F. WONDRA.

INTERNAL COMBUSTION TURBINE.

APPLICATION FILED FEB. 27, 1911. RENEWED AUG. 1, 1918.

1,298,430. Patented Mar. 25, 1919.

5 SHEETS—SHEET 1.

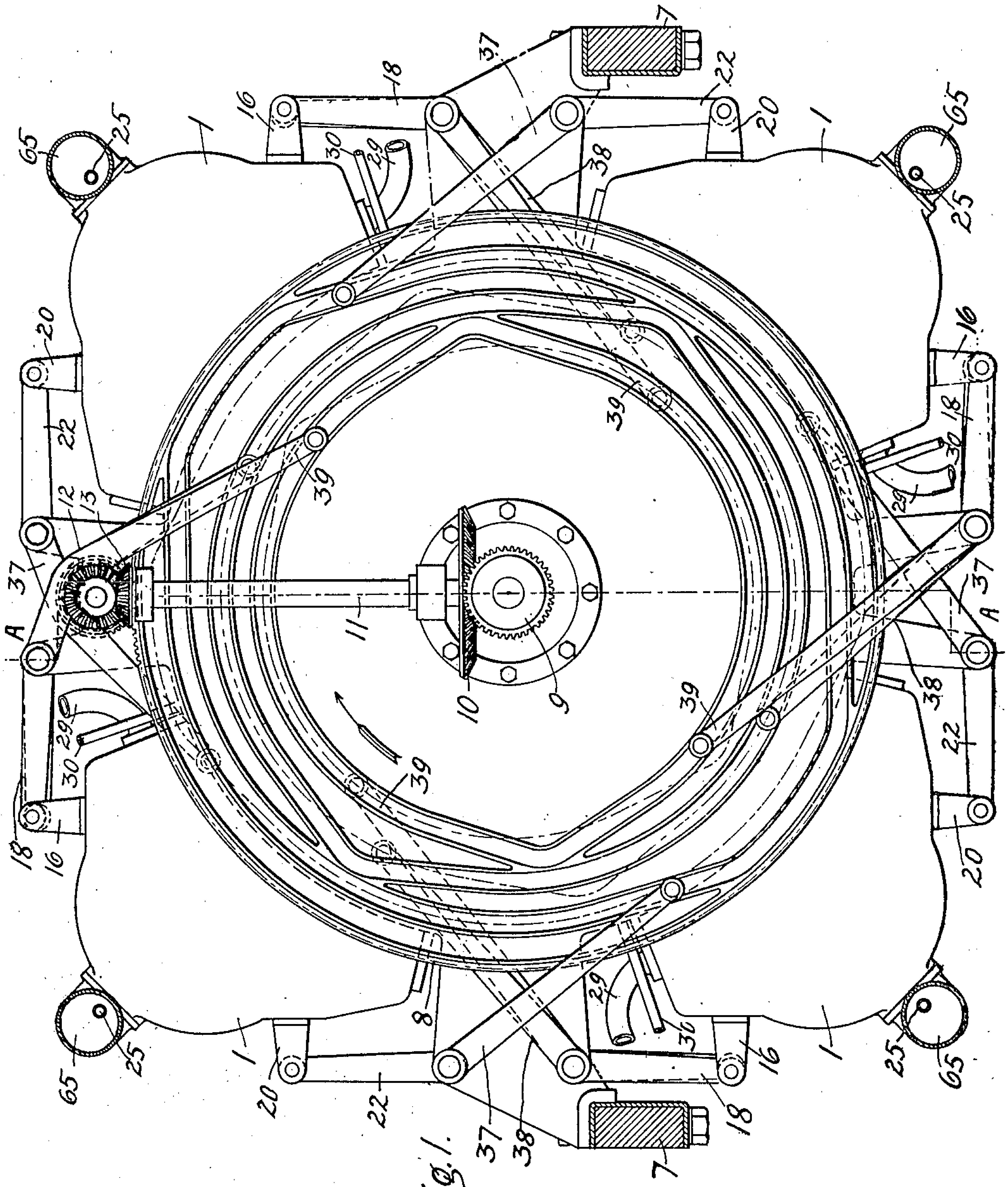

Fig. 1.

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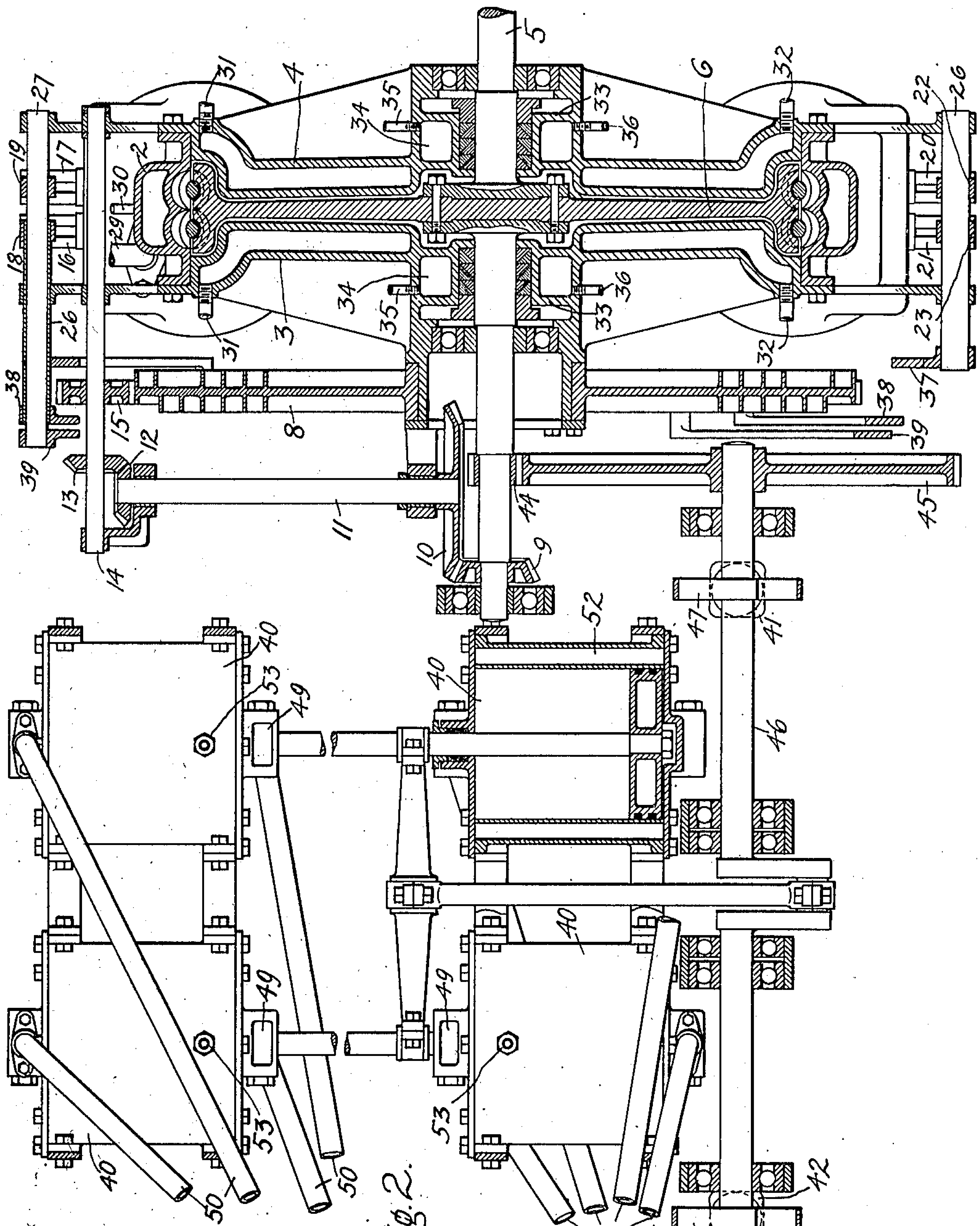

Fig. 2.

