an opening therethrough in coincident axially aligned relation with said rotor assembly.

5. The assembly as claimed in claim **1** wherein said moveable blades each include a balance weight to maintain the center of gravity of a said blade at a constant radius from the axis of rotation of the shutter fan assembly, to minimize the force required to position said blade.

* * * * *