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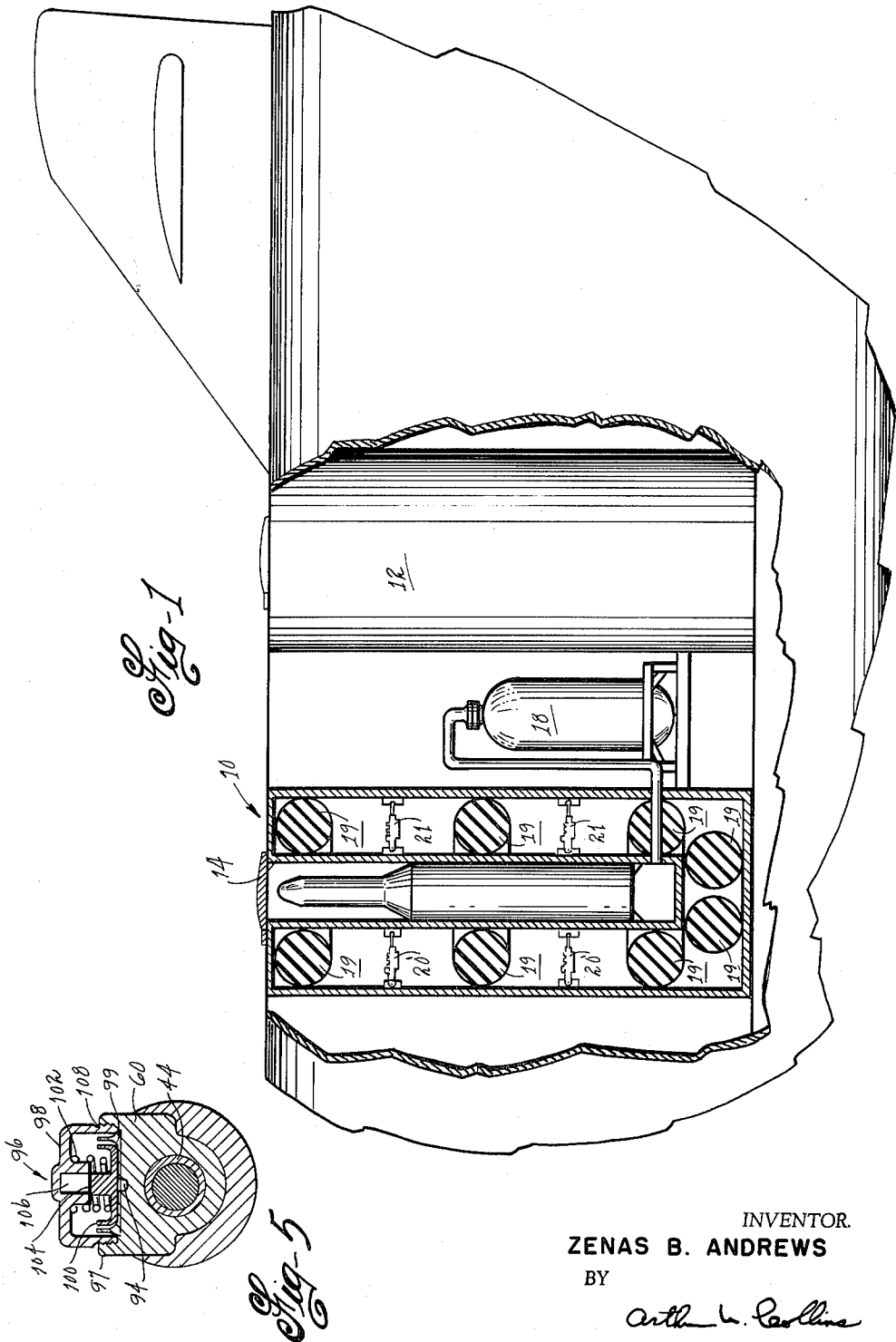
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HYDRAULIC CYLINDER-ZERO EXTERNAL VOLUMETRIC CHANGE TYPE

