Nov. 4, 1930. J. F. WALLACE 1,780,659

SHOCK ABSORBING STRUT

Filed Dec. 9, 1927

FIG. 1.

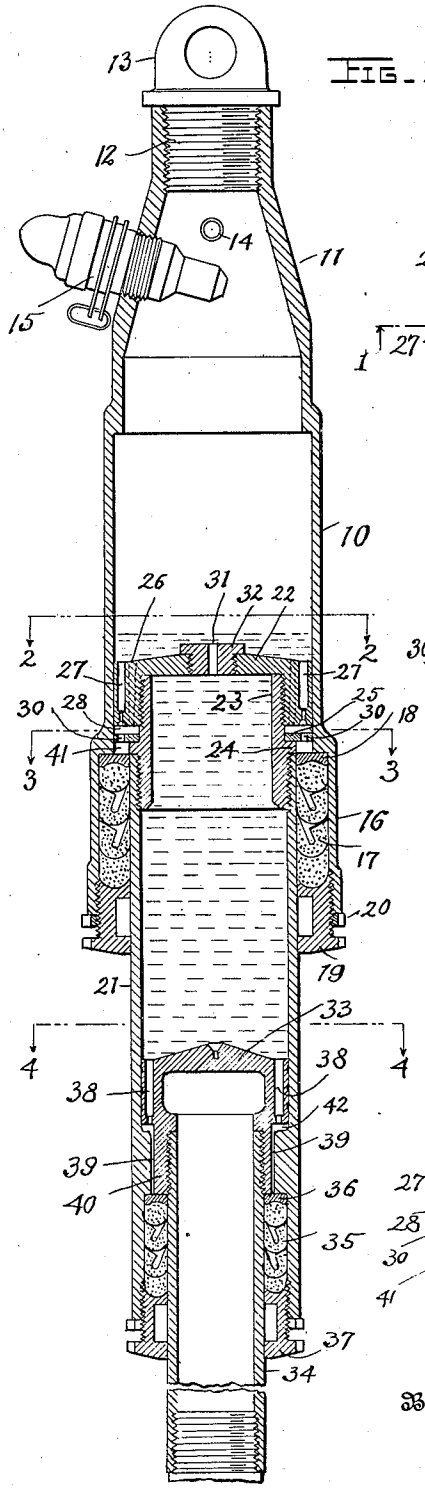


FIG. 2.

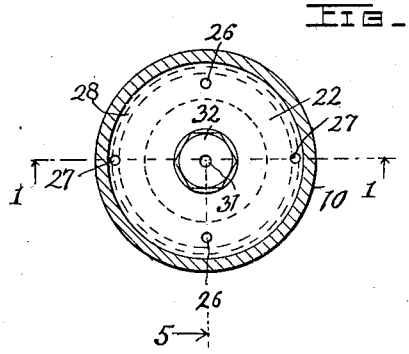


FIG. 3.

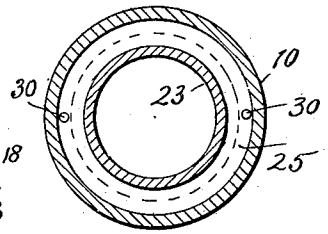


FIG. 4.

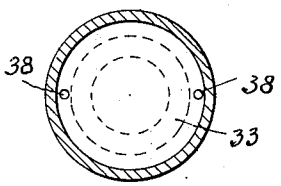
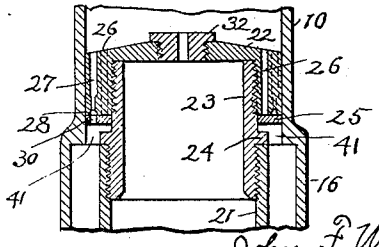


FIG. 5.



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UNITED STATES PATENT OFFICE

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SHOCK-ABSORBING STRUT

Application filed December 9, 1927. Serial No. 238,839.

