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(54) Master cylinder mounting arrangement for vehicular use

(57) In order to suppress oscillation in both vertical and right-and-left directions of a master cylinder (M) during vehicle travel while enabling reduction in weight of the booster shell, a pair of tie rods (30) are provided which extend through the booster shell (1) and are fixed at the opposite ends to the body of the master cylinder and the front wall panel (W) of the vehicle compartment to form a rigid rectangular frame together with the cylinder body and the wall panel which lies in an axial plane inclined at an angle to the horizontal.

FIG. 2

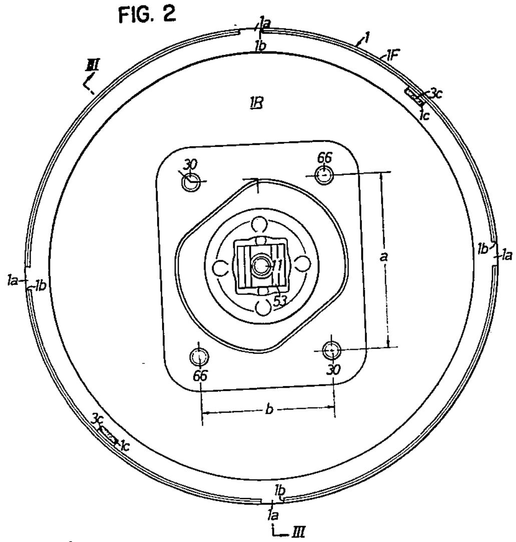

FIG. 3

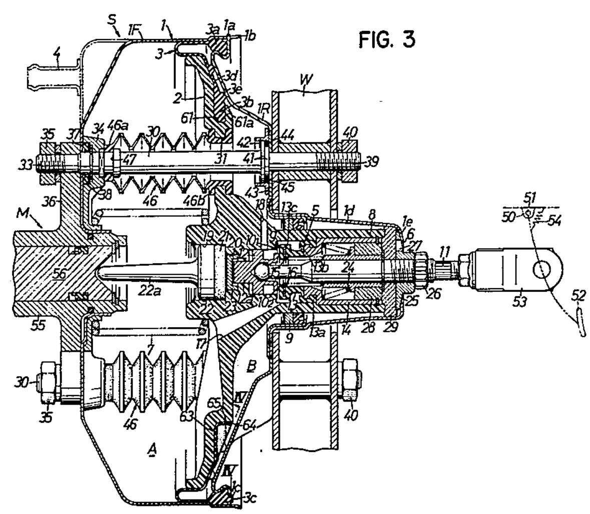

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FIG. I

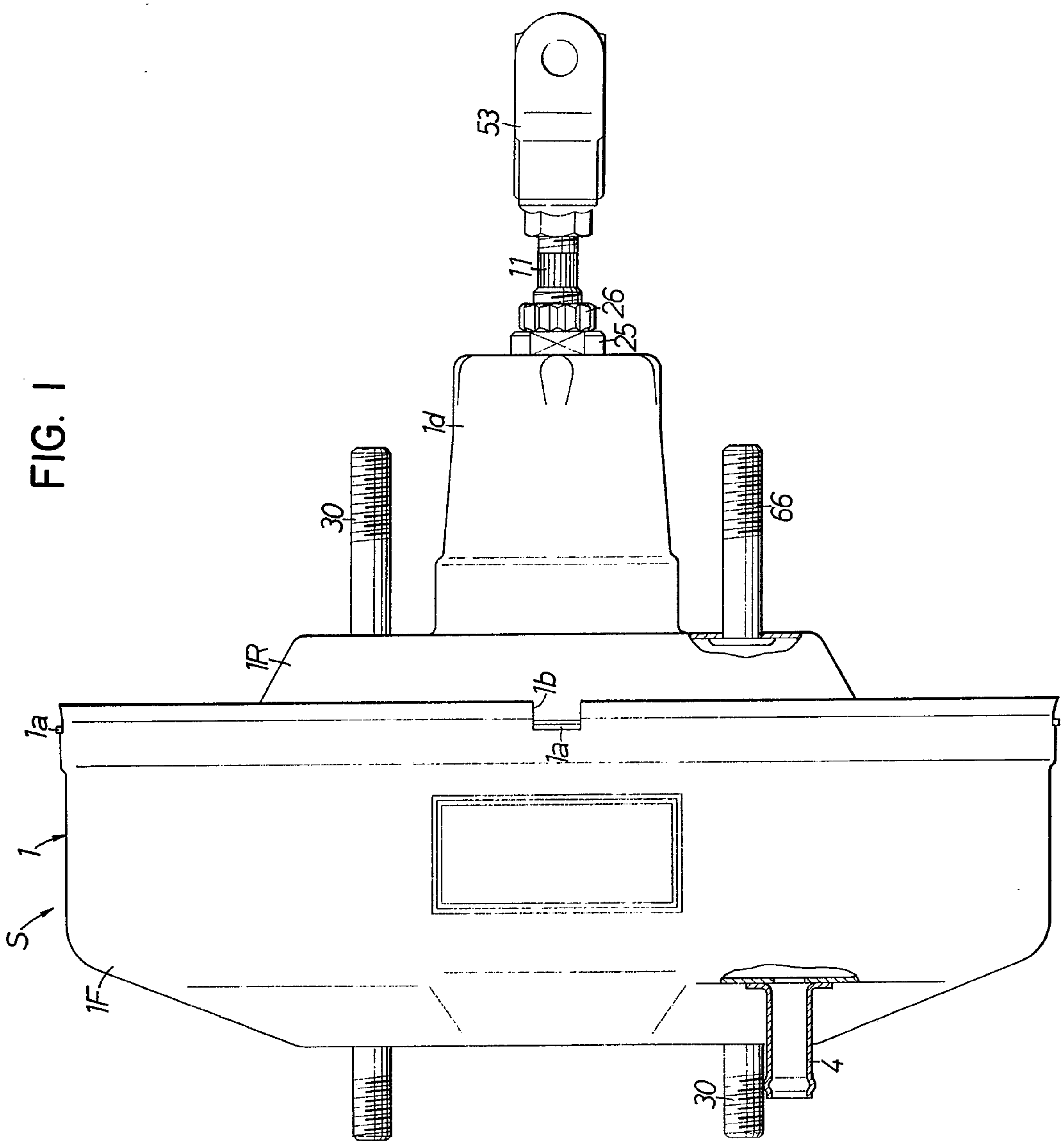

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FIG. 2

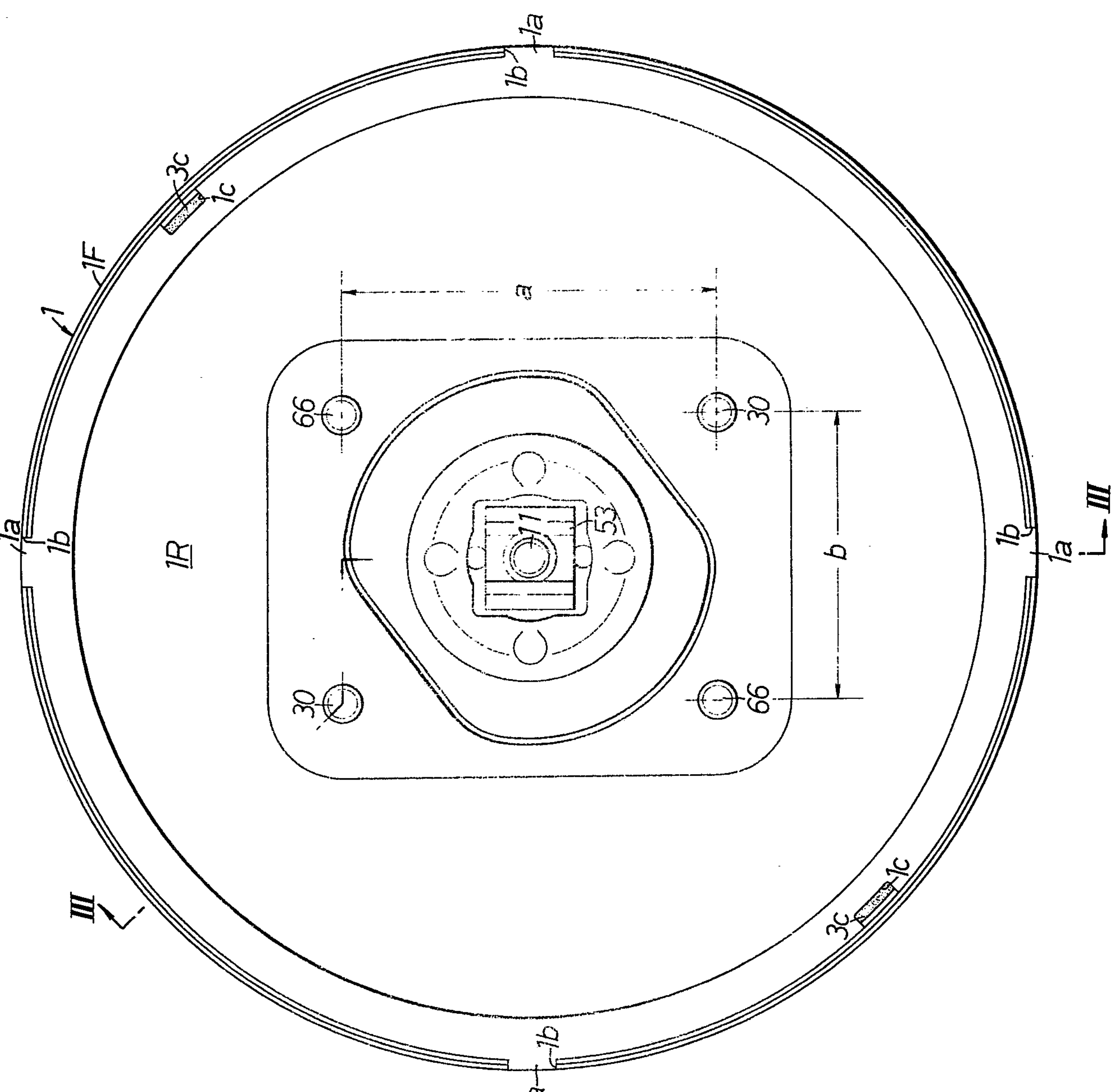

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FIG. 3

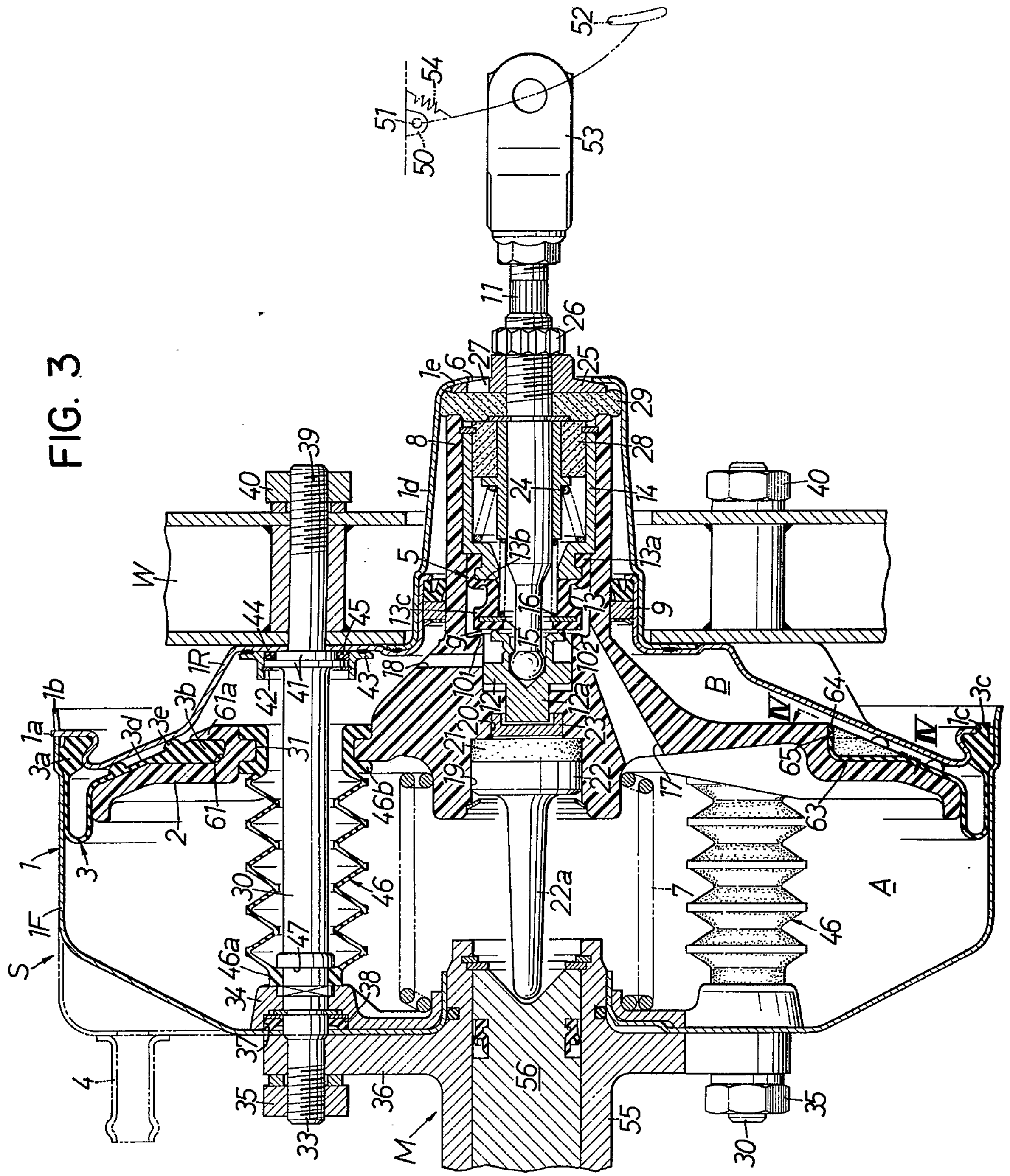


FIG. 4

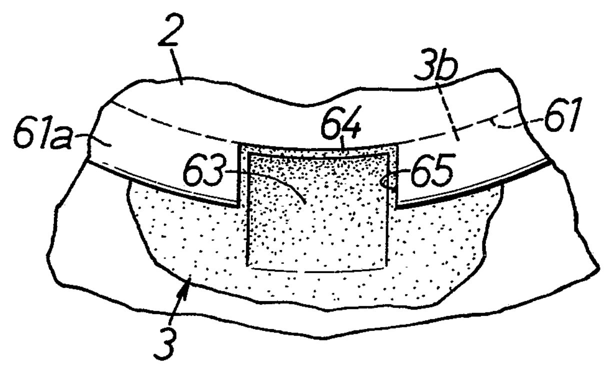
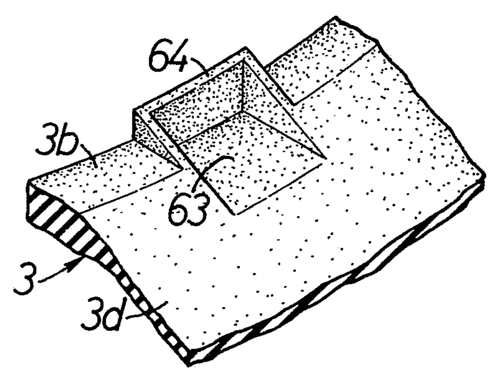


FIG. 5



SPECIFICATION

Master cylinder mounting device for vehicular use

The present invention relates to master cylinder mounting devices for vehicles of the type including a vacuum type booster unit the booster shell of which is arranged on the front surface of the front wall panel of the vehicle compartment and a master cylinder to be actuated by the booster unit and the body of which master cylinder is arranged on the front face of the booster shell.

