Feb. 6, 1951 W. B. B. ASSCHER 2,540,416

RECIPROCATING LIQUID FUEL BURNER

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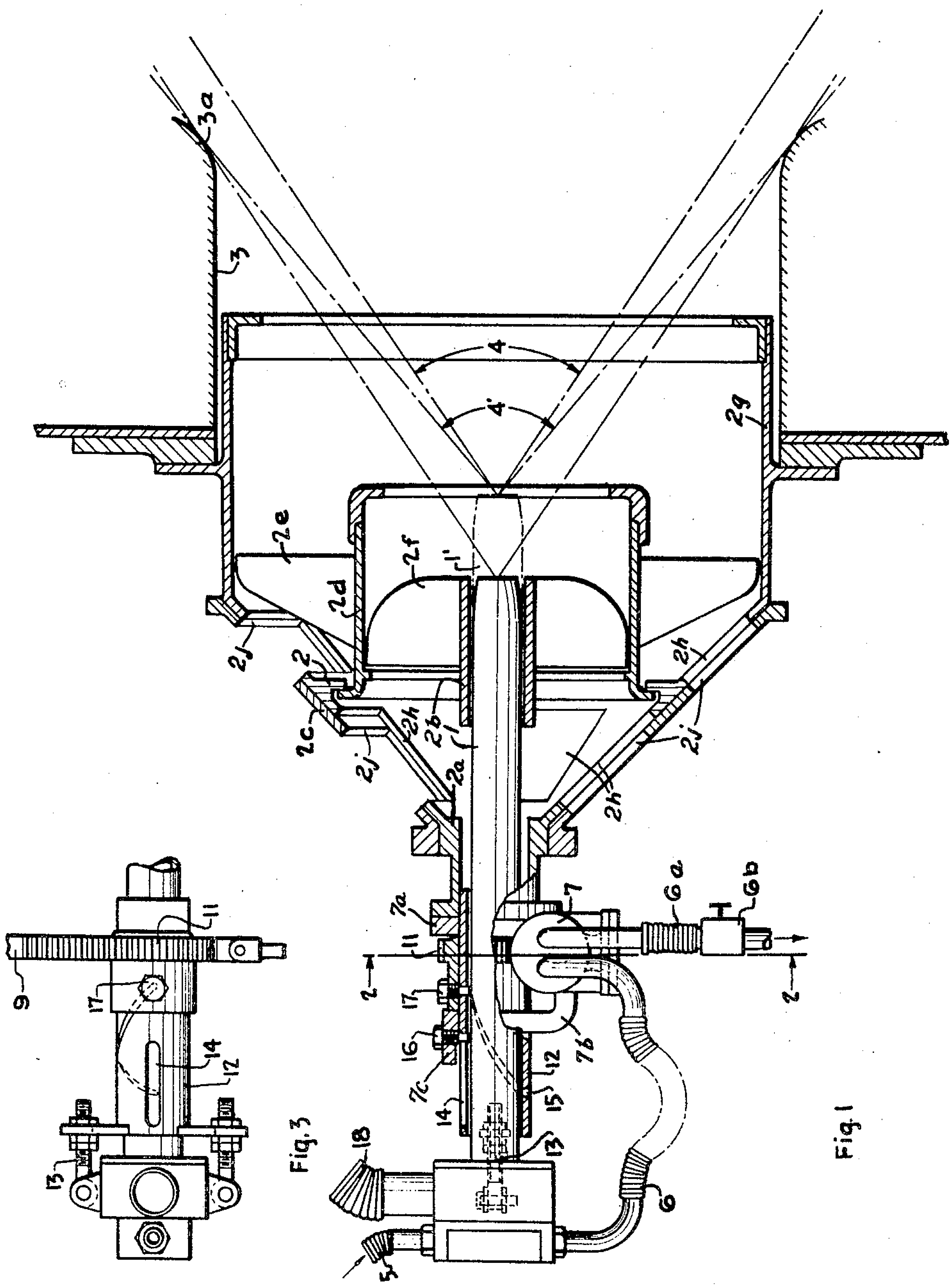