This invention relates to improvements in shock absorbing struts for airplanes and hydroplanes.

In certain types of airplanes the design of the plane and running gear is such that by the use of struts now on the market it is impossible to secure a desirable cushioning effect upon landing without danger of having the ends of the wings strike the ground when the plane is taxying. This is due to the fact that a relatively long stroke of the strut is necessary to secure the resiliency that is essential in order to effect an easy landing, but the degree of resiliency is objectionable in a low-hung airplane when the latter is taxying over the ground, on account of the small clearance between the ends of the wings and the ground. The only way that has heretofore been found feasible for guarding against possible damage to the wings of such planes has been to make the struts quite stiff in their action, but obviously such an expedient is very unsatisfactory as it detracts greatly from the usefulness of the strut in making a landing.

It is an object of the present invention, therefore, to provide a strut in which there is a long total stroke available for landing with a comparatively short stroke available for taxying over the ground when the blows which must be absorbed by the strut are of much less force than the blow delivered to the strut by the impact of landing.

Other objects and features of novelty will appear as I proceed with the description of that embodiment of the invention, which, for the purposes of the present application, I have illustrated in the accompanying drawings, in which:

Figure 1 is a longitudinal central sectional view of a compound strut embodying my invention, the section corresponding to line 1—1, Figure 2,

Figure 2 is a cross-sectional view taken substantially on the line 2—2 Fig. 1,

Figure 3 is a cross-sectional view taken substantially on the line 3—3 Fig. 1,

Figure 4 is a cross-sectional view taken substantially on the line 4—4 Fig. 1,

Figure 5 is a detail sectional view taken substantially on the line 5—5, Fig. 2, and showing the valve ring in its upper position.

The embodiment illustrated herein consists essentially of two pistons of different diameters operating in cylinders to fit, which cylinders may or may not be rigidly connected together, the larger cylinder and the smaller piston being connected to the parts whose movements it is desired to cushion.

In the drawing, the upper and larger cylinder is indicated at 10 and has a dome-shaped head 11 closed by a threaded plug 12 which may carry some suitable connector element, such as a perforated lug 13, by means of which attachment may be made to the wing or body of an airplane or to the frame or body of a ground vehicle. 14 is a plug through which oil or other liquid may be introduced, and 15 is an air valve of any known or suitable form. At the lower end of the cylinder 10 there is an enlargement 16 in which is mounted a packing 17. While the details of the packing constitute no part of the present invention, I prefer to use the arrangement herein illustrated which is referred to more in detail in my co-pending application, Serial No. 179,483, filed March 30, 1927. The packing 17 is radially expansible upon the application of pressure lengthwise of the cylinder. It bears at the upper end against a retaining ring 18 loosely mounted in the enlargement 16 and normally resting against a shoulder at the juncture of the cylinder 10 and enlargement 16. The other end of the gland or enlargement is closed by a gland nut 19 which may be threaded inwardly to tighten the packing and may be locked in adjusted position by a lock nut 20. The gland nut 19 merely sets the minimum pressure on the packing while automatic regulation is obtained by force exerted upon the upper surface of the retaining ring 18 either mechanically or through the fluid in the strut.

The smaller and lower cylinder 21 in the present instance is in effect a tubular continuation of the upper and larger piston 22, the connection being effected through a sleeve 23 which is threaded into the piston and into the upper end of the cylinder 21, there being a collar 24 on the sleeve which forms a stop

for the upper end of the cylinder and also forms a stop for a valve ring 25 which is vertically movable between the stop 24 and the lower surface of the head of piston 22. The piston 22 has passages 26 extending therethrough adapted to be closed by the valve ring 25 when in its upper position. These passages 26 are shown in Fig. 2 and their radial position indicated by dotted lines in Fig. 1. Other passages 27 also extend through the piston 22, opening into an annular groove 28 on the bottom of the piston head, and by this means communicating with ports 30 through the valve ring 25 when the latter is in its uppermost position. This valve construction is referred to more in detail in my application Serial No. 238,838, filed of even date herewith. The spaces above and below the center of the piston 22 are in communication through a restricted or metering opening 31 which is conveniently formed in a plug 32 threaded into a hole in the piston. Plugs 32 with different sized openings therethrough may be interchanged in order to modify the action of the strut.

