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BY A. P. C.

R. LARAQUE
SHOCK ABSORBING MEANS FOR
AIRCRAFT LANDING GEAR
Filed March 17, 1939

Serial No.
262,509
4 Sheets-Sheet 1

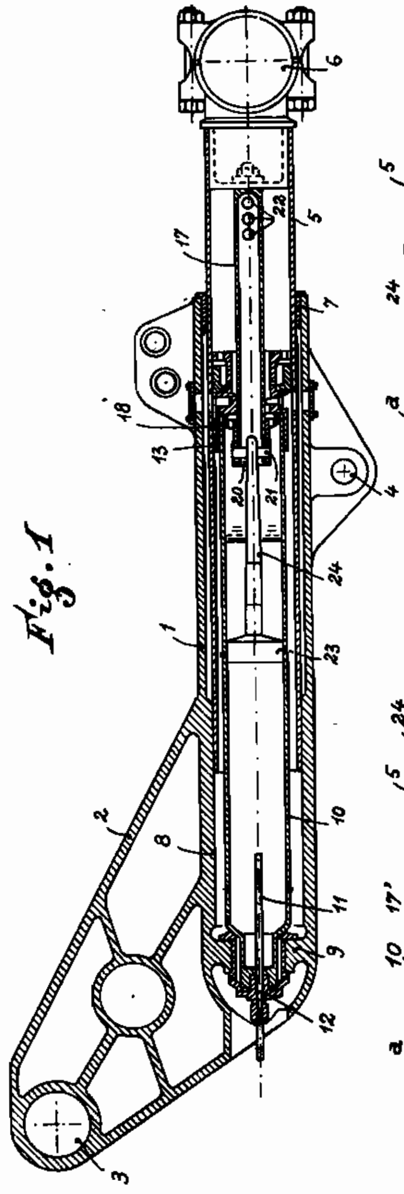

Fig. 1

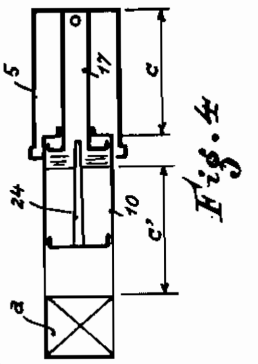

Fig. 4

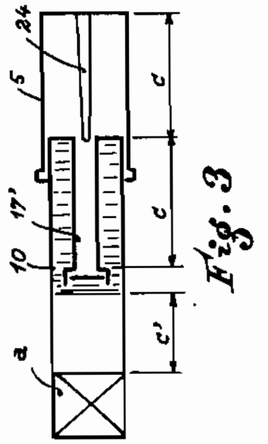

Fig. 3

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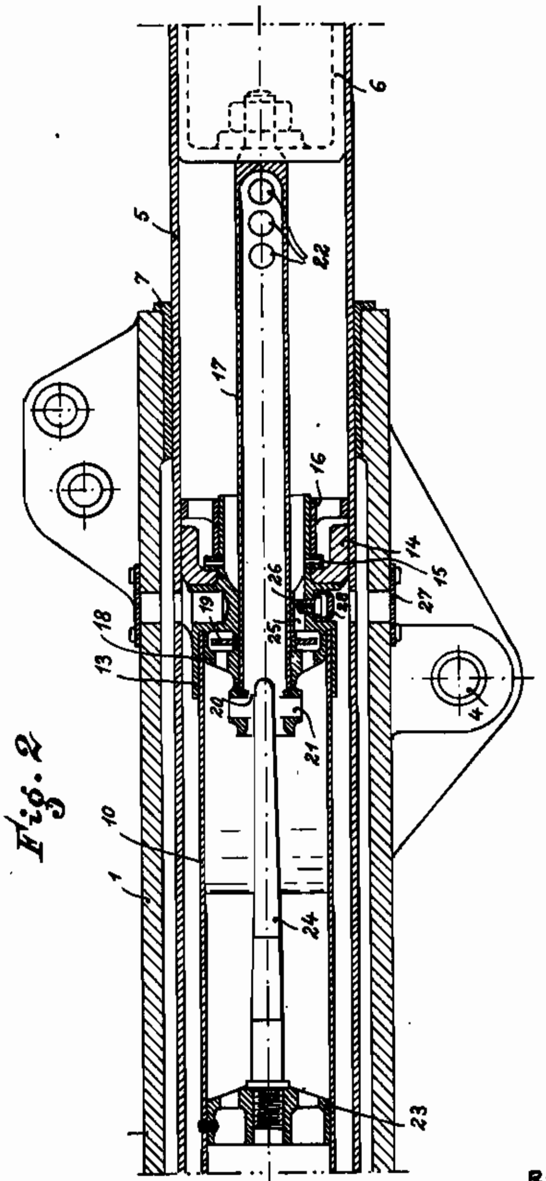

