

July 31, 1945.

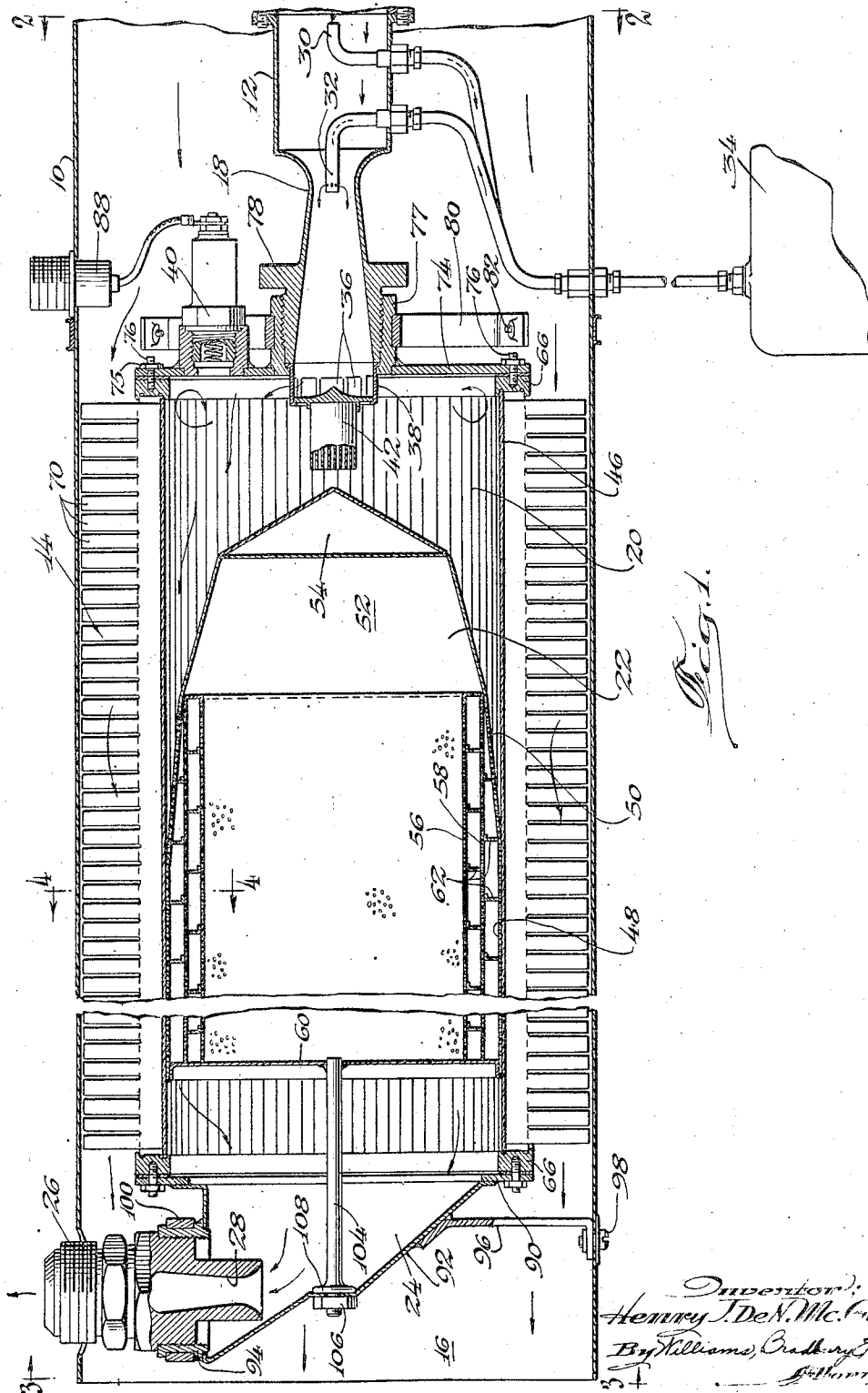
H. J. DE N. McCOLLUM

2,380,602

HEATER

Filed Nov. 4, 1942

2 Sheets-Sheet 1



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HEATER

