Jan. 28, 1947. H. J. DE N. McCOLLUM 2,414,830

SELF-OPERATED INTERNAL-COMBUSTION HEATER FOR HEATING AIR

Filed Oct. 29, 1943 7 Sheets-Sheet 1

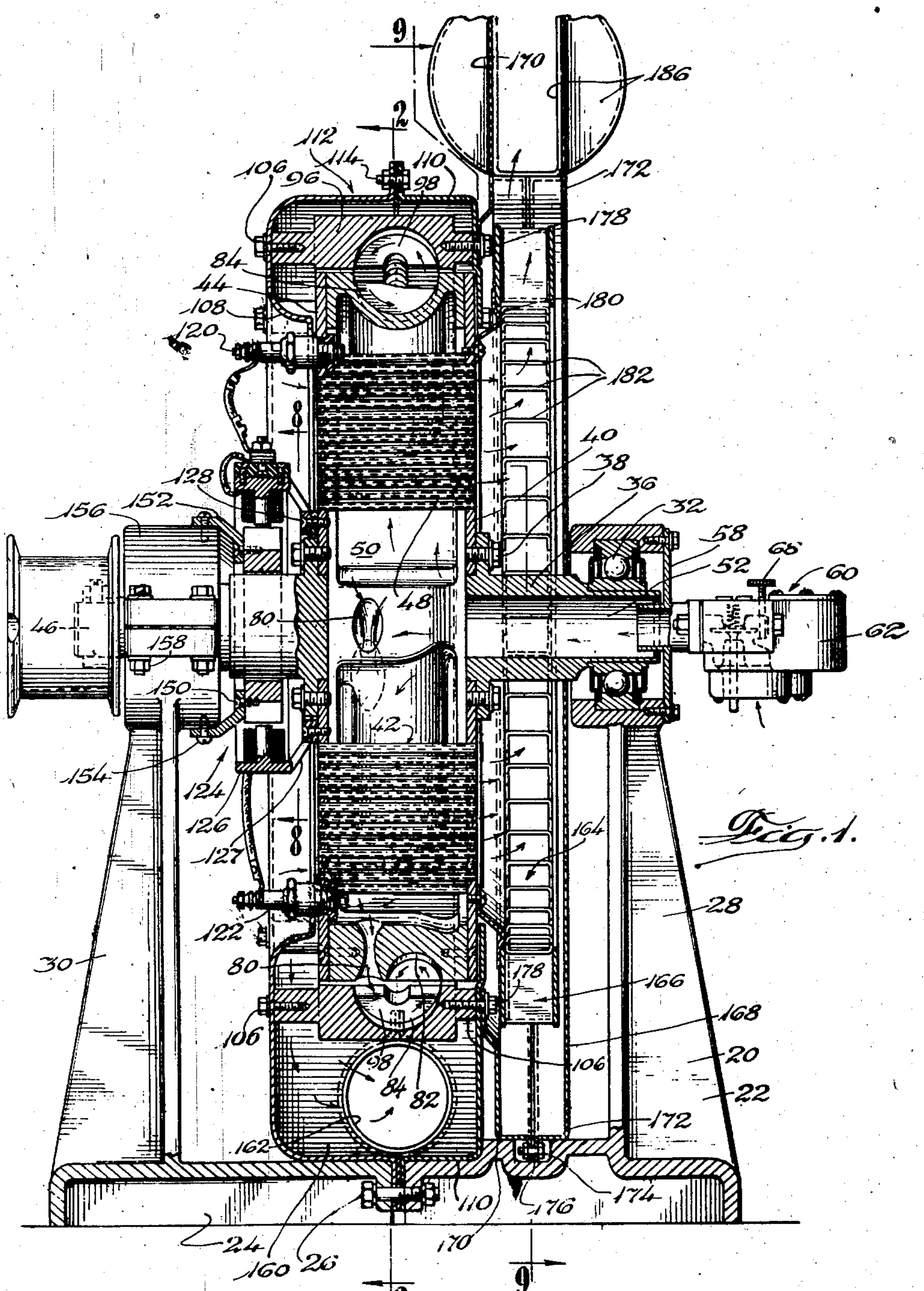

Fig. 1.

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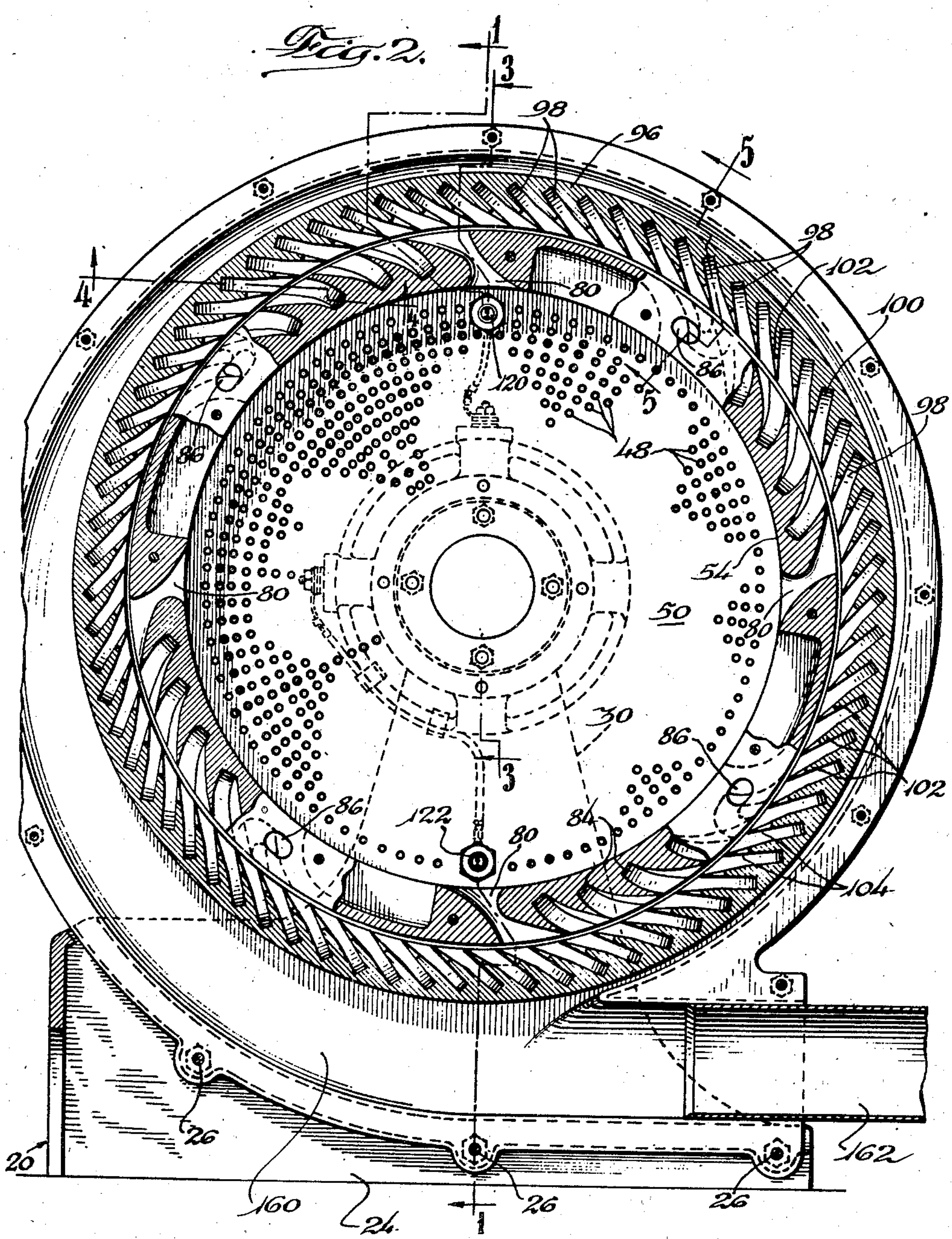
Fig. 2.



