

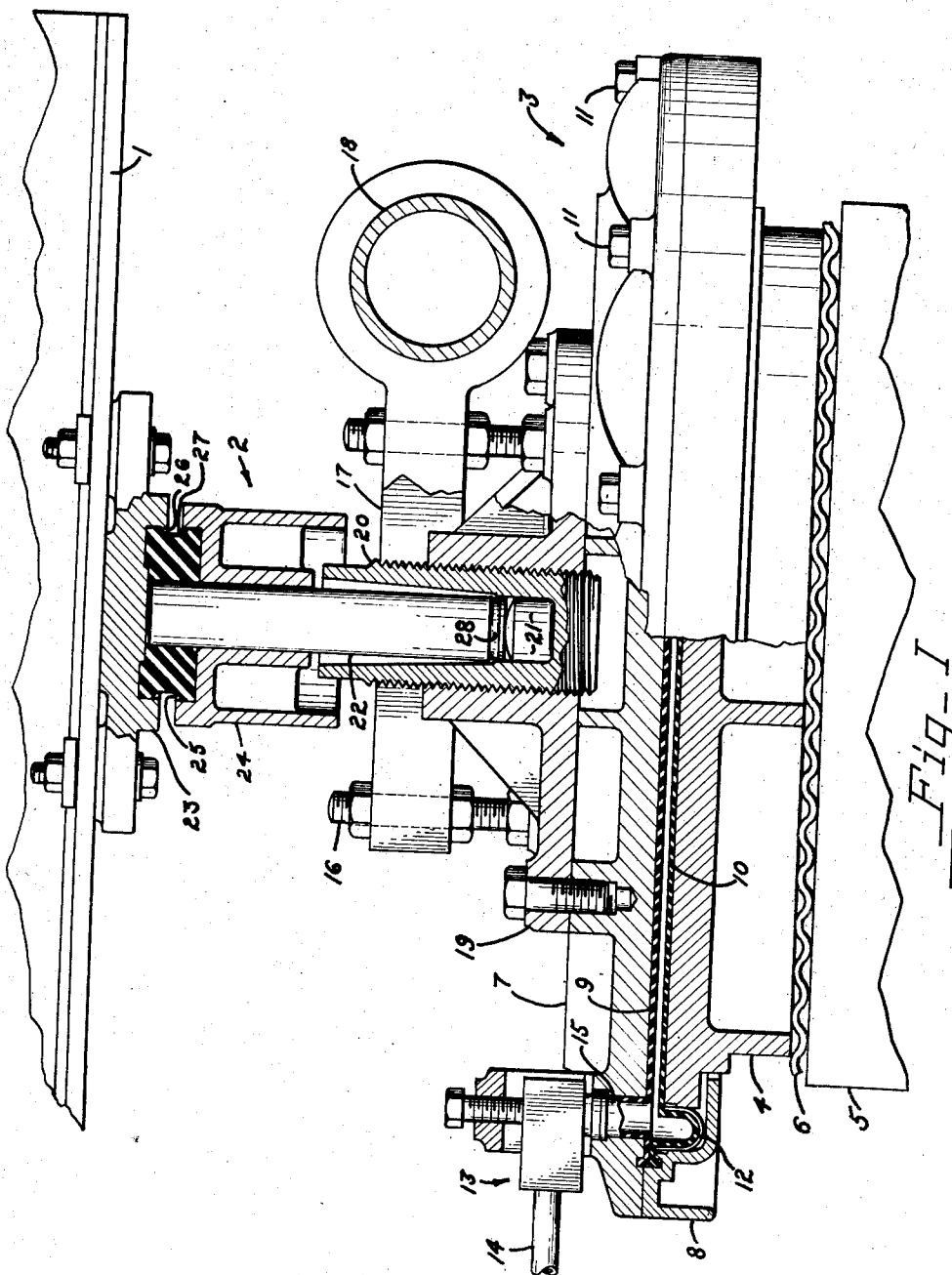
Sept. 15, 1953

L. S. WILLIAMS
STRUT PLATFORM SUPPORT

2,652,241

Filed Jan. 6, 1951

3 Sheets-Sheet 1



