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SHOCK ABSORBER.

APPLICATION FILED AUG. 20, 1914.

1,141,310.

Patented June 1, 1915.

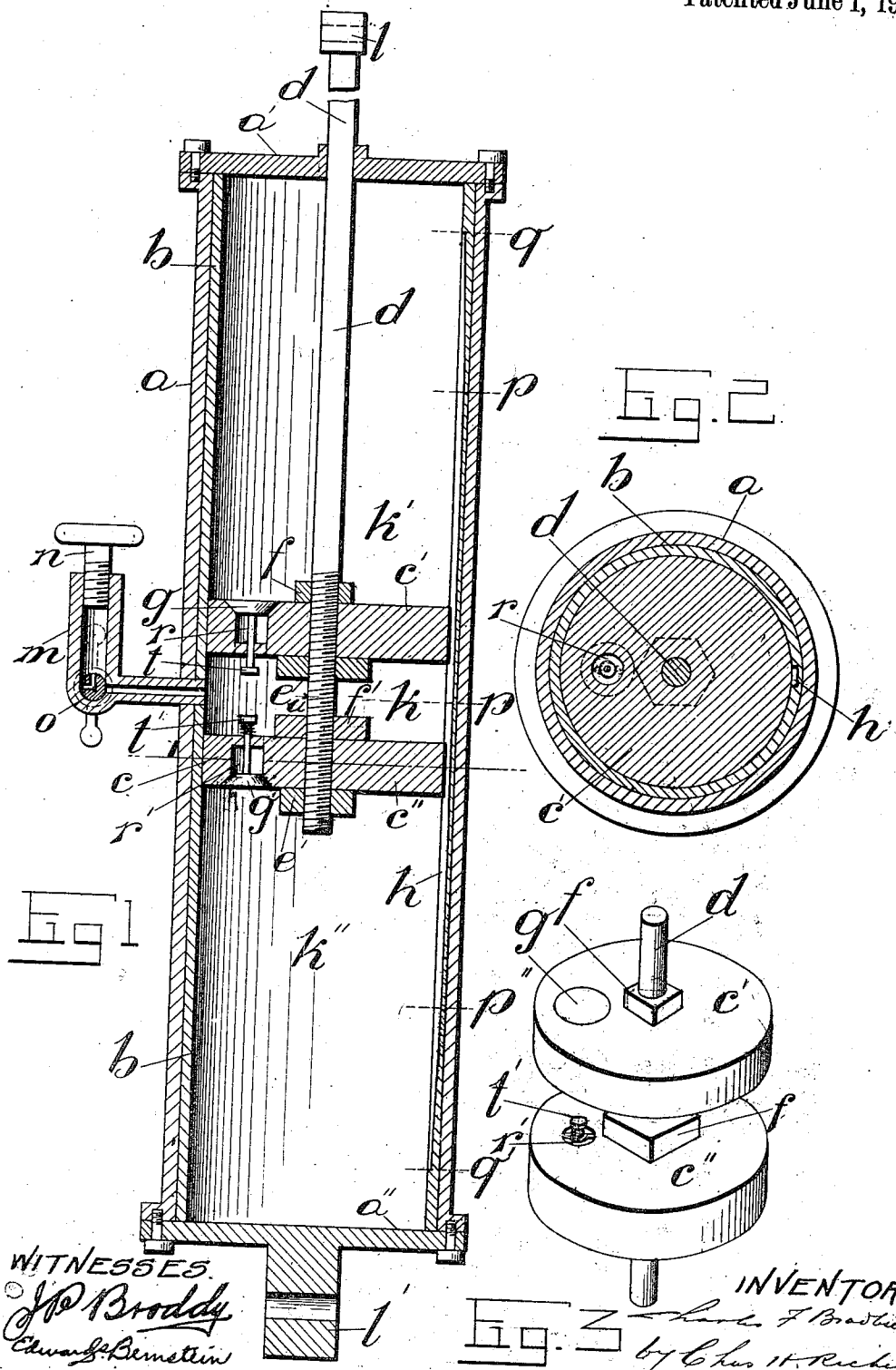


Fig. 1

Fig. 2

Fig. 3

WITNESSES.