In general, a master cylinder of the kind concerned is designed so as to be mounted on the front wall panel of the vehicle compartment through the intermediary of the booster shell and the master cylinder so mounted is liable, if the booster shell is not rigid enough, to violently oscillate vertically and sidewise while flexing the booster shell as the vehicle vibrates in vertical and sidewise directions during its travel. This involves the danger that air bubbles be formed in the hydraulic fluid held in the oil reservoirs of the master cylinder, constituting a factor of the vapor lock phenomenon, and the danger that the hydraulic fluid leaks out through the vent holes in the reservoir covering. To avoid such difficulties, it has been usual practice to form the booster shell from light-weight alloy material such as an aluminum alloy by casting or from sheet steel of relatively large thickness thereby to ensure the rigidity of the shell structure. Such practice, however, has necessarily involved a disadvantage that the booster shell is made undesirably heavy in weight.

In view of the above, the present invention has for its object the provision of a novel master cylinder mounting device which is designed to enable reduction in weight of the booster shell associated therewith and at the same time to suppress vertical and sidewise oscillations of the master cylinder during vehicular travel.

According to the present invention, there is provided a master cylinder mounting device for vehicular use which comprises a pair of tie rods extending through both the front and rear walls of the booster shell in oppositely spaced parallel relation to the axis of the booster shell, said tie rods being each firmly fixed at the front end to the body of the master cylinder and at the rear end to the front wall panel of the vehicle compartment so as to form a rectangular-shaped rigid frame in combination with the cylinder body and the front wall panel.

The above and other objects, features and advantages of the present invention will become apparent from the description of a preferred embodiment of the invention which follows when taken with the several views in the accompanying drawings.

In the drawings:

Fig. 1 is a side elevational view of the preferred embodiment of the present invention;

Fig. 2 is a rear view of same;

Fig. 3 is a cross-sectional view taken along the line III-III in Figure 2;

Fig. 4 is a fragmentary rear view, partly in cross section taken along the line IV-IV in Fig. 3; and

Fig. 5 is a fragmentary perspective view of the piston diaphragm shown in Figs. 3 and 4.

Referring first to Figs. 1 and 2, reference numeral 1 indicates the booster shell of a vacuum type booster unit S, which consists of a pair of dished front and rear sections 1F and 1R formed light in weight of thin sheet steel or plastics material. Formed on the rear dished section 1R at equal intervals around the outer periphery thereof