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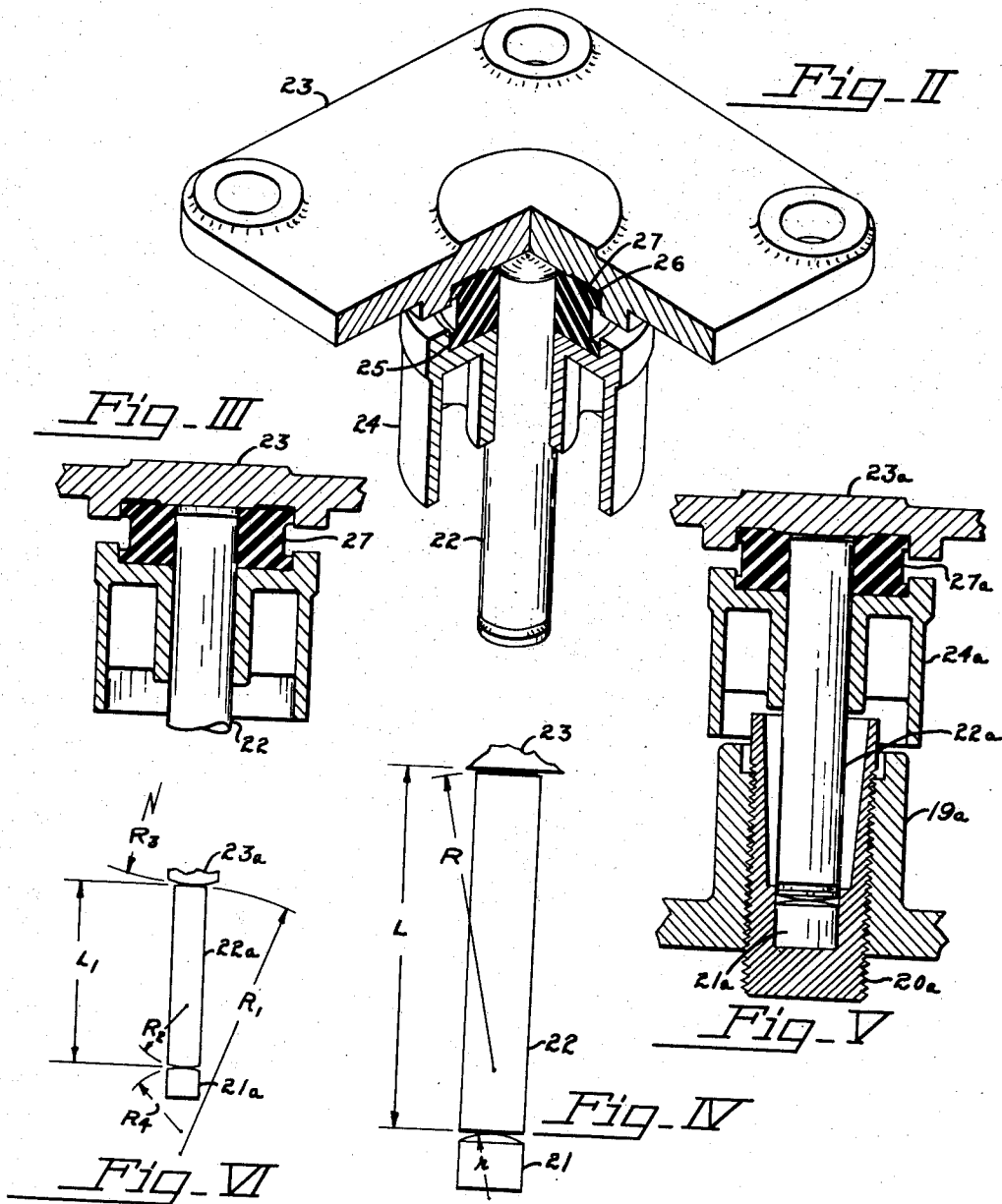
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