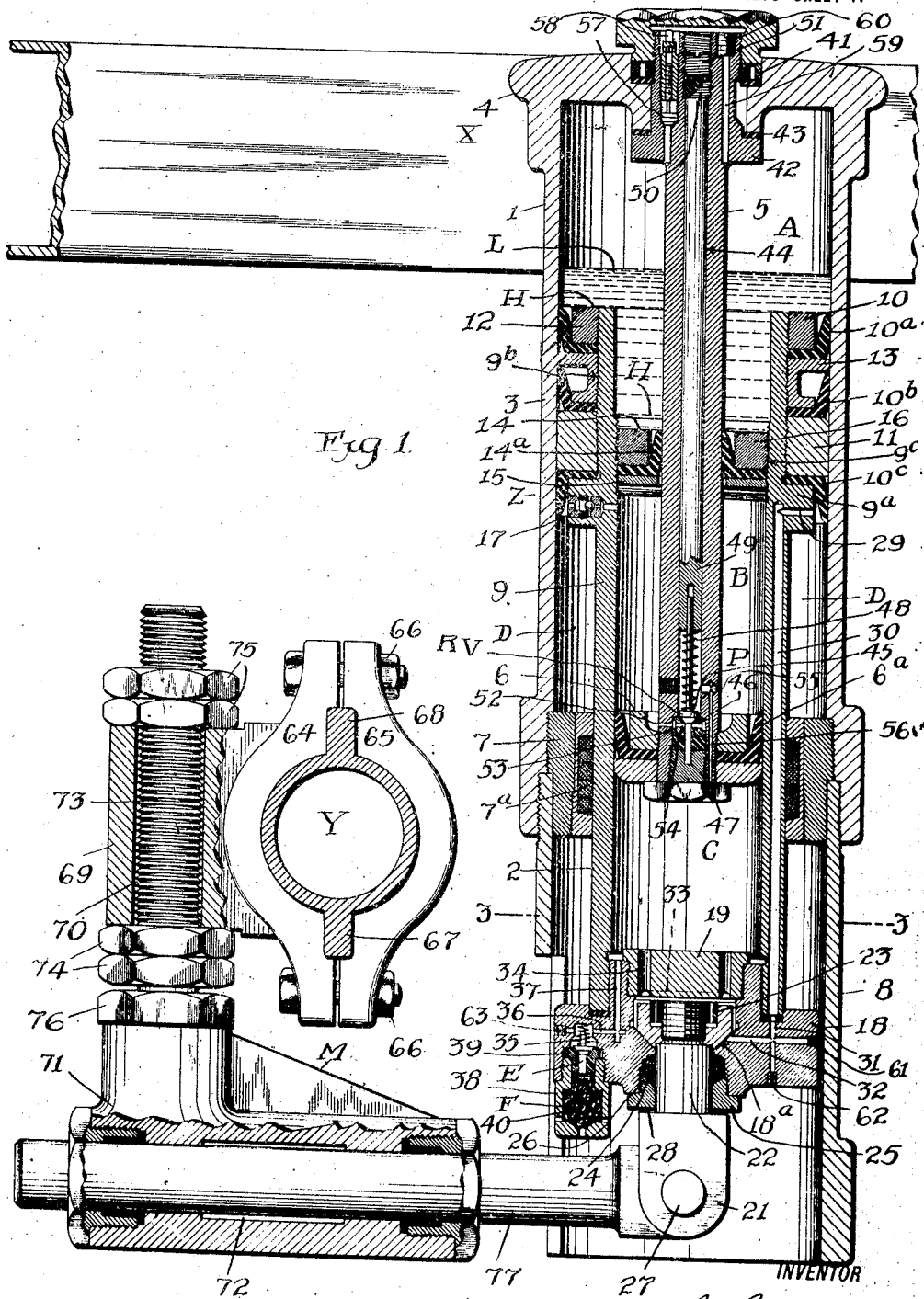


1,289,082.

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AIR CUSHIONING DEVICE.
APPLICATION FILED FEB. 6, 1917.

Patented Dec. 31, 1918.