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2 Sheets-Sheet 2

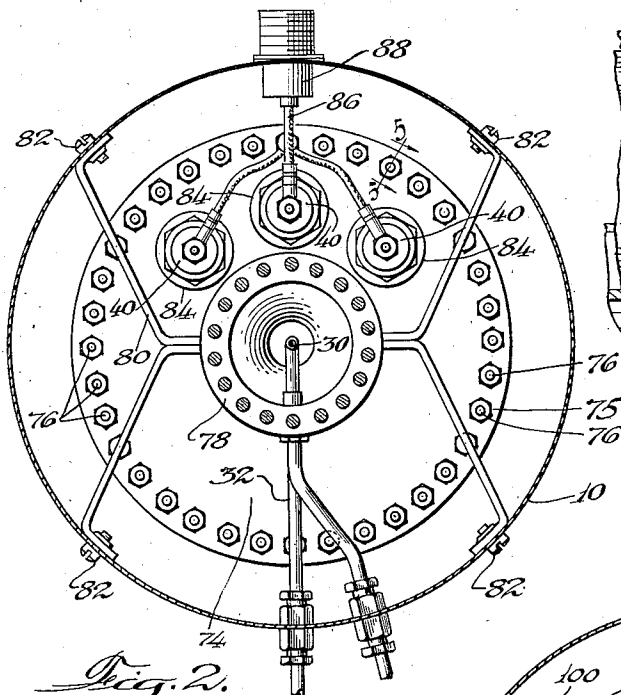


Fig. 2.

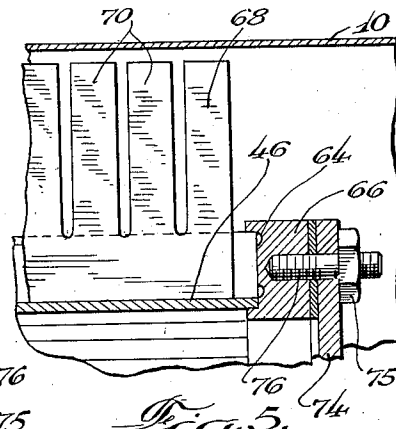


Fig. 5.

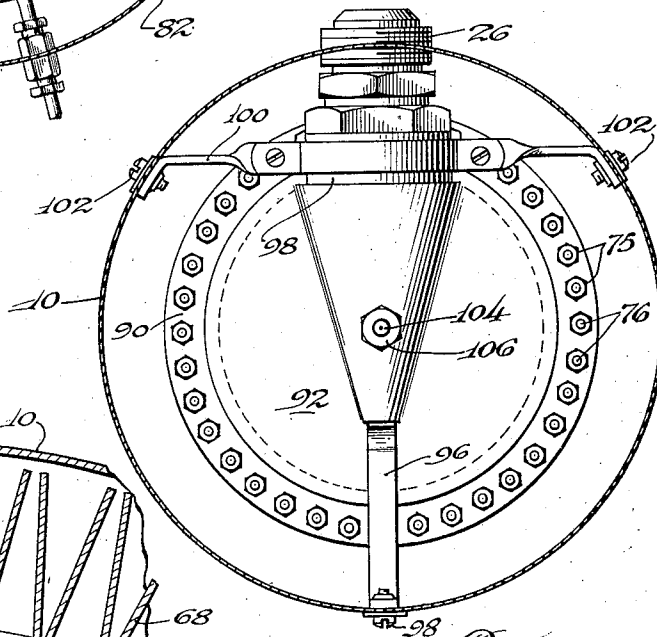


Fig. 3.

