Aug. 11, 1931. J. S. LANG 1,818,140

SHOCK ABSORBER

Filed Oct. 1, 1927

Fig. 1.

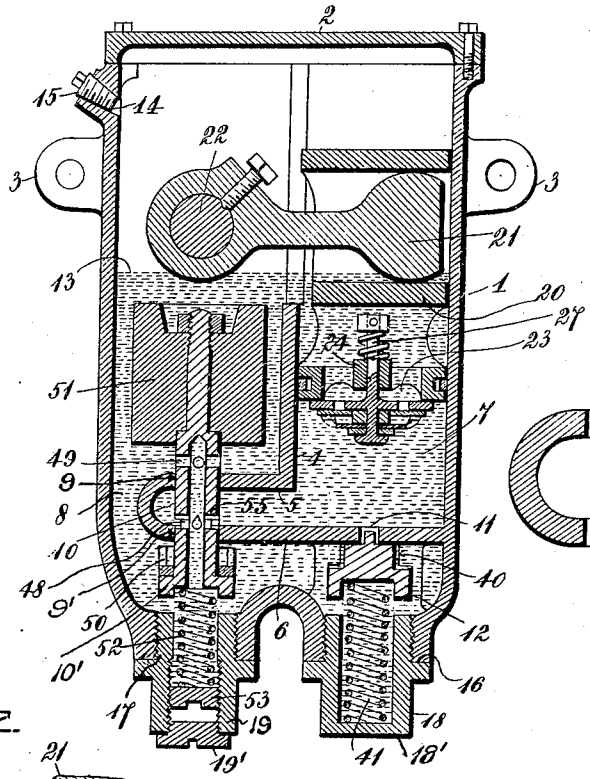


Fig. 5.

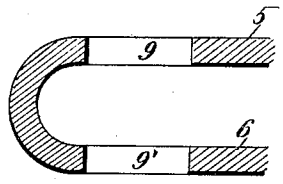


Fig. 2.

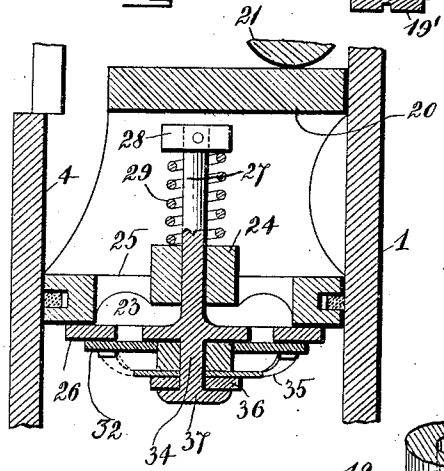


Fig. 3.

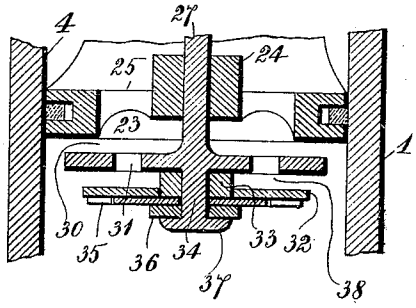
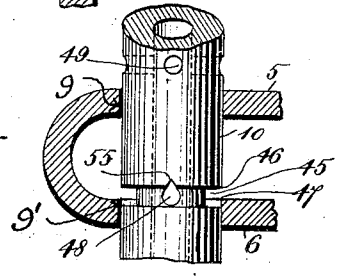


Fig. 4.



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UNITED STATES PATENT OFFICE

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SHOCK ABSORBER

Application filed October 1, 1927. Serial No. 223,401.

The present invention belongs to that class of shock absorbers which are especially adapted for motor vehicles, and in which the force required to pass a fluid through a constricted opening is utilized to prevent excessive vibration or rebound. Examples of this class of shock absorbers are shown in the various United States patents previously granted me and including Patent No. 1,448,131 of March 13, 1926 and Patent No. 1,561,009 of November 10, 1925.