Fig. 1

Fig. 3

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Fig. 2

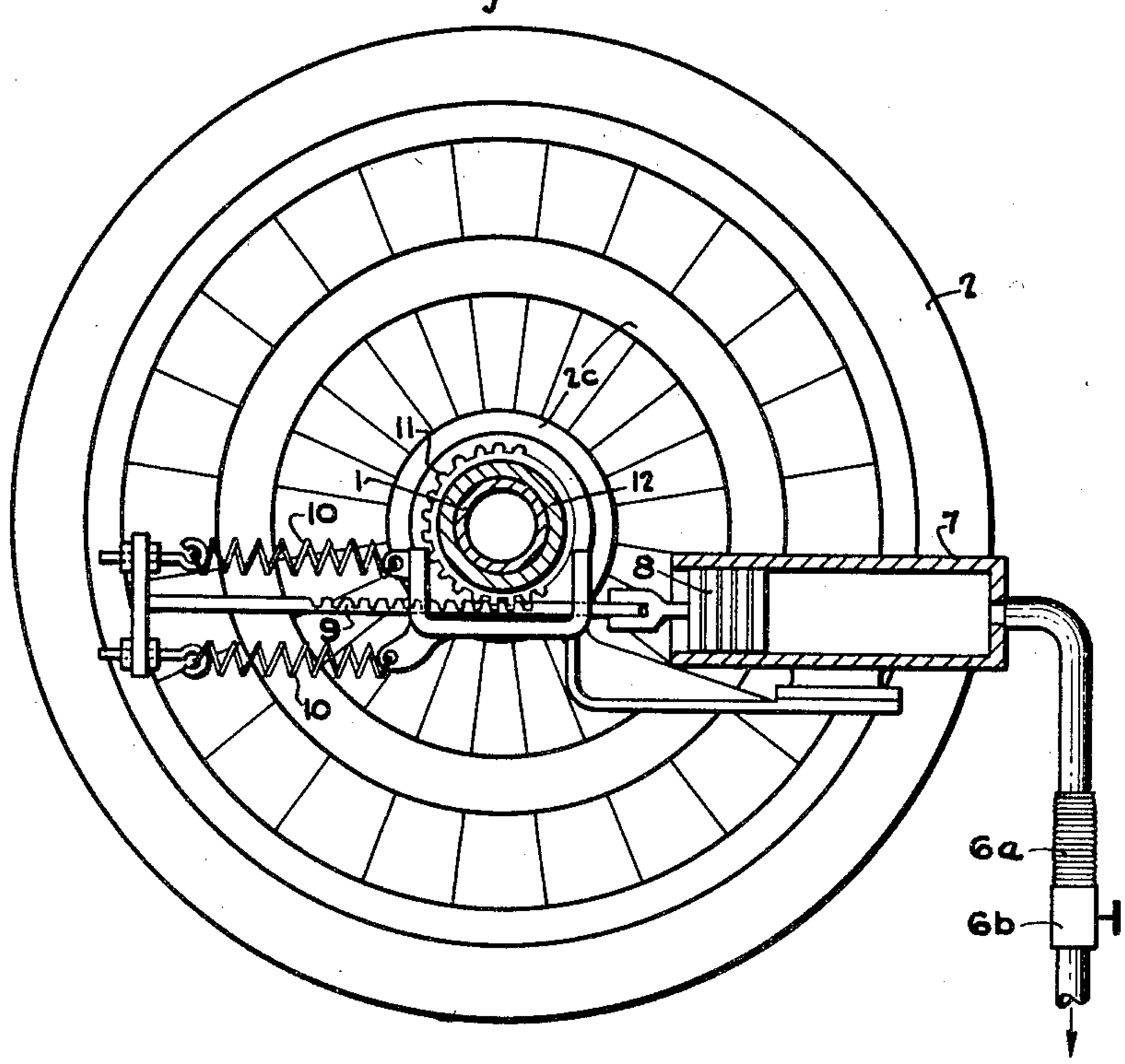


Fig. 8

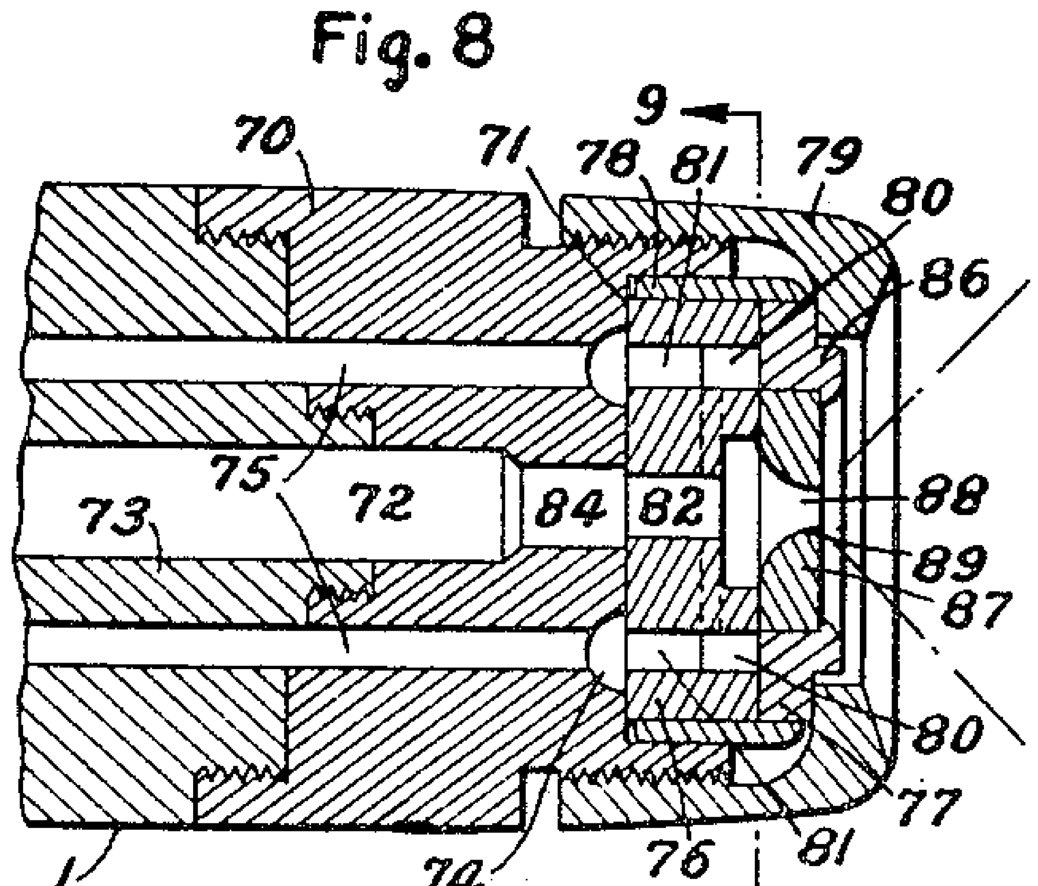
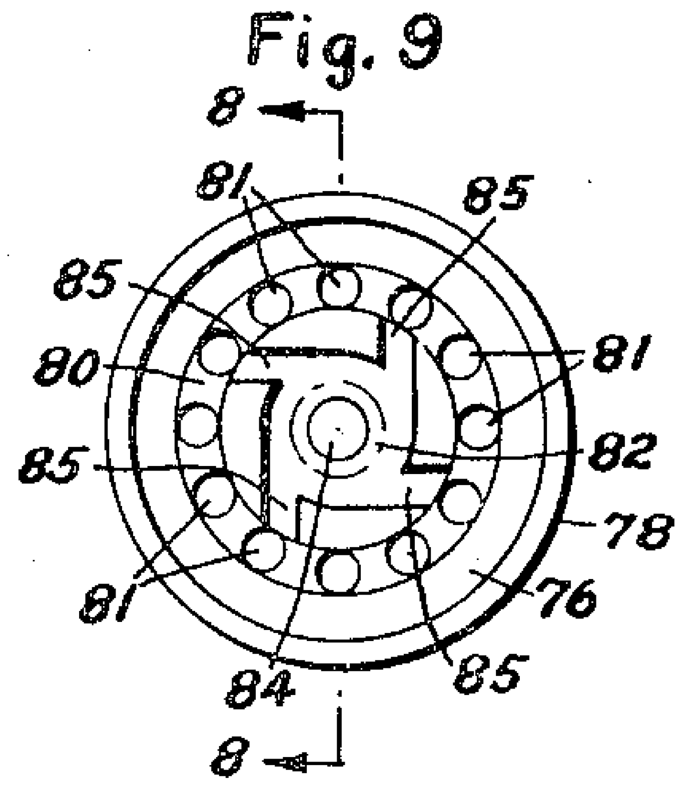


