

June 26, 1962

L. L. J. MASSAL

3,040,989

FUEL INJECTORS

Filed April 20, 1961

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Fig. 1

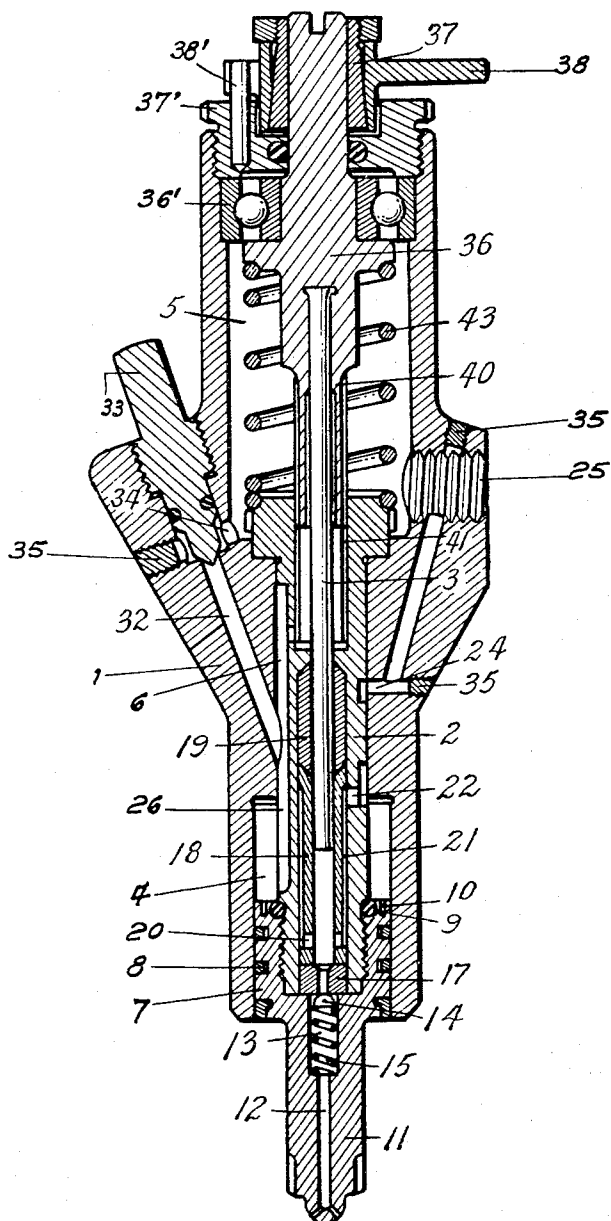


Fig. 2

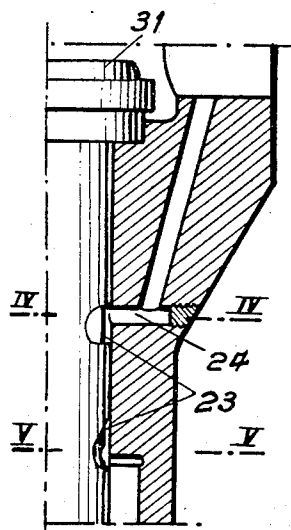
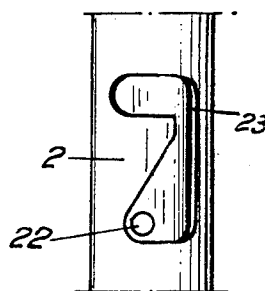