are a plurality of detent lugs 1a which extend radially outwardly to be fittingly engaged in respective notches 1b formed in the front dished section 1F around the rear end opening thereof at circumferentially equal intervals so that the front and rear shell sections 1F and 1R are angularly positioned relative to each other. The opposing walls of the two shell sections 1F and 1R are interconnected by means of a pair of tie rods 30. The connecting structure of these tie rods 30 with the shell sections will be described later in detail.

As shown in Fig. 3, a booster piston 2 is accommodated in the booster shell 1 for axial reciprocating movement and is formed in the rear face thereof with an annular groove 61 for fitting engagement with a piston diaphragm 3.

The piston diaphragm 3 is formed around the outer and inner peripheries thereof with annular beads 3a and 3b, respectively. The outer annular bead 3a has two positioning protrusions 3c formed on the rear end face thereof at locations diametrally opposite to each other and is clamped between the two shell sections 1F and 1R with the positioning protrusions 3c fitted in respective positioning apertures 1c formed in the outer peripheral edge of the rear shell section 1R. The piston diaphragm 3 has its inner peripheral bead 3b fitted in the annular groove 61 formed in the booster piston 2 and divides, in cooperation with the latter, the interior space or cavity of booster shell 1 into a front, first working chamber A and a rear, second working chamber B.

