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Hagerty

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[54] **METHOD AND APPARATUS FOR HEATING FLUID**

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[52] **U.S. Cl.** **219/10.49**, 219/10.51, 219/10.79

[51] **Int. Cl.** **H05b 5/08**

[58] **Field of Search** 219/10.49, 10.51, 10.79

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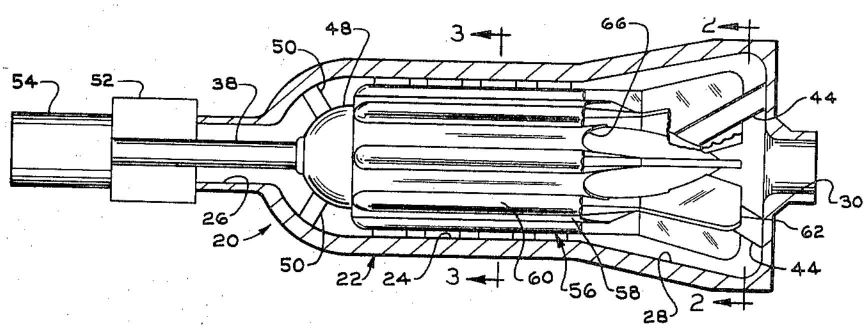
[57] **ABSTRACT**

A first plurality or group of magnets is mounted in a housing in a pattern having a circular cross section. A second plurality or group of magnets is mounted in spaced relationship with respect to the first group and means are provided for moving one of the groups of magnets relative to the other. A conductive member is located in the space between the two groups of magnets, in the magnetic field therebetween. Rotation of the one group and variation in the flux causes the conductive member to become heated. A fluid is then directed past the member, in heat-transfer relationship with respect thereto, to cause the fluid to be heated and useable as a working fluid.

18 Claims, 11 Drawing Figures



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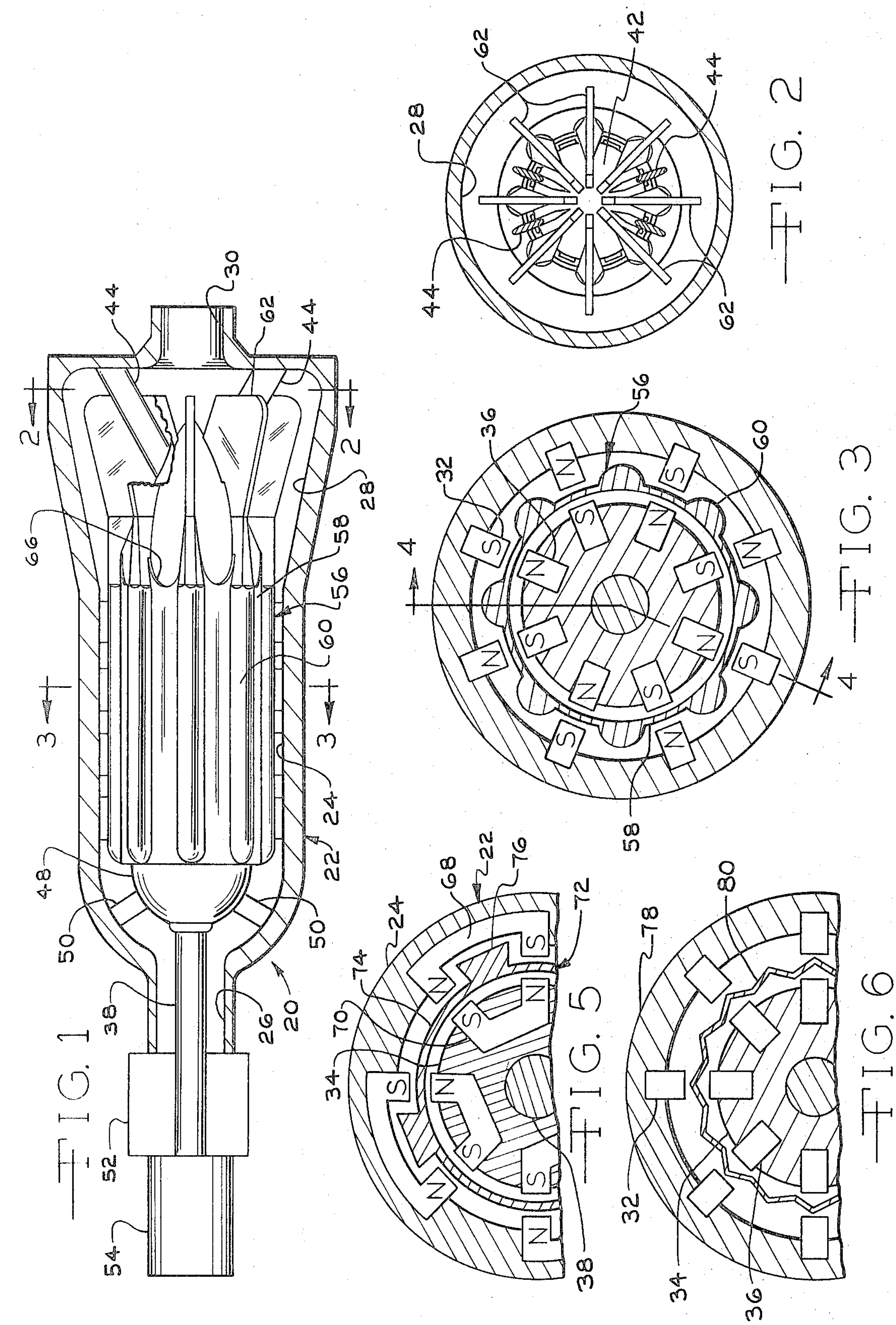

