# United States Patent [19]

**Beck et al.**

[11] **3,858,644**

[45] **Jan. 7, 1975**


[54] **FAN SHROUD EXIT STRUCTURE**


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[73] Assignee: **International Harvester Company**, Chicago, Ill.



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[21] Appl. No.: **348,437**

[52] **U.S. Cl.** ................ **165/51,** 123/41.49, 165/122, 180/54 A, 415/210, 415/219 R, 415/DIG. 1

[51] **Int. Cl.** ................ **F28d 21/00**

[58] **Field of Search** ................ 123/41.48, 41.49; 180/54 A, 68 R; 415/210, 219 R, DIG. 1; 165/51, 122, 126



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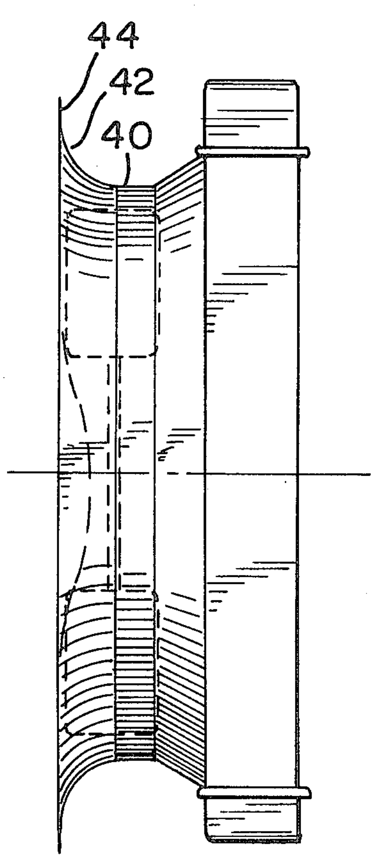
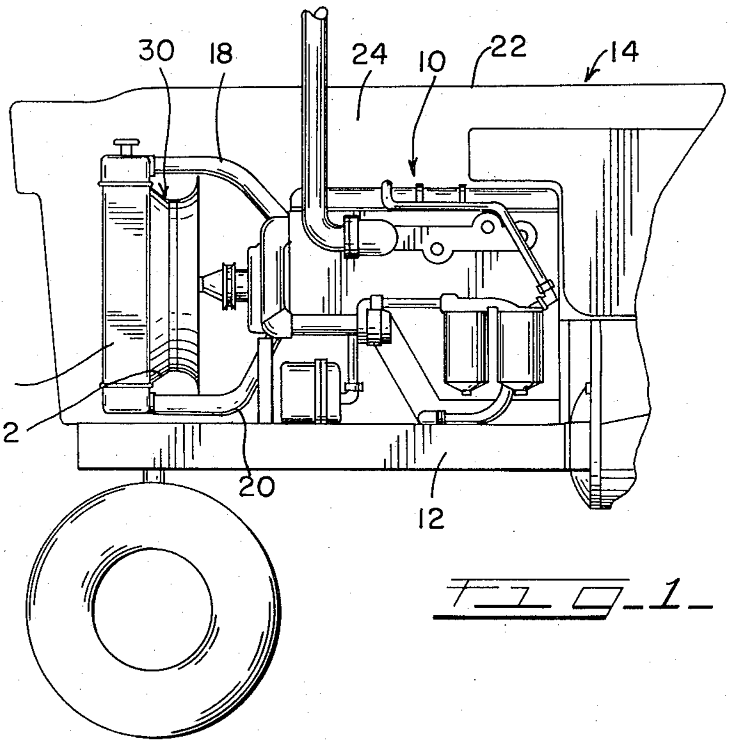
[57] **ABSTRACT**

An internal combustion engine, having a heat exchange system, a fan for moving air therethrough and a shroud and shroud exit section for controlling the air path. The shroud exit encloses the fan and includes throat (CF) radial expander (R) and radial flat (RF) sections whereby air is drawn through the heat exchanger axially and expelled radially along said exit sections simultaneously interruption sections or cutout portion are strategically located in the shroud exit to direct parts of the air flow whereby they exit axially. The fan has a projected axial width (AW) such that a general relationship exists with the shroud exit sections: CF = AW/3, RF = AW/3, and R = 2AW/3.

