

[54] ROTARY ENGINE

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[51] Int. Cl..... **F02b 53/06, F01c 1/00**

[58] Field of Search..... **123/8.01, 8.09, 8.31, 123/8.27; 418/12, 243, 244-251, 86, 88**

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Primary Examiner—Allan D. Herrmann
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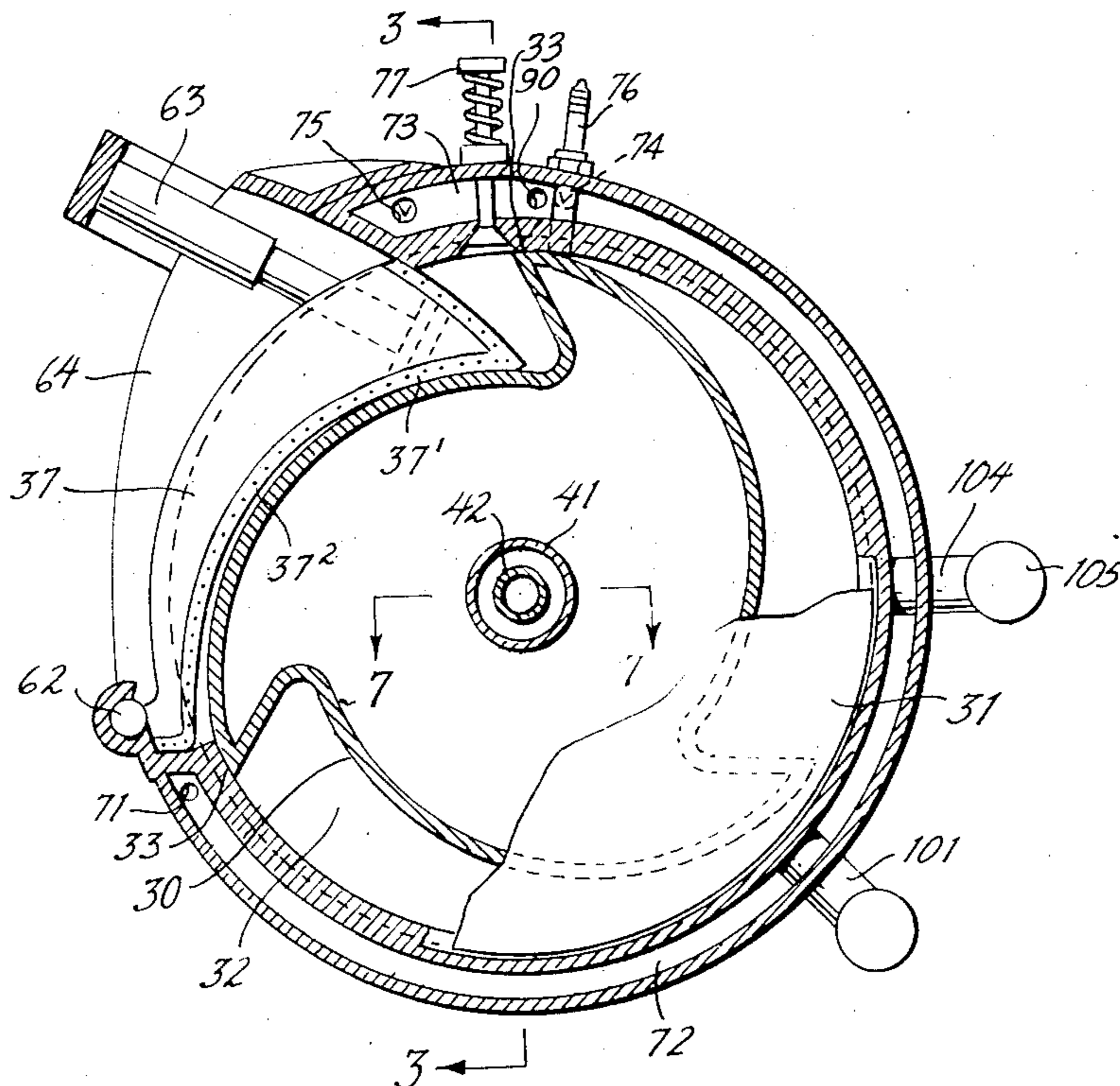
[57] **ABSTRACT**

A rotary engine having a power generating rotor with a plurality of chests at the outside of the rotor, the rotor being rigidly connected to a concentric shaft and within a housing of circular cylindrical form. Each of the chests has a power generating or pressure wall and

a trailing cam, and the chest which delivers the fuel generating stroke is closed at that time by a plunger and the circular housing of the rotor. In one form of the invention, combustion drives the rotor around. The highly compressed combustion gases escape through an exhaust port as the chest is rotated to coincide with the position of the exhaust port. The chest then comes to an air intake while some part of it still communicates with the exhaust port, The rush of air into the chest helps the exhaust gases, which have gained some momentum during escape, to clear out of the chest into the exhaust pipe. Some air goes out of the exhaust port sweeping combusted gases ahead of it. The chest is then filled with partly pressurized air and rotates to a position where the plunger enters it and further pressurizes the air by reducing the free space available in the chest, suitably by spring action. Just as the plunger reaches the lowest position in the chest, the charge valve opens and injects superheated fuel vapor into the air in the enclosed space of the chest. A spark ignites the highly compressed mixture, and the expansion caused by combustion rotates the rotor around. The operation is continuous and the output torque is taken by the drive shaft which is concentric with the rotor and the housing. The number of chests in the rotor is subject to design variation, but at least three will be used in this form. The fuel is vaporized and superheated in a jacket of the rotor housing before entering the chest in the rotor. The engine does not require conventional cooling equipment or a conventional carburetor and does not require air and exhaust valves.

A variation of the engine operates on steam, introducing steam into the chest which has the plunger at its innermost position, and exhausting steam at a more advanced position at which another chest communicates with the exhaust.