Fig. 2

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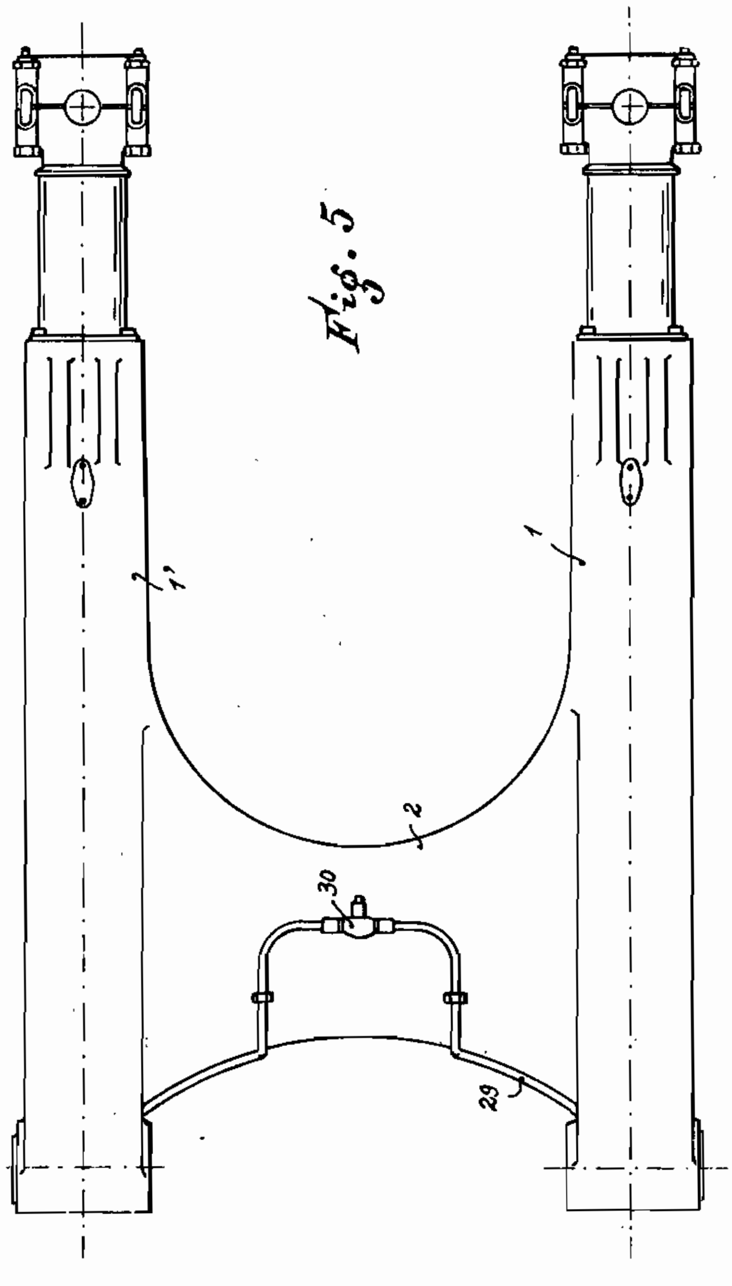
Fig. 5