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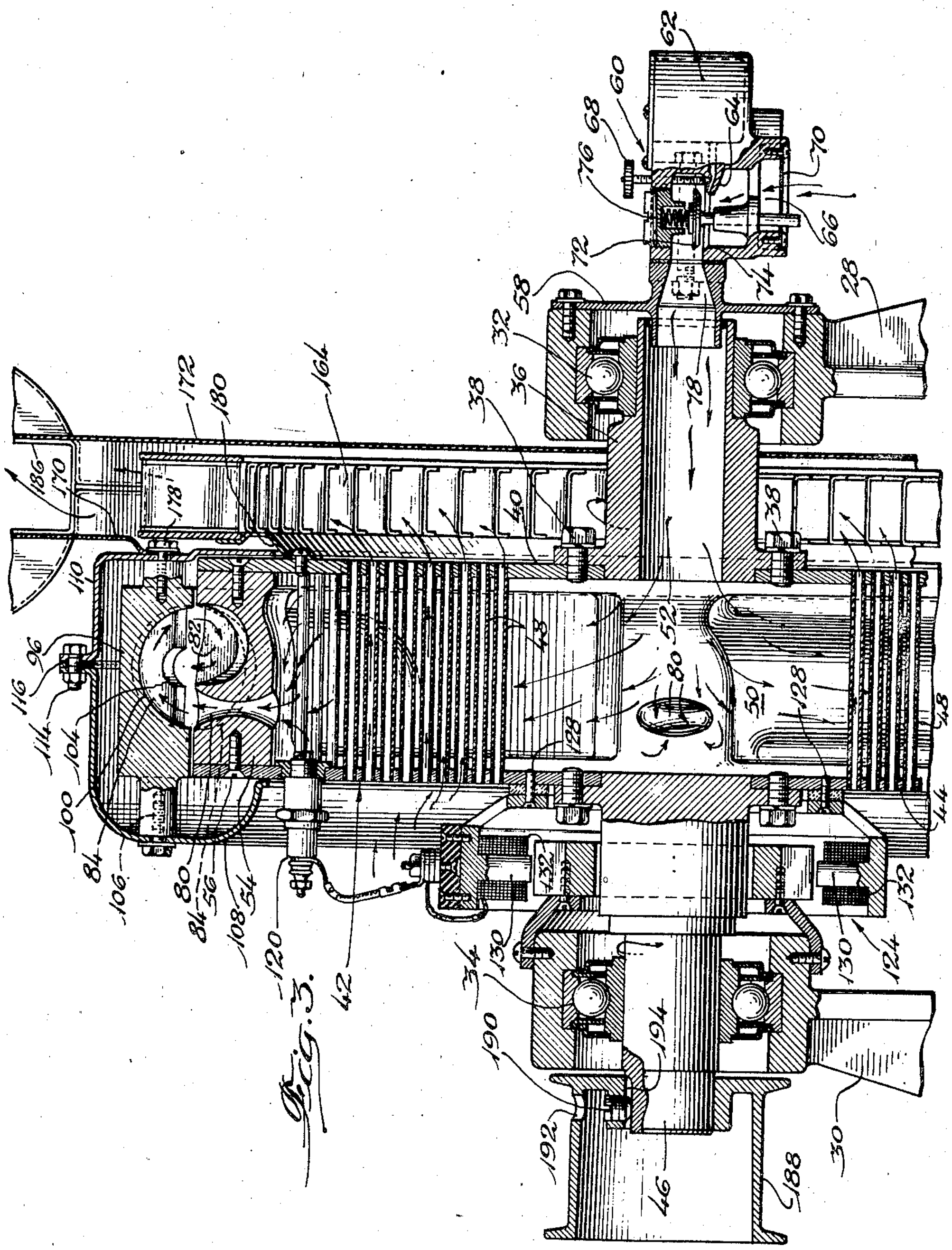

Fig. 3.

