I. COWLES & E. H. MacDOWELL.

PNEUMATIC CUSHIONING DEVICE.

APPLICATION FILED OCT. 23, 1909.

1,002,822. Patented Sept. 12, 1911.

3 SHEETS—SHEET 1.

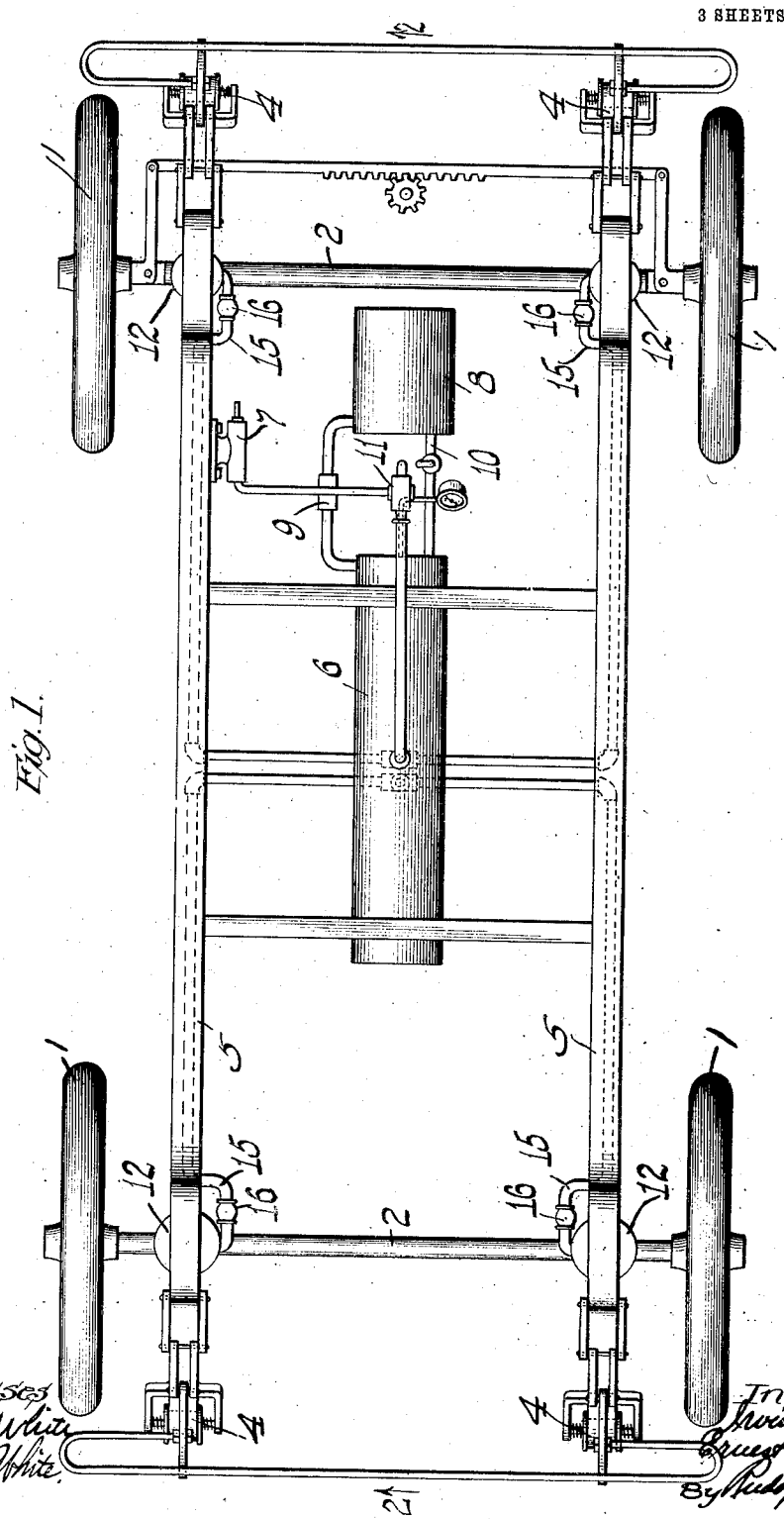

Fig. 1.