Filed May 15, 1964

2 Sheets-Sheet 1



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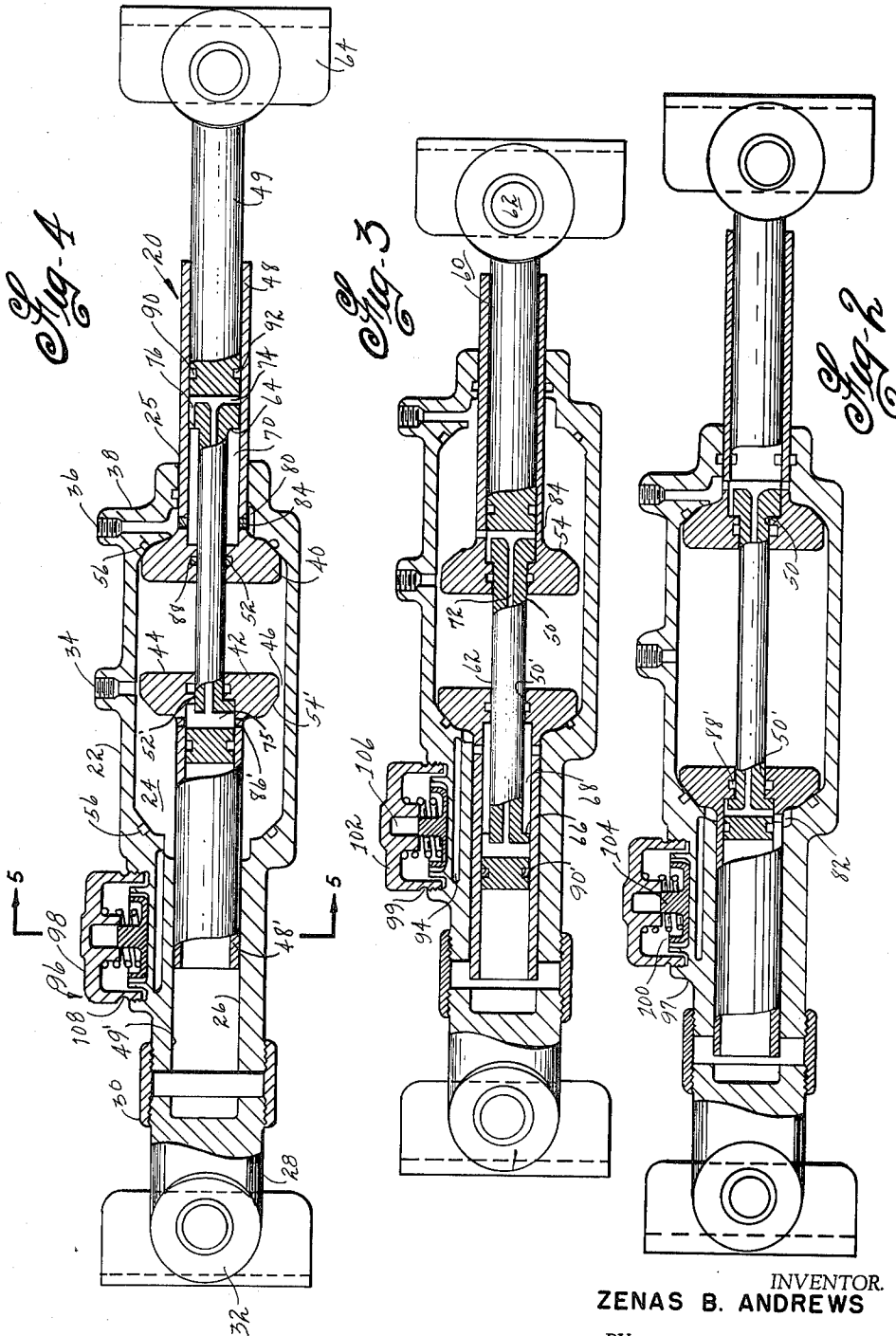
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HYDRAULIC CYLINDER-ZERO EXTERNAL VOLUMETRIC CHANGE TYPE

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2 Claims. (Cl. 267-1)

This invention relates to missile launchers and particularly to mountings for such devices.