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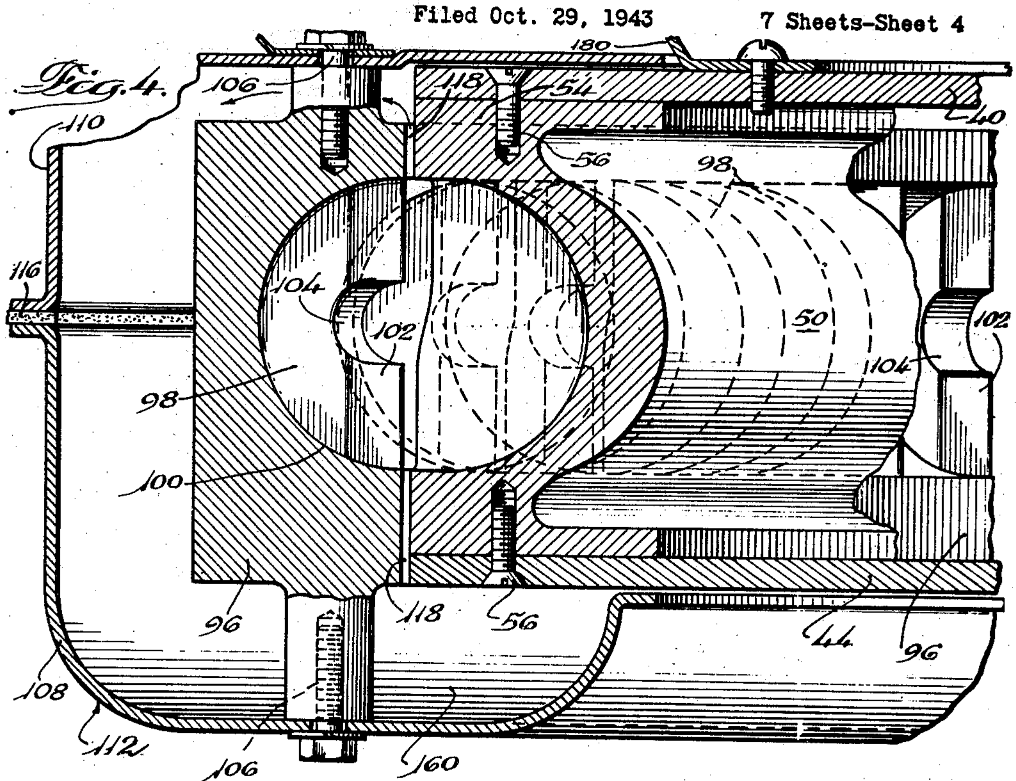
Fig. 4.



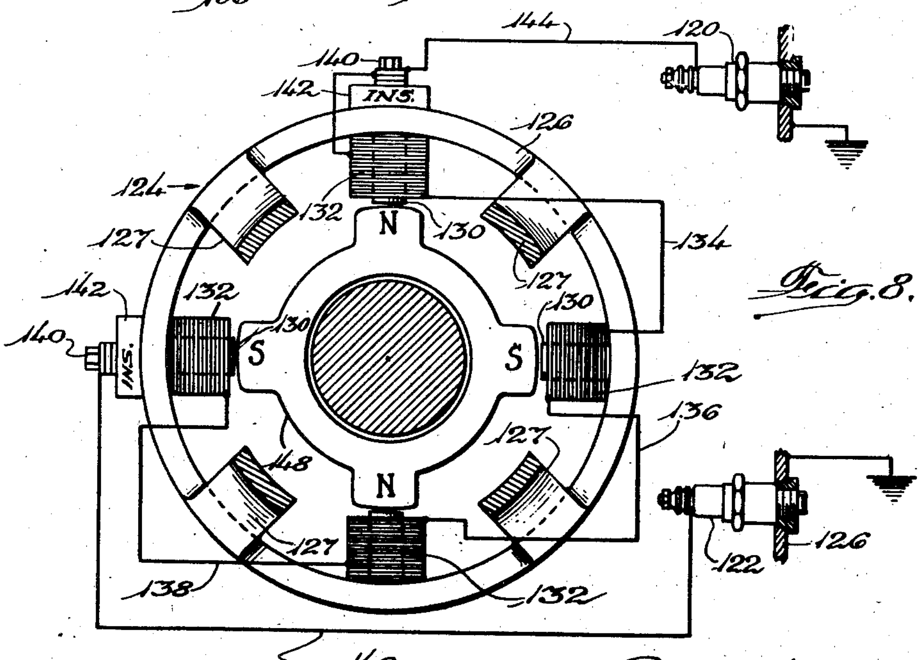


Fig. 8.

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Fig. 5.

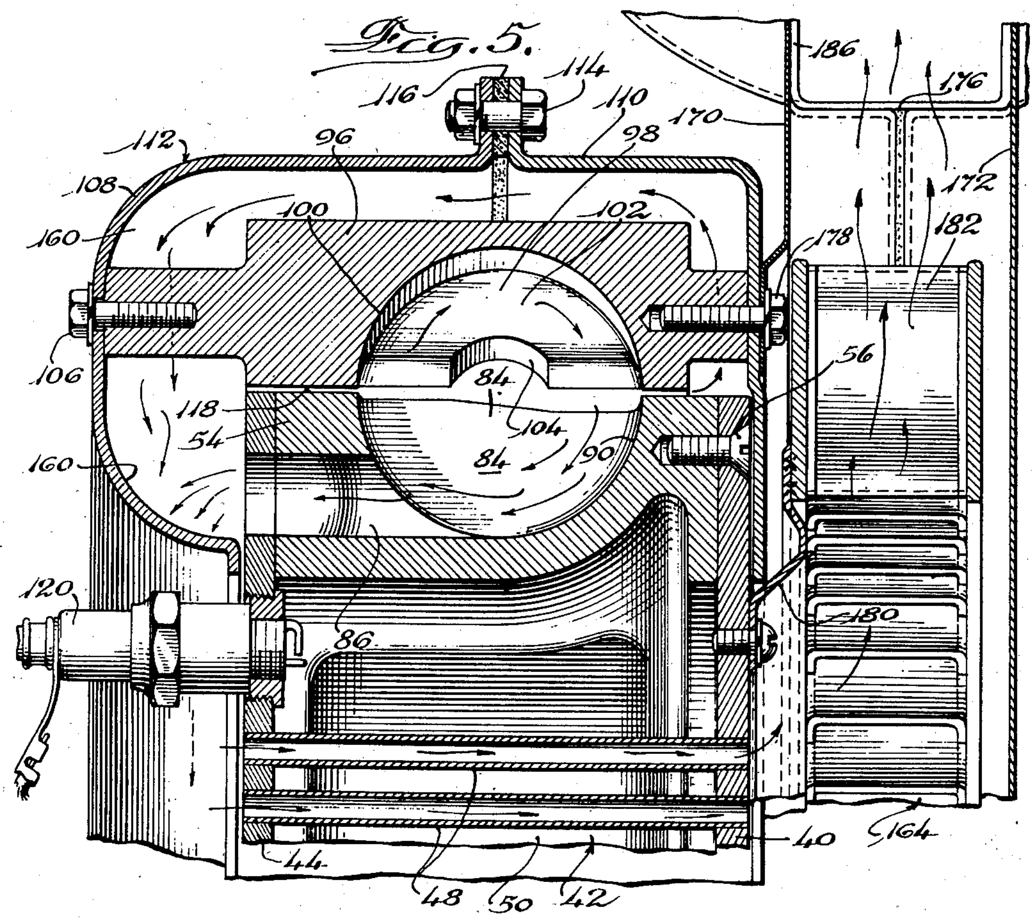
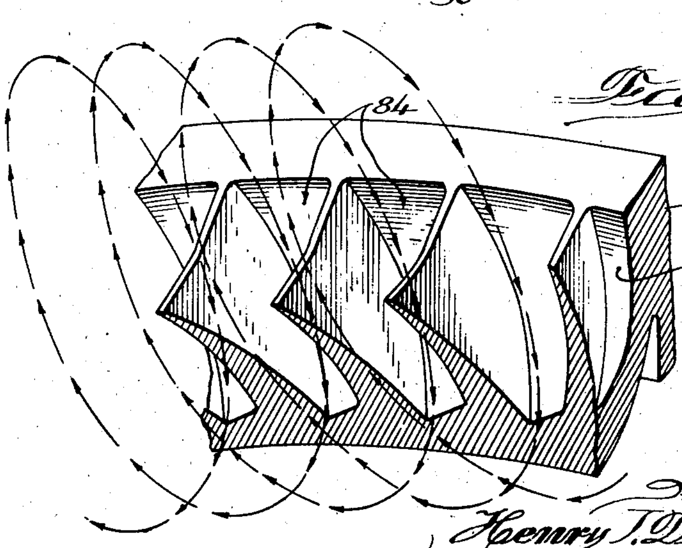