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Fig. 3.

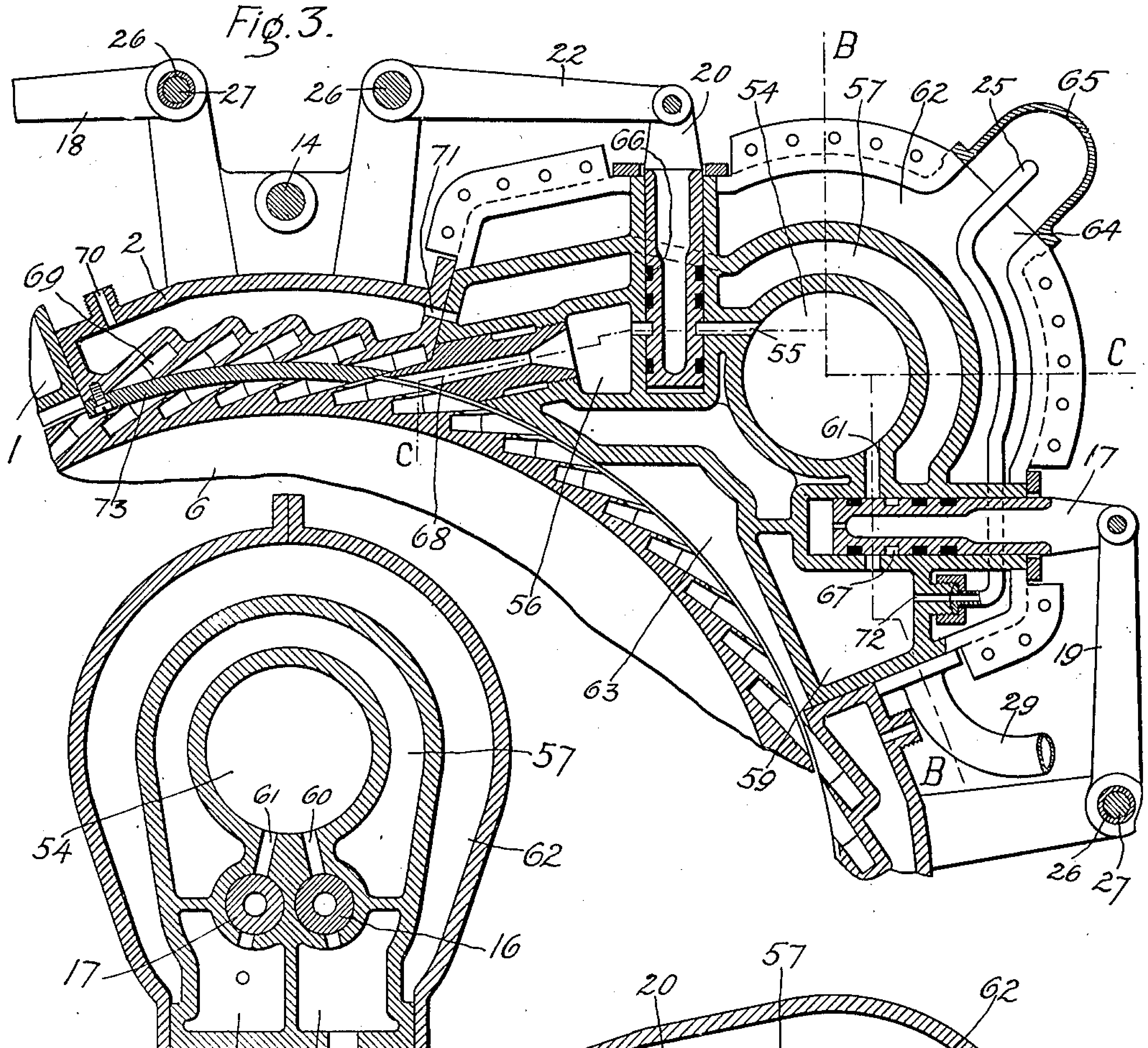

Fig. 4.