3 SHEETS—SHEET 1.

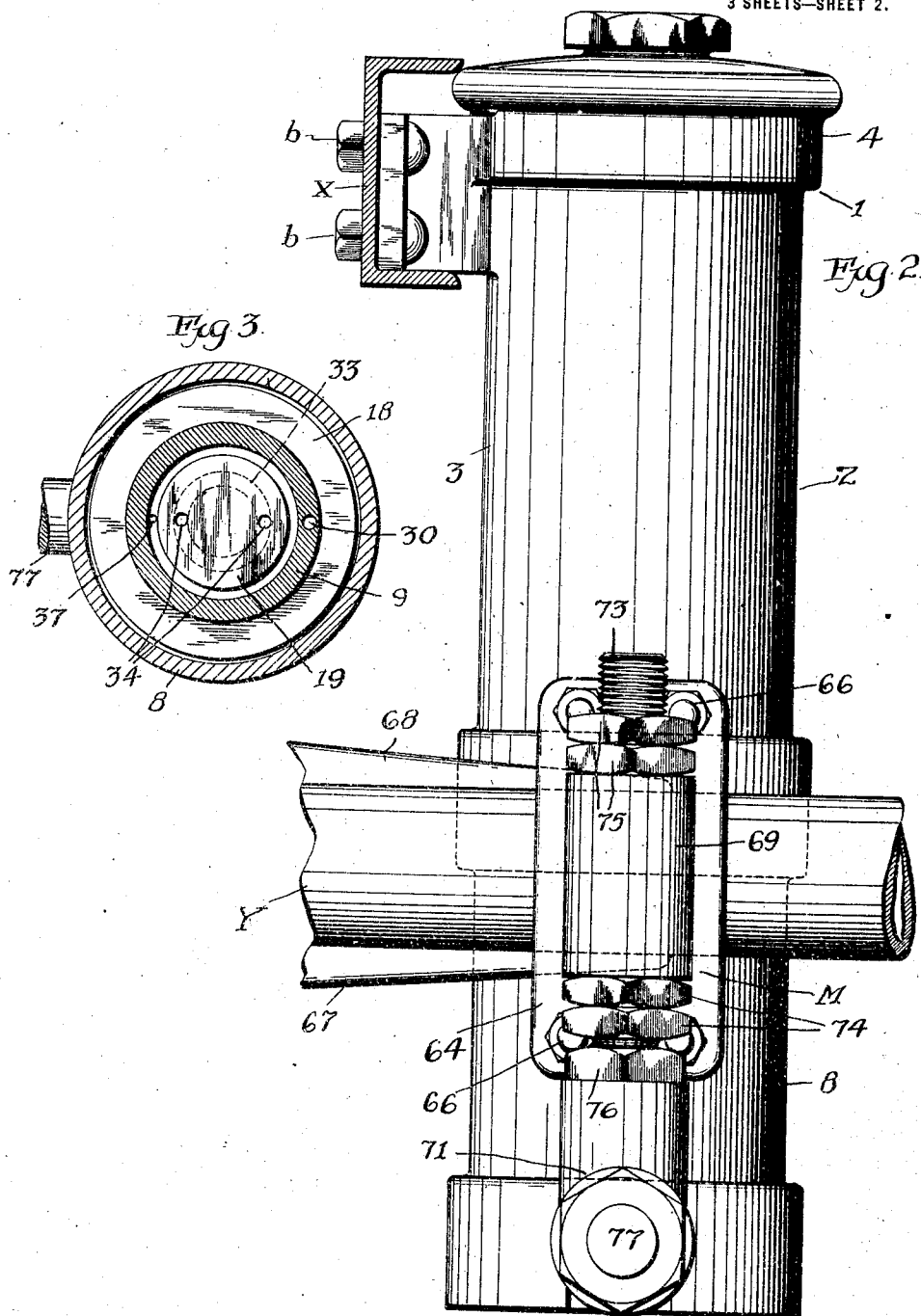


INVENTOR
A. M. Bangs
BY
Kiddell & Thurgood
HIS ATTORNEYS

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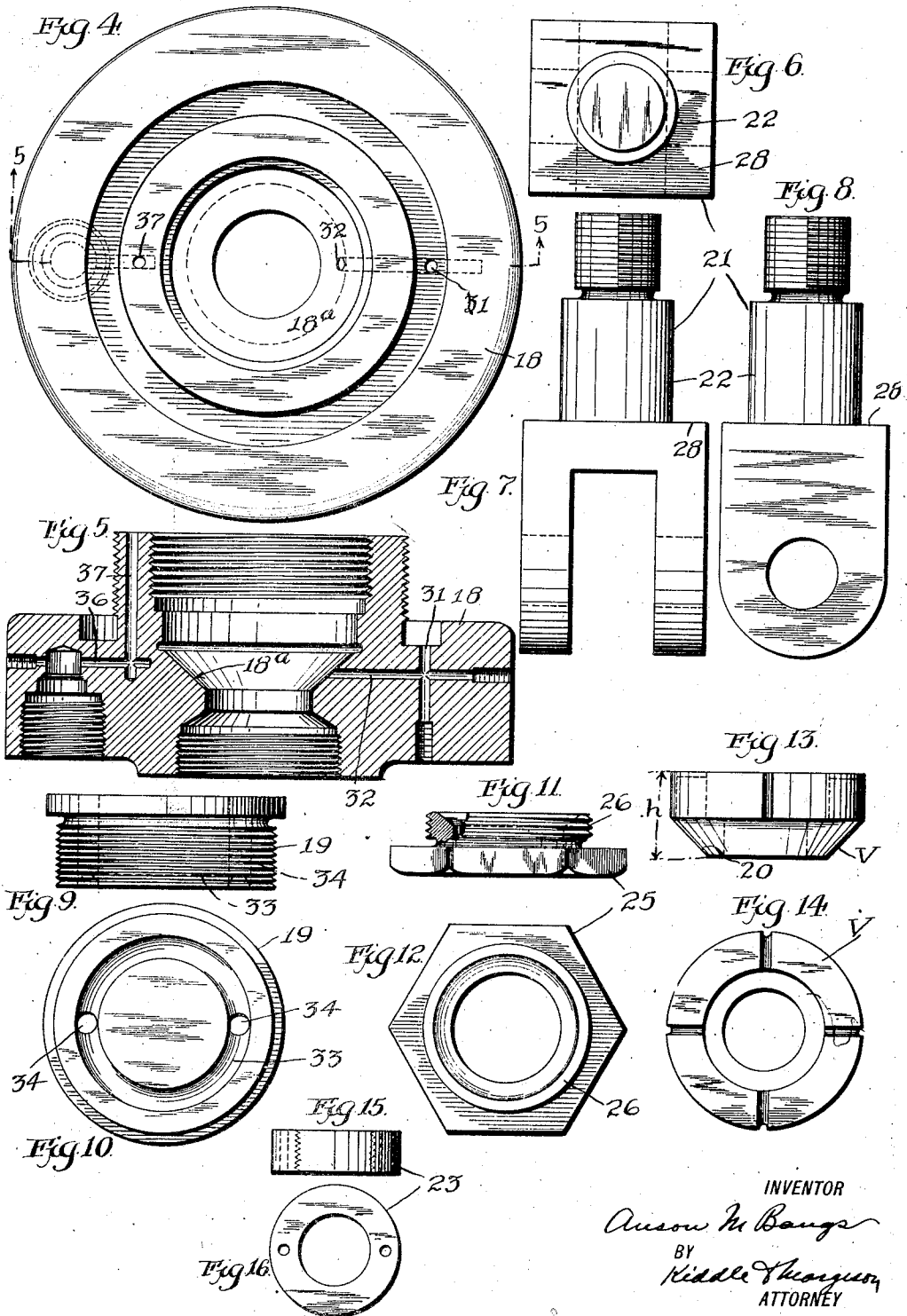
INVENTOR
Amos M. Bangs
BY
Kidd & Thompson
ATTORNEYS

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INVENTOR

Amos M. Bangs
BY
Kiddle & Thompson
ATTORNEY

UNITED STATES PATENT OFFICE.

ANSON M. BANGS, OF SOUTH BETHLEHEM, PENNSYLVANIA.

AIR-CUSHIONING DEVICE.

1,289,082.

Specification of Letters Patent.

Patented Dec. 31, 1918.

Application filed February 6, 1917. Serial No. 146,934.

To all whom it may concern:

Be it known that I, ANSON M. BANGS a citizen of the United States, and a resident of South Bethlehem, in the county of Easton and State of Pennsylvania, have invented certain new and useful Improvements in Air-Cushioning Devices, of which the following is a specification.