The essential object of the invention is to improve the shock absorber by making it more sensitive and responsive in action.

The invention can best be seen and understood by reference to the drawings in which such portion of a shock absorber is shown as is necessary for a proper understanding of the invention and in which—

Figure 1 is a medial vertical cross section of the shock absorber.

Fig. 2 illustrates a part of the construction shown in Fig. 1 in enlarged detail.

Fig. 3 illustrates a changed position of certain valvular parts shown in Fig. 2.

Fig. 4 shows partly in elevation and partly in section a detail of construction to which special reference will later be made, and

Fig. 5 is a sectional view of a further detail of construction.

Referring to the drawings:—

1 represents a casing having a removable cover 2. Projecting laterally from the casing are lugs or ears 3 by which it may be secured to the body or framework of a vehicle. On its inside the casing is provided with various parts or partitions 4, 5 and 6, respectively which provide within the casing a compression chamber 7 and outside this chamber a secondary or expansion chamber 8. The compression chamber outlets into the secondary chamber by way of aligned openings 9 and 9′ formed respectively in the partitions 5 and 6. These openings are controlled by a valve 10. Communication also is provided between the compression chamber and the secondary chamber by way of an opening 11 in the partition 6 at the bottom of the compression chamber. This opening is controlled by a valve 12.

The casing forms a receptacle for oil contained within its respective chambers and maintained within the casing at about the level indicated at 13. The oil is introduced into the casing at the top by way of an inlet 14 controlled by a filling plug 15. At the bottom the casing is provided with outlet openings 16 and 17. These openings are closed by flanged plugs 18 and 19, respectively, the plug 18 closing the outlet opening 16 and the plug 19 closing the outlet opening 17. The bodies of both plugs are hollow and generally tubular in form and are threaded to fit within the respective openings closed by them. The inner ends of both plugs are open to the secondary chamber. The outer end 18′ of the plug 18 is a permanent end while the outer end of the plug 19 is closed by a removable threaded header 19′.

The compression chamber 7 comprises a cylinder formed by the co-operation of the wall or partition 4 with the wall of the casing. Contained to reciprocate within this cylinder is a piston 20. The piston is reciprocated within the cylinder by a rocker arm 21 secured to a rock shaft 22 mounted to turn on the casing and provided with an external rocker arm (not shown) which is connected to the axle of the vehicle, all substantially as shown in my patents previously referred to.

The piston when reciprocated is freely movable in the cylinder and through the oil in it on the upstroke of the piston, but acts with a compression stroke for compressing the oil in the compression chamber lying below the piston on its down stroke. In the operation of the shock absorber the piston is frequently reciprocated with a relatively quick and short range of movement. As the piston moves upwardly it is necessary in the proper operation of the shock absorber that the space in the compression chamber lying below the piston shall fill with oil as the piston rises for otherwise if the oil does not fill in and space is left, as when a short, quick, upward stroke of the piston is followed by a quick downward compression stroke improper action will ensue and is a thing to be avoided. Accordingly as one phase of the

present invention there is provided means whereby the compression chamber lying below the piston will remain at all times filled with oil and especially at the time when the piston is moving upwardly in the cylinder with a relatively short quick stroke. The means provided is one taking the form of an opening through the head of the piston from which lead separate passages controlled by inwardly-closing valves which open as the piston moves upwardly and close simultaneously with its movement in a reverse direction.