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SHOCK-ABSORBER.

1,141,310. Specification of Letters Patent. Patented June 1, 1915.

Application filed August 20, 1914. Serial No. 857,623.

To all whom it may concern:

Be it known that I, CHARLES FRANKLIN BRADBURN, of the village of Delmer, in the county of Oxford and Province of Ontario, Dominion of Canada, have invented certain new and useful Improvements in Shock-Absorbers, and I hereby declare that the following is a full, clear, and exact description of the same.

This invention comprises a means by which, in a liquid filled cylinder containing a piston or double piston or plunger, the liquid may be made to offer a controllable variable resistance to the movement of the piston, the resistance varying with the position of the piston in the cylinder and the direction of its motion. This resistance opposes the motion of the piston, within the cylinder, by exercising a retarding influence upon it, and may be made to vary within wide limits and at various rates of increase and decrease in respect of the position of the piston within the cylinder. By suitably connecting one portion of the mechanism, the piston by preference, to the body of a vehicle, and the other portion of the mechanism, viz:—the cylinder, to the running gear, this varying resistance of the liquid may be utilized to perform the functions of a shock absorber, *i. e.*, to prevent the sudden contraction of the springs to their compression limits, or expansion to their elastic limits, or beyond.

Gas may be employed as a resisting medium, but in this case, in addition to a retarding influence, there will be also a secondary accelerating influence, due to the pressure gas gives under confinement or partial confinement, because of its elasticity, and in these specifications I shall limit my description of the operations of the invention more particularly to the case in which a liquid is used as a medium, and of liquids, oil will possess advantages.

When the running gear of a vehicle encounters a sudden elevation in the roadway it rises and momentarily compresses the springs, against the weight of the body of the vehicle, which immediately expand and lift the vehicle body from its normal position with relation to the running gear. Owing to the compression of the springs resulting from the inertia of the body, the piston will reach the lower limit of its stroke within the cylinder. Following this, the body of the vehicle will rise under the elasticity of its springs, and be carried to a point or plane higher than that represented by the simple elastic limit of its springs; during which, the piston will rise to the upper limit of its stroke. Following this movement, the body of the vehicle will fall under gravity and the retractive action of the distended springs, the latter again reaching their mid position, and the piston of the mechanism its mid position in the cylinder.

The movement outlined is an extreme or primary movement which will always be followed by secondary movements or oscillations, due to the reaction of the inertia or weight of the body and the elasticity of the springs. For simplicity sake, we will treat these movements as constituting a simple rise and fall of the piston within its cylinder. The half stroke or mid position will correspond or approximate at least to the normal position of the springs, that is, their position when the vehicle is at rest under its weight and normal load.

The design roughly depicted herein is one in which the mechanism is intended for ordinary use and is such as to cause the liquid to give practically negligible resistance to the piston as it moves across the middle transverse planes of the cylinder, and increasing resistance as the piston approaches either end of the cylinder, the maximum resistance being attained by further displacement of the liquid becoming impossible as the piston reaches either limit of its stroke; a slighter resistance occurring the instant of reversal which rapidly decreases as the piston moves inwardly or toward its mid-position, becoming negligible at points nearer the limits of its stroke than the points at which negligible resistance ceases, when the piston moves outwardly from its mid position.

Different resistances, both in respect to the amount of resistance opposed to the piston and to the rates of variation, having regard for the piston's position and direction of advance, may be obtained by variations in the details of the construction of the cylinder to meet any practical case required, within the limit of engineering practice.

Furthermore, the invention comprises a means by which the length of the piston stroke and amplitude of oscillation or throw of the vehicle springs may be varied, and extreme compression and extreme distention of the springs both be prevented, and these re-

sults together with those outlined in the preceding paragraph may be termed ideal conditions of operation, under ordinary conditions of service.

In the drawings: Figure 1, shows a longitudinal section of the mechanism; Fig. 2, shows a transverse section, taken through the cylinder and one of the piston heads; and, Fig. 3, shows a perspective view of the double piston or plunger.