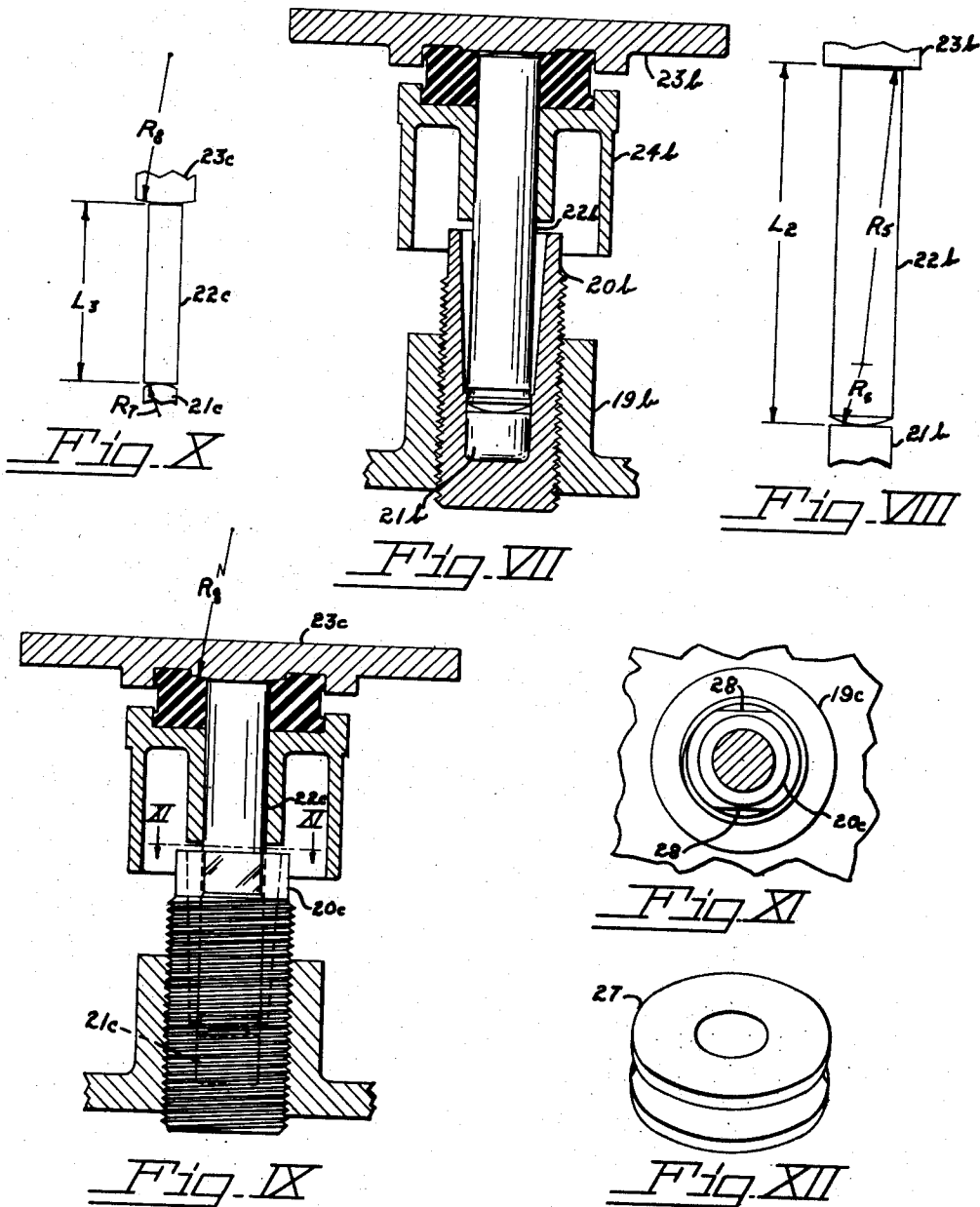
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UNITED STATES PATENT OFFICE

