A. F. ROCKWELL.

PNEUMATIC SPRING.

APPLICATION FILED MAR. 7, 1905.

962,246.

Patented June 21, 1910.

2 SHEETS—SHEET 1.

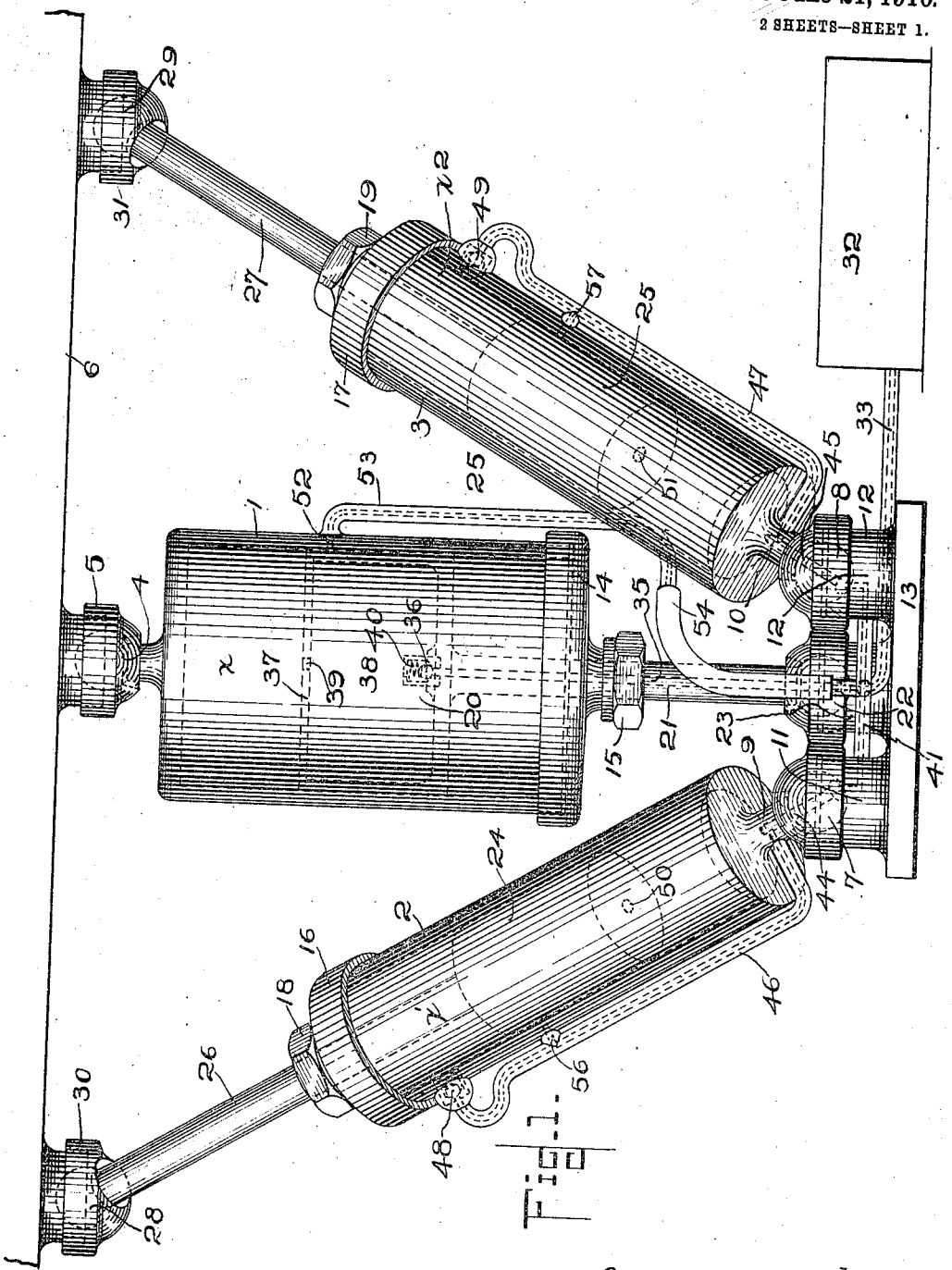

Fig. 1.

Witnesses.