**7 Claims, 8 Drawing Figures**


30
18
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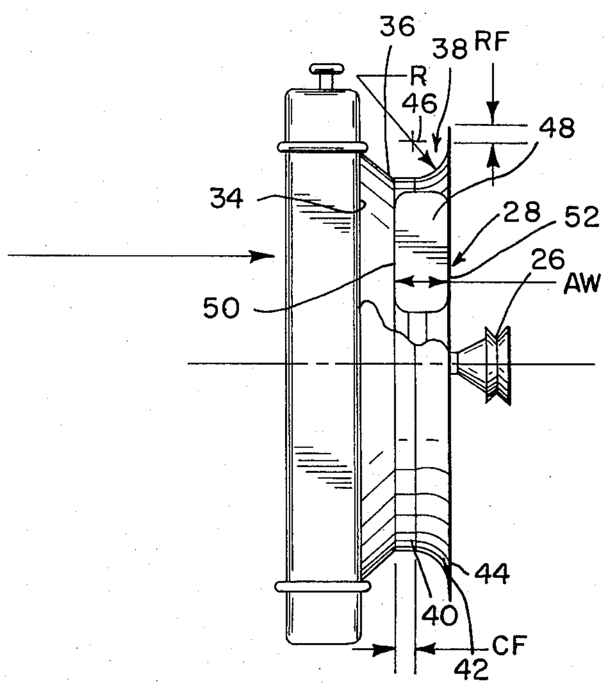
12

FIG-1


36
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RF
R
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48
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52
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AW
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44
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CF
42

FIG-2

Fig. 3

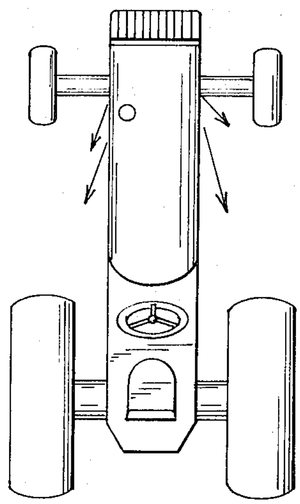
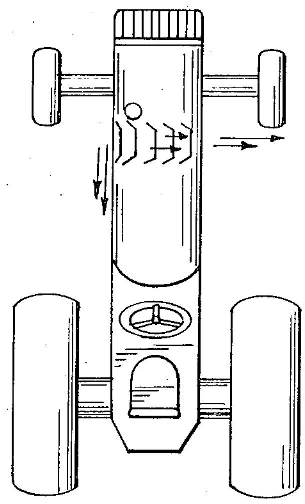