10 Claims, 16 Drawing Figures



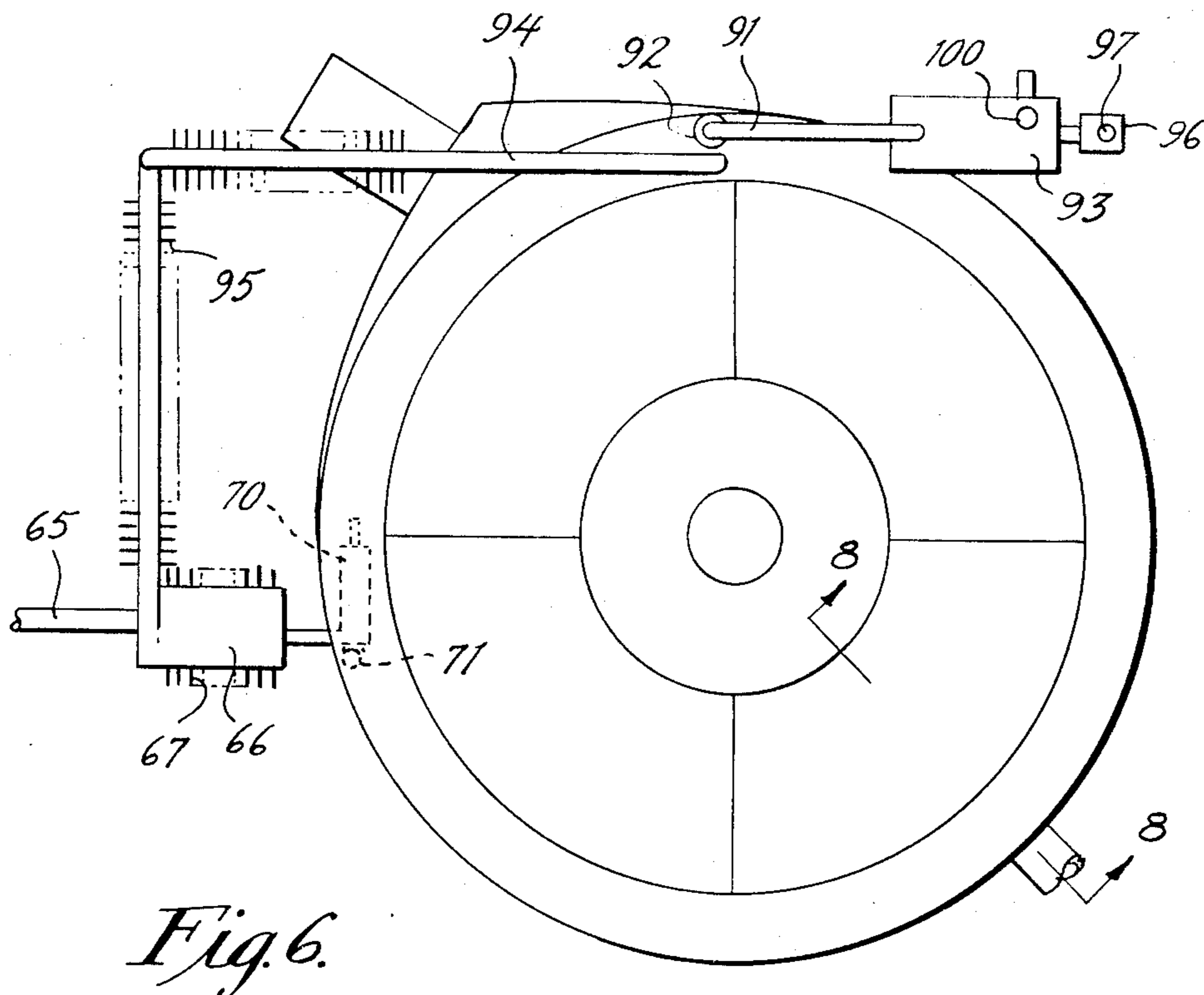
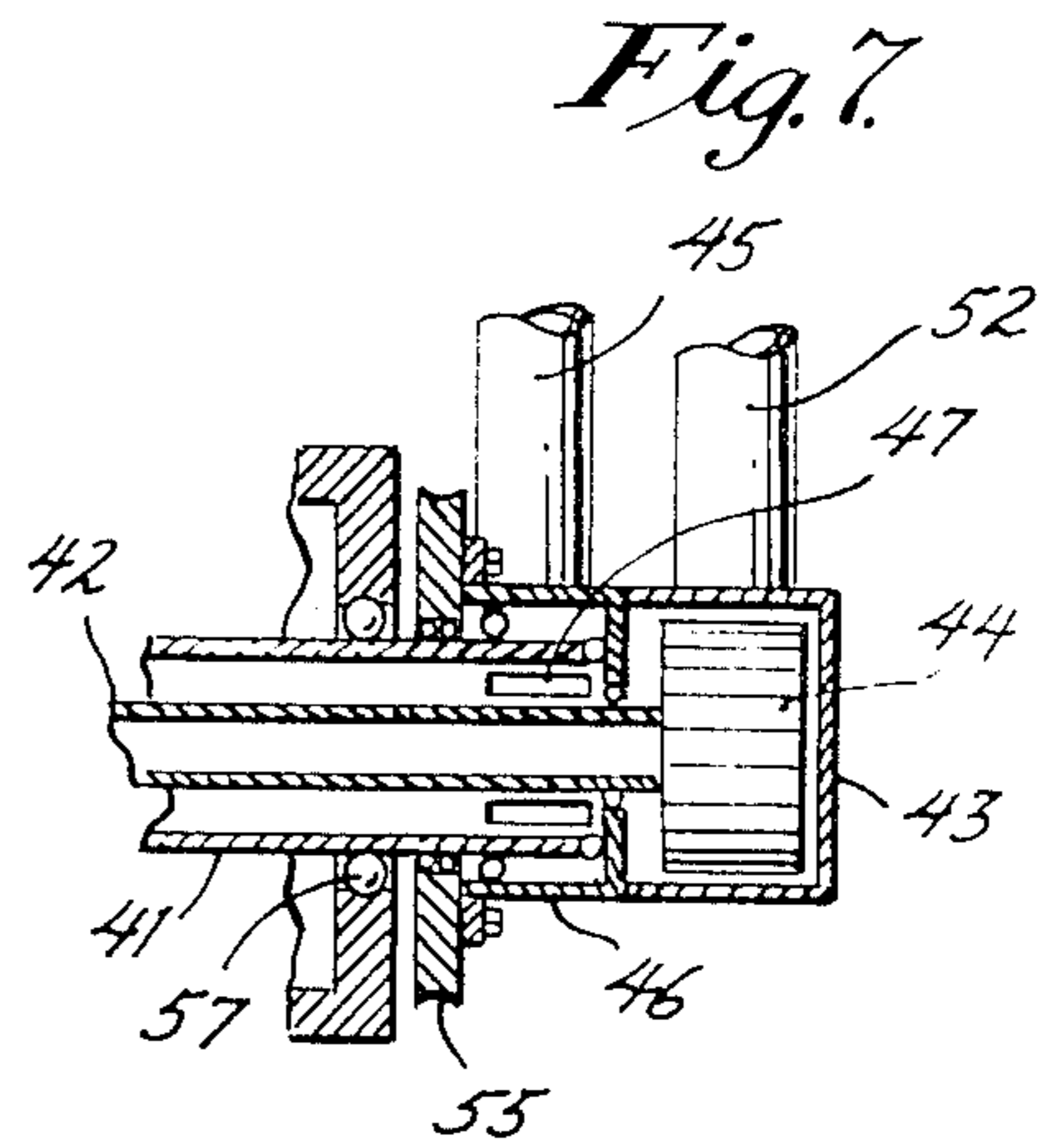
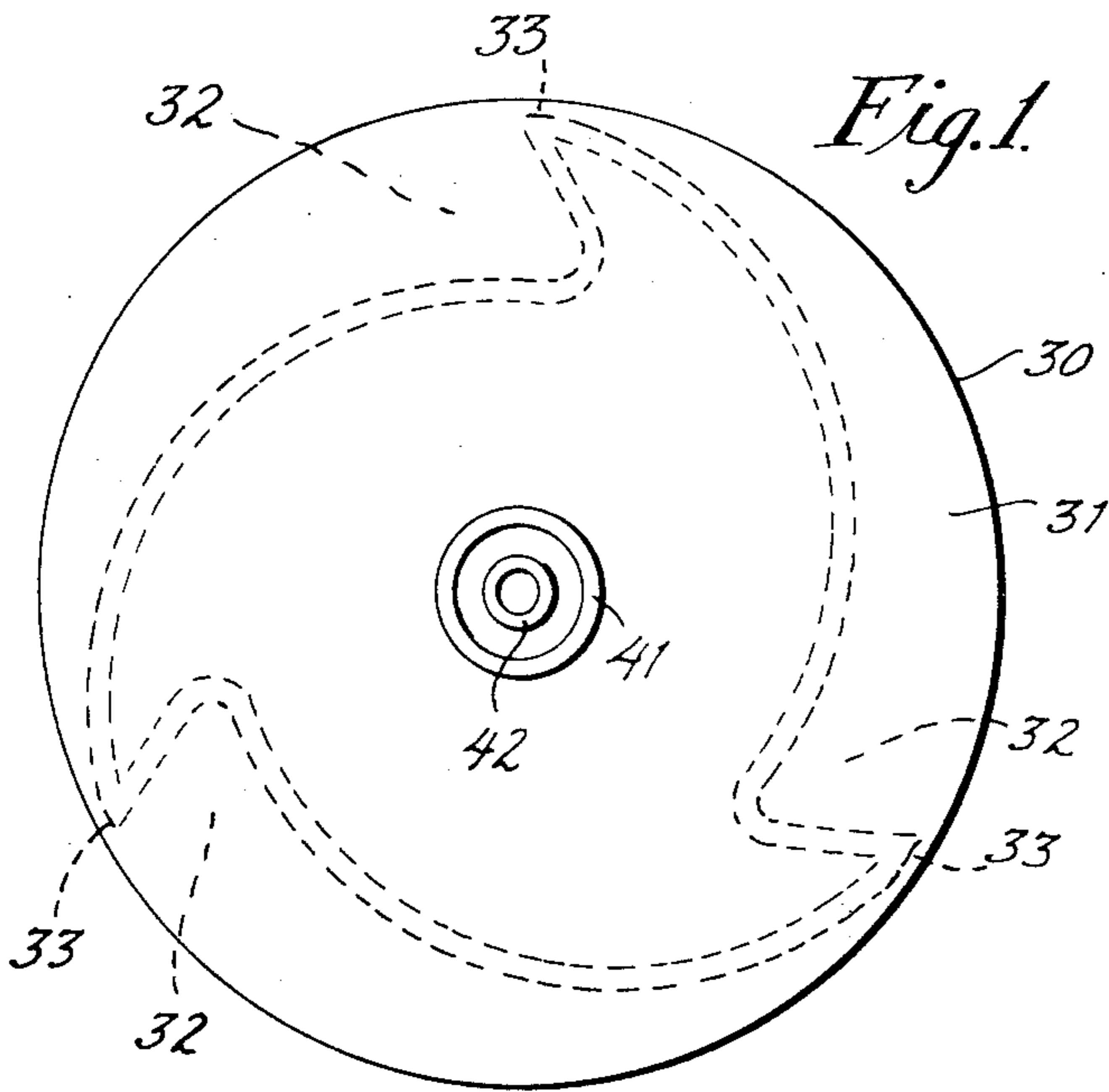


Fig. 6.

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Fig. 3.