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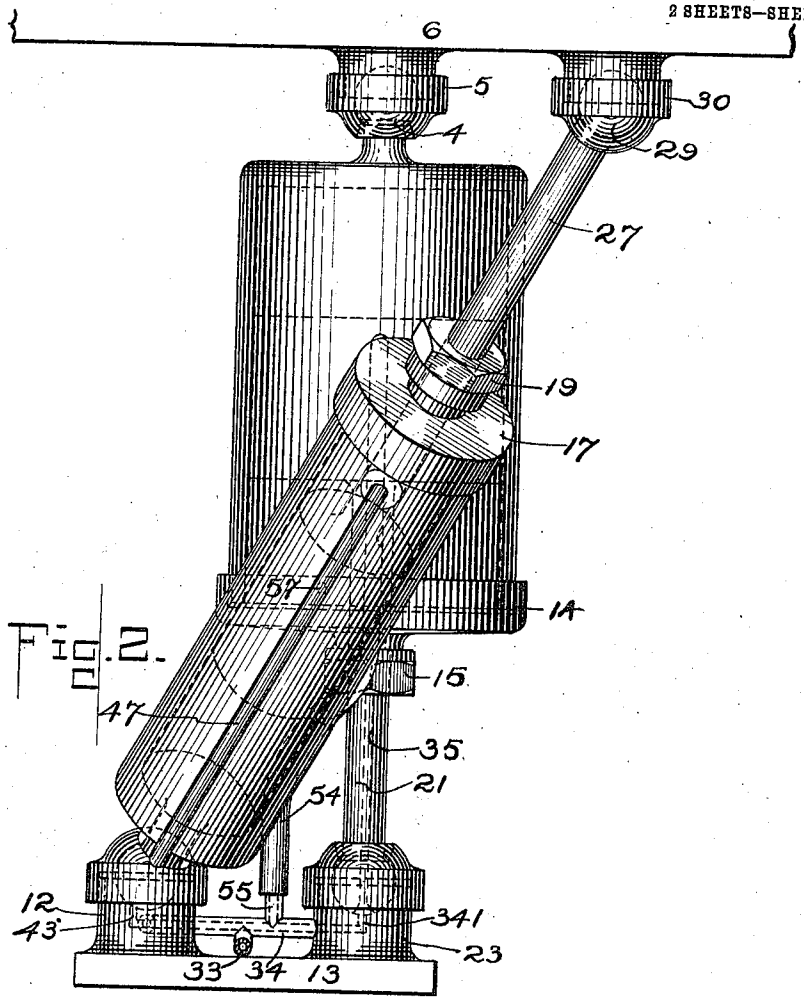

Fig. 2.

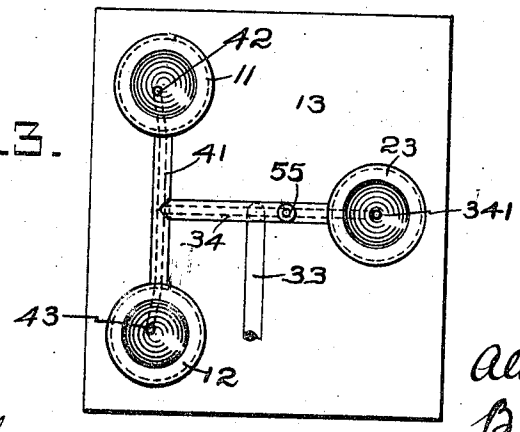

Fig. 3.

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UNITED STATES PATENT OFFICE.

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PNEUMATIC SPRING.

962,246. Specification of Letters Patent. Patented June 21, 1910.

Application filed March 7, 1905. Serial No. 248,916.

To all whom it may concern:

Be it known that I, ALBERT F. ROCKWELL, a citizen of the United States, residing at Bristol, in the county of Hartford and State of Connecticut, have invented certain new and useful Improvements in Pneumatic Springs; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to means for resiliently supporting bodies, and one object thereof is to provide a convenient and simple construction of devices for resisting the shocks of the running-gear of a vehicle, and for reducing the liability of said shocks being communicated to the vehicle body.

Another object of the invention is to provide a device capable of exerting a yielding resistance to the movements of the running-gear and vehicle body, which resistance may be automatically equalized to compensate for varying conditions, so that the yielding resistance will be approximately uniform at all times.

A simple form of my invention is illustrated in the accompanying drawings as including a fluid controlled piston working in a cylinder, and connected to both the body and running-gear.