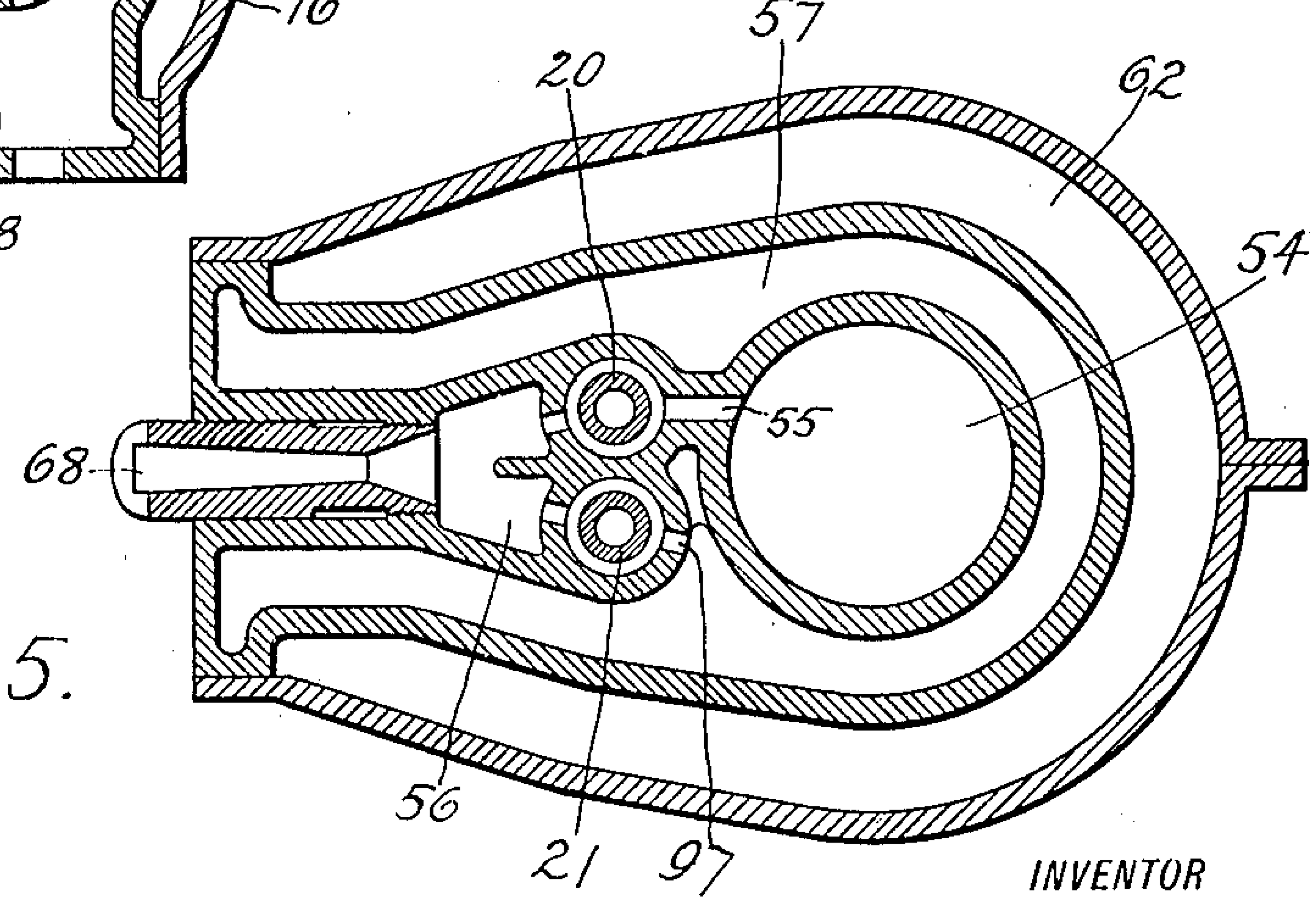

Fig. 5.

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5 SHEETS—SHEET 4.

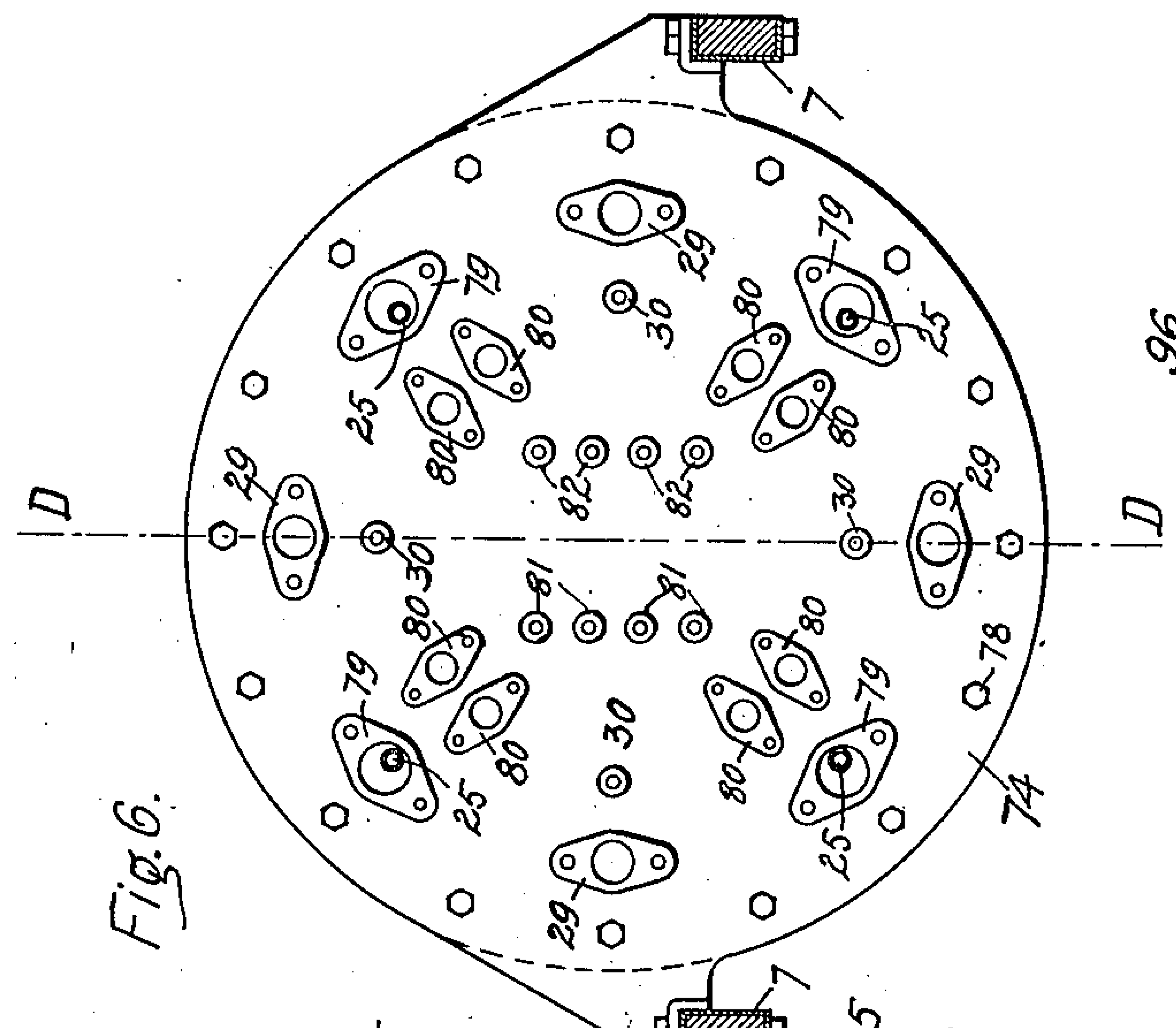

Fig. 6.