Like characters of reference refer to like parts throughout the specification and drawings.

a is a cylinder having cylinder heads a' and a''. The head a' is removable, and the head a'' carries a connecting block 1'.

b is a removable lining, containing a groove or several similar grooves h, forming a by-pass, or by-passes for the liquid from one side to the other of the piston.

p represents the middle point, or transverse plane of the cylinder, and coincides with the mid position or half stroke of the piston.

p' and p'' represent points or transverse planes, equidistant from p above and below respectively, while q and q' are points or transverse planes beyond p' and p'', and also equidistant from p, and from their respective ends of the cylinder, the distance p'—q or p''—q' being slightly less than the extreme length of the piston to be described.

The groove h is of varying cross section, and is greatest between the points p' and p''. From p' outwardly and upwardly, the cross section of the groove gradually decreases, and the groove terminates at q, similarly from the point p'' outwardly, or downwardly, the groove tapers or diminishes in cross-section and terminates at q'. These points q and q' mark the limits of the piston stroke.

c is the piston, or double piston, having two like heads c' and c'' separated and inclosing a space of chamber k. Thus the cylinder is made to contain three spaces or chambers k, k' or k''; within the piston head; k' above, and k'' below the piston head, all spaces being kept filled with the liquid resisting medium.

d is the piston rod carrying the piston head c at its lower end and at its upper end the connecting block l. These blocks l, l' have bolt holes suitable for the attachment of clips or such devices as may be used to effect connections with the body and running gear of a vehicle, or with opposing portions of the vehicle springs, but no particular type of connections is shown here, since these will vary greatly in different types of vehicles. The piston rod d is threaded at its lower end and extends through borings in the piston heads c' and c''; the head c' being held in place by the threaded collars or nuts e and f while the head c'' is held by the collars e' and f', and the spacing of these heads may be effected by the said collars, and should be in all cases symmetrical, that is, if we take a point or plane u equidistant from the inner faces of the heads c' and c'', this point should lie in the plane p when the piston is at half stroke or in mid position. The piston heads c' and c'' are traversed by passages or ports r, r, respectively, and these ports are respectively controlled by outwardly opening valves g and g', the travel of these valves being limited respectively by the snubbing collars t and t' attached to the valve stems. The valve g admits a passage or flow of the resisting medium from the space k to the space k' whenever there is an excess of pressure in the space k over that in the space k'. Similarly the valve g' opens into the space k'' whenever there is an excess of pressure in the space k. While, if there is a defect of pressure in k, in respect of k', the valve g will be held closed, or if the pressure in k is in defect of k'', the valve g' will be closed. When the piston is traveling toward the upper end of the cylinder, the valve g will be held closed, and when moving toward the lower end of the cylinder, the valve g' will be closed. When the piston starts on the down stroke, the valve g will open at the instant of reversal, and remain open at least until the entire length of the piston is alongside the broadened part p'—p'', of the groove h, and similarly, when the piston rises, the valve g' will open at the instant of reversal, and remain open at least until on the upstroke, the entire length of the piston is alongside this broadened part of the groove. The lower valve g' is provided with a spring t' to counterbalance its weight, but the valve g' does not require a spring unless the mechanism be used in some unusual adaptation in a horizontal position, in which case, both valves will need springs to compensate for their inertia if the highest balance in operation be desired.

The piston c, in respect of the groove h, acts as its own valve to control the flow of the medium across the edges of its heads from any one chamber or space to any other or others, and the extreme length of the piston, that is, its length in maximum spacing should be such that at the end of a full stroke, the inner edge or face of the inner piston head should fall slightly within the tapered part of the groove corresponding to the particular end of the cylinder at which the piston may be, that is, should pass the points p' and p'' in the outward travel. By "inner piston head" is meant the particular head that, at this phase of the cycle, lies toward the plane p, and by "inner face" is meant that face of the same which bounds one side of the space or chamber k within the piston head; the term "inner" referring

to position within the cylinder in the first case, and in the last case, to position upon or within the double piston head. The cylinder is provided with a small reservoir *m* having a force screw *n* by which, when a stop cock *o* is opened liquid may be forced into the cylinder to refill it and then compensate for any loss therefrom. From the foregoing description the full operation of the mechanism will now be easily understood.

