March 6, 1951 W. E. MEYER 2,544,561

FUEL INJECTION PUMP

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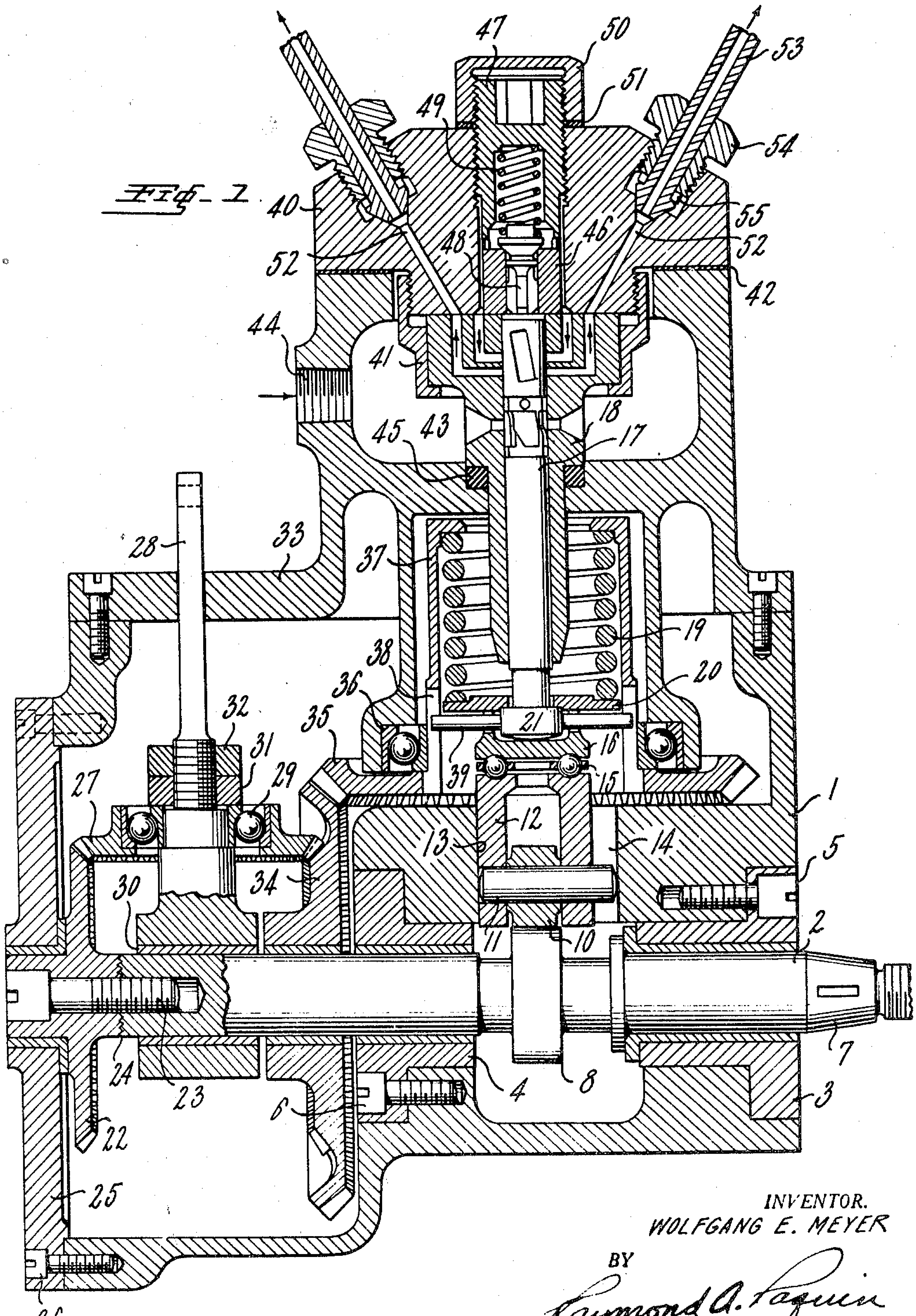

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FUEL INJECTION PUMP

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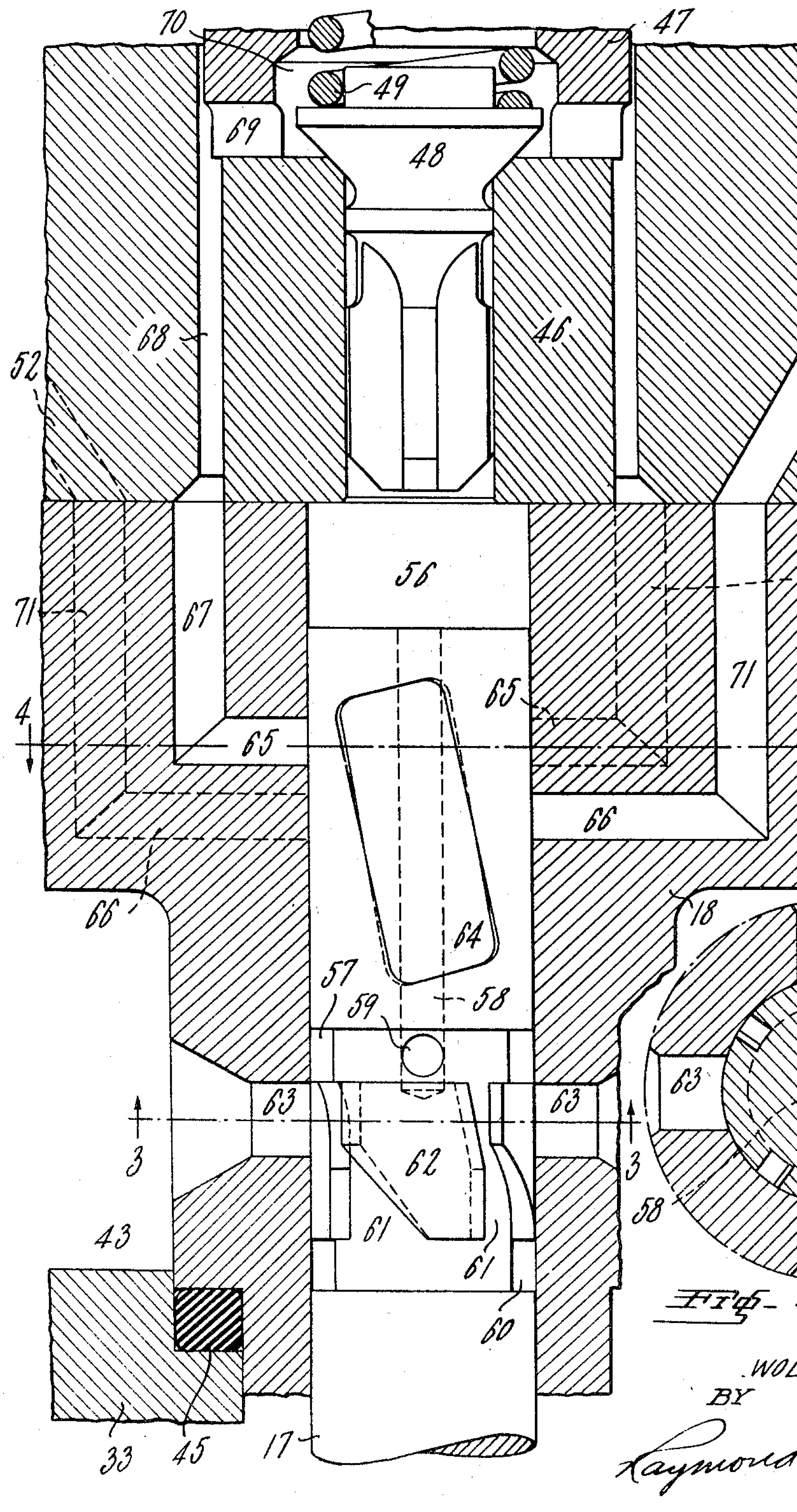