Fig. 4



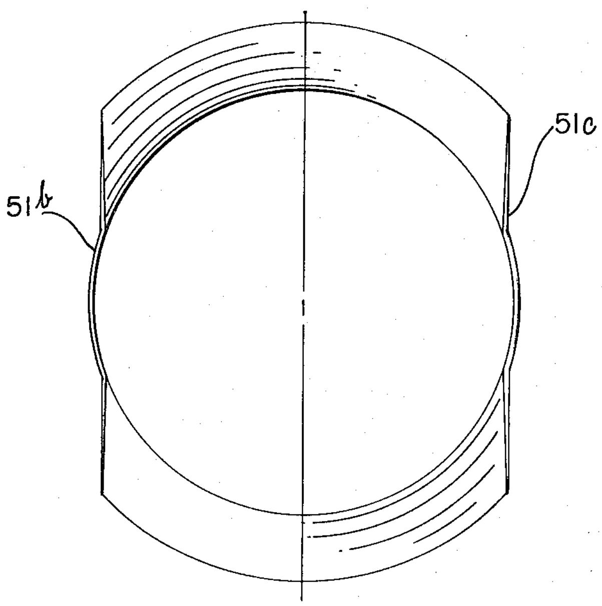



Fig. 7

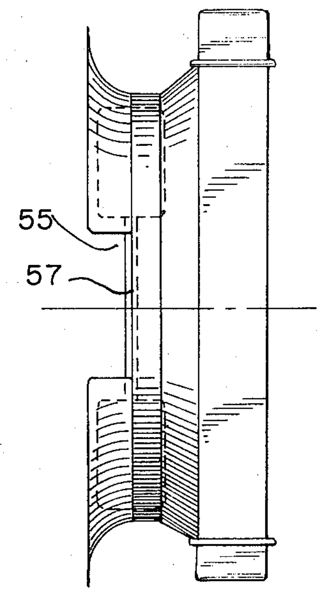



Fig. 8

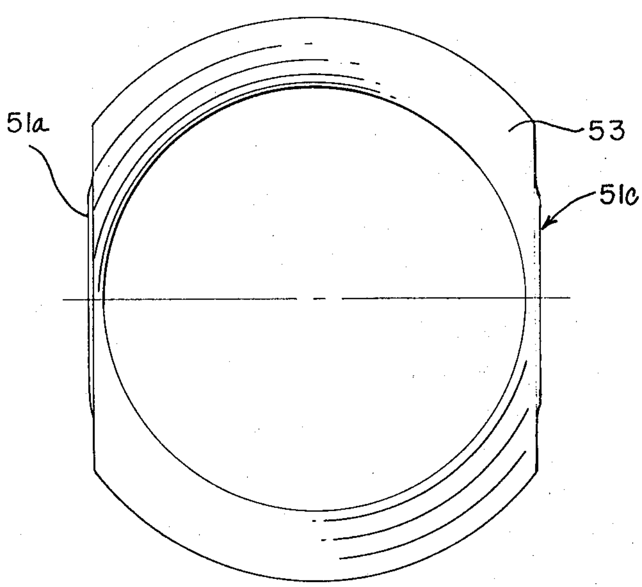



Fig. 5

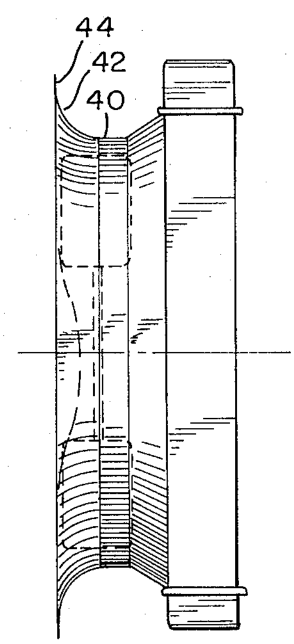



Fig. 6

## FAN SHROUD EXIT STRUCTURE

This invention relates to a cooling assembly and more particularly to a contoured fan shroud exit section having interruptions therein and a fan located therein.

Most vehicles in general used today are driven by internal combustion engines. These engines being heat producing are for the most part water cooled, that is, the engine is jacketed for circulation of water which takes up the heat and subsequently transfers it to the atmosphere. The radiator is used for cooling the liquid circulating through the engine by dissipating the heat to an air stream. The air flowing through the radiator absorbs the heat and carries it out into the atmosphere. Different types of fan systems are used to achieve the necessary air velocity through the radiator. That is, some fan assemblies draw air from the atmosphere through the radiator and back over the engine thereafter exiting to the atmosphere. This type of fan is known as an axial flow suction fan, drawing air axially through the radiator and discharging into the engine compartment. Other fans work in the reversed manner, that is, they draw air from the engine compartment wherefrom it is blown forwardly through the radiator to achieve the necessary radiator cooling. This latter system is often employed when the vehicle is performing tasks that generate large amounts of dust or air borne particles, to keep such material from settling in the engine compartment or where thermal and/or air pollution are detrimental to operator environment. This dust problem is found in many cases to have a detrimental effect upon the engine and its performance while heat and noise reduce the efficiency of the operator. Baffle systems are often involved to redirect the air drawn rearwardly by the suction fan, however, such devices are often complicated and as is apparent employ additional parts, labor, and services. The reverse or forwardly blown air through the radiator also suffered from the fact that the air was often heated substantially by the passage around the hot engine and, depending upon how fast the vehicle was moving forwardly necessitated additional fan power to overcome the rearward vehicle generated air stream. With the increase in power delivered to the fan, fuel consumption increased and noise pollution increased.

It is thus apparent that both above methods possess characteristics which are far from that which are desirable. It is therefore an object of this invention to provide a cooling assembly which generates simultaneously axially and radial air streams. Yet another object of this invention is to provide an air exit section for a fan shroud which directs parts of the fan generated air stream axially and parts radially. Still another object of this invention is to provide an air exit section having interrupted sections which discharge an air stream axially. A further object of this invention is to provide a shroud exit section having a plurality of interrupted sections and radial flat portions whereby air is discharged axially and radially respectively.

In accordance with the preferred embodiment of this invention a vehicle is provided having a fluid cooled internal combustion engine and a radiator cooling system for dissipating the heat produced. The radiator cooling system includes a standard radiator, an axial flow fan facing the radiator and having a plurality of angular blades whereby air is drawn rearwardly through the radiator. A shroud rearwardly extends from the back face of the radiator to channel air through the radiator and hamper the fan from drawing air which has not passed through or at least come in contact with the perforated heat exchanging surfaces of the radiator. For the most part the shroud encloses the entire perforated heat exchanging rear area of the radiator. A fan shroud exit means is also provided having secured to the backwardly extending portion of the fan shroud and extending rearwardly thereof as well as outwardly. As will be later explained it is the particular contour of this exit section in combination with an axial flow fan located therein, the location thereof also being important, which allows the air stream to be converged and part directed radially and part axially away. The simultaneous discharge of air via axial and radial flow paths around the circumference of the shroud exit allows avoidance of structural obstructions etc., while still achieving an optimum air flow. As is apparent this invention is also applicable to a stationary engine where it is desired to tailor the air stream.