23 represents the opening through the head of the piston. This is a relatively large opening and surrounds a central piece or butt 24 fixed to the piston head by ribs 25. Controlling the opening 23 through the piston head is an outwardly-opening valve 26, this valve closing inwardly against the end of the piston. The valve is carried by a valve stem 27 which extends upwardly through the butt 24 and is slidable therein. The valve stem extends upwardly through and beyond the butt and arranged thereon interposed between the butt and a shoulder 28 on the top end of the stem is a spring 29. This spring operates to maintain the valve 26 in a normal closed position. The spring, however, is of relatively light tension permitting of an easy opening of the valve. The relative arrangement of the valvular parts just described is that the valve 26 will have only a limited opening, 30 representing the passage leading from the opening through the piston head into the compression chamber below the piston when the valve is open. This passage with a full open valve is hardly sufficient, owing to the limited degree of opening of the valve, to take care of all the oil that might be permitted to pass through the opening 23 in the piston head. In order to permit of a further passage of oil from the opening 23 in the piston head ports 31 are formed in the valve 26. These ports are in alignment with the opening 23 through the piston head and are controlled by an outwardly-opening valve 32. This valve is mounted to slide on an annular bearing 33 arranged upon an extension 34 of the valve stem 27. The valve 32 is held normally closed closing the ports 31 by a spring 35 backed by a washer 36 and all retained by a head 37 on the bottom end of the stem extension 34. The arrangement of these valvular parts last described is such that the valve 32 will have only a limited opening, 38 representing the passage leading from the ports 31 into the compression chamber by the valve when the valve is open.

The advantage of having separate valves controlling separate passages leading from the opening 23 through the piston head resides in the fact that a sufficient amount of opening is provided by way of the passages 30 and 38 by the respective valves when open from the main opening through the piston head to permit of the oil freely passing from above the piston into the compression chamber below it, thereby keeping the compression chamber filled with oil, even when the piston has a relatively slight quick upward movement and this for the reason that both valves require but a slight upward movement of the piston to open them to their full degree of opening. In other words, if a single valve were employed controlling the opening through the piston head this valve in order to permit of a free passage of oil would have to have a relatively large degree of opening, and this would require a considerable upward movement of the piston. With two valves the same effect is obtained with but a slight degree of upward movement of the piston accordingly even when the piston has a slight upward movement followed by a quick reverse, yet sufficient oil is admitted by the valves at all times to keep the compression chamber below the piston entirely filled with oil.

The valve 12 which controls the opening 11 out of the bottom of the compression chamber into the secondary chamber is slidable upon ways 40 formed within the casing and is held in a normal closed position by means of a powerful spring 41. The tension of this spring is such that the valve 12 will be opened only in case the compression of oil in the compression chamber by the piston reaches a danger point when the valve 12 will be opened by the pressure relieving it.

The valve 10 which controls the openings 9 and 9′ forming the outlet out of the compression chamber into the secondary chamber is a hollow valve and is mounted to slide vertically through said openings forming the outlet, the walls of the respective partitions 5 and 6 in which the openings are formed providing bearings for the valve.

Passage of oil from the compression chamber by the valve 10 is provided for as follows: An annular incision 45 of appreciable depth is made in the exterior wall of the valve. This incision leaves a cutting edge 46 on the valve body. The disposition of the incision 45 and edge 46 is such that when the valve is in its substantially normally operative position the edge 46 will co-operate with the top edge 47 of the partition 6 in such manner that the oil may either freely pass between these edges into the annular cavity formed by the incision 45 or be entirely cut off from passing when the edges overlap one another, such opening and closure depending upon the relative position of valve and partition. Leading from the incision 45 through the wall of the valve into the interior thereof are ports 48. At the upper end of the valve leading from the valve chamber into the secondary chamber above the partition 5 are ports 49, while the lower end of the valve

chamber below the partition 6 is open to the secondary chamber. In consequence of this arrangement of ports oil admitted to pass between the edges 46 and 47 of valve and partition when the valve is open will enter into the chamber formed by the incision 45 and then pass into the interior or chamber of the valve where the oil will be diverted in its passage, a part flowing into the secondary chamber, through the top of the valve, and a part flowing into the secondary chamber through the lower end of the valve, this diversion being such that the pressure will not disturb any normal setting or positioning of the valve. Below the partition 6 the valve 10 has a widened skirt portion 10′ the bottom end of which lies above and separate from the top end of the plug 19. The widened portion 10′ of the valve has arranged to rest upon it a castellated ring 50 which by its bearing against the under side of the partition 6 limits the opening of the valve or, in other words, limits the amount which the edges 46 and 47 on valve and partition may be separated from one another. In practice the relative arrangement of the parts is such that a very slight space will separate the top bearing surface of the castellated ring from the under side of the partition 6 when the valve is supported in its normal substantially balanced open position, to which attention will now be directed.

