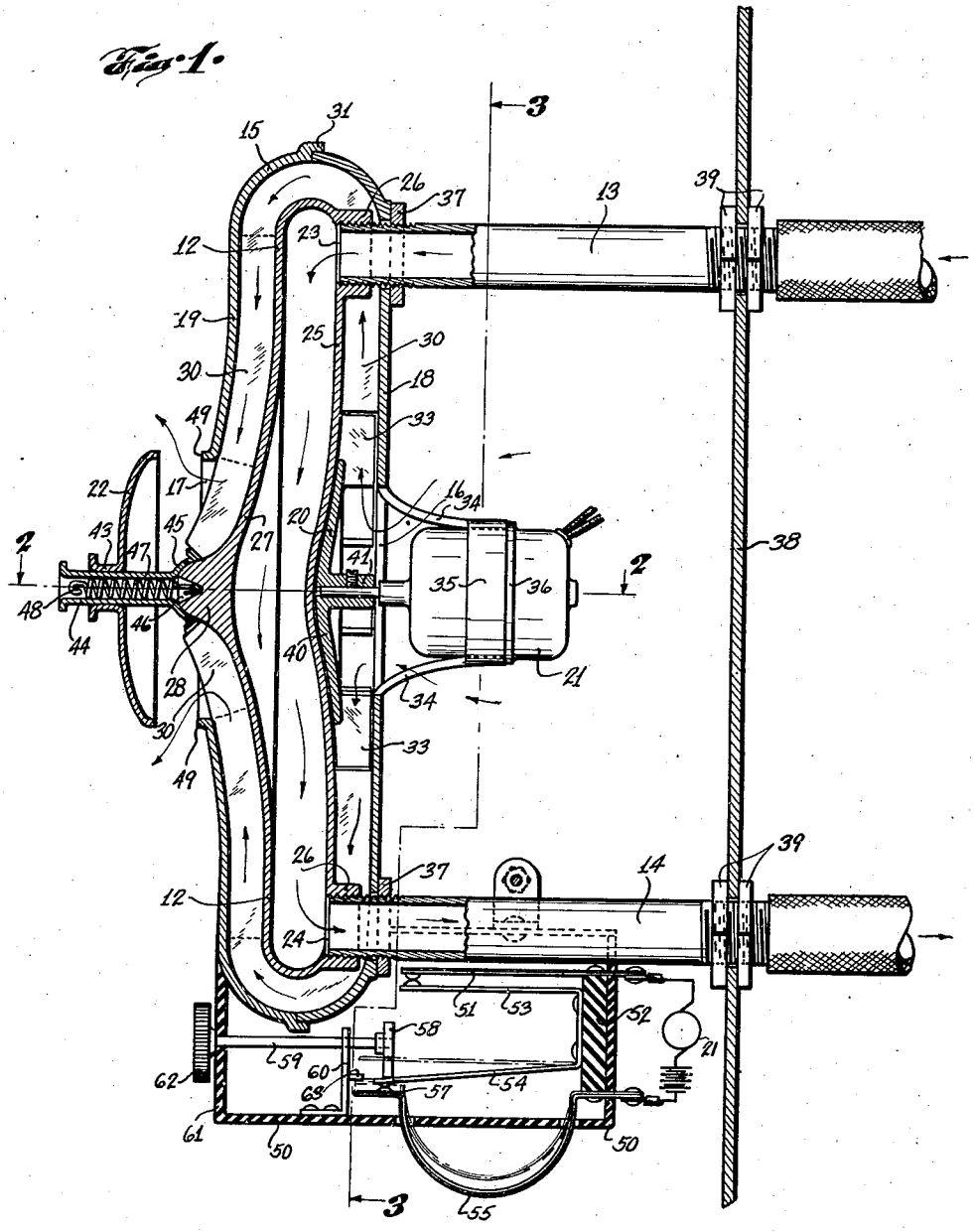
Jan. 11, 1938. C. R. PIEPER 2,104,813

HEAT EXCHANGER

Filed July 20, 1936 4 Sheets-Sheet 1

Fig. 1.



INVENTOR.
CHESTER R. PIEPER
BY
Lawrence H. Cohn
ATTORNEY.

Jan. 11, 1938. C. R. PIEPER 2,104,813

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Fig. 2.