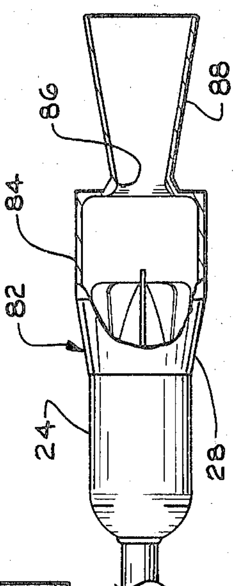

FIG. 7

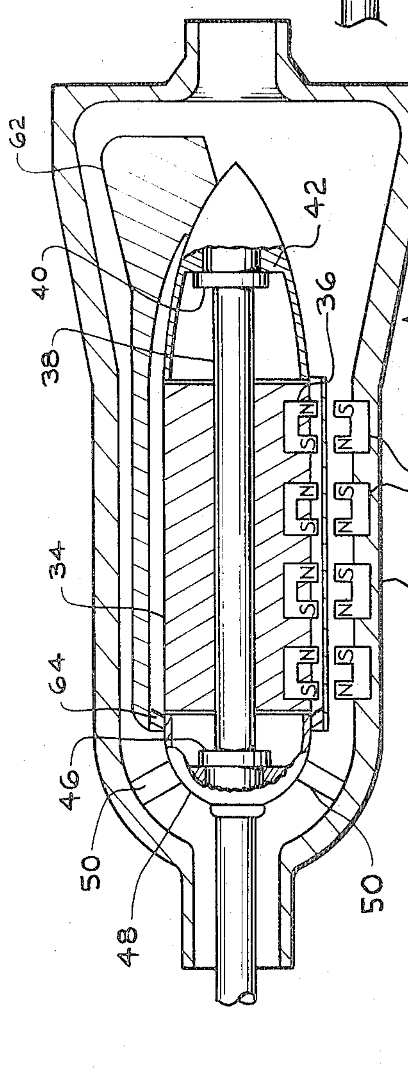

FIG. 4

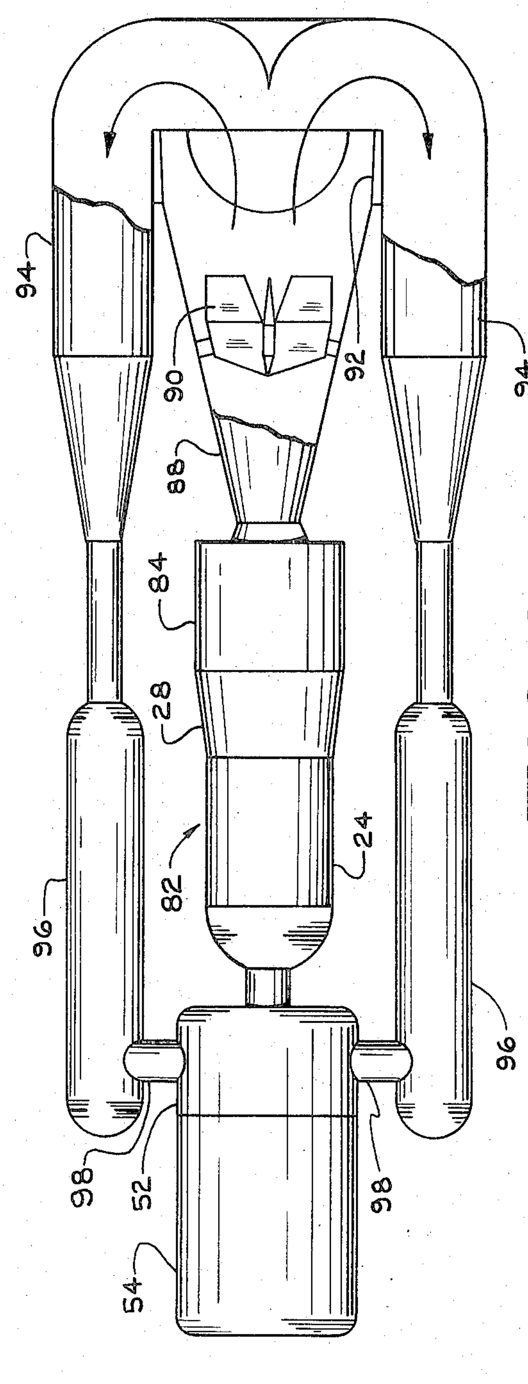

FIG. 8

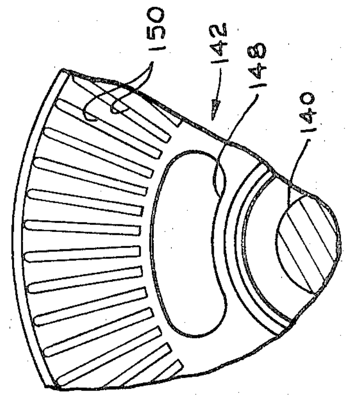

FIG. 10

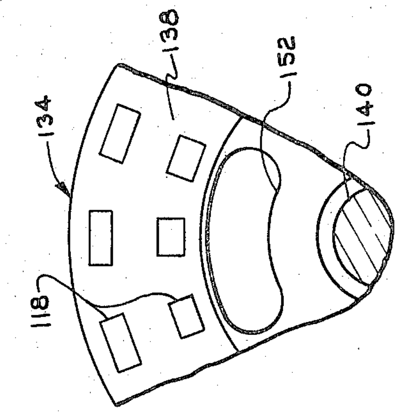

FIG. 11

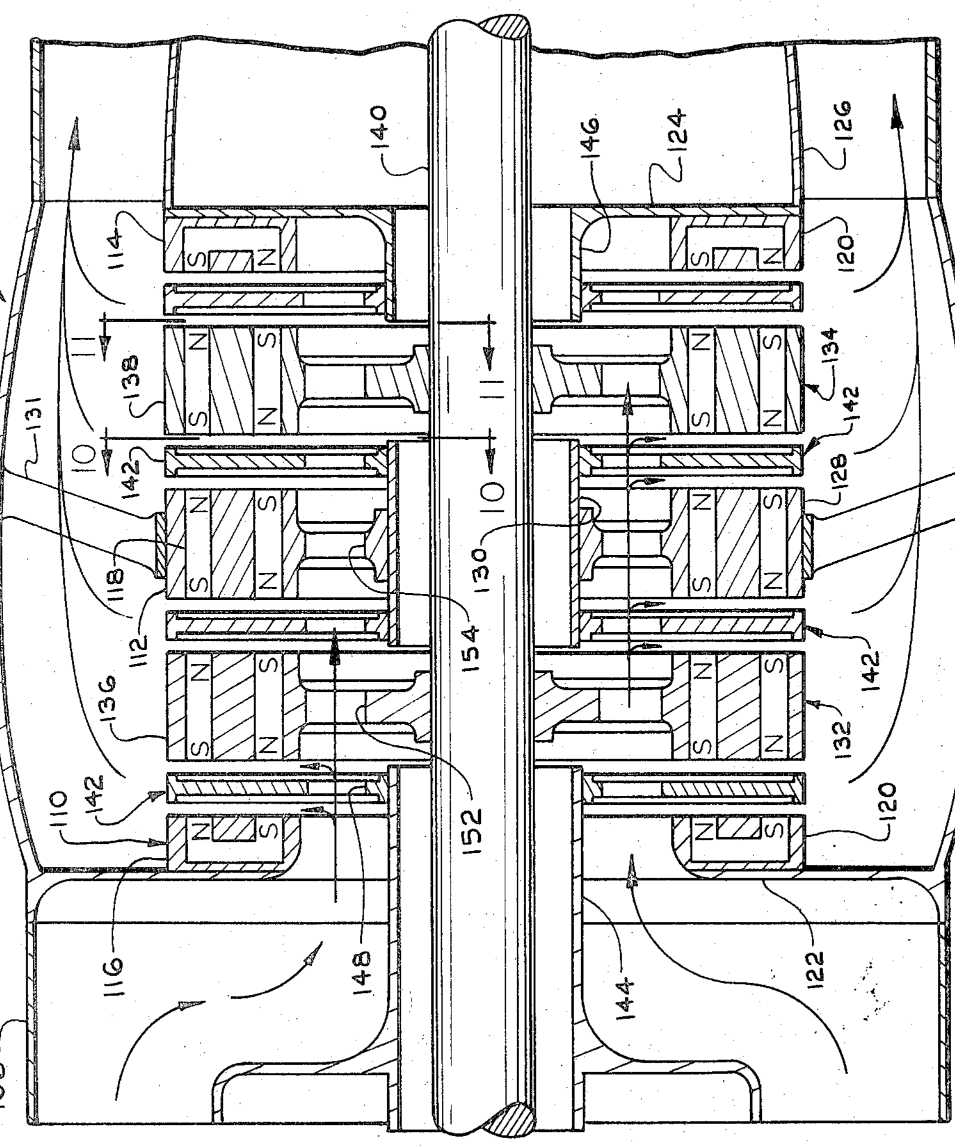

FIG. 9

METHOD AND APPARATUS FOR HEATING FLUID

This invention relates to a method and apparatus for converting the forces of magnetism into heat.

The subject matter is disclosed in Disclosure Document No. 016625.

In accordance with the invention, a first plurality of magnets are disposed in a circular pattern, as viewed in transverse cross section. A second plurality of magnets are maintained in spaced relationship with respect to the first plurality. A conductive member is positioned in the space between the two groups of magnets. At least one of the groups of magnets is rotated to establish a variable flux therebetween by the alternate attraction and repulsion, or variation in the strength of the retraction or repulsion, of the magnets. This induces heating in the conductive member. A