The present invention is illustrated in the accompanying drawings, in which:—

Figure 1 shows in elevation one set of my improved springs. Fig. 2 shows the spring in side or end elevation, and Fig. 3 shows a plan view of the bottom support.

Similar reference characters will be employed throughout the specification and drawings to designate corresponding parts.

As shown in the drawings each set of my improved springs comprises a plurality of fluid containing cylinders, as many as may be desired, but preferably three as shown, a central cylinder 1 and two side cylinders 2 and 3. The cylinders 2 and 3 are illustrated as being reversely arranged with relation to the cylinder 1. That is, the compression chamber in the cylinder 1 is at the end opposite to the ends of the cylinders 2 and 3, in which the compression chambers are arranged. By thus relatively inverting the cylinder 1, I provide a construction which resists the movements of the connected bodies (in this instance the vehicle body and its running-gear) either toward or away from each other.

The top of the cylinder 1 is provided with a ball 4 formed integrally therewith which is seated in a bearing 5 supported upon the under side of a base or platform 6 which may be either the bottom of the vehicle to be supported, or a separate plate or base adapted to be secured to the under side of the vehicle. The bases of the cylinders 2 and 3 are likewise provided with the balls 7 and 8 formed integrally with the studs 9 and 10 projected from the bottoms of said cylinders and which are seated in bearings 11 and 12 preferably formed integrally with a base plate 13 which is intended to be fastened securely to the truck or axle of the vehicle.

The open end of the cylinder 1 is closed by a cap 14 provided at its center with a stuffing box 15 and the cylinders 2 and 3 are likewise closed by caps 16 and 17 provided respectively with the stuffing boxes 18 and 19.

Within the cylinder 1 is a piston 20 having a connected piston rod 21 which passes out of the stuffing box 15 and having at its end a ball 22 which is seated in a bearing 23 of the plate or base 13. The cylinders 2 and 3 are likewise provided with pistons 24 and 25 connected respectively to piston rods 26 and 27, which rods carry at their ends balls 28 and 29, seated in bearings 30 and 31 of the base or plate 6.

It will be noted that the cylinder 1 and its coöperating piston rod is mounted in a perpendicular position, the bearings 5 and 23 being in direct vertical alinement, but that the cylinders 2 and 3 and their coöperating pistons and rods are inclined with relation to the central cylinder, the bearings 11 and 12 being relatively nearer the bearing 23 than the bearings 30 and 31 are to the bearing 5 and the bearings 11 and 12 being upon one side of a line cutting the axis of the cylinder 1 and the bearings 30 and 31 an equal distance upon the other side of such line. This arrangement will cause the cylinders 2 and 3 and their coöperating pistons and rods to incline outwardly in opposite directions from the base 13 to the base 6 and with relation to the central cylinder as shown in Fig. 1, and also to incline inwardly toward the central line of the supported vehicle from a point outside of the

support of the central cylinder to a point inside of said support, all as clearly shown in Fig. 2. By this arrangement, which is considered to be an important feature of the device, the resistance to the longitudinal and also the lateral swaying of the vehicle is properly provided for and a quick recovery of the equilibrium of the vehicle is assured. It will of course be understood that the universal joints which connect the cylinders and pistons to the vehicle body and the axle or trucks will permit the swaying of the vehicle without the liability of disarranging the operative relation and action of the pistons in the cylinders.

While as before suggested either a fluid or a liquid may be employed to charge the cylinders I preferably charge them with air, and for this purpose there is provided a suitable air tank or receptacle 32 which by means of a suitable air pump (not shown) may be charged with air at the desired pressure. The air is conducted from the air tank 32 through a pipe 33 and a branch pipe 34 entering the bearing 23 of the piston rod 21 of the central cylinder, and passing through an aperture 341 in said bearing and through a passage 35 in the piston rod 21, is admitted past a ball valve 36 in the piston to the cylinder above the piston.