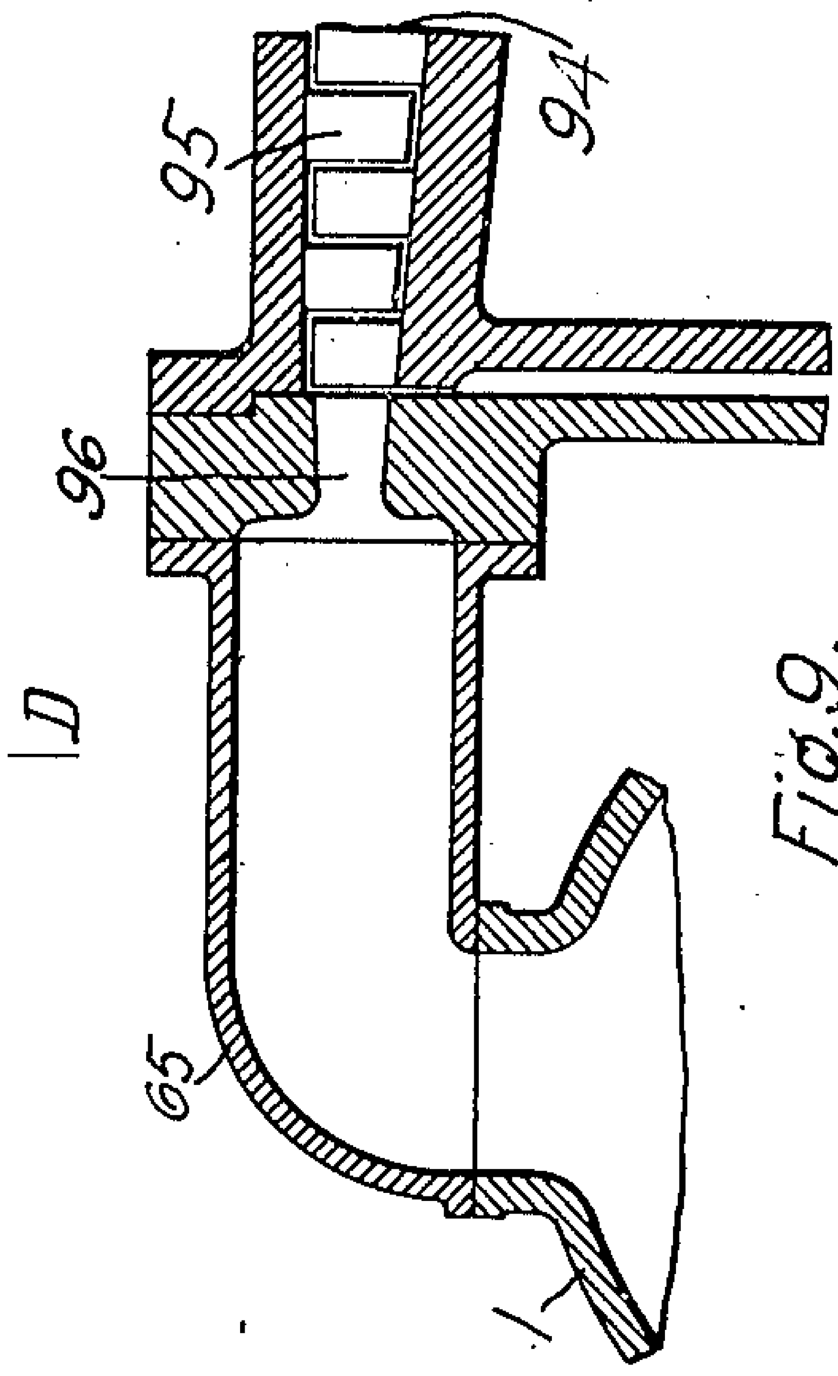

Fig. 9.

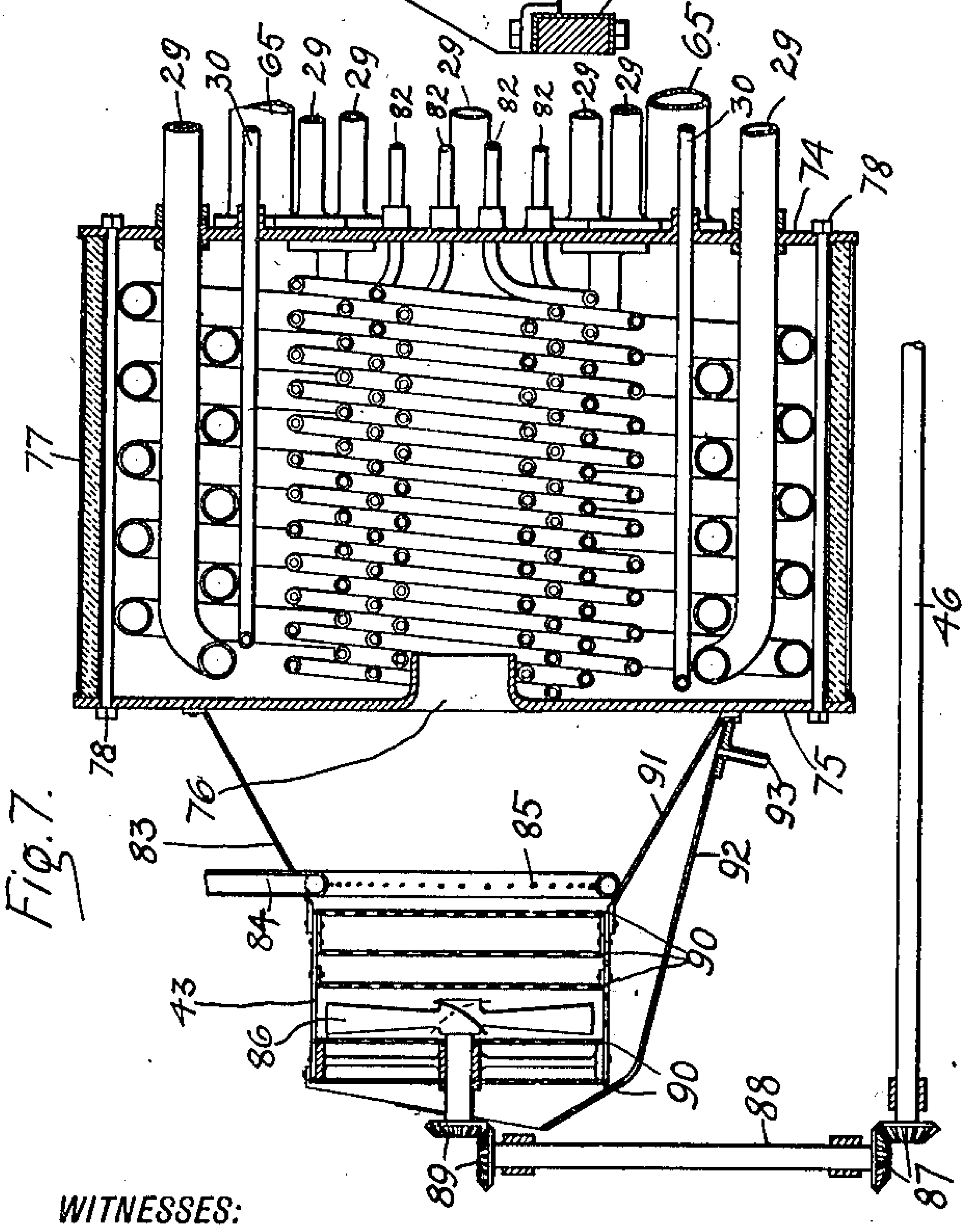

Fig. 7.

