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CROSSFLOW RADIATORS

Filed April 9, 1963

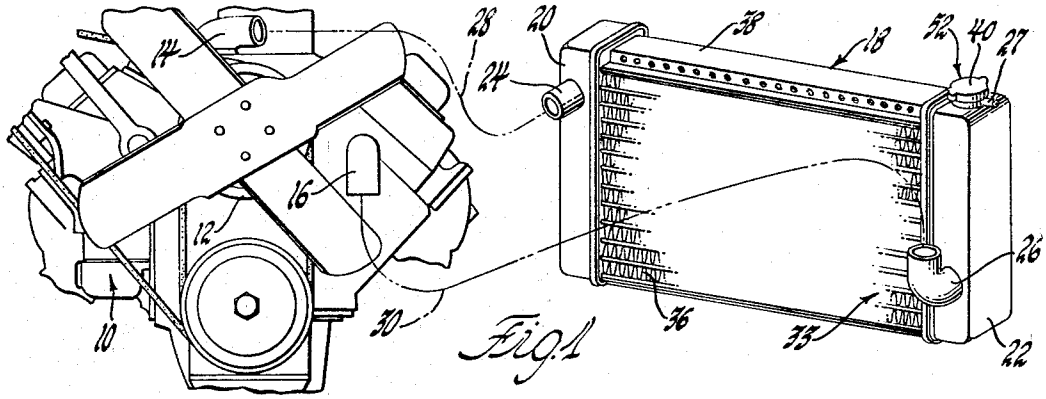


Fig. 1

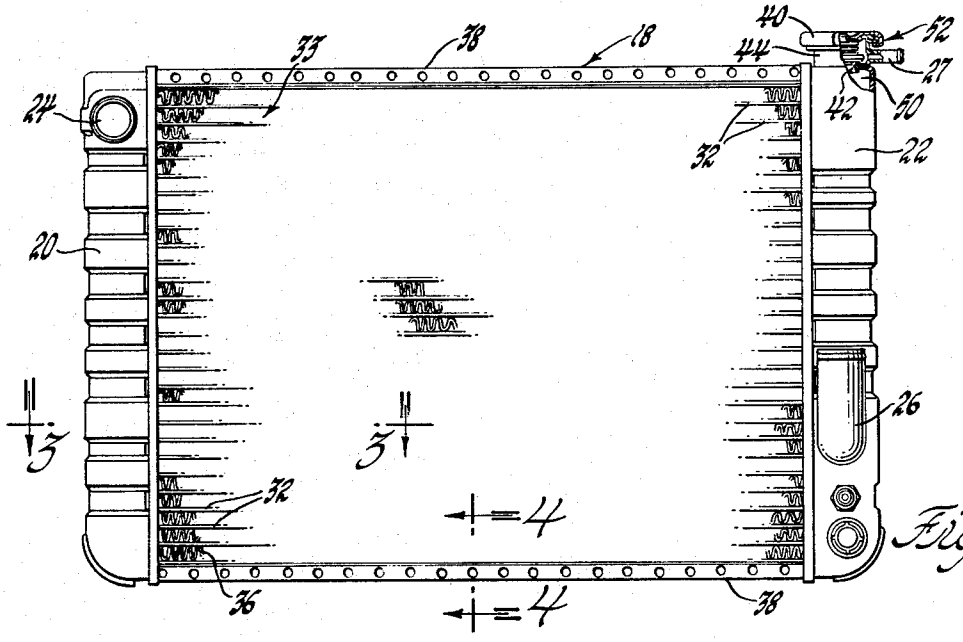


Fig. 2

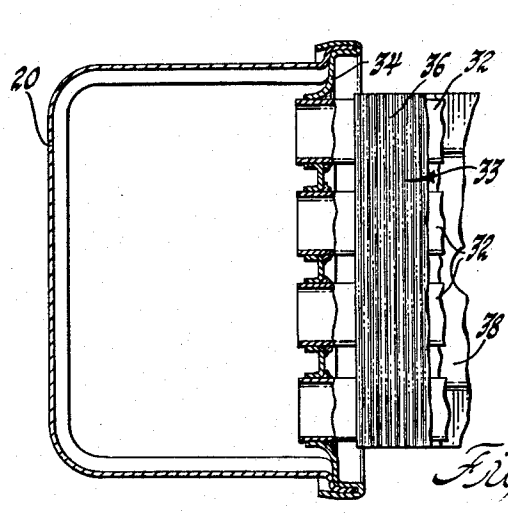


Fig. 3

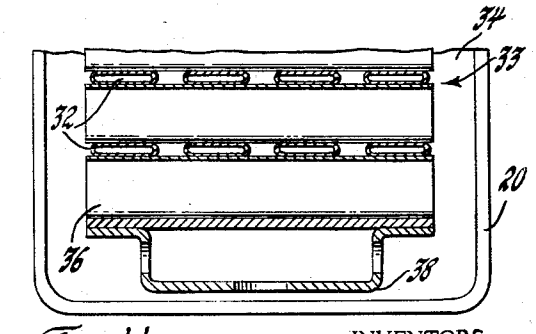


Fig. 4

INVENTORS
Paul K. Beatenbough &
BY Robert W. Bishop
George E. Johnson
ATTORNEY

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CROSSFLOW RADIATORS

Paul K. Beatenbough, Medina, and Robert W. Bishop, Lockport, N.Y., assignors to General Motors Corporation, Detroit, Mich., a corporation of Delaware