Fig. 10.



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SELF-OPERATED INTERNAL-COMBUSTION HEATER FOR HEATING AIR

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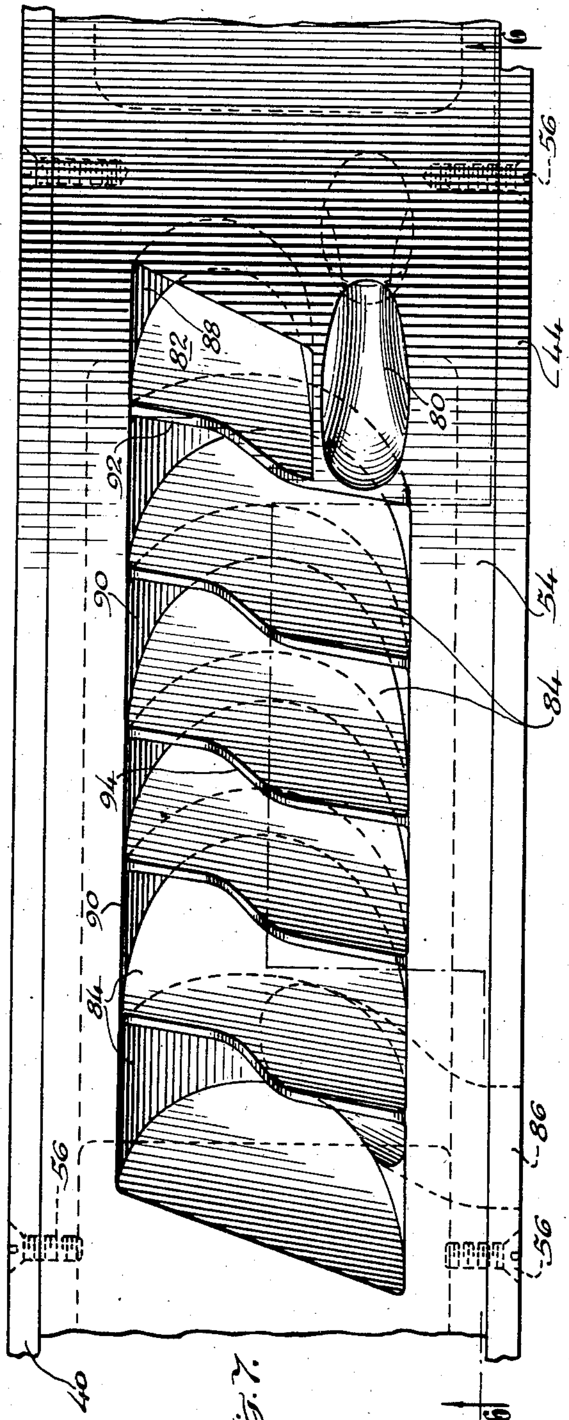

Fig. 7.

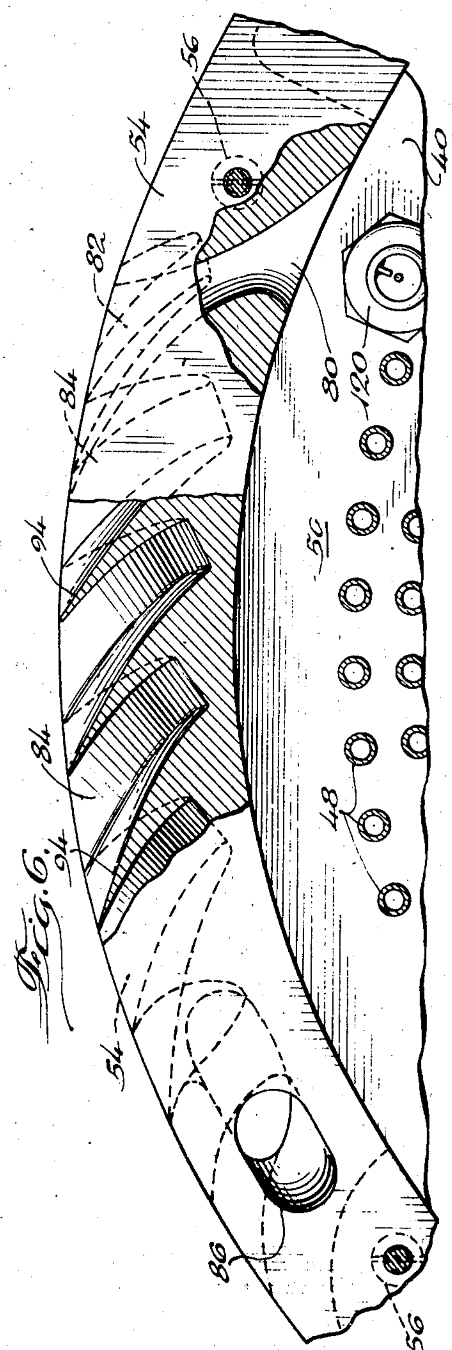

Fig. 6.