Fig. 9



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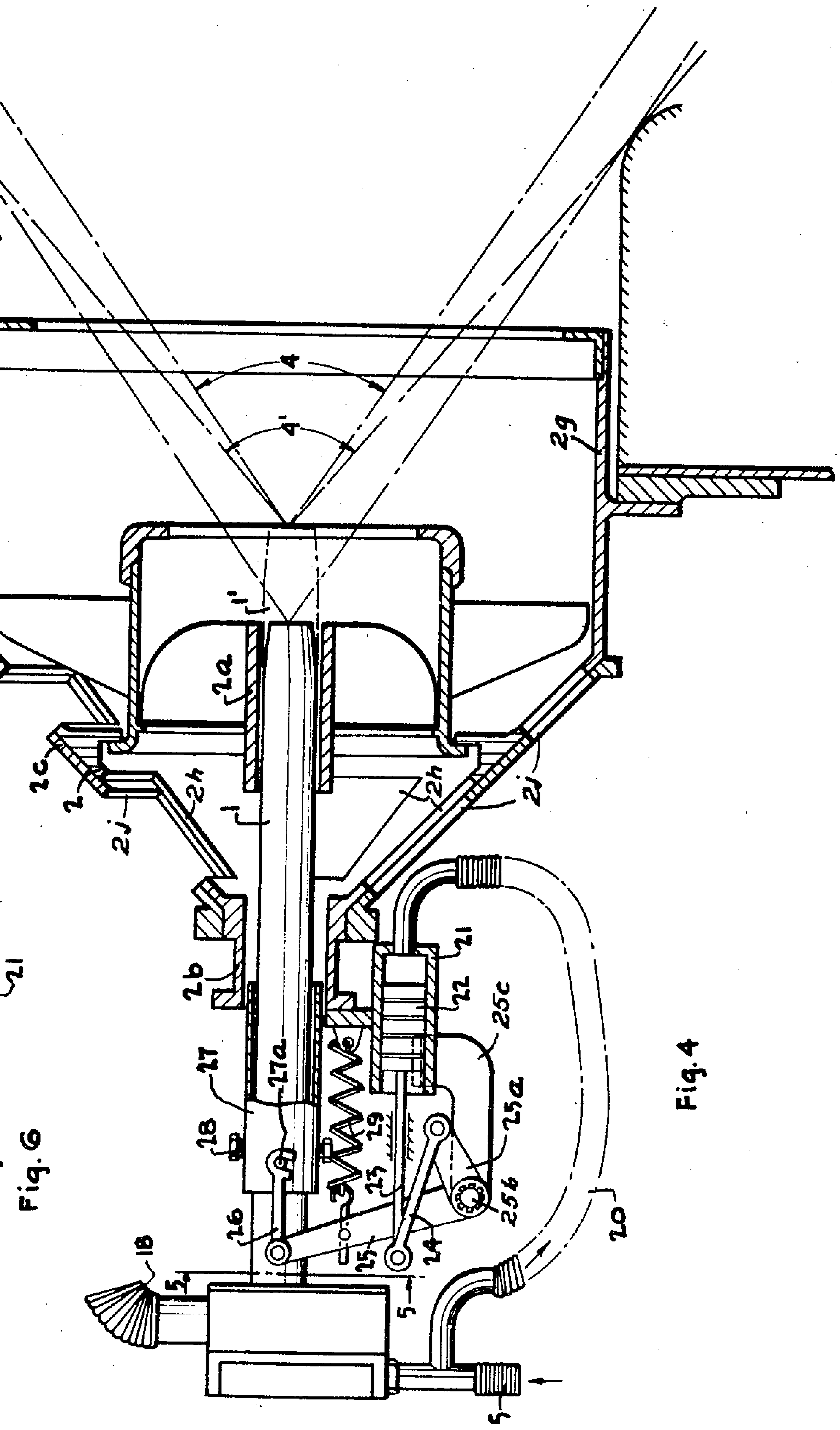