The invention relates to an air-cushioning device that is placed between the underframe and axle of a vehicle in order to lessen the shocks due to unevenness of the road over which the vehicle passes. If the air-cushioning device is secured at one end directly to the underframe of the vehicle and at the other end directly to the axle it can be employed to take at least some of the load from the usual springs which are located between the underframe and the axle.

As showing a specific embodiment of the invention reference is made to the drawings forming a part of this specification, in which drawings,

Figure 1 is a vertical view mostly in section showing the air-cushioning device connected to a portion of the underframe and to a portion of the axle. This is a sectional view looking toward the side of the vehicle.

Fig. 2 is a vertical elevation of the device shown in Fig. 1. This is a view looking toward the end of the vehicle.

Fig. 3 is a view taken as on the plane indicated by the line 3—3 of Fig. 1 looking downwardly.

Figs. 4 to 16 inclusive show details of different parts which are employed in the air-cushioning device shown in Figs. 1 and 2.

A portion of a longitudinally extending side member of a vehicle-body underframe is designated by X and a portion of a transversely extending axle of the vehicle is designated by Y. The air-cushioning device is designated by Z. The upper portion of a casing 1 of this device is connected to the underframe X in any suitable manner, as by bolts b. The lower end of a movable member 2 within this casing 1 is connected in any suitable manner to the axle Y as by means of connecting mechanism M. The casing 1 just referred to may be considered as a body member of the air-cushioning device Z because it is the part which is connected to the body—that is to the underframe of the body. This casing and the parts carried thereby may be arbitrarily referred to as the fixed member of the air-cushioning

device Z, in order to distinguish it from the member 2 and its associated parts which may be arbitrarily referred to as the movable member of the air-cushioning device. This member 2 may also be referred to as the axle member of the air-cushioning device because of its being connected to the axle.

The casing or fixed member 1 of the air-cushioning device Z comprises an outer tubular shell or outer cylinder 3, a cap or head 4, a piston-rod 5 which is carried by the head 4 and a pump-piston 6 that is on the lower end of the piston-rod 5. This fixed member is furthermore provided with a head 7 at the lower end of the outer tubular shell 3. This head may be referred to as the lower fixed head. The casing or shell has a depending protecting apron 8.

The movable member 2 of the air-cushioning device Z comprises an inner tubular shell or inner cylinder 9 which extends into the outer tubular shell or outer cylinder 3 above referred to. On the exterior of the upper end of this shell 9 there is provided what may be referred to as the outer portion 10 of a piston or head H. This outer portion of the piston or head has washers or packing rings 10^a, 10^b, 10^c. The shell 9 has upon it a surrounding ledge 9^a and the upper exterior portion of said shell is preferably threaded at 9^b whereby the packing ring 10^c can be clamped in place against the ledge 9^a by means of a ring or nut 11. Between the nut 11 and another ring or nut 12 the packing rings 10^a, 10^b are clamped, said packing rings being separated by a ring 13 which may also be a clamping-nut, if it is desired to make it so as to perform this function. On the interior of the upper end of this shell 9 there is provided what may be referred to as the inner portion 14 of a movable piston or head H. This inner portion of the piston or head has a washer or packing ring 14^a. This packing ring 14^a is clamped in place between an inner ledge 15 and a clamping ring or nut 16 having a screw-thread connection at 9^c with the shell 9. The outer portion 10, the upper end of the shell 9 and the inner portion 14 together constitute the piston or head H at the upper end of the movable member 2. The washers on the exterior of this head, to wit, the washers or packing rings 10^a, 10^b, 10^c, fit the interior of the outer tubular shell 3 and the washer or packing ring 14^a fits the exterior of the pis-

ton rod 5. On the top of this head H there is located a liquid, such as oil, that provides a liquid seal L between the head and the parts along which the head slides, to wit, between the head H and the outer shell 3 on the one hand and the head H and the piston rod 5 on the other hand. The air space above said head, to wit, the space A defined by the liquid L, the outer shell 3, the head 4 and the piston rod 5, may be referred to as the compression space and the parts which define this space may be considered to constitute the compression chamber of the air-cushioning device. The washers or packing rings 10^a and 10^b in the outer portion of the piston or head H fit the interior of the outer shell 3 and are arranged so as to oppose the flow of fluid—oil or air—from the space above the head downwardly past said packing rings. The packing ring 14^a fits the exterior of the piston rod 5 and is arranged so as to oppose the flow of fluid—oil or air—downwardly past said packing ring. This packing ring is constructed, however, so as to permit the flow of air upwardly along the piston rod past said packing ring whereby the air can flow into the compression chamber A, as will hereinafter appear. The pump piston 6 heretofore referred to is located below the inner portion 14 of the head H and within the inner shell 9. This pump piston is provided with a packing ring 6^a which engages and fits the inner portion of the shell 9. The shell 9, the inner portion 14, the pump piston 6 and the piston rod 5 constitute the essential elements of a pump P having a pump chamber B.

From the drawings it will be observed that the inner portion 14 of the piston or head H constitutes or provides the head of the pump P. As the inner portion 14 and the pump piston 6 approach each other the volume of the pump chamber is of course correspondingly decreased and air within the pump chamber—providing the pressure within the pump chamber B is greater than the pressure within the compression chamber A—will be forced from the pump chamber B past the packing ring 14^a into the compression chamber A. It will here be noted that the packing 14^a performs the function of a valve that allows the flow of air from the pump chamber B into the compression chamber A, but which prevents any back flow into the pump chamber. The lower fixed head 7 is provided with a packing ring 7^a having a sliding fit with the exterior of the inner shell 9. In the space D defined by the outer tubular shell 3, the outer portion 10 of the movable piston or head H, the shell 9 and the lower fixed head 7 there can be entrapped air. The parts defining this space may be considered as the parts which provide a rebound chamber for

the air-cushioning device. The packing ring 10^c fits the interior of the shell 3 and is arranged to oppose the flow of air upwardly from the rebound chamber D past the removable head H, to wit, past the outer portion 10 of said head. When the pressure within the pump chamber B reaches a certain upward limit it can then flow from the pump chamber past a normally closed check-valve 17 into the rebound chamber. This flow of air from the pump chamber B into the rebound chamber D takes place only when the volume within the rebound chamber and when the volume within the pump chamber are both decreasing. The function of this rebound chamber is to minimize any shock which may result from the movable member 2 of the air-cushioning device Z moving suddenly downward relative to the fixed member 1 of the air-cushioning device directly after the air within the compression chamber A has been compressed due to a preceding upward movement of the movable member. The air within the rebound chamber remains entrapped in this chamber during the entire downward movement of the movable member 2. However, the instant this member 2 starts to move upwardly, or immediately upon the axle of the vehicle and the under-frame approaching each other, there is a release of the air that is entrapped within the rebound chamber, said release being effected as by the opening of a valve V which takes place prior to or practically simultaneously with the upward movement of the movable member 2 relative to the fixed member 1. The construction whereby this is accomplished will be hereinafter more fully described.