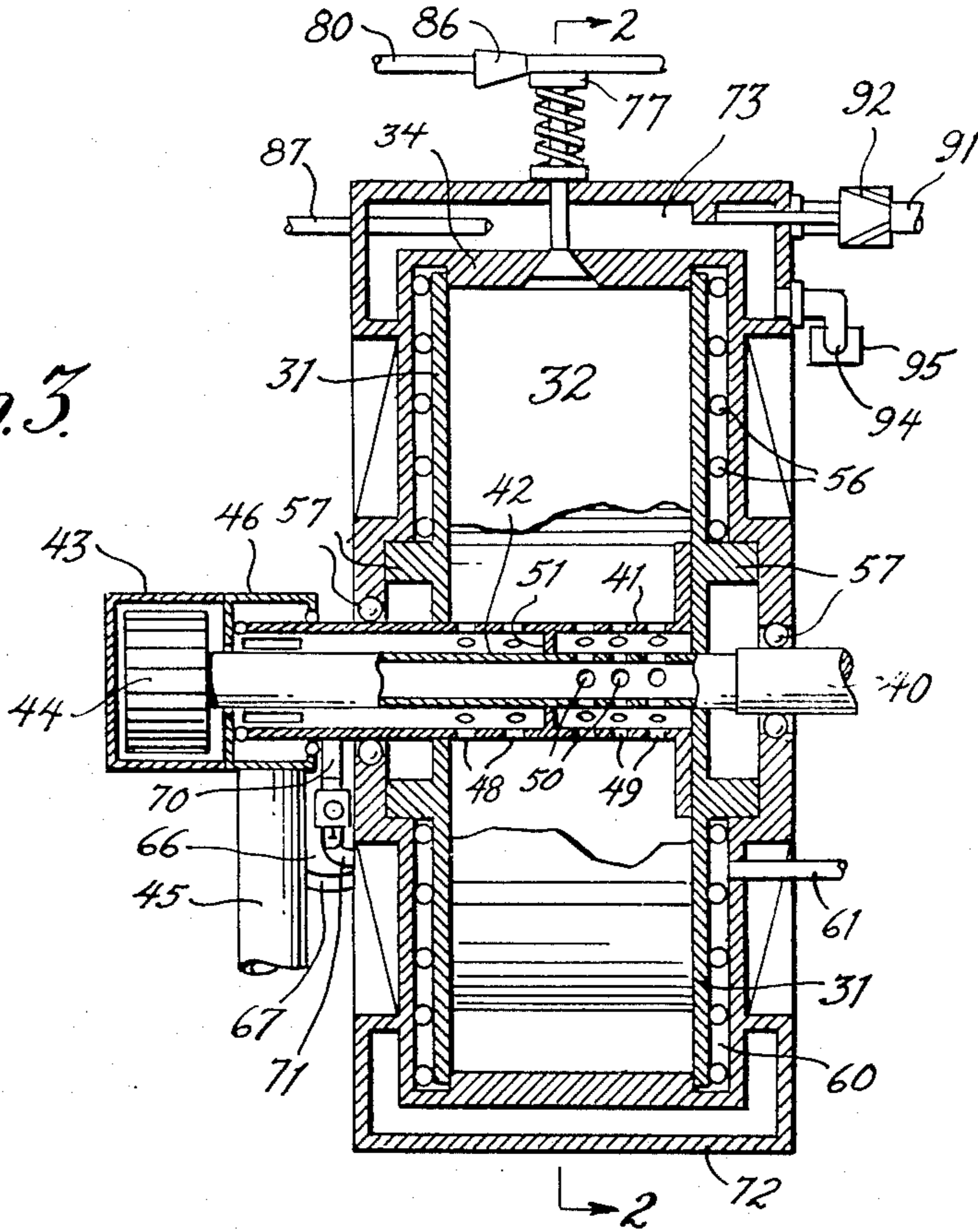
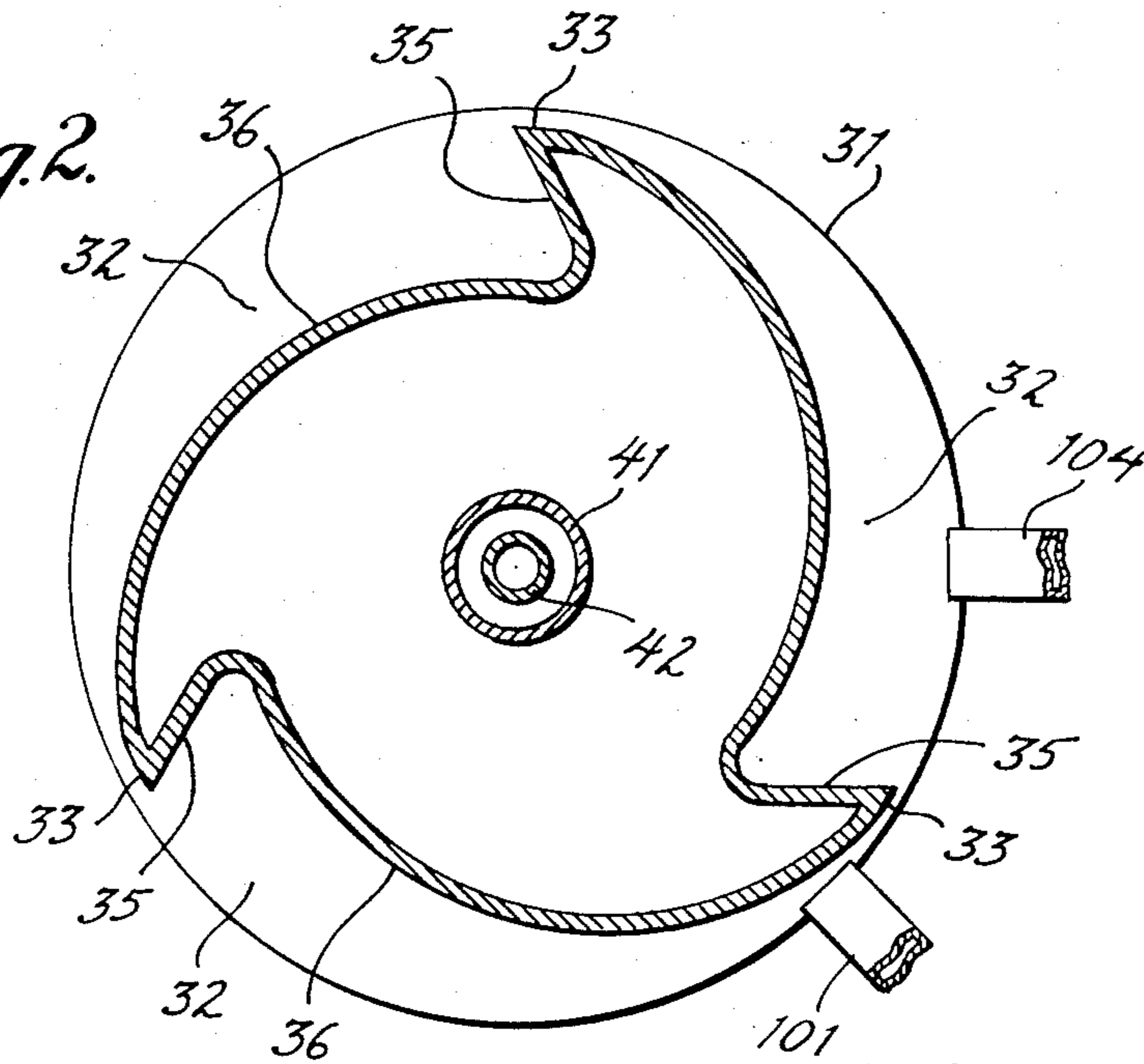


Fig. 2.



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Fig. 5.

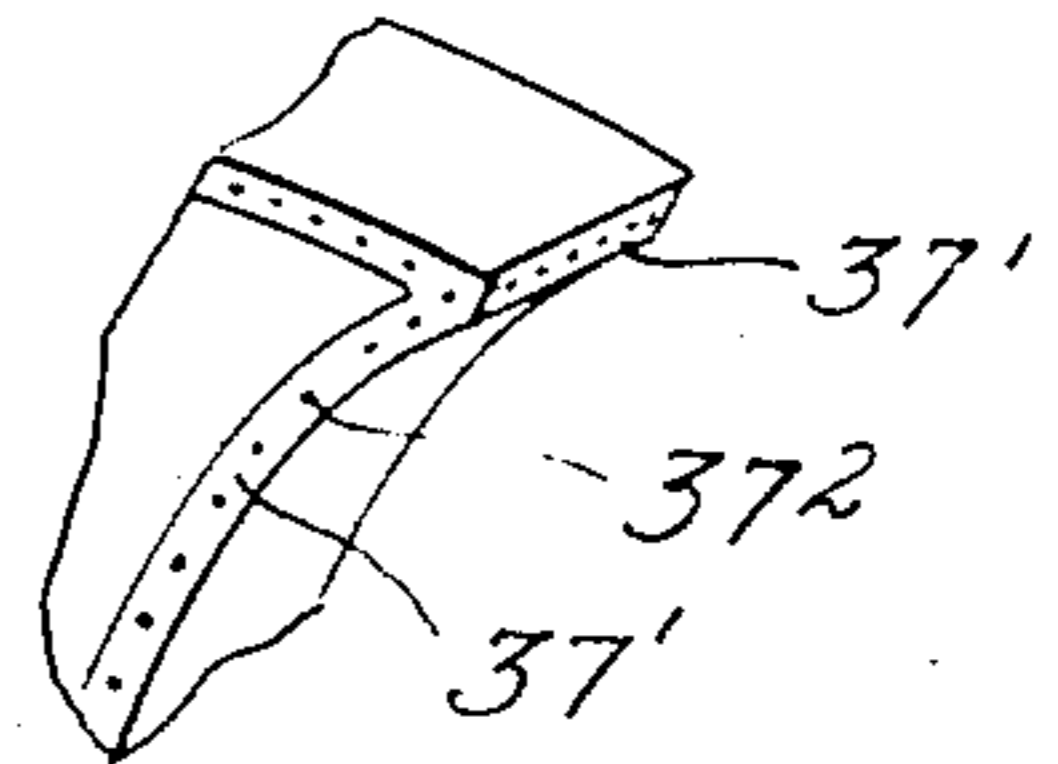
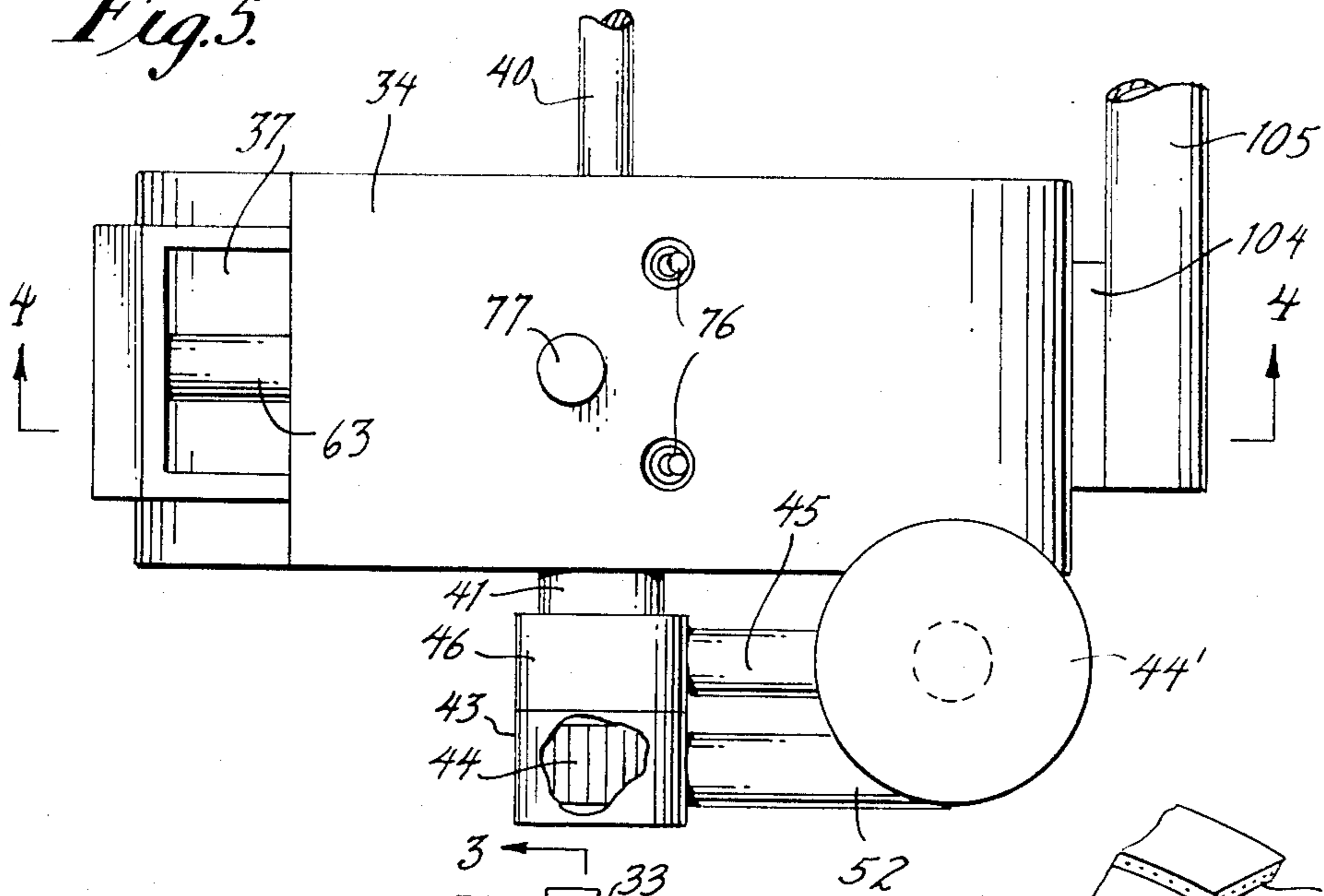