Fig. 3



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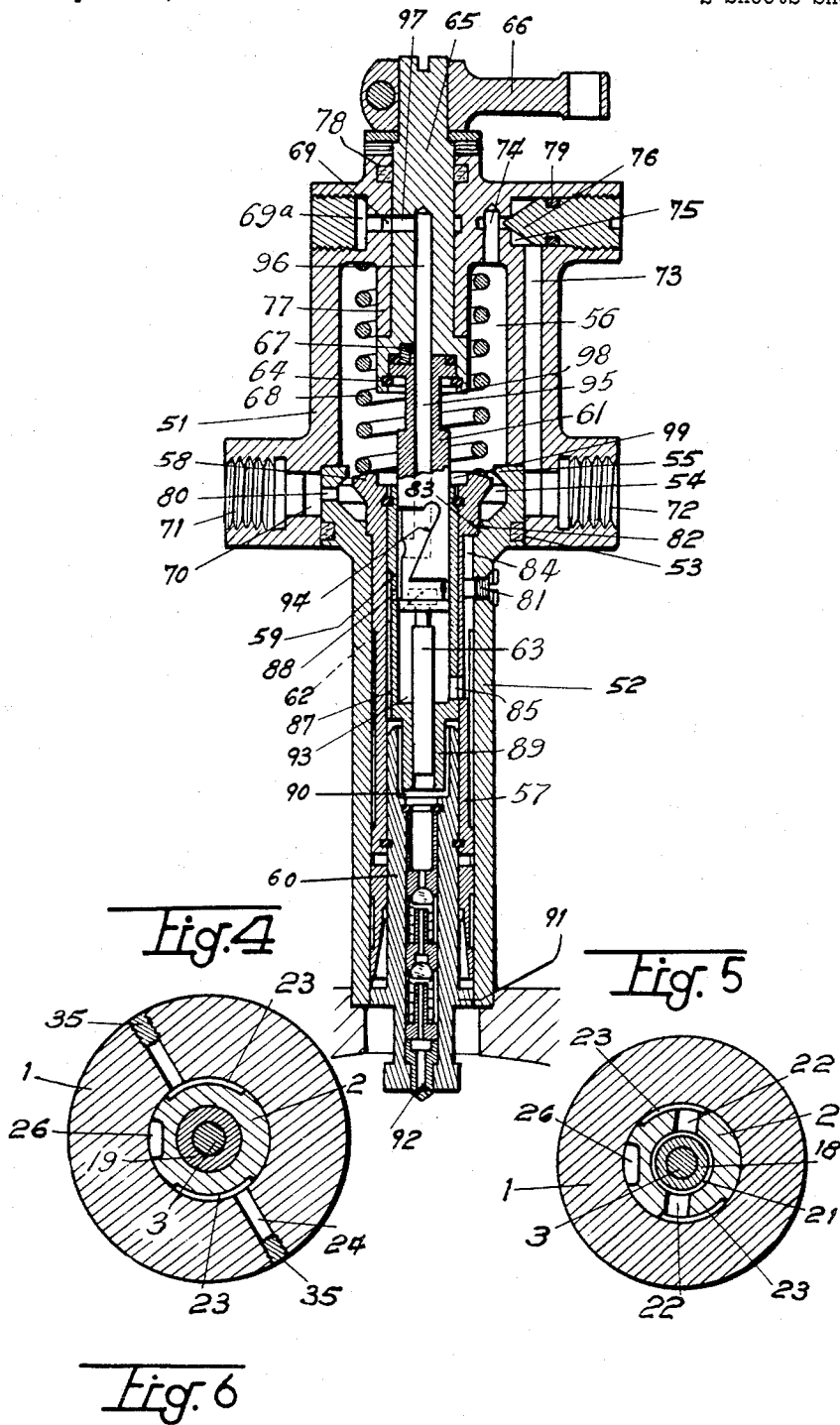
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FUEL INJECTORS

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Filed Apr. 20, 1961, Ser. No. 104,269

Claims priority, application France Apr. 22, 1960

5 Claims. (Cl. 239—87)

The present invention is directed to fuel injectors for internal combustion engines, of the type comprising a body which is provided with two communicating chambers, and inside which moves a cylinder on which is fitted the injection nozzle, said cylinder being rigidly coupled to a piston moving inside one of said chambers and providing a passage for a fixed plunger which is integral with said body and delimits inside the said cylinder an injection chamber which communicates on the one hand with the fuel and on the other hand with the injection nozzle.

Injectors of this type have already been constructed which provide a means of applying the pressure existing in the interior of the engine-cylinder so as to produce a movement of displacement of the nozzle-cylinder which drives towards the engine-cylinder the liquid which is imprisoned by the plunger inside the injection chamber.

However, these injectors have substantial disadvantages.

In the first place, the locking of the nozzle-cylinder is effected mechanically, usually by means of a spring located inside one of the chambers. This spring therefore constitutes a delicate and unstable element which, moreover, continues to work during the upward travel of the nozzle-cylinder and brakes the movement of this latter, thereby preventing a good injection. Finally, the said spring does not permit easy regulation of the injection pressure and therefore makes it necessary to provide an auxiliary regulating device which can be, for example, a point-screw mounted on a by-pass between the two chambers.