In launching certain missiles from a ship's deck or a submerged submarine, a launcher is utilized that employs a vertically disposed firing tube. For various reasons, the launcher is a single capacity unit and is used in batteries.

The firing tube of each launcher is supported within an outer tube or housing which is secured to the vessel's structure. To isolate shock, a shock absorbing device is fixed between the firing tube and its housing. This is normally a resilient member, like a spring.

A properly supported firing tube requires that the support hold the firing tube rigidly, or in a locked position, while the missile is being ejected, but that the locked position be instantly broken if motion is imparted to the firing tube by an external explosion.

In the invention, the firing tube is separated from the outer tube by elastomeric mountings to absorb and prevent jars and strains from being transmitted between the firing tube and the housing. A strut is also mounted between the firing and outer tubes which is a hydraulic member having piston-like compression and tension valves. The strut is normally locked out, that is, the valves are separated under the fluid pressure within the strut. An external force of a predetermined magnitude results in stroking of the compression or tension valve. Movement of a valve displaces fluid from the cylinder and opens a passageway into a low pressure chamber. The locked position of the strut is immediately broken, and removes its resistance to the normal action of the elastomeric mounting.

The strut is self-centering in that the pressure within it causes both piston valves to move into the locked position. The action of the piston valves does not cause fluid flow in the lines connecting the strut. Provision is made in the form of an accumulator to receive fluid displaced at an extremely rapid rate from the strut. One accumulator is capable of serving both piston valves, or a separate accumulator may be provided for each of them. The seals are disposed so that leakage is from a high pressure area to a low pressure area within the strut, and any external leakage from the strut is from a low pressure area. The construction of the accumulator is such that excessive forces within the strut only cause destruction of one of its replaceable elements.

Various other features and advantages of the invention will become apparent upon reading the detailed description in view of the drawing wherein:

FIG. 1 is a sectional view of a portion of a submarine equipped with launchers employing the invention showing a launcher in side elevation and a sectional view of another;

FIG. 2 is a longitudinal sectional view, with some parts broken away, of one of the struts showing it in its locked position;

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FIG. 3 is similar to FIG. 2 but shows the position of the piston valves during a compression stroke;

FIG. 4 is like FIG. 2 but with the piston valves under a tension stroke; and

FIG. 5 is a sectional view of the accumulator along the line 5-5 of FIG. 4.

Referring to the drawing, in FIG. 1, 10 indicates a portion of a vessel, such as a submarine, provided with a number of single capacity missile launchers. Each launcher, 12, generally includes a firing tube 14, which carries a missile 1, disposed in an outer tube 16, and a source of pressurized fluid as the flask 18. The flask 18 is connected to the firing tube 14 through a launcher valve, not shown. Opening the valve releases the pressurized fluid beneath the missile 1 and ejects it from the launcher.

The outer tube 16 is sunk into the hull of the craft 10 and disposed in substantially a vertical position with its upper end terminating at the deck level. It is secured to the craft's structure by welds, struts, or some other well known means, not shown.

The inner or firing tube 14 is concentrically mounted within the outer tube 16 on resilient members, such as the rubber rings shown, at 19.

To hold the firing tube 14 rigidly while firing a missile against normal movements and forces, there are a plurality of struts 20, 21, 20' and 21'. Preferably there are four, only two shown, equally spaced struts in a plane near the top of the firing tube and four more similarly spaced in a lower plane. As shown in FIG. 1, movement of the firing tube 14 to the left will subject strut 20 to a compression force while its opposed member 21 undergoes a tension force. Movement to the right reverses the forces applied to the struts.

Each strut, for instance strut 20 in FIG. 4, has a tubular casing 22 recessed in one end portion to provide a cylindrically shaped, high pressure chamber 24 with an aperture 25 through its end wall that forms a cylinder for guiding a piston-like, compression stroke valve 40. The other end portion is bored through to form a cylinder 26 for guiding a tension stroke valve 42. The tension cylinder 26 is closed at its far end by a cap 28 which is joined to it by a threaded sleeve 30. An eye 32 in cap 28 is designed for securing the strut to a lug or bracket 33, fixed to either the firing or outer tubes.