The piston 20 is formed as shown in dotted lines in Fig. 1 with a cylindrical wall and a plate 37 forming an air chamber 38 within the piston, the plate 37 being provided with a small aperture 39 for a purpose to be hereinafter described. The ball valve 36 may be of any usual construction, that shown in the drawing being adapted for the purpose and comprising a ball backed up by a spring 40, the arrangement being such that the air from the tank 32 passes through the pipe 33 and through the piston rod 21 out of the valve 36 within the chamber 38 in the piston and through the opening 39 in the plate 37 to the space above the piston, the valve 36 preventing any return movement of the air through the piston rod 21. The air is admitted to the cylinders 2 and 3 by means of the pipe 34 and a pipe 41 connecting the pipe 34 with the bearings 11 and 12 respectively, and passes from the openings 42 and 43 respectively through the passages 44 and 45 formed in the studs 9 and 10 of the respective cylinders 2 and 3. From the passages 44 and 45 (which do not enter the base of the cylinders), the air is conducted by means of pipes 46 and 47 to the upper end of the cylinders and enters the said cylinders above the pistons 24 and 25, past the ball valves 48 and 49, which valves like the valve 36 while designed to admit air into the cylinders, will not permit the escape of the air therefrom.

It will be noted that the central cylinder is considerably larger than the side cylinders and the relative size of the cylinders will be such that the central cylinder will exert four times the pressure of each of the smaller cylinders or double the combined pressure of the two smaller cylinders. The pistons 24 and 25 of the smaller cylinders will be formed hollow or with an interior air chamber substantially like the piston of the central cylinder and like the central cylinder the bottom of each of these pistons will be provided with a small opening 50 and 51 for a purpose to be hereinafter described.

From the foregoing arrangement it will be seen that the air from the supply tank is admitted to the central cylinder above the piston; that is to say in such a way as to cause the cylinder to rise upon its piston rod 21 and that the air will be admitted to the smaller cylinders 2 and 3 above the pistons or at such a point as to cause the pistons to be depressed in their respective cylinders. Now, assuming that no air has been admitted into the cylinders and that the piston 20 is at the extreme upper end of the cylinder 1, and that the pistons 24 and 25 are at the lower ends of the cylinders 2 and 3, upon the admission of the air thereto the effect will be to cause the cylinder 1 to rise or move upward with relation to its piston and this lifting movement will be resisted by the pistons 24 and 25 of the cylinders 2 and 3, and in practice it is designed to admit sufficient air into the cylinders and to maintain the air in the tank 32 at a pressure suitable to maintain the cylinders and pistons in the positions shown in the drawings, the air pressure above the piston 20 or in the space marked x being equal with the pressure of the air above the pistons 24 and 25 or in the spaces marked x^1 and x^2, this pressure operating in the larger cylinder to raise and support the vehicle and in the smaller cylinders to resist this raising and supporting; but inasmuch as the large cylinder exerts four times the pressure of each of the smaller cylinders it will result that under a suitable and predetermined air pressure in the tank 32, the respective cylinders and pistons will assume and maintain approximately the positions shown, for the weight of the vehicle added to the resistance of the side cylinders to the elevating action of the central cylinder will balance the weight of the body of the vehicle with its maximum load with the cylinders and pistons in the positions shown.

The ball valves 36, 48 and 49 as before explained will permit the free flow of air into the cylinders, but not to flow back into the supply tank, so that in order to maintain the pistons and cylinders in the position shown under the conditions incident to the travel of the vehicle over the road, which of course would have a tendency to cause a slight pumping action of the pistons within their cylinders, and to maintain a uniform

pressure in the cylinders and the tank, there is provided for each of the cylinders a by-pass valve normally closed by the pistons, the valve 52 of the central cylinder connecting with a pipe 53, which in turn is connected by means of a flexible connecting pipe 54 to a nipple 55 of the pipe 34 and the valves 56 and 57 of the cylinders 2 and 3 connecting with the pipes 46 and 47. These valves 52 and 56 and 57 are located so as to enter the cylinders at a point removed about a quarter of an inch from that end of the piston acted upon by the air pressure; that is to say, about a quarter of an inch from the top of the piston 20, and a quarter of an inch from the top of the pistons 24 and 25. This arrangement is such that should the pumping action of the pistons in their cylinders cause an excessive pressure between said pistons and the cylinders in the spaces marked x x^1 and x^2, as soon as such pressure so exceeding the tank pressure is sufficient to cause a movement of the pistons a sufficient distance to uncover the by-pass valves 52, 56 and 57 or any of them, as the case may be, the excess air will be discharged from the cylinders and flow back into the tank, thus bringing the pressure in the cylinders and the tank back to its normal condition. It is important to note at this point that by this arrangement of by-pass valves the pressure in the tank 32 and the cylinders is maintained uniform and is a very important feature of the present invention, and in so far as I am advised of the state of the art it has never been proposed to provide in so-called pneumatic springs any means for taking air from a tank or air supply at a predetermined pressure and maintaining that pressure automatically in the cylinders of the springs.