fluid such as air is moved past the heated member, in heat-transfer relationship with respect thereto, to become heated and ready to impart energy as it exits as a heated working fluid.

It is, therefore, a principal object of the invention to provide an improved method and apparatus for heating a fluid with the aid of a magnetic field.

Many other objects and advantages of the invention will be apparent from the following detailed description of preferred embodiments thereof, reference being made to the accompanying drawings, in which:

FIG. 1 is a somewhat schematic view in longitudinal cross section, with parts broken away, of apparatus according to the invention;

FIG. 2 is a view in transverse cross section, taken along the line 2—2 of FIG. 1;

FIG. 3 is a view in transverse cross section taken along the line 3—3 of FIG. 1;

FIG. 4 is a view in longitudinal cross section, taken along the line 4—4 of FIG. 3;

FIG. 5 is a fragmentary, transverse sectional view of modified apparatus;

FIG. 6 is a view similar to FIG. 5 of further modified apparatus;

FIG. 7 is a schematic view, with parts broken away and with parts in section, of the apparatus of FIGS. 1–4 embodied in a reaction engine;

FIG. 8 is a schematic, enlarged view in elevation, with parts broken away, of the apparatus of FIG. 7 embodied in a closed system;

FIG. 9 is an enlarged, fragmentary view in longitudinal cross section of modified apparatus embodying the invention;

FIG. 10 is a fragmentary view in elevation taken along the line 10—10 of FIG. 9; and

FIG. 11 is a fragmentary view in elevation taken along the line 11—11 of FIG. 9.

Referring to the drawings and particularly to FIGS. 1–4, apparatus for heating a fluid is indicated at 20 and includes a main housing 22. The housing 22 has a central cylindrical portion 24, a fluid inlet 26, a flared rear portion 28, and a fluid outlet 30. A first plurality or group of U-shaped magnets 32 are mounted in the cylindrical portion 24 of the housing 22, with the legs or ends of the magnets extending substantially radially inwardly and with the magnets being disposed in a configuration which is circular in transverse cross section.