A central port 34 is provided in the casing 22 intermediate its ends for filling the high pressure chamber 24 with pressurized hydraulic fluid, and a port 36 near the end wall 38 for returning the fluid. The ports 36 and 38 are coupled by lines having check valves to a source of fluid pressure and a return tank, not shown.

Since both the compression valve 40 and the tension valve 42 are similar in construction, like parts are indicated with the same reference characters, except they are primed for the tension stroke valve 42 and only the compression stroke valve will be described. It has a head, 44, of slightly smaller size than the high pressure chamber 24 in which it is disposed so that there is a space, 46, between the two for passage of fluid from one side of the head to the other, and a tubular stem, 48, with a bore 49. A hole 50 in the center of the valve head, 44, is aligned with the stem bore 49; it is smaller than the bore, 49, and as a result, there is a shoulder 52 within it.

The valves, 40 and 42, are positioned within the high pressure chamber with their heads opposed. The stem

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48 of the compression valve 40 is mounted in and extends through the aperture or cylinder 25, and the stem 48' of the tension valve 42 extends into the bore or tension cylinder 26. The stems, 48 and 48', have sufficient length to permit movement of the valves in the high pressure chamber 24 without being dismantled from their cylinders, 25 and 26.

The annular under surfaces, 54 and 54', of the compression and tension valves, 40 and 42, respectively seat on the ends of the high pressure chamber 24 on high pressure sealing rings, 56 and 56'.

A connecting rod 60 having an eye 62 at one end for attachment to a bracket, as shown at 64, secured to either the firing tube 14 or the outer tube 16, has its other end inserted through the bore of the compression valve's stem 48 and into the bore of the tension valve stem 48'. When the valves, 40 and 42, are seated or in the locked position, as in FIG. 2, the inserted end of the piston rod 60 terminates a short distance within the tension valve's stem 48'. The size of the rod portions disposed within the bore of valve stems, 48 and 48', are dimensioned for a sliding fit. As shown in FIGS. 2-4, the intermediate portion 62 of the piston rod 60, as defined by the distance between the valves (40 and 42) when seated is sized for a sliding fit within the holes, 50 and 50', of the valve heads. This construction permits movement between the valves and the rod and forms shoulders, 64 and 66, on the rod portion within the valve stems which are adapted and engage and disengage with the shoulders 52 and 52' within the valve stem.

Movement between the valves and the rod 60 also produces a low pressure fluid chamber between the shoulders on the rod 60 and the under surface of the piston heads. Thus, movement of the compression valve 40, as in FIG. 3, creates chamber 68 in tension valve stem 48', and movement of the tension valve 42, as in FIG. 4, creates a chamber 70 in the compression valve stem 48.

Movement of a piston, 40 or 42, permits fluid flow between the high pressure chamber 24 and a low pressure chamber, 68 or 70. For this purpose, the intermediate portion 62 of the rod 60 is provided with a longitudinal passage 72 which is connected by radial passages 74 and 75 to longitudinal grooves, as shown at 76 and 78, that penetrate the shoulders 64 and 66 in a direction toward the piston head. The end surfaces defining the high pressure chamber 24 are also provided with annular grooves, 80 and 82, around the cylinders, 25 and 26, which receive the valve stems and the walls of the stems are penetrated with apertures, 84 and 86, at the neck between the stem and head of the valves.

In the operation of the device, the high pressure chamber 24 is filled with pressurized fluid which separates the valves 40 and 42 causing them to seat as in FIG. 2. When a compression force is applied to the strut (FIG. 3), the rod 60 moves inwardly carrying with it compression valve 40 off its seat, since the rod's shoulder 64 is engaged with the valve shoulder 52. At the other end, the rod shoulder 66 disengages from the valve shoulder 54' in the tension valve stem 48'. Part of the stem 48 of the valve 40 enters the high pressure chamber, decreasing its fluid volume. Fluid flows around the compression valve head through the space 46, through the stem aperture 84 into passage 72 in the rod 60 and empties in chamber 68 under the head of the tension valve 42, which is increasing in volume.