Witnesses
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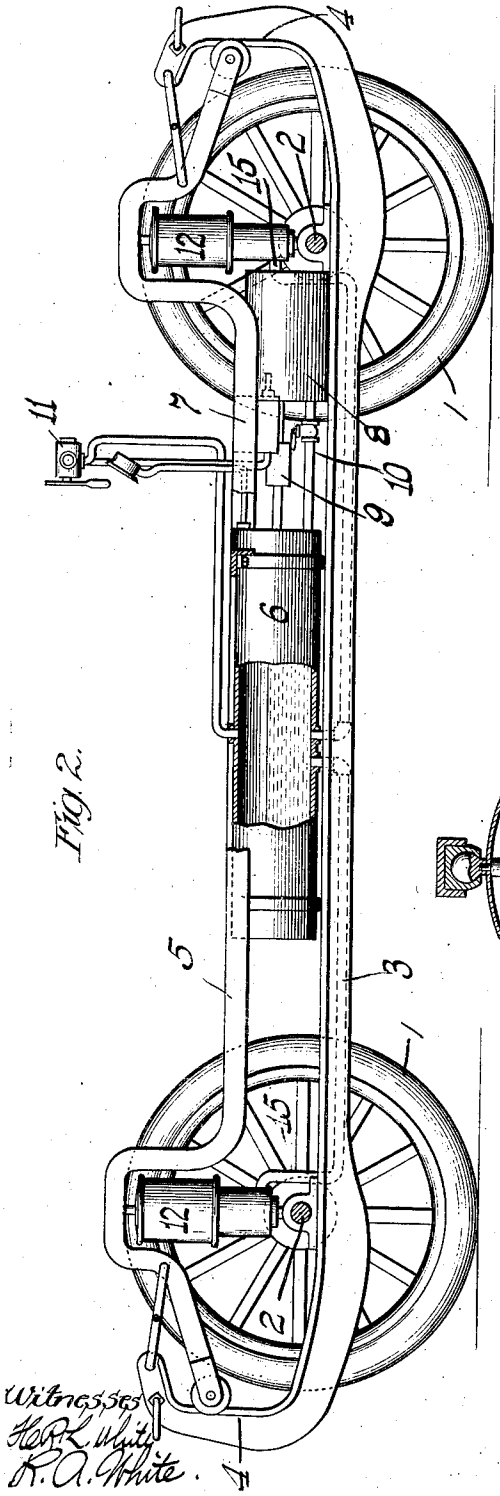

Fig. 2.

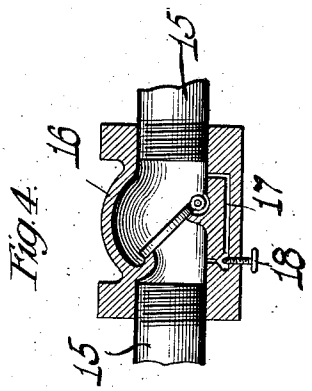

Fig. 4.

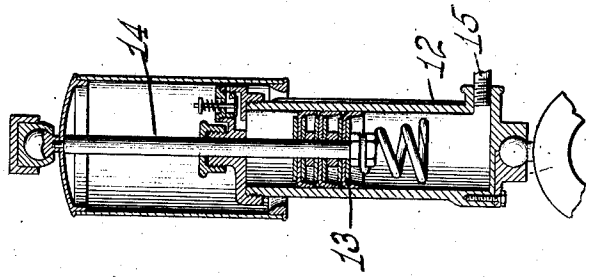

Fig. 3.

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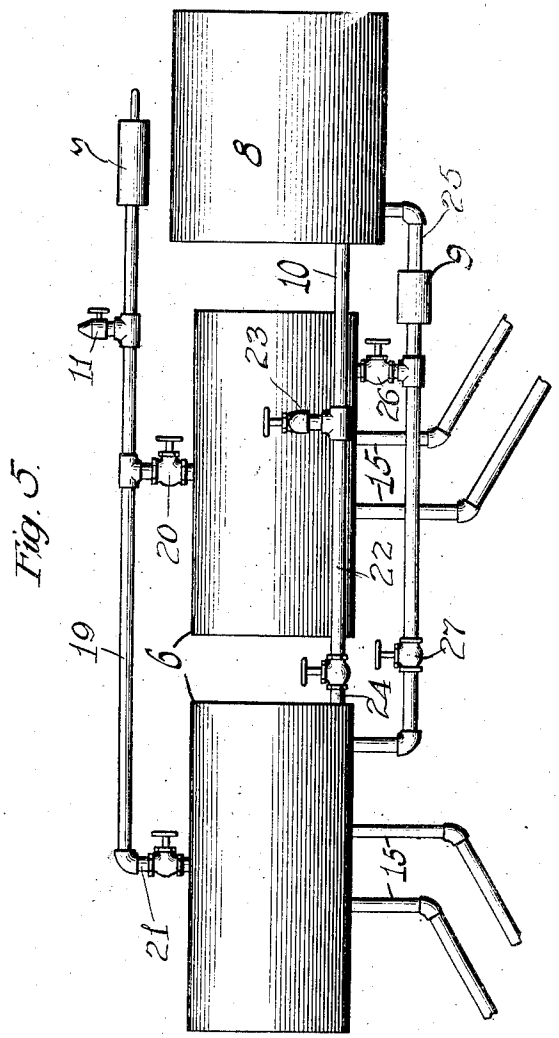