Other objects and advantages of the invention will become apparent upon reading the following detailed description and upon reference to the drawings, in which:

FIG. 1 is a side elevation of an internal combustion engine showing the device of my invention attached to a vehicle;

FIG. 2 is a fragmentary vertical section showing the relationship of the fan to the contoured exit section;

FIG. 3 is a top view of a tractor showing the air stream of the prior art fan assemblies;

FIG. 4 is a top view of a tractor showing the directed air stream achieved with the radiator cooling assembly herein disclosed;

FIG. 5 is a rear view of the shroud exit section showing one embodiment of the interruption section means;

FIG. 6 is a side view of FIG. 5;

FIG. 7 is a rear view of the shroud exit section showing a second embodiment of the interruption section means; and

FIG. 8 is a top view of the shroud exit of FIG. 7.

While the invention will be described in connection with a preferred embodiment, it will be understood that it is not intended to limit the invention to that embodiment. On the contrary, it is intended to cover all alternatives, modifications and equivalents as may be included within the spirit and scope of this invention as defined by the appended claims.

Turning first to FIG. 1 there is shown a conventional water cooled heat producing internal combustion engine means **10** forwardly carried on longitudinally extending parallel support means **12** of vehicle means **14**. As shown herein vehicle means **14** is a tractor, however, as will hereafter become more apparent this invention can be applied to any type of vehicle employing a heat generating internal combustion engine or any other portable or stationary device requiring an air moving fan. Forwardly mounted is a water cooling radiator means **16** employed to dissipate the engine generated heat. Water flows between the water jacket on the engine (not shown) and the radiator through a series of fluid communicating means **18** and **20**. In this particular embodiment sheet metal means **22** encircles engine means **10** thereby forming the engine compartment area means **24**.

Carried at the forward end of engine means **10** is a fan shaft means **26** whereby power is delivered to drive fan means **28.** As is apparent, the particular mode whereby power is transmitted thereto is not critical and belts and pulleys could also be employed. As employed here, fan means **28** is a rotatable suction fan positioned opposite the radiator means **16,** and normally creating a flow of air or drawing in a stream of cooling air rearwardly through the radiator with a subsequent axial discharge thereof. This axial flow of air is directed to the fan means by a shroud means **30.** The particular shape of the forward section **32** is dependent upon the shape and design of the perforated heat exchanging design of the radiator. The nature of the connection between the leading edge **32** and the rear face **34** of the radiator will be dependent upon the particular characteristics of these componets, that is, some connections being provided with air gaps while others are substantially sealed over the entire circumference of the enclosure. In the preferred form of this invention the entire perforated area is substantially sealed against the passage of air from any other direction except through the radiator. From the forward edges the shroud means **30** (be it a taper transition as shown or a box type) converges rearwardly to a circular rear section **36.**

Referring now to FIG. **2** wherein is more clearly shown a shroud exit means **38** extending rearwardly and outwardly from shroud edge **36.** The connection between the shroud and the shroud exit can be achieved by any suitable means, however, it is desirable that such connection be relatively free of gaps or spaces which would allow the passage of air. Exit shroud means **38** includes a tubular means **40,** an arcuated means portion **42** and a flat flange portion means **44.** For the most part tubular means portion **40** forms the leading edge of the exit shroud means while arcuated means portion **42** still extending generally rearwardly simultaneously extends outwardly around an arch the reference point of which is defined as point **46.** That is, arcuated section **42** has a general bell-shaped appearance being a section of a transition surface or some approximation thereof. In the preferred embodiment arcuated section **42** is a section of a constant radius arch. Flat flange portion **44** forms the trailing edge of exit shroud means **38** and has a major plane perpendicular to that of tubular section **40.** For purposes of simplicity, tubular means **40** will be hereafter referred to as the cylindrical throat means, arcuated portion **42** will be referred to as the radial expanding means and flat flange portion **44** will be referred to as radial flat means. Overall the entire fan shroud exit means **38** has a horn-like configuration.