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This invention refers to heat exchangers and more particularly to a radiator of the crossflow type adapted to serve an internal combustion engine, and also to a combination of such a radiator with a liquid cooled internal combustion engine.

Crossflow radiators have been used for many years. One reason for the continued efforts to use them is that they permit lower installation in vehicles as compared with the more conventional downflow type. Heretofore, however, such radiators have been generally unacceptable. Expensive provisions for air removal and supplementary coolant reserve tanks have been employed with crossflow radiators to insure that the radiator tube outlets are maintained full of engine coolant at all times. A common and basic difficulty has been that, as coolant is heated, it expands and some of it is lost through an overflow port. As the coolant subsequently cools and contracts, air is drawn into the system through the overflow port or a vacuum valve. If the air is not collected at the overflow zone, the cooling system will act like a pump to exhaust coolant with each heating and cooling cycle. In the teachings of the United States patents to Muir, 1,860,783, granted May 31, 1932 and 1,576,756, granted March 16, 1926, air vents are provided at the tops of outlet header tanks where air gathers but users of such radiators continually replaced coolant in vain attempts to maintain top tanks full. Providing top header tanks eliminated a main advantage (lower installation) of crossflow radiators and in the patented structures referred to, coolant loss is great because of the frequent refills referred to.

It has now been discovered that top or supplementary coolant reserve tanks are not necessary while the flow of coolant is maintained through all tubes in a crossflow radiator capable of stable and efficient performance—i.e.—an operation without the operator feeling it necessary often to check the coolant level.

To this end, an object of the present invention is to provide an improved crossflow radiator capable of efficient performance without the use of a top or added reserve supply tank. Another object is to provide an improved combination of an engine and a crossflow radiator.

A feature of the present invention is a crossflow radiator comprising a core with tubes connecting two side tanks, one of the latter being adapted to serve as a coolant inlet tank for receiving coolant and the other having means for removing air and being adapted to serve as a coolant outlet tank, the air removing means being above the outlet and the coolant capacity of the radiator being sufficient to include a necessary reserve supply of coolant in the absence of a top or supplementary tank. Another feature is a combination of an engine and a crossflow radiator in which no reserve radiator tank in the form of a top, side or detached tank is employed.

These and other important features of the invention will now be described in detail in the specification and then pointed out more particularly in the appended claims.

In the drawings:

FIGURE 1 shows a front elevation of an automobile engine with a direct connection to a radiator being shown diagrammatically, the radiator being shown in perspective and the combination representing one embodiment of the present invention;

FIGURE 2 is an elevation view of the radiator shown in FIGURE 1 and drawn to a larger scale and with a portion broken away better to illustrate the invention;

FIGURE 3 is a sectional view, drawn to a larger scale, looking in the direction of the arrows 3—3 in FIGURE 2; and

FIGURE 4 is a sectional view drawn to the same scale as FIGURE 3 and looking in the direction of the arrows 4—4 in FIGURE 2.

In the drawings, a typical automobile V-8 engine is illustrated at **10**. This engine is provided with a coolant pump **12** and a pump outlet flow connection **14** as well as a coolant jacket inlet connection **16**. A crossflow radiator is depicted at **18**. This radiator has two side tanks—an inlet tank **20** and an outlet tank **22**. These two tanks are provided with an inlet **24** and an outlet **26** respectively. The inlet **24** is preferably but not necessarily located in the top portion of the inlet tank **20**. The outlet **26** is preferably located in a low portion of the outlet tank **22** and is necessarily located below a vent connection **27** which communicates with a top portion of the outlet tank **22** as will further appear. The pump coolant outlet **14** and the radiator inlet **24** are directly connected by a conduit diagrammatically represented by a dotted line **28**. The radiator outlet **26** and the engine jacket coolant inlet **16** are directly connected by a conduit diagrammatically represented by a dotted line **30**. It will be noted that there are no supplementary tanks utilized in the cooling system of the illustrated combination of the engine **10** and the radiator **18**.

In FIGURE 3, it is seen that horizontally extending tubes **32** of the radiator core **33** have ends passing through a tube sheet **34** and in communication with the inlet tank **20**. Air centers **36** in the form of corrugated thin sheets of metal are utilized in a conventional manner between sets of adjacent rows of tubes **32** to enhance heat exchange characteristics of the radiator as is well known in the art. It will be also understood that the tubes **32** communicate with the outlet tank **22** in the same manner as depicted with relation to the inlet tank **20**.