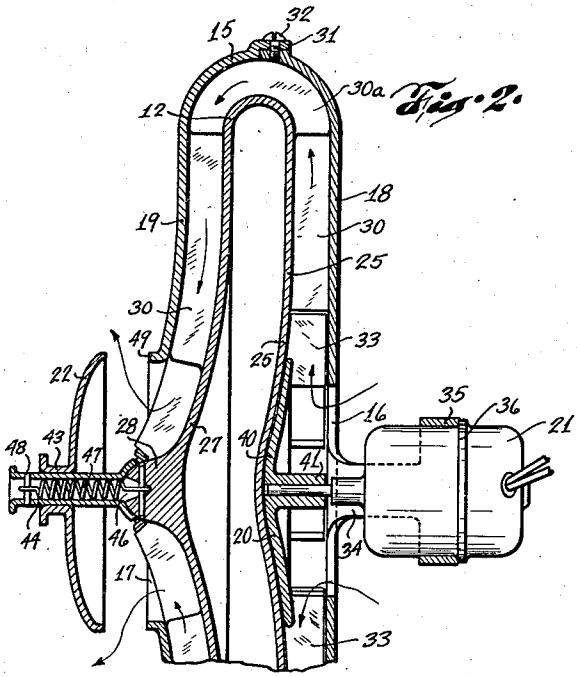
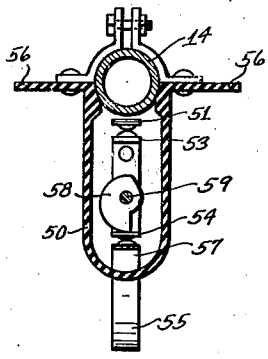


Fig. 4.



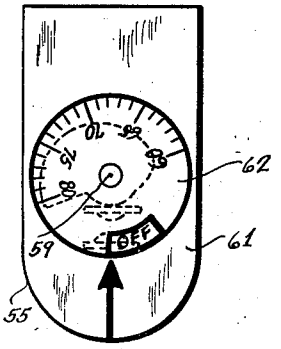


Fig. 5.

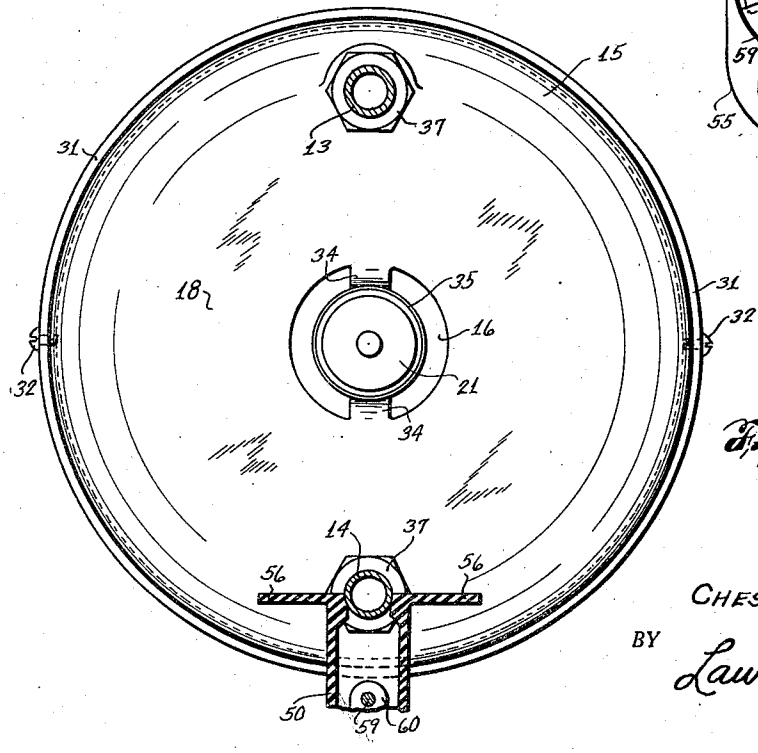


Fig. 3.

INVENTOR.
CHESTER R. PIEPER
BY
Lawrence H. Cohn
ATTORNEY.

Jan. 11, 1938. C. R. PIEPER 2,104,813

HEAT EXCHANGER

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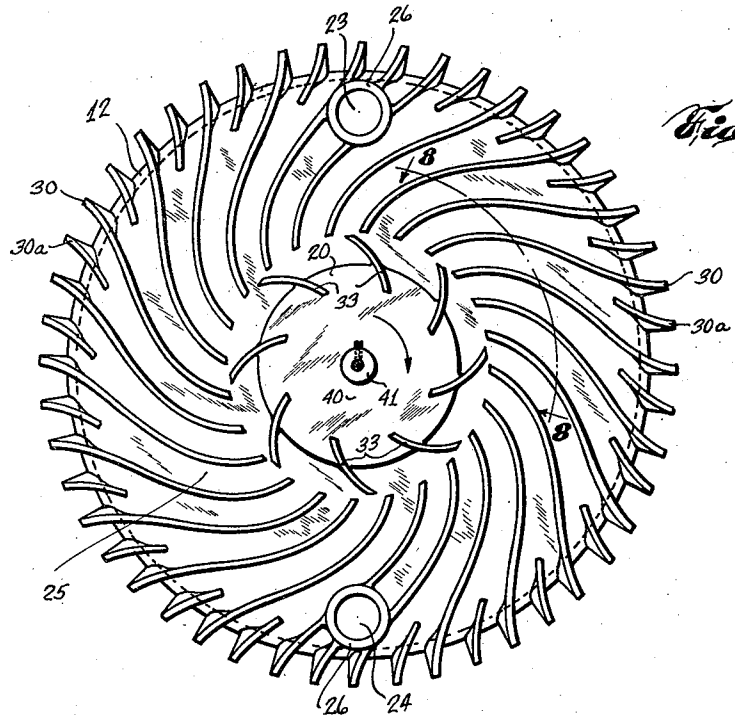


Fig. 6.

