Jan. 17, 1950 F. A. SIMMONS 2,494,837

SPRAYER OR ATOMIZER

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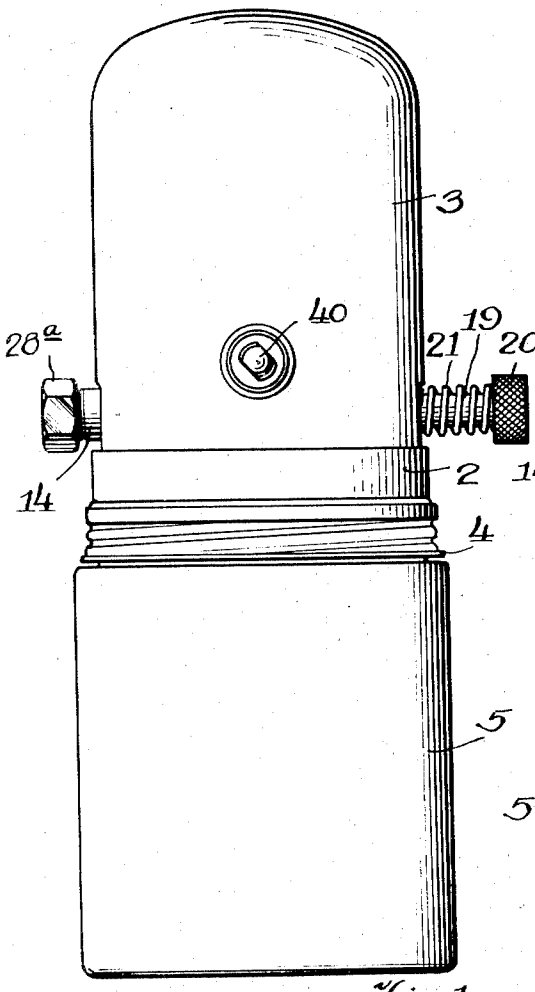