At the lower end of the inner shell 9 there is secured in position a head 18, which head may be referred to as the lower movable head. A plan view and a cross-sectional elevation of this head is shown in Figs. 4 and 5 respectively, Fig. 5 being a vertical view taken as on the plane indicated by the line 5—5 of Fig. 4 looking in the direction of the arrows. In this head 18 there is screwed a nut 19, a vertical side elevational and a bottom view of this nut being clearly shown, respectively, in Figs. 9 and 10. This head 18 has a seat portion 18^a for the valve V, which valve is clearly shown in Figs. 13 and 14, the conical portion 20 of the valve V fitting against the seat portion 18^a. The height or depth h of the valve V is less than the distance from the seat to the bottom of the nut 19, when the latter is in place, so that the valve V can be raised a slight distance from the seat. The valve V is secured to a knuckle member 21, which provides a valve rod 22 for said valve, by means of a nut 23. This knuckle member is clearly shown in Figs. 6, 7 and 8 and the nut

23 which secures the valve in place is clearly shown in Figs. 15 and 16. A packing ring 24 surrounds the valve-rod 22 and is held in place by a nut 25 having a gland 26. The nut 25 is shown in Figs. 11 and 12. The knuckle member 21 is secured to the connecting mechanism M by means of a pin 27 and it will be observed that the knuckle member 21 has a shoulder 28 which when being raised engages the under side of the nut 25 that in turn is seated on the under side of the lower movable head 18. In other words, there is a direct thrust of the knuckle member 21 against the under side of the head 18.

It will be observed that when the knuckle member 21 is pressing against the under side of the nut 25 the valve V is away from its seat. When the valve V is away from its seat it allows the flow of air from the rebound chamber D through openings or passageways 29 and 30 in the inner shell 9 and openings or passageways 31 and 32 in the head 18 past the valve V, thence through openings or passageways 33 and 34 of the nut 19 into the space C which is provided by the head 18, shell 9 and pump piston 6. This space C is referred to as the storage space because air is stored therein. From this space air flows past the packing ring 6^a of the pump piston 6 into the pump chamber B and the packing ring 6^a can perform the function of a valve between the storage space C and the pump chamber B. During the time that the member 2 is being moved upwardly relative to the pump piston 6 the pressure of air in the storage space C is approximately the same as the pressure of air in the rebound chamber D, due to the fact that the valve V is off its seat and allows air to flow from the rebound chamber D into the storage space C. As the member 2 moves downwardly relative to the pump piston 6, that is, as the lower head 18 recedes from the pump piston 6, the valve V is closed and the storage space C is continuously increasing in volume. The air cannot escape from the storage space C to the atmosphere due to a check-valve E which closes the pasageway leading from a breather F to the storage space C. When, however, the pressure within the storage space C falls a small amount below atmospheric pressure the pressure of the outside air forces the check-valve E upward away from its seat against the pressure of a spring 35 and the air can flow through passageways 36 and 37 that are in the lower movable head 18 into the storage space C. The breather F comprises a small perforated casing 38 which is screwed into the head 18 and there is held in place by means of a gland or nut 39 any suitable filtering material, as 40, for instance mineral wool. The function of this breather F is to filter

the air thus eliminating any substances which are liable to cause wear between the moving parts. The protecting apron 8 depends from the outer shell 3 and the function of said apron is to prevent the accumulation of dirt on the inner shell 9.

Reverting to the piston rod 5 and the parts carried thereby it will be observed that this piston rod is secured in the cap or head 4 by means of a nut 41. In order to prevent a leakage of air from the interior of the compression chamber A between a shoulder 42 of the piston rod 5 and the cap or head 4 there is provided a packing ring 43. The piston rod 5 has a longitudinally extending bored opening 44 through which there is introduced a relief valve RV. The movable member 45 of this valve RV presses against a seat 46 which is at the end of a nut 47. The pressure of a spring 48 of this valve is regulated by the adjusting of a rod 49 which has a screw-threaded end 50. A lock-nut 51 serves to lock the rod 49 in its adjusted position. When the air within the pump chamber exceeds a certain pressure it can cause an opening of the valve RV whereby air can flow from the pump chamber B through openings or passageways 52, 53, 54 past the movable member 45 of the valve, through openings or passageways 55 and 56 into a storage space C. The valve RV which comprises said movable member 45 may be referred to as the relief valve between the pump chamber and the storage space. The check-valve 17 previously described may be referred to as the relief valve between the pump chamber B and the rebound chamber D. The relief valve RV between the pump chamber and the storage space is preferably set so that it will not open until after the relief valve 17 has been opened. In other words, when a certain pressure within the pump chamber is reached the relief valve 17 allows a flow of air from the pump chamber into the rebound chamber and when a sufficiently higher pressure in the pump chamber has been reached the relief valve RV allows a flow of air from the pump chamber into the storage space. The liquid L in the compression chamber A tends to seal any air pressed into the chamber A so as to prevent any substantial leakage of the air from said space. There may be times, however, when it is desired to supply air to the compression chamber. For example, when it is desired to supply air in the first instance before the device has been used or to replace air which may have leaked from the space from any cause whatever. In order to facilitate the initial insertion of air into this compression chamber A, as by means of an outside pump, there is provided a valve 57,—such as is inserted in tubes of pneumatic tires—that is constructed so as to per-

mit the flow of air into the compression chamber, but so as to normally prevent the flow of air from the compression chamber unless the rod 58 thereof is depressed. A passageway 59 is also provided through which the oil for the liquid seal L may be supplied. The passageway or opening 59 is normally closed by a plug 60.