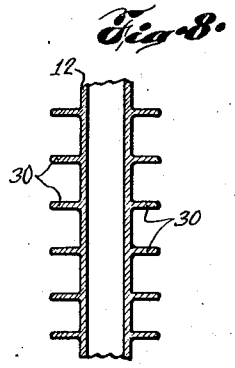


Fig. 8.

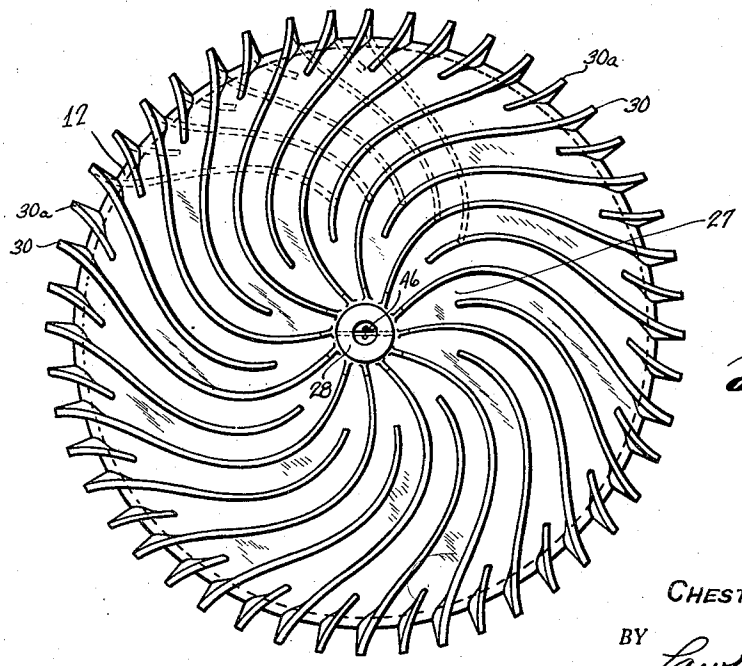


Fig. 7.

INVENTOR.
CHESTER R. PIEPER
BY Lawrence H. Cohn
ATTORNEY.

Jan. 11, 1938. C. R. PIEPER 2,104,813

HEAT EXCHANGER

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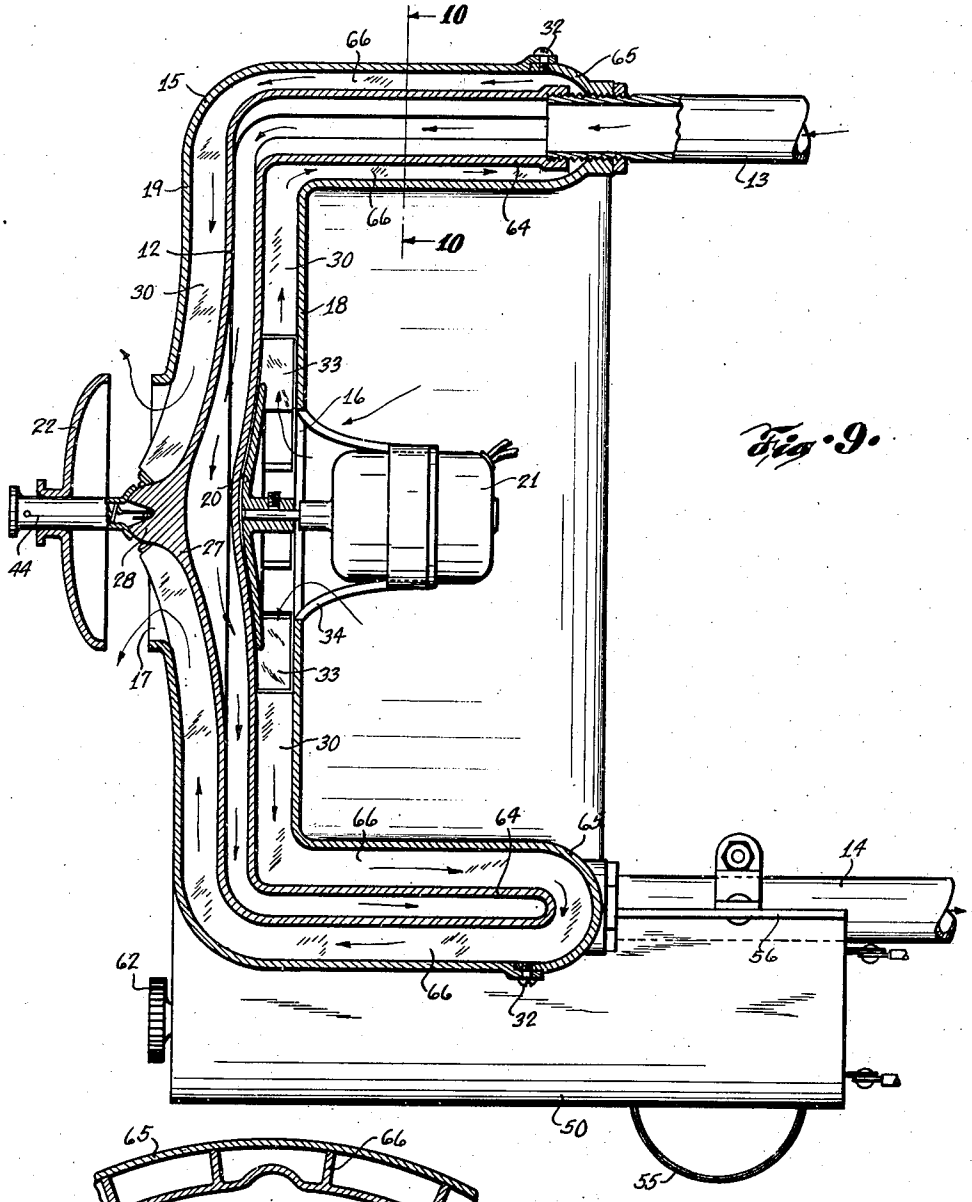


