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HYDRAULIC SHOCK ABSORBER AND LANDING GEAR EMBODYING SAME
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Fig. 3.

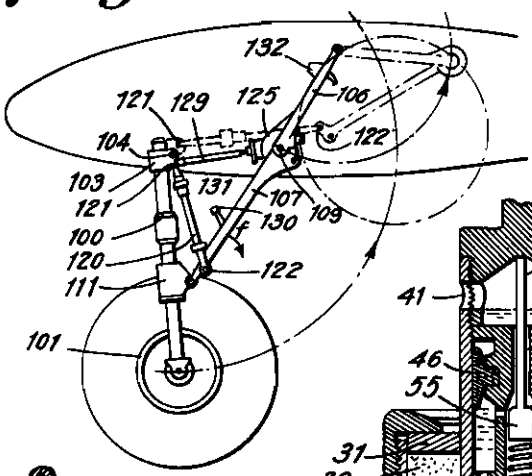

Fig. 4.

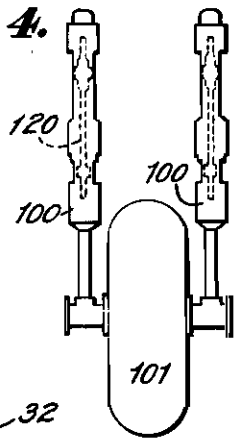

Fig. 1.

Fig. 2.

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HYDRAULIC SHOCK ABSORBER AND LANDING GEAR EMBODYING SAME

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This invention relates to the hydraulic shock absorbers, more particularly adapted to be used in landing gears for aircraft, of the kind comprising two bodies telescopically sliding relatively to each other, the relative displacement of said bodies being effected in the one direction by the action of an external force against a yielding medium and causing a liquid—usually oil—to be forcibly driven through a passage, the free section of which is relatively large, and in the other direction by the action of the expansion of said medium which has been energised, the speed of this expansion being limited by the throttling of the liquid flow.

The aforesaid yielding medium is usually compressed air contained in a chamber the volume of which varies in response to the relative position of said bodies, the shock absorbers being then called hydro-pneumatic shock absorbers.

The shock absorbers adapted to be used on aircraft machines are required not only to be strong enough to resist without risk of failure to all the strains likely to be encountered in use, but also to be of light welght, as compact as possible and able to be tilted in every direction without impairing the operation thereof. The latter qualities are particularly useful in case the shock absorber is to be made a part of a retractable landing gear for the housing of which a very limited space only is available in the airplane structure.

One essential object of this invention is to provide a new and improved construction of shock absorber fully answering to the special requirements and conditions of use on aircraft and remarkable namely in that the space into which the same can be lodged, at rest, is very small relatively to its power.

In view of this main object, the present invention consists in a hydraulic shock absorber of the aforesaid kind in which the relative displacement of the two bodies telescopically sliding relatively to each other in the direction of the extension of the assembly corresponds to the energization course of the yielding medium, while the relative displacement of said bodies in the direction of the contraction of the assembly corresponds to the de-energization course, the speed of which is braked by throttling the flow of liquid.

This results in a construction of shock absorber the length of which, in the position of rest, is reduced to a minimum as compared with the usual constructions hitherto used.

In accordance to a preferred embodiment of this shock absorber, the same comprises two tubular bodies one of which is provided with a bottom member and serves as a cylinder and the other of which, having a smaller diameter than the first one and sliding therein, is closed at its end inserted in said first one by a one-way valve adapted to be pressed upon its seat by the liquid returning from the first body into the second as the shock absorber is contracting, said valve being adapted then to present a throttled passage for the flow of liquid.

The second tubular body may conveniently serve as a cylinder for a sealing piston engaging with the walls thereof and normally contacting with the upper surface of the liquid therein, said piston having a passage normally closed by a valve which is adapted to open—preferably automatically—as said piston rises in said body above a predetermined level, thus allowing the shock absorber to be drained when filling same.

The oil leakages are thus avoided whatever be the angle of inclination of the shock absorber.