Fig. 4

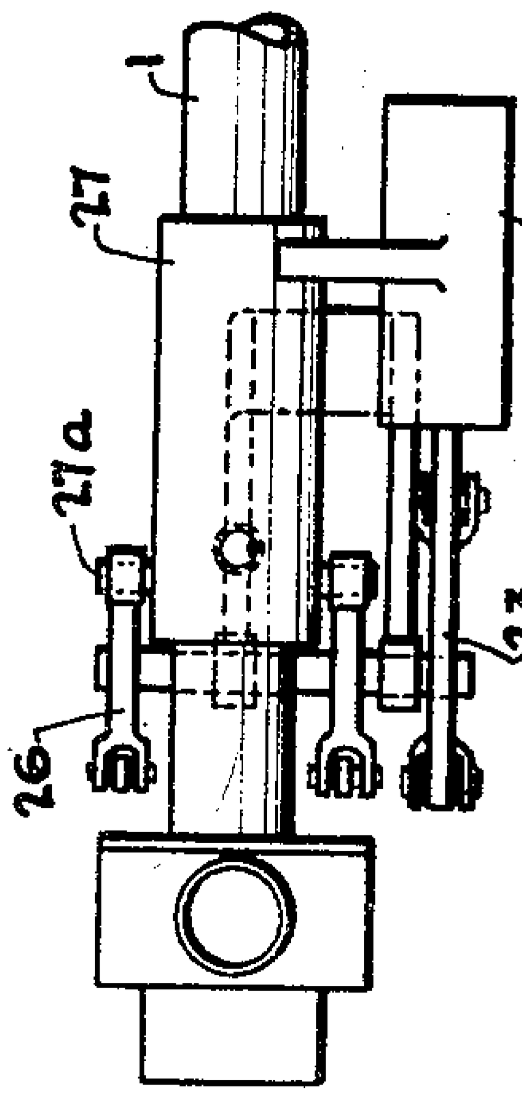

Fig. 6

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RECIPROCATING LIQUID FUEL BURNER
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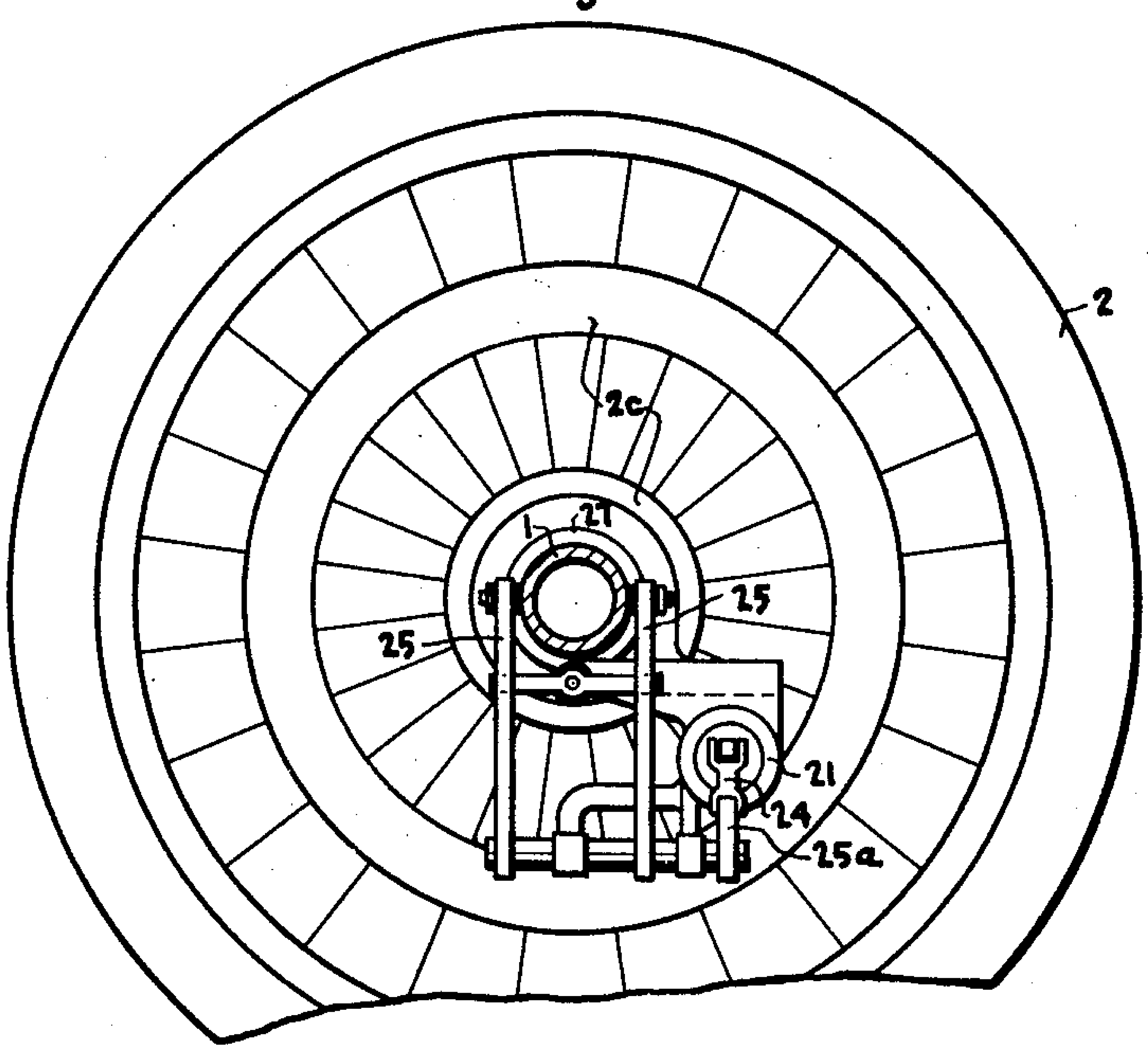
Fig. 5