Fig. 9.

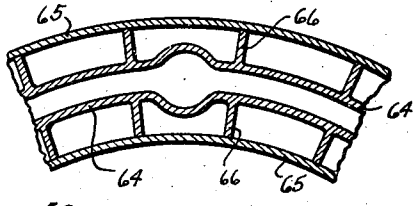


Fig. 10.

INVENTOR.
CHESTER R. PIEPER
BY
Lawrence H. Cohn
ATTORNEY.

Patented Jan. 11, 1938 2,104,813

UNITED STATES PATENT OFFICE

2,104,813

HEAT EXCHANGER

Chester R. Pieper, La Crosse, Wis.

Application July 20, 1936, Serial No. 91,495

15 Claims. (Cl. 257—137)

My invention relates to heat exchangers, and more particularly to an improved heater of the type in which heat from a supply of hot water is transferred to a stream of air. My improved device is especially applicable for heating the interior of automotive vehicles, the fluid utilized for cooling the engine being readily available for circulation through the heater where it serves as the heating agent.

An object of my invention is to provide a heater of the character described which is simple in design and construction, economical of manufacture, and highly efficient in operation.

Another object of my invention resides in the provision of an improved water-heated air-heater of compact, rugged construction, which requires only a small mounting space, and is capable of withstanding high internal pressures as well as the deleterious effects of jar and vibration.

Yet another object of my invention is attained in the provision of an improved heater in which air is impelled through a multiplicity of passages defined by heating surfaces, the formation and course of the passages being such that the flow of air therethrough is not unduly impeded, yet which provide extensive heating surfaces confined in a relatively small space.

A further object of my invention is to provide in combination with a heater of the character described, improved, simplified means for controlling and directing the air as it issues from the heater.

Yet a further object of my invention is to provide, in combination with a water-heated air-heater embodying an electrically driven fan or impeller for obtaining positive circulation of air through the device, of improved manual and automatic means for controlling the operation of the impeller and coordinating its operation with the temperature of the heating fluid and the temperature of the air to be heated.

My invention resides in the construction, shape, configuration and arrangement of the various parts, openings and passageways which provide the foregoing advantages, and by which the objects are fulfilled.

In the drawings, Fig. 1 is a sectional side elevation of the heater assembly; Fig. 2 is a sectional plan view of a portion of the heater shown in Fig. 1, the plane at which the section is taken being indicated by line 2—2 on Fig. 1; Fig. 3 is a rear view of the heater as viewed from a plane indicated by line 3—3 on Fig. 1; Fig. 4 is a transverse sectional view of the control means for the fan motor; Fig. 5 is a front view of the manipulating element and dial for the control means; Fig. 6 is a rear view of the inner member which constitutes a water chamber, showing the air impeller as positioned relative thereto; Fig. 7 is a front view of the inner member; Fig. 8 is a sectional view through the inner member, taken at line 8—8 of Fig. 6; Fig. 9 is a sectional side elevation of a heater assembly of modified form but generally similar to the heater illustrated in Figs. 1 et seq.; and Fig. 10 is a fragmentary sectional view through the heater illustrated in Fig. 9 and taken at line 10—10 of that figure.