With a tension force applied to the strut 20 (FIG. 4), rod 60 and tension valve 42 are engaged by shoulders 66 and 52' and valve 42 is unseated; whereas, shoulders 64 and 52 are disengaged and chamber 70 in the compression valve stem 48 increases in volume. Flow then is around the head of valve 42 through its stem aperture 86, the longitudinal passage 72 of rod 60 and into the chamber 70.

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When external forces are removed, the cylinder is self-centered in that the liquid pressure in the high pressure chamber 24 causes both the compression and tension piston, 40 and 42, to move to the locked out position, FIG. 2.

Four high pressure seals, 56, 56', 88 and 88' and four low pressure seals, 90, 90', 92 and 92' are provided as shown. With this design, any leakage in the high pressure seal will result in leakage into low pressure chambers. External dynamic seal liquid leakage can only occur across the low pressure seals.

To provide for a rapid displacement of fluid within the high pressure chamber 24, that is when the low pressure chambers, 70 and 72, within the stems of the valves 40 and 42, are incapable of handling the displaced fluid, a passageway 94 is provided which connects the annular groove 82 with an accumulator 96. The latter comprises an annular projection 97 on the outer surface of the casing 22 which is threadedly closed with a clip 98. A diaphragm 99 is secured at its periphery by the cap 88 over the passageway 94. The diaphragm is stiffened at its center by a disk 100 and urged down toward the passageway 94 by a spring 102. A projection 104 from the disk 100 extends into a tubular member 106 on the under side of the cap for guiding vertical movement of the diaphragm. Fluid pressure enters the passageway 94, and if of sufficient force, will drive the diaphragm 99 upward and fill the space developed under it. If this proves insufficient, a groove 108 is furnished around the exterior of cap 98 which will permit the cap to fracture and allow fluid to escape.

Obviously a similar accumulator may be provided for opposite side of the high pressure chamber 24 as well as various other changes and arrangements of parts without departing from the spirit and scope of the invention, the form hereinbefore described being merely a preferred embodiment thereof.

What is claimed:

1. A hydraulic strut for use between two relatively movable structures comprising a casing adapted to be secured to one of said structures and having a high pressure fluid chamber therein connected by an aperture through one end of said casing defining a compression cylinder and a bore in the other end defining a tension cylinder;
- a compression stroke valve including a head disposed in said high pressure chamber having a hollow stem extending through said compression cylinder;
- a tension stroke valve including a head disposed in said high pressure chamber and a hollow stem extending in said tension cylinder;
- said heads of said compression and tension stroke valves each having a hole aligned with the hollow of its stem;
- a rod having an end adapted to be secured to the other said structure and the other end inserted through the hollow of said stem of said compression stroke valve and into the hollow of said stem of said tension stroke valve;
- a shoulder on the portion of said rod within the hollow of said tension stroke valve stem and a shoulder on the portion of said rod within the hollow of said compression stroke valve stem adapted to engage the under side of said head within their stems whereby inward movement of said rod unseats said compression stroke valve moving the stem thereof into said high pressure chamber, displacing fluid and creating a low pressure cavity between the rod shoulder and valve head in said compression valve stem, and outward movement of said rod unseats said tension stroke valve moving its stem into said high pressure chamber and creates a low pressure cavity between the rod shoulder and valve head in said compression valve stem;
- and passage means connecting said high pressure cham-

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ber of the hollows of said stems of said valves including a groove in the end wall around said aperture and said bore, a hole in the stem of said valves at the neck thereof and a passage through the intermediate portion of said rod, and said valve heads adapted to close and open said passage means with seating and unseating thereof over said groove.

2. The device of claim 1 including an accumulator connected to said passage means having a normally closed spring diaphragm.

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