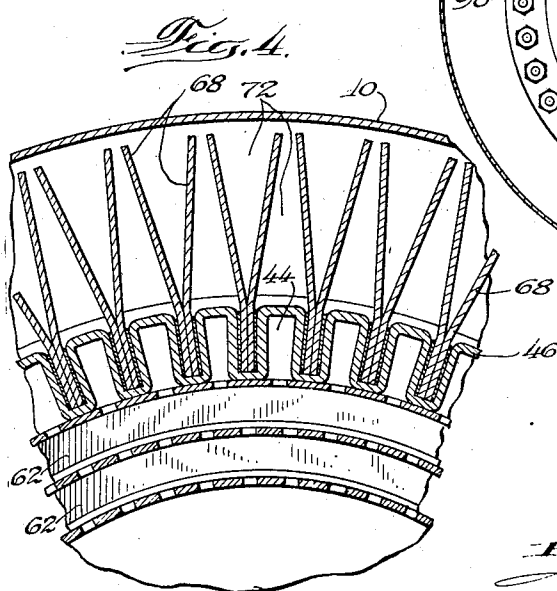


Fig. 4.

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UNITED STATES PATENT OFFICE

2,380,602

HEATER

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McCollum, deceased

Application November 4, 1942, Serial No. 464,451

3 Claims. (Cl. 126-116)

The present invention relates to heaters particularly of the internal combustion type, and more especially heaters of this type adapted for use in aircraft.

It is one of the objects of the present invention to provide a novel heater of the above type which is efficient and safe in operation and which has a maximum of heat output, together with a minimum of weight.

Yet another object of the present invention is to provide an internal combustion heater of the above type having an improved arrangement for quieting and steadying the operation of the heater and preventing pulsations known as "motor boating."

Still another object of the present invention is to provide a novel heater having any or all of the above advantages which can be manufactured in production at comparatively low cost.

Yet another object of the present invention is to provide a novel internal combustion heater having improved heat exchange mechanism.

Other objects and advantages will become apparent from the following description of a preferred embodiment of my invention illustrated in the accompanying drawings.

In the drawings, in which similar characters of reference refer to similar parts throughout the several views,

Fig. 1 is a vertical longitudinal sectional view through the major portion of a heater embodying the present invention;

Fig. 2 is an end view of the heater illustrated in Fig. 1 as seen from the right;

Fig. 3 is an end view of the heater illustrated in Fig. 1 as seen from the left;

Fig. 4 is a transverse sectional view of a fraction of the heater drawn to larger scale. It may be considered as taken in the direction of the arrows substantially along the lines 4-4 of Fig. 1; and

Fig. 5 is a longitudinal sectional view of a fraction of the heater mechanism drawn to larger scale. This view may be considered as taken in the direction of the arrows along the line 5-5 of Fig. 2.

The heater illustrated in Fig. 1 of the drawings is intended to receive air for its operation from one or more air rams, these rams being located at the leading edge of the airplane wing or in some other position where they face against the moving air stream. Air from the ram or rams passes into the inlet end of a tubular casing 10 and into the inlet end of a fuel induction tube 12. The air passing into the

casing 10 moves past a plurality of heat exchange fins, indicated generally by the numeral 14, and out of the opposite end 16 of the casing to the space to be heated.

Air entering the induction tube 12 flows through a Venturi throat 18 into a combustion chamber 20 around an acoustic silencer 22 to an exhaust collecting space 24. From the collecting space 24 the gases are passed outwardly through a fitting 26 to a position outside of the airplane or to some other low pressure area. This fitting includes a venturi type restriction 28 which serves to smooth out irregularities in the pressure differential at the two ends of the heater.

The air intake vent 30 is located within the air induction tube 12 and faces against the direction of air flow therethrough. A set of fuel aspirating jets 32 are located within the Venturi throat 18. These jets, therefore, are at a lower pressure than the air within the intake vent 30. This pressure differential is used in any well known manner to cause a flow of liquid fuel from a carbureting device, indicated by the numeral 34, to the jets 32. The carbureting device 34 is not illustrated in detail inasmuch as the construction of such devices is well known and need not be described in detail here in order to illustrate the present invention.