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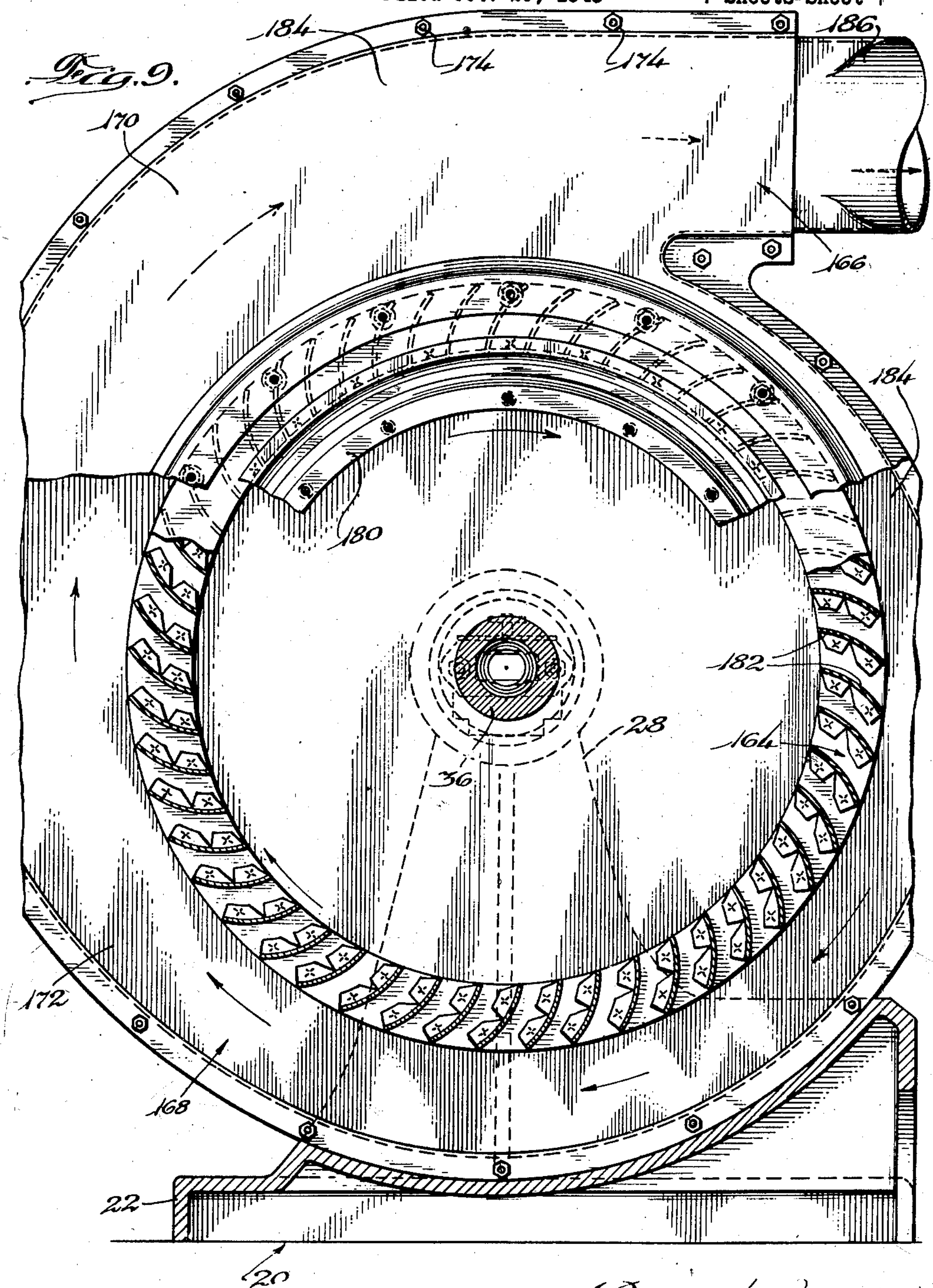
Fig. 9.



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Patented Jan. 28, 1947

2,414,830

UNITED STATES PATENT OFFICE

2,414,830

SELF-OPERATED INTERNAL-COMBUSTION HEATER FOR HEATING AIR

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Application October 29, 1943, Serial No. 508,169

14 Claims. (Cl. 126—110)

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My invention relates to self-operated heaters, and more particularly to a self-operated heater of the internal combustion type.

An object of my invention is to provide a new and improved self-operated heater of the internal combustion type which is more efficient than heaters heretofore known.

Another object of my invention is to provide a new and improved self-operated heater of the internal combustion type which is quieter in operation than the heaters of the prior art.

Another object of my invention is to provide a new and improved self-operated heater of the internal combustion type which has relatively few parts, and which is simple to manufacture, install and operate.

Another object of my invention is to provide a new and improved self-operated heater of the internal combustion type wherein there are provided relatively movable parts which may have relatively loose fits without impairing the operation of the heater.

Another object of my invention is to provide a new and improved self-operated heater of the internal combustion type which is smoother in operation than the heaters heretofore known.

Another object of my invention is to provide a new and improved self-operated heater of the internal combustion type which automatically controls its own rate of operation, and requires no accurate timing mechanism.

Other objects and advantages will become apparent as the description proceeds.

In the drawings:

Fig. 1 is an irregular vertical section through a preferred embodiment of my invention, and is taken on the irregular line 1—1 of Fig. 2;

Fig. 2 is a vertical sectional view of my invention taken at right angles to the view of Fig. 1, and is taken in the plane of the line 2—2 of Fig. 1;

Fig. 3 is a partial vertical section taken on the irregular line 3—3 of Fig. 2;

Fig. 4 is a partial horizontal section taken on the line 4—4 of Fig. 2;

Fig. 5 is a partial irregular section taken on the line 5—5 of Fig. 2;

Fig. 6 is a side view of a portion of the rotor, and is taken on the line 6—6 of Fig. 7;

Fig. 7 is a top view of the rotor structure shown in Fig. 6;

Fig. 8 is a sectional view taken on the line 8—8 of Fig. 1, with the addition of a diagrammatic representation of the electrical connections;

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Fig. 9 is a vertical section taken on the irregular line 9—9 of Fig. 1, and

Fig. 10 is a perspective view of a portion of the rotor buckets indicating the helical path travelled by the exhaust gases.