FIG. 2

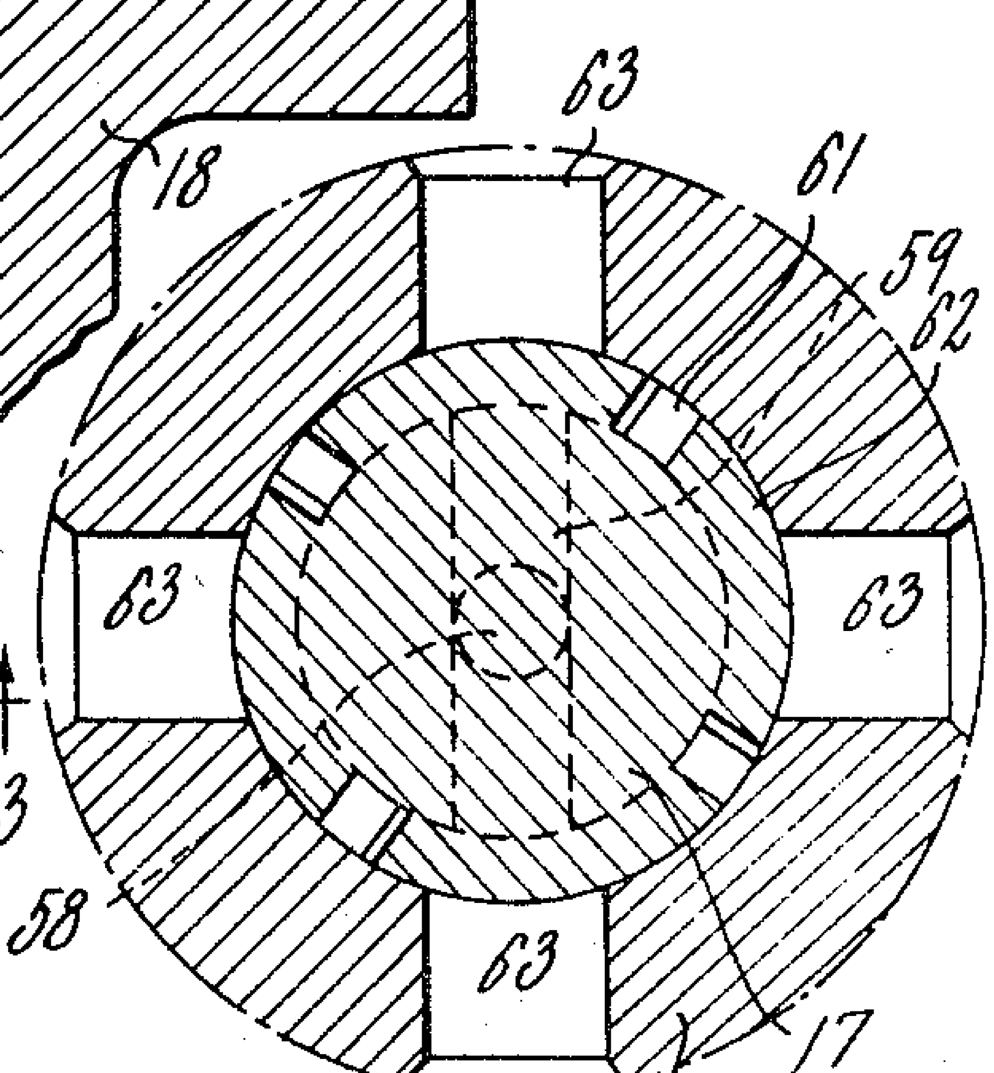

FIG. 3

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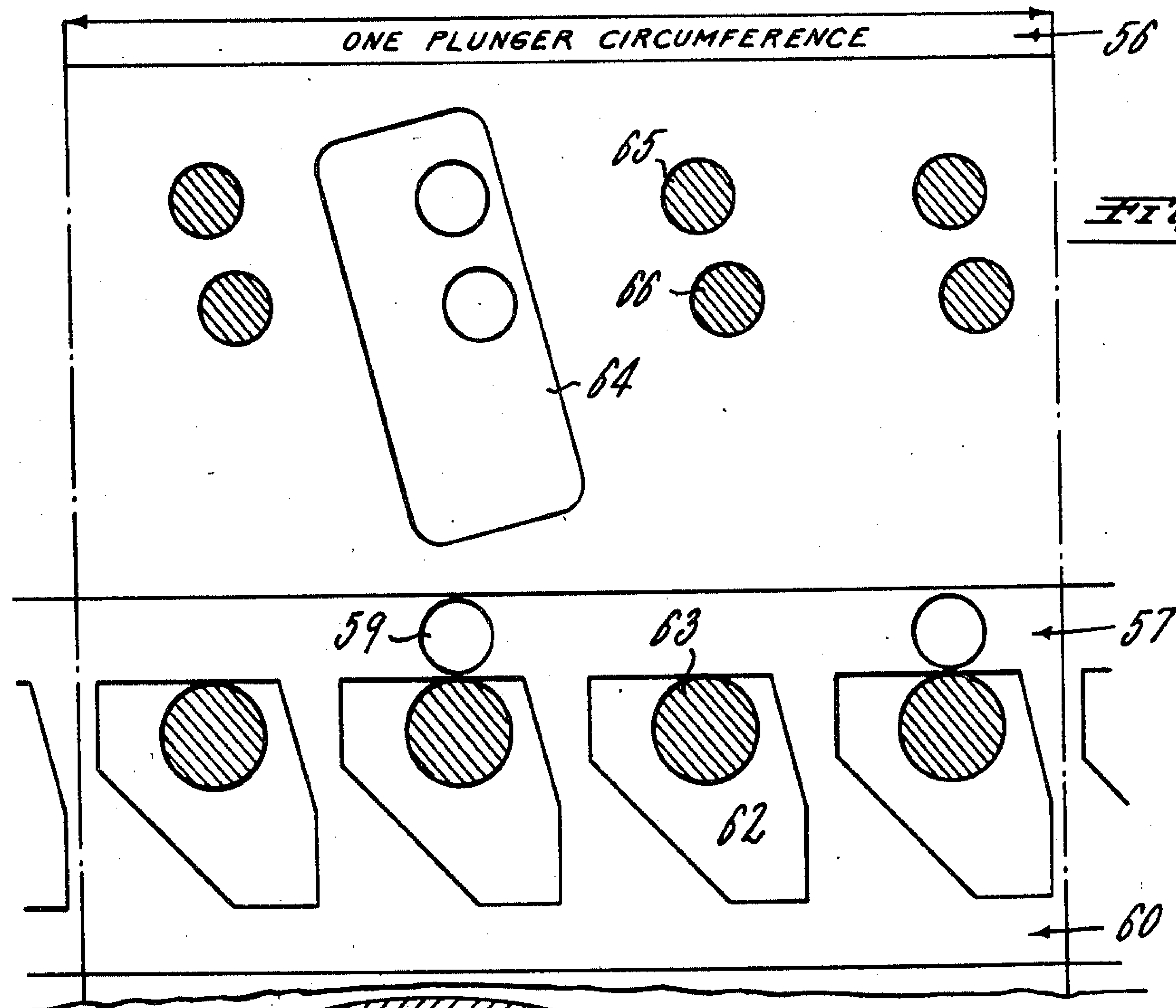