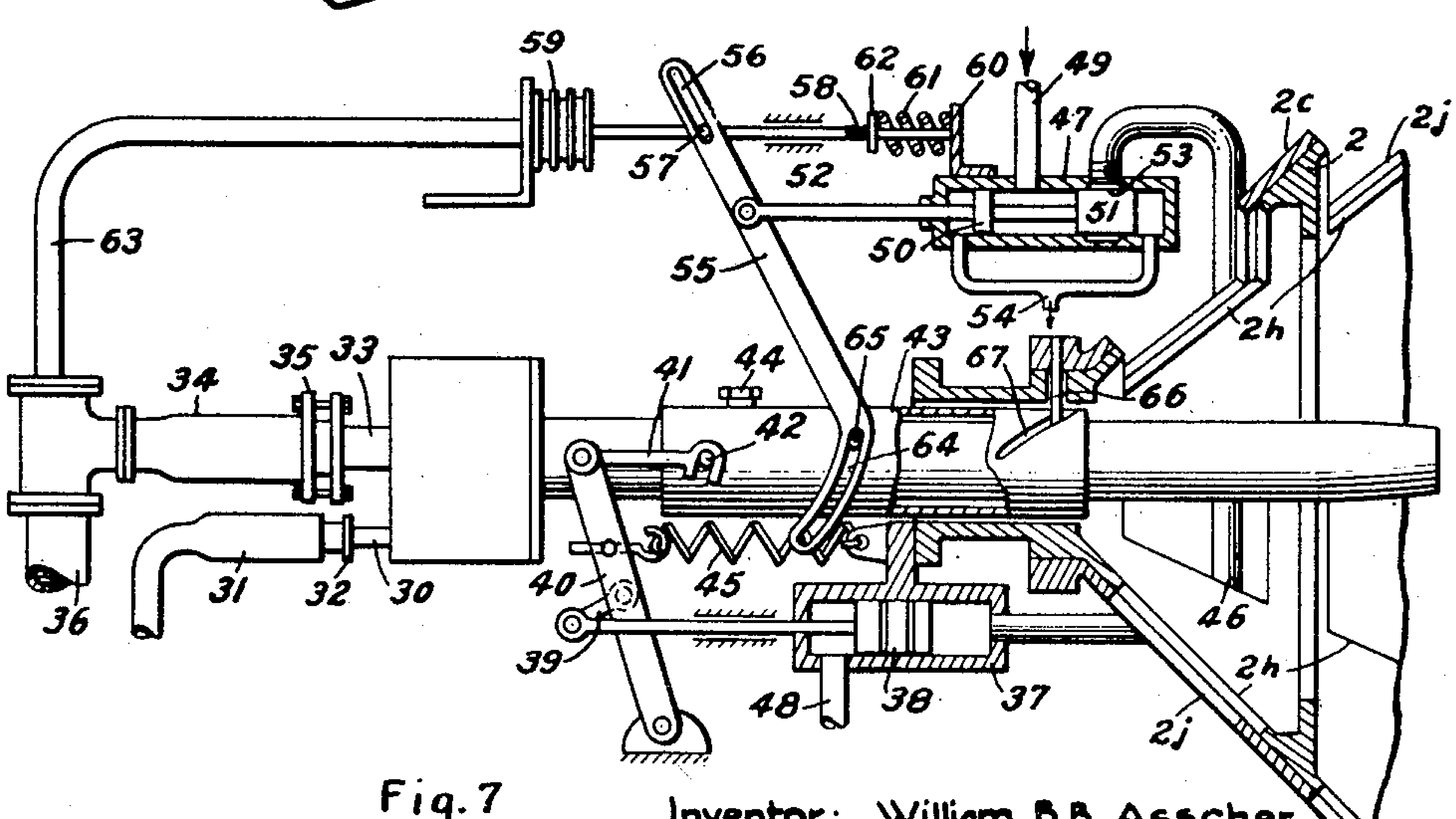


Fig. 7

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UNITED STATES PATENT OFFICE

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RECIPROCATING LIQUID FUEL BURNER