FIGURE 4 illustrates the relation of a radiator stiffening or frame structure **38** with respect to the core **33** with its air centers **36** and mutiple flat tubes **32**.

On the top of the outlet tank **22** is located a conventional pressure cap **40** which seats on a shoulder **42** within a radiator filler neck **44**. It will be understood that when a predetermined pressure is exceeded in the radiator or cooling system, a spring of the pressure cap will compress and the radiator will be vented by way of the vent **27**. A cap suitable for use in regulating the pressure is disclosed in the United States Patent 2,865,531 granted December 23, 1958 in the names of J. R. S. Gorst and S. W. Kemp.

In operation, engine coolant is forced by the pump **12** to flow through the conduit **28** and into the inlet tank **20**. The coolant then flows horizontally through all the tubes **32** and is cooled by air flowing through the core **33** and by the fins or air centers **36**. The air-cooled coolant then flows into the outlet tank **22** which defines an integrated, substantially unrestricted, or free flow zone **50** served by the outlet **26** and venting means generally indicated at **52** and including the closure **40** and the vent pipe **27**. The air-coolant interface in the outlet tanks moves up and down in operation but this in no way interferes with the flow of coolant through the upper horizontal tubes **32**. The zone **50** is sized to fit other proportions and dimensions of a given cooling system to permit the air-coolant interface to form. In a given design, if the flow rate were increased unduly, a condition would be reached at which the flow velocity in the zone **50** will sweep air along with it and thereby prevent air separation—i.e.—the flow velocity

in a given installation must be low enough to permit entrained air to separate for venting and in the zone having the vent. The de-aerated coolant then returns directly to the jacket of the engine **10** by way of the conduit **30**.

In the operation as above outlined, the cooling system depends upon pump pressure to force coolant through the radiator core **33** against the flow resistance of the latter. The cooling system is designed so that pump flow rate exceeds the gravity flow rate through the radiator (that is, the flow rate is such that the inlet tank **20** is maintained full of water). If this condition is met then flow occurs in only one horizontal direction through the radiator and through all radiator tubes **32** without regard to the location of the air-water interface in the outlet tank **22**. The size and shape of the inlet tank **20** are immaterial considerations provided that the tank **20** is not so small as to throttle pump flow rate to an extent that the latter falls below the radiator gravity flow rate. Under the proper conditions described, air cannot separate in the inlet tank **20** since it will be swept therefrom and by way of the radiator core tubes to the separation zone **50**. If the pump flow rate is permitted to fall below the radiator gravity flow rate, the system will continue to separate some air in the outlet tank but some air will also collect in the upper portion of the inlet tank and coolant flow will cease through those radiator tubes which are above the air-coolant interface in the inlet tank. With proper pump pressure and no undue throttling of flow between the pump **12** and the core **33**, the system and radiator will operate in a stable and efficient fashion.

We claim:

1. A crossflow radiator comprising only two elongated tanks each having a vertical side, the said tanks being an inlet tank and an outlet tank, a core with tubes extending horizontally and connecting the vertical sides of said tanks to form flow passages leading from said inlet tank to said outlet tank, said inlet tank having a coolant inlet, said outlet tank having a coolant outlet, a pressure actuated air vent connected to atmosphere and located at the top portion of said outlet tank in free communication with tubes of said core, the horizontal cross sectional area within the said top portion of said outlet tank being clear

and sufficiently large relative to the coolant flow rate through the said tubes to permit air to separate from said coolant upon the latter discharging from said tubes into said outlet tank, and the path for fluid defined by said two tanks and tubes being in only one horizontal direction.

2. A combination of an internal combustion engine coolant jacket with an engine coolant pump and a crossflow radiator forming a closed circulatory system, said radiator being an integral unit of only two tanks and a core with horizontally extending tubes, said tanks being separated by a space occupied by said core and having vertically elongated facing sides serving as tube sheets for said tubes, one of said tanks having a coolant inlet, conduit means in said system forming a direct connection between said jacket and pump to said coolant inlet, said conduit means defining a flow path of substantially constant cross section to give a substantially uniform flow rate along its length, the other of said tanks having a top portion defining a zone in free communication with said tubes and having a sufficiently large volume relative to the flow rate through the said tubes to permit air to separate from coolant discharged by said tubes, said other tank having a coolant outlet located below said zone and connected to other conduit means forming part of said system, a pressure actuated air vent connected to said zone, and the path for coolant flow defined by said radiator being in only one horizontal direction.

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ROBERT A. O'LEARY, *Primary Examiner.*

CHARLES SUKALO, JAMES W. WESTHAVER, *Examiners.*

A. W. DAVIS, *Assistant Examiner.*