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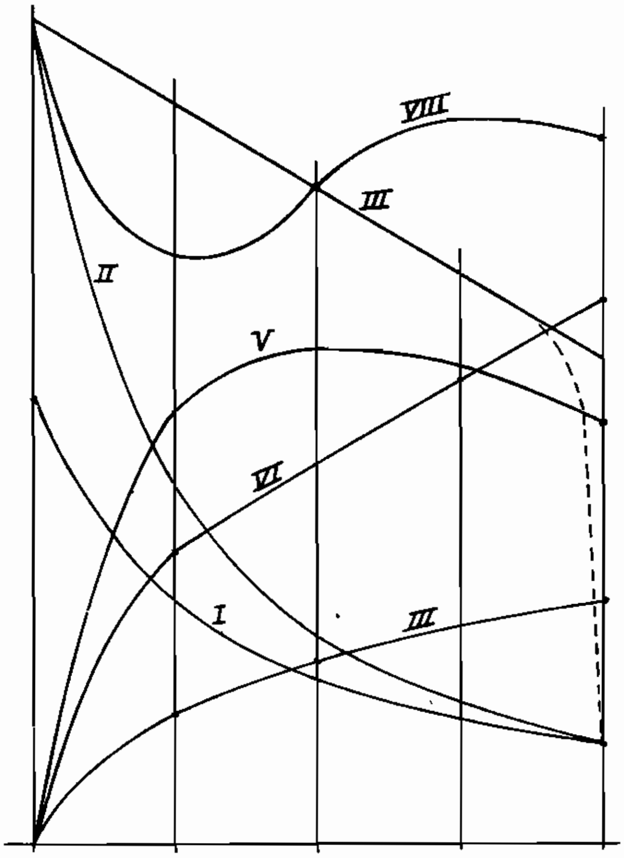

Fig. 6

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ALIEN PROPERTY CUSTODIAN

SHOCK ABSORBING MEANS FOR AIRCRAFT LANDING GEAR

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Application filed March 17, 1939

The constant increase in weight and load on aircraft renders the problem of landing more and more difficult. It is obvious that independently of the static charge which it has to resist, the landing gear must support efforts presenting multiple components. But to these various forces must be added a live force all the more considerable as the weight and the speed of aircraft daily increase.

It is therefore necessary to give not only to all the elements of the landing gear a resistance proportionate to the said efforts but also to devise a system of shock absorber for the landing gear which is in relation to the static charge and the important live force which has been referred to.

By reason of the order of the forces set up it is no longer possible to utilise mechanical shock absorbers with springs or "sandows" or even air actuated shock absorbers which are found to be insufficient. That is why aircraft constructors have since several years adopted shock absorbers braked by liquid and commonly known as hydro- or oleo-pneumatic absorbers.

But the already existing arrangements have the inconvenience of presenting either an insufficient stroke or else a cumbersomeness necessitating an abnormal elevation of the fuselage above the ground and difficulties in retracting the landing gear.

The present invention therefore has for object an oleo-pneumatic shock absorbing device for landing gear adapted to resist all the efforts above referred to and designed to absorb the live force of the apparatus in such a manner that the absorption of work resulting from this shock absorption, can occur, on the one hand, independently of the speed of the latter by:

1. The wheel tyres situated at the extremity of the gear legs;

2. the compression of the air in the shock absorbers and on the other hand, in relation to the speed of said shock absorption, by:

3. the slicing off of the liquid passing through a variable section created in each shock absorber between an upper cylinder integral with the landing gear and a lower cylinder integral with the wheel bearing and sliding alongside of the first cylinder which encases it, this section being adjusted in such a manner that the slicing shall be very considerable at landing and very slight in travel.

Conditions 2 and 3 are fully realised by the shock absorbing device provided by the invention and which more particularly has the following characteristics:

One of said characteristics resides in the means used to obtain a variation of the section for the passage of liquid, according to the course, such that it permits of obtaining on landing a given shock absorbing graph preferable of trapezoidal course and, consequently, a progressively of the load transmitted to the supporting planer.

Another feature resides in that the above devised variation in section of the passage of liquid is obtained with aid of a needle valve of known type the section of which can be easily adaptable to any characteristic desired and the position of which on the upper cylinder in the shock absorber permits, for an equal stroke, a much less amount of space occupied than that with shock absorbers of the same type already existing.