Fig. 1

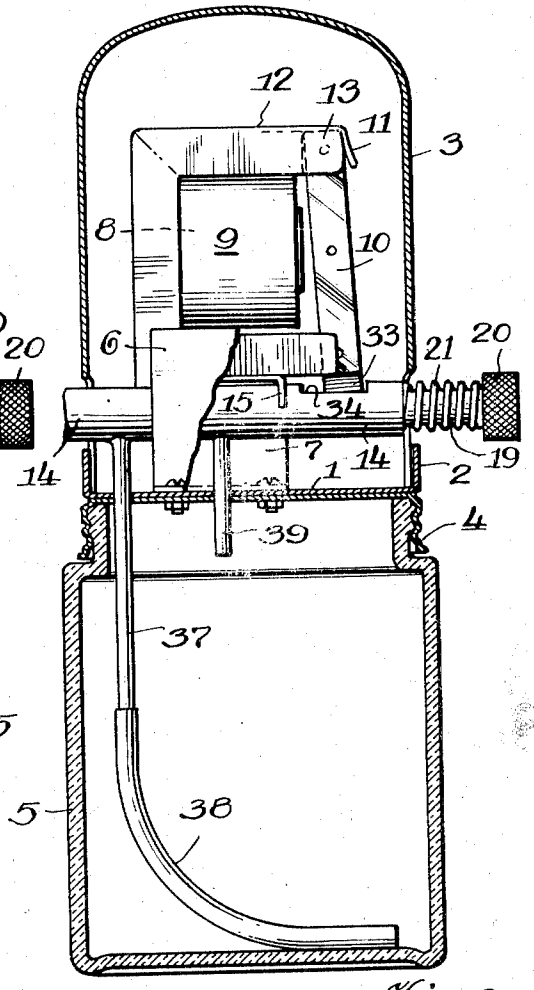

Fig. 2

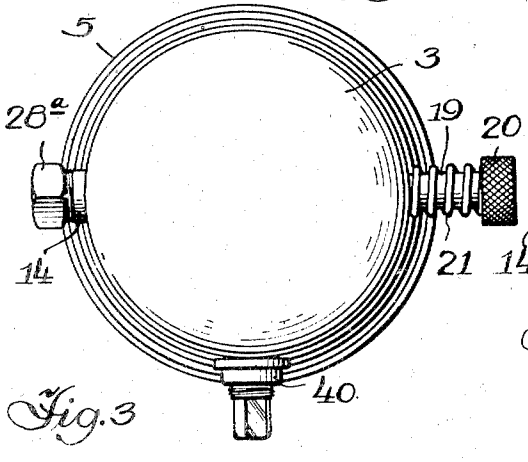

Fig. 3

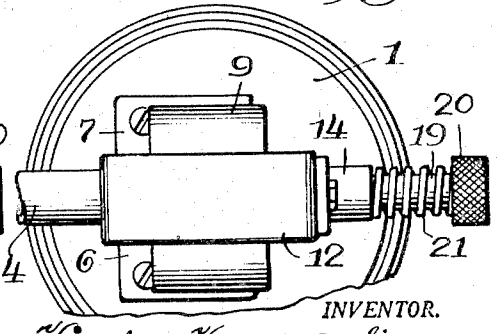

Fig. 4

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Fig. 6

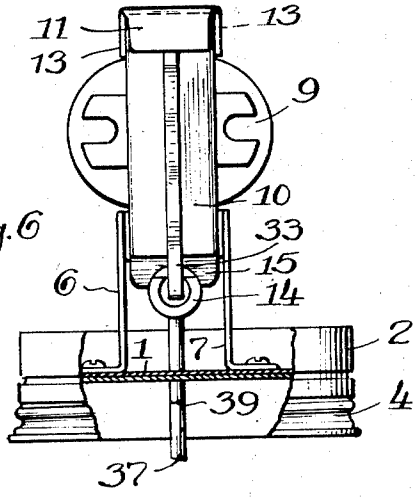
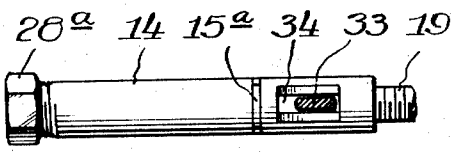


Fig. 7



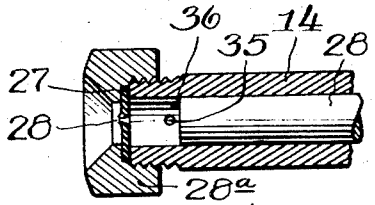
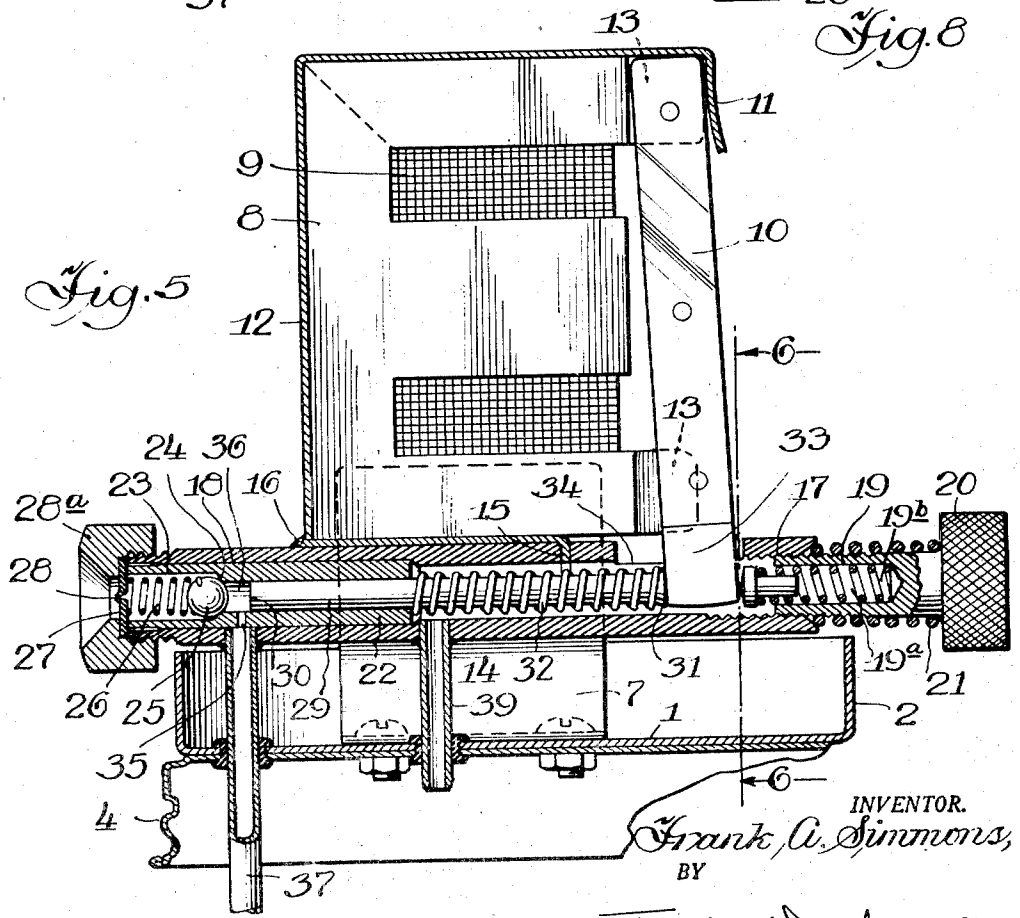