Fig. 5.

Witnesses
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UNITED STATES PATENT OFFICE.

IRVING COWLES AND ERNEST H. MACDOWELL, OF CHICAGO, ILLINOIS.

PNEUMATIC CUSHIONING DEVICE.

1,002,822. Specification of Letters Patent. Patented Sept. 12, 1911.

Application filed October 23, 1909. Serial No. 524,283.

To all whom it may concern:

Be it known that we, IRVING COWLES and ERNEST H. MACDOWELL, citizens of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Pneumatic Cushioning Devices; and we 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 a novel construction in cushioning means for interposition between two relatively movable bodies, the object being to provide simple, and efficient means for the prevention of transmission of sudden jar from one body to the other, and to provide a simple method for determining the degree of cushioning effect produced, and consists in the features of construction and combinations of parts of the apparatus and in the several steps of the method hereinafter fully described and claimed.

In the accompanying drawings illustrating a suitable embodiment of apparatus for carrying out our invention: Figure —1— is a plan view of the running gear and body-supporting frame of a vehicle equipped with cushioning means constructed in accordance with our invention, the vehicle body being omitted from illustration. Fig. —2— is a central vertical section of the same on the line 2—2 of Fig. —1—. Fig. —3— is a central vertical section of one of the cylinders employed. Fig. —4— is a detail sectional view of a check-valve employed. Fig. —5— is a fragmentary detail side elevation of another embodiment of our apparatus.

Our invention is particularly adapted for vehicles of all kinds but may be adapted for interposition between relatively movable bodies of all kinds requiring a cushion, and has for its object to provide means in the manner as hereinafter set forth for adjusting the resiliency of the cushion.

The present invention may be described as constituting a further development of that forming subject of a companion application filed September 13, 1909, Serial No. 517482, the matter herein described and claimed being partially disclosed in the said companion application but not claimed therein.

The present invention relates particularly to and has for its essential object the provision of means whereby the resiliency of the cushion may be changed and varied to suit the requirements of the vehicle to which it is applied and to this end we make use of well-known physical laws.

Pleasure or passenger vehicles are equipped usually with springs which are relatively soft and very resilient, it being generally true of this class of vehicles that the weight of the vehicle body greatly exceeds the maximum load, while in freight carrying vehicles the maximum load greatly exceeds the weight of the vehicle body. Consequently in the pleasure vehicle the difference between minimum and maximum loads on the springs or cushions is relatively small in proportion to the minimum load while in the freight carrier it is relatively very great. In the one case the comfort and ease of the passengers is the main consideration while in the other it is only the safety of the merchandise being transported. Therefore the springs or cushions of such vehicles are intended mainly to prevent transmission of destructive jars either to the merchandise or to the running gear.

The degree of the cushioning effect obtained is dependent entirely upon the distance the load moves from its normal position by the jar to the point at which such jar is neutralized by the resistance of the cushion. Where the stroke is long and the resistance gradually increased, the jar is felt to a less degree than where the stroke is relatively short and the increase in resistance is correspondingly sudden.

The regulation of the rapidity of increase of resistance in the cushion constitutes the essence of this invention and its accomplishment in a simple and efficient manner its essential object.

In carrying out our present invention we employ substantially the same devices as are shown and described in our companion application above mentioned together with such additional apparatus as is necessary to enable us to successfully attain the object above stated.