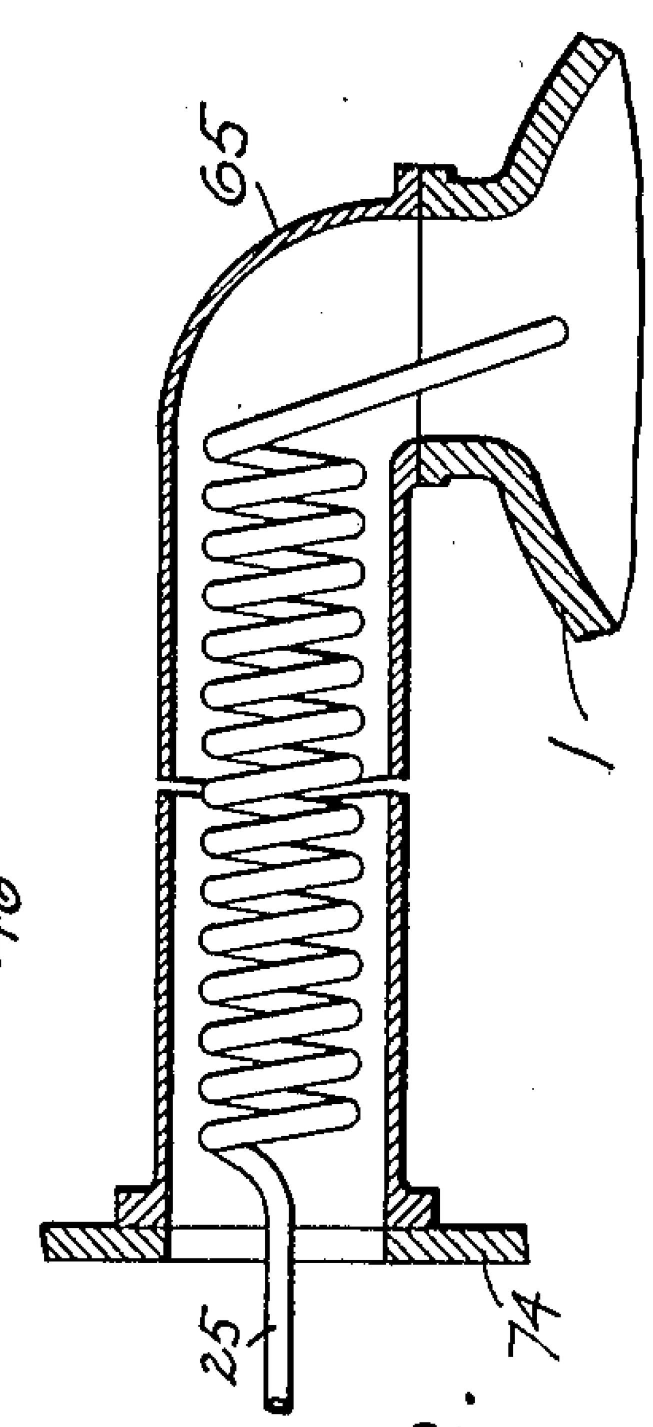

Fig. 8.

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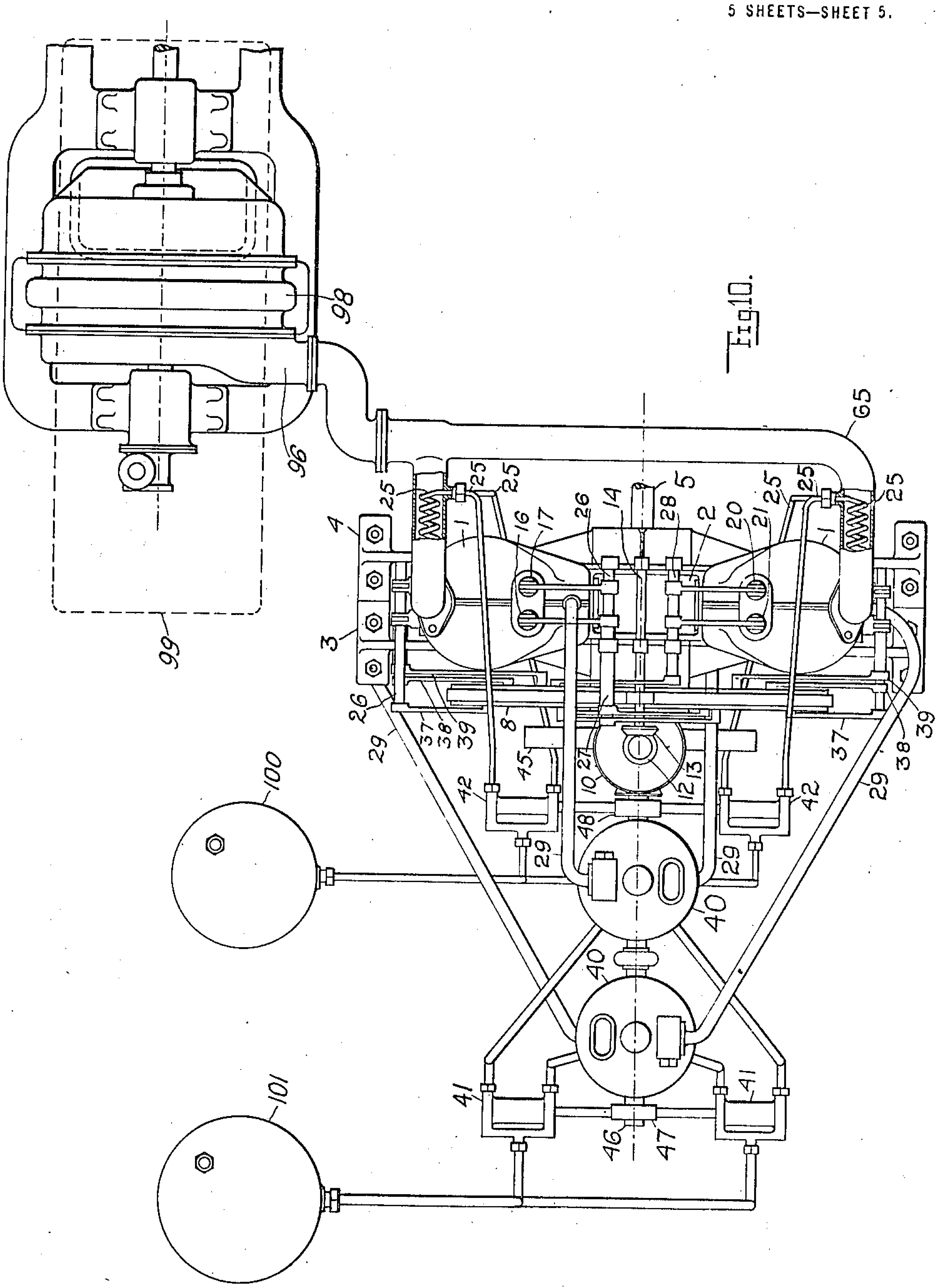
5 SHEETS—SHEET 5.

Fig. 10.



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UNITED STATES PATENT OFFICE.

FRANZ WONDRA, OF SCHENECTADY, NEW YORK.

INTERNAL-COMBUSTION TURBINE.

1,298,430. Specification of Letters Patent. **Patented Mar. 25, 1919.**

Application filed February 27, 1911, Serial No. 611,139. Renewed August 1, 1918. Serial No. 247,863.

To all whom it may concern:

Be it known that I, Franz Wondra, a citizen of the United States, residing at Schenectady, county of Schenectady, and State of New York, have invented certain new and useful Improvements in and Relating to Internal-Combustion Turbines, of which the following is a specification.

My present invention relates to improvements in turbine engines of the character described in my prior application, Serial No. 458,157, filed October 17, 1908, and has for its object the novel construction and arrangement of parts hereinafter specifically described.