Fig. 8

Fig. 5



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SPRAYER OR ATOMIZER

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Application February 26, 1948, Serial No. 11,119

6 Claims. (Cl. 299—97)

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This invention relates to devices for spraying or atomizing liquids.

The principal purpose of the invention is to provide a sprayer for paint, enamels, lacquers, insecticides, and the like, in which a piston-cylinder mechanism acts directly upon the liquid at the nozzle and which does not depend upon a source of compressed air or other gaseous medium for its operation. A further object is to provide a compact mechanism of this character which efficiently breaks up the liquid into minute particles.

Another object is to provide a sprayer in which the rate of consumption of the liquid may be varied and the character of the spray may be altered to suit the requirements of a particular use. A further object is to provide a spray of the direct-acting type in which no moving valve mechanism is required or only a single check valve is employed and the mechanism is otherwise reduced to maximum simplicity.

In one aspect of the invention, a further object is to provide an electrically operated direct-acting sprayer or atomizer. In this connection, a further object of the invention is to provide an adjustably synchronized spring system for returning the driving armature.

In the accompanying drawings,

Fig. 1 is a side elevational view of a preferred form of the sprayer;

Fig. 2 is a side elevational view of the internal structure of the sprayer, portions of the structure being broken away for illustrative purposes;

Fig. 3 is a top view of the sprayer of Fig. 1;

Fig. 4 is a top view of the internal structure of the sprayer;

Fig. 5 is an enlarged, sectional view of the sprayer mechanism;

Fig. 6 is a sectional view taken at the line 6—6 of Fig. 5;

Fig. 7 is a top view, partly in section, of the barrel of the sprayer and immediately related elements; and

Fig. 8 is a detailed sectional view of an alternative form of sprayer mechanism.

The sprayer, of which a preferred embodiment is illustrated in Figs. 1–7 of the drawing, comprises essentially a cylinder having a liquid inlet port in a wall and a check valve at the outlet end thereof, a piston reciprocating within the cylinder as it is driven by the armature of a vibratory motor, means for supplying liquid to the inlet port, and a nozzle through which the liquid is forced.

The sprayer mechanism is mounted upon a platform 1 which may be in the form of a cup

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with side flanges 2 adapted to receive the sprayer housing 3 and retain the same in position. Platform 1 may also be fastened to a conventional jar cover 4 adapted to screw upon the top of a liquid-containing jar 5. It is not necessary that the cover 4 be screwed upon jar 5 in an air-tight manner.

Suitably mounted upon platform 1 by means of supporting plates 6 and 7 is a vibratory motor consisting essentially of a core 8 of stacked "E" laminations, a single coil 9, and an armature 10. For most efficient operation, the armature should also be laminated, as shown. A clip 11, which may be an extension of core cover 12, engages the upper end of armature 10 to hold the same in an essentially pivotal relation with the adjoining portion of the core. The lower end of the armature is free to oscillate, within limits, away from and toward the core. Sidewise shifting or movement of the armature is prevented by retaining guides 13 which may also be extensions of core cover 12.