Reverting for the instant to the openings or passageways 31, 32 and 36 in the lower movable head 18, it will be observed that the outer ends of these openings are also closed, respectively, by plugs 61, 62 and 63. The mechanism M which connects the movable axle Y and the movable member 2 comprises a pair of yoke members 64 and 65 which are clamped by means of bolts 66 upon the housing of the rear axle Y. Use may also be made of such members as webs 67 and 68 to prevent any turning of the clamps about the axle. The yoke member 64 has a projecting ear portion 69 having a vertically extending bored opening 70. To this ear 69 there is secured a socket member 71 which provides a horizontally extending bored opening 72 and this socket member is carried by a bolt 73 constituting a shank for said socket member 71. This bolt 73 extends through the opening 70 and is held in place by pairs of nuts 74 and 75. A nut 76 serves to lock the bolt 73 in place upon the socket member 71 whereby the bolt can serve as a shank for said member. Through the opening 72 there extends a rod 77 which is connected to the knuckle member 21 by the pin 27. This rod 77 is slidably mounted in the socket member 71, as will be manifest from an inspection of Fig. 1, and this permits any sliding which is necessitated by the axle Y moving in a horizontal direction relative to the underframe. The pairs of nuts 74 and 75 may be adjusted so that the socket member can have a slight angular movement relative to the axle. Of course any relative vertical movement between the axle Y and the underframe X of the vehicle will effect, due to the connections described, a vertical movement of the movable member 2 of the air cushioning device Z relative to the fixed member 1 of said air cushioning device.

It will be observed that any upward movement or approach of the member 2 relative to the fixed member 1 will cause a decrease in volume of the compression chamber and also in the storage space and that it will cause an increase in volume in the pump chamber and in the rebound chamber. During this time the air is consequently being compressed in the chamber A and air can also flow from the storage space into the pump chamber, provided the pressure of air in the storage space is then greater than the pressure within the pump chamber. Also during this same period the rebound chamber D is practically ineffective because

the air is free to flow from the rebound chamber into the storage space as the valve V is then open. When, however, the movable or axle member 2 is being moved away from the relatively fixed member of the air cushioning device the volume of the compression chamber A is increasing and the air therein is expanding, the volume of the pump chamber B is decreasing and air will flow from the pump chamber B into the compression chamber A when the pressure of air in the pump chamber exceeds that in the compression chamber, the volume of the storage space C is increasing and external air can be sucked into said space past the check-valve E providing the air in said storage space falls below the pressure of the external air, and the volume of the rebound chamber D is decreasing whereby the air entrapped in said chamber—due to the valve V then being closed—can serve to absorb any recoil resulting from the tendency to expand the air which is in the compression chamber.

From what has previously been stated it will be observed that the air within the rebound chamber is released by the valve V being opened immediately upon the approach of the axle Y and underframe X. The air within the pump chamber cannot be compressed beyond a certain amount—providing the pressure within the rebound chamber D is less than that in the pump chamber B—because of the relief valve 17 which will under those conditions permit a flow from the pump chamber B into the rebound chamber D, when a predetermined pressure within the pump chamber has been reached. Should, however, the pressure within the pump chamber and the rebound chamber exceed said predetermined amount and should the air within the pump chamber be compressed to a still higher pressure than a second relief valve RV may be provided to permit a flow of air from the pump chamber B into the storage space C. It will therefore be seen that under no conditions can the pressure within the pump chamber exceed a certain amount, due to the relief valves 17 and RV. In some forms of the apparatus it may be practicable to eliminate one or both of these relief valves but the nicety of regulation of the pressures would be correspondingly lessened.

The improvements herein set forth are not limited to the precise construction and arrangement shown and described for they may be embodied in various forms and modifications without departing from the spirit and scope of the invention.

What I claim and desire to secure by Letters Patent of the United States is:

1. An air-cushioning device of the class described comprising in combination a body member and an axle member constructed so

as to provide a compression chamber, a pump for supplying air to said compression chamber when the space within said compression chamber is increasing in volume, and a rebound chamber in which the space is simultaneously decreasing in volume, said device being constructed so as to provide a passageway leading from the pump to the rebound chamber and also having a relief valve normally closing said passageway.

2. An air-cushioning device of the class described comprising in combination a fixed member and a movable member constructed so as to provide a compression chamber, a pump for forcing air into the compression chamber, and a rebound chamber, the construction also being such that when the pressure within the pump exceeds a certain amount air can escape through the shell of the pump into the rebound chamber past a relief valve on the shell.

3. An air-cushioning device of the class described comprising in combination a body member, an axle member, which body and axle members are constructed so that they provide between them a compression chamber, a pump for forcing air into said compression chamber, a rebound chamber, and means for permitting the escape of air from the rebound chamber prior to or simultaneously with the decreasing in volume of the compression chamber.

4. An air-cushioning device of the class described comprising in combination a body member having an outer shell and a piston rod carried thereby having at the lower end thereof a pump piston, an axle member slidable in said outer shell, said axle member comprising an inner shell having at the upper end thereof inner and outer head portions, the outer head portion of which engages the inner wall of said outer shell and the inner head portion of which engages the piston rod, there being a slidable engagement between the inner part of the inner shell and said pump piston, a washer or packing ring in said inner head portion which permits a flow from the pump chamber that is between said pump piston and said inner head portion into a compression chamber that is within said outer shell and above the head which comprises said inner and outer head portions, and packing rings in said outer head portion which oppose the flow of fluid from said compression chamber.

5. An air-cushioning device of the class described comprising in combination a body member having an outer shell, a piston rod with a pump piston carried thereby, an axle member having an inner shell, and inner and outer portions of a movable head at the upper end of said inner shell, which outer head portion is provided with packing rings that engage said outer shell and which inner head portion is provided with a packing

ring that engages said piston rod, said outer shell also having a fixed head which extends to the inner shell, there being provided, in the space between the outer shell, the piston rod and the movable head, a compression chamber, and within the inner shell and between the inner portion of the movable head and pump piston a pump chamber, there also being provided, in the space which is defined by the inner and outer shells, the outer portion of the movable head and the fixed head, a rebound chamber.

6. An air-cushioning device of the class described comprising in combination a body member having an outer shell, a piston rod with a pump piston carried thereby, an axle member having an inner shell, and inner and outer portions of a movable head at the upper end of said inner shell, which outer head portion is provided with packing rings that engage said outer shell and which inner head portion is provided with a packing ring that engages said piston rod, said outer shell also having a fixed head which extends to the inner shell, there being provided, in the space between the outer shell, the piston rod and the movable head, a compression chamber, and within the inner shell and between the inner portion of the movable head and pump piston, a pump chamber, there also being provided, in the space which is defined by the inner and outer shells, the outer portion of the movable head and the fixed head, a rebound chamber; said device comprising a valve construction between the pump chamber and the compression chamber which permits a flow of air from the pump chamber to the compression chamber, also a relief valve between the pump chamber and the rebound chamber to permit a flow of air from the pump chamber into the rebound chamber.