As heretofore stated, each of the pistons is provided with a chamber, the piston 20 with a chamber 38 and the pistons 24 and 25 with similar chambers and the plates of said pistons removed from the piston rods are provided with a small opening such as shown at 39 in the plate 37 of the piston 20 and at 50 and 51 in the pistons 24 and 25. This permits the air to flow through the apertures 39 and 50 and 51 from the piston chambers into the space above the piston 20 and below the pistons 24 and 25, this flowing of the air being restricted according to the size of the apertures, but, however, preventing the air passing quickly, but rather with a cushioning effect; that is to say, a quick motion of the pistons while permitting the air to escape through the apertures in the pistons, will to a certain extent produce an auxiliary or supplemental cushioning effect as the pistons are moved quickly as the vehicle passes over an uneven road, and I consider this to be an important feature of my invention.

The air contained in the cylinders below the pistons is intended to be maintained at atmospheric pressure, and for this purpose it may be found in practice to be desirable to provide a suitable vent in the cap of the central cylinder and in the lower end of the side cylinders to secure this result.

It is thought that the operation of my improved springs for vehicles has been sufficiently described by the foregoing description of its form and arrangement and that any further description of its operation is unnecessary.

Having described my invention I claim as new and desire to protect by Letters Patent of the United States:—

1. A vehicle spring comprising a plurality of independently mounted cylinders and pistons arranged for reverse operation with respect to one another, a source of fluid pressure supply for said cylinders and suitable valves for maintaining a uniform pressure in the cylinders and the source of fluid pressure supply, substantially as described.

2. A vehicle spring comprising a plurality of independently mounted cylinders and pistons arranged for reverse operation, one of said cylinders and pistons operating in one direction being of greater power than the combined cylinders and pistons operating in the opposite direction, substantially as described.

3. A vehicle spring comprising a central vertically disposed cylinder, piston, and piston rod, and two cylinders, pistons, and piston rods one upon each side of the central cylinder, piston and piston rod and inclined with relation thereto, substantially as described.

4. A vehicle spring comprising a central vertically disposed cylinder, piston and piston rod, and two cylinders, pistons and piston rods one upon each side of the central cylinder, piston and piston rod and inclined in planes which cross each other, substantially as described.

5. A vehicle spring comprising a central vertically disposed cylinder, piston and piston rod, and two cylinders, pistons and piston rods one upon each side of the central cylinder, piston and piston rod, the piston rods of the pistons of the side cylinders being connected to a support in line with each other upon one side of a plane cutting the axis of the central cylinder, piston and piston rod and the side cylinders being connected to a support in line with each other upon the opposite side of said plane, substantially as described.

6. A vehicle spring comprising a plurality of reversely arranged cylinders, pistons and piston rods and joints connecting the cylinders and piston rods to their supports, one of said piston rods and joints having a communicative passage with the interior of one of the cylinders through which

fluid pressure may be introduced into said cylinder.

7. A vehicle spring comprising a weight lifting and supporting element, a plurality of independently mounted and oppositely operating resisting elements, the combined power of the latter elements being less than the former element, means for operating said elements by fluid pressure and means for maintaining a uniform pressure in said elements and in the source of fluid pressure supply, substantially as described.

8. A vehicle spring comprising a plurality of oppositely arranged and operating cylinders and pistons, an air inlet valve to admit air in one of the cylinders upon one side of its piston and in another of said cylinders upon the relatively opposite side of its piston, and outlet valves to discharge air from said cylinders, said outlet valves being located with relation to the pistons to be uncovered thereby and discharge the air whenever the pressure in the cylinders exceeds a normal and predetermined pressure, and connections between said inlet and outlet valves and a source of fluid pressure supply, substantially as described.

9. A vehicle spring comprising a cylinder, a piston working therein, a piston rod provided with an air passage to admit air upon one side of the piston, connections between the piston rod and a source of fluid pressure supply, a by-pass valve for discharging air from the cylinder and a flexible connection between said by-pass valve and the source of fluid pressure supply, substantially as described.

In testimony whereof I affix my signature, in presence of two witnesses.

ALBERT F. ROCKWELL.

Witnesses:
D. W. PAGE,
T. HART ANDERSON.