Referring now by characters of reference to the drawings, my improved heater comprises an inner member 12 which provides a chamber for hot water or other fluid constituting the heating medium, the fluid being conducted through a supply conduit 13 to the inner member 12, where it gives up part of its heat, and is conducted from the member 12 at a lower temperature through discharge conduit 14. The flow of fluid through member 12 may be induced solely by reason of the temperature differential existing between the fluid in the upper inlet passage and that in the lower outlet passage, in accordance with well known principles of convection currents, or such flow may be augmented by the provision of a pump (not shown) in the fluid circulating system. When the device is installed in an automotive vehicle propelled by a water-cooled motor, the conduits 13 and 14 may be suitably connected into the water circulating system so as to utilize the water pump, customarily provided in connection with such systems, for inducing a positive flow of fluid through member 12.

Enclosing member 12 is a casing or jacket member 15, the walls of which are spaced from the walls of member 12 to provide a heating passage of air. Inlet and outlet openings for the air, designated 16 and 17 respectively, are located in the rear and front walls 18 and 19 of jacket member 15. An air impeller 20 located adjacent the inlet opening 16 and driven by a suitable motor 21 serves to force the air through the passage wherein it becomes heated. An adjustable control and deflecting plate 22 located adjacent the outlet opening 17 serves to regulate the amount of air flowing through the passage and direct its course into the space to be heated, after it leaves the heating passage.

Describing now with greater particularity the preferred construction, shape and arrangement of the parts, openings and passages above men-

tioned, the inner, water-receiving member 12 is of relatively flat, circular shape and may be well described as a hollow, thin-walled, substantially discoidal member. It may be cast, die-pressed, or otherwise formed as an integral member as shown, preferably of a light-weight metal having good heat conducting properties, aluminum or aluminum-alloy being satisfactory for the purpose. Inlet and outlet openings 23 and 24 for the heating fluid are located diametrally at the upper and lower margins of the inner member, preferably in the rear wall 25 thereof. Threaded nipples 26 at the openings 23 and 24 accommodate the ends of conduits 13 and 14 and provide for a fluid-tight connection between the conduits and the inner member. The interior of the inner member may be provided with suitable baffles or partitions (not shown) to increase the path of travel of, and contact with the heating fluid.

The central portion of the forward wall 27 bulges outwardly and merges into an outwardly projecting boss 28, which formation aids in directing air, flowing toward the center along the forward wall, axially outwardly through the air outlet opening 17. The rear wall 25 of the inner member may be dished inwardly as shown, for purposes of enlarging the air intake space, and providing increased space for the impeller 20.

Referring now to Figs. 6 and 7 as well as to Fig. 1, the inner member is provided with a series of heat radiating fins designated 30 which are joined edgewise to the outer surface of the inner member. The fins 30 extend with radial trend from the center to the periphery of the forward wall 27 (Fig. 7), thence over the circumferential wall and inwardly toward the center along the rear wall 25 of the inner member. The fins do not extend completely to the center of the rear wall 25 but terminate at points spaced from the center, thus providing a space to accommodate the rotary impeller 20, as best appears from Fig. 6. Auxiliary fins 30*a* are disposed in the spaces or air passages formed between fins 30 and serve to subdivide such passages where the same become enlarged near the periphery of the inner member.

The heat radiating fins thus described may extend rectilineally and with true radial trend from the center to the peripheral margins of the inner member. It is my preference, however, to have the fins extend with spiral trend from the center to the peripheral edge on one side wall of the inner member, the spiral trend of the fins continuing in the same direction on the opposite side of the inner member. This will be clearly understood by referring to Fig. 7, wherein dotted lines indicate the trend of a plurality of fins on the side of the member 12 opposite to that which is shown.

The purpose and advantages of the preferred fin arrangement is twofold. The length of the air passages from the inlet to the outlet openings is increased, thus allowing the air flowing through the individual passages to absorb more heat from the surrounding surfaces. Also, since the rotary impeller imparts a circular as well as centrifugal movement to the air entering the passages, by having the course of the passages conform to the general trend or direction of air flow, impedance to such flow is minimized. This advantage is reflected in the size of the impeller motor required to circulate a desired amount of air through the heater.

The casing or jacket member 15 conforms in shape with that of the inner member 12, and accordingly may be described as substantially discoidal. For ease of manufacture and assembly, the jacket 15 is preferably formed of a pair of complemental sections, joined together along circumferential edges as appears in Fig. 1. One of such sections is provided with an offset annular flange or lip 31 which fits over the peripheral margin of the mating section, producing a substantially airtight joint. The sections are mounted over the fins 30 and 30*a* and supported by the fins in spaced relation to the inner member 12. A pair or more of screws 32 (Fig. 3) serve to maintain the sections in assembled relation, yet permit the same to be readily disassembled for purposes of cleaning.