A piston 33 slides in the smaller cylinder 21. It is threaded onto a tubular piston rod 34 which is threaded also at its lower end for connection with attaching parts such, for instance, as a plug similar to the plug 12 previously mentioned. The joint between the cylinder 21 and the piston rod 34 is closed by a packing 35 similar in every respect to the packing 17 and working against a retainer 36 at one end and an adjustable gland nut 37 at the other. The upper face of the retainer 36 is exposed to the pressure above the piston 33 through passages 38 in the piston and through a clearance 39 between the cylinder 21 and the piston shank 40.

Operation.—Assuming that the strut is properly connected between the landing gear and a wing of an airplane, for example. the operating fluid is fed into the strut while the landing gear is in normal position, that is to say, with the struts bearing the weight of the plane. The struts being thus in their collapsed position, the plugs 14 are removed and each strut is filled with a liquid, such as oil, up to the level of the plug opening. The plug 14 is then reinserted and an air pressure connection is made to the air valve 15. Enough air under pressure is then admitted to depress the piston 22 to the desired extent, preferably to a short distance above the lower limit of its movement. During these operations the piston 33 remains in engagement with the sleeve 23, the pressure within the strut when acting upon the surface area of the smaller piston 33 being insufficient to support the weight of the plane.

When the plane is taxying over the ground, the maximum possible stroke of the strut is through a distance equal to the maximum possible movement of the piston 22, that is, from the position where the piston contacts with the retainer ring 18 to a position where it engages against the cylinder head 11. This stroke is sufficient for taxying purposes, and is short enough to prevent the wings from descending sufficiently to touch the ground. When the airplane rises from the ground, thereby taking the weight off the landing gear and off the piston 33, the latter moves downwardly to its limit of movement under the influence of the pressure within the strut. At this time the space above the piston 33 and below the piston 22 is filled with oil.

When a landing is made, the first effect of the impact is to raise piston 33, causing the oil above the same to be displaced through the opening 31 and through the passages 38. The speed of movement at this time of course depends upon the size of the opening 31 and upon the size of the openings 38. The piston 22 will be unaffected unless the force of the impact is sufficient to overcome the pneumatic pressure above the piston 22, in which event the two pistons will move together for a time or until the excess pressure below the piston 22 becomes dissipated through the metering openings 31 and 38. As soon as the piston 33 engages the piston 22, or rather the sleeve 23 thereon, the further force of the impact will be taken by the compressed air above the piston 22 acting upon the full area of that piston. At such time the oil that is above the piston flows quite freely through the passages 26 and 27 into an annular space 41 below the piston head.

When the energy built up in the compressed air above the piston 22 equals the energy of the impact transmitted to that piston, the latter begins its rebound stroke. The rebound is slowed down by the valve ring 25 moving into position to close the passages 26, as illustrated in Fig. 5, thereby decreasing greatly the size of the path of movement of the oil out of the annular space 41. The action of the strut upon rebound is thereby made smooth and slow. Furthermore, it is limited to the possible stroke of the piston 22. There is very little tendency for the piston 33 to continue on the rebound stroke after the piston 22 has been stopped by the retaining ring 18. In fact this tendency is practically nil, being limited to the pressure which may be transmitted through the very small opening 31. Therefore, my invention provides a long stroke for the impact of landing and a short stroke for the rebound after landing. The two pistons thereafter for so long as the plane is on the ground remain in contact and move together in unison.

Below the head of piston 33 and in communication with passages 38 and clearance space 39 there is an annular space 42 which constitutes a dash-pot, being filled with oil at all times. It cushions any sudden outward

movement of the piston 33 when the airplane takes off, and makes the device as free as possible from mechanical noise.