FIG. 5

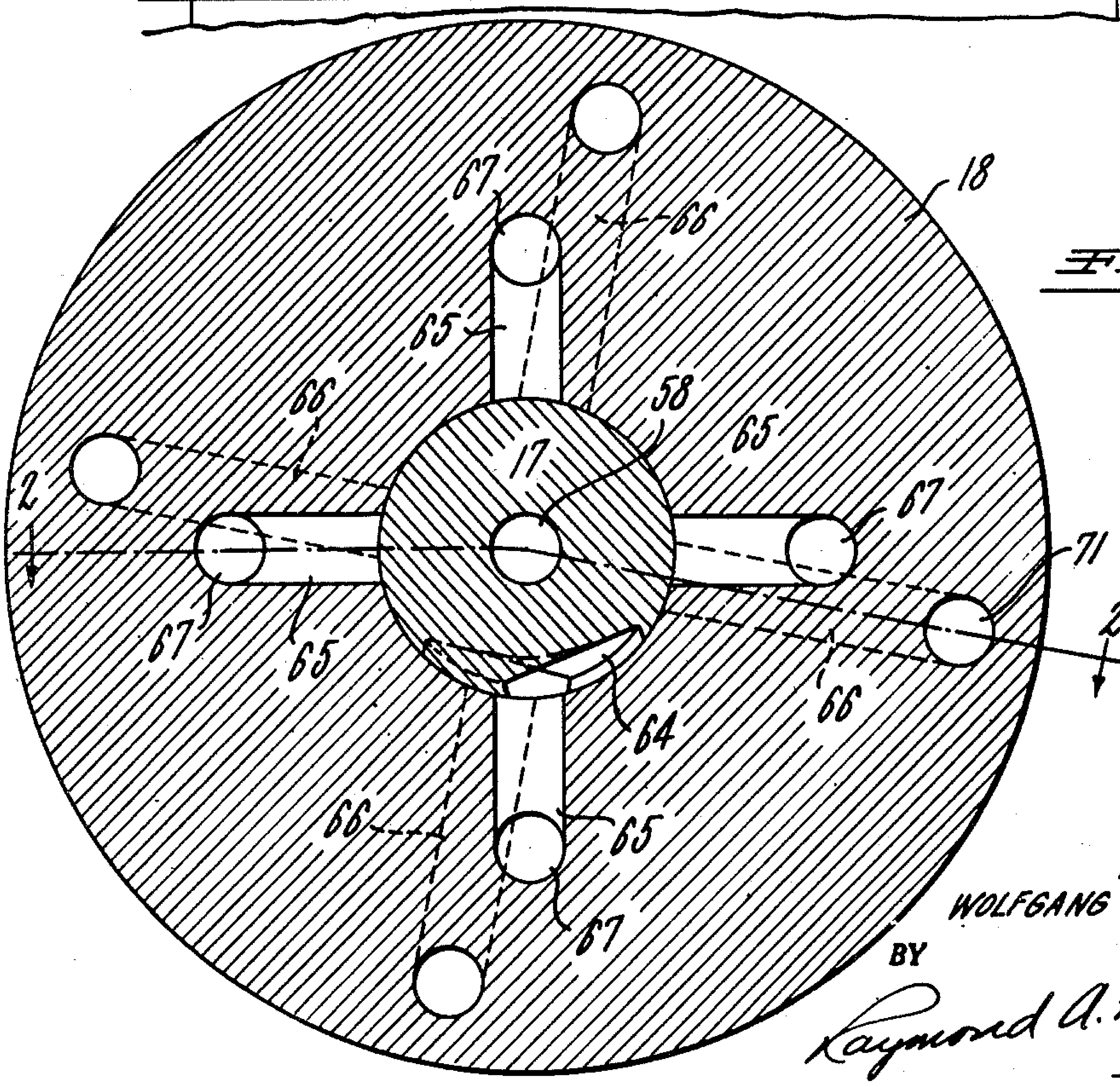

FIG. 4

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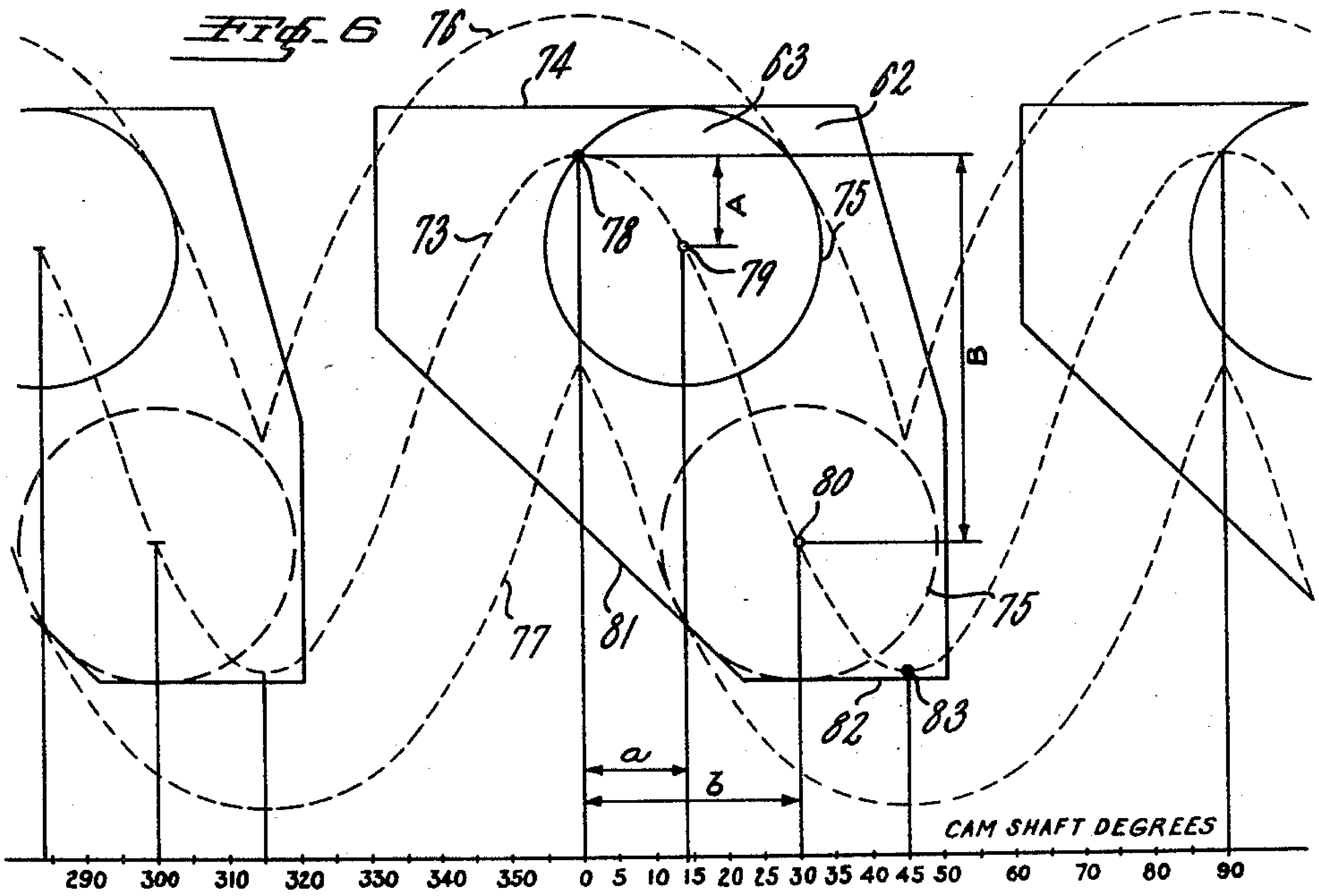
FIG. 6