The piston diaphragm 3 further includes a major pressure-receiving region 3d extending between the outer and inner peripheral beads 3a and 3b thereof and held in close contact with the rear face of the booster piston 2. The pressure-receiving diaphragm region 3d is folded as shown between the outer peripheral surface of the booster piston 2 and the inner peripheral wall surface of front shell section 1F in a U-shaped cross-sectional form extended into the front, first working chamber A. The annular diaphragm region folded in U-shaped cross section is rollingly movable along the adjacent inner wall surface of the front shell section 1F to allow fore and aft axial movement of the booster piston 2.

Referring to Figs. 3, 4 and 5, the rear side wall 61a of annular groove 61 in the booster piston 2 is slotted or notched as indicated at 65 and the inner peripheral bead 3b of piston diaphragm 3 has a portion 63 thereof recessed at a location opposite to the notch 65. Though normally held in close contact with the adjacent rear face portion of the booster piston 2, the recessed bead portion 63 is readily flexible apart therefrom, as will be described later in detail. As clearly seen in Figs. 4 and 5, a positioning wall 64 of U-channel configuration is formed integral with the inner peripheral bead 3b and upstanding therefrom around the recessed bead portion 63 for fitting engagement with the notch 65 in the rear face of booster piston 2 and serves to restrain the booster piston 2 and diaphragm 3 against relative rotational movement therebetween.

The first working chamber A is normally held in communication with a vacuum source in the form of an engine intake manifold (not shown) by way of a vacuum inlet tube 4. The second working chamber B is adapted to be alternately placed in communication with the first working chamber A and with an air inlet port 6, provided in the rear end wall of a tubular rearward extension 1d of the booster shell 1, under the control of a switching control valve 5, which will be described later in detail.

Under the bias of a return spring 7 held compressed in the first working chamber A, the booster piston 2 is normally urged in the retracting direction, that is, rearwardly into the second working chamber B, the retracting movement of piston 2 being limited by means of ribs 3e formed integral on the rear face region of piston diaphragm 3 for abutting engagement with the inside surface of the rear wall of booster shell 1.

The booster piston 2 is formed with an integral tubular valve housing or sleeve 8 which extends axially rearwardly from the central, hub portion of the booster piston. The valve housing 8 is slidably supported by a plain bearing 9 fitted in the tubular extension 1d of booster shell 1 and is open at its rear end toward the air inlet port 6 formed in the tubular extension 1d at the rear end thereof.

The control valve 5 in the valve housing 8 is constructed and arranged as follows: First, the valve housing or sleeve 8 is formed on the inside wall of its forepart with a first annular valve seat 10_1. Slidably fitted in the forepart of sleeve 8 is a valve piston 12 which is connected to the booster input rod 11 as a front end member of the latter and is formed at the rear end thereof with a second annular valve seat 10_2 which extends coaxial with and radially inside of the first annular valve seat 10_1.

Arranged also in the tubular valve housing 8 is a generally tubular valve element 13 which is open at its opposite ends and has a base end portion 13a clamped against the adjacent inner wall surface of the tubular valve housing 8 by means of a valve-element retainer sleeve 14 fixedly fitted in the latter. The valve element 13 is formed from an elastic material such as rubber and includes a diaphragm portion 13b of limited thickness extending radially inwardly from the base end portion 13a and a valve head section 13c of enlarged thickness connected with the inner peripheral edge of the diaphragm portion 13b. As illustrated, the valve head section 13c has its front end face set opposite the first and second annular valve seats 10_1 and 10_2. As will be noted, the valve head section 13c is movable fore and aft upon deflection of the diaphragm portion 13b and thus capable of abutting against the front end face of the valve-element retainer sleeve 14.

Embedded in the valve head section 13c of valve element 13 is an annular reinforcing plate 15 whose inner peripheral edge extends radially into the hollow of the tubular valve element 13 to support a valve spring 16 at the front end thereof so that the valve head section 13c is normally urged toward the valve seats 10_1 and 10_2 under the bias of a valve spring 16.

It is to be observed that the annular space radially outside of the first valve seat 10_1 is continuously held in communication with the first working chamber A by way of a passageway 17 formed through the booster piston 2 and the annular space between the first and second valve seats 10_1 and 10_2 in communication with the second working chamber B by way of another passage-way 18 radially extending through the hub portion of booster piston 2. The space radially inside of the second valve seat 10_2 is in communication with the air inlet port 6 by way of the hollow of the tubular valve element 13.