As in my previous application Serial No. 179,483 above referred to, the packing retainer rings 18 and 36 are subjected to heavy pressure when the plane is off the ground, the pressure transmitted to the ring 18 being that which is brought to bear upon the entire upper surface of piston 22, and the pressure transmitted to ring 36 being that which is brought to bear upon the entire upper surface of piston 33. The packings 17 and 35 are, therefore, expanded strongly and the sliding parts are all sealed very effectively.

Having thus described my invention, I claim:

1. In a pneumatic and hydraulic shock absorbing strut, a cylinder, a piston therefor movable against pneumatic pressure to absorb shock, and a second piston movable against liquid displaceable through a metering opening to absorb shock, the movement of said second piston being communicable to said first piston through said liquid whenever the pressure in said liquid equals the pneumatic pressure acting against said first piston.

2. In a pneumatic and hydraulic shock absorbing strut, a cylinder, a piston therefor movable against pneumatic pressure to absorb shock, and a second piston movable against liquid displaceable through a metering opening to absorb shock, said second piston being adapted to engage and communicate its movement to said first piston after a predetermined amount of liquid has been displaced.

3. In a shock absorbing strut for vehicles, cylinders of different cross-sectional areas, a floating piston in the larger of said cylinders, a piston in the smaller of said cylinders adapted to communicate pressure to said larger piston through an intervening column of fluid, and means for attaching the load between said larger cylinder and smaller piston.

4. In a shock absorbing strut for vehicles, three relatively slidable parts, namely, a large piston, a small piston and a cylinder having a portion to fit each piston, means for attaching the load to said small piston and one of said remaining parts, the third part being a floating part, the smaller piston being adapted to communicate pressure to said floating part through an intervening column of fluid, and the larger portion of the cylinder containing a compressible fluid adapted to absorb the pressure communicated to said floating part.

5. In a shock absorbing strut for vehicles, a cylinder adapted to be attached to one side of the load, a floating piston therein having a large area on one end exposed to pneumatic pressure and a smaller area on the other end, and a second piston adapted to be attached to the other side of the load and adapted to communicate pressure to the smaller end area of said first named piston through an intervening column of fluid.

6. In a shock absorbing strut for vehicles, a cylinder, a floating piston therein having a large area on one end exposed to pneumatic pressure and a smaller area on the other end, a second piston adapted to be attached to the load and adapted to communicate pressure to the smaller end area of said first named piston through an intervening column of fluid, and means for metering fluid from one side of said floating piston to the other, whereby said pistons at times engage each other and move in unison.

7. In a shock absorbing strut for airplanes, a cylinder closed against the discharge of fluid, said cylinder containing two pistons of different cross-sectional areas, means for connecting said cylinder and the smaller of said pistons between the airplane proper and its landing gear, means providing intercommunication between those portions of the cylinder which are directly above and directly below the larger piston and a fluid in said strut under pressure such that its force acting upon the smaller piston is insufficient to support the weight of the airplane imposed thereupon, whereby the two pistons engage and act together when the airplane is taxying.

8. In a shock absorbing strut for airplanes, a cylinder closed against the discharge of fluid, said cylinder containing two independent pistons, a stop to limit the downward movement of the upper piston, means for attaching the landing gear of the plane to the lower piston, pressure fluid in said strut, and means for metering said fluid from one side of the upper piston to the other.

9. In a shock absorbing strut for airplanes, a cylinder closed against the discharge of fluid, said cylinder containing two independent pistons, a stop to limit the downward movement of the upper piston, means for attaching the landing gear of the plane to the lower piston, said strut containing compressed air and containing also a liquid sufficient to fill the space between the pistons in the extended position of the strut, and means for metering the liquid from one side to the other of said upper piston.

In testimony whereof, I hereunto affix my signature.

JOHN F. WALLACE.