7. An air-cushioning device of the class described comprising in combination a body member having an outer shell, a piston rod with a pump piston carried thereby, an axle member having an inner shell, and inner and outer portions of a movable head at the upper end of said inner shell, which outer head portion is provided with packing rings that engage said outer shell and which inner head portion is provided with a packing ring that engages said piston rod, said outer shell also having a fixed head which extends to the inner shell, there being provided, in the space between the outer shell, the piston rod and the movable head, a compression chamber, and within the inner shell and between the inner portion of the movable head and pump piston, a pump chamber, there also being provided, in the space which is defined by the inner and outer shells, the outer portion of the movable head and the fixed head,

a rebound chamber, said device comprising a valve construction between the pump chamber and the compression chamber which permits a flow of air from the pump chamber to the compression chamber, a relief valve between the pump chamber and the rebound chamber to permit a flow of air from the pump chamber into the rebound chamber, and a second relief valve whereby when the pressure within the pump chamber and the rebound chamber exceeds a certain amount air can escape from one of said chambers.

8. An air-cushioning device of the class described comprising in combination an outer shell, a piston rod carried thereby, a pump piston at the lower end of said rod, a fixed head secured to the lower end of said outer shell, an inner shell which fits and slides in said fixed head, said inner shell having at the upper end thereof a movable head comprising an outer portion which fits and engages the outer shell and an inner portion which fits and slides along said rod, and a lower head secured to the lower end of said inner shell, the construction being such that there is provided a compression chamber within the outer casing above the upper movable head, a pump chamber which is defined by the inner portion of said movable head, the piston rod, the pump piston at the end of the rod and the inner shell portion, a rebound chamber which is defined by the inner shell, the outer portion of said movable head at the end of said shell, the outer shell and the fixed head carried by the outer shell, and a storage space which is defined by the pump piston at the end of the piston rod, the inner shell and the movable head secured to the lower end of said shell, there being a valve controlled passage way leading from the rebound chamber to the storage space which passageway is normally closed when air within the compression chamber is being expanded and which is open when the air within the compression chamber is being contracted.

9. An air-cushioning device of the class described comprising in combination an outer shell, a piston rod carried thereby, a pump piston at the lower end of said rod, a fixed head secured to the lower end of said outer shell, an inner shell which fits and slides in said fixed head, said inner shell having at the upper end thereof a movable head comprising an outer portion which fits and engages the outer shell and an inner portion which fits and slides along said rod, and a lower head secured to the lower end of said inner shell, there being provided a compression chamber within the outer casing above the upper movable head, a pump chamber which is defined by the inner por-

tion of said movable head, the piston rod, the pump piston at the end of the rod and the inner shell portion, a rebound chamber which is defined by the inner shell, the outer portion of said movable head at the end of said shell, the outer shell and the fixed head carried by the outer shell, and a storage space which is defined by the pump piston at the end of the piston rod, the inner shell and the movable head secured to the lower end of said shell, the construction being such that the pump forces air into the compression chamber only when the volume of the space within the compression chamber is increasing.

10. An air-cushioning device of the class described comprising in combination an outer shell, a piston rod carried thereby, a pump piston at the lower end of said rod, a fixed head secured to the lower end of said outer shell, an inner shell which fits and slides in said fixed head, said inner shell having at the upper end thereof a movable head comprising an outer portion which fits and engages the outer shell and an inner portion which fits and slides along said rod, and a lower head secured to the lower end of said inner shell, the construction being such that there is provided a compression chamber within the outer casing above the upper movable head, a pump chamber which is defined by the inner portion of said movable head, the piston rod, the pump piston at the end of the rod and the inner shell portion, a rebound chamber which is defined by the inner shell, the outer portion of said movable head at the end of said shell, the outer shell and the fixed head carried by the outer shell, and a storage space which is defined by the pump piston at the end of the piston rod, the inner shell and the movable head secured to the lower end of said shell, there being a valve controlled passageway leading from the rebound chamber to the storage space which passageway is normally closed when air within the compression chamber is being expanded and which is open when the air within the compression chamber is being contracted, there also being a valve controlled passage way leading from the exterior atmosphere to the storage space that permits the entrance of air into the storage space but which prevents the flow of air from said storage space to the atmosphere.

11. An air-cushioning device of the class described comprising in combination an outer shell, a piston rod carried thereby, a pump piston at the lower end of said rod, a fixed head secured to the lower end of said outer shell, an inner shell which fits and slides in said fixed head, said inner shell having at the upper end thereof a movable head comprising an outer portion which fits and engages the outer shell and an inner

portion which fits and slides along said rod, and a lower head secured to the lower end of said inner shell, the construction being such that there is provided a compression chamber within the outer casing above the upper movable head, a pump chamber which is defined by the inner portion of said movable head, the piston rod, the pump piston at the end of the rod and the inner shell portion, a rebound chamber which is defined by the inner shell, the outer portion of said movable head at the end of said shell, the outer shell and the fixed head carried by the outer shell, and a storage space which is defined by the pump piston at the end of the piston rod, the inner shell and the movable head secured to the lower end of said shell, there being a valve controlled passageway leading from the rebound chamber to the storage space which passageway is normally closed when air within the compression chamber is being expanded and which is open when the air within the compression chamber is being contracted, there also being a valve controlled passageway leading from the exterior atmosphere to the storage space that permits the entrance of air into the storage space but which prevents the flow of air from said storage space to the atmosphere and a valve controlled passageway leading from the pump chamber into the storage space whereby when the pressure within the pump chamber exceeds a certain amount air can escape from the pump chamber into the storage space.