As previously stated, fan means **28** is rotatingly carried adjacent said radiator means and operably to establish a flow of cooling air therethrough. Fan means **28** includes a plurality of fan blade means **48** (only one shown) as is well known in the art. As shown in FIG. **2** fan means **28** is surrounded by said contoured fan shroud exit section **38.** The enclosure of the fan means **28** within shroud means **30** is such that a front plane struck out by the leading edge **50** is coextensive and passes through the leading section of throat means **40** and a rear plane struck out by trailing edge **52** is about coextensive and parallel with said radial flat portion **44.** It should be noted, however, that there is a plus or minus error factor involved in both of these values of about 12 percent of AW. That is, the respective planes formed by the blade means can be within about 12 percent of optimum and still function satisfactorily within the scope of this invention. Thus, within this range the deflected air stream will still be substantially radial.

It has been determined, however, that best results are obtained when the front plane struck out by leading edge means **50** passes through the juncture point between converging shroud **36** and the throat section **40.** Even more determinative on the result is the relationship between the rear plane and the radial flat portion **44.** Overall performance is achieved when the rear plane and the radial flat portion **44** are coextensive and parallel. Deviations from this orientation cause the air stream to change more rapidly than corresponding percentage changes in the front plane location.

The following relationship exists between these parameters: $RF = AW/3$, $CF = AW/3$, and $R = 2AW/3$ there RF is the length of the radial flat portion **44,** CF is the length of the cylindrical throat section **40** and R is a radius of the radial expanding section **42** or distance from the reference point to the transition surface and AW is the projected axial width of fan **28.**

FIGS. **3** and **4** show the path in which air is dispersed by the fan means comprising again a standard assembly and the improved assembly, the improved assembly having louver means **56** to facilitate air dispersement.

The amount or relation of the fan means **28** to the exit section means **38** is most conveniently expressed in terms of the amount of the fan which is exposed past the end of the shroud or projects rearwardly thereof. It has been found that a $X_E$ equal to zero gives optimum results; however, reasonable results can be achieved by having $X_E$ about equal to plus or minus **12** percent of AW. That is, as explained previously when the plane swept out by the rear edge is coextensive with the surface of the radial flat or within the tolerance set forth. By changing the orientation of the fan with respect to the fan exit section it is also possible to direct the air stream, straight back, at an angle off radial, etc., depending on preference and need.

Referring now to FIGS. **5 – 8** wherein are shown different embodiments of the interruption section means whereby the discharged air stream is part radial and part axially. Hence, it is possible to tailor the pattern of air discharged from shroud exit **38.** The interruption section means **51** and **51***a* shown in FIG. **5** extend through both the radial flat means **44** and the transitional surface means **42.** The interruption section means **51***b* and **51***c* shown in FIG. **7** extend through both the radial flat means **44** and the transitional surface means **42** and also forms an extension of the cylindrical throat means **40.**

In these embodiments as well as others which will be apparent therefrom, in the transitional zones such as at **53** between the interrupted means section and the contoured sections there is mixed radial and axial air flow. However, the air flow away therefrom is basically axial.

As is apparent there can be a plurality of interruption section means of different design and location. Additionally if the cylindrical throat means **40** is cut back as abreviated throat means **55** it is possible to direct the straight axial flow radially. That is, the rear edge means **57** can be in a plane parallel with the plane passing through radial flat means **44** but transistionally disposed thereof. That is, a third plane perpendicular to edge means **57** would pass through fan means **28** some where between its front and rear plane. Such horizontal movement allows for further control of the air stream exiting adjacent the interruption section.

It is thus apparent that by the provision of the basic shroud exit as above described and in copending application Ser. No. 348,436, filed the same day as this application, radial air flow can be achieved. This shroud exit can thereafter be modified with interruption section means to simultaneously achieve axial air flow. Such axial flow being desired to direct air around structural obstructions, or through limited openings or to direct a warm air flow toward or away from the operator station, etc. Such conditions if not corrected as herein described hamper the movement of air, reduce the overall system efficiency, lead to the generation of higher noise levels etc.

Thus it is apparent that there has been provided, in accordance with the invention, a shroud exit having interruptions therein that fully satisfies the objects, aims, and advantages set forth above. While the invention has been described in conjunction with specific embodiments thereof, it is evident that many alternatives, modifications, and variations will be apparent to those skilled in the art in light of the foregoing description. Accordingly, it is intended to embrace all such alternatives, modifications, and variations as fall within the spirit and broad scope of the appended claims.