A further object of my invention is the introduction of a heater or regenerator with a rotary exhauster and condenser into the internal combustion engine, of the turbine type.

Another object of my invention is to heat and evaporate liquid or gaseous fuel by the exhaust heat from the turbine to a self-igniting temperature.

Another object of my invention is to utilize the exhaust from an internal combustion turbine as working fluid for turbine engines already installed.

Another object of my invention is to reduce the temperature of the working fluid before it is discharged against the movable parts of the turbine.

In the accompanying drawings which are illustrative of my invention Figure 1 is a front elevation of the internal combustion turbine with a plurality of fluid pressure generators;

Fig. 2 is an axial section of the turbine taken on line A—A showing also the air compressor, the location of the fuel and water pumps and the mechanism for actuating the various pumps;

Fig. 3 is a vertical section of one of the fluid pressure generators showing also a fraction of the turbine wheel;

Fig. 4 is a section taken on line B—B of Fig. 3;

Fig. 5 is a section taken on line C—C of Fig. 3;

Fig. 6 is a side elevation of the heater or regenerator, showing only the flanges for the various connection pipes;

Fig. 7 is a section taken on line D—D of Fig. 6, showing the heater in connection with the exhauster;

Fig. 8 is a section view of one of the exhaust pipes, showing the fuel pipe coiled inside the same;

Fig. 9 shows the exhaust pipe connected to a secondary turbine in which the exhaust of the primary turbine is further utilized;

Fig. 10 is a plan view showing the different pumps and the internal combustion turbine connected to a secondary turbine and condenser.

Referring to Fig. 1, the casing of the turbine is formed of a plurality of fluid pressure generators 1, between which are inserted segments 2, forming thus a complete ring.

The covers or side walls 3, and 4, (Fig. 2), which are bolted to the heads and segments, tighten the casing.

The turbine wheel 6 is mounted upon the shaft 5, and the latter is supported in suitable bearings carried by the side walls of the casing.

These side walls serve also as standards for the turbine, having in the lower portion flanges or feet which rest upon the beams 7, or other foundation. The cover 3 has on the outside of its hub a bearing for the cam groove wheel 8, the latter having geared periphery, and is actuated from the turbine shaft. The bevel gear 9 is fastened on the turbine shaft and transmits its motion to the cam groove wheel through the bevel gear 10, the shaft 11, bevel gears 12 and 13, shaft 14 and pinion 15, which meshes with the geared periphery of the cam grooves wheel.

Each fluid pressure generator has admission valves 16 and 17, which are connected to lever-arms 18 and 19 and outlet valves 20 and 21, connected to lever-arms 22 and 23. The exhaust pipes are shown broken off (Fig. 1), also the fuel pipes 25, which are coiled inside of the exhaust pipes.

The side walls of the casing have radially extending arms with bearings on ends for the shafts 26, 27 and 28 to which the various lever-arms are fastened. The longer lever arms are provided at their inner ends with pins, with friction rollers thereon engaging the cam groove, and slide therein shifting thus the different slide valves of the fluid pressure generators into open or closed position.

The pipes 29 supply air under pressure into the combustion head and pipes 30, supply water or steam.

The cam grooves on the other side of the wheel are shown in dot and dash center lines and are 45 degrees superposed.

In Fig. 2 the turbine wheel is shown with two rows of U shaped buckets. The side walls are jacketed and water enters through the conduit 31 for the purpose of being heated and evaporated and leaves through the conduit 32.

Around the stuffing box 33 is jacket 34, in which water or oil from a separate source is conveyed through pipes 35, and abstracted through pipes 36 for cooling purpose. The lever-arms 37, 38 and 39 are located over the cam groove wheel, two diametrically opposite sets are actuated from one side, the other sets from the other side of the wheel.

The shaft 26 is tubular and turns on shaft 27 (Fig. 2).

The turbine shaft 5 is preferably connected to a multiple cylinder double-acting air compressor 40, the water pump 41, fuel pump 42, and the exhauster 43 (Fig. 7).

The motion of the turbine shaft is transmitted through the pinion 44, gearwheel 45, to the crankshaft 46, which actuates the air compressor and is provided also with the eccentrics 47 and 48, which operate the water pump and the fuel pump.

The arrangement of the various pumps is immaterial and can vary according to the available space and the purpose of the turbine.

The air compressor has suction valves 49, and the compressed air is delivered through the pipes 50, to the regenerator.

The cylinders of the air compressor are provided with waterjackets 52, and the water enters through the conduit 53, and leaves through a similar conduit on the diametrically opposite side of the cylinder jacket. The further circulation of this water will be described later.

I desire to have it understood that the various pumps can also be of the rotary or turbine type and can be connected to the turbine shaft directly. At present I employ reciprocating pumps and the Fig. 2 shows the design of the turbine as a flying machine motor. The beams 7 are part of the frame structure of the flying machine. Each of the fluid pressure generators consists of a combustion chamber 54 (Figs. 3, 4 and 5), which communicates through the outlet port 55, with the mixing chamber 56, and both are surrounded by a steam jacket 57, having port 97. Adjacent to the steam jacket is the air chamber 58, and fuel chamber 59, with ports 60 and 61, leading to the combustion chamber. All these chambers are surrounded by the exhaust jacket 62, which forms the port 63, from the interior of the casing and exhaust port 64, to which is bolted the exhaust pipe 65, communicating thus the turbine with the regenerator.

For convenience in manufacturing and assembling the exhaust jacket is made of two separate halves bolted together and fitted over the other chambers, which are cast in one piece. The ports between the various chambers are closed or opened by the different piston valves. The piston valve 16 is for admitting the air from the air chamber into the combustion chamber, the valve 17 for admitting the fuel from the fuel chamber into the combustion chamber, the valve 20 for admitting the product of combustion from the explosion chamber into the mixing chamber, and the valve 21 for admitting the steam from the steam jacket into the mixing chamber. The piston valves being pushed by the different levers toward the shaft of the turbine, cover and uncover the respective ports. Each of the piston valves has piston rings 66, and an annular groove 67, which registers with the corresponding port.

The working fluid is discharged through the nozzle 68 from the mixing chamber against the bucket of the turbine-wheel. The segment 2 which is inserted between the fluid pressure generators is provided with a set of reversing buckets 69, and is jacketed. Steam enters in the jacket from the regenerator through the conduit 70 and passes through the passage 71 in the steam jacket around the combustion chamber. The fuel is delivered from the regenerator through the fuel pipe 25, which is coiled inside the exhaust pipe 65, passing through the exhaust jacket, and is conveyed through the conduit 72 in the fuel chamber. The air is delivered from the regenerator through the pipe 29, into the air chamber 58.

In the semi-circular opening of the reversing buckets is fastened a segmental bar 73, projecting in the buckets of the turbine-wheel.