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19 Claims. (Cl. 158—77)

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The invention relates to burners for liquid fuel wherein the fuel is atomized and the atomized fuel leaves the atomizing nozzle in the form of a cone. Such atomization may be effected by known means, such as the mechanical energy contained in the fuel itself (i. e., pressure atomization), or the mechanical energy contained in a separate atomizing medium, e. g., steam or air. In other words, the instant invention is applicable generally to liquid fuel burners of the group known as pressure, air or steam atomizing burners.

When burners of this group are operated under varying loads the pressure of a fluid in the burner also varies; as a result, the spray cone angle varies; such burners may, therefore, be designated as being of the type in which the spray angle varies with the load on the burner or, more specifically, with the pressure of a fluid in the burner. The "spray angle" is the apex angle of the spray cone.

Combustion air is usually supplied to the burner from the rear of the spray cone, both in the case in which air is used in the atomizing nozzle for atomization or initial combustion, and in the case in which no other air is introduced into the nozzle. To insure complete combustion, it is necessary that the whole mass of combustion air be contacted intimately with the atomized fuel. When the atomizing burner is mounted within an elongated pre-combustion chamber opening into the mouth of a larger, main combustion chamber, such mixing is best attained when the spray cone is tangent to the mouth of the combustion chamber, i. e., when the spray meets the place where the pre-combustion chamber joins the larger main combustion chamber along an annular line without further impingement against the walls of the pre-combustion chamber, in such a way that all of the main combustion air, moving as an annular forwardly moving stream about the atomizing nozzle and passing through the mouth, cannot enter the larger combustion chamber without crossing the fuel cone.

Consequently, for a given position of the mouth of the combustion chamber with respect to the atomizing head or nozzle, the spray angle must have a specified value. However, as was noted above, most atomizing burners have different spray angles at different loads, and when such burners are to be used under conditions in which the load is not constant but variable, difficulty has been experienced. Such installations are best designed for the maximum spray angle, because

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when the burner is positioned to make the fuel spray tangent to the mouth of the combustion at the smaller spray angle, the spray impinges on the side walls of the pre-combustion space at greater spray angles, resulting in the deposition of coke on the refractory material and frequent shut-downs for cleaning. However, when the burner is correctly located for the maximum spray angle, a decrease in the spray angle upon a change in the load causes the spray cone to enter the main combustion chamber without linking up with the mouth of the chamber, so that air can enter the main combustion space without or with insufficient mixing with the atomized fuel, causing a decrease in the combustion efficiency, sometimes to an appreciable extent.

It is an object of this invention to provide a liquid fuel atomizing burner of the type in which the spray angle varies with the load on the burner which is automatically adjustable with the load so as to permit the position of the atomizing nozzle to be always in the best location for effecting high combustion efficiency.

It is another object to provide a liquid fuel burner of the type described reciprocally mounted in an elongated pre-combustion chamber and provided with means responsive to the load on the burner, e. g., acted upon by the pressure of the fuel or of a separate atomizing medium, for advancing the atomizing nozzle as the spray angle increases and for retracting the atomizing nozzle as the spray angle decreases, so as to maintain the spray cone at all times tangent to the mouth of the main combustion chamber, or substantially so.

A specific object is to provide a mechanism for reciprocating a liquid fuel atomizing nozzle, comprising an element responsive to the pressure of an atomizing fluid supplied to the burner (e. g., the liquid fuel itself, either before introduction into the atomizer, or in the case of a spill type burner, after withdrawal therefrom, or the steam or air) and actuating mechanism connected to the nozzle. Ancillary thereto, it is an object to provide a mechanism of the type described wherein the response may be varied or wherein the shape of the parts can be varied to correlate the extent of the reciprocating movement with the pressure to which the pressure responsive element is subjected to conform to the corresponding changes in the spray angle with the load.

With these and other objects in view, which will become apparent from the following descrip-

