Aug. 21, 1962 D. B. NEFF ET AL 3,049,800

METHOD OF CONNECTING A PISTON SHOE PERMANENTLY TO A PISTON

Original Filed May 9, 1957

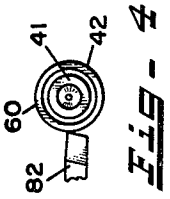


Fig - 4

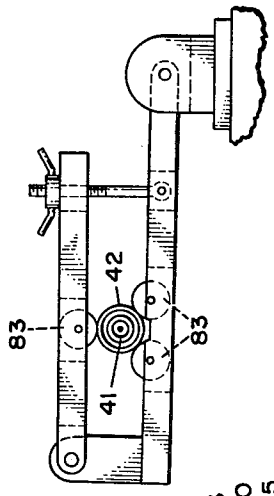


Fig - 5

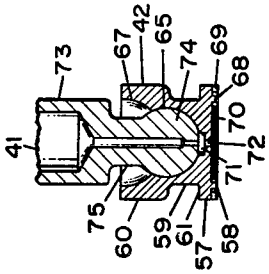


Fig - 6

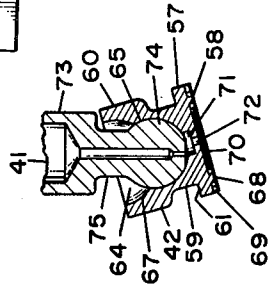


Fig - 7

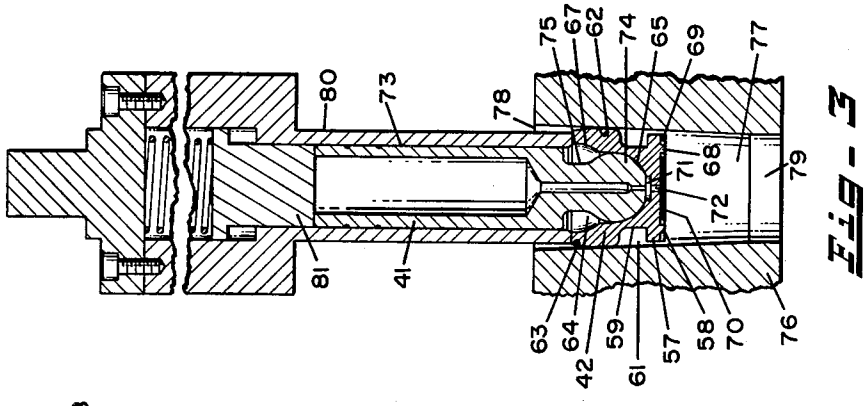


Fig - 3

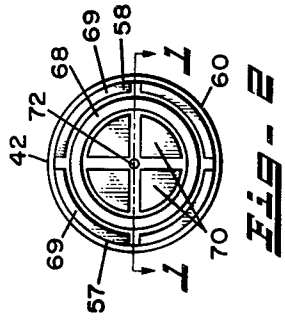


Fig - 2

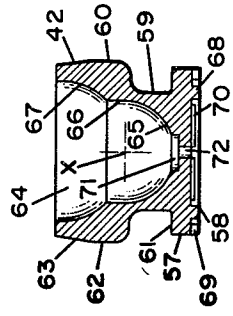


Fig - 1

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METHOD OF CONNECTING A PISTON SHOE PERMANENTLY TO A PISTON

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Original application May 9, 1957, Ser. No. 658,165. Divided and this application Apr. 30, 1958, Ser. No. 731,958

4 Claims. (Cl. 29—441)

Our invention relates generally to fluid pressure energy translating devices and more particularly to improved methods of permanently attaching a piston shoe to a piston for nutating or universal movement with respect to the latter.

The main object of the invention is to provide new and improved methods of permanently attaching a piston shoe to a ball of a piston.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein a preferred form of embodiment of the invention is clearly shown.