Referring particularly to Figs. 1 and 3, it will be seen that I have illustrated my invention as being embodied in a form comprising a base 20 formed of a pair of castings 22 and 24 secured to each other by bolts 26, or in any other suitable manner. The castings 22 and 24 have pedestals 28 and 30, respectively, and these pedestals support ball bearings 32 and 34, respectively. A hollow shaft 36 is journaled in the bearing 32 and is attached by studs 38 to the side plate 40 of a rotary heat exchanger indicated generally by reference character 42. This rotor includes a second side plate 44 secured to one end of a solid shaft 46 journaled in the ball bearing 34.

The side plates 40 and 44 of the rotor constitute headers to which are affixed the ends of ventilating air tubes 48, which are spaced slightly from each other to provide openings therebetween for the flow of hot gases in a manner hereinafter described. The multiplicity of ventilating air tubes 48 forms a ring surrounding a central chamber 50 communicating with the induction passage 52 provided by the hollow shaft 36. The rims of the rotor plates 40 and 44 are attached to a ring 54 by means of screws 56.

A plate 58 is attached to the upper end of pedestal 28 and supports a carburetor 60 having a float bowl 62 supplied with fuel from any suitable source. This float bowl communicates with a jet 64 located in the carburetor air inlet 66, and the amount of fuel delivered by the jet 64 may be manually-regulated by a needle valve 68. A screen 70 attached to the carburetor air inlet prevents dirt or other impurities from entering this inlet.

A valve 72 is urged towards its seat 74 by a light spring 76. This valve controls communication between the jet 64 and inlet 66, and the passage 78 communicating with the passage 52 in the tubular shaft 36; in other words, this valve controls the communication between the carburetor and the interior of the rotor. This valve is open to admit a combustible mixture of fuel and air to the rotor by suction created by rotation of this rotor either in the normal operation of the heater or by manually rotating the rotor to start the heater.

The ring 54 of the rotor constitutes one element of a reaction-type turbine and is provided with four nozzles 80 spaced circumferentially around this ring, as clearly shown in Fig. 2. Each nozzle 80 is located at one side of a small reversing pocket 82 formed in the ring 54. This ring is also provided with a plurality of larger reverisng pockets 84 arranged in four series, each series having one end adjacent a nozzle 80, and the pocket at the other end of the series communicates with a lateral outlet 86, best shown in Fig. 5.

Each of the pockets 82 has a curved or reversing wall 88 located at an angle with respect to the axis of the ring 54. Each of the larger reversing pockets 84 is also provided with a curved wall or reversing surface 90, likewise located at an angle with respect to the axis of the nozzle ring 54. The pockets 82 are separated from the adjacent pockets 84 by an offset wall 92, and the pockets 84 are separated from each other by similar offset walls 94.

The nozzle ring 54 is located inside of a stator ring 96 containing buckets 98 having curved reversing walls 100 and separated by lips 102. These reversing buckets are arranged tangentially, as clearly shown in Fig. 2, but lie in planes parallel to the axis of the stator ring 96. The lips 102 are preferably provided with semi-circular notches 104, best shown in Figs. 3 and 4.

The stator ring 96 is secured by screws 106 to the sheet metal sections 108 and 110 of an annular housing indicated generally by reference character 112 which is secured to the base 20 by bolts 26, as clearly shown in Fig. 1. Portions of this housing remote from the base 20 are secured together by bolts 114, and a suitable sealing gasket 116 is preferably clamped between adjacent edges of the sections 108 and 110 to prevent escape of combustion gases therebetween.

A feature of my invention lies in the fact that it is not necessary for the nozzle ring 54 of the rotor and the stator ring 96 to fit closely together. In Fig. 4 there is clearly shown an appreciable space 118 existing between the opposing surfaces of the stator ring 96 and rotor or rotor ring 54, and the presence of this space does not impair the efficiency of my heater. Because of the presence of this space, it is not necessary to locate the rotor with minute precision at the exact center of the stator, and the permissible tolerance materially reduces the cost of manufacture and assembly.

The combustible mixture drawn into the interior of the rotor is ignited by a pair of spark plugs 120 and 122 screwed into suitable bushings attached to the rotor side plate 44. These spark plugs are supplied with current by a generator indicated generally by reference character 124, and shown most clearly in Figs. 1 and 8. This generator includes an outer ring 126 having arms 127 secured to the rotor side plate 44 by screws 128, or in any other suitable manner. This ring 126 has inwardly-projecting iron cores 130 surrounded by wire coils 132. In the particular embodiment shown, the ring 126 supports four coils 132, although any other suitable number may be provided as desired.

The four coils 132 are connected in series by wires 134, 136 and 138. Each of the end coils of this series is connected to a terminal 140 insulated from the ring 126 by an insulating block 142. One terminal 140 is connected by a wire 144 to the spark plug 120, and the other terminal 140 is connected by a wire 146 to the spark plug 122. These spark plugs are in electrical communication with each other through the ring

126, so that the spark plugs and coils are in series with each other.

The coil-supporting ring 126 rotates with the rotor and causes the coils 132 to rotate about a stationary armature 148 composed of permanent magnets having alternating north and south poles, as clearly shown in Fig. 8. This armature is attached by screws 150 to an annular support 152 secured by screws 154 to the upper end of the pedestal 30, and a semi-circular cover 156 attached thereto by bolts 158. The armature 148 is illustrated as having four poles, but any number of poles may be provided, it being desirable, however, to provide as many poles for the armature as there are coils 132.

The exhaust gases discharged from the reversing chambers through the lateral outlets 86 pass into a tapered annular exhaust passage 160 communicating with an exhaust pipe 162 through which the exhaust gases are discharged to atmosphere. The exhaust passage 160 has portions on both sides of the nozzle ring 54 and stationary ring 96, and also a portion surrounding the latter ring. This arrangement permits any exhaust gases which flow in either direction through the space 118 between these rings to enter the exhaust passage and be discharged through the exhaust pipe 162.

The wheel 164 of a blower 166 is attached to the rotary heat exchanger and rotates therewith. This wheel is enclosed in a sheet metal casing 168 (see Fifs. 1 and 9) composed of two sections 170 and 172 clamped together by bolts 174 and with an intervening washer 176 to prevent escape of air therebetween. The section 170 (See Fig. 3) is in the form of a ring secured by screws 178 to the section 110 of the housing 112. A guide ring 180 is attached by screws to the rotor side plate 40 and serves to direct into the interior of the blower wheel 164 heated air leaving the right-hand ends of the tubes 48 of the rotor. This guide ring 180 constitutes a support and driving means for the blower wheel 164. Air passing outwardly through the vanes 182 of the blower wheel 164 enters a tapered annular passage 184 (Fig. 3) communicating with a pipe 186 through which the heated air passes to its point of application.