A further disadvantage of known injectors is the absence of means which permit of suitable damping of the nozzle-cylinder both during the upward and downward travel of the said cylinder.

The present invention has for its object to provide a remedy for these disadvantages by creating an injector provided with easily regulated means for hydraulic locking, the effect of which is cancelled as soon as the nozzle-cylinder begins to move, as well as means for hydraulic damping both on the upstroke and downstroke of the said cylinder.

An injector in accordance with the invention is essentially characterized by the fact that it comprises, inside one of the said chambers, an evacuation passage provided with an adjustable point-screw and, between the two chambers, a direct communication which is closed off by the cylinder only when this latter is in the bottom position.

While the pressure rises in the combustion chamber, the nozzle-cylinder remains stationary until the point-screw has evacuated the volume of locking fluid. The point of commencement of the injection can thus be easily pre-determined by adjustment of the point-screw. As soon as the nozzle-cylinder has begun its upward movement, the direct communication between the chambers is opened. There thus takes place the free upward movement of the cylinder, this latter being no longer held back except by a very light spring which is just sufficient to ensure the return of the said cylinder to its bottom position after the injection period.

In a first form of embodiment of the present invention, the direct communication between the two cham-

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bers is provided by at least one transfer passage which is hollowed-out round the periphery of the cylinder at the level of a bore formed in the body and joining the two chambers together, the said bore terminating in the vicinity of the top chamber when the cylinder is in the position of rest. It will be understood that, as soon as the cylinder has begun its upward movement, the transfer passage or passages provide direct communication between the two chambers.

In another form of embodiment, the cylinder is provided with a head working in association with a throttled portion of the body which defines the two chambers so as to close off the communication between the said chambers in the vicinity of the bottom position of the cylinder. It is understood that in this form of embodiment, direct communication between the two chambers is also established as soon as the head has passed upwards beyond the said throttled portion.

In accordance with an improvement, at the end of each stroke, the cylinder closes off a damping chamber into which the said cylinder penetrates by means of an abutment having a corresponding bore. This arrangement has for its object to damp hydraulically, by means of the liquid imprisoned in the chamber, both the upstroke and downstroke of the cylinder.

The invention will in any case be clearly understood with reference to the description which follows below, reference being made to the accompanying drawings which show, by way of non-limitative examples, a certain number of forms of embodiment of the invention, and in which:

FIG. 1 is a view in cross-section of an injector in accordance with the invention, details of which are shown on a larger scale in FIGS. 2 and 3, while FIGS. 4 and 5 are cross-sections taken along the lines IV—IV and V—V of FIG. 2, and

FIG. 6 is a cross-section of another form of embodiment.

Reference being made first of all to FIGS. 1 to 5, it can be seen that the injector which is illustrated comprises a body 1 inside which moves a cylinder 2 provided with a bore in which is fitted a plunger 3. The body 1 forms two chambers 4 and 5 joined together by means of a bore 6 of smaller diameter. A piston 7 provided with piston-rings 8 and rigidly coupled to the cylinder moves inside the bottom compression chamber 4. The piston is screwed on to the cylinder and locked by means of a keeper-ring 9 which is pressed elastically against the cylinder by virtue of a circular slot 10 formed in the piston and useful for ensuring fluid-tightness, the said piston being extended by an injection nozzle 11 providing a passage for the injection bore 12 which communicates with the internal bore of the cylinder through a chamber 13 containing a ball-valve 14 applied by a spring 15 against a ball-seating 17 disposed in the cylinder-bore. The seating 17 also serves to clamp a spacing-tube 18 which compresses a sealing ring 19. The spacing-tube 18 is pierced and machined so as to permit the circulation of fluid both transversely at 20 and longitudinally at 21, and communicates with the bore 22 which is fitted in the cylinder and which in turn opens into the hollowed-out portions 23 which can more especially be seen in FIGS. 2, 3, 4 and 5, the said hollowed-out portions being supplied in their turn by means of the intake bore 24 which communicates with the fuel supply pipe 25.