The booster piston 2 has a stepped axial bore including a larger-diameter portion 19 opening in the center of the front face of the booster piston and a smaller-diameter portion 20 formed behind the larger-diameter portion 19. In the larger-diameter bore portion 19, a reaction disc 21 of elastic material such as rubber and an output piston 22 of rigid material, of the same diameter, are slidably fitted in the order named. A reaction piston 23 smaller in diameter than the disc 21 and output piston 22 is slidably fitted in the smaller-diameter bore portion 20. An axial projection 12a of limited diameter formed on the front end face of valve piston 12 partly extends into the smaller-diameter bore portion 20 from behind to face the rear end face of reaction piston 23. The output piston 22 has a forwardly projecting output rod 22a formed integral therewith.

The input rod 11 is normally urged in the retracting direction under the bias of a return spring 24. The retracting movement of the input rod 11 is limited by abutting engagement of a movable stop plate 25, threadably mounted on the input rod 11, with the inside surface of the end wall 1e of the tubular rearward extension 1d of booster shell 1. The threaded position of the movable stop plate 25 on the input rod 11 can be changed by turning the stop plate 25 and therefore the limit of rearward movement or the retracted position of the input rod 11 is adjustable fore and after as required. The movable stop plate 25 can be fixed in adjusted position by tightening a lock nut 26, also threaded on the input rod 11. A vent aperture 27 is formed through the movable stop plate 25 so as to keep the air inlet port 6 at all times open.

Fitted in the tubular valve housing 8 at its rear end are filter elements 28 and 29 which serve to clean atmospheric air as entering through the air inlet port 6 and are deformable so as not to obstruct axial movement of the input rod 11.

Description will next be made of the connecting structure of the tie rods 30 with the booster shell 1 with particular reference to Fig. 3.

The tie rods 30 are each formed at its front end with an integral mounting bolt 33 which extends forwardly through the front wall of booster shell 1. Fixedly mounted on the tie rod 30 close to the mounting bolt 33 is an annular spring-support plate 34 which is held in abutting engagement with the inside surface of the front wall of booster shell 1. The body of brake master cylinder M includes an integral mounting flange 36 which is fitted to the front face of the booster shell 1 and through which the mounting bolt 33 of tie rod 30 forwardly extends. By threading a nut 35 on the front end of mounting bolt 33 and tightening it against the mounting flange 36, the four members, tie rod 30, spring-support plate 34, the front wall of booster shell 1 and mounting flange 36, are solidly joined together. Incidentally, the front face of spring-support plate 34 is recessed to define an annular space 37 around the mounting bolt 33 in which a sealing ring 38 is tightly fitted to seal the tie rod 30 with respect to the front wall of booster shell 1, through which the tie rod 30 forwardly extends. The spring-support plate 34 is intended to fixedly support the return spring 7 previously referred to as its front end so that the resilient bias of the return spring 7 may entirely sustained by the tie rods 30 and thus the booster shell 1 left free from any proportion of the spring bias.

Further, there are formed integral with each of the tie rods 30 at its rear end a mounting bolt 39 which extends rearwardly through the rear wall of booster shell 1 and a stepped flange 41 which is held in abutting engagement with the inside surface of the rear wall of booster shell 1. Secured to the inside wall surface of booster shell 1 by welding is a support bushing 43 in which the stepped flange 41 is fixedly fitted with a retaining ring 42 engaged to the inner periphery of support bushing 43 to extend radially along the stepped flange 41 on the front side thereof so that the tie rod 30 and the rear wall of booster shell 1 are again solidly joined together. As indicated at 45, a sealing ring is fitted in the annular space 44, defined by the support bushing 43 around the smaller-diameter section of stepped flange 41, to seal the tie rod 30 with respect to the rear wall of booster shell 1, through which the tie rod rearwardly extends.

The mounting bolt portion 39 of tie rod 30, which extends through the rear wall of booster shell 1, further extends rearwardly through the front wall panel W of the vehicle compartment and a nut 40 threaded on the bolt portion 39 is tightened to firmly secure the tie rod 30 to the front wall panel W with the rear shell wall clamped between the latter and the stepped flange 41 on the tie rod 30.

In this manner, the booster shell 1 is mounted on the front wall panel W of the vehicle compartment by means of the tie rods 30 and the brake master cylinder M secured to such booster shell 1 again by means of the tie rods 30.

The tie rods 30 are arranged in a pair extending parallel to the axis of booster shell 1 or that of input rod 11 of the booster unit S and oppositely spaced a predetermined distance from the axis in both vertical and horizontal directions so that a rectangular-shaped rigid frame is formed which includes the paired tie rods 30 as a pair of opposite side members and the front wall panel W of the vehicle compartment and the mounting flange 36 of brake master cylinder M together forming another pair of opposite side members of the frame and which frame lies in a plane containing the axis of booster shell 1 and inclined at an appropriate angle to the horizontal.