The regenerator consists of two heads, head 74 with flanges for the various connection pipes, head 75 with the exhaust opening 76, and a cylinder body 77, preferably comprising two cylinders of sheet metal with non-conductive material between the same. The through passing bolts 78 clamp the heads to the body, forming thus the regenerator casing. The heads have flanges which rest on the beam 7 or other foundation. The exhaust pipes 65 are bolted to the flanges 79, the air pipes 29 to the flanges 80, the fuel pipes 25 to the flanges 81, and the water pipes 30 to the flanges 82. All the above mentioned connection pipes are delivering the various substances from the pumps to the regenerator. The exhaust pipes end on the shield flanges, discharging the exhaust of the turbine into the regenerator. Similar flanges are also on the inner side of the head 74, to which the coiled pipes are fastened. These pipes take up the respective substances, carry it through the whole length of the regenerator, abstracting thus the heat of the exhaust gases and return through the coils to the head 74, passing through the same, and deliver the heated substances to the respective chambers of the turbine.

To the regenerator head 75 is riveted or otherwise fastened the exhaust hood 83, with the coiled water pipe 84, the latter having ducts 85. In the contracted portion of the hood is mounted the fan 86 which is driven from the crankshaft 46 by means of extension of the shaft 46, a set of bevel gears 87, upright shaft 88 and gears 89.

Before and behind the fan 86 are arranged a number of screens 90. The lower portion of the hood has a number of ducts 91 for draining off the condensed water, which is collected in a jacket 92 and leaves through the conduit 93 to be delivered to the water tank.

In Fig. 9 the pipes 65 convey the exhaust instead of to the regenerator to a secondary turbine which is designed for the low pressure fluid and has a number of rows of buckets for axial flow for further abstraction of the energy of the fluid. The buckets 94 are fastened to the revolving elements, the buckets 95 are stationary.

The nozzle 96 discharges the exhaust from the primary turbine against the bucket of the secondary turbine 98, and the exhaust is finally condensed in the condenser 99.

Any installed steam turbine may be used as the secondary turbine.

Fuel is supplied to the fuel pump 42 from the fuel tank 100 and water to the water pump 41 from the water tank 101. Where the turbine is used without the regenerator, the fuel pipes carry the fuel from the pumps 42 through the exhaust pipe 65, (Fig. 10), into the fuel chambers 59 and the water is delivered from the pumps 41 into the jackets of the air compressor and from there into the chambered side walls of the primary turbine, wherefrom it is led into the jackets of the reversing buckets and finally into the steam jackets.

The turbine is intended to be operated by a liquid or gaseous fuel and the working cycle is as follows:

With an auxiliary air compressor, (not shown), the air is compressed to the compression pressure for which the turbine is designed and admitted into the air pipes 29 leading to the air chamber 58 of the pressure generators. The liquid fuel is evaporated in an auxiliary evaporator and compressed to a higher pressure than the highest explosion pressure of the cycle and admitted into the fuel pipes 25 and fuel chamber 59. The compression temperature of the air and fuel should be higher than the self-igniting temperature of the fuel.

The cam groove wheel which revolves preferably in a direction opposite to the turbine wheel is set in motion by a suitable starting device, actuating first the air valve. The latter forms a passage between the air chamber and combustion chamber, admitting the compressed air into the combustion chamber. Further motion of the cam wheel shifts the air valve into the closed position and opens the fuel valve admitting the highly compressed fuel into the combustion chamber. The fuel having self-igniting temperature and coming in contact with the air, starts combustion in the combustion chamber.

As the fuel is forced into the air and since the whole volume destined for one cycle can not enter at once, the combustion does not occur suddenly. Further rotation of the cam wheel cuts off the fuel admission. The combustion now takes place in a perfectly closed chamber and occurring separated from the fresh charge, can be complete. The developed heat can partly escape through the walls of the combustion chambers into the steam jacket.

The combustion chamber is closed for a while so as to allow the heat developed by the combustion to radiate through the walls. The outlet valve 20 for gas and 21 for steam are operated both at the same time from the same lever and cam groove. Continued rotation of the cam wheel withdraws both valves and the products of combustion rush through the mixing chamber, whereby the temperature is lowered and are discharged through the nozzle 68, against the buckets of the wheel.

After the discharge period the outlet valves are shifted by the continued rotation of the cam wheel into closed position and further the air valve is opened and admits a new charge into the combustion chamber, whereby the cycle is repeated.

The steam outlet valve has a broader groove than the gas valve, thus admitting steam into the mixing chamber before the gas is admitted and also after the gas discharge has been cut off.

The turbine wheel being once in motion drives the various pumps and thus delivers the different substances to the pressure generators.

After a few revolutions the walls of the different chambers become so highly heated that they can generate steam. The water is supplied first as cooling medium to the water jacket of the air compressor cylinder, circulates around the same, is further guided through the jackets of the side-walls of the turbine, abstracting here the heat radiating through the walls and is taken from here and guided through the regenerator, being there heated from the exhaust gases, passing in coiled tubes through the whole length of the regenerator and is returned to the turbine as steam, which enters the jacket of the reversing bucket and from here through the passage 97, in the steam jacket, from which it is discharged into the mixing chamber and together with the products of combustion against the buckets of the turbine wheel.

This so composed jet of working fluid is returned several times through the reversing buckets against the buckets of the turbine wheel, the segmental bar 73 prevents the jet from splitting and finally escapes through the exhaust port 63 of the forwardly located pressure generator. The exhaust gases circulate around the different chambers, heating the same and finally are discharged through the exhaust pipe into the regenerator. The fuel pipe being laid in the path of the exhaust gases, is highly heated and the fuel attains by the rise in temperature high pressure and therefore the work of forcing the fuel against the explosion pressure in the combustion chamber is considerably reduced. The exhaust from the regenerator passing through the spray of cold water radially discharged from the ducts 85 of the pipe 84 is cooled, the steam is condensed, and the burned gases are rushed out by the fan 86 passing through the different screens 90.

The purpose of these screens is the further precipitation of the exhaust steam.

The pressure in the regenerator will be by removing the exhaust through the fan 86, lower than the atmospheric pressure, and therefore the expansion of the turbine can be carried also below the atmospheric pressure.

The above described cycle occurs simultaneously in two diametrically opposite fluid pressure generators and before the one pair of fluid pressure generators is entirely exhausted the other pair starts to discharge the working fluid at the highest pressure, against the turbine wheel. Fig. 1 shows the four fluid pressure generators in action, two ending and two starting.

The governing of the turbine can be accomplished preferably by throttling the fuel and air, the proportion ratio remaining the same. Suitable governing mechanism can be actuated from the crank shaft 46.

The governing mechanism will be the subject matter of a separate application and therefore not specified herein.

For gaseous fuel the fuel pump 42 should be replaced by a suitable gas compressor and the compressed gas should take the same course as the liquid fuel. The liquid fuel is evaporated and its temperature raised by the exhaust gases; the gaseous fuel must be first compressed and then heated from the exhaust.

Any suitable form of vacuum pump may be employed for creating vacuum in the regenerator for the purpose of carrying out the expansion of the working fluid in the turbine below the atmospheric pressure.