2,652,241

STRUT PLATFORM SUPPORT

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Application January 6, 1951, Serial No. 204,789

5 Claims. (Cl. 265—47)

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This invention relates to weighing scales and in particular to supporting structure for carrying a load receiver or platform on a plurality of hydraulic capsules.

One of the difficulties that must be overcome in the construction of any hydraulic weighing scale is the weakness of the capsules in resisting horizontally applied forces. Such forces may result from the starting or stopping of trucks or other vehicles being driven across the load receiver. The permissible lateral movement of the pressure plate of a hydraulic capsule is a small fraction of the lateral movement of the load receiver in response to lateral forces. Therefore, to secure satisfactory life in the capsules it is necessary to interpose some form of horizontally yieldable support between the capsule and the load receiver. It is furthermore desirable in a hydraulic scale to centralize the load on each capsule to minimize the forces tending to tip the capsule pressure plate with respect to its base. In this connection it is also desirable that the point of force application to the capsule should be as close as possible to the hydraulic chamber of the capsule to reduce the moment arm of any horizontal forces applied to the capsule.

The principal object of this invention is to provide a load receiver supporting structure that is mounted on a capsule and that serves to centralize the application of force to the capsule and at the same time to offer only sufficient lateral force to the load receiver and capsule to insure that the receiver returns to its central position when the lateral forces are no longer applied.

Another object of the invention is to provide an extremely compact supporting system offering little resistance to horizontal movement of the load receiver.

A still further object of the invention is to provide a strut interposed between surfaces on the capsule and load receiver at least some of the cooperating end surfaces of the strut and the capsule and load receiver surfaces being convex and of such radii that a small restoring force tending to center the platform is exerted when the platform is laterally displaced by horizontally applied forces.

A still further object of the invention is to provide a collar of rubber or other resilient material that is compressed between a pair of shallow sockets one mounted on the strut and the other on the load receiver, said collar serving to protect the hardened surfaces and providing some restoring force in addition to that of the strut.

More specific objects and advantages are ap-

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parent from the following description of preferred embodiments of the invention.

According to the invention the load receiver of a hydraulic scale is supported from a plurality of capsules by a plurality of struts each of which has its hardened ends cooperating with hardened surfaces of members mounted on the capsule and on the load receiver, some of which hardened surfaces of the strut and adjacent members are spherical or sections of a spherical surface and are of such radius of curvature that little or no restoring force is generated whenever the load receiver is deflected laterally from its midposition.

Preferred embodiments of the invention are illustrated in the accompanying drawings.

In the drawings:

Figure I is a side elevation, partly in section, of a hydraulic capsule, a portion of a load receiver and the improved strut for supporting the load receiver from the capsule.

Figure II is a broken away isometric view of a strut and a portion of a support plate that is attached to the load receiver.

Figure III is a fragmentary section of the upper end of the strut and cooperating members showing the relationship between the parts when not subjected to load.

Figure IV is a diagrammatic sketch showing the relationship between the length of the strut and the radii of curvature of the various cooperating surfaces.

Figure V is a fragmentary vertical section of a modified form of strut assembly.

Figure VI is a diagrammatic illustration showing the radius of curvature of each of the various surfaces of the structure shown in Figure V.

Figure VII is a vertical section showing still another arrangement constructed according to the invention.

Figure VIII is a diagrammatic sketch to show the radius of curvature of the cooperating surfaces of the elements shown in Figure VII.

Figures IX and X show still another possible arrangement of the self stabilizing strut.

Figure XI is a horizontal section taken along the line XI—XI of Figure IX.

Figure XII is an isometric view of the resilient collar that is interposed between the members at the upper end of the strut.

These specific figures and the accompanying description are intended merely to illustrate the invention and not to limit its scope.

In a hydraulic weighing scale constructed according to the invention a load receiver comprising a girder or beam 1 is supported by a strut

assembly 2 from a hydraulic capsule 3. The capsule 3 includes a base member 4 that is supported from a pier or foundation 5 by a corrugated lead sheet 6 interposed between the base member 4 and the foundation 5. The corrugated lead cushion or sheet 6 yields with the initial application of load to the load receiver and by such yielding allows the base member 4 of capsule to be uniformly supported throughout its area. A capsule plate 7 that includes a clamping ring 8 is hydraulically supported from the base member 4 by hydraulic fluid confined within a rubber liner comprising an upper membrane 9 and a lower membrane 10. The rubber membranes 9 and 10 are held in fluid tight engagement with each other around the periphery of the capsule by a plurality of bolts 11 drawing the clamping ring 8 tightly against the upper capsule plate 7. In the gap between the periphery of the base member 4 and the clamping ring 8 the membrane 10 is supported by a plurality of narrow metallic strips 12 which, while being flexible in bending, are non-stretchable and thus prevent stretching of the membrane 10 in the gap. A coupling 13 is provided to hydraulically connect a pressure pipe 14 through a neck 15 and to the hydraulic space within the capsule 3.

A plurality of threaded studs 16 erected from the upper capsule plate 7 adjustably support a pair of horizontal arms 17 connected to a pipe 18. The pipe 18 is part of a frame work that connects the capsule plate 7 to the capsule plates of the remaining capsules. The frame work, by interconnecting the plates, prevents tipping of the capsule pressure plates with respect to the base members 4.