12. An air-cushioning device of the class described comprising in combination an outer shell, a piston rod carried thereby, a pump piston at the lower end of said rod, a fixed head secured to the lower end of said outer shell, an inner shell which fits and slides in said fixed head, said inner shell having at the upper end thereof a movable head comprising an outer portion which fits and engages the outer shell and an inner portion which fits and slides along said rod, and a lower head secured to the lower end of said inner shell, the construction being such that there is provided a compression chamber within the outer casing above the upper movable head, a pump chamber which is defined by the inner portion of said movable head, the piston rod, the pump piston at the end of the rod and the inner shell portion, a rebound chamber which is defined by the inner shell, the outer portion of said movable head at the end of said shell, the outer shell and the fixed head carried by the outer shell, and a storage space which is defined by the pump piston at the end of the piston rod, the inner shell and the movable head secured to the lower end of said shell, there being a valve controlled passageway leading from the rebound chamber to the

storage space which passageway is normally closed when air within the compression chamber is being expanded and which is open when the air within the compression chamber is being contracted, there also being a valve controlled passageway leading from the exterior atmosphere to the storage space that permits the entrance of air into the storage space but which prevents the flow of air from said storage space to the atmosphere and a valve controlled passageway leading from the pump chamber into the storage space whereby when the pressure within the pump chamber exceeds a certain amount air can escape from the pump chamber into the storage space, the inner shell having a relief valve for permitting the flow of air from the pump chamber into the rebound chamber.

13. An air-cushioning device of the class described comprising in combination an outer shell, a piston rod carried thereby, a pump piston at the lower end of said rod, a fixed head secured to the lower end of said outer shell, an inner shell which fits and slides in said fixed head, said inner shell having at the upper end thereof a movable head comprising an outer portion which fits and slides along the interior of the outer shell and an inner portion which fits and slides along said rod, and a lower head secured to the lower end of said inner shell, the construction being such that there is provided a compression chamber within the outer casing above the upper movable head, a pump chamber which is defined by the inner portion of said movable head, the piston rod, the pump piston at the end of the rod and the inner shell portion, a rebound chamber which is defined by the inner shell, the outer portion of said movable head at the end of said shell, the outer shell and the fixed head carried by the outer shell, and a storage space which is defined by the pump piston at the end of the piston rod, the inner shell and the movable head secured to the lower end of said shell, there being a valve controlled passageway leading from the rebound chamber to the storage space which passageway is normally closed when air within the compression chamber is being expanded and which is open when the air within the compression chamber is being contracted, there also being a valve controlled passageway leading from the exterior atmosphere to the storage space that permits the entrance of air into the storage space but which prevents the flow of air from said storage space to the atmosphere and a passageway leading from the pump chamber into the storage space, which passageway is controlled by a relief valve constructed so that when the pressure within the pump chamber exceeds a certain amount

air can escape from the pump chamber into the storage space, the inner shell also having a relief valve for permitting the flow of air from the pump chamber into the rebound chamber.

14. On air-cushioning device of the class described comprising in combination a fixed member and a movable member which are constructed so as to provide a compression chamber, a pump for supplying air to said compression chamber, a rebound chamber in which air is compressed while being expanded in the compression chamber, and means for automatically permitting the escape of air from the rebound chamber during the time that the air within the compression chamber is being compressed.

15. An air-cushioning device of the class described comprising in combination a body member having an outer shell, a piston rod carried by said shell, a piston at the end of said rod, a fixed head carried by said outer shell, and a movable axle member comprising an inner shell having thereupon an upper movable head that engages the outer shell and said rod and a lower movable head, the exterior of said inner shell slidably engaging the fixed head and the inner portion of said inner shell slidably engaging the piston which is located below said upper movable head, the construction being such that there is a compression chamber within the outer shell and above the upper movable head, a rebound chamber below said movable head between the inner and outer shells the movable head and said fixed head, a pump chamber between the upper movable head and the piston, and a storage space between the piston and the lower movable head, the construction also being such that the pump forces air into the compression chamber when the volume within said chamber is increasing.

16. An air-cushioning device of the class described comprising in combination a body member having an outer shell, a piston rod carried by said shell, a piston at the end of said rod, a fixed head carried by said outer shell, and a movable axle member comprising an inner shell having thereupon an upper movable head that engages the outer shell and said rod and a lower movable head, the exterior of said inner shell slidably engaging the fixed head and the inner portion of said inner shell slidably engaging the piston which is located below said upper movable head, the construction being such that there is a compression chamber within the outer shell and above the upper movable head, a rebound chamber below said movable head between the inner and outer shells the movable head and said fixed head, a pump chamber between the upper movable head and the piston, and a storage space between the piston and the lower movable head, the construction

also being such that the pump forces air into the compression chamber when the volume within said chamber is increasing, said device having a valve controlled passageway which permits the flow of air from the rebound chamber into the storage space when the volume of the space within the compression chamber is decreasing.

17. The combination with an underframe and axle of a vehicle of an air-cushioning device comprising a body member connected to the underframe and a movable member connected to the axle, said body member comprising a connected outer shell and pump piston and also having a fixed head, said axle member or movable member comprising an inner shell having a movable head which fits said outer shell and the rod carrying said pump piston, said inner shell fitting the head of said outer shell, a cap or cover which is connected to the lower end of the inner shell and to the axle the construction being such that there is provided within the outer shell and above said head on the inner shell a compression chamber, between the under side of said last mentioned head and the pump piston, a pump chamber from which air is pumped into the compression chamber when the volume of the compression chamber is increasing, and between the under side of said head on the inner shell and the stationary head on the body member a rebound chamber, and means dependent upon the direction in which the axle member is moving relative to the body member for permitting the escape of air from the rebound chamber.

18. A device of the class described comprising in combination a compression chamber, a pump for forcing air into the compression chamber while air is being expanded in said compression chamber, a rebound chamber, and means for automatically releasing air entrapped in the rebound chamber prior to or at the commencement of the compressing of air in the compression chamber.

19. An air-cushioning device of the class described comprising in combination a compression chamber, a pump chamber, means for permitting air to flow from the pump chamber into the compression chamber, a rebound chamber, means for permitting air to flow from the pump chamber into the rebound chamber when the pressure within the pump chamber exceeds a certain amount, a storage chamber from which air is received into the pump, and means for permitting a flow of air from the rebound chamber into the storage chamber when the compression chamber is decreasing in volume.

20. An air-cushioning device of the class described comprising in combination a compression chamber, a pump for supplying air to the compression chamber, a rebound chamber, means for permitting a flow of air from

the pump into the rebound chamber, a storage chamber, means for permitting air when a sufficient pressure has been reached within the pump to flow into the storage chamber, and means for permitting air to flow from the rebound chamber into the storage chamber during the period when air is being compressed in the compression chamber.