Located centrally, or axially in the rear and front walls 18 and 19 of the jacket 15 are the air inlet and outlet openings 16 and 17, respectively, previously mentioned. The inlet opening 16 is preferably circular and of such size that the marginal portions of the rear wall 18 which surround the opening extend toward the center beyond the ends of the fins, and completely shield the impeller blades 33, to be hereinafter described.

Extending rearwardly from wall 18 at the edge of the inlet opening is a pair of bracket arms 34 by which the impeller motor 21 is supported. The arms 34 terminate in a circular band 35 which embraces the motor 21, a shoulder 36 on the motor serving to fix the axial position of the motor.

The jacket wall 18 is also provided with apertures to accommodate the inlet and outlet water conduits 13 and 14, nuts 37 on the conduits engaging the wall 18 and serving fixedly to secure the inner member 12 to the jacket. The heater assembly may be conveniently mounted on the dashboard 38, or on any other suitable support, by means of the conduits 13 and 14, and clamping nuts 39 threaded thereon.

The air impeller designated generally at 20 comprises a disc 40 which may be dished to conform to the shape of the central part of wall 25. A hub portion 41 on the disc 40 receives the motor shaft, and is secured thereto by means of a set screw. The impeller blades 33 project from one side of the disc and are disposed substantially at right angles thereto. Further, the blades are preferably positioned angularly with respect to the radii of the disc so that they tend to sweep the air into the mouths of the passages formed between the fins.

It will now appear that rotation of the impeller in the direction indicated by the arrow in Fig. 6 causes air to be drawn into the jacket through opening 16, then impelled with rotary as well as centrifugal movement into the air passages. The mouths of the passages, being directed toward the reaction surfaces of the impeller blades and being of the same trend as that with which the air leaves the blades, receive the air with minimum turbulence.

The control and deflecting means located adjacent the outlet opening 17 comprises the concavo-convex plate 22 having an axial, tubular extension 43 which receives, and frictionally embraces the tubular arm 44. The inner end of arm 44 is mounted on the boss 28 in such manner as to be adjustable angularly with respect to the heater axis, in all planes defined by the axis of the heater. For this purpose the boss 28 has a spherical surface upon which is seated the flared end portion 45 of arm 44, such end portion being shaped to conform to the boss. A conical

recess 46 in the boss receives one end of a spring 47, which spring-end is secured to the boss at the pivotal center of arm 44. The spring extends longitudinally within the arm and is secured near the outer end thereof as by means of a pin 48. By means of spring 47, the arm 44 is held in any set position. The outer end of the arm 44 is suitably flared for purposes of preventing complete removal of the plate therefrom.

It will now appear that inasmuch as the control plate 22 may be adjusted along arm 44, which is of itself angularly adjustable, the plate may be positioned to control and deflect the heated air issuing from the outlet opening upwardly, downwardly or laterally. The control plate 22 may be adjusted to close completely the opening 17 by moving the plate into engagement with the annular lip 49 which skirts the opening.

I now describe my preferred means for manually and automatically controlling the operation of the impeller motor, the automatic control serving to correlate motor operation with such temperature conditions of the heating fluid and the air to be heated as make the same expedient. The electrical control means include a pair of thermally responsive switches which are connected in series circuit relation with each other and with the impeller motor. One of such switches is constructed and arranged to be operatively influenced by the temperature of the fluid in the outlet conduit 14. When the fluid, after having passed through the inner member 12, has attained the desired, predetermined temperature, this switch automatically closes. The switch is adjusted so that it will close when there is sufficient heat in the fluid to affect materially the temperature of the air passing through the heater. When the temperature of the fluid drops below the point corresponding to this heat value, the switch automatically opens. Obviously, under normal conditions of use it would be an inexpedient waste of electrical energy to have the impeller motor operate when the device cannot function as a heater because of insufficient heat in the heating fluid.

The other switch is constructed and arranged so as to be influenced by the temperature of the air after the same has circulated through the space to be heated, the automatically operable switch arm of this switch being situated in the air path near the intake opening 16. When the temperature of the air reaches a desired predetermined point, this switch, previously in closed condition, automatically opens the circuit to suspend motor operation until the switch recloses the circuit as a consequence of a drop in air temperature. Motor operation depends, of course, also upon the open or closed condition of the first mentioned switch. Means are provided for manually presetting the second switch to open and close at any desired air temperature to maintain, automatically, comfortable conditions within the space to be heated. By such means the circuit may also be interrupted manually to render the impeller motor inoperative irrespective of temperature conditions.