The solid shaft 46 has a drum 188 (Fig. 3) attached thereto by a stud 190 which is accessible through an opening 192 provided in the drum whereby this drum may be readily applied to or removed from the end of the shaft. The shaft has a keyway 194 receiving the end of the stud 190 so that rotation of the drum 188 causes rotation of this shaft and the several assemblies attached thereto. This drum is used for starting purposes and a rope may be wrapped about this drum and the free end of the rope pulled strongly to start the heater. It will be understood, however, that any other suitable starting mechanism may be used in lieu of this drum and the pull-rope.

When it is desired to start the heater, the needle valve 68 of the carburetor is unscrewed to permit fuel to flow from the carburetor float bowl 62 to the jet 64. A rope is wrapped about the drum 188 and a strong pull exerted thereon to rotate the axle 46 and parts connected thereto. Rotation of this axle rotates the rotary heat exchanger 42, the generator ring 126 with its coils 132, and the blower wheel 164. Rotation of the heat exchanger creates a suction in the interior thereof, which raises carburetor air valve 72 and induces a flow of air through the carburetor and into the interior of the heat exchanger. This air mixes with fuel supplied by the jet 64 to form a combustible mixture which is ignited by the spark plugs 120 and 122 as soon as this mixture completely fills the interior of the rotary heat exchanger.

The resulting explosion closes carburetor value 72 and creates a pressure which forces the burned gases through the nozzles 80 in the form of jets of burned gases. These jets or streams of burned gases enter the pockets 98 of the stator ring 96 creating a reaction which tends to rotate the heat exchanger. The pockets 98 reverse the flow of the burned gases and cause the streams of these gases to enter reversing chambers 84 which are adjacent the nozzles 80 on the rotor. Impingement of the streams of burned gases upon the curved walls of the reversing chambers 84 exerts an additional force tending to rotate the heat exchanger. The reversing chambers 84 reverse the streams of burned gases and re-direct them into succeeding pockets or reversing chambers in the stator ring 96. This is repeated until the burned gases flow through the outlets 86 into the discharge manifold or passage 160.

Fig. 10 represents somewhat diagrammatically the helix-like flow of the burned gases leaving the nozzles and passing successively through alternate reversing chambers or pockets formed in the stator ring 96 and rotor ring 54. Each time a gas stream impinges upon the stator ring a reaction is created which tends to rotate the heat exchanger, and each time a stream impinges upon the rotor ring 54 of this heat exchanger an additional force is created tending to cause rotation thereof. The repeated reversals of the gas streams create repeated impingements which utilize the full energy of the streams to create maximum turning effort on the rotary heat exchanger.

After the pressure created in the interior of the heat exchanger by an explosion has been dissipated by a flow of burned gases through the nozzles in the manner heretofore described, continued rotation of the heat exchanger creates a suction therein which draws a fresh charge of combustible mixture into the interior of the rotor. As soon as this fresh mixture reaches the spark plugs 120 and 122, it likewise is ignited, and the cycle of operation is repeated.

Where the alternator which supplies these spark plugs is provided with a multiplicity of coils, these spark plugs create a spark several times for each rotation of the heat exchanger, whereas, successive explosions occur at longer intervals such as, for example, every two complete rotations. It is advantageous to have frequent sparking at the spark plugs to eliminate the need for any close timing between the creation of these sparks and the introduction of a fresh charge of combustible mixture into the interior of the heat exchanger.

These successive explosions in the interior of the rotor or rotary heat exchanger give off heat, and a part of this heat is absorbed by the tubes 48 which transmit this heat to the air drawn through these tubes by the rotation of the blower wheel 164. This blower wheel is attached to the rotary heat exchanger by an annular attaching plate 180 and rotates therewith. The centrifugal blower discharges the heated air into a pipe 186 which may lead to any point of application for this air.

My new and improved self-operating heater is particularly adapted for use around airports to

supply hot air for heating aircraft engines, and other similar purposes. A particular advantage of my invention in this regard lies in that fact that it requires no separate internal combustion engine for its operation, and thus eliminates the service difficulties which are commonly encountered with small engines of this kind. The several parts of my heater are of simple construction and subjected to little wear, so that my heater can operate almost indefinitely with little or no attention.

While I have described my invention as being particularly adapted for use around airports, it is not limited to such use, but is capable of general application. It is also to be understood that my invention is not limited to the particular details shown and described, but may assume numerous other forms, and that my invention includes all modifications, variations and equivalents coming within the scope of the following claims.

I claim:

1. A self-operated internal combustion type heater of the class described, comprising a rotary heat exchanger incorporating a combustion chamber, means for supplying a combustible mixture to said chamber, means for igniting said mixture, a nozzle through which combustion gases are discharged from said chamber, a stationary member against which said discharged gases impinge for rotating the heat exchanger, means driven by said heat exchanger for creating a flow of air through said heat exchanger in out-of-contact heat exchange relation to said combustion gases, and means confining and conducting the heated air for delivery to a space to be heated.

2. A self-operated internal combustion type heater of the class described, comprising a rotary heat exchanger incorporating a combustion chamber, means for supplying a combustible mixture to said chamber, means for igniting said mixture, a nozzle through which combustion gases are discharged from said chamber, a stationary member against which said discharged gases react to rotate the combustion chamber, means driven by said heat exchanger for creating a flow of air through said heat exchanger in out-of-contact heat exchange relation to said combustion gases, and means confining and conducting the heated air for delivery to a space to be heated.

3. A self-operated internal combustion type heater comprising a rotary heat exchanger which includes a shaft journalled for rotation, means forming a combustion chamber, said means comprising a pair of spaced side plates carried by the shaft enclosing a central space and an annular space around said central space and a ring connecting said plates around the annular space, a portion of said shaft being hollow, a carburetor positioned to supply combustible mixture to said central and annular spaces through the hollow shaft, means to ignite said mixture, said ring having a nozzle for discharging the products of combustion, a stator ring against which the discharged gases react to rotate the combustion chamber means, a plurality of tubes extending parallel to the axis of rotation across the annular space with their ends fixed in the side plates, a suction fan at one side of said combustion chamber rotatable therewith, each of said tubes being open to the atmosphere at one end and opening at its opposite end into the inlet of the fan, whereby said fan draws air through said tubes to be heated by the products of combustion in out-of-contact relation thereto, and conduit

means arranged to convey the heated air from said fan to a space to be heated.