Fig. 4a.

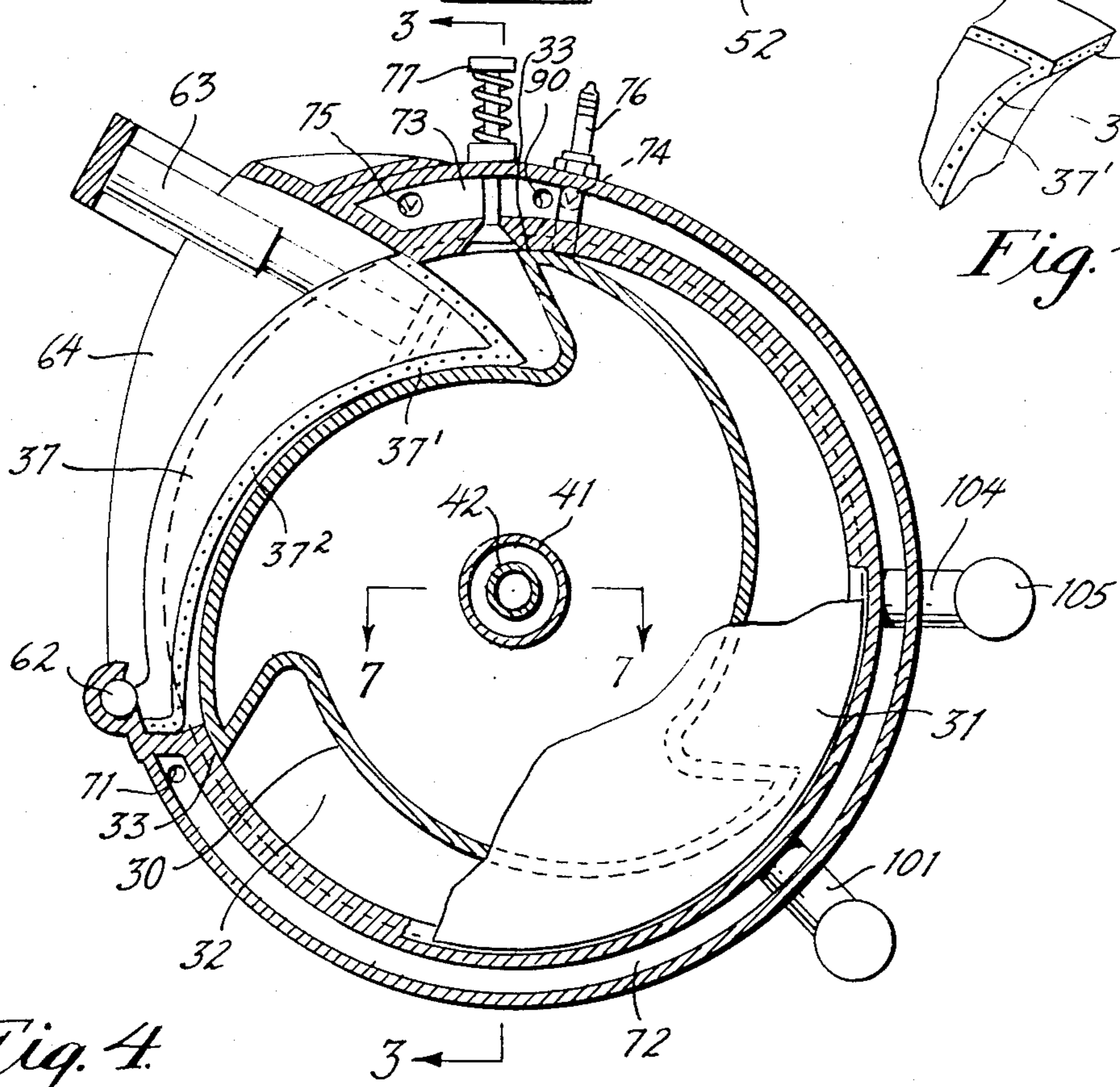


Fig. 4.

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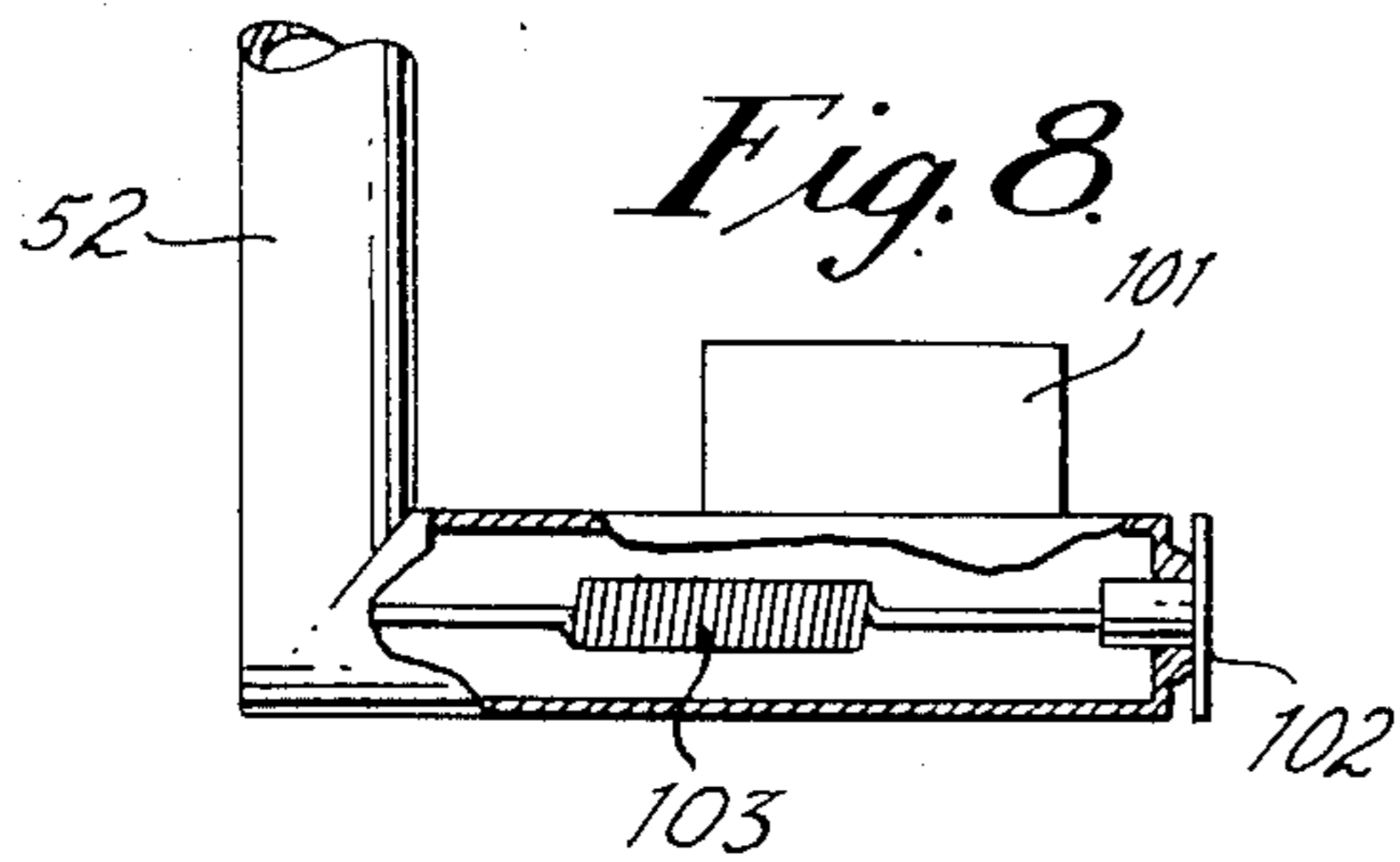


Fig. 8.