Referring to Fig. 1, the switching assembly is mounted in a suitable housing 50 which is preferably formed of fibre, moulded plastic or other material having good electrical and thermal insulating properties. The switch, first mentioned above, comprises a bimetallic strip 51 which is secured at one end to an insulating base 52 and extends therefrom along, spaced from, but in close proximity to conduit 14. The strip, or switch arm 51 becomes warped when heated by the water in conduit 14 and when the proper temperature is reached it contacts switch arm 53, comprising one arm of a substantially U-shaped, resilient metal strip. The other arm of such strip provides the manually adjustable switch arm 54 of the second switch and cooperates with the bi-metallic switch arm 55. The arm 55 has its major part situated exteriorly of the housing 50 and in the path of the air near the intake opening of the heater. Accordingly, this thermal-responsive arm 55 is adapted to be influenced by the temperature of the air flowing into the heater. The housing 50 and fins 56 thereon shield the arm 55 from heat emanating from pipe 14, and consequently heat directly therefrom does not materially influence the operation of the switch 55.

Under normal operating conditions the forward end 57 of arm 55 contacts arm 54 and tends to move downwardly away from arm 54 with rising temperatures. A cam 58 having a spiral camming surface operatively engages arm 54 to raise and lower the same, the arm, due to its inherent resilience, maintaining itself in engagement with the cam. Cam 58, preferably of insulating material, is mounted on one end of a shaft 59 which is supported by a bearing arm 60 and projects through the forward wall 61 of the housing 50. A manipulating knob 62 is secured to the forward end of the shaft and is suitably marked to indicate the position at which it may be pre-set to cause interruption of the impeller circuit when the temperature in the space to be heated has attained the selected, pre-set degree. By way of example, assume that the knob 62 has been set to place the 80 degree mark in registration with a suitable mark such as an arrow on the front face of wall 61. This setting causes arm 57 to be displaced by cam 58 into its lowermost position (see Fig. 4). The bi-metallic arm 55 is also forced downwardly which produces an initial stress in the same. Electrical contact between arms 54 and 55 will not be broken until the temperature of arm 55 is raised sufficiently, first, to set up warping stresses which equal the said initial stress, and thereafter (at 80 degrees) to move the arm out of contact with arm 54. When the manipulating knob is set at 70 degrees, the initial stress produced in arm 55, and hence the temperature at which such initial stress is equalized before breaking contact with arm 54, is proportionately less than the condition existing by reason of the 80 degree setting.

The manipulating knob may also be set in an "off" position (Fig. 5) whereby arm 54 is allowed to move to a position upwardly beyond the uppermost limit of travel of the contact surface of arm 55, which contact surface is prevented from following arm 54 by means of a stop member 63. Thus the circuit may be broken to stop motor operation regardless of the temperature conditions of the heating fluid and air.

Considering the operation of the heater when installed in an automobile, and with the control knob 62 set, say at 70 degrees, when the driver stops the engine, the impeller motor will normally continue operating until the temperature of the fluid in conduit 14 drops sufficiently to cause interruption of the impeller motor circuit at switch arms 51 and 53. Thus, if the driver does not desire, or forgets to turn off the impeller motor immediately with the engine, the motor is turned off automatically shortly after engine operation ceases. The driver may, however, stop the impeller motor when he turns off his engine

by moving the manipulating knob 62 to "off" position.

The modified heater illustrated in Fig. 9 is similar in general construction and operation to the heater previously described, but distinguishes from the described heater in that it is designed to utilize efficiently a larger amount of heating fluid, and to provide increased heat radiating surfaces. In short, the heater of Fig. 9 is more suitable where the space to be heated is great.

Thus, the inner fluid-receiving member previously described as discoidal has a hollow annular projection 64 which increases the fluid capacity of the member. Inlet and outlet fluid conduits 13 and 14 are connected to the projecting portion 64 in diametrally opposite relation at the rear extremity thereof. The jacketing member likewise is provided with a portion 65 which encloses the projecting portion 64 of the inner member. Heat radiating fins 66 extend between the projecting portions of the members, as best appears in Fig. 10. The air and fluid paths through the heater are indicated by arrows in Fig. 9.

Having described my invention with reference to two practical, simple and economical embodiments thereof, it should be understood that various changes may be made in the construction and arrangement of parts herein shown and described without departing from the spirit and full intended scope of my invention as the same is fairly construed by the appended claims.

I claim:

1. A heater comprising a hollow, substantially discoidal member having fluid inlet and outlet openings and a series of outwardly projecting fins of substantially radial trend thereon, a jacket member mounted over said fins and with the discoidal member forming an air passage, and air inlet and outlet openings in said jacketing member.

2. A heater comprising a hollow discoidal member having fluid inlet and outlet openings, a series of fins projecting outwardly from opposite sides of said member and extending with a substantially spiral trend, from the center to the periphery thereof, a jacket member mounted over said fins, and air inlet and outlet openings in said jacket member located centrally with respect to said discoidal member.

3. A heater comprising a hollow, substantially discoidal member having water inlet and outlet openings, said member having an outwardly projecting air deflecting portion located centrally at one side thereof, a jacket having walls spaced from said member to provide an air passage around the same, said jacket having an air outlet opening facing said air deflecting portion of the member and an air inlet opening having air propelling means adjacent thereto.