The valve 10 in accordance with the principle of its operation, later to be referred to, is an inertia valve and to this end is normally maintained in a position of substantial balance. It is a weighted valve carrying on its head a weight 51, the weight and attached valve being considered as one with reference to the effect of their inertia. The weighted valve is maintained in a normal position of substantial balance by means of a spring 52 bearing against its lower end. This spring is contained within the hollow of the tubular plug 19 with bottom end bearing against the threaded adjustable nut 53 arranged also within the hollow of the plug and to which access is had upon removing the header 19′. By means of the adjusting nut 53 the valve 10 may be initially positioned for obtaining a determinate opening of the valve gauged by the degree of opening of the edges 46 and 47 of valve and partition as aforesaid, and its adjustment is such that this opening between these edges in the normal positioning of the valve will preferably be about $\frac{1}{32}$ of an inch. Such opening will be sufficient to take care of the pressure in the compression chamber when the oil is compressed by the operation of the piston inasmuch as it is an opening of some considerable length extending as it does around the valve, and moreover, whatever the opening may be any oil passing through the opening may then pass freely to the secondary chamber by way of the incision in the valve body and through the chamber thereof as aforesaid.

The essential advantage of the construction just described, where the opening and closing of the valve is determined by the co-operating edges 46 and 47, resides in the fact that a very slight opening between these edges is necessary for permitting passage of the fluid between the two chambers. Consequently a very quick cut-off is obtained on a very slight relative movement between the valve and partition with which it is co-operating to form the cut-off.

Arranged just above the edge 46 of the valve body are small auxiliary openings 55 extending through the wall of the valve into the interior thereof. These auxiliary openings are made gradually narrowing as they rise from the edge 46, being preferably made in the shape of an inverted V. The arrangement is also preferably such that the bottom of the auxiliary openings will be flush or substantially flush with the edge 46 of the valve so that as the valve is closed by the meeting of the edges 46 and 47 fluid will still pass from the compression chamber into the secondary chamber by way of these auxiliary openings 55, freedom of passage through the auxiliary openings gradually decreasing until the edges 46 and 47 have so far overlapped one another as to entirely close the auxiliary openings when fluid can no longer pass between the compression chamber and the secondary chamber by way of the valve, the valve then being entirely closed. By these auxiliary openings 55 the valve is provided with separate determinate lines of cut-off between it and its seat depending upon the extent of closing movement of the valve, one a primary line of cut-off and the other a secondary line of cut-off. The primary line of cut-off is between the edge 46 of the valve and the edge 47 of the seat. This effects only a partial closure of the valve or valve area between the compression and secondary chambers. The secondary line of cut-off is where the valve co-operates with the edge 47 of the seat along a line drawn through the apexes of the openings 55 in the valve. When thus co-operating a complete closure of the valve or valve area is effected between the compression and secondary chambers. Beyond the primary line of cut-off and between it and the secondary line of cut-off the valve co-operates with its seat to effect a closure gradually increasing as approach is made to the secondary line of cut-off. This takes place by reason of the auxiliary openings 55 in the valve, these openings gradually narrowing or contracting from the point of the primary cut-off to that of the secondary cut-off, thereby effecting a decrease in valve area between the compression and secondary chambers. It will also be observed that the primary cut-off or the cut-off

effected between the edge 46 of the valve and the edge 47 of its seat is a relatively quick cut-off effected by relatively little movement of the valve. On the other hand, the gradually increasing cut-off effected between the primary and secondary lines of cut-off is a relatively slow cut-off, the valve necessitating a considerable relative movement before the line of the secondary cut-off has been reached when the valve becomes fully closed by the complete closure of the valve area.