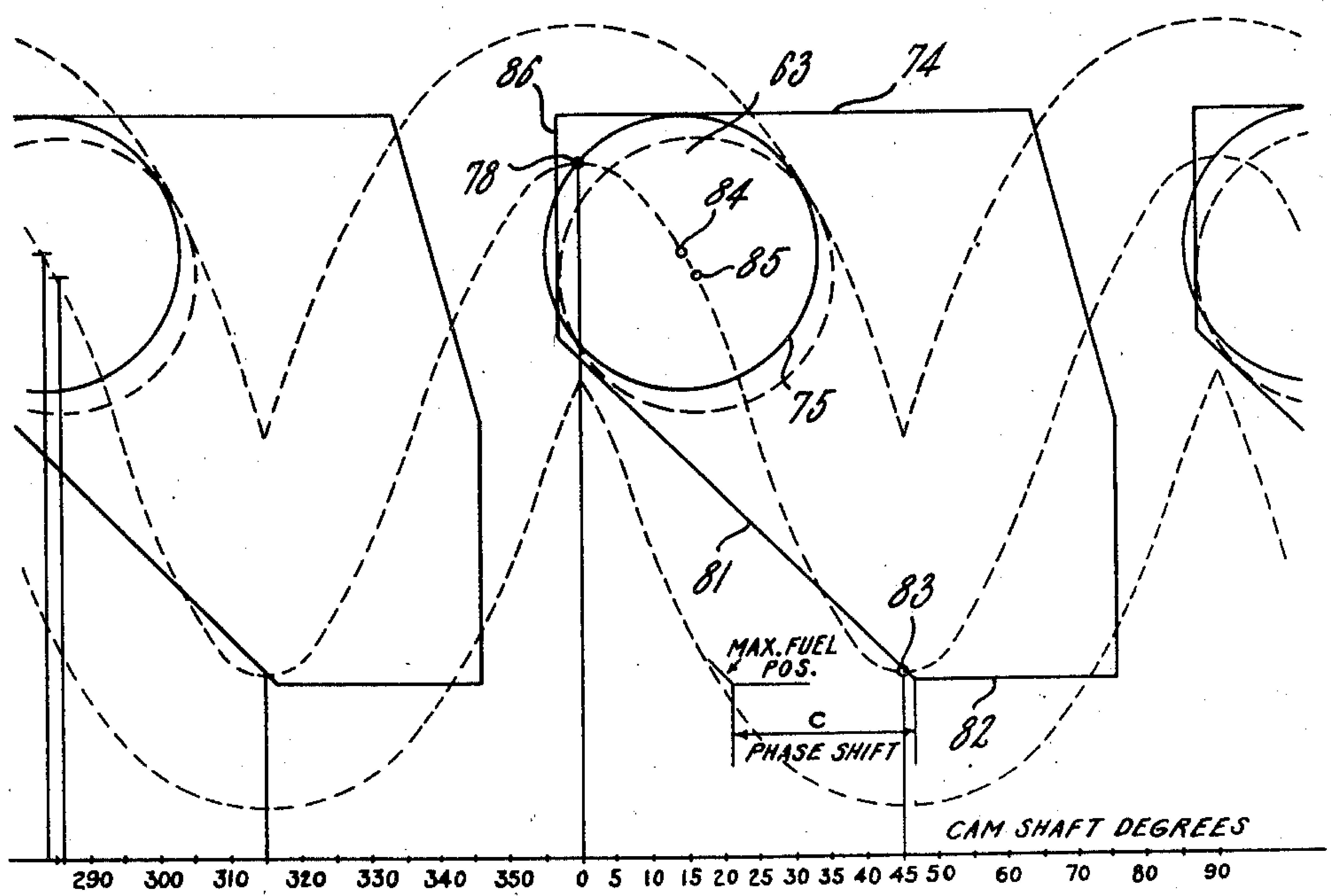


FIG. 7

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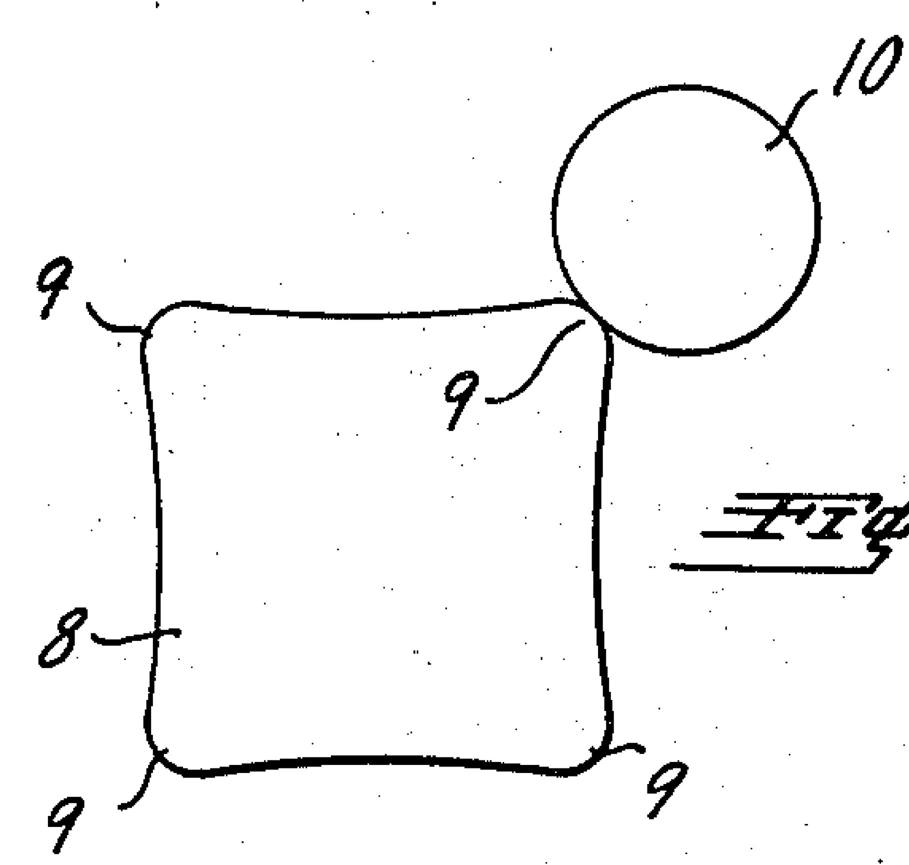