The combustible mixture formed at the Venturi throat 18 passes forwardly and thence radially outwardly through a plurality of ports 36 formed by striking vanes outwardly from the side wall of a cylindrical tube 38, which extends a short distance into the combustion chamber 20. The vanes are bent outwardly in an oblique manner and therefore cause the combustible mixture to enter the combustible chamber with a swirling motion. This produces considerable turbulence within the combustion chamber and aids in the maintenance of uniform, efficient combustion.

Within the combustion chamber one or more igniters 40, three being shown in the present embodiment, raise the temperature of a comparatively isolated portion of the combustible mixture to the ignition point and thus bring about a burning within the combustion chamber. The hot products of combustion thus formed pass rearwardly and out through the fitting 26.

The igniters 40 shown are of the hot wire type and are described in detail in my co-pending application, entitled "Heating apparatus," Serial No. 447,345, filed June 17, 1942. These igniters

are energized until the heater has been placed in operation. The heat produced by the burning combustible mixture actuates a thermostatic element, not shown, in a well known manner and causes deenergization of the igniters 40.

In the event that combustion should for some reason become momentarily interrupted after the igniter 40 has been deenergized, combustion is re-established by a re-igniter element 42 which projects outwardly from the end of the inlet tube 38. This re-igniter may be formed of a loosely coiled sheet of heat and corrosion resistant material, such as "Inconel," for instance. A re-igniter of this type is more fully disclosed in my co-pending application Serial No. 410,039, filed September 8, 1941.

From the combustion chamber the hot products of combustion pass around the acoustic silencer 22 and through longitudinally extending passages 44 formed in the side walls of the heat exchange member 14 constructed in a manner to be described presently. The side walls of the passages absorb the heat from the hot gases and this heat is transferred to the air stream passing through the casing 10 in an annular stream around the combustion chamber.

As best illustrated in Fig. 4, the wall of the heat exchanger is formed of a length of longitudinally corrugated tubing, indicated generally by the numeral 46. The creases in the tubing wall which form the corrugations are substantially rectangular, thus dividing the wall of the tubing into a plurality of inner and outer longitudinally extending substantially rectangular slots. The inner surface of this tubing rests against the outer circumference of the rearward portion of the acoustic silencer 22, thus forcing the hot gases to flow through the inner passages 44 in intimate heat transfer relation to the tubing wall.

The acoustic silencer 22 is formed of a rearward generally cylindrical portion 48 fitted to the interior surface of the heat exchange tube 46. Just ahead of the cylindrical portion mentioned, the side wall of the silencer converges inwardly slightly, as indicated at 50, while ahead of this portion, the wall of the silencer slopes inwardly still more abruptly, as indicated at 52; the extreme forward end of the silencer being closed by a conical nose cap 54.

This arrangement provides good turbulence within the combustion chamber while at the same time moving the hot products of combustion outwardly into the longitudinally extending passages 44 without the formation of hot spots within the combustion chamber, which are likely to cause deterioration of the heater and produce other disadvantageous effects.

A pair of concentric inner and outer tubes 56 and 58, respectively, are arranged within the portions 48 and 50 and are secured to a disc 60 which closes the rearward end of the acoustic silencer. The concentric tubes 56 and 58 and the side wall portions 48 and 50 are perforated, the holes forming these perforations in the present instance being approximately a sixteenth of an inch in diameter and arranged on quarter inch centers. Between the wall portions 48 and 50 and the tube 50, and between the tube 58 and the tube 56, a plurality of annular plates 62 divide the spaces between the several general cylindrical members into a plurality of annular chambers. The inner row of plates 62 is staggered with relation to the outer row so that gases passing inwardly through the perforations will meet with sufficient

resistance to damp out pulsations. Further, these holes are of such size that flame cannot be propagated through into the interior of the silencer. This is important because a quantity of combustible mixture may collect within the interior of the silencer during operation of the heater.