The general operation of the shock absorber is as follows. It will first be assumed that all parts of the absorber are in a normal position and the casing filled with oil. The piston will then be occupying a position about midway the cylinder. The inertia valve 10 supported in a state of substantial balance will then be occupying a position where a very slight space will separate the edges 46, 47, the one on the valve 10 and the other on the partition 6 as previously explained. Preferably an opening of only about $\frac{1}{32}$ of an inch is left between these edges. This opening though slight is ample inasmuch as it extends all around the valve to permit of an escape of oil out of the compression chamber when compressed by the piston, the oil passing through the narrow annular passage or crevice between the two edges above referred to, thence into the annular cut in the valve and thence through the interior of the valve into the secondary chamber. That is, the inertia valve is then open with relation to the outlet which it controls.

Assuming now that the vehicle with its axle in normal relation to the body encounters a road surface having a large number of small inequalities not in themselves sufficient to cause rebound of the vehicle body. In passing over these inequalities the axle is vibrated rapidly up and down as it follows the contours of the ground with a small range of movement. The rocker arm 21 and piston 20 will have a corresponding movement. The weighted inertia valve, however, will be but slightly influenced and will maintain substantially its normal wide open position permitting relatively free communication between the compression chamber and the secondary chamber. In other words, no action occurs which will affect the normal and proper resiliency of the springs.

It will now be assumed that the vehicle encounters a raised obstruction in the roadway having an abrupt rise succeeded by a corresponding decline and of such height and width as under ordinary circumstances to produce a violent rebound. The vehicle and shock absorber with it reaches the obstruction with all its parts as before in substantially normal positions. As the wheels mount the rise the axle is brought nearer to the body of the vehicle compressing the vehicle springs. Simultaneously with the rise of the axle the piston will be raised in the cylinder. As the piston rises in the cylinder, oil within the cylinder and casing will freely pass through the piston by way of the opening 23 through it and separate passages 30 and 38 leading from this opening into the compression chamber below the piston so that this chamber will remain filled with oil in order that there may be no void spaces left in this chamber even though the piston be raised rapidly and with relatively slight movement. As previously explained if the opening through the piston was controlled by a single outwardly opening valve the piston must necessarily have moved a considerable distance before this valve becomes fully open. By providing the piston, however, with the two outwardly-opening valves 26 and 32 controlling separate passages leading from the opening in it a full opening through the piston by way of these passages is obtained by only a relatively slight movement of the piston.

If as assumed above the approach to the obstruction is quite abrupt followed by an immediate decline the inertia of the vehicle body will prevent its appreciable rise until the wheels have reached the top of the obstruction when an incipient rebound will begin. The vehicle body then rises slightly from its previous line of travel and simultaneously the axle begins to move away from the body. Thereupon the piston will move downward in the cylinder and the two valves controlling the passages leading from the opening through it will then become instantly closed by the pressure and the piston will operate to compress the oil in the compression chamber. The oil being thus compressed will be forced outwardly through the clearance between the edges 46, 47 of the inertia valve and partition of the casing, respectively, and thence will pass by way of the annular cut around the valve into and through the valve into the secondary chamber. At just about this precise instant, however, at substantially the beginning of the tendency of the vehicle body to rebound, following the compression of the springs another force is experienced tending to close the inertia valve and outlet from the compression chamber into the pressure chamber which is controlled by this valve. Such closure is effected by the rise of the vehicle body to which the casing is fixed, the weighted valve 10 then tending to maintain its normal position by reason of its inertia. In consequence the opening between the edges 46, 47 of the valve and the partition respectively will become closed thereby preventing any further substantial flow of oil through the valve, oil then only being permitted to flow through the valve by way of the auxiliary openings 55 through the valve, the permitted passage of oil gradually lessening on account of the form of these openings until the edge 47 on the partitions