FIG. 8

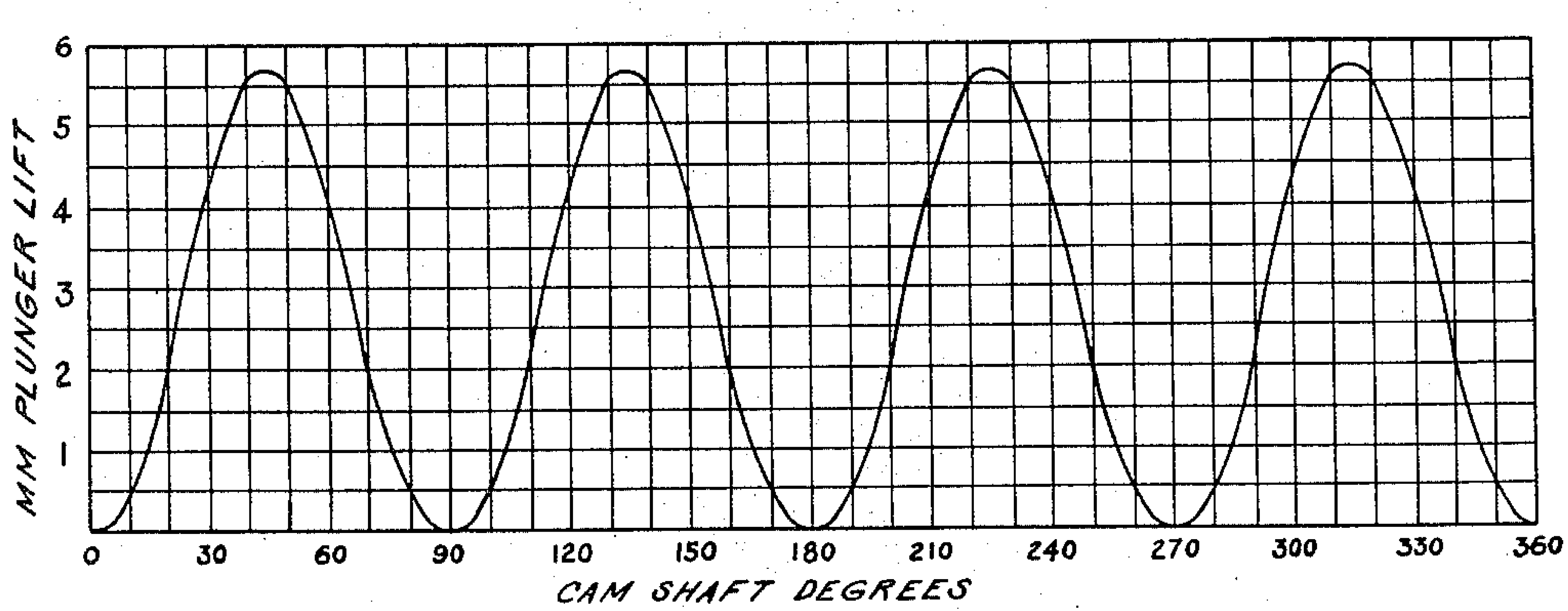

FIG. 9

PLUNGER TRAVEL DURING ONE CAM SHAFT REVOLUTION

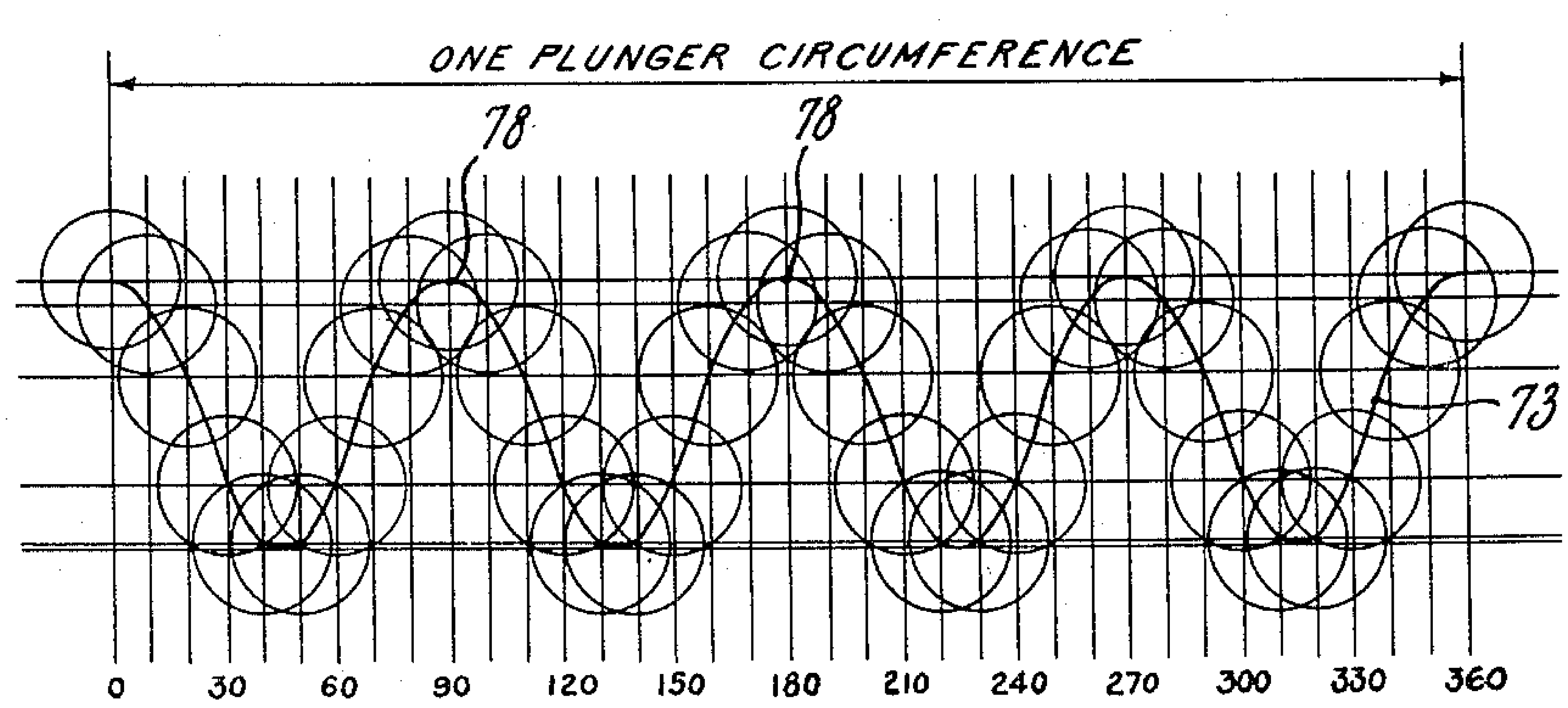

FIG. 10

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UNITED STATES PATENT OFFICE

2,544,561

FUEL INJECTION PUMP

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Application June 11, 1945, Serial No. 598,754

13 Claims. (Cl. 103—2)

This invention relates to fuel injection pumps for use with internal combustion engines wherein liquid fuel must be injected periodically in accurately metered amounts into the engine cylinders or into the air intake pipe or pipes near the engine cylinders.

The invention relates more particularly to a new and improved jerk pump wherein a single pumping plunger and a single delivery valve is employed for feeding fuel under pressure to more than one engine cylinder.

An object of the invention is to provide a pump of the type set forth in which a single plunger is employed for pumping and metering the fuel and also for distributing it to more than one engine cylinder.

Another object of the invention is to provide a fuel injection pump for use with internal combustion engines, in which a plunger is oscillated and reciprocated for pumping and metering the fuel and for distributing it to the engine and wherein the relation between the oscillating and rotary motions of the plunger may be varied to control the quantity of fuel injected.

Another object of the invention is to provide a fuel injection pump for use with internal combustion engines, in which a single plunger is employed for pumping and metering the fuel and also for distributing it to more than one engine cylinder and wherein the action of the plunger may be varied to control the quantity of fuel injected.

Another object of the invention is to provide a pump of the type set forth which is relatively light, compact, and inexpensive, being only slightly heavier, bulkier, and higher in cost than a conventional pump which feeds fuel to only one engine cylinder.

Another object of the invention is to provide a pump of the type set forth which overcomes certain shortcomings in the construction, operation and performance of prior art pumps in which one plunger feeds fuel to more than one engine cylinder.

Another object of the invention is to provide a pump of the type set forth in which the same elements are used to meter the fuel to each one of the several engine cylinders fed by the single plunger, thereby insuring uniform metering without the necessity of equalizing the amounts of fuel delivered to the individual engine cylinders.

Another object of the invention is to provide a pump of the type set forth in which the same hydraulic conditions prevail for the delivery periods of each one of the several engine cylinders

fed by a single plunger. This avoids the shortcomings of certain prior art designs of one-plunger pumps in which, for instance, the compression volume in the pump is different for the injections to each one of the engine cylinders, resulting in variations of the injection characteristics and of the amounts of fuel fed to the several engine cylinders supplied with fuel by one plunger.