The running gear of the vehicle consists of wheels —1—, axles —2— and the side bars —3— to which the axles are secured, the said side bars being equipped at their ends with vertical projections —4— constituting guide rails between which the side bars —5— of the vehicle body are verti-

cally movable, said projections preventing relative longitudinal movement between the body and the running gear. The said side bars —3— and axles —2— constitute the running gear frame while the bars —5— support the vehicle body and we will therefore hereinafter refer to these parts as the "running gear frame" and "body frame" respectively. The construction shown is intended only to illustrate embodiments of these parts of a vehicle suited to our purpose but not necessarily the only examples of construction and relative arrangement suited to our needs.

Supported on the body frame is a tank or reservoir —6— for fluid under pressure, it being essential to the carrying out of our invention that said tank or reservoir be made of metal or other suitable inflexible material and of sufficient strength to resist a relatively very high pressure. The said tank —6— is connected with the delivery end of an air compressor —7— operable either by hand or power, and with a tank or reservoir —8— for a suitable liquid such as oil, the last-named connection including a pump —9— for transferring liquid from the reservoir —8— to the tank —6— and a valve-controlled pipe —10— for discharging liquid from the tank —6— to the reservoir —8—, the pump —9— being either hand or power actuated. The air pump connection includes a blow-off controlled by the valve —11— for relieving the pressure in the tank —6—.

Interposed between the running gear frame and the body frame is a plurality of cylinders —12— which preferably are supported on the running gear frame and in which pistons —13— are reciprocally movable, the piston rods —14— being secured to the body frame. The particular points of connection and the specific manner of effecting such connections of cylinders and piston rods with the respective frames is not material to the present invention except that they shall be suitable to meet requirements. Each of the cylinders —12— is connected at one end with the tank —6— by means of a pipe —15— in which a check-valve —16— is interposed which will permit flow of fluid from the cylinder to the tank but will prevent its flow in the opposite direction. A by-pass duct —17— is provided around each check-valve and is controlled by a suitable hand operated valve —18— by which it may be partly choked to retard flow from the tank —6— to the cylinder to the requisite extent required for the proper carrying out of the invention. The cylinders —12— with the pistons —13— represent a suitable embodiment of fluid pressure chambers of varying capacity having inflexible walls which are necessary to the proper carrying out of the invention. The movements of the piston in the cylinder cause a variation in capacity of the pressure chamber thereof which is connected with the tank —6— and must therefore be accompanied by influx or discharge of fluid. The upper or other chamber of the cylinder also constitutes a fluid pressure chamber which performs a function as fully described in our companion application. The said function does not, however, affect the present invention and particular description thereof and the means for its accomplishment will therefore be omitted herefrom. The fluid contained in the pressure chambers of the cylinders supports the vehicle body and contents by means of the piston —13— as will be obvious. The pipes —15— connect with the tank —6— at or adjacent the lowest point therein and are adapted to conduct only the liquid contents of the said tank —6— and of the cylinders —12— from each to the other.

It is well known that liquids are relatively incompressible, and, therefore, inelastic while gases are extremely elastic and may be compressed to a very great extent to reduce the volume of space occupied thereby. In our device we take advantage of the elasticity of air to provide a resilient cushion and employ liquid as the vehicle for transmission of the air pressure in the tank —6— to the different cylinders and pistons therein to support the load. The air in the tank, therefore, actually supports the vehicle body, and such air must necessarily be under the requisite pressure to sustain such load. The volume of space occupied by the air cushion in proportion to the cross-sectional area of the pressure chambers of the cylinders, will, independently of the air pressure, determine the resiliency or elasticity of the cushion. That is to say, an air cushion under pressure of 100 lbs. to the sq. in. occupying a cubic foot of space will be more resilient and elastic than an air cushion under the same pressure but occupying only one-half the volume of space for the reason that each cu. in. of contraction of space occupied will increase the air pressure under the last-named condition to a greater extent than in the first-named and consequently the pressure under the last-named condition would be increased to the point necessary to neutralize the momentary increase in load due to a jar by a less displacement of liquid from the cylinders than would be necessary under the first-named condition to effect this result. In other words the supporting power of the cushions would be the same in both instances but the power of resisting impact would be greater where the volume of air is less. Thus if the piston area in each cylinder is twenty-five square inches, or a total of one

hundred square inches in the four and the air pressure in the tank —6— is one hundred lbs. to the square inch, the supporting power of the cushion would be ten thousand lbs. regardless of the volume of space occupied by the air cushion. If the space occupied by the air cushion were one thousand cubic inches then a simultaneous downward movement of all pistons a distance of one inch would cause a contraction of only ten per cent. of the space occupied by the air and a corresponding increase in pressure would result, but if the volume of space occupied is only 500 cu. in. then the contraction resulting from the aforesaid movement of all pistons would be twenty per cent. and the increase in pressure correspondingly greater. Therefore, the increase in resistance to displacement of the liquid in the cylinders would be more rapid under the last-named condition than under the first-named.