The heat exchange portion 14 is constructed by providing the corrugated tubing 46, previously mentioned, cut to appropriate length. This tubing may be formed by corrugating a sheet, and then forming the sheet into a tube with overlapping edges crimped together. As best shown in Fig. 5, each end of this tubing is seated in an annular groove in the face 64 of an end ring 66. Two thin metal fin strips 68 are then placed face to face and inserted in one of the outer slots formed by the corrugations in the tube 46. These fin strips extend longitudinally substantially the full distance between the two rings 66, and extend outwardly almost the distance between the corrugated tube and the casing 10. Other pairs of fin strips are similarly inserted in the other outer slots in the side wall of the corrugated tubing 48 until all of these slots are filled. Preferably the fin strips are formed with spaced slots extending inwardly from their outer edges to approximately the outer surface of the corrugated tube. These slots separate the fin strips into a plurality of tabs 70 and thus prevent warping of the fins as might otherwise take place with successive heating and cooling. The assembled heat exchange structure is then placed in an oven and brazed to form the several elements into an integral unit. When a heater of this type is intended to be used in an airplane, it is preferable that the corrugated tube and the fins, as well as the rings 66, be formed of aluminum. Under these conditions, I prefer to use a brazing flux comprised of 90 to 95% aluminum, and 10 to 5% silicon. Or, if desired, aluminum sheet, commonly known as 2S or 3S aluminum can be obtained already coated with a layer of 90 to 95% aluminum and 10 to 5% silicon, in which case no flux is necessary. In some instances, the corrugated tube and fins may preferably be formed of copper or a copper alloy, in which case the elements can be brazed in the ordinary copper brazing manner.

Each of the two fin strips, comprising one pair, is bent outwardly away from each other as best shown in Fig. 4 so that the outer edge of each of the fin strips is comparatively close to the outer edge of the contiguous fin strip in the next adjacent slot. This arrangement divides the air space between the casing 10 and the corrugated tube 46 into a plurality of longitudinally extending triangular passages 72 of approximately equal volume. Thus, the amount of air flowing on one side of any one of the fin strips will be approximately the same as the amount of air on its opposite side. This, in effect, means that the temperatures of the air on each side of each of the fin strips will be approximately equal, thereby producing good heat exchange efficiency.

The forward ring 66 is secured to a circular plate 74 by a plurality of nuts 75 threaded to studs 76, threaded at their opposite ends into the ring 66. The plate 74 acts as a closure for the forward end of the combustion chamber and has a central opening into which a spud 77 is fitted. This spud may be secured in place in any suitable means, such as by brazing, for instance. The spud is internally threaded to

receive a threaded fitting 78, formed to provide the Venturi throat 18 at its inlet end, and which at its opposite end is secured to the cylindrical tube 38. The external surface of the fitting 78 is secured to a strap metal spider 80 by clamping or by brazing, the spider having legs extending outwardly where they are secured to the casing 10 by screws 82, thus centering the combustion chamber and heat exchanger relative to the casing 10.

The plate 74 is also provided with one or more, in the present instance three, threaded fittings 84 which receive the igniters 40. These igniters are energized through a branched cable 86 which passes to a connector block 88 secured in the side wall of the casing 10.

At the opposite end of the heat exchanger, the ring 66 is similarly secured to an annular plate 90 having a comparatively large opening therethrough. This plate is brazed or otherwise suitably secured to a sheet metal cap 92 which forms the closure for the outlet end of the burned gas passage, and which is shaped to deflect the exhaust gases to one side where these gases pass through the outlet fitting 26, this outlet fitting being threaded into a ring 94 brazed to the sheet metal cap 92.

The outlet end of the heat exchanger is aligned within the casing 10 by means of a leg 96, brazed to the cap 92 at one end and secured to the sheet metal casing 10 by means of a screw 98 at its opposite end. Additional support is provided by means of a transversely extending bracket 100, secured at its opposite ends to the casing 10 by means of screws 102 and which, at its central portion, is clamped to the ring 98 into which the outlet fitting 26 is threaded.