When using compressed gas as the aforesaid yielding medium—and this is an advantageous feature of the invention—the second tubular body carries at its end inserted in the first body a sealing device acting as a piston, while another sealing device or a stuffing box carried by said first body clamps the second body where it emerges from said first body so as to form between the two bodies a sealed annular chamber of substantial space into which compressed gas is introduced and the volume of which varies in proportion but in a reverse ratio with the length of the shock absorber.

This chamber may easily be given a sufficient inner space to allow of dispensing with any additional reservoir requiring delicate piping and couplings.

The present invention has also for its object a landing gear embodying a shock absorber the expansion course of which corresponds to its energization and which advantageously though not necessarily comprises the aforesaid features, and more particularly a landing gear of the kind described in U. S. Patent Application No. 226,569 filed on the 24th of August, 1938, in which said shock absorber acts as an accumulating device and is carried by the foldable elements of the gear so as to accumulate energy during the lifting of the gear and to restore this energy during the descent of the gear controlled thereby at a speed limited thereby.

In a preferred embodiment, in which said landing gear consists of a supporting frame hinged to the structure of the aircraft and carry-

ing a wheel or the like and of a folding strut holding said frame in low position, the shock absorber of the aforesaid kind is coupled between the upper part of said frame and the lower part of said strut without requiring the provision of a hinged system therebetween.

Other features and advantages of this invention will be apparent from the following description and the accompanying drawing, given solely as an example and in which:

Fig. 1 is a sectional elevation of a shock absorber, the middle part being broken away;

Fig. 2 shows diagrammatically the assembly at a smaller scale with the elements in another position;

Fig. 3 shows a landing gear according to the invention in its low position and, in chain dotted lines, part of its elements in an intermediate position;

Fig. 4 is a corresponding front view.

Referring to Fig. 1, the shock absorber comprises two cylindrical bodies or solids of revolution 1 and 2, the middle part of which is broken away in order to show more clearly the remaining parts, though it obviously extends continuously between the upper and lower parts as shown in Fig. 2.

These two cylindrical or tubular bodies are telescopically mounted relatively to each other. The outer body or tube 1, i. e. that of larger diameter, carries at its end a bottom member 3 underneath which said tube is integrally connected with fastening devices by means of which it may be operated and secured. Other devices adapted to fasten the shock absorber are integral with a jointing member 5 connected by a screw-thread with the upper end of body 2.

The bottom member 3 is provided with a passage 6 communicating with the outside through a non-return valve member 7 co-acting with a seat presented by a pipe union or coupling 8 normally closed by a cap 10. The valve member 7, adapted to be used for filling the shock absorber with liquid, carries a protruding stem 12 by means of which said member may be opened from the outside. A similar valve 16, mounted by means of a coupling 17 on the outer wall of tube 1, permits of introducing compressed gas into the latter, said valve being protected by a cap 20. A pressure gauge 21 is connected with coupling 17. The tube 2 acts as a piston inside the outer tube 1 and, for this purpose, it carries on the one hand at its lower end a series of sealing gaskets 25 engaging with the inner wall of said outer tube 1; on the other hand, the part of said inner tube 2 that emerges from said outer tube 1 is clamped by a surrounding stuffing-box 27 mounted in the latter at the upper end thereof. Said stuffing-box 27 is covered by a layer of grease 30 protected by a washer 31 which is held in position by a flanged collar having a threaded engagement with the upper end of body 1.

A plug 35 is screwed to the lower end of the inner tubular body 2 and is provided with a central opening 36 the mouth of which is formed as a seat for a perforated plate-valve 37. In front of said seat, the plug 35 carries a stop flange 38 adapted to limit the downward or opening movement of valve 37.