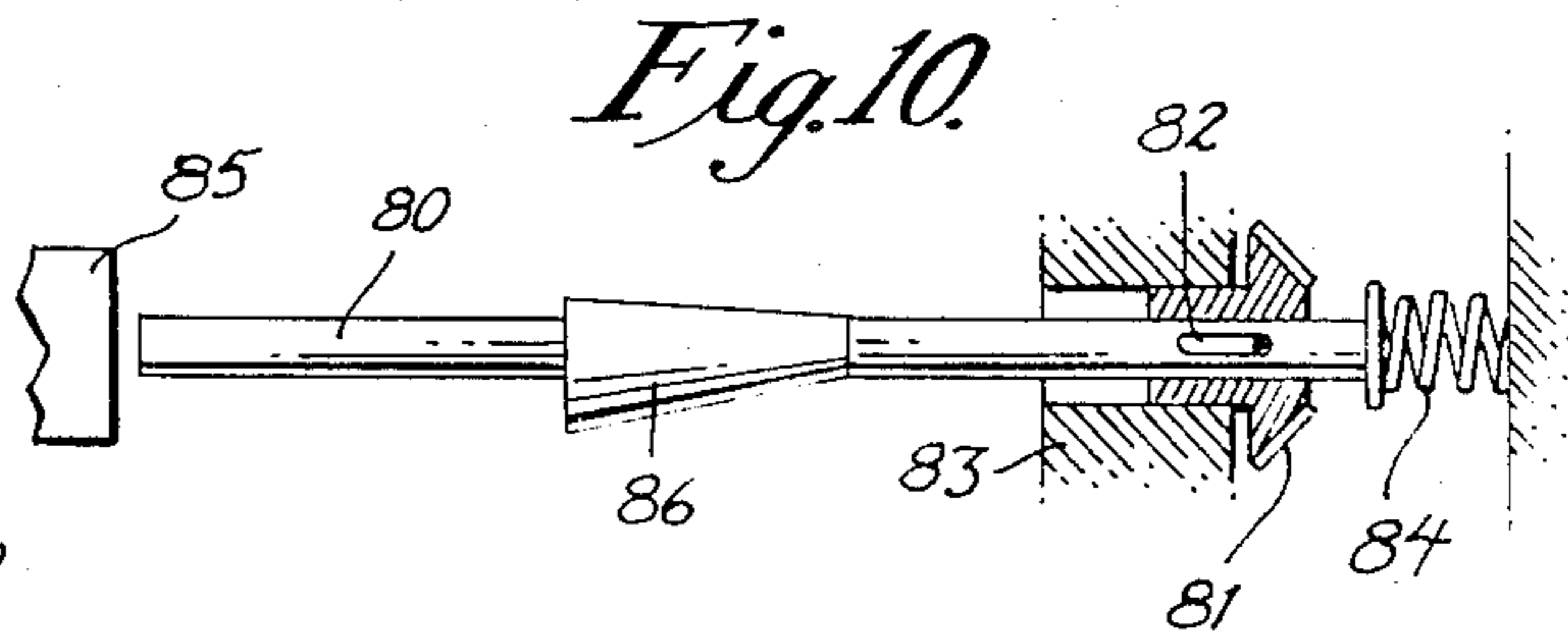


Fig. 10.

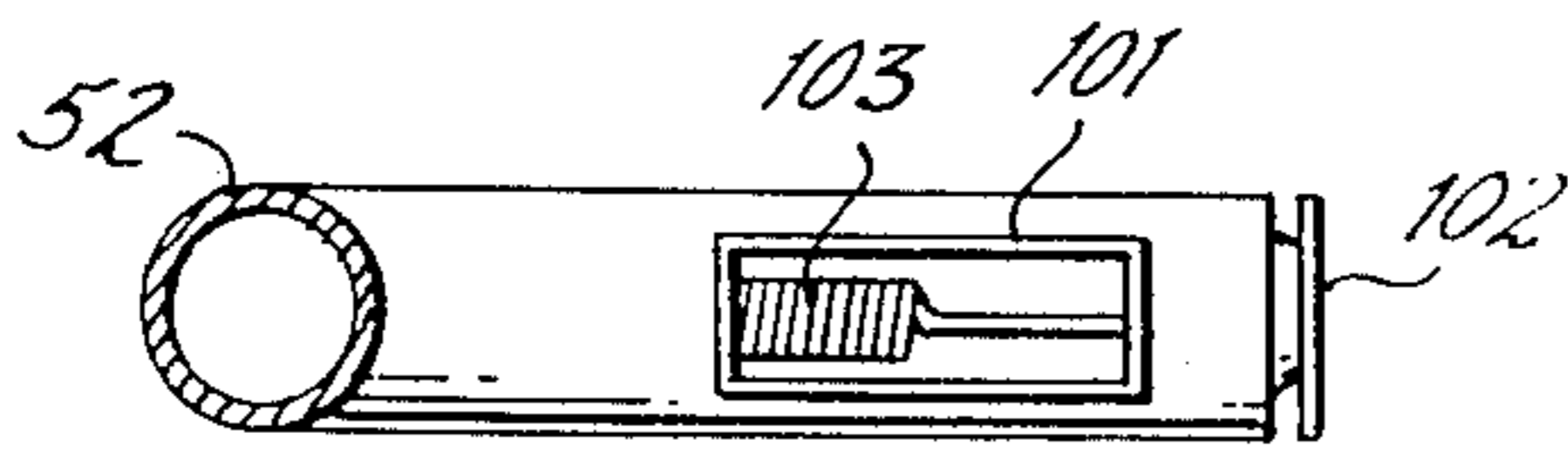


Fig. 9.

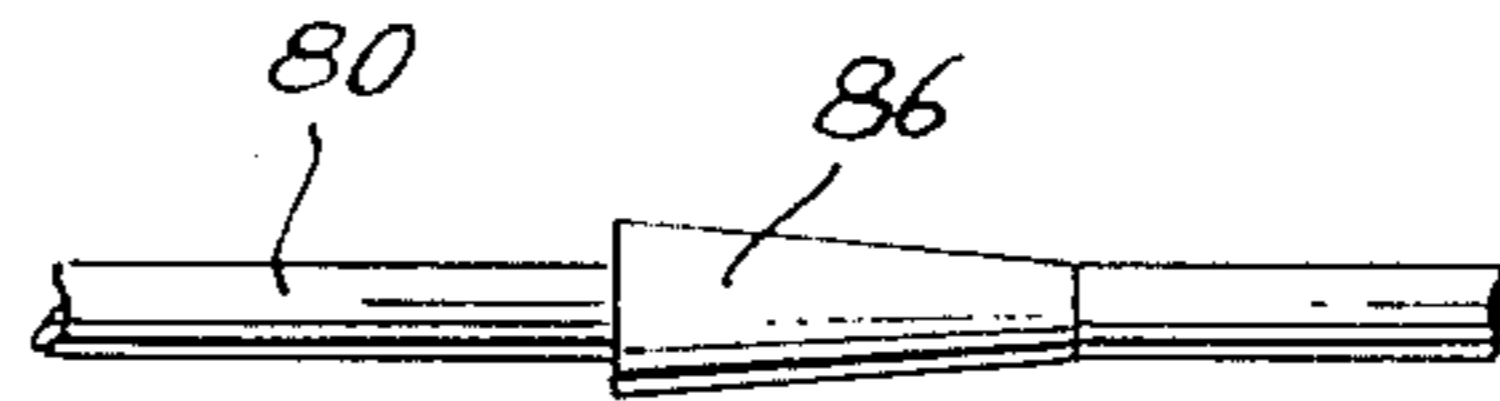


Fig. 11.

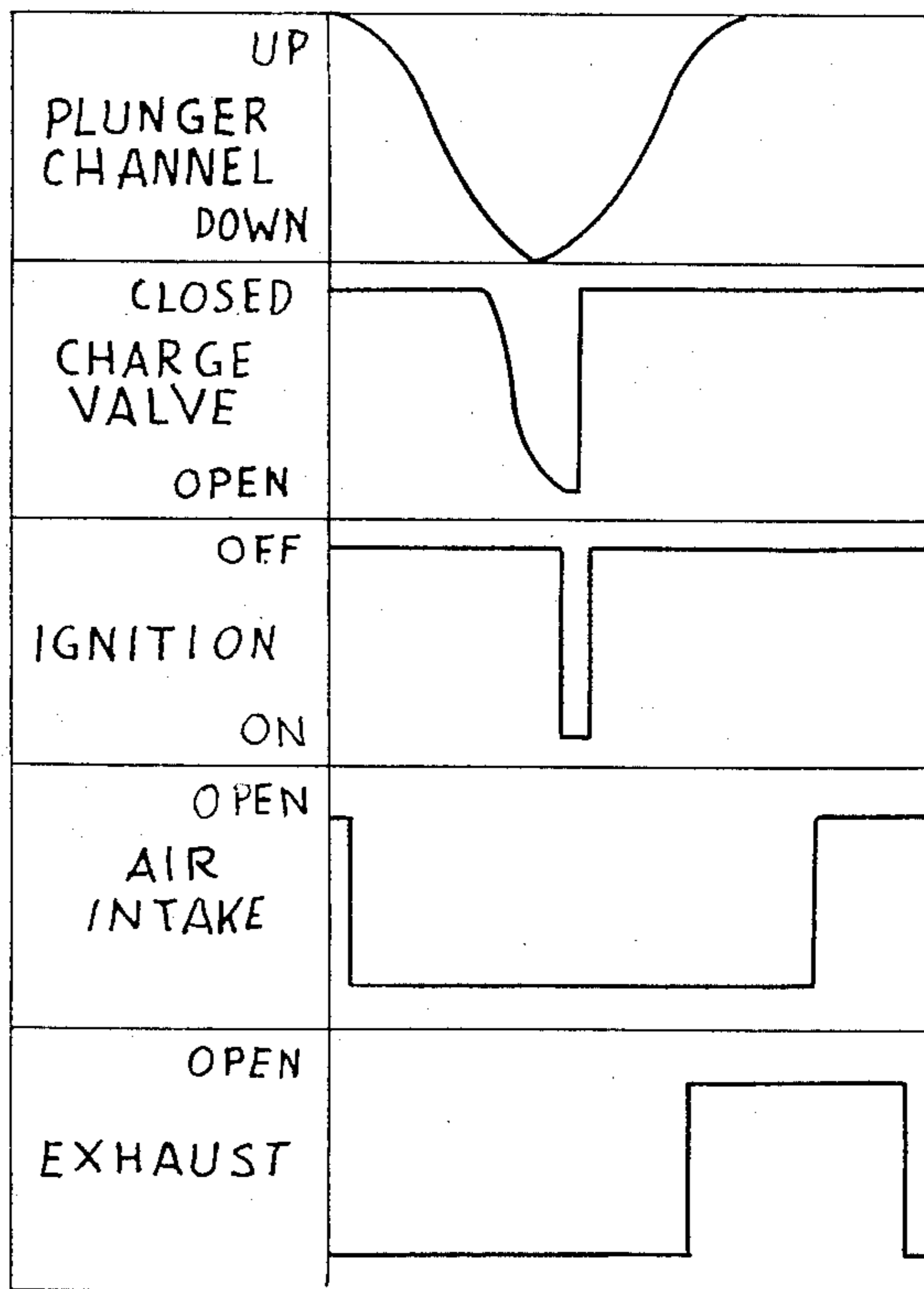


Fig. 12.