has passed beyond the auxiliary openings when the permitted flow of oil through the valve and outlet is entirely cut off. The effect of this is to prevent further downward action of the piston and to hold the vehicle springs in a state of compression, thereby preventing the rebound of the vehicle body. The action of preventing the rebound is very quick occurring at the very instant that the tendency to rebound occurs owing to the very slight space to be closed, viz: the space between the edges on the valve and partition of the casing respectively. While the closure between these edges tends to substantially prevent the rebound of the vehicle body, yet this tendency is relieved slightly by the permitted flow of oil through the auxiliary openings until such time as these openings are closed, the action accordingly increasing until the cut-off has been entirely completed. Accordingly as the wheels pass over the crown of the rise or obstruction the vehicle springs are being held in a state of compression and the rebound of the vehicle body prevented as above noted. At this time should the compression of oil within the compression chamber by the piston be so great as to injure the structure of the shock absorber, then this pressure may be relieved by the opening of the valve 12 at the bottom of the compression chamber, this valve being controlled as before explained by the spring 41, to be opened only to relieve excessive pressure within the compression chamber. Following this action, as the wheels of the vehicle descend on the further side of the obstruction the weighted valve tends to regain its original normal open position, thereby permitting of the flow of oil from the compression chamber through the valve and outlet controlled by it into the secondary chamber, the piston then being relieved and the springs and vehicle body then eased to assume their normal relative positions.

A case the opposite of the preceding will now be considered in which the vehicle passes a wide and deep depression in the roadway. When the wheels of the vehicle first come into the depression the axle moves away from the vehicle body. As this movement takes place the piston moves downward in the cylinder compressing the oil in the compression chamber and forcing it outwardly through the valve which then remains open. The valve is open at this time by reason of the fact the shock absorber fixed as it is to the vehicle body tends to drop. At this same time the weighted valve maintains its position on account of its inertia. In consequence the edge 47 on the partition of the casing will drop away from the edge 46 of the valve leaving a larger clearance than the normal clearance so that oil will freely pass it and through the valve to the secondary chamber. The separation of these two edges is limited, however, on account of the fact that as the casing tends to drop with the valve remaining in its normal position by reason of its inertia, the under side of the partition 6 will be brought into contact with the castellated stop 50 on the valve body. As previously noted, the space between the under side of the partition and the stop is very slight, in any event being only sufficient to permit of setting the valve in a normal substantially balanced open position. Due to the fact that the resistance to the flow of oil from the compression chamber to the secondary chamber is very slight, the piston will move downward with comparative freedom allowing the vehicle springs to expand beyond their normal state of compression and thus maintaining the vehicle body at nearly its former level. As the wheels pass the bottom of the depression free opening is afforded through the valve controlling the opening between the compression and secondary chambers. Accordingly the vehicle springs will remain expanded maintaining the vehicle body well up in position. When the wheels strike the rise on the opposite side of the depression and pass onto the level roadway the springs will resume their normal position and the piston return to its normal position in the cylinder. Any tendency for rebound of the vehicle body at this time is prevented by an action resembling somewhat that taking place when the body rebound is prevented as in the case of the raised obstruction previously described.

Having thus fully described my invention, I claim and desire to secure by Letters Patent of the United States:—

1. A fluid check shock absorber for controlling the movement of relatively movable parts, comprising an element attachable to one of said parts and having a compression chamber and a secondary chamber outside the compression chamber with a controllable outlet out of the compression chamber into the secondary chamber with a valve seat adjacent said outlet, a piston attachable to the other of said parts reciprocable in the compression chamber, means permitting of the circulation of a contained fluid from the secondary chamber back into the compression chamber, an inertia valve controlling said outlet, said valve presenting separate determinate lines of cut-off between it and its seat dependent upon the extent of relative closing movement of the valve and including a primary line of cut-off and a secondary line of cut-off, said valve co-operating with the seat along its primary line of cut-off to effect a partial closure of said outlet as the valve tends to close, said valve co-operating with its seat within the space between its primary line of cut-off and its secondary line of cut-off to effect a further closure of said outlet gradually increasing as approach is made to said sec-

ondary line of cut-off, and said valve co-operating with its seat along said secondary line of cut-off to effect a complete closure of said outlet, and means for yieldingly supporting said valve in a normal open position.