One feature of the invention also resides in a plunging tube serving to establish the level of liquid at the filling operation, provided in the upper cylinder and which allows, owing to its easy dismantling and its interchangeability, to modify the ratio of air compression on which the smoothness of running depends.

A feature also resides in the complete filling with liquid in the forward travel, of a kind of return pump, consisting of an air cylinder and its lower end on the one hand, and a piston, with valve, integral with the lower cylinder, on the other hand, and connecting the return to the discharge of liquid in the lower cylinder through an adjustable passage formed in the lower bottom of the air cylinder, this filling thus eliminating any vacuum in the pump which is a cause of hardness of the shock absorber at the forward movement and of a rapid return (rebound).

A feature in addition resides in the arrangement of the regulating member of the section for the passage of said liquid which permits of the easy access of said organ from the outside at any moment and in any place without necessitating any dismantling, the delivery of return liquid from the upper cylinder to the lower cylinder being thus easily brought to a value such that any rebound is suppressed and this facility of adjustment rendering it always possible to adapt the characteristics of the shock absorber to those of aircraft type under consideration.

Another feature resides finally in that the communication between the lower cylinder and the air cylinder, with reference to the return speed, in all positions is important, ensuring in this way the complete return to the lower cylinder of the small complement of oil not delivered by the return pump and eliminating in this manner in this cylinder any vacuum which would be a cause of shock at the next following forward stroke.

Various other particularities will on the other hand, be brought into evidence from the following description with reference to the accompanying drawing showing in:

Fig. 1, one of the limbs of the landing gear shown in longitudinal section;

Fig. 2, a section to a larger scale of the main part of a shock absorber;

Figs. 3 and 4 comparative diagrams of the space occupied by the shock absorber constructed according to the invention and that of an existing shock absorber;

Fig. 5, the landing gear seen in plan view;

Fig. 6, the diagram or graph of the shock absorber.

In one form of embodiment of the object of the invention, the shock absorber is partly housed in casings 1, 1' (Fig. 1) provided in form of a fork in each of the limbs of the landing set.

The landing set is articulated by means of bearings 3 on the driving spindle and receives in a bearing 4 the shaft of the wind bracing.

Each shock absorber comprises a lower cylinder 5 terminated, at its base, by a bearing 6 for the wheel axle and sliding in a lower bearing 7 and in an upper bearing 8 disposed in the casing 1.

At the end of the forward stroke the wheel bearing 6 abuts at the end of the casing against the lower bearing 8.

On the upper end 9 of the casing 1 is mounted with a ball joint a cylinder 10 engaging in the previously mentioned lower cylinder 5.

The upper end 9 is traversed by a depending level indicating tube 11, accessible and dismantleable from the outside of the casing by reason of a screw plug 12 which carries it.

At its other extremity the cylinder 10 (Figs. 1 and 2) is provided with a lower bottom 13, which can be dismantled and is provided with a tight sleege 14 tightened onto it by a washer 15 and a nut 16 of a shape such that it forms a means for guiding the upper cylinder 10 in the lower cylinder 5.

The lower bottom 13 is traversed by a hollow brace 17 secured at one of its extremities, on the wheel bearing 6 and carrying at its other extremity a piston 18 with valve 19 moving in the cylinder 10.

The piston 18 is provided with openings 20 and 21 adapted to allow the passage of the liquid which is to be contained in the two cylinders 5 and 10. The cross member 17 has at its base, openings 22 formed for the same purpose. All these openings must have a very large section of passage from one cylinder to the other.

At the inside of the cylinder 10 is secured a mandrel 23 carrying a needle valve 24 of variable diameter in its length and readily interchangeable. The play between the section of this needle and the bore 20 of the movable piston 18 determines the section of variable passage according to the stroke of this latter.

A small channel 25 is bored in the end 13 and more or less obturated at will by a plug 28 accessible from the outside of the casing 1 through a door 27 and after unscrewing a tight cover 28.

It will immediately be seen that such a device has a very great advantage over oleo-pneumatic apparatus already in existence; that of offering a much smaller encumberment for an equivalent stroke.