The cylinder body is also provided with one or a number of transfer passages 26 which terminate at a certain distance from the piston 7 and from the head 31. This passage is in communication with a bore 32 formed in the injector body and controlled by an adjustable point-screw 33 screwed into the said body; the said point-screw 33 could also be subjected to the action of a calibrated

elastic member. The pipe 32 opens into the chamber 5 through a pipe 34. The bores are each provided with inspection plugs designated by the general reference 35.

The angular displacements of the cylinder inside the top chamber are guided by a fluted shaft 36 which is rigidly fixed to a hub 37 operated by a lever 38. For this purpose, the shaft 36 is mounted on a ball-bearing 36' tightly held in position by the body cap 37' in which is fitted a sealing joint. A stop 38' is inscribed in a slot for limiting the movement of the lever 38 and permits the regulation and synchronization of the rates of flow.

The shaft 36 co-operates with the cylinder by means of its splines 40 which are engaged with grooves 41 of the cylinder.

A compression spring 43 is provided between a shoulder 42 of the shaft 36 and the head 31 of the cylinder.

The operation of the injector which has been described takes place as follows:

The fluid supplied through the pipe 25 flows in so as to fill all the cavities of the injector body and circulates continuously in a closed circuit from the fuel tank, while the outlet pipe, which is also pierced in the chamber 5, has not been illustrated in the drawings. The apparatus is thus powerfully cooled and perfectly lubricated, thereby increasing its safety and length of service. The said apparatus is mounted in the usual position on the engine to be supplied, the bottom portion of the body being made to rest on a suitable joint; the extremity of the injection nozzle 11 occupies in the explosion chamber the position chosen by the manufacturer. During the compression stroke, the piston 7 is thrust upwards in opposition to the spring 43 which is held by the shaft 36, while the liquid imprisoned inside the chamber 4 cannot in any case be evacuated except through the transfer passage 26 and the pipe 32. This liquid must therefore pass through the control of the point-screw 33, thereby making it possible to obtain a more or less rapid rate of flow of the liquid, and therefore to regulate the speed of upward travel of the piston. It is already known that the time taken by the piston to move upwards predetermines the moment at which the injection commences. It can therefore be seen that the adjustment of the point-screw 33 makes it possible to set the timing so that the injection takes place at the most effective moment. It is to be noted that the closure of the point-screw would block the piston and prevent the injector from working.

The retarding of the upward travel of the piston and of the cylinder which is rigidly coupled to the said piston continues until the moment when the top shoulder of the transfer passage 26 reaches the chamber 5. Direct communication between the two chambers is then established through the said passage, and this results in the rapid upward movement of the cylinder. This is the injection period, which therefore takes place freely and under substantial pressure. In fact, the means employed for retarding the commencement of the upward movement of the cylinder make it possible to provide that the spring 43 has only a moderate force which does not counteract a good injection.

At the end of the stroke, the bottom shoulder of the transfer passage reaches the top plane of the chamber 4, and the liquid which is thus imprisoned inside the said chamber produces a damping effect. The return of the cylinder towards the bottom position thereof is effected under the thrust of the spring 43 and is damped by the entrance of the head 31 inside the corresponding cavity of the body which imprisons a certain mass of liquid with a sufficient clearance.

During the downward movement of the cylinder, the supply of fuel to the injection chamber is ensured by means of the bores 20, 21, 22 and 24 through the hollowed-out portions 23, while the regulation of the quantity of fuel injected is effected by rotating the cylinder, this rotation being controlled by means of the lever 38 and having the effect of modifying the relative position of the inclined

walls of the hollowed-out portions 23 and of the bore 24. The movement of the lever 38 is transmitted to the cylinder by means of grooves 41 and splines 40.

The injector which is illustrated in FIG. 6 is composed of a body constituted by a locking housing 51 in which is fitted a cylinder 52 with interposition of a sealing joint 53. That portion of the cylinder 52 which has the largest diameter constitutes a chamber 54 limited by a throttled portion 55 which separates the said chamber 54 from the chamber 56 of the locking housing. A cylinder 57 provided with a head 58, the external diameter of which corresponds to the diameter of the throttled portion 55, moves inside the cylinder 52 and the two chambers 54 and 56. The said cylinder contains a liner 59 and a spraying sleeve 60. Inside the liner 59 is located the supply plunger 61 into which is fitted the head 62 of the high-pressure plunger 63. A ring 64 holds the plunger 61 inside a blind hole of the regulating rod 65 which passes through the housing 51 and which is driven in rotation by means of the lever 66, the said rotation being transmitted to the plunger 61 by virtue of the locking-pin 67. A spring 68 is interposed between the top wall of the chamber 56 and the head 58.