Referring again to Figs. 1 and 2, a pair mounting bolts 66 are firmly secured to the rear wall of booster shell 1 as by welding at locations diametrically opposite to the respective mounting bolt portions 39 of the two tie rods 30 with respect to the axis of booster shell 1 to serve solely as additional means for securely mounting the booster shell 1 on the front wall panel W of the vehicle compartment. In the embodiment illustrated, it is to be noted that the two tie rods 30 are arranged, as seen in Fig. 2, with their axes vertically spaced from each other by a distance *a* larger than their horizontal distance from each other *b*.

Provided between the booster piston 2 and each of the tie rods 30 which extend through respective apertures 31 formed in the booster piston 2 is a sealing means for sealing the tie rod against the booster piston 2 without hindering operation of the latter. As illustrated, the sealing means takes the form of a bellow-like expansible boot 46 made from rubber or the like elastic material which is arranged in the first working chamber A in encircling relation to the tie rod 30 and fixedly fitted at the front end 46a in an annular groove 47 formed in the tie rod around the periphery thereof and at the rear end 46b in the associated through aperture 31 in the booster piston 2.

In the vehicle compartment, the input rod 11 of the booster unit S is fitted at the rear end with a connecting link 53 and connected through the intermediary thereof with a brake pedal 52, which is pivotally secured as at 51 to a fixed bracket 53. Reference numeral 54 indicates a return spring for normally biasing the brake pedal 52 rearwardly.

As seen in Fig. 3, the body 55 of brake master cylinder M includes a rear end portion which extends through the front wall of booster shell 1 into the first working chamber A and the brake master cylinder piston 56 fitted in the cylinder body 55 has its rear end face opposite to the front end of the output rod 22a of the booster unit S.

Description will next be made of the operation of the embodiment described above.

In the illustrated, inoperative state of the booster unit, the valve piston 12, input rod 11 and brake pedal 52, connected with each other, are in their retracted position with the movable stop plate 25 held against the rear end wall 1e of tubular extension 1d of booster shell 1 under the bias of return spring 24. It is to be noted that, upon retraction of the valve piston 12, the second valve seat 10_2 formed thereon is pressed against the front end face of the valve head section 13c of valve element 13 to drive the latter rearwardly into light pressure contact with the front end face of tubular valve-element retainer 14 so that the valve head section 13c is separated from the first valve seat 10c, formed on the tubular valve housing 8, to form an axial gap of small distance *g* therebetween. Such positional relationship is readily obtainable with appropriate axial adjustment of the movable stop plate 25 on the input rod 11.

Accordingly, the first working chamber A, which is maintained under vaccum during engine operation, is held in communication with the second working chamber B through the passageway 17, valve gap *g* and passageway 18 and the pressure across the piston diaphragm 3 is equalized with the front opening in the valve head section 13c closed by the second valve seat 10_2, allowing the booster piston 2 to assume its retracted position under the bias of return spring 7, as shown.

When the brake pedal 52 is depressed in order to brake the vehicle, the input rod 11 and valve piston 12 are driven forward to allow the valve head section 13c, normally urged forwardly by valve spring 16, to advance following the valve piston 12. However, since the gap *g* normally maintained between the valve head section 13c and the first valve seat 10_1 is very limited, the valve head section 13c comes immediately to engage against the first valve seat 10_1 to interrupt communication between the two working chambers A and B. On the other hand, the second valve seat 10_2 on the valve piston 12, moving apart from the valve head section 13c, places the second working chamber B in communication with the air inlet port 6 of the booster shell 1 through the passageway 18 and the axial bore of valve element 13. Accordingly, the second working chamber B is immediately filled with atmospheric air and the pressure therein raised above the level in the first working chamber A. Under the pressure differential created in this manner between the two working chambers A and B, the booster piston 2 is moved forwardly against the bias of return spring 7 to drive the output rod 22a forwardly through the intermediary of elastic disc 21. As the result, the piston 56 in the brake master cylinder M is driven forward and the wheel brakes of the vehicle actuated. In this connection, it is to be noted that the two tie rods 30 arranged in a common plane inclined at a predetermined angle to the horizontal act in cooperation against any vertical or sidewise oscillation of the brake master cylinder M as occurring upon brake application to effectively suppress any such oscillation of the master cylinder. Owing to this, formation in the oil reservoirs integral with the brake master cylinder M of air bubbles as a factor of the vapor lock phenomenon in the brake system and oil leakage through the vent holes in the reservoir covering are prevented and the braking operation is made further reliable. In general, the vehicle during travel is liable to vibrate in vertical direction more than in lateral direction and it has been found that such situation can be rationally dealt with by employing the spatial relationship, $a>b$, between the axes of paired tie rods 30. Further, under the pressure differential occurring between the two working chambers A and B, the recessed portion 63 of inner peripheral bead 3b of the piston diaphragm 3 is held in close contact with the adjacent surface of booster piston 2, thus ensuring interruption of fluid communication between the two working chambers A and B.