At its upper end the inner tube 2 communicates with the open air by means of ports 40 provided in its side wall and registering with openings 41 provided in the jointing member 5. The latter serves as a stop for a piston 45 adapted to slide freely in the inner tube 2 and to seal the latter by means of a gasket 46 carried by said piston and engaging with the wall of said tube 2. Inside said piston 45 is provided a recess 48 permanently connected with the inner portion of tube 2 comprised between said piston and the plug 35. An axial bore 52 connects said recess 48 with the upper portion of the internal space of tube 2. Said bore 52 is enlarged at its lower part so as to form the seat of a valve 55 having a rear stem projecting through the bore. A spring inserted in the recess 48 urges said valve 55 against its seat. The whole device is so arranged that the stem 56 engages with the jointing member 5 for opening the valve 55 when the piston 45 abuts against said jointing member at the end of its course.

Previously to the use of this shock absorber, the chamber formed between the sealing gaskets 25 and the stuffing box 27 is filled with compressed air through the valve 16 which causes the gaskets, together with the inner tube 2, to be yieldingly urged towards the bottom of Fig. 1, the position of rest of the shock absorber corresponding to the abutment of the plug 35 against the bottom member 3. On the other hand, oil is introduced into the shock absorber through the coupling 8 so as to fill the internal space of tube 2. During the filling operation, the piston 45 is lifted in accordance with the rise of the liquid. When the piston reaches the end of its course, as shown in Fig. 1, the valve 55 opens, thus relieving any air that may overlie the layer of liquid. The appearance of leakage oil issuing through the holes 40 indicates that the filling operation is completed.

During the use, the extension course corresponds to the compression of the air cushion and to the free flow of liquid through the opening 36 at the lower part of tube 2. As soon as this course is completed, the compressed air tends to drive back the tube 2 downwardly and to return the liquid into said tube. During this movement (Fig. 2), the valve 37 closes itself and the liquid can only flow through the hole or holes provided at the center of said valve, which throttles the flow and causes a braking action reducing the speed of expansion.

As shown in Fig. 2, the piston 45 follows the variations of the liquid level, isolates the liquid from the surrounding air and avoids any leakage, particularly at inclined positions of the shock absorber.

Figs. 3 and 4 show a landing gear in which the new shock absorber acts as an accumulator during the descent.

This landing gear comprises substantially one or two landing gear shock absorbers 100, of the usual kind, to the end of which a landing wheel or the like 101 is secured. This shock absorber is supported at its upper end by a clamping collar 103 hinged to the aircraft structure through the medium of a shaft 104. Each landing gear shock absorber 100 is held by a folding strut consisting of two links 106 and 107 hingedly jointed together at 109 and one of which, 106, is pivoted to the aircraft structure, while the other, 107, is pivoted to a collar 111 clamping the shock absorber 100 at its lower end.

A shock absorber of the above described type 120 is directly coupled between a pivot 121 carried by the collar 103 and a pivot 122 carried by the link 107. As viewed in Fig. 4, this shock absorber 120 is entirely hidden at the front by the

corresponding shock absorber **100** and thus takes no space in the transverse direction.

It will be assumed that the landing gear is of the driving hinge connection kind and comprises a lifting motor assembly contained in a casing **125** arranged at the hinge connection **109** of the links **106** and **107**.

This landing gear is completed by low and high position locking devices, respectively, consisting of fingers **126** and **130** co-acting with hooking systems **131** and **132**. A landing gear of this kind is described in U. S. Patent Application No. 226,569 filed on the 24th of August, 1938 under the name of the applicant.

The whole arrangement operates as follows:

During the lifting course effected in response to the operation of the relative rotation of the links **106** and **107** by the driving mechanism contained in the casing **125**, the link **107** swings in the direction of the arrow *f* relatively to the shock absorber **100**. This causes the extension of the shock absorber **120**, i. e. a compression of the air or the like contained therein and an accumulation of power. The linkage is so arranged that at the end of the lifting course, as shown by chain dotted lines, the pivot **121** is located above the shaft **104**, so that the turning couple imparted to the landing gear by the shock absorber **120** is slightly negative though remaining smaller than that produced by the weight of the landing gear, so as to relieve the locking device **130**—**132** when the landing gear is lifted.

For lowering the gear, the finger **130** is disengaged, which causes the gear to move down under the conjoint action of its own weight and of the force imparted to it by the shock absorber jack **120**, which at the same time acts as a brake for limiting the speed of this lowering course.

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