Another object of the invention is to provide a pump of the type set forth in which a single delivery valve cooperates with the pumping plunger feeding fuel to more than one engine cylinder. This permits relief of the pressure in the pipes leading from the pump to each one of the engine cylinders at a uniform rate and to a uniform final value. This will further aid in obtaining uniform injection characteristics for all the engine cylinders supplied with fuel by one plunger.

Another object of the invention is to provide a pump of the type set forth in which the provision of a single delivery valve for the relief of the pressure in the fuel lines to more than one engine cylinder permits the use of certain devices for modifying the injection and delivery characteristics, such as a delivery valve stop, a throttling orifice, or a variable retracting volume without the necessity of having more than one of these devices for all engine cylinders supplied with fuel by one pumping plunger. This not only simplifies the design but also eliminates the need for adjusting such devices for uniform performance as must be done on pumps with individual delivery valves for each engine cylinder.

Another object of the invention is to provide a pump of the type set forth which is particularly well suited to handling highly volatile fuels.

Another object of the invention is to provide a pump of the type set forth which is particularly well suited to cooperating with engines operating at relatively high speeds.

Another object of the invention is to provide a pump of the type set forth wherein the pumping chamber is in open connection with the source of fuel supply during the entire return stroke of the plunger, thus preventing the formation of vapor in the pumping chamber during the plunger return stroke as is the case in all conventional pumps unless they are equipped with an automatic suction valve or a positively operated valve which shuts the pumping chamber off from the fuel supply during the delivery period only, and thus eliminating the necessity of employing a suction valve.

Other objects and advantages of the invention will be apparent from the following description taken in connection with the accompanying drawings. It will be understood that many changes may be made in the details of construction and arrangement of parts without departing from the spirit of the invention as expresesd in the appended claims. I, therefore, do not wish to be limited to the exact details of construction and arrangement of parts shown and described as the preferred form has been given by way of illustration only.

Figure 1 is a longitudinal sectional view of a pump constructed according to this invention with the plunger shown in its highest or "port open" position.

Figure 2 is a longitudinal section through the plunger and plunger sleeve similar to Figure 1 but on an enlarged scale with the plunger shown in "port closing" or delivery beginning position.

Figure 3 is a sectional view taken on line 3—3 of Figure 2, looking in the direction of the arrows.

Figure 4 is a sectional view taken on line 4—4 of Figure 2, looking in the direction of the arrows.

Figure 5 shows a development of the plunger and barrel with the parts which are covered by the plunger for the condition shown designated by cross hatching.

Figure 6 is a diagrammatic view showing the development of the metering portion of a plunger and barrel with the plunger adjusted for maximum delivery.

Figure 7 is a diagrammatic view showing the development of the metering portion of a plunger and barrel adjusted for zero delivery.

Figure 8 shows the cam and roller of a pump constructed according to Figure 1.

Figure 9 shows the plunger travel during one camshaft revolution if a cam and roller according to Figure 8 are used.

Figure 10. Successive positions of one port relative to plunger during one camshaft revolution.

Referring more particularly to the drawings, wherein similar reference characters designate corresponding parts throughout the several views, there is shown for the purpose of illustrating the invention an embodiment of the invention comprising a pump adapted to feed fuel to four engine cylinders by means of one plunger.

In a casing or frame 1, the shaft 2 is rotatably mounted by means of two bearing sleeves 3 and 4 which are fastened to the casing or frame 1 by the screws 5 and 6.

The shaft 2 is driven by a coupling (not shown) mounted onto the taper 7 into which the shaft is formed on its one end. The coupling in turn is driven by the engine, in the case of the pump shown in the drawings, at one half of the engine crank shaft speed, as the engine is of the type which operates according to the four-stroke cycle (or at engine crank shaft speed if it were a two-stroke cycle engine). The cam 8, fastened to or machined out of the shaft 2, carries four identical lobes 9 equally spaced about the circumference of the cam. The lobes 9 cooperate with the tappet roller 10 which is rotatably mounted on the pin 11 which is inserted into the tappet 12. The tappet 12 is adapted to reciprocate in a bore 13 of the casing or frame 1. The pin 11 projects on one side beyond the tappet 12 to engage a slot 14 in the casing or frame 1 for the purpose of keeping the roller 10 in the proper relation to the cam 8.

The upper end of the tappet 12 carries the

ball bearing 15, upon which the bearing plate 16 rests. The plunger 17, adapted to reciprocate in the stationary bushing 18, is held against the bearing plate 16 by means of the spring 19 and the spring seat 20, the latter resting on the enlarged plunger portion 21. As evident from the drawing, the spring 19 will act to keep the roller 10 in contact with the cam 8 when the latter is rotated, and therefore the plunger will oscillate in the manner determined by the cam contour. Since the cam has four lobes 9, the plunger will ascend and descend four times during one revolution of the shaft 2, thereby executing four pumping strokes during two engine crank shaft revolutions.

To the shaft 2, on its end which projects beyond the bearing sleeve 4, the bevel gear 22 is fastened by means of the screw 23. The gear and the shaft are adapted to remain in a predetermined angular relationship by means of the radial serrations 24. The bearing shield 25, which is secured to the casing or frame 1 by means of the screws 26, acts as radial and thrust bearing for the bevel gear 22. The latter engages the second bevel gear 27 which is rotatably supported to the quantity control lever 28 by means of the ball bearing 29. The lever 28 carries on its lower end the bearing 30 through which the shaft 2 passes. The ball bearing 29 is secured to the lever 28 by means of the nut 31 and the locknut 32. The lever 28, which passes through an opening of the upper portion 33 of the casing 1 to the outside of the pump proper, will be held against rotation around shaft 2.

From the gear 27 through the double gear 34 (which is carried on and is adapted to rotate around shaft 2), the plunger gear 35 is driven. The gear 35 has an upwardly extended hollow hub which rotates within the ball bearing 36 and on its upper end has a flange for supporting the plunger spring 19. This hub 37 has in its lower portion a pair of diametrically opposed slots 38 into which the ends of the pin 39 extend. Since this pin 39 passes through the enlarged lower end 21 of the plunger 17, rotation of the gear 35 produces rotation of the plunger 17 about its axis and relative to the stationary plunger bushing 18.

The oscillating motion of the plunger 17, as well as the rotating motion, is caused by the rotation of the shaft 2, therefore a definite relationship between the two types of plunger motions exists and will be maintained at all times. In the example of the invention shown in the drawings this relationship is such that for every revolution of the shaft 2, the plunger 17 makes one complete revolution. Since the plunger also makes four complete pumping and return cycles during one revolution of the shaft 2, one complete pumping and return cycle is executed by the plunger during one quarter of a full revolution of said shaft 2.

The plunger bushing 18 is clamped tightly with its upper face against the block 40 by means of the retaining nut 41. The block 40 is mounted to the upper casing 33 by screws which are not shown, while the gasket 42 provides a fluid tight seal between the two parts. The casing 33 has in its upper portion a cavity 43 through which the upper portion of the plunger bushing 18 extends, and said cavity 43 is kept filled with fuel when the pump is in operation. Fuel enters the cavity 43 through the opening 44 which is threaded to receive any suitable fitting (not shown) to connect the cavity to a fuel supply means (not shown). The synthetic rubber ring 45 is con-

59, groove 57, recesses 61, and groove 60. Therefore the pressure in the pumping chamber will drop to substantially the pressure maintained in the space 43, permitting the delivery valve 48 to close under the force of the spring 49, thus terminating the injection.

While the plunger 17 continues to lift until it reaches its highest point 83, fuel will be displaced from the pumping chamber 56 but instead of being injected into one of the engine cylinders, it will be returned into the space 43.