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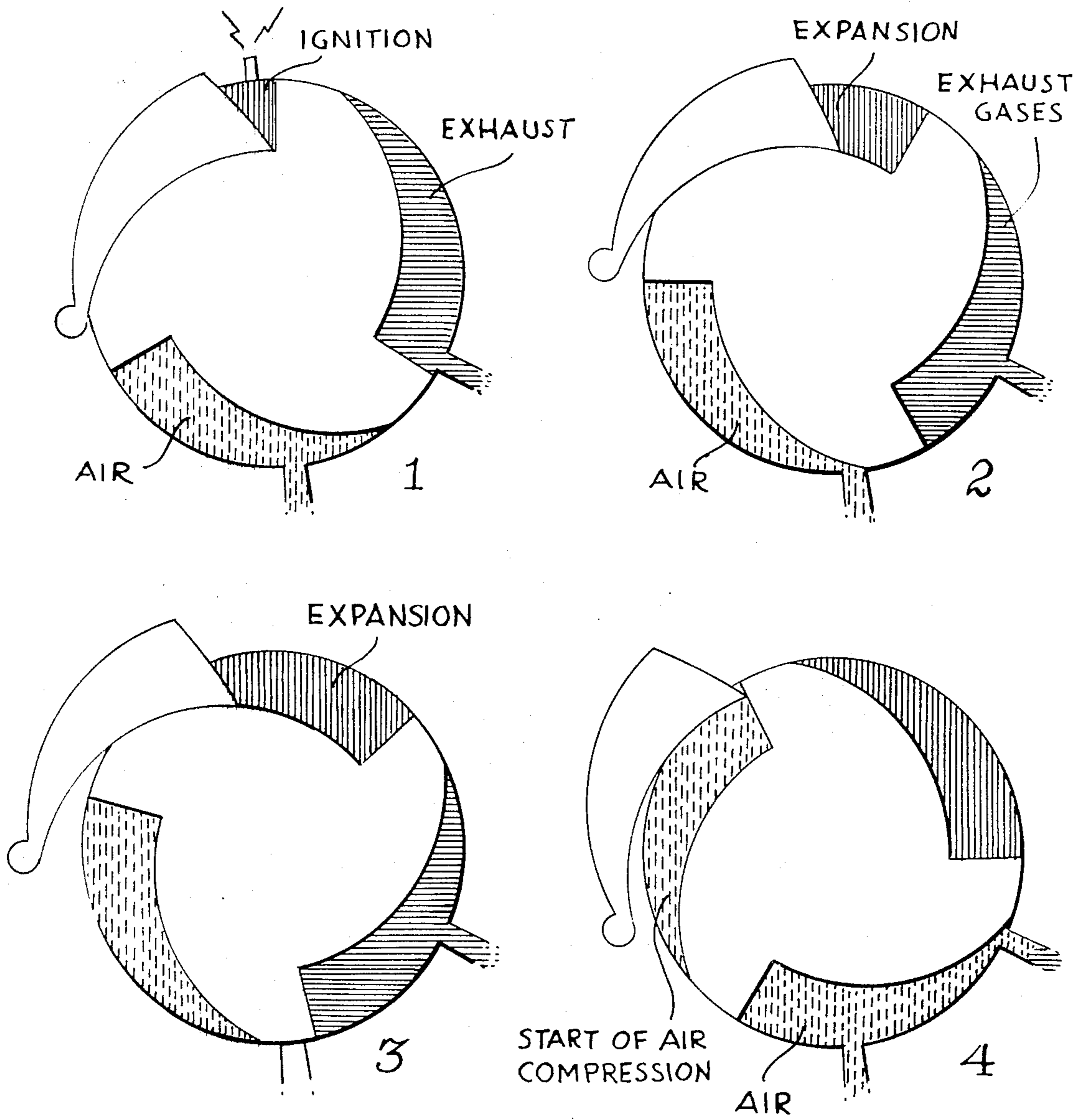


Fig. 13.

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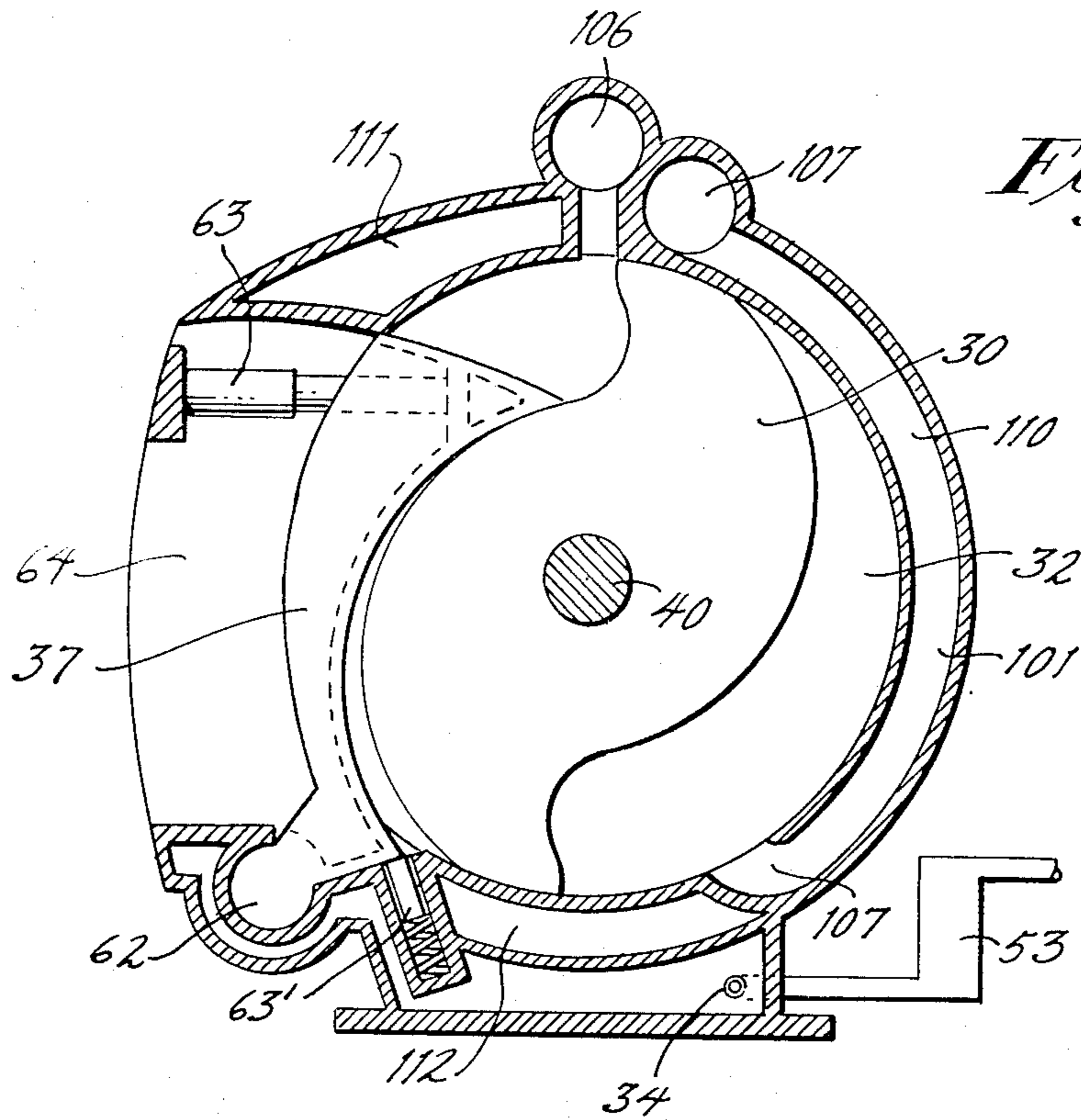


Fig. 14.

UP PLUNGER DOWN	
YES INLET NO	
YES EXHAUST NO	

Fig. 15.

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ROTARY ENGINE

DISCLOSURE OF INVENTION

The present invention relates to a rotary engine having a concentric rotor operating in a concentric housing affixed to a concentric shaft. The engine may operate as an internal combustion engine or as a steam engine.

In the internal combustion engine, which will be described first, the usual type of cooling is not used and air and exhaust valves are not required.

The engine has a relatively large cylindrical rotor with chests forming radial pockets in its outside circumference. The rotor includes two circular side plates which provide side limits for the chests and the outside circumferential wall is closed by a circular housing. The rotor is hollow and is cooled from within by air drawn through a blower operated by the rotor shaft. In the present design, it is contemplated that the rotor will turn clockwise, although it can be made to turn counter clockwise, if desired. The rotor freely rotates inside the housing supported by suitable bearings. The outer edge of the rotor closely fits the inside of the circular housing. The drive shaft is rigidly connected at the center to one end of the rotor and at the other end there are two concentric hollow drive shaft extensions extending opposite from the drive shaft to a blower and air filter. The air is drawn through the air filter and the outer hollow shaft into the rotor and heated by heat transfer from the rotor and blown under partial compression into the chest which is in communication with the air intake.