Each corner of the load receiver is supported on a strut assembly comprising a strut assembly foot 19 that is centrally positioned on the pressure plate 7 and that has a vertical generally cylindrical section which is internally threaded to receive an externally threaded socket 20. A strut bearing 21 fitted in the bottom of a bore in the socket 20 supports the lower end of a strut 22. The upper end of the strut 22 supports a top plate 23 attached to the bottom surface of the load receiver girder 1. A collar 24 that is fixedly mounted on the strut 22 has a socket 25 in its upper surface in juxtaposition to a socket 26 in the top plate 23. A molded rubber collar 27 that fits into the sockets and around the strut 22 serves to position the strut 22 with respect to the top plate 23 and at the same time exert a restoring force when the receiver is deflected laterally.

To accommodate lateral movement of the load receiver the greater portion of the hole in the socket 20 is tapered. This taper is sufficient to accommodate any lateral movement that is permitted by platform stops or bumpers that are ordinarily installed in the walls of the pit in which the load receiver is installed. The bottom end of the hole in the socket 20 is cylindrical to closely fit the strut bearing 21. The cylindrical portion of the hole extends upwardly beyond the strut bearing 21 and half way past a groove 28 encircling the bottom end of the strut. The strut itself is also a close fit within the cylindrical bore of the hole in the socket 20. To accommodate lateral movement the upper surface of the strut bearing 21 is formed as a section of a spherical surface. The cooperating lower end surface of the strut 22 is flat. Likewise the upper end of the strut 22 is formed as a section of spherical surface and the cooperating surface of the top plate 23 is flat. These mem-

bers are constructed of a material that can be hardened sufficiently to withstand, without permanent yield, the high forces that are transmitted through the comparatively small area of contact between the members. Thus the force from the load on the load receiver is transmitted downward from the flat undersurface of the top plate 23 to the upper end of the strut 22 and from the flat bottom of the strut 22 to the spherical surface of the strut bearing 21 that is supported directly from the pressure plate 7 of the capsule 3.

The relative position of the various parts of the strut 22 and top plate 23 in their no-load condition is shown in Figures II and III. The rubber or resilient member 27 is of such thickness that the upper end of the strut 22 is separated a small distance from the top plate 23. When load is applied, for example the weight of the load receiver, the resilient member is compressed until the strut 22 contacts the top plate 23. This application of a preload to the resilient member 27 increases its capacity to withstand and resist angular movement of the strut 22 with respect to the top plate 23.

One of the objects of the invention is to support the load receiver in a stable condition and at the same time allow it to move laterally without transmitting large lateral forces to the supporting capsules. To satisfy this condition the ends of the strut and the cooperating surfaces of the strut bearing 21 and the top plate 23 must have particular degrees of curvature. It is possible by varying the curvature to make the system exhibit either stable equilibrium, neutral equilibrium or unstable equilibrium. The condition which exists depends upon the radii of curvature of the surfaces and the length of the strut. Figure IV illustrates in schematic form the condition required for neutral equilibrium in the preferred form. In this figure the bottom end of the strut 22 and the lower surface of the top plate 23 are each flat, i. e., each has an infinite radius of curvature. The strut bearing 21 has as small a radius of curvature as can be made without concentrating the load over such a small area that permanent yield of the strut or bearing material occurs. In a medium size truck scale the diameter of the strut bearing 21 and the radius of curvature of its upper surface are equal and each is one inch in length. The upper end of the strut 22 is also curved with a radius of curvature "R" of a length such that the sum of the radius of curvature of the strut bearing 21 plus the radius of curvature of the upper end of the strut 22 is equal to the length "L" of the strut 22. It may be shown that under this condition, at least for small lateral movements, the load receiver moves in a horizontal direction and is therefore in neutral equilibrium. If the radii of curvature are decreased so that the sum is less than the length of the strut the system is unstable and any lateral deflection produces a force tending to increase the deflection. Likewise, if the sum of radii of curvature is greater than the length of the strut the resulting system is in a condition of stable equilibrium and is urged toward its midposition by force that is proportional to the lateral displacement of the load receiver and load on the load receiver of the scale. In the preferred form of the invention the radii of curvature are selected for substantially neutral equilibrium and the resilient collar 27 supplies the restoring force.