Point 80 is defined by the amount B the plunger has been lifted above its lowest point 78 and the angle *b* through which it has been rotated during the same interval. The effective pumping stroke is B—A while *b*—*a* is the delivery duration in degrees. The lobes 9 of the cam are designed to give values for the effective stroke and the duration similar to those customarily employed on other types of injection pumps. Consequently the plunger velocity is also the same as on a pump which feeds one engine cylinder only.

From the foregoing it will be understood that the injections produced by the three remaining cam lobes will be identical with that produced by the first lobe, except that the plunger will have turned 90 degrees about its axis during the interval between each two consecutive injections, thus connecting consecutive pairs of ports 65 and 66 and thereby directing the fuel flow to consecutive engine cylinders.

On the return stroke of the plunger (moving from point 83 to point 78) the lands 62 will never cover the ports 63 entirely. Therefore, fuel may flow into the pumping chamber 56 from the cavity 43 by way of the ports 63, the recesses 61, the groove 57 and the ducts 59 and 58 during the entire return (or suction) stroke of the plunger.

It is a distinct advantage of the pump design described that the pumping chamber remains in connection with the source of fuel supply during the entire suction stroke. This precludes formation of vapor in the pumping chamber during that portion of the plunger return stroke during which the ports are closed, as is the case in conventional pumps of the port-controlled type. This feature is of added importance in the type of pump described because the interval between successive injections is considerably shorter than on pumps which feed fuel to only one engine cylinder. Therefore the time interval available for the absorption of any vapor formed during the filling stroke of the plunger is also shortened. This has interfered with the high speed operation of pumps in which one plunger feeds fuel to more than one engine cylinder because any vapor present in the pumping chamber after "port closing" will cause a reduction in delivery which is equal to the difference between the volume of the vapor and the volume of the liquid that has been formed by the condensation of the vapor.

The effective pumping stroke is varied by adjusting the control lever 28 to change the relationship between the oscillatory and the rotary motions of the plunger. Figure 7 shows this relationship for the "no-fuel" condition. In position 84 the periphery 75 of port 63 is tangent to edge 74 of the land 62. This would represent the "port closing" condition, if the edge 86 of the land would not now intersect the port periphery 75 and thus keep part of the port 63 uncovered. By the time edge 86 becomes tangent to 75 due to the relative motion of plunger and bushing against each other, 75 has become tangent to edge 81 also (position 85). This is the only position in which the port 63 is closed completely, but only momentarily, because as soon as the plunger has moved beyond position 85, the port is being uncovered again. Therefore the effective plunger stroke is zero for this condition. The angle *c* indicates the amount of phase shift that is required to reduce the effective plunger stroke from the amount of Figure 6 to zero, which is accomplished by moving the lever 28 (Figure 1).

While I have herein specifically described one form which my invention may assume in practice, it will be understood that this form has been shown for purposes of illustration and that my invention may be modified and embodied in other forms without departing from its spirit or the scope of the appended claims.

From the foregoing it will be seen that I have provided simple, efficient and economical means for obtaining all of the objects and advantages of the invention.

Having described my invention, I claim:

1. In an internal combustion engine fuel injection pump, a housing, a bore in said housing, a plunger in said bore, means for reciprocating and rotating said plunger simultaneously, supply and delivery port means in said housing and communicating with said bore and port means on said plunger for connecting said supply and delivery port means for delivering fuel to each of the engine cylinders, and means for changing the relation between the reciprocating and rotary motions of the plunger to vary the effective pumping stroke of the pump and thereby vary the quantity of fuel to be injected.

2. In a fuel injection pump for internal combustion engines in which a single pumping plunger and delivery valve is employed for feeding fuel under pressure to more than one engine cylinder, a plunger, means for reciprocating and rotating said plunger simultaneously, a housing, a bore in said housing, fuel supply port means in said housing and communicating with said bore and means on said plunger adapted to cooperatively function with said port means whereby the desired amount of fuel is injected into each engine cylinder and means for changing the relationship between the reciprocating and rotary motions of the plunger to vary the effective pumping stroke of the pump and thereby vary the quantity of fuel to be injected.

3. In a fuel injection pump for internal combustion engines in which a single plunger is employed for pumping and metering the fuel and also for distributing it to more than one engine cylinder, a housing, a bore in said housing, a plunger in said bore, means for reciprocating said plunger in said bore, means for rotating said plunger in said bore simultaneously with the reciprocation thereof and means for changing the relation between the reciprocating and rotary motions of the plunger to vary the effective pumping stroke of the pump and thereby vary the quantity of fuel injected.

4. In a fuel injection pump for an internal combustion engine in which a single plunger is employed for pumping and metering the fuel and also for distributing it to more than one engine cylinder, a housing, a bore in said housing, a plunger in said bore, means for reciprocating said plunger, means for rotating said plunger simultaneoulsy with the reciprocation thereof and means for changing the relation between the reciprocating and rotary motions of the plunger to vary the effective pumping stroke of the pump and thereby vary the quantity of fuel injected,

fined in the circular space between a shoulder of the plunger bushing 18 and a recess in the casing 33, in order to prevent fuel from passing out of the cavity 43 into the lower portion of the pump.

The block 40 has a central bore through which the valve body 46 is inserted and pressed against the upper face of the plunger bushing 18 by the retaining screw 47. The delivery valve 48 is adapted to operate in the valve body 46 and is urged by the spring 49 which is confined between the valve 48 and the screw 47 against its seat in the valve body. In order to prevent fuel from leaking past the threads of the screw 47 to the outside of the pump, the cap nut 50 is fastened to the upper end of the screw 47 in such a manner that the lower face of the nut seals against the block 40 by means of the gasket 51.

Four ducts 52 (only two of which are shown in Figure 1), located in the block 40, terminate in conical recesses into which the swedged ends of discharge tubes 53 are pressed by nuts 54 and washers 55 to form a fluid tight connection for the fuel to be forced by the pump to the fuel valves or discharge nozzles (not shown) of which one is located in each engine cylinder.

Referring now to Figures 2 to 5, which show the details of the upper portions of the plunger 17 and the plunger bushing 18, it will be seen that the pumping chamber 56 is connected to the annular groove 57 of the plunger by means of the longitudinal bore 58 and the transverse bore 59. Somewhat below the groove 57 there is a second groove 60 provided on the plunger 17. These two grooves are connected to each other by four identical recesses 61 extending below the plunger surfaces. The recesses 61 are located exactly at right angles to each other and therefore form four identical lands 62. At about the center of that portion of the bore of the plunger bushing 18 over which the lands 62 travel during the oscillation of the plunger 17, there are provided in the bushing four ports 63 which are spaced exactly 90 degrees apart and which connect the space 43 with the bore of the plunger bushing 18.

Above the groove 57 one oblique recess 64 is provided in the surface of plunger 17. In the portion of the bore of plunger bushing 18 which is wiped by the recess 64 when the plunger executes its combined oscillatory and rotary motion, two groups of ports 65 and 66, each group consisting of four ports located at exactly right angles to each other, are located. The upper group of ports 65 is connected by four vertical ducts 67 to the annular space 68 formed between the delivery valve body 46 and the wall of the central bore of the block 40. Through slots 69 in the lower end of the retaining nut 47, the space 68 is connected with the spring chamber 70 which is formed in the retaining nut 47. The lower group of ports 66 is connected individually by four vertical ducts 71 to the four ducts 52 in the block 40.