4. A self-operated internal combustion type heater comprising a rotary heat exchanger which includes a shaft journalled for rotation, means forming a combustion chamber, said means comprising a pair of spaced side plates carried by the shaft enclosing an annular space and a ring connecting said plates around the annular space, a carburetor positioned to supply combustible mixture to said annular space, means to ignite said mixture, said ring having a nozzle for discharging the products of combustion, a stator ring against which the discharged gases react to rotate the combustion chamber means, a plurality of tubes extending across the annular space with their ends fixed in said side plates, a suction fan at one side of said combustion chamber rotatable therewith, each of said tubes being open to the atmosphere at one end and opening at its opposite end into the inlet of the fan, whereby said fan draws air through said tubes to be heated by the products of combustion in out-of-contact relation thereto, and conduit means arranged to convey the heated air from said fan to a space to be heated.

5. A self-operated internal combustion type heater comprising a rotary heat exchanger which includes a shaft journalled for rotation, means forming a combustion chamber, said means comprising a pair of spaced side plates carried by the shaft enclosing an annular space and a ring connecting said plates around the annular space, a carburetor positioned to supply combustible mixture to said annular space, means to ignite said mixture, said ring having a nozzle for discharging the products of combustion, a stator ring against which the discharged gases react to rotate the combustion chamber means, a plurality of tubes extending across the annular space with their ends fixed in said side plates, a centrifugal blower and a casing therefor, said casing being attached to the stator ring and the blower wheel having a central inlet connected in air-tight relation to one side plate of the combustion chamber for rotation therewith, each of said tubes being open to the atmosphere at one end and opening at its opposite end into said inlet of the blower wheel whereby the blower draws air through said tubes to be heated by the products of combustion in out-of-contact relation thereto, and conduit means connected to the blower casing to convey the heated air from the blower to a space to be heated.

6. A self-operated internal combustion type heater comprising a rotary heat exchanger which includes a shaft journalled for rotation, means forming a combustion chamber, said means comprising a pair of spaced side plates carried by the shaft enclosing an annular space and a ring connecting said plates around the annular space, a carburetor positioned to supply combustible mixture to said annular space, with a spring-loaded valve controlling communication between said carburetor and said space, means to ignite said mixture, said ring having a nozzle for discharging the products of combustion, a stator ring against which the discharged gases react to rotate the combustion chamber means, a plurality of tubes extending across the annular space with their ends fixed in said side plates, a suction fan at one side of said combustion chamber rotatable therewith, each of said tubes being open to the atmosphere at one end and opening at its opposite end into the inlet of the fan, whereby said fan draws air through said tubes to be heated by the products of combustion in out-of-contact relation thereto, and conduit means arranged to convey the heated air from said fan to a space to be heated.

7. A self-operated internal combustion type heater comprising a rotary heat exchanger which includes a shaft journalled for rotation, means forming a combustion chamber, said means comprising a pair of spaced side plates carried by the shaft enclosing an annular space and a ring connecting said plates around the annular space, a carburetor positioned to supply combustible mixture to said annular space, electrical ignition means in the combustion chamber and a generator therefor driven by the rotation of said combustion chamber means, said ring having a nozzle for discharging the products of combustion, a stator ring against which the discharged gases react to rotate the combustion chamber means, a plurality of tubes extending across the annular space with their ends fixed in said side plates, a suction fan at one side of said combustion chamber rotatable therewith, each of said tubes being open to the atmosphere at one end and opening at its opposite end into the inlet of the fan, whereby said fan draws air through said tubes to be heated by the products of combustion in out-of-contact relation thereto, and conduit means arranged to convey the heated air from said fan to a space to be heated.

8. In an apparatus of the class described, the combination of a support, a collector for products of combustion and a blower housing carried by said support, a rotary assembly comprising a combustion chamber casing surrounded by said collector, means including a check valve for supplying a combustible mixture of fuel and air to the combustion chamber in said casing, a plurality of reaction nozzles carried by said combustion chamber casing for the discharge of the products of combustion therefrom into said collector, heat exchange means providing passageways extending through said combustion chamber and into the space within said blower housing, means including a blower impeller in said housing rotatable with said casing and operable to draw ventilating air through said passageways in said heat exchanger and to force the air thus heated to a space to be heated, and electrical ignition means operating substantially continuously to ignite the combustible mixture in said combustion chamber.

9. The combination set forth in claim 8, in which said electrical ignition means comprises a high tension alternator having one part thereof stationary with respect to said support and the other part thereof connected for rotation with said combustion chamber casing.

10. The combination set forth in claim 8, in which said electrical ignition means comprises a spark plug, and an electrical generator driven by said rotary combustion chamber casing for supplying electrical energy to said spark plug.

11. The combination set forth in claim 8, in which said collector provides an involute passageway for the discharge of products of combustion from said reaction nozzles, and said housing provides an involute passageway for the discharge of heated ventilating air.

12. In a heater comprising means providing a combustion chamber having reaction nozzles and forming the rotor of a reaction turbine, means to supply a combustible mixture of fuel and air in said combustion chamber, electrical ignition

means in the combustion chamber located remotely from the point at which the fuel and air are supplied thereto, means including a blower having an impeller driven by the reaction turbine rotor and operable to cause flow of ventilating air past the combustion chamber to a space to be supplied with heated air, means providing the combustion chamber with a sufficiently effective heat transfer surface area, relative to the heat produced by the combustion of the fuel and air in the combustion chamber, to cause the transfer to the ventilating air of the major part of the heat produced by the combustion, and an electrical generator driven by said rotor and connected to said ignition means for supplying energizing current thereto.

13. The combination set forth in claim 12, in which said rotor, said impeller, and the driven part of said electrical generator are secured together, and in which common bearings are provided for said last named elements.

14. In a heater comprising means providing a combustion chamber having reaction nozzles and forming the rotor of a reaction turbine, means to supply a combustible mixture of fuel and air to said combustion chamber, electrical ignition means in the combustion chamber located remotely from the point at which the fuel and air are supplied thereto, means including a blower having an impeller driven by the reaction turbine rotor and operable to cause flow of ventilating air past the combustion chamber to a space to be supplied with heated air, and heat exchange means attached to the combustion chamber means and having sufficient area and heat transfer effectiveness relative to the heat produced by the combustion of the fuel and air in the combustion chamber to cause the transfer to the ventilating air of the major part of the heat produced by the combustion.

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