Figure V shows a similar strut construction

having a strut assembly foot 19a, a collar 24a, a rubber member 21a and a top plate 23a. A strut bearing 21a set in a socket 20a of the strut assembly foot 19a supports a strut 22a. In this example each end of the strut 22a is rounded as well as the cooperating surfaces of the strut bearing 21a and top plate 23a. This condition is illustrated in Figure VI wherein the length of the strut is L_1 while the radius of curvature at the upper end of the strut is R_1 , and the radius of curvature at the bottom end of the strut is R_2 . The radius of curvature of the top plate 23a is R_3 and the radius of curvature of the strut bearing 21a is R_4 . In this arrangement wherein all of the contacting surfaces are curved the radii of curvature must be increased, to secure sufficient area of contact to support the loads as well as to secure a condition of neutral or stable equilibrium. It may be shown that, except for large displacements, the length L_1 of the strut 22a should be equal to the sum of two functions one of which involves the radii of curvature of the two contacting surfaces at the bottom of the strut and the other of which involves the radius of curvature of the two contacting surfaces at the top of the strut. Each of these functions is the product of the radii of curvature divided by the sum of the radii of curvature. Thus the function representing the equivalent radii of curvature at the bottom end of the strut 22a is:

$$R_{eq.} = \frac{R_2 R_4}{R_2 + R_4}$$

In this example, as in the preceding example, if the radius of curvature of any of the surfaces is increased beyond that giving neutral equilibrium the system becomes stable while if the radius is decreased the system becomes unstable. In fact the preferred embodiment is a special case wherein R_2 and R_3 of the Figure VI are infinite in length, i. e., bottom surfaces of the strut 22a and of the top plate 23a are flat. In this case the specified functions (the sum of which for neutral equilibrium is equal to the length of the strut) reduce to the radii of curvature shown in Figure IV.

Still other combinations of flat and spherical surfaces may be employed in the design of the improved strut assembly for weighing scales. Thus Figure VII illustrates an assembly wherein a strut 22b is fitted with a collar 24b and is interposed between the top plate 23b and a strut bearing 21b. The strut bearing 21b is mounted on the bottom of a hole in a socket member 20b which in turn is carried on a strut assembly foot 19b. In this example, as illustrated in Figure VIII, each end of the strut is a portion of a spherical surface while the cooperating surfaces of the top plate 23b and the strut bearing 21b are flat. The condition for neutral equilibrium in this example occurs when the sum of the radius of curvature R_5 of the upper end of the strut 22b plus the radius of curvature R_6 of the bottom end of the strut is equal to the length L_2 of the strut 22b. This example may be derived from the second example by allowing R_3 and R_4 to each become infinite in length.

This example clearly indicates the condition of neutral equilibrium because as long as the flat surfaces of the strut bearing 21b and the top plate 23b are horizontal a line passed through the points of contact between the strut and cooperating surfaces is perpendicular to the surfaces and passes through the center of curvature of each end of the strut. Therefore the strut is

in effect a pair of hemispheres having a common polar axis and therefore behaves like a ball in permitting lateral movement of the load receiver without raising or lowering the load receiver. This is the condition for neutral equilibrium.

Figures IX and X illustrate another version or example of the improved strut wherein the ends of the strut are flat and the cooperating surfaces of a strut bearing 21c and a top plate 23c are curved. In this example neutral equilibrium is obtained if the sum of the radii of curvature R_7 plus R_8 is equal to the length L_3 of the strut 22c.

In all of the examples the radii of the cooperating surfaces at the bottom end of the strut are made as small as possible consistent with satisfactory life of the material and freedom from permanent yield under the maximum expected load force. If the radius of curvature is made too small the stress in the material in the area of contact exceeds the elastic limit and a permanent yield takes place. This has the effect of increasing the radius of curvature of the contacting members and thus makes the system much more stable and as a direct result increases the transmission of lateral forces to the hydraulic capsule. This is undesirable because it is difficult to construct a capsule that is both accurate and sufficiently rugged to withstand the increased lateral forces.

It therefore follows, since the radius of curvature or the radii of curvature of the surfaces of the bottom end of the strut are fixed by the strength of the material and the desirability of making them as small as possible, that the radius or radii of curvature of the surface or surfaces at the top of the strut are varied to secure a condition of neutral or slightly stable equilibrium.