The operation of the pump is as follows:

The roller 10 follows the contour of the cam 8 when the latter is rotated upon rotation of the shaft 2 and the center of the roller 10 describes a path 72 (Figure 8) about the center of the cam. The motion of the roller is imparted to the plunger 17 in the manner previously described. The resultant elevation of any point of, or on, the plunger 17 above its lowest position is shown in Figure 9 for any angular position of the cam 8. At the same time, however, the plunger is also rotated at such a rate and by the means previously described, that it executes one complete revolution during one revolution of the cam. These motions combine to give a definite motion of any port in the plunger bushing 18 relative to the plunger 17. Figure 10 shows successive positions of a port in relation to the plunger if the latter is considered to be stationary while the bushing 18 is thought to execute the combined oscillatory and rotary motion which in reality is made by the plunger. Also shown is the path 73 which the center of the port describes. The plunger is in its lowest position when the port hole is in its highest position (relative to the plunger). Therefore the highest points 78 of the curve 73 represent the lowest plunger positions.

Turning now to Figure 6, the ports 63 are shown together with the lands 62 in such relation to each other that the upper horizontal edges 74 of the lands 62 are tangent to the periphery 75 of the ports 63 at its uppermost point. The paths 73 of the center of the ports are also shown, and since the ports 63 are spaced exactly 90 degrees apart and their centers lie in one plane which is perpendicular to the plunger and plunger bushing bore axis, and since furthermore, the plunger makes one up and one down stroke during 90 degrees of its rotation, the paths of all four ports 63 coincide with each other and are completely described by the path or curve 73. The curves 76 and 77 are the common tangents to the periphery 75 of an infinite number of positions of the ports 63.

The points 78 represent the lowest plunger positions and the points 79 the plunger positions in which the edges 74 of the lands 62 are tangent to the periphery 75 of the ports 63 if the path of the centers of the ports 63 are used as the common reference points. The plunger has then lifted the distance A while turning through the angle a since having been in the lowest position. The position defined by point 79 is the "port closing" position because in it the port 63 has just been completely covered by land 62. Therefore the connection between space 43 (see Figure 2) and the pumping chamber 56 (through groove 57 and ducts 59 and 58) has now just been broken (this is the position in which plunger 17 and bushing 18 are shown relative to each other in Figures 2 to 5).

As the plunger now moves on in the direction towards point 80 the fuel trapped in the pumping chamber 56 is compressed. When the pressure in the pumping chamber has risen sufficiently, the delivery valve 48 will be lifted from its seat and raised until fuel can flow past it into the chamber 70 in the retaining nut 47. From here it will pass through the slots 69, the space 68, and one of the ducts 67, and out through that one of the ports 65 which is uncovered at this time by the plunger recess 64. Since the recess 64 is long enough to uncover at the same time that port 66 which is directly below the presently open port 65, the fuel will continue to flow from the open port 65 through the recess 64 into the open port 66, and from there through those ducts 71 and 52, the line 53 and the discharge nozzle, into one of the engine cylinders which is associated with the presently open port 66.

When point 80 is reached (Figure 6) the inclined edges 81 and the horizontal edges 82 become tangent to the periphery 75 (shown as a broken line for this position) of that port 63. This is the "port opening" position. If the plunger moves beyond it, ports 63 will have become uncovered, re-establishing communication between pumping chamber 56 and space 43 by way of ducts 58 and said bore having ports and means on said plunger adapted to cooperatively function with said ports in said bore to control the quantity of fuel delivered to said bore.

5. In a fuel injection pump for an internal combustion engine in which a single plunger is employed for pumping and metering the fuel and also for distributing it to more than one engine cylinder, a housing, a bore in said housing, a plunger in said bore, means for reciprocating said plunger, means for rotating said plunger simultaneously with the reciprocation thereof and means for changing the relation between the reciprocating and rotary motions of the plunger to vary the effective pumping stroke of the pump and thereby vary the quantity of fuel delivered to the engine cylinders, said bore having ports and means on said plunger adapted to cooperatively function with said ports in said bore to control the quantity of fuel delivered to said bore.

6. In a fuel injection pump for internal combustion engines in which a single pumping plunger and delivery valve is employed for feeding fuel under pressure to more than one engine cylinder, a bore, a plunger in said bore, means for reciprocating and rotating said plunger simultaneously, a plurality of ports connected with said bore and means on said plunger adapted to cooperatively function with each of said ports successively whereby the desired amount of fuel is delivered to said bore and means for changing the relation between the reciprocating and rotary motion of the plunger to vary the effective pumping stroke of the pump and thereby vary the quantity of fuel to be delivered to the engine cylinders.

7. In a fuel injection pump for an internal combustion engine in which a single plunger is employed for pumping and metering the fuel and also for distributing it to more than one engine cylinder, a housing, a bore in said housing, a plunger in said bore, a shaft, means on said shaft for reciprocating said plunger, means on said shaft for effecting the rotation of said plunger simultaneously with the reciprocation thereof and adjustable means for changing the relation between the reciprocating and rotary motions of the plunger to vary the effective pumping stroke of the pump and thereby vary the quantity of fuel injected.

8. In a fuel injection pump for an internal combustion engine in which a single plunger is employed for pumping and metering the fuel and also for distributing it to more than one engine cylinder, a housing, a bore in said housing, a plunger in said bore, means for reciprocating said plunger, means for rotating said plunger simultaneously with the reciprocation thereof and means adjustable at will for changing the relation between the reciprocating and rotary motions of the plunger to vary the effective pumping stroke of the pump and thereby vary the quantity of fuel injected, said bore having ports communicating therewith and means on said plunger adapted to cooperatively function with said ports to control the quantity of injected fuel.

9. In a fuel injection pump, a housing, a bore in said housing, a plunger in said bore serving as pumping element and distributing element, a fuel passage externally of the bore and adapted to supply fuel from that portion of the bore in which fuel is pumped under pressure to the portion thereof in which fuel is distributed, a check valve in the fuel path between said pumping and distributing portions and a spill passage in said plunger and adjustable means for controlling the spill through said spill passage.

10. In a device of the character described, a housing, a bore in said housing, a plunger in said bore and adapted to be reciprocated and rotated therein for pumping and distributing fuel, said plunger having pumping and distributing portions, a fuel path extending between said pumping and distributing portions, a check valve in said fuel path, a spill chamber in said housing and communicating with said bore, and a spill passage in said plunger and adapted to allow the spilling of fuel from said bore to said spill chamber.

11. In a device of the character described, a housing, a bore in said housing, a plunger in said bore and adapted to be reciprocated and rotated therein for pumping and distributing fuel, said plunger having pumping and distributing portions, a fuel path extending between said pumping and distributing portions, a check valve in said fuel path, a spill chamber in said housing and communicating with said bore, and a spill passage in said plunger and adapted to allow the spilling of fuel from said bore to said spill chamber and means for controlling the spilling of fuel through said spill passage.

12. In a fuel injection pump, a housing, a bore in said housing, a plunger in said bore, said plunger having a pumping portion and a distributing portion, said plunger being adapted to be reciprocated and rotated in said bore, a delivery passage connecting the portion of the bore in which fuel is pumped under pressure to the distributing portion of the plunger, a check valve in the fuel path between the portion of the bore in which fuel is pumped under pressure and the distributing portion of the plunger, a chamber and a spill or bypass passage adapted to connect said chamber and the portion of the bore in which fuel is pumped under pressure for controlling the quantity of fuel delivered by the pump.

13. In a fuel injection pump, a housing, a bore in said housing, a plunger in said bore, said plunger having a pumping portion and a distributing portion, said plunger being adapted to be reciprocated and rotated in said bore, a delivery passage connecting the portion of the bore in which fuel is pumped under pressure to the distributing portion of the plunger, a check valve in the fuel path between the portion of the bore in which fuel is pumped under pressure and the distributing portion of the plunger, a chamber and a spill or bypass passage adapted to connect said chamber and the portion of the bore in which fuel is pumped under pressure for controlling the quantity of fuel delivered by the pump and adjustable means for adjusting the quantity of fuel delivered by said pump.

WOLFGANG E. MEYER.

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