What is claimed is:

1. A heat transfer system for an internal combustion engine comprising:

a heat exchange means having a front and rear section;

a shroud including a forward section arranged to enclose said rear section, and a rearwardly extending unitary contoured exit section including means defining a cylindrical throat, a radial expanding section and a radial flat portion;

a fan assembly including a plurality of fan blades having leading and trailing edges wherein the following relationship within plus or minus 12 percent of AW exists: RF = AW/3, CF = AW/3, and R = 2AW/3 where RF is the length of the radial flat portion, CF is the length of the cylindrical throat, R is the radius of the radial expanding section and AW is the projected axial width of the fan means wherein the improvement comprises: an interruption section means in said shroud exit means whereby the continuity is changed and the fan induced stream of air will have radial and axial components.

2. A cooling system for an internal combustion engine means comprising:

a radiator means including a tube means, and a rearward area means;

a shroud means having a forward section arranged to include said rearward area, and a rearwardly extending unitary contoured exit section means including a cylindrical throat means, a radial expanding section means and a radial flat portion means;

a plurality of interruption section means cut into said rearwardly extending unitary contoured exit section; and

a fan assembly means including a plurality of fan blade means having leading and trailing edge means, said leading edge means being adjacent said radiator means, wherein the following relationship plus or minus 12 percent exists: RF = AW/3, CF = AW/3, and R = 2AW/3 where RF is the length of the radial flat portion, CR is the length of the cylindrical throat, R is the radius of the radial expanding section and AW is the projected axial width of the fan whereby the fan induced stream of air is converged and directed out generally radially adjacent said radial flat portion means and generally axially adjacent said interruption section means.

3. The cooling system of claim 2 wherein:

said radiator means includes a rearwardly extending perforated area means;

said shroud means entirely encloses said perforated area means; and

said trailing edge of said fan means forms a plane coextensive with said radial flat means wherein the following relationship exists: RF = AW/3, CF = AW/3, and R = 2AW/3 where RF is the length of the radial flat portion, CF is the length of the cylindrical throat, R is the radius of the radial expanding section and AW is the projected axial width of the fan.

4. A vehicle having an operator station, an internal combustion engine, a radiator for cooling liquid from said engine, an axial flow fan axially facing said radiator and including a plurality of angular blades drawing air rearwardly through said radiator, and a shroud rearwardly extending from said radiator, a unitary shroud exit section means for closely surrounding said fan means and extending in the same directions as said shroud including a tubular means portion forming the leading edge thereof, an arcuated means portion extending generally rearwardly and outwardly and a flat flange portion means forming the trailing edge and lying in a plane perpendicular to said tubular means portion, wherein the following relationship plus or minus 12 percent exists: RF=AW/3, CF=AW/3 and R=2 AW/3 where RF is the length of the flat flange portion means, CF is the length of the tubular means portion, R is the radius of the arcuated means portion and AW is the projected axial width of the fan said fan means striking out a front and rear plane, said front plane intersecting said tubular means portion and said rear plane means intersecting said flat flange portion; and

a plurality of interruption section means in said exit shroud means extending through said flat flange portion means and said arcuated means whereby the continuity and air flow characteristics of said exit shroud are changed such that radial and axial air streams are created.

5. The shroud exit section of claim 4 wherein said tubular means portion is secured to said shroud around the entire circumference thereof forming a junction section; and

said front plane struck out by said fan means intersects said junction section.

6. A vehicle having an operator station and an internal combustion engine, a radiator for cooling liquid from said engine, an axial flow fan axially facing said radiator and including a plurality of angular blades drawing air rearwardly through said radiator, and a shroud rearwardly extending from said radiator wherein the improvement comprises:

a unitary fan shroud exit means secured to said shroud and extending rearwardly and outwardly including: a cylindrical throat means defining a leading edge, a radial expanding means and a radial flat means defining a trailing edge; said fan being enclosed therein, said blade means striking out a front plane coextensive with said cylindrical throat means wherein the following relationship exists: RF

= AW/3, CF = AW/3, and R = 2AW/3 where RF is the length of the radial flat portion, CF is the length of the cylindrical throat, R is the radius of the radial expanding section and AW is the projected axial width of the fan; and interruption means extending into said fan shroud exit means whereby the fan induced stream of air is divided into axially and radially flows.



**7.** The improvement of claim **6** wherein:

said fan shroud exit means is secured to said shroud around its entire circumference; and

said interruption section means has a rear edge means, whereby a plane perpendicular to said edge means intersects said fan blade means between said front plane and said rear plane.

* * * * *