To attain the best results the supporting power of the spring or cushion must not greatly exceed the load else the primary resistance of the spring or cushion would defeat its object by too great rigidity of the support afforded thereby. On the other hand too great elasticity of the spring or cushion or too little would result either in the accumulation of resistance too slowly or too rapidly thereby either rendering possible the complete displacement of all liquid in the cylinders and the pounding of the pistons on the cylinder heads or causing a jerky stop. Therefore the cushion should be primarily adjusted to substantially balance the load and the stiffness of the cushion regulated to a degree to insure the accumulation of the maximum resistance requisite to neutralize the heaviest jar likely to be encountered before the pistons can approach dangerously near the downward limits of their movement.

The first condition is easily regulated by adjusting the air pressure which may be effected either by operating the compressor —7— to effect an increase, or operating the blow-off —11— to effect decrease. The volume of space occupied by the air cushion is regulated either by operating the pump —9— to deliver into the tank —6— or by operating the valve in pipe —10— to permit escape of some of that contained in the said tank. Either of the last-named operations would necessarily cause variation in the air pressure and in effecting adjustment it is preferable to first adjust the volume of space to be occupied by the air cushion and to subsequently adjust the pressure.

Any suitable means for reading the level of liquid in the tank —6— may be provided and likewise a pressure gage for reading the air pressure.

The small by-pass ducts around the check-valves prevent the return of displaced liquid to the cylinders as rapidly as it leaves them and thus cause a slow and gradual reaction and elevation after sudden depression.

In heavy trucks the rear wheels usually carry a greater load than the front and in adapting our invention to this class of vehicles the cylinders supporting the greater load may be of greater diameter or the stroke of the piston may be increased or both so as to proportion the cushioning effect to the load upon different parts of the vehicle.

While we have shown and described all cylinders as being connected with a single tank —6— it will be apparent that this particular arrangement is capable of variation to suit widely different requirements, the appartus being intended to be varied to suit its adaptation to all purposes. Thus as shown in Fig. —5— two of said tanks —6— may be provided, one thereof being connected with the cylinders supporting the rear end portion of the body and the other with those supporting the forward end portion. Each of said tanks may be separately connected with the source of supply of air as by the pipe —19— and the valve controlled branches —20— and —21—. Said tanks —6— are also separately connected with the reservoir —8— by means of the pipe —22— and its valve-controlled branches —23— and —24— and similarly connected in the other direction by means of the pipe —25— in which the pump —9— is interposed, the last-named connections being controlled by means of the valves —26— and —27—. This arrangement may be further modified to meet certain conditions but it is preferable to employ as few valves as possible and maintain the apparatus as simple as is consistent with its adaptation to any given purpose.

We claim as our invention:

1. In a pneumatic spring device, the combination with fluid pressure cushioning devices interposed between two relatively movable members, and a reservoir connected with said devices, an air space in said reservoir containing air under pressure, a liquid in said reservoir partly filling the latter and constituting the vehicle for communicating the pressure in said reservoir to said fluid pressure cushioning devices, of a tank containing a liquid supply, and means communicating with said tank and reservoir for supplying liquid from the tank to the reservoir and for exhausting liquid from the latter into the tank thereby increasing and decreasing the volume of liquid within the reservoir to vary the resiliency of the cushion.

2. In a pneumatic spring device, the combination with fluid pressure cushioning devices interposed between two relatively movable members, and a reservoir connected with said devices, an air space in said reservoir

containing air under pressure, and a liquid in said reservoir partly filling the latter and constituting the vehicle for communicating the pressure in said reservoir to said fluid pressure cushioning devices, of a compressor and an exhaust valve connected with said reservoir to vary the volume and pressure of air therein, a second reservoir for liquid, connections between the same and said first-named reservoir, a pump interposed in one of said connections and a valve interposed in the other thereof to respectively increase and decrease the volume of liquid in said first-named reservoir.

In testimony whereof we have signed our names in presence of two subscribing witnesses.

IRVING COWLES,
ERNEST H. MACDOWELL.

Witnesses:
RUDOLPH WM. LOTZ,
M. M. BOYLE.