2. A fluid check shock absorber for controlling the movement of relatively movable parts, comprising an element attachable to one of said parts and having a compression chamber and a secondary chamber outside the compression chamber with a controllable outlet out of the compression chamber into the secondary chamber with a valve seat adjacent said outlet, a piston attachable to the other of said parts reciprocable in the compression chamber, means permitting of the circulation of a contained fluid from the secondary chamber back into the compression chamber, an inertia valve controlling said outlet, said valve presenting separate determinate lines of cut-off between it and its seat dependent upon the extent of relative closing movement of the valve and including a primary line of cut-off and a secondary line of cut-off, said valve co-operating with the seat along its primary line of cut-off to effect a partial closure of said outlet as the valve tends to close, said valve co-operating with its seat within the space between its primary line of cut-off and its secondary line of cut-off to effect a further closure of said outlet gradually increasing as approach is made to said secondary line of cut-off, and which closure effected by the valve in the space between its main line of cut-off and its secondary line of cut-off is slower than the closure effected by said valve between its main line of cut-off and said seat for a determinate movement of said valve, and said valve co-operating with its seat along its secondary line of cut-off to effect a complete closure of said outlet, and means for yieldingly supporting said valve in a normal open position.

3. A fluid check shock absorber for controlling the movement of relatively movable parts, comprising an element attachable to one of said parts and having a compression chamber and a secondary chamber outside the compression chamber with a controllable outlet out of the compression chamber into the secondary chamber with a valve seat adjacent said outlet, a piston attachable to the other of said parts reciprocable in the compression chamber, means permitting of the circulation of a contained fluid from the secondary chamber back into the compression chamber, an inertia valve controlling said outlet, said valve presenting separate determinate lines of cut-off between it and its seat dependent upon the extent of relative closing movement of the valve and including a primary line of cut-off and a secondary line of cut-off, said valve co-operating with its seat along its primary line of cut-off to effect a partial closure of said outlet as the valve tends to close, said valve co-operating with its seat within the space between its primary line of cut-off and its secondary line of cut-off to effect a further closure of said outlet gradually diminishing in valve area as approach is made to said secondary line of cut-off, and said valve co-operating with its seat along said secondary line of cut-off to effect a complete closure of said outlet, and means for yieldingly supporting said valve in a normal open position.

4. A fluid check shock absorber for controlling the movement of relatively movable parts, comprising an element attachable to one of said parts and having a compression chamber and a secondary chamber outside the compression chamber with a controllable outlet out of the compression chamber into the secondary chamber with a valve seat adjacent said outlet, a piston attachable to the other of said parts reciprocable in the compression chamber, means permitting of the circulation of a contained fluid from the secondary chamber back into the compression chamber, an inertia valve controlling said outlet, said valve presenting separate determinate lines of cut-off between it and its seat dependent upon the extent of relative closing movement of the valve and including a primary line of cut-off and a secondary line of cut-off, said valve co-operating with the seat along its primary line of cut-off to effect a partial closure of said outlet as the valve tends to close, said valve co-operating with its seat within the space between its primary line of cut-off and its secondary line of cut-off to effect a further closure of said outlet gradually diminishing in valve area as approach is made to said secondary line of cut-off, and which closure effected by the valve in the space between its main line of cut-off and its secondary line of cut-off is slower than the closure effected by the valve between its main line of cut-off and said seat for a determinate movement of the valve, and said valve co-operating with its seat along said secondary line of cut-off to effect a complete closure of said outlet, and means for yieldingly supporting said valve in a normal open position.

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