A lenth of brass or other suitable tubing forms the barrel 14 of the sprayer mechanism. This barrel is rigidly fastened to the core structure by suitable means, as foot 15 firmly inserted into a transverse slot 15a provided in the upper portion of barrel 14 and by means of soldering at 16. Barrel 14 is provided with an internally threaded bore 17 at its rear end and an enlarged smooth bore 18 at its forward end. The former is adapted to receive a threaded adjusting screw 19 having a knurled knob 20 and a central bore 19a with a coil spring 19b therein whose function is more fully described hereinafter. A coil spring 21, held in compression between the end of barrel 14 and screw head 20, retains screw 19 at a desired position.

Bore 18 is adapted to receive a cylinder sleeve 22. This sleeve may be an integral part of the barrel, if desired. An enlarged bore 23 of sleeve 22 terminates in a circular shoulder 24 which forms a seat for ball 25 to provide a check valve for the purposes hereinafter described. Ball 25 is urged toward engagement with seat 24 by coil spring 26 which is held in compression by disc 27. This disc has a very small aperture 28 and forms the spray nozzle, being retained in position upon the forward end of barrel 14 by suitable means, such as nut 28a threaded upon the end of the barrel.

A rod 29 closely fitting within sleeve 22, serves as both piston and connecting rod. The forward face 30 is the working piston surface and the rearward end of rod 29 is enlarged or headed, as at 31, to retain coil spring 32 in compression be-

tween the inner end of sleeve 22 and head 31 to continuously urge rod 29 toward the retracted position in cylinder sleeve 22, as illustrated. A driver head 33, attached to or formed by an integral extension of armature 10, extends into the bore of barrel 14 through a slot 34 provided for this purpose. It engages the end of rod 29 to drive the same and is limited in its movement away from core 8 by spring 19a which engages the rear surface of driver head 33. As shown more clearly in Fig. 6, the driver head may be an extension of several laminations or a heavier iron bar riveted between the armature laminations along the center line of the armature.

A small inlet port 35 passes through cylinder sleeve 22 and connects cylinder 36 with inlet tube 37 which passes through or connects with an opening in barrel 14 and sleeve 22. An extension tube 38 which may be flexible, if desired, carries the sprayer liquid inlet to the bottom of container 5. A second tube 39 passes through platform 1, cap 4 and barrel 14 to connect the space beyond the inner end of sleeve 22 with the interior of container 5. This tube furnishes an air inlet for jar 5 and, opening into the barrel space at a point at the bottom of the bore, also permits the return to the liquid container of any liquid escaping between rod 29 and sleeve 22. This portion of the barrel serves as a drip pan.

The electrical leads of coil 9, not shown, may be connected with a suitable switch 40 and brought out through housing 3 in any suitable manner.

To operate the sprayer, the liquid to be sprayed is poured into jar 5 and the jar screwed into cap 4. The apparatus is connected with a suitable source of alternating electrical current whereupon the piston 29 is caused to oscillate in reciprocation within cylinder sleeve 22 by the action of armature 10 which pivots about its upper extremity as it is alternately attracted by core 8 and returned by spring 32 in unison with the reversals of the alternating current. The resultant characteristics of combined springs 32 and 19a (as adjusted by screw 19) are such that rod 29 is moved back during the retraction stroke with optimum velocity to synchronize this action with current fluctuations in the core and resulting armature action. In this way, maximum efficiency is attained. Where 60 cycle alternating current is used, rod 29 is driven at the rate of 7200 strokes per minute.

As the piston is withdrawn during a part of each operating cycle, cylinder 36 is evacuated and liquid is drawn through tube 37 and inlet port 35 into the cylinder space. The check valve formed by ball 25 and seat 24 prevents the flow of air or liquid into the cylinder except through the inlet port. Then, after a momentary pause at the end of the back stroke sufficient to permit the flow of an appreciable quantity of liquid into the cylinder space, rod 29 is driven forward by armature 10 and driver head 33. This movement of the piston lifts ball 25 from its seat at the outlet port of the cylinder and forces the liquid through this outlet port and aperture 28 from which it emerges as a substantially continuous fine spray or mist. Although the travel of rod 29 is small, the rapid rate at which it oscillates accumulates a considerable displacement over a given period of time. It is likely that the inertia of the liquid stream flowing through inlet port 35, together with an unsatisfied suction, tends to continue the inward flow even after completion of a substantial part of the forward travel of the rod, or, at least, prevents a reversal in flow prior to the substantial closing of the port by the rod.