Referring to Figure XI the upper end of the socket member 20c has a pair of flats 28 so that the socket member 20c may be rotated to screw it in or out of the strut assembly foot 19c and thus regulate or adjust the height of the load receiver with respect to the edges of the pit or with respect to the capsules themselves. This adjustment also makes it possible to accurately distribute the weight of the load receiver among the several capsules and thus relieve the load receiver from twisting strains that might cause warping.

Figure XII shows the elastic or resilient member 27 which performs two functions in the improved strut assembly. First, it provides a constant amount of restoring force to resist lateral movement of the load receiver and, second, it excludes moisture, dust and gritty material from the cooperating surfaces at the upper end of the strut. The surfaces at the bottom of the strut are protected against dirt and water by filling the lower socket around the lower end of the strut with a heavy grease. This grease does not restrict the rolling motion of the strut on the bearing but does prevent any dust or dirt that works in below the skirt of the collar 24 from settling into and binding in the close clearance between the lower end of the strut and the cylindrical hole in the socket 20.

This construction of a strut and cooperating surfaces at least some of which are curved makes possible a substantially neutral equilibrium supporting system and at the same time keeps the point of force application of force to the capsule located very near the center of the effective area of the capsule so that the tipping forces are reduced to a minimum. This permits the stabilizing frame work comprising the arms 12 and

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pipe 18 to be made of relatively light material and still provide sufficient rigidity to hold the capsule pressure plate 7 in parallel relation to the capsule base 4.

Various modifications of the invention may be made of specific details without departing from the spirit and scope of the invention.

I claim:

1. A support for carrying a load receiver on a hydraulic capsule, comprising, a member supported on the capsule, the member having an upwardly opening socket, a bearing surface in the bottom of the socket, a strut having its lower end supported on the bearing surface in the bottom of the socket said structure extending upwardly from said member, and a bearing plate attached to the load receiver and supported on the strut, said bearing plate having a surface to engage the upper end of the strut and the strut having an upper end cooperating with the bearing plate, at least one of the cooperating surfaces being convexly curved with a radius of curvature substantially greater than half the length of the strut to permit rolling movement, and at least one of the juxtaposed surfaces of the bearing in the socket and the end of the strut therein being convexly curved with a radius of curvature substantially less than half the length of the strut to permit rolling movement of the strut in the socket.

2. A support for carrying a load receiver on a hydraulic capsule, comprising, a member supported on the capsule, said member having an upwardly opening flaring socket, a bearing surface forming the bottom of the socket, a strut the lower end of which is guided in the socket and rests on the bearing surface, a bearing plate attached to the load receiver and having a flat surface engaged by and supported on the upper end of the strut, the upper end of the strut having a spherical surface the center of curvature of which is located between the center and the lower end of the strut, the surface of the lower end of the strut and the bearing surface in the socket being in rolling contact with at least one of the surfaces being of convex generally spherical form and having a radius of curvature that is less than half the length of the strut.

3. A support according to claim 2 in which the sum of the radii of curvature of the generally spherical surfaces is substantially equal to the length of the strut, whereby the system when

lightly loaded is theoretically in neutral equilibrium.

4. A support for carrying a load receiver on a hydraulic capsule, comprising a member supported on the capsule, said member having a socket, a bearing surface in the socket, a strut that fits into the socket with its lower end surface resting on the bearing surface, one of the surfaces being convexly curved to permit rolling motion of the strut, a bearing plate attached to the load receiver and having a flat bearing surface resting on the upper end of the strut, the upper end of the strut having a generally spherical form, the center of curvature of which is located between the center and lower end of the strut.

5. In a device of the class described, in combination, a hydraulic capsule structure having formed thereon an upwardly facing bearing surface, a strut having formed thereon a downwardly facing bearing surface at its lower end, which downwardly facing bearing surface engages the upwardly facing bearing surface of the capsule structure, one of said bearing surfaces being convexly curved with a radius of curvature substantially less than half the length of the strut to permit rolling motion between said bearing surfaces, the upper end of said strut having formed thereon an upwardly facing bearing surface, a load receiver structure having formed thereon a downwardly facing bearing surface which downwardly facing bearing surface engages the upwardly facing bearing surface of said strut, at least one of the contacting surfaces at the upper end of the strut being convexly curved with a radius substantially greater than half the length of the strut to permit rolling motion therebetween, and means for preventing substantial shifting of the bearing surfaces formed on said strut in respect to the bearing surfaces formed on said capsule structure and said load receiver structure.

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