A rotor 34 is centrally located within the housing 22 and also has a plurality of magnets 36 mounted therein with the legs or ends extending radially outwardly and forming a circular pattern in transverse cross section. While the magnets are shown as being of the permanent type, the electromagnets can also be employed.

The housing 22, at least the cylindrical portion 24 carrying the magnets 32, and the rotor 34 are made of a heat resistant material which will not have a deleterious effect on the flux of the magnets. A beryllium-copper alloy can be used for this purpose. If necessary, the magnets 32 and 36 can be provided with sheaths therearound of a silver-copper alloy, comprising one part of copper to nine parts of silver, to direct the flux more effectively outwardly toward the other magnets. The ends of the magnets, however, do not have such sheaths. The rotor 34 and the cylindrical housing portion 24 can also be made of heat-resistant plastic material, such as a commercially-available silicone designated RTV 615 which resists heat at temperatures exceeding 4,000° F. With a plastic material, the magnets can be completely embedded therein to provide additional heat protection for the magnets, since the magnetic flux will not be impeded or absorbed by the plastic material. A combination of metallic and plastic materials can also be employed.

The rotor 34 is supported on a shaft 38 extending therethrough. The shaft 38 is rotatably carried by a bearing 40 at its rearward or downstream end, with the bearing mounted in a stationary support or cowl 42. The cowl 42, in turn, is supported in the housing 22 by struts 44 (FIGS. 1 and 2). At the forward or upstream end, the shaft 38 is rotatably carried by a bearing 46 through which the shaft extends. The bearing 46 is mounted in a cowl or shield 48 which is also supported by the housing 22 through struts 50. The rotor 34, the rear cowl 42, and the front cowl 48 provide a smooth teardrop configuration to minimize resistance to fluid flowing through the housing 22.

The shaft 38 extends forwardly through the inlet 26 of the housing 22 and through a high-speed rotary compressor 52 (FIG. 1) which supplies fluid under pressure through the inlet 26. A drive motor 54 or other suitable power source rotates the shaft 38 to drive the compressor 52 and to rotate the rotor 34.

A heating element 56 is positioned in the space between the first plurality or group of the magnets 32 and the second plurality or group of the magnets 36. The heating element 56 includes a generally cylindrical portion 58 with heavier ribs 60 extending outwardly therefrom between the outer stationary magnets 32. The ribs 60 terminate at their downstream ends in dispersion fins 62 which further aid in transferring heat to the working fluid. As best shown in FIG. 4, the fins 62 are mounted on the rear cowl 42 to support the rear portion of the heating element 56. The forward portion of the element 56 has short struts 64 mounted on the front cowl 48 to support the front portion of the element 56. The forward portion of the element 56 is open except for the struts 64, while the rear portion has outlets 66 (FIG. 1) between the fins 62 to enable fluid to pass between the element 56 and the rotor 34, as well as between the element 56 and the cylindrical portion 24 of the housing 22.

The magnets 32 and 36 can be positioned according to FIGS. 3 and 4, with the north poles N and the south poles S being oriented as shown. With this arrangement, when the rotor 34 is in the position shown in FIG. 3, opposite or unlike magnetic poles are in alignment. When the rotor moves to the position that the next poles are in alignment, these are the same or like poles.

Hence, with this arrangement of the magnets, the flux varies from a maximum attraction force to a maximum repulsion force to produce a rapidly alternating flux which cuts back and forth across the heating element **56.** The flux is of an intermediate strength when the magnetic poles of the magnets **36** are between the poles of the magnets **32.**

The magnets can also be arranged with like poles always being directly opposite when the poles are aligned. This can be accomplished by reversing the poles of all of the magnets **32** or the poles of all of the magnets **36,** or by placing all the magnets **32** and **36** with the north poles, for example, toward the inlet end of the housing **22.** In this instance, there is no attraction force but only pulsating repulsion forces which vary from a minimum when the magnets **36** are between the magnets **32** to a maximum when they are directly opposite. Similarly, the magnets can be arranged with unlike poles always being directly opposite when the poles are aligned. Accordingly, the magnets **32** can be positioned with their north poles toward the inlet end of the housing, for example, and the magnets **36** can be positioned with their south poles toward the exhaust end of the housing. In this instance, only pulsating attraction forces exist, with these varying from a minimum with the poles of the magnets **36** between the poles of the magnets **32** to a maximum when the poles are directly opposite.