The limit of travel of the forward stroke, determined by engagement of armature 10 with core 8, is just short of contact with ball 25. The characteristics of the spray and the rate at which liquid is withdrawn from the container and passed through the nozzle may be altered by adjusting the length of the stroke of the piston. This adjustment may be made by means of screw 19. By turning it into the threaded bore, the length of the stroke of rod 29 is reduced. This adjustment also increases the compression strain in springs 32 and 19a which, as noted above, affects the efficiency of the device. Thus, the spraying rate may be varied by adjusting either the efficiency of the sprayer or the length of stroke of the piston, or by adjusting both of these factors.

The modified form of sprayer mechanism shown in Fig. 8 is simpler than that above described in that the check valve at the nozzle is omitted. This device delivers a very fine spray and is entirely satisfactory as a spray mechanism. Due to the absence of the check valve, however, it is somewhat slow to prime when first put into operation and is capable of drawing liquid only from a relatively shallow container because of the lower suction values attainable in the cylinder.

The simpler device of Fig. 8 is otherwise similar to that previously described. The separate cylinder sleeve may be dispensed with, if desired and as shown, and piston 29 reciprocated in cylinder 36 directly formed by barrel 14. The nozzle structure, including plate 27 with orifice 28 therein and the retaining nut 28a, are mounted immediately at the end of the cylinder. Inlet port 35 opens into cylinder 36 and suitable means, not shown, are provided to connect a supply of liquid to this port. For this particular device, a suitable arrangement is one in which a small container is arranged alongside barrel 14 to avoid the necessity of drawing the liquid through a feeder tube from a great depth, suitable precaution being taken to avoid flow of liquid into the cylinder by gravity when the sprayer is not in use.

Such an assembly is particularly useful as an air brush. Upon withdrawal of piston 29 in the cylinder during the back stroke, liquid is sucked into the cylinder through inlet port 35. At the same time, due to the absence of a check valve at the nozzle, air is taken into the cylinder. The rate of flow of air into the cylinder is limited, of course, by the capacity of orifice 28. Being very small, only a small amount of air passes into the cylinder. Because this is insufficient to satisfy the partial vacuum within the cylinder, liquid is also drawn in through the relatively large inlet port 35. On the forward stroke of the piston, this mixture of air and liquid is forced through orifice 28 under great pressure and in the form of a finely atomized spray. The limit of forward travel of the piston is just short of contact with plate 27; that is, the piston face approaches very close to orifice 28 which is the outlet port of the cylinder.

It will be understood that the piston of either form of sprayer mechanism described may be operated by any suitable means. The vibratory motor specifically described above is suitable for most purposes. However, an air hammer of standard construction may be employed or an ordinary high speed electric motor with a suitable mechanism to transform the rotory to reciprocat-

ing motion may be used. Other types of driving mechanism may also be used.

It will be apparent to those skilled in the art that many modifications may be made in the specific structure of the sprayer without departing from the invention. Many different forms of nozzle may be employed in accordance with the particular needs of a given application. The forward end of the cylinder may be closed by a wall integral with the cylinder wall, if preferred, and the orifice drilled or punched in this wall. The form of the piston and other elements may also be varied.

The sprayer herein described is intended to operate at high speed. For this reason, it is generally desirable to limit piston travel to a distance less than the diameter of the cylinder, particularly when the vibratory motor is employed to drive the piston. In this way, a substantially continuous spray stream is produced which is suitable for spray painting and air brush work, as well as for spraying insecticides, atomizing perfumes, deodorant liquids, etc.

Invention is claimed as follows:

1. A sprayer comprising means forming a cylinder having an outlet port at the forward end and an inlet port in the wall of said cylinder spaced rearwardly from said outlet port, a piston adapted to reciprocate within said cylinder between an extended position and a retracted position uncovering at least a portion of said inlet port, the face of the piston when said piston is in its extended position being at least just short of said outlet port, whereby on the forward movement of said piston the piston expels substantially all fluid from said cylinder, a nozzle connected with said outlet port, a check valve at said outlet port adapted to prevent fluid flow into said cylinder, means for driving said piston in reciprocation, and means for continuously supplying liquid to said cylinder through said inlet port.