I have described herein the principle of operation of my invention together with the apparatus which I now consider to represent the best embodiment thereof, but I desire to have it understood that the invention can be carried out by other means, for instance, the fluid pressure generators can be arranged for axial or any other flow, and their number reduced or increased, or the turbine employed without the regenerator, the exhaust being utilized in a low pressure turbine and finally condensed in a condenser.

What I claim as new and desire to secure by Letters Patent of the United States, is,—

1. In an internal combustion turbine in combination a plurality of fluid pressure generators for supplying the turbine with vapor energy, a combustion chamber in each of said generators, means for intermittently admitting air under pressure therein, means for intermittently admitting fuel under pressure therein, the temperature of the air or fuel being sufficient to cause spontaneous combustion therein, the combustion chamber being closed after the admission of fuel and air whereby combustion at constant volume takes place, a jacket surrounding each of said combustion chambers, means feeding condensable fluid thereto to be subjected to the heat of the burning gases during the combustion, a mixing chamber adjacent to each of said combustion chambers whereto the products of combustion and the condensable fluid are intermittently discharged and mixed, a turbine wheel, a nozzle in each of said generators, that discharges the mixed fluid against the turbine wheel to produce rotation, a compressor for discharging air under pressure into said generators, a regenerator heated by the gases exhausting from the turbine, and through which the fuel and the condensable fluid passes before admitted into said generators.

2. In combination, a turbine, a fluid pressure generator supplying products of combustion mixed with steam to the turbine and comprising a combustion chamber wherein spontaneous combustion at constant volume takes place having separate ports for fuel and air, a mixing chamber adjacent to said combustion chamber, a connecting port leading from said combustion chamber and discharging the products of combustion into said mixing chamber, a steam chamber surrounding the combustion chamber and mixing chamber, means for delivering condensable medium thereto to evaporate it from the heat of the live gases radiating from said combustion chamber during the combustion, communication port between said mixing chamber and the steam chamber discharging steam into said mixing chamber, an air chamber with connection port leading into said combustion chamber, means for admitting air under pressure thereto, a fuel chamber having a connection port leading

into said combustion chamber, means for delivering fuel under pressure thereto, an exhaust hood surrounding the various chambers, adapted to guide the exhaust from the turbine around said chambers, assisting thereby in heating the working fluid, valves for controlling the connection ports between the different chambers and means for shifting said valves.

3. In an internal combustion turbine a jacketed combustion chamber having supply and outlet valves, means for supplying condensable fluid to said jacket, means for supplying intermittently fuel and air separately under pressure to said chamber, the temperature of the fuel or air being sufficient to cause spontaneous combustion at constant volume therein, a mixing chamber adjacent said combustion chamber, means discharging intermittently the products of combustion supplied from said combustion chamber into said mixing chamber, and means for discharging intermittently steam from said jacket into said mixing chamber, the discharge of the products of combustion and the discharge of steam occurring simultaneously.

4. In an internal combustion turbine, in combination a plurality of fluid pressure generators for supplying the turbine with vapor energy, a combustion chamber in each of said generators, means for intermittently admitting air under pressure therein, means for intermittently admitting fuel under pressure therein, the combustion chamber being closed after the admission of fuel and air whereby combustion at constant volume takes place, a jacket surrounding each of said combustion chambers, means feeding condensable fluid thereto to be subjected to the heat of the burning gases during the combustion, a mixing chamber adjacent to each of said combustion chambers whereto the products of combustion and the condensable fluid are intermittently discharged and mixed, a turbine wheel, a nozzle in each of said generators, that discharge the mixed fluid against the turbine wheel to produce rotation, a compressor for discharging air under pressure into said generators, a regenerator heated by the gases exhausting from the turbine, and through which the fuel and the condensable fluid passes before admitted into said generators.

5. An internal combustion turbine having fluid pressure generator supplying intermittently the turbine with motive fluid, a turbine wheel with rows of buckets for abstracting the energy of the fluid, a nozzle that receives the fluid from said generator and discharges it against the buckets of the wheel, rows of reversing buckets receiving the fluid from the wheel buckets and discharging it against the buckets of the wheel for further abstraction of the energy of the fluid, an exhaust passage connected to said fluid pressure generator, in combination with a regenerator receiving the exhaust from the turbine through the exhaust passage and having pipes carrying the fuel and condensable fluid laid in the path of the exhaust gases whereby the heat of the exhaust is abstracted by the fuel and condensable fluid.

6. In an internal combustion turbine the combination of a fluid pressure generator, means supplying separately air, fuel and condensable fluid thereto, and causing intermittently combustion at constant volume therein to produce the fluid pressure in said generator, a wheel having buckets thereon, a nozzle that discharges the fluid against the buckets of the wheel to produce rotation, an exhaust passage leading through said generator and discharging the exhaust from said wheel, a fuel delivering conduit inside said passage for abstracting the heat from the exhaust.

7. In an internal combustion turbine in combination a wheel provided with buckets thereon, a fluid pressure generator supplying said wheel with working fluid, a combustion chamber within said generator having supply and exhaust ports, means supplying air and means feeding fuel into said combustion chamber to cause intermittently combustion at constant volume therein, a steam jacket surrounding said combustion chamber and having a discharge port, means delivering condensable fluid into said jacket, piston valves in said fluid pressure generator for controlling the ports for the admission of fuel and air, piston valves for controlling the discharge of the working fluid and means operatively connected to said wheel for actuating said piston valves.

8. In an internal combustion turbine in combination a turbine wheel, a plurality of fluid pressure generators having a combustion chamber surrounded by a steam chamber for supplying the turbine wheel with vapor energy, means for discharging the vapor energy from said generators against the wheel to cause rotation, jacketed segmental blocks interposed between said generators and having reversing buckets thereon to direct the vapor energy against the turbine wheel, side walls fastened to said generators and blocks, said walls being chambered to receive cooling fluid, an air compressor with jacketed cylinders for discharging air under pressure into said generators, a regenerator which receives the exhaust from the turbine, pump delivering cooling water into the jacket of said air compressor, conduits to conduct the water therefrom and convey it into the chambers of said side walls which increases the temperature of the water, conduits for trans-

ferring the water from said chambers through said regenerator and returning it as steam into the jackets of said segmental blocks, wherefrom the steam enters the steam jackets.

9. In an internal combustion turbine in combination a turbine casing, fluid pressure generators secured to said casing for supplying the turbine with vapor energy, a wheel-shaft, a turbine wheel with buckets mounted on said shaft, means adapted to receive the vapor energy from said generators and discharge it against the buckets of the wheel to cause rotation, a regenerator heated by the gases exhausting from the turbine, conduits carrying fuel and water through the regenerator, conduits discharging the exhaust from the turbine into said regenerator which increases the temperature of the fuel and water, conduits to deliver the heated fuel and water vapor respectively from said regenerator into the fluid pressure generators, a condenser connected to said regenerator to condense the steam in the exhaust and means for removing the exhaust from said condenser.

In witness whereof I have hereunto set my hand the 25th day of February, 1911.

FRANZ WONDRA.

Witnesses:
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