The magnets can be placed transversely of the housing **22** rather than longitudinally, if desired. An arrangement of this type is shown in FIG. **5** where outer magnets **68** are positioned transversely in the cylindrical portion **24** of the housing **22** and inner magnets **70** are similarly positioned transversely in the rotor **34.** In this instance, a slightly modified heating element **72** has a generally cylindrical portion **74** and heavier ribs **76** which are generally of a wedge shape in transverse cross section rather than semi-cylindrical, as is true of the ribs **60.**

In addition to rotating the rotor **34,** it is also possible to rotate the housing in the opposite direction to increase the frequency of pulsations or alternations in the flux field. Referring to FIG. **6,** a modified outer housing **78** is rotatably supported, as by bearings at inlet and outlet end portions thereof, and is also suitably driven in a direction opposite that of the rotor **34.** A modified heating element **80** is generally cylindrical and specifically of an angular, corrugated shape which is less massive than the heating elements **56** and **72.** However, the element **80** provides a sizable surface area for heat transfer and is less expensive to fabricate. The shape of this element also causes variations in space and distance from one magnet field to the opposite one to provide further variations in the flux.

Rather than using the heated fluid to perform work in some other device or location, the apparatus can have a high velocity reaction nozzle to serve as a reaction engine. Referring to FIG. **7,** a modified housing **82** includes the cylindrical portion **24** and the flared portion **28** but has an extension chamber **84** therebehind to provide space in which the high temperature working fluid can accummulate and dwell before partially exhausting through a Vena Contracta **86** of a high velocity nozzle **88.** This provides the necessary velocity for propulsion of the overall apparatus.

Referring to FIG. **8,** the reaction engine of FIG. **7** is mounted in a closed system in an environment where air is not present in sufficient quantities or where a different working fluid such as an inert gas, is employed. In this instance, the nozzle **88** has four vanes **90** therein located at mutually perpendicular angles which direct the fluid through an outlet opening **92** to return ducts **94.** The vanes **90** can stabilize or change the flight direction of a vehicle in which the system is installed. The return ducts **94** direct the fluid to displacement tanks **96** which communicate with the rotary compressor **52.** The compressor **52** receives the fluid through inlets **98,** recompresses it, and again delivers it to the housing **82** to receive additional heat from the element **56.** The displacement tanks **96** provide space for negative pressure into which the nozzle **88** can exhaust, to maintain mozzle efficiency.

Referring particularly to FIGS. **9–11,** modified apparatus for transferring heat to a fluid is indicated at **100.** The apparatus includes a housing **102** having an enlarged, generally cylindrical, intermediate section **104,** an annular fluid inlet **106,** and an annular fluid exhaust **108.** The apparatus **100** has three stationary groups or pluralities **110, 112, 114** of magnets, including U-shaped magnets **116** for the groups **110** and **114** and bar magnets **118** for the central stationary group **112.** The magnets **116** are mounted in annular supporting members **120** with the forward member mounted on an inwardly-extending flange **122** near the fluid inlet **106,** and the rear member **120** mounted on a transversely-extending wall **124** of a cowl **126.** The center bar magnets **118** are mounted in an annular supporting member **128** which is located on a hub **130** and supported by struts **131** extending outwardly to the inner surface of the housing portions **104.**

Two rotatable groups or pluralities **132** and **134** of the bar magnets **118** are also mounted in circular rotors or rotatable members **136** and **138.** The members **136** and **138** are affixed to a drive shaft **140** which can be driven by a suitable power source or drive motor similar to the motor **54.**

Heating elements **142** are located between the adjacent stationary and rotatable magnet groups, including one between the stationary group **110** and the rotatable group **132,** one between the rotatable group **132** and the stationary group **112,** one between the stationary group **112** and the rotatable group **134,** and one between the rotatable group **134** and the stationary group **114.** The outer heating elements **142** are mounted on tubular hubs **144** and **146** while the inner two heating elements **142** are mounted on the hub **130** carried by the stationary group **112.** Fluid openings **148** are provided in each of the elements **142** and the elements also preferably have slots **150** therein, as shown in FIG. **10,** to increase the surface area presented to the fluid passing through. The rotatable groups **132** and **134** also have fluid openings **152** therein and the stationary group **112** has fluid openings **154** therein. The fluid can then flow from the annular inlet **106** through the openings and past the heating elements **142** as the fluid moves outwardly toward the annular exhaust passage **108.**

The heating elements **142** are heated in a manner similar to the elements of FIGS. **1, 5,** and **6** and also transfer the heat to the fluid. The magnets can be located with opposite poles aligned or with like poles aligned to provide either an alternating or a pulsating type of flux variance. If desired, the apparatus **100** can be employed in a turbine in the section normally carrying the combustion cans to heat the fluid from the forward compressor section of the turbine in a manner similar to that achieved with the combustion cans but without the need for combustible fuels.