The acoustic silencer is dimensioned so as to have a slip fit within the corrugated tube 46 and is properly located in a longitudinal direction therein by means of a threaded rod 104, this rod being brazed at one end to the plate 60, while its opposite end extends through an opening in the sheet metal cap 92. The end which projects through the sheet metal cap is threaded to receive a nut 106 which, when tightened, clamps the adjacent portion of the sheet metal cap against an upset head 108 formed upon the rod 104 in a position just inside the cap.

When a heater of the above type is intended for use in an aircraft, I prefer that the acoustic silencer be built up of comparatively thin stainless steel parts spot or seam welded together, excepting that the nose cap 54, which is at the highest temperature point, be made from "Inconel" or similar heat and corrosion resistant material. The re-igniter 42 also preferably is constructed of sheet "Inconel" or similar materials. The remaining structural portions of the heater, that is, the corrugated tube 46, the fin strips 68, the end closures 74 and 92, the casing 10, the brackets 80, 96 and 100, and the several fittings are preferably constructed of aluminum elements which may be clamped or brazed together in the manner previously described.

During the operation of the heater, combustible mixture will flow into the combustion chamber 20 through the radial ports 38. This mixture will be ignited and burned and will pass outwardly around the nose end of the acoustic silencer into the longitudinally extending passages 44 formed in the side walls of the cor-

rugated tube 46. The heat will be absorbed by this corrugated tubing and will be transferred to the fin strips 68 which project outwardly into the annular space between the corrugated tubing and the casing 10. Air flowing through the casing 10 will be forced outwardly by the combustion chamber portion of the heater so as to flow through the longitudinally extending substantially triangular passages 72 arranged between adjacent fin strips 68. The fresh air thus efficiently absorbs the heat produced within the combustion chamber 20. At the opposite end of the heat exchanger, the comparatively cool products of combustion are collected and passed outwardly through the fitting 26, while the heated air passes from the outlet end of the casing 10 to the space to be heated.

By constructing a heater in the manner shown, high heat output can be obtained from a heater of extremely low weight and small size. It will be apparent also that such a heater fulfills the other objectives set forth for the invention at an earlier portion of this specification.

While I have shown and described particular embodiments of my invention, it will be apparent to those skilled in the art that numerous modifications and variations may be made without departing from the underlying principles of the invention. I therefore desire, by the following claims, to include within the scope of the invention all such modifications and variations by which substantially the results thereof may be obtained by substantially the same or equivalent means.

I claim:

1. A heater comprising a longitudinally corrugated tube, an acoustic silencer located within said tube, caps for the ends of said tube, said silencer together with said tube and said caps forming a combustion chamber and longitudinally extending heat exchange passages connected to said combustion chamber, means for conveying air to be heated longitudinally and externally of said tube, said silencer comprising a generally cylindrical portion and a portion for deflecting products of combustion outwardly into said heat exchange passages, said silencer having a perforated side wall over at least a portion of the area thereof, and means within said silencer forming perforated sound damping chambers communicating with the first said perforations.

2. A heater comprising a generally tubular element having grooves formed in the side wall thereof, means to produce a fluid flow through said tubular element, means located within said tubular element to form with said tubular element and said closures a combustion chamber and fluid passages connected to said combustion chamber, the last said means comprising an acoustic silencer having a generally cylindrical portion and a tapering nose to deflect fluid from said combustion chamber outwardly into said passages, said acoustic silencer being perforated over at least its generally cylindrical portion, means within said silencer forming a group of perforated sound damping chambers communicating with said perforations, and means forming a second set of perforated sound damping chambers communicating with the first set of sound damping chambers.

3. A heater comprising a generally tubular element having grooves formed in the side wall thereof, means to produce a fluid flow through said tubular element, means located within said

tubular element to form with said tubular element and said closures a combustion chamber and fluid passages connected to said combustion chamber, the last said means comprising an acoustic silencer having a generally cylindrical portion and a tapering nose to deflect fluid from said combustion chamber outwardly into said pas-

sages, said acoustic silencer being perforated over at least its generally cylindrical portion, said acoustic silencer including a plurality of comparatively small interconnected perforated chambers and at least one large chamber communicating with said small chambers.

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