chamber to the fuel tank from which the supply pump takes its suction. By altering, for example, the flow in the return line by means of a control valve, it is possible to vary the pressure in this return line, thereby changing the fuel pressure in the atomizer and regulating the quantity of liquid fuel discharged through the orifice and atomized by the nozzle. However, this regulation also changes the spray angle. This is illustrated in Fig. 1, wherein 1 represents the burner tube enclosing fuel supply and return tubes and supporting an atomizing nozzle (not shown in Fig. 1) in its tip, in one position in solid lines. The burner tube is shown in dotted lines at 1' in a more forward position. The tube 1 can be reciprocated longitudinally within a fixed support, represented by bushings 2*a* and 2*b* which are part of an air register 2. The register has openings 2*h* to admit combustion air in regulated amounts about the tube 1, the regulation being effected by rotating the outer conical shutter portion 2*c* having openings 2*j* which can be brought into registry with the openings 2*h*. The combustion air flows in two annular currents, separated by partition 2*d* and may, if desired, be given a rotary motion by inclining the vanes 2*e* and 2*f* to provide a helical path. The air enters the pre-combustion chamber defined by the circular-cylindrical wall 3 which may be formed by refractory material, e. g., fireproof masonry. The precombustion chamber widens out at 3*a* into the main combustion chamber. The cylindrical portion 2*g* of the air register extends the precombustion chamber rearwardly. For the forward position 1' of the burner tube, the spray angle corresponding to a low load on the burner is indicated by the angle 4'; it will be noted that in this position of the burner tube, and with this spray angle, the spray cone links up with the mouth 3*a* of the combustion chamber, i. e., it is tangent thereto. The expression "tangent to the mouth of the combustion chamber" is intended to indicate a condition wherein the spray cone barely touches the mouth, regardless of whether the mouth is curved, as shown, or angular or of some other shape. As a result all of the combustion air entering through the air register must cross the spray cone of atomized fuel in its passage into the main combustion chamber. Provided that other necessary conditions have been fulfilled (e. g., proper atomization and the proper fuel to air ratio, which conditions are, per se, known in the art) this results in intimate mixing of all of the air with the atomized fuel and in efficient combustion. However, when the load on the burner is increased, i. e., when the quantity of fuel atomized is increased, by raising the pressure on the fuel return line, the spray angle becomes smaller. This reduced spray angle is indicated by the angle 4. With such a spray angle the spray cone no longer links up with the mouth 3*a* and the air can enter the main combustion chamber behind the spray cone, i. e., without being mixed thoroughly with the atomized fuel, thereby causing a reduction in the combustion efficiency which may be indicated, for example, by a decrease in the CO_2-content of the flue gases.

However, if the burner tube carrying the atomizing nozzle is moved back to the position shown at 1 the spray cone can again be made to link up with the mouth of the combustion chamber, thereby bringing about favorable combustion. According to the instant invention, this shifting of the atomizing nozzle is effected automatically

with the load; in the embodiments illustrated in Figs. 1–3, this is effected by operating the displacement mechanism by the pressure in the fuel return line.

The burner tube is connected, in the rear, by means of flexible tubes to sources of fluids: liquid fuel supply line 5 is connected to a fuel pump to supply fuel at a constant rate, and air, usually under moderate pressure is admitted through a flexible tube 18. The auxiliary air is supplied to the burner tube for discharge close to the liquid spray, e. g., around the atomizing nozzle, for the purpose of effecting initial mixing of the fuel with air and avoiding the deposition of entirely or partly unburned fuel on the burner tip. The auxiliary air usually forms a minor part of the total air supplied to the burner. The fuel return line is connected to a flexible tube 6 which discharges into a cylinder 7 which is secured to the rear end of the bushing 2*a* through a flange ring 7*a* carried by the cylinder 7. The rear of the cylinder carries a standard 7*b* which is fixed to a stationary rear guide ring 7*c*. From the cylinder the return fuel flows out through a line 6*a* and return flow regulating valve 6*b* to the fuel storage tank. Instead of flexible tubes, I may use rigid pipes with sliding expansion joints, of the type illustrated in Fig. 7.

The cylinder 7 is provided with a piston 8 connected to a rack gear 9 and to a tension spring 10 which urges the rack gear and piston against the pressure of the return fuel in the cylinder 7. The rack gear 9 meshes with a ring pinion 11, rotatable about a bushing 12 which surrounds the rear end of and is adjustably fixed to the burner tube 1 by means of adjusting bolts 13. These bolts are pivotally secured to the enlarged, rear portion of the tube 1 and engage bifurcated wings on the bushing 12. The bushing is axially reciprocable within the guide ring 7*c*, flange ring 7*a* and bushing 2*a* and is provided with a longitudinal groove 14 and with an inclined cam groove 15, which may be helical or of any shape depending upon the characteristics of the atomizing nozzle. A bolt or cam pin 16 is fixed to the ring 7*c* which may be regarded as constituting a rearward portion of the air register 2; the pin 16 extends into the groove 14. A similar cam pin 17 extends radially inwardly from the pinion 11 into the groove 15, being carried by and rotatable with the pinion. The pinion is secured against axial movement by engagement on both front and rear ends thereof with portions of the flange ring 7*a* and guide ring 7*c*.

The operation of the burner is as follows: In Fig. 2, the piston 8 is shown in its outermost position, i. e., the fuel return pressure is at its highest, and the burner is operating at its maximum load. Corresponding thereto, the burner tube 1 is shown in Figs. 1 and 3 in its fully retracted position, with the pin 17 in the forward portion of the groove 15. If the fuel return pressure is reduced, springs 10 move the piston 8 against the fuel pressure until a new position of equilibrium is reached; the pinion 11 and cam pin 17 are thereby rotated, urging the bushing 12, which is secured against rotation by the cam pin 16, forwardly as the cam pin 17 runs along the groove 15. By choosing a suitable shape for the groove 15 the displacement of the burner tube can be made to adapt itself to a change in the fuel return pressure in such a way that the spray cone is always tangent or substantially tangent to the mouth of the combustion chamber. The bushing 12 can be readily replaced by loosening the nuts

burner tube until the motion of the pin 65 restores the piston 51 to the position shown in the drawing.

The response of the burner to changes in pressure may be designed to fit any requirement peculiar to the atomizing nozzle employed by an appropriate choice of the shape of the cam slot 64.