Various modifications of the above described embodiments of the invention will be apparent to those skilled in the art and it is to be understood that such modifications can be made without departing from the scope of the invention, if they are within the spirit and the tenor of the accompanying claims.

I claim:

1. Apparatus for heating a fluid comprising a first plurality of magnets, means holding said magnets in a predetermined pattern, a second plurality of magnets, means holding the second plurality of magnets in a predetermined pattern in spaced relationship with said first plurality, means for moving at least one of said plurality of magnets relative to the other, a stationary conductive member, means positioning said conductive member in the space between said first and said second plurality of magnets, and means for passing fluid in heat transfer relationship with both sides of said conductive member between said first and second pluralities of magnets.

2. Apparatus according to claim 1 characterized by said first and second pluralities of magnets being positioned so that like poles and unlike poles are alternately aligned as the one plurality of magnets is moved.

3. Apparatus according to claim 1 characterized by said first and second pluralities of magnets being positioned so that only like poles are aligned as the one plurality of magnets is moved.

4. Apparatus according to claim 1 characterized by said first and second pluralities of magnets being positioned so that only unlike poles are aligned as the one plurality of magnets is moved.

5. Apparatus according to claim 1 characterized by said conductive member being of a generally cylindrical shape, said moving means rotates said one plurality of magnets around an axis, and said fluid passing means directs the fluid in a direction substantially parallel to the axis of rotation.

6. Apparatus according to claim 1 characterized by said conductive member being of a generally circular shape.

7. Apparatus according to claim 1 characterized by said magnets being U-shaped permanent magnets with legs extending generally radially.

8. Apparatus according to claim 1 characterized by said magnets being permanent bar magnets extending transversely to the movement of the one plurality of magnets.

9. Apparatus according to claim 1 characterized by said first and second pluralities being disposed generally in cylindrical configuration.

10. Apparatus according to claim 1 characterized by there being at least two of the first plurality of magnets and at least two of the second plurality of magnets with at least one of the second plurality being disposed between two adjacent ones of the first plurality.

11. Apparatus for heating a fluid comprising a housing, a first plurality of magnets mounted in a pattern with a circular transverse cross section in said housing, a rotatable member with an outer circular configuration, a second plurality of magnets held by said rotatable member, means for rotating said rotatable member, a conductive member between said first and said second plurality of magnets, and means for establishing a flow of fluid past both sides of said conductive member from one end of said housing toward the other.

12. Apparatus according to claim 11 characterized by said first and second pluralities being positioned so that like poles and unlike poles are alternately aligned as the second plurality of magnets is rotated by said rotatable member.

13. Apparatus according to claim 11 characterized by said first and said second pluralities of magnets being positioned so that only like poles are aligned as the second plurality of magnets is rotated by the rotatable member.

14. Apparatus according to claim 11 characterized by said first and said second pluralities of magnets being positioned so that only unlike poles are aligned as the second plurality of magnets is rotated by the rotatable member.

15. Apparatus according to claim 11 characterized by said heat conductive member being of generally cylindrical shape, and said means for establishing the flow of fluid directs the flow generally parallel to the axis of rotation of said rotatable member.

16. Apparatus according to claim 11 characterized by said conductive member being of generally circular shape.

17. Apparatus for heating a fluid comprising a housing, a first plurality of magnets mounted in a pattern with a circular transverse cross section in said housing, a rotatable member with an outer circular configuration, a second plurality of magnets held by said rotatable member, means for rotating said rotatable member, a conductive member between said first and said second plurality of magnets, means for establishing a flow of fluid past said conductive member, said conductive member being of generally cylindrical shape and having a plurality of longitudinally-extending ribs which extend outwardly between certain ones of said first plurality of magnets.

18. Apparatus according to claim 17 characterized by said ribs terminating in dispersion fins downstream of said magnets.

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