21. An air-cushioning device of the class described comprising in combination an outer shell member and a cooperating piston member which provide between them a compression space, said members being constructed so that they also cooperate to provide a pump by which air is forced into the compression space, and a liquid seal through which air from the pump must pass on its way to the compression space.

22. An air-cushioning device of the class described comprising in combination an outer shell, an inner shell having a head slidable in said outer shell, said inner and outer shells carrying members which constitute a pump for forcing air into a compression chamber provided between said inner and outer shells, and liquid covering the upper end of said inner shell in a manner to seal the sliding joint between the head and the outer shell and in a manner to separate the pump from the compression chamber, the construction being such that the air from the pump passes through said liquid on its way to the compression chamber.

23. An air-cushioning device of the class described comprising in combination an outer shell having a cap carrying a piston rod upon the lower end of which there is a pump piston and at the lower end of said shell a head, an inner shell having at the upper end thereof an outer head which slidably engages the interior of the outer shell and an inner head which slidably engages said piston rod, a packing ring on said inner head and arranged to oppose the flow of fluid downwardly along said rod past said packing ring said packing ring being constructed so as to permit the flow of fluid from a pump chamber at one side of the packing ring upwardly into a compression chamber at the other side of the packing ring, a packing ring on said outer head and arranged to oppose the flow of fluid downwardly along the interior of said outer shell past said last-mentioned packing ring, a liquid seal covering said inner and outer heads, said inner shell slidably fitting the head on the outer shell, the space defined by the outer shell, the inner shell, the outer head on the inner shell and the head on the outer shell serving as a rebound chamber, the walls of the inner shell having a passageway therein for permitting a flow of air from the rebound chamber into a storage space that is also provided in the inner shell, and a valve adapted to be operatively connected to an

axle of the vehicle for permitting flow, when open, into the storage space from the rebound chamber.

24. An air-cushioning device of the class described comprising in combination a fixed member and a movable member which provide between them a compression chamber, a pump, a rebound chamber, and a storage chamber, which pump is constructed and arranged so as to receive air from the storage chamber, and so as to force air into the compression chamber, said device also having a valve controlled passageway for permitting a flow of air from the rebound chamber into the storage chamber.

25. An air-cushioning device of the class described comprising in combination a compression chamber, a pump chamber, a rebound chamber, and a storage chamber, said device having valve controlled means for permitting the flow of air from the pump chamber into the compression chamber when the compression chamber is expanding in volume and the pump chamber and the rebound chamber are contracting in volume, the construction of the device also being such that the pump chamber receives air from the storage chamber when the pump chamber is expanding in volume and the storage chamber is contracting in volume, the device also being provided with a passageway leading from the pump chamber to the storage chamber, which passageway is controlled by a relief valve.

26. An air-cushioning device of the class described comprising in combination a compression chamber, a pump that forces air into the compression chamber, a rebound chamber, and means for permitting air to escape from the pump into the rebound chamber when the air within the pump exceeds a certain pressure.

27. An air-cushioning device of the class described comprising in combination a fixed member and a movable member which provide a compression chamber, a pump for forcing air into the compression chamber when the compression chamber is increasing in volume, a rebound chamber which decreases in volume when the compression chamber is increasing in volume, and means for allowing air to escape from the rebound chamber when the compression chamber is decreasing in volume.

28. In combination an underframe, an axle and an air-cushioning device comprising a member secured to the underframe and a movable member connected to the axle by means comprising a yoke member which clamps the axle, a socket member which is connected to said yoke, and a rod slidably mounted in said socket member which rod is connected to said movable member.

29. An air-cushioning device comprising an inner member and an outer member mov-

able relative to each other which inner and outer members are constructed so as to provide the following: a compression chamber, a pump for forcing air into the compression chamber as the compression chamber is increasing in volume, a rebound chamber which decreases in volume as the compression chamber increases in volume, a storage space in which air is entrapped and from which it passes to the pump when the pump chamber is increasing in volume, and means for permitting air to flow from the rebound chamber when the rebound chamber is increasing in volume.

30. An air-cushioning device of the class described comprising in combination a compression chamber, a pump chamber, and a rebound chamber provided with valve controlled means which permits a flow of air from the rebound chamber during the period when the compression chamber is contracting in volume.

31. An air-cushioning device of the class described comprising in combination a compression chamber, a pump for forcing air into the compression chamber, a rebound chamber which expands in volume when the compression chamber is contracting in volume and vice versa, said device having a passageway in communication with the rebound chamber and which passageway is controlled by a valve that is closed when the rebound chamber is contracting in volume and that is open when the rebound chamber is expanding in volume.

32. A device of the class described comprising in combination a compression chamber, a pump for forcing air into the compression chamber when the compression chamber is expanding in volume, a rebound chamber which decreases in volume as the compression chamber expands in volume, a storage chamber in communication with the rebound chamber when the rebound chamber is increasing in volume, and a valve for closing this communication when the rebound chamber is decreasing in volume, the construction being such that the pump receives air from the storage chamber when the compression chamber is decreasing in volume.

33. A device of the class described comprising in combination a compression chamber, a pump for forcing air into the compression chamber as the compression chamber increases in volume, and a storage chamber from which the pump receives air when the compression chamber is decreasing in volume, said device being provided with a passageway leading from the pump chamber to the storage chamber and which passageway is controlled by a relief valve that permits a flow of air from the pump to the storage chamber when the pressure within the pump exceeds a predetermined amount.

34. A device of the class described comprising in combination a compression chamber, a pump which forces air into the compression chamber when the compression chamber is expanding in volume, a storage chamber, and a rebound chamber which increases in volume as the compression chamber decreases in volume and at which time the pump receives air from the storage chamber, said device being provided with a relief valve which permits a flow of air from the pump to the storage chamber when the pressure within the pump exceeds a predetermined amount.

35. A device of the class described comprising in combination a compression chamber, a pump for forcing air into the compression chamber, a rebound chamber which expands when the compression chamber contracts, and a storage chamber, said device being provided with a valve controlled passageway leading from the rebound chamber to the storage chamber which passageway is open when the compression chamber is decreasing in volume, said device also having a passageway controlled by a relief valve and which passageway leads from the pump to the storage chamber and allows the escape of air from the pump into the storage chamber when the pressure within the pump exceeds a predetermined amount.

This specification signed and witnessed this third day of Feb. A. D. 1917.

ANSON M. BANGS.

Signed in the presence of—

C. DANIEL FRIEBELY,
STOVER H. NICLOS.