An annular chamber 69 of the housing 51 communicates with the orifice 69a for the admission of fuel. Another annular chamber 70 of the same housing communicates with the orifices 71 and 72 for the circulation of the lubricating liquid. A passage 73 and two bores 74 are additionally provided, by means of which the chamber 56 is caused to communicate with the chamber 70 through a chamber 75 which is provided with an adjustable point-screw 76. The housing 51 also comprises a socket 77 which guides the spring 68 and the rod 65. Suitable means for ensuring fluid-tightness are provided, in particular at 78 and 79.

The cylinder 52 is provided with a number of bores 80 causing the chamber 70 and the chamber 54 to communicate with each other, as well as with a screw 81 and an annular chamber 82 at the bottom of the chamber 54.

The cylinder 57 is provided with a shoulder 83 which co-operates with the above-mentioned annular chamber 82 and is provided with a longitudinally passage 84 which co-operates with the screw 81 and communicates with a bore 85.

The liner 59, which is mounted in fluid-tight manner inside the cylinder is provided with a longitudinal passage 87 and a transverse passage 88, as well as with a passage forming an extension of the previous passage 85. The said liner 59 terminates in a portion 89 having a smaller bore in which slides the plunger 63.

The spraying sleeve 60 comprises a blind hole 90 which holds the portion 89 mentioned above. The said spraying sleeve 60 is also provided with a guiding annular flange 91 and is fitted with the spraying device 92 proper.

The plungers 61 and 63 limit inside the liner 59 a chamber which communicates with the passages 84 and 85. There is formed in the plunger 61 a portion 94 which has been cut away and which forms a sloping surface which cooperates with the passage 88 so as to ensure the regulation of the quantity of fuel injected in the manner which has already been described above. The fuel which reaches the blind hole 90 through the passages 87 and 88 reaches the regulating elements through the axial bores 95 and 96 formed in the plunger 61 and in the rod 65, this latter communicating at 97 with the annular chamber 69 and, through this latter, with the supply tank.

The rod 65 is provided with a head, the rim 98 of which co-operates with an annular trough 99 of the head 58.

A description now follows below with reference to the operation of the device which has just been described, first of all as regards the movements of the cylinder with respect to the body, while noting that the liquid serving for the purpose of lubrication, locking, damping and cooling circulates between the orifices 71 and 72 and flows in the chambers 70, 54, 56, 75 and 93, through the passages

80, 73, 74, 84 and 85. When the pressure rises in the combustion chamber, the cylinder 57 moves freely upwards for a few tenths of a millimeter until the head 58 of the said cylinder closes off the passage 55. At this moment, the liquid contained in the chamber 56 prevents the upward movement of the cylinder as a function of the opening of the point-screw 76. The length of time taken by the head 58 to pass through the passage 55 can thus be regulated by means of the point-screw 76. This adjustment makes it possible to choose the point of commencement of the injection with respect to the position of the engine or engine-piston. As soon as the head 58 has passed through the passage 55, direct communication is established between the chambers 54 and 56 and the liquid can thus be evacuated directly through the multiple bores 80. The cylinder is no longer retained in any way and moves upwards very rapidly, thus producing a free and rapid injection. In fact, the force of the spring 63 is exactly calculated so as to ensure the return of the cylinder to the position as illustrated, after the injection has taken place. At the end of the injection stroke, the rim 98 falls into its housing inside the annular trough 99, thus imprisoning a certain quantity of liquid so as to ensure the hydraulic damping action.

When the pressure inside the combustion chamber has dropped, the cylinder returns towards the position in which it is shown in the figure; the said cylinder is damped hydraulically at the end of its stroke as a result of the co-operation of the shoulders 82 and 83 which in turn imprison a certain quantity of liquid. The passages 84 and 85 eliminate any counter-pressure inside the chamber 93, while the first passage or passage 84 co-operates with the screw 81 so as to ensure the guiding of the cylinder.