4. A heater comprising a hollow, substantially discoidal jacket member having air inlet and air outlet openings located centrally in relatively opposite sides thereof, a hollow, substantially discoidal water chamber having inlet and outlet openings spaced within and coaxial of said jacket member, the space between said members constituting a passage interconnecting the air inlet and outlet openings, and a plurality of fins for directing air in a substantially helical course through said passage.

5. A heater comprising a hollow, substantially discoidal member having water inlet and outlet openings, one side of said member having an outward bulge at the center thereof, a jacket enclosing said member having wall portions spaced from the walls of said member, the space between the walls of said member and jacket constituting an air passage, an air inlet opening in said jacket, and an air outlet opening in said jacket adjacent the bulge on said member.

6. A heater comprising a pair of hollow, substantially discoidal members, one thereof being spaced centrally within the other and constituting a water chamber, the space between said members constituting a passage for air to be heated, inlet and outlet openings in the inner member located diametrally in one side thereof, inlet and outlet openings for air located axially in relatively opposite sides of the outer member, and a series of fins in the air passage for dividing the air passing therethrough into a multiplicity of individual streams.

7. A heater comprising a fluid-receiving heating element, a casing member disposed about said element and spaced therefrom to provide an air passage between the element and casing, air inlet and outlet openings in said casing, means adjacent said inlet opening for impelling air through said passage, and air-controlling and deflecting means adjacent said outlet comprising an arm projecting axially through the outlet opening and adjustably secured at its inner end to the heating element, and a deflecting plate mounted on said arm and adjustable therealong.

8. A heater comprising a hollow, substantially discoidal member having water inlet and outlet openings, said member bulging outwardly at the center of one side thereof, a jacket having walls spaced from the walls of said member to provide an air passage therebetween, air inlet and outlet openings in said jacket located axially with respect to said discoidal member, and a series of fins in the air passage for dividing the air passing therethrough into a multiplicity of individual streams.

9. A heater comprising a pair of hollow, substantially discoidal members, one thereof being spaced within the other and constituting a water chamber, the space between the members constituting a passage for air to be heated, said inner member having diametrally located water inlet and outlet openings, one side of said inner member bulging outwardly at the center thereof; inlet and outlet openings for air located axially in opposite sides of the outer member, and a series of outwardly projecting fins formed on the inner member for dividing air passing between the members into a multiplicity of individual streams.

10. A heater comprising a pair of hollow, substantially discoidal members, one thereof being spaced within the other and constituting a water chamber, inlet and outlet openings in the inner member, inlet and outlet openings for air located axially, in relatively opposite sides of the outer member, a series of fins dividing the space between said members into a multiplicity of air passages, and an air impeller adapted to force air centrifugally into said air passages, disposed within the outer member.

11. A heater comprising a pair of hollow, substantially discoidal members, one thereof being spaced internally of the other and constituting a water chamber, inlet and outlet openings in the inner member, inlet and outlet openings for air located axially in relatively opposite sides of the outer member, a series of fins of radial trend projecting outwardly from opposite sides of the inner member, said fins dividing the space between said members into a plurality of

air passages, and means for forcing air through said passages including a rotary impeller disposed within the outer member adjacent the air inlet opening.

12. In a heater including a jacket member having an air outlet opening, means for controlling the air at said outlet opening, said means including a shaft projecting outwardly through said opening and mounted at its inner end, for adjustable rocking movement, and a plate mounted for adjustable sliding movement along said shaft.

13. In a heater including a pair of hollow, substantially discoidal members, one thereof being spaced internally of the other and constituting a water chamber, inlet and outlet openings for air located axially in relatively opposite sides of the outer member, an air impeller adjacent the inlet opening and air controlling means adjacent the outlet opening, said means comprising an arm mounted for pivotal adjustment on the inner member and projecting outwardly through the air outlet opening, and a deflecting and closure plate mounted on said arm for adjustment therealong.

14. In a fluid-heated air-heater, a hollow-walled, substantially cup-shaped member adapted to receive heating fluid in the wall space thereof, fluid inlet and outlet conduits communicating with the wall space, a jacket member spaced about the fluid-receiving member, said jacket member being of shape conforming to that of the fluid-receiving member and having air inlet and outlet openings located axially in opposite walls thereof, and an air impeller disposed adjacent the air inlet opening.

15. An automobile heater of fluid-heated circulating air type, comprising an inner, substantially cup-shaped member having hollow walls adapted to receive the heating fluid therein, fluid inlet and outlet conduits connected at diametrally opposite points to the rim of said inner member, said inner member having a series of heat radiating fins on the outer surface thereof; a jacket member of shape conforming to that of the inner member, mounted over said fins, said jacket member having air inlet and outlet openings located axially in opposite walls thereof, an air impeller disposed within the jacket member adjacent the air inlet opening, and adjustable air deflecting means disposed adjacent the air outlet opening.

CHESTER R. PIEPER.