Let the piston be connected with the body of a vehicle and the cylinder with the running gear. Let the springs of the vehicle be at mid position with the piston of the mechanism at mid position or the point *p*. Let the movement of the piston be considered as a simple rise and fall within the cylinder and let the extreme case be taken, viz:—that in which the piston moves to the limits of its travel and completes two full strokes. Then as the piston falls toward the end *a''* of the cylinder *a*, there will obtain an excess of pressure of liquid in the space *k''* over that in the spaces *k* and *k'*, the valve *g'* will remain closed and a flow of liquid will occur from the space *k''* to the space *k* through the groove *h* across the edge of the piston head *c''* and thence to the space *k'* through the groove *h* across the edge of the head *c'*. The valve *g* may open, but this is immaterial, the determining factor of resistance being the cross section of the groove *h* directly in line with the outer or advancing surface or face of the piston head *c''*. The resistance encountered by the piston however will, owing to the large cross section of the groove, be practically negligible until the advancing face of the piston *c''* registers with the point *p''*, thence an increasing resistance will set in and this will attain a maximum as the advancing face of the piston registers with the point *q'* and cuts off the flow from *k''*, this point marking the limit of the downstroke and the imprisonment of a portion of the liquid in the lower end of the cylinder to cushion the blow.

On the upstroke at the instant of reversal the advancing face of the piston *c* meets an unbalanced pressure in the space *k'* which causes a flow of the medium from the space *k'* to the space *k* through the groove *h* and thence into the space *k''*, this excess of pressure being transmitted to the space *k* or chamber of the double piston and causing the valve *g'* to open and allow a flow through the passage *r'* and into the space *k''*. The valve *g* will not be opened as the pressure of *k* cannot at this phase exceed the pressure within *k'* and hence the controlling factor of resistance will be the cross section of that particular portion of the groove *h* that may lie directly in line with the inner or retreating face of the piston head *c'*; that is, that face of *c'* which bounds the central chamber, the magnitude of the above cross section being the measure of the flow from the space *k'* to the space *k* and thence to the space *k''*. As the retreating face of *c'* above mentioned moves across successively greater cross sections of the tapering portion of the groove, the resistance diminishes and when this face registers with the point or plane *p''* the resistance becomes a minimum and practically negligible and remains so until the advancing face of *c'* reaches the point *p'*. From this forward, the resistance increases, the determining factor being the magnitude of the cross section of the groove that for the instant registers with the advancing face of the piston in this phase of its upward stroke or travel. When the said face reaches the point *q*, the resistance attains its maximum, the flow is cut off and a portion of the liquid is imprisoned in the upper end of cylinder to cushion the blow in like manner to the action described as resulting when the piston terminated its antecedent downward half stroke. Then finally, in brief, as the piston reverses its motion and travels downward to the mid position plane *p* and to the completion of a full primary cycle or two complete strokes, there will be a flow from *k''* to *k* through the groove *h* and thence mostly through the valve *g* to the space *k'*, while the valve *g'* will be held closed. The resistance factor, similarly to the corresponding case, before described, will be determined by the magnitude of the particular cross section of the groove *h* that may from instant to instant register with the retreating surface or face of the piston head *c''*; that is the face *c''* which bounds the space *k* or piston chamber. This resistance as before, decreases until the above face registers with the point *p'* and from this forward to the completion of the full cycle or return of the piston to the mid position *p*, the said resistance is at a minimum.