It will be understood that while the three specific embodiments involving a bushing with a cam groove, a bell crank linkage, and a servo-motor with a cam lever, respectively, have been described applied to three specific types of burners, these types may be interchanged; thus, for example, it is possible to use the servo-motor arrangement of Fig. 7, or any other servo-motor, for operating a burner of the types shown in Figs. 1–6. Moreover, it is not necessary that the pressure responsive element, (such as the pistons 8 or 22 or the bellows 59) be acted upon directly by a fluid fed to the burner; they may be acted upon by a separate operating fluid the pressure of which is varied in proportion to the load, e. g., by the pressure fluid in a regulator for the burner. As a specific example, if the spray angle depends upon the rate of flow of atomizing air, which is supplied at approximately constant pressure, by means of a Venturi tube a pressure difference can be created which depends on the quantity of air supplied, and this pressure difference can be utilized, if necessary via a servo-motor, for the readjustment of the position of the burner tube.

If desired, the readjustment of the burner tube may be coupled to the operating lever for the air register shutter 2c, or other means controlling the supply of combustion air, so that both are reset with the aid of one fluid pressure responsive motor. This is illustrated in Fig. 7, where the shutter 2c is provided with a cam pin 66 extending through a circumferential slot in the register 2 and into a cam slot 67 in the bushing 43. Reciprocation of the burner tube and bushing 43 will cause the shutter 2c to be rotated to move the holes 2j into or out of registry with the holes 2h.

I claim as my invention:

1. An atomizing burner for liquid fuel comprising a fixed support, a liquid fuel atomizing nozzle of the type in which the spray angle varies with the pressure of a fluid in the burner reciprocably mounted with respect to said support, and means responsive to the said pressure of the fluid in the burner for retracting the atomizing nozzle with respect to said support as a change in said pressure causes the spray angle to diminish and for advancing the atomizing nozzle as an opposite change in said pressure causes the spray angle to increase.

2. An atomizing burner for liquid fuel comprising a fixed support, a liquid fuel atomizing nozzle of the type in which the spray angle varies with the pressure of an atomizing fluid in the burner reciprocally mounted with respect to said support, and means responsive to the pressure of said atomizing fluid in the burner for retracting the atomizing nozzle with respect to said support as a change in said pressure causes the spray angle to diminish and for advancing the atomizing nozzle as an opposite change in said pressure causes the spray angle to increase.

3. The burner according to claim 2 wherein the means for retracting and advancing the atomizing nozzle comprises a fluid pressure responsive element operatively connected to a liquid fuel line of said burner.

4. The burner according to claim 3 wherein the atomizing nozzle is of the whirler type and is connected to a liquid fuel supply line and to a liquid fuel return line, the atomizing burner is of the type wherein the load is controlled by regulating the pressure in the fuel return line, and the fluid pressure responsive element is connected to the liquid fuel return line.

5. The burner according to claim 2 wherein the atomizing nozzle is of the whirler type and is connected to a liquid fuel supply line of said burner, the atomizing burner is of the type in which the load is controlled by regulating the pressure in the fuel supply line, and the fluid pressure responsive retracting means comprises a fluid pressure responsive element operatively connected to the liquid fuel supply line.

6. The burner according to claim 2 wherein the atomizing nozzle of the type in which liquid fuel is atomized by means of a gaseous atomizing medium, and the pressure of said gaseous medium is varied with the load on the burner, said atomizer being provided with a supply line for said gaseous atomizing medium, and the said means for retracting and advancing the atomizing nozzle comprises a fluid pressure responsive element connected to said supply line for the gaseous atomizing medium.

7. An atomizing burner structure for liquid fuel comprising an elongated pre-combustion chamber having a mouth at its forward end connecting with an enlarged combustion chamber, a liquid atomizing nozzle of the type which forms a spray cone of atomized fuel and spray angle of which diminishes with an increase in the pressure of a fluid in the burner and increase with a decrease in said pressure, said nozzle being mounted for reciprocating motion substantially along the longitudinal axis of said pre-combustion chamber to discharge a spray cone tangentially with respect to said mouth, means for admitting combustion air into the pre-combustion chamber in the rear of the tip of the nozzle for passage through said spray cone, and means responsive to the said pressure of the fluid in the burner for retracting the atomizing nozzle with respect to said pre-combustion chamber as an increase in said pressure causes the spray angle to diminish and for advancing the atomizing nozzle as a decrease in said pressure causes the spray angle to increase.

8. The atomizing burner according to claim 7 wherein the means for retracting and advancing the atomizing nozzle comprises a fluid pressure responsive element operatively connected for operation in response to the pressure of an atomizing fluid in the burner.

9. An atomizing burner for liquid fuel comprising a fixed support, a liquid fuel atomizing nozzle of the type in which the spray angle varies with the pressure of a fluid in the burner reciprocally mounted with respect to said support, a bushing having a cam surface, a rotatable ring, means inter-connecting said rotatable ring, bushing, atomizing nozzle, and fixed support for reciprocating said atomizing nozzle with respect to said support in response to rotation of said rotatable ring, and a fluid pressure actuated mechanism operatively connected to move in response to the pressure of said fluid in the burner and connected to said rotatable ring for rotating said ring in a direction to retract the atomizing nozzle as a change in said pressure causes the spray angle to diminish and for advancing the atomiz-