Apparently, as the brake master cylinder piston 56 is actuated, a forward load of thrust is applied to the cylinder body 55. The thrust load, however, is transmitted through the tie rods 30 to the front wall panel W of the vehicle to be sustained by the latter and the booster shell 1 remains free from any such axial thrust.

On the other hand, the front end projection 12a of valve piston 12 when advanced comes into abutting engagement with the elastic disc 21 by way of the reaction piston 23 and the elastic disc 21 is deformed to bulge against the reaction piston 23 under the effect of the reaction force of output rod 22a. This enables part of the reaction force to be fed back through the valve piston 12 to the brake pedal 52 to serve the operator as an indication of the intensity of the booster output force being produced and the resulting braking force of the system.

Subsequently, when the brake pedal is released, first the input rod 11 is retracted under the reaction force acting on the valve piston 12 and the bias of return spring 24 so that the second valve seat 10_2 on the valve piston 12 is moved against the valve head section 13c to cause the latter to abut against the front end face of tubular valve-element retainer 14. As the input rod 11 continues to retract, the valve head section 13c is axially compressed and there is formed between the first valve seat 10_1 and valve head section 13c an axial gap which is larger than the normal gap *g*. As the result, the pressure across the piston and diaphragm assembly 2-3 is rapidly equalized. With the loss of the pressure differential between the working chambers A and B, the booster piston 2 is retracted under the bias of return spring 7 to restore its normal position when the ribs 3e on the rear face of diphragm 3 come into abutting engagement with the front surface of the rear wall of booster shell 1. Finally, when the input rod 11 comes to abut against the rear end wall 1e of booster shell 1, the valve head section 13c now released from the reaction force of input rod 11 is allowed to restore its original form, reducing its gap distance from the first valve seat 10_1 to the limited valve *g*.

If the brake pedal 52 is depressed to drive the booster piston 2 forward with no vacuum build-up in the first working chamber A, the air in the chamber A must be more or less compressed as it cannot flow out freely in the direction of the engine intake manifold because of the flow resistance of the associated conduit. However, as the pressure in the first working chamber A rises to exceed that in the second working chamber B, part of the air remaining in the first working chamber A intervenes between the rear face of booster piston 2 and the front surface of pressure-receiving region 3d of the piston diaphragm 3 and acts to push the recessed bead portion 63 thereof rearwardly apart from the adjacent surface of the booster piston 2 to place the two working chambers A and B in communication with each other. In this manner, the pressure across the piston and diaphragm assembly 2-3 is rapidly equalized and the danger of any excessively large backward force of pressure acting on the diaphragm 3 to cause the latter to bulge out rearwardly is precluded. Upon loss of the pressure differential between the two working chambers, the recessed bead portion 63 of the diaphragm 3 comes again into close contact with adjacent surface of booster piston 2.

To summarize, according to the present invention, a pair of tie rods are provided which extend parallel to the axis of the booster shell and are spaced oppositely a predetermined distance from the shell axis in both horizontal and vertical directions. Also, the two tie rods are fixedly fitted through the front and rear walls of the booster shell and firmly secured at the front and rear ends to the body of a brake master cylinder and the front wall panel of the vehicle compartment, respectively, to form together with the cylinder body and the front wall panel a rectangular-shaped rigid frame which lies in an axial plane inclined to the horizontal. The paired tie rods so arranged cooperate to resist any vertical or horizontal oscillation of the master cylinder during vehicle travel, making it possible to suppress such oscillation either in vertical or horizontal direction even where the booster shell is fabricated from a lightweight material. It follows from this that such inconveniences as formation of bubbles in the fluid held in the master cylinder reservoirs as a factor of vapor locking and oil leakage through the vent holes in the reservoir covering are effectively avoided.

CLAIMS

1. In a vehicle having a vacuum type booster unit the booster shell of which is arranged on the front surface of the front wall panel of the vehicle compartment and a master cylinder to be actuated by the booster unit and the body of which master cylinder is arranged on the front face of the booster shell, a master cylinder mounting device comprising a pair of tie rods extending through both the front and rear walls of the booster shell in oppositely spaced parallel relation to the axis of the booster shell, said tie rods being each firmly fixed at the front end to the body of the master cylinder and at the rear end to the front wall panel of the vehicle compartment so as to form a rectangular-shaped rigid frame in combination with the cylinder body and the front wall panel.

2. A device as claimed in claim 1, in which said tie rods extend parallel to the axis of the booster shell at a predetermined distance, respectively, above and below the shell axis.

3. A device as claimed in claim 1 or 2, in which said tie rods extend parallel to the axis of the booster shell at a predetermined horizontal distance from the shell axis, respectively, to the right and left, thereof.

4. A device as claimed in claim 3, in which said tie rods are arranged so that the vertical distance between the axes of said tie rods is larger than the horizontal distance therebetween.

5. A master cylinder mounting device for use in a vehicle as claimed in claim 1, substantially as hereinbefore described with reference to, and as shown in the accompanying drawings.

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