The engine can be enlarged in size by increasing its diameter, increasing the size of the chests, increasing the number of the chests so that there are two or more chests operating as power cylinders at the same time, or the engine can have several different rotors along the shaft. The power output of the same engine can be increased by increasing the pressure of the fuel entering the chest for the power stroke or by increasing the pressure of the air entering that chest.

The power chest is partially closed and restricted in space by a plunger, preferably supported by a hinge on the housing and pressed down by a spring supported on the housing.

Ignition is accomplished by spark plugs located along the top of the cylinder, preferably at each side. A fuel charge valve is located preferably at the top of the cylindrical housing. The air intake and the exhaust port are located about 50° from each other so that one chest will bridge them at the beginning of air injection. The fuel for the engine is suitably colorless kerosene which does not leave any residue behind when evaporated. The fuel is pumped into a jacket within the rotor housing. Part of the heat of combustion passed to the cylindrical housing will superheat and vaporize the pressurized fuel. Injection of this pressurized charge increases the power output. The charge valve will be operated by a shaft with tapered cam or cams depending on the number of rotors.

Fuel is supplied to a fuel pump from an intermediate tank and the fuel pump pumps to the jacket. A by-pass is provided from the upper part of the jacket under the control of a relief valve so as to relieve excess pressure. The intermediate tank and the by-pass have fins around them so as to be cooled by the air. In case of excess heat build-up, a control thermostat located on the top

of the jacket lengthens the stroke of the fuel pump electrically so that the excess heat will be carried away by increased fuel circulation through the jacket and the by-pass line.

The topmost of the jacket forms a vapor accumulator where an air vent is provided to let out air from the jacket the first time that the system is filled with fuel.

Fuel for the starting period when the engine is cold is gaseous fuel of the type of propane which does not liquefy in kerosene and will be supplied to the upper part of the jacket under pressure until enough heat will build-up to vaporize the liquid fuel.

While there have been previous attempts to design rotary internal combustion engines, none of them, as far as I know, uses the operating principles of the present engine. The prior art does not provide for injection of fuel into a rotor chest in superheated vapor form with a high pressure than that of the compressed air by using a plunger entering the chest. In this engine the supercharging and pressurization are done by the heat of combustion which otherwise had to be carried away at the cost of some output power.

Operation of the engine is continuous and rotation of the rotor is accomplished by combustion in one chest after another as far as possible removed from the center so as to render maximum effective torque. The engine offers tremendous advantages from a construction standpoint due to the circularity of the housing, the circularity of the rotor, and the rigid concentric connection between the shaft and the rotor, making possible the automatic manufacture of parts.

The engine is very flexible with respect to arrangement for usage and power output. The rotors can have two chests and one plunger, three chests and one plunger, four chests and two plungers, five chests and two plungers, six chests and two plungers, six chests and three plungers, seven chests and three plungers, and so on. The rotors can also be mounted along the central shaft displaced axially. In case of rotors with more than one plunger, proper piping should be installed to carry the fuel, the air, and the exhaust.

Considering now for the moment the application of the invention to a steam engine, much of what has been said applies, except for the fuel, air and exhaust systems. The steam engine rotor can be made with two or with more chests as preferred and with two or more rotors. One of the chests is equipped with a plunger and when the chest space is reduced to a minimum by the plunger, steam is admitted and the plunger is forced out of the chest by rotation of the rotor. The other chest, if there are only two, opens to exhaust. If there are several chests, one may be equipped to admit steam and the other to exhaust. Intermediate between the exhaust and the admission of steam the housing is preferably cooled, as by air.

In the drawings I have chosen to illustrate a few only of the numerous embodiments in which the invention appears, selecting the forms shown from the standpoints of convenience in illustration, satisfactory operation, and clear demonstration of the principles involved.

FIGS. 1 to 13 relate to the internal combustion engine, and FIGS. 14 and 15 relate to the steam engine form.

FIG. 1 is a detail side view of the rotor and drive shaft.

FIG. 2 is a section of FIG. 3 on the line 2—2, showing the rotor in section.

FIG. 3 is a section through the rotor housing and rotor on the line 3—3 of FIG. 4.

FIG. 4 is a section of FIG. 5 corresponding in position to the line 4—4 and including the housing.

FIG. 4a is a fragmentary perspective of the plunger nose, showing the ceiling strips and the lubrication ports which are used in the invention.

FIG. 5 is a top plan view of the rotor housing, partially broken away to disclose the blower.

FIG. 6 is a side elevation of the engine of the invention showing various auxiliaries.

FIG. 7 is a section of FIG. 3 on line 7—7, showing the details of the blower and related construction.

FIG. 8 is a fragmentary section of FIG. 6 on the line 8—8.

FIG. 9 is a fragmentary detail of FIG. 8 corresponding to the position at right angles to FIG. 8.

FIG. 10 is an enlargement of the cam operating mechanism of FIG. 3 sectioned along the axis of the cam shaft.

FIG. 11 is a bottom plan view of the cam of FIG. 10.

FIG. 12 is a chart of operation of the internal combustion engine.

FIG. 13 is a series of position diagrams, 1 to 4, showing the combustion (position 1) and exhaust (position 1), the expansion (positions 2 and 3) and the entrance of air into the chest (positions 3 and 4). Position 4 shows the start of air compression.

FIG. 14 is a view of the steam engine corresponding to the position of FIG. 4.

FIG. 15 is a chart showing the operation of the steam engine of the invention.

Describing first the internal combustion engine, it has a rotor 30, which is provided with two circular plates 31 at the sides, a series of chests 32 (three are shown;) and between the chests a sliding circular cylindrical crown 33 concentric with the rotor. The rotor is housed within a housing 34 which has an internal circular surface in close proximity to the sliding crown 33. The side plates 31 seal with respect to housing 34. Each of the chests has a forward pressure wall 35 and a cam surface 36 which joins the forward pressure wall at a relatively deep portion of the chest and which forms a cam extending radially outward until it encounters the next crest 32.

The end plates 31 and the cam surface 36 are smooth and fit closely providing easy movement with a plunger 37 which seals in the chest at one point in the circumference. The plunger has ceiling strips 37' on its radial edge and its sides which engage the rotor, and it has ports 37² which allow oil to come to circulate from the interior of the rotor to the ceiling strips to lubricate the plunger as the rotor rotates. The rotor is mounted rigidly and concentrically on a drive shaft 40 which protrudes from one end of the rotor. The drive shaft 40 continues through the center of the rotor in the form of two concentric shafts 41 and 42. The shaft 42 is hollow and rotates the blower 44, in a stationary housing 43, joined to the moving ports by bearings and seals, to draw air through the interior of the shaft 42.

Blower 44 creates suction which draws air through air filter 44', then through pipe 45, into annular box 46, then through ports 47 into the space between shafts 41 and 42. The air passes through radial ports 48 into the interior of rotor 30, where it cools the rotor. The air is

drawn out of the ports 49 and 50 into the interior of shaft 42, it being prevented from mixing with intake air to the interior of the rotor by baffle 51. The air is then drawn through the interior of blower 44, and expelled through pipe 52 to air intake to the rotor chests before they encounter the plunger.

Pulley 55 is mounted on shaft 41 to provide a power connection for accessories, as shown in FIG. 7.

The rotor rotates in the housing 34. The rotor 30 is laterally supported inside the housing 34 by bearings 56 and is centrally supported by bearing 57 around the shafts connected to the housing. Between the lower part of the rotor 30 and the housing 34 there is a space 60 for holding oil for lubricating purposes, fed by an oil line 61. Openings are provided in the crowns 33 of the rotor 30 to distribute oil.

The plunger 37 connects to the housing 34 by hinge 62 which is at the trailing end of the plunger so that the plunger can pivot and enter the chest, but will be cammed outwardly by the cam surface of the chest. The plunger is pushed into the chest by spring damper assembly 63 which is supported by the housing. The plunger 37 is sealed at the sides by the housing 34 but is open radially outward to be subjected to air cooling. The plunger 37 moves in and out between the sealing rotor side plates 31 and the sealing area 64 between the interior sides of the housing located flush with the wall side plates. When the plunger is in its lateral inward position, it closes one end of the chest, and at the same time restricts the space within the chest and compresses gas within the chest, which gas has come into the forward part of the chest from the rear of the chest by passing under the plunger during the time required for it to descend from its upper position to its bottom-most actual position, against the bottom wall of the chest, — after the forward wall of the chest has passed under the plunger to free it for this descent.

THE FUEL SYSTEM

Fuel from a main tank (not shown) enters by a fuel line 65 into an intermediate tank 66 which has fins 67 around it. From the intermediate tank 66 the fuel is pumped by a fuel pump 70 of positive pressure type with an adjustable stroke as well known capable of developing a pressure sufficient to enable the fuel when converted to vapor to be injected into the chest at the end of a pressure stroke of the engine. The pump 70 is suitably driven from an extension of shaft 40 and the quantity of fuel pumped is adjustable according to the temperature of the engine, the details of the adjustment being well known. From the fuel pump 70 the fuel passes through an opening 71 into a jacket 72 within the housing in heat transfer relating with the rotor. The topmost area of this jacket forms a vapor accumulator 73. From the vapor accumulator there is a relief valve 74 operating under excess pressure to return fuel by a bypass to the intermediate tank. The vapor accumulator also communicates with an air discharge valve 75 which eliminates the air from the space for the purpose of starting, under the control of the operator and thus serves as an air vent.