The injection proper takes place as soon as communication is cut-off at 88 by the sloping surface 94; the upward movement of the head 89 against the high-pressure plunger 63 then effects the compression of the liquid to be injected beneath the said plunger. The liquid passes through the two ball-valves and reaches the engine cylinder. The suction of the fuel to be injected takes place during the movement in reverse direction.

What I claim is:

1. A fuel injector for internal combustion engines, of the type comprising a body which is provided with two communicating chambers, and inside which moves a cylinder carrying the injection nozzle, said cylinder being rigidly coupled to a piston moving inside one of said chambers and providing a passage for a fixed plunger which is integral with said body and limits inside and cylinder an injection chamber which communicates on the one hand with the fuel and on the other hand with said injection nozzle, said injector comprising, inside one of said chambers, an evacuation passage provided with an adjustable point-screw and between the two chambers, a direct communication which is closed off by the cylinder only when said cylinder is in the bottom position.

2. A fuel injector for internal combustion engines, of the type comprising a body which is provided with two communicating chambers, and inside which moves a cylinder carrying the injection nozzle, said cylinder being rigidly fixed to a piston moving inside one of said chambers and providing a passage for a fixed plunger which is integral with said body and limits inside said cylinder an injection chamber which communicates on the one hand with the fuel and on the other hand with said injection nozzle, said injector comprising, inside one of said chambers, an evacuation passage provided with an adjustable point-screw and between the two chambers, a direct communication which is closed off by the cylinder only when said cylinder is in the bottom position, said communication being ensured by at least one transfer passage hollowed-out round the periphery of said cylinder at the level of a bore formed in said body and joining the two cham-

bers together, said bore terminating in the vicinity of the top chamber when said cylinder is in the position of rest.

3. A fuel injector for internal combustion engines, of the type comprising a body which is provided with two communicating chambers, and inside which moves a cylinder carrying the injection nozzle, said cylinder being rigidly coupled to a piston moving inside one of said chambers and providing a passage for a fixed plunger which is integral with said body and limits inside said cylinder an injection chamber which communicates on the one hand with the fuel and on the other hand with said injection nozzle, said injector comprising, inside one of said chambers, an evacuation passage provided with an adjustable point-screw and between the two chambers, a direct communication which is closed off by the cylinder only when said cylinder is in the bottom position, said direct communication being ensured by means of a head working in association with a throttle portion of said body which defines the two chambers so as to close off the communication between said chambers in the vicinity of the bottom position of said cylinder.

4. A fuel injector for internal combustion engines, of the type comprising a body which is provided with two communicating chambers, and inside which moves a cylinder carrying the injection nozzle, said cylinder being rigidly coupled to a piston moving inside one of said chambers and providing a passage for a fixed plunger which is integral with said body and limits inside said cylinder an injection chamber which communicates on the one hand with the fuel and on the other hand with said injection nozzle, said injector comprising, inside one of said chambers, an evacuation passage provided with an adjustable point-screw and between the two chambers, a direct communication which is closed off by the cylinder only when said cylinder is in the bottom position, said communication being ensured by at least one transfer passage hollowed-out round the periphery of said cylinder at the level of a bore formed in said body and joining the two chambers together, said bore terminating in the vicinity of the top chamber when said cylinder is in the position of rest, said cylinder closing-off, at the end of each stroke, a damping chamber into which said cylinder penetrates by means of abutment having a corresponding bore.

5. A fuel injector for internal combustion engines, of the type comprising a body which is provided with two communicating chambers and inside which moves a cylinder carrying the injection nozzle, said cylinder being rigidly coupled to a piston moving inside one of said chambers and providing a passage for a fixed plunger which is integral with said body and limits inside said cylinder an injection chamber which communicates on the one hand with the fuel and on the other hand with said injection nozzle, said injector comprising, inside one of said chambers, an evacuation passage provided with an adjustable point-screw and between the two chambers, a direct communication which is closed off by the cylinder only when said cylinder is in the bottom position, said direct communication being ensured by means of a head working in association with a throttle portion of said body which defines the two chambers so as to close off the communication between said chambers in the vicinity of the bottom position of the cylinder, said cylinder closing-off, at the end of each stroke, a damping chamber into which said cylinder penetrates by means of an abutment having a corresponding bore.

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