If one considers, in fact, a shock absorber of known type (Fig. 3) comprising a needle 24 integral with the lower cylinder 5 a flue 17' must be provided at least of the same length as the stroke and as the level of the liquid in the upper cylinder 10 must at no moment descend below the valve situated at the upper part of the flue, it will be seen that the dead space *a* being always reserved, the total length of the absorber must include a first space *c'* corresponding to the cylinder space and twice the stroke *c*.

The shock absorber according to the invention comprises, as is seen in Fig. 4, only once the stroke instead of twice and gives, for this reason, a gain in total height of the absorber, all other conditions being equal.

The operation of the shock absorber is as follows:

At the moment of landing the cylinder 5 plunges into the casing 1 and the piston 18 slides inside the cylinder 10; during this forward stroke the valve 19 offers a large section for the passage of liquid for the complete filling, under the pressure of the air, of the pump for the return created between the lower end 13 of the air cylinder 10 and the movable piston 18.

It will thus be seen that during the forward stroke, no vacuum, cause of a rapid return and a rebound over all or part of the return stroke, can occur. In fact, at the start of the return stroke the valve 19 closes automatically and the imprisoned liquid is then no longer discharged for the major part, into the lower cylinder except through the passage of adjustable section 25, whereas the play between the piston 18 and the needle 24 offers, through the intermediary of the hollow cross member 17, a large return passage to ensure the complete filling of the lower cylinder.

The return of the movable equipment takes place therefore slowly and it is thus impossible for a vacuum, cause of shock in the consecutive forward stroke, to be produced in the lower cylinder 3.

The speed of this return can be easily modified at any place and at any moment without any dismantling by simply acting on the plug 28 after having placed the fork on a jack and brought the shock absorber to abut against the return abutment (position of Fig. 1 and 2).

This faculty of adjustment permits by the above simple movement to adapt the features of the shock absorber to all types of aircraft.

The ratio of compression can likewise be adjusted very easily by modifying the length of the plunger tube 11 directly dismantleable with the plug 12 accessible from the outside.

On the length of the tube 11 depends in fact the quantity of liquid introduced in the cylinders and from its selection there results therefore a more or less smooth running.

In order to ensure that the ratio of compression shall be identical in the shock absorbers of both limbs 1 and 1' (Fig. 5) of the half carriage, the plunger tubes 11 of the two absorbers are interconnected by piping 29 passing through a device 30 which permits of the filling and inflation of the shook absorbers.

The variation of the section for the passage of liquid by the openings 20 and 21 can be modified at will by the adoption of a needle 24 of appropriate shape and which, being removable, can be replaced by any other needle adapted to the characteristics desired.

This variation in section of the passage for the liquid according to the stroke permits of obtaining, for example, on landing, a trapezoidal shock absorbing diagram and thereby progressiveness of the load transmitted to the wing surface. This diagram is represented at Fig. 6 and shows the advantage of the device of the invention over absorbers with constant section.

On this diagram the curve I relates to the variation of the load according to the isotherm, for a slow compression and for the case of running on the ground, the static equilibrium of the load being at half stroke.

The curve II corresponds to the compression of the air according to the adiabatic at the moment of landing.

The curve III (casing: air+liquid) determines the total surface of the diagram of work to be absorbed by the shock absorber in terms of the height of fall at landing.

Curve IV corresponds to the variation of the speed of shock absorption, deduced from the curve III. The surface comprised between the curves II and III delimits the slicing work of the liquid, transformed into heat.

Curve V represents the over-pressure in kg/cm^2 in the lower cylinder 5 with regard to the air cylinder 10, deduced from the difference, at all points, between the curves III and II.

Curve VI represents the section of passage of the liquid, corresponding to the curve III (total absorbed work) through the medium of curves V, IV and II.

VII represents the graph of a shock absorbing for a hydro-pneumatic absorber comprising hydraulic braking by slicing or lamination of the liquid through a constant section. The surfaces delaminated by the curves III and VII are identical.

It is obvious that modifications in shape and detail can be embodied in the shock absorber described hereinbefore by way of example in no way limitative and that without exceeding the scope of the invention.

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