There are two spark plugs 76 on the top of the housing with spark tips effective to discharge sparks and ignite in the chest opposite that point. A charge valve 77 located at the top of the inside of the housing opens from the vapor accumulator 73 to the chest immediately laterally inside it which is filled with compressed

air. The charge valve 77 will be closed when the engine is not operating and will have a valve opening when the engine is operating depending on the position of the accelerator to obtain various speeds by power variation, and the rotor position. A shaft 80 will rotate with a gear 81 by an intermediate drive from shaft 40 to time the opening of the charge valve. The shaft 80 engages the gear 81 by a spline 82 so that the shaft is longitudinally free for movement in bearings 83. A compression spring 84 forces the shaft 80 endwise. A lever connection 85 from the accelerator moves the shaft 80 endwise, and by a tapering longitudinal and rotary cam 86 depresses the charge valve 77.

There is a pressure and temperature control 87 which has its sensing element at the top within the vapor accumulator and, as the pressure drops, turns off the engine since this indicates a failure to operate correctly. When the vapor accumulator becomes excessively hot, the control 87 increases the stroke of fuel pump 70 by means well known. This is shown in FIG. 13. In the top of the vapor accumulator there is an inlet port 90 which is fed by line 91 having a thermostatic check valve 92 opening in the direction of the vapor accumulator. The line 91 connects to a small gaseous fuel tank 93 which contains compressed gas. If the engine is cold at the time of start, the thermostatic check valve 91 will open allow gas to enter into the vapor accumulator and will drive liquid fuel out through the relief valve 74 into a by-pass line 94 cooled by baffles 95 and which communicates with the intermediate tank. As the engine runs, heat transferred through the housing to the jacket vaporizes the liquid fuel and the thermostatic valve 92 will shut off gas entry from the tank 93 and the heat of combustion will vaporize the fuel in the vapor accumulator. The vapor is superheated and is supercharged into the combustion chest. The pressurized gas tank 93 is fed by an electric pump 96 through a port 97 from a main gas tank (not shown). The tank 93 should always contain pressurized gas so that as soon as the pressure drops due to gas entering the vapor accumulator, a pressure indicator 100 will activate the electric pump motor 96 to maintain uniform pressure. When the engine is turned off, the vapor in the vapor accumulator liquefies and decreases in volume, causing gas to enter the vapor accumulator and maintain fuel in there for subsequent starting.

AIR INTAKE AND EXHAUST

Air intake is accomplished by blower 44 blowing heated air drawn from the hollow interior of the rotor, through pipe 52 and duct 101 which leads to chest 32. The air is blown at some pressure. The throttle valve 102 can be adjusted by tension spring 103 to let excess air out.

The exhaust escapes through duct 104 in the housing into exhaust line 105. The ducts 101 and 104 preferably have a narrow rectangular opening with the longer side spanning the distance between the rotor plates 31. There is no control requirement for intake or exhaust.

OPERATION OF INTERNAL COMBUSTION ENGINE

The fuel system is filled with liquid fuel up to the level of relief valve 74, while the air vent 75 is open and then the air vent is closed. Compressed gas enters the vapor accumulator to insure that all entrapped air is replaced by gas, before the air vent is closed. The gas will

enter the area 73 until equilibrium is obtained between the pressure in the tank 93 and the pressure in the area 73. Now the engine is started and the fuel consumed will be gas until enough heat is obtained to vaporize liquid fuel. As soon as a steady stage of operation occurs, the heat of combustion absorbed by the housing and jacket will vaporize liquid fuel. Since the liquid fuel is under pressure, the boiling point will rise and the vapor obtained is superheated vapor.

When the chest 32 rotates by turning the rotor to a position at which the plunger is released, the compression stroke starts. The plunger by entering the chest compresses the air into the front part of the chest. Just before completion of the compression, the charge valve 77 opens and supercharges the mixture as shown in FIG. 12. The charge valve then closes and ignition occurs, and combustion causes the rotor to turn.

As the rotor turns, the crest and the main surface of the chest pushes the plunger laterally outward.

Expansion due to combustion turns the rotor, the chest which is filled with combusted gases reaches a position opposite the exhaust as shown in FIG. 2, and the burnt gases escape through the exhaust. As the rotor continues to rotate the chest, which has been exhausting, it rotates to opposite the air inlet, while the same chest is still trailing in front of the exhaust. The rush of compressed air helps the escaping gas which has gained some momentum to clear out the chest space.

As the rotor continues to turn, it ceases to be in communication with the exhaust and is in communication with the air intake only which fills the chest with air.

FIG. 12 shows the positions for one chest only.

With the chest full of air, the plunger comes down and compresses the air, and the charge valve opens as the plunger is reaching the lowest position. At the closing of the charge valve, the ignition occurs and the plunger moves up as the chest rotates. The burnt gases go out of the exhaust when the chest comes to exhaust position. Further rotation places the same chest out front of the air intake.

OPERATION OF STEAM ENGINE

As shown in FIGS. 14 and 15, a modified rotor 30 has two chests in this form. The plunger 37 has a spring system 63 to force it into the chest on the pressure stroke and an auxiliary spring system 63' operating on the hinge to also pull it in although this is optional. There is a steam inlet 106 into the chest for the pressure stroke and a steam outlet 107 which flows through the wall of the housing at 110 between the steam outlet 107 and the plunger and between the plunger and the steam inlet there are jackets 111 and 112 through which air or steam can be circulated to maintain uniform temperature for the housing.

FIG. 15 shows the position of the plunger up or down, the steam inlet, and the steam exhaust. In the first of the operation, the plunger moves and before it is fully down, steam begins to enter the chest while exhaust is caused from the chest. As the steam is used, the chest and rotor begin to turn and steam is eventually cut off from this space. Steam begins to discharge, and discharge is completed, and later the next pressure stroke takes place.

ADVANTAGES OF PRESENT INVENTION

The engine operates by rotary motion, resulting in increased efficiency. It is concentric and rigid with re-

spect to the shaft and thus has minimum wear. Operation is continuous.

The engine is flexible regarding variations in design, which are very simple.

There is no air intake valve, and there is no exhaust valve, thus eliminating the use of gearing and parts.

In the internal combustion form, fuel vapor enters the jacket and is superheated, and charged into the chest. Likewise air entering the chest has absorbed heat from the rotor. The combination of superheated fuel vapor which is completely atomized with preheated air forms a highly combustible medium and burns completely for a better thermal efficiency and combustion free from pollution.

The superheated vapor enters the chest for the power stroke at the end of compression and pressurizes the mixture, thus imparting energy by gas pressure analogous to steam power, as well as by combustion.

Most engines contribute the worst air pollution when they are starting, but the engine of the present invention which starts on gaseous fuel does not contribute to air pollution in starting at all.

The construction of the engine of the invention is relatively simple due to its lack of excess moving parts.

The operation can be accomplished with extreme economy of fuel.

The engine uses kerosene as fuel which is relatively inexpensive.

The pressurized fuel in the jacket has a damping effect on sudden expansion and noise of propulsion.

In view of my invention and disclosure, variations and modifications to meet individual whim or particular need will doubtless become evident to others skilled in the art, to obtain all or part of the benefits of my invention without copying the structure shown, and I therefore claim all such insofar as they fall within the reasonable spirit and scope of my claims.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. A rotary engine comprising a housing having a cylindrical interior, a shaft concentric with the interior of the housing, a rotor rigidly connected with the shaft having a cylindrical exterior portion turning within the housing and having a plurality of chests intruding inwardly from the outside, a plunger successively entering the chests and sealing with respect thereto, means for urging the plunger into the chest opposite it, and means for applying a gas to the residual space in the chest not occupied by the plunger to propel the rotor, each of the chests having a forwardly acting pressure wall, and also having a trailing cam wall which is effective to expel the plunger from the chest as the rotor advances, and the plunger being pivoted at its trailing side to the housing, the rotary engine also having a fuel jacket in the housing in heat transfer relationship with the interior, the fuel jacket including a vapor accumu-

lator, a charge valve discharging fuel vapor into the adjoining chest and operatively connected to the vapor accumulator, a fuel pump pumping fuel under pressure into the jacket, an air inlet introducing air into a chest at a position ahead of the charge valve in the direction of rotor rotation and an exhaust communicating with a chest between the charge valve and the air inlet in the direction of rotor rotation.

2. A rotary engine of claim 1, in combination with a pump communicating with the air inlet, and an air heating chamber receiving air from the pump inside the rotor and in a heat transfer relation with the walls of the chests.

3. A rotary engine of claim 2, in combination with means for introducing compressed combustible gas into the vapor accumulator to start the engine.

4. A rotary engine of claim 3, in combination with a cam shaft under control of the operator and having a cam operatively connected to the charge valve, whereby the opening of the charge valve is under the control of the operator.

5. A rotary engine of claim 4, in combination with an intermediate tank supplying fuel to the fuel pump, a by-pass from the vapor accumulator to the intermediate tank and a relief valve in the by-pass to relieve excess pressure beyond the operating pressure.

6. A rotary engine of claim 5, having fins on the intermediate tank and fins on the by-pass for cooling recirculated fuel.

7. A rotary engine of claim 6, in combination with an air release valve at the top of the vapor accumulator.

8. A rotary engine comprising a housing having a cylindrical interior, a shaft concentric with the interior of the housing, a rotor rigidly connected with the shaft having a cylindrical exterior portion turning within the housing and having a plurality of chests intruding inwardly from the outside, a plunger successively entering the chests and sealing with respect thereto, means for urging the plunger into the chest opposite it, and means for applying a gas to the residual space in the chest not occupied by the plunger to propel the rotor, the means for applying gas to the residual space in the chest including a jacket in the housing and having a vapor accumulator at the top of the jacket, a fuel pump pumping fuel into the jacket, and a charge valve controlling the admission of fuel vapor from the vapor accumulator into the chest which is adjoining the plunger.

9. A rotary engine of claim 8, in combination with means for introducing compressed gas into the vapor accumulator to start the engine.

10. A rotary engine of claim 9, in combination with an intermediate tank supplying fuel to the fuel pump, a by-pass from the vapor accumulator to the intermediate tank and a relief valve for the by-pass to relieve excess pressure beyond the operating pressure.

* * * * *