2. A sprayer comprising means forming a cylinder having an inlet port in the wall thereof, a wall covering the forward end of said cylinder, said wall having a permanently open orifice therein smaller than said inlet port, a piston adapted to reciprocate within said cylinder between an extended position and a retracted position uncovering at least a portion of said inlet port, the face of the piston when said piston is in its extended position being at least just short of said orificed wall, whereby on the forward movement of said piston the piston expels all fluid from said cylinder, means for driving said piston in reciprocation, and means for continuously supplying liquid to said cylinder through said inlet port.

3. In a sprayer including an electric vibrating motor having an armature with a free end adapted to vibrate in reciprocating motion, a tubular barrel having an intermediate portion with a bore smaller than that of the forward and rearward portions and a longitudinal slot in the rearward portion thereof, said intermediate portion having an inlet port in the wall thereof, a piston adapted to reciprocate within said intermediate portion between an extended position approaching the forward extremity thereof and a retracted position uncovering at least a portion of said inlet port, a connecting rod within the rearward portion of said barrel and connected with said piston, spring means for continuously urging said connecting rod rearwardly, the free end of the armature of the motor extended through said slot in said barrel in engagement with said connecting rod, a stop in the rearward end of said barrel for limiting movement of said armature, a spring mounting for said stop for permitting limited longitudinal movement thereof, a nozzle at the forward end of said barrel, a check valve at the forward extremity of the intermediate portion of said barrel, and means for continuously supplying liquid at said inlet port.

4. A sprayer comprising means forming a cylinder having an inlet port in the wall thereof, a piston adapted to reciprocate within said cylinder between a retracted position uncovering at least a portion of said inlet port and an extended position beyond said port, a nozzle at the forward end of said cylinder, means for driving said piston in reciprocation between said retracted and extended positions, a stop for limiting the movement of said piston in the return stroke thereof to the retracted position, said stop being adjustable independently of said means for driving said piston in reciprocation and including spring means adapted to cushion the impact of engagement therewith and urge said piston forwardly during the initial stage of the forward stroke thereof, said stop being so arranged and located that it is engaged during the final stage of the return stroke and the initial stage of the forward stroke of said piston, and means for continuously supplying liquid to said cylinder through said inlet port.

5. In a sprayer including an electric vibrating motor having an armature with a free end adapted to vibrate in reciprocating motion and a supporting body for said sprayer, a cylinder member mounted horizontally upon said body and having an inlet port opening into the bore thereof, a piston adapted to reciprocate within said cylinder between an extended position approaching the forward extremity of said bore and a retracted position uncovering at least a portion of said inlet port, a connecting rod connected with said piston and extending rearwardly from said cylinder member, spring means for continuously urging said connecting rod rearwardly, the free end of the armature of the motor operatively engaging the rearward end of said connecting rod, a stop mounted in said supporting body for engagement with said armature to limit movement thereof on the return stroke, a spring mounting for said stop adapted to permit limited longitudinal movement thereof, a nozzle connected to the forward extremity of said cylinder member, a check valve at the forward extremity of said bore, and means for continuously supplying liquid at said inlet port.

6. A sprayer comprising means forming a cylinder having an inlet port in the wall thereof, a piston adapted to reciprocate within said cylinder between a retracted position uncovering at least a portion of said inlet port and an extended position beyond said port, a nozzle connected to the forward end of said cylinder, means for driving said piston in reciprocation between said retracted and extended positions, said means including an actuating member having a face operatively engaging the rear end of the piston for moving the piston forwardly to its extended position and spring means exerting its effective force against the piston and said face of the actuating member for moving the piston and the actuating member to the retracted position of the piston, stop means adapted to engage a face of said actuating member opposite said first-mentioned face thereof for limiting the movement of said piston on the return stroke thereof to the retracted position, spring means adapted to

cushion the impact of engagement with said stop and urge said piston forwardly during the initial state of the forward stroke thereof, and means for continuously supplying liquid to said cylinder through said inlet port.

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