The description of the action of the secondary oscillations or incomplete strokes will be obvious, and, in short, as the piston moves across the central transverse planes of the cylinder, the resistance is a minimum, and as it approaches either end, an increasing resistance sets in and gradually becomes a maximum terminating the full strokes of the piston, while as the piston reverses its motion at either the upper or lower limiting positions a considerable resistance is encountered which, as the piston travels toward mid position, soon decreases to a minimum and remains so while the travel of the piston is across the aforesaid middle portions of the cylinder; that is, while the double piston in its entire length is moving alongside the broadened portion of the groove. The spaces through which

increasing resistance acts as the piston advances toward either end of the cylinder are much greater than the spaces through which decreasing resistance acts as the piston recedes from either end of the cylinder. The connection between the action of the mechanism and the movements of a vehicle body and its running gear and the relationship to the reactions of the inertia of a body and of the elasticity of its springs are now sufficiently evident not to require further description. A single point may be noted, when the piston heads are most widely spaced and the extreme stroke made shorter, the recessional or receding resistances are small, and when the spacing of the piston heads is least and the extreme stroke made greatest, the resistances are great, that is, are small and great, having regard for the full or extreme strokes.

The advantages of a construction of this kind for shock absorbing purposes are plain, inasmuch as it furnishes a control in respect to resistances that cannot be duplicated in any system of springs. Many shock absorbers do not relieve the springs of a vehicle either from undue compression or distention. The bouncing effect of springs is particularly well taken care of, so that the inertia of a vehicle body does not tend to jerk up the running gear, and allow, in the case of an automoblie, the traction wheels to lose their grip and cause "racing" or "skidding".

If the resisting medium employed be air, or other gaseous mixture or gas, the invention possesses many advantages, as we may imprison in the ends of the cylinder sufficient gas to cushion the piston at the end of its stroke, but not enough to bounce it, as in the case of a mechanism in which all the gas, or at least half the contents of the cylinder is compressed alternately in the ends of the cylinder. Of course, in using this mechanism as a pneumatic or gas shock absorber, the passages will need to be much larger and although the general design will remain unchanged, the particular proportions of parts will require modification.

Having thus fully described the nature of my invention, what I claim as new and desire to secure by Letters Patent, is:—

1. A shock absorber comprising a liquid filled cylinder, and a double piston therein, said piston containing a chamber, having ports with valves opening outwardly, the cylinder having a longitudinal groove of a varying cross section, to cause the liquid to offer a variable resistance to the motion of the piston relatively to the cylinder.

2. A shock absorber comprising a liquid filled cylinder, and a double piston therein, said piston containing a chamber, having ports with valves opening outwardly, the cylinder having a longitudinal groove of a varying cross section, to cause the liquid to offer a variable resistance to the motion of the piston relatively to the cylinder, this resistance being negligible as the piston moves from its mid-position outwardly across the middle transverse planes of the cylinder but increasing as the piston approaches the limit of its extreme strokes and reaching a maximum thereat, this resistance rapidly decreasing when the piston reverses its motion at either of these limits and becoming negligible when the piston continues its travel inwardly toward its mid-position or mid-stroke.

3. A shock absorber comprising a liquid filled cylinder, and a double piston, said piston containing a chamber, having parts with valves opening outwardly, the cylinder having a longitudinal groove of a varying cross section, to cause the liquid to offer a variable resistance to the motion of the piston, and in such manner that the resistance is practically negligible as the piston moves across the middle portions of the cylinder, but increasing as the piston approaches the limits of its extreme strokes, and, as the piston reverses its motion to recede to mid-position, capable either of rapid or of instant decrease to negligible proportions.

4. A shock absorber comprising a cylinder, and a piston therein, said cylinder having a removable lining, having a lengthwise groove of variable cross section, and said piston having a chamber with ports controlled by outwardly-opening valves.

5. A shock absorber comprising a cylinder, and a piston therein, said cylinder having a lengthwise groove of variable cross section, and said piston having a chamber with ports controlled by outwardly-opening valves.

6. In a shock absorber comprising a liquid filled cylinder and a double piston, a means of varying the length of the extreme strokes through variation in the spacing of the piston heads.

Toronto, July 17th, 1914.

CHARLES FRANKLIN BRADBURN.

Signed in the presence of—

C. H. RICHES,

EDWARD S. BERNSTEIN.