In the accompanying drawings:

FIG. 1 is a view in section of a piston shoe of a hydraulic pump;

FIG. 2 is a view looking at the swash or cam plate engaging surface of the sole portion of the piston shoe seen in FIG. 1;

FIG. 3 is a view in section of a punch and swaging or shrinking die operating upon a piston and the piston shoe seen in FIG. 1 to attach the piston shoe to the piston permanently, the parts being shown in the positions which they occupy at the beginning of a swaging or shrinking operation;

FIG. 4 is a view illustrating the operation of reducing the external diameter of the skirt of the piston shoe by turning in a lathe after the swaging or shrinking operation of FIG. 3 has been performed on the skirt of the piston shoe;

FIG. 5 is a diagrammatic view illustrating a rolling or kneading operation performed upon the skirt of the piston shoe after the external diameter of the piston shoe has been reduced to loosen or free the connection or joint produced by the swaging or shrinking operation on the piston shoe skirt whereby the shoe may oscillate and/or rotate upon the ball of the piston without binding;

FIG. 6 is a view in section showing a finished piston and piston shoe assembly, and

FIG. 7 is a view similar to FIG. 6 but showing the piston and piston shoe in different relative positions.

This application is a division of our copending application Serial No. 658,165, filed May 9, 1957, now abandoned, for "A Balanced Piston Shoe and Method of Making It."

We have devised an improved one-piece piston shoe 42 which is best seen in FIGS. 1 and 2 of the drawings and, as hereinafter described in detail, we have devised a new and improved method of permanently attaching this one-piece shoe to a piston. The piston shoe 42 is preferably formed of a swagable resilient high strength bronze and it includes a cylindrical base or sole portion 57 having a flat end, face or sole surface 58 adapted to engage and slide over a flat cam or swash plate surface of a pump or motor, not shown. It also includes a cylindrical neck portion 59 the diameter of which is less than the diameter of the sole portion 57 and the axis of which coincides with the axis of said sole portion 57 and intersects the plane of the flat sole surface 58 at right angles. The neck portion 59 extends between the sole portion 57 and a skirt portion 60 to provide a circular shoulder 61 on the latter

which neck and shoulder are engaged by a hold-down plate of the pump or motor. The skirt portion 60 includes a cylindrical section 62 adjacent the neck portion 59 the diameter of which is preferably made greater than the diameter of the sole portion 57 for the purpose of carrying out our new method of attaching the shoe permanently to a piston, and it includes a section 63 in the form of a frustum of a cone having its greatest diameter where it joins the cylindrical section 62 and tapering to a diameter which is also preferably greater than the diameter of the sole portion 57.

The piston shoe 42 also includes internal walls or surfaces which form a cavity 64 formed symmetrically about the axis of the piston shoe and which includes a hemispherical portion 65 the radius of which originates at a point X on the axis of the piston shoe and which point is substntially at the center of gravity of the piston shoe. The hemispherical portion 65 extends into or is contained substantially wholly within the neck portion 59 of the piston shoe and, as seen in FIG. 1 of the drawings, its open upper end joins a short cylindrical portion including straight parallel walls 66 which extend upwardly and join a generally upwardly outwardly tapering cavity portion having arcuate walls 67.

The cam or swash plate engaging face or surface 58 of the sole portion 57 of the piston shoe is grooved to form an endless circular sealing land 68 (FIG. 2) which is surrounded by four arcuate wear pads 69 and the sealing land 68 surrounds four quadrants which form deflection pads 70. All of the wear pads 69 and the sealing land 68 lie on a first plane whereby they will engage the cam or swash plate surface 43 of the pump but the deflection pads 70 are faced off so that they lie on a second plane spaced slightly from the first plane and which extends through the sealing land and wear pads.

The cam engaging surfaces of the deflection pads 70 are recessed into the sole portion of the piston shoe to permit the shoe to deflect as the hydraulic pressure at which the device into which it is incorporated builds up to or falls below the rated operating pressure of the device and so that should the operating pressure of the device increase above its rated pressure further deflection of the piston shoe, or the sole portion thereof, will be prevented. In this manner, a better seal is obtained between the endless sealing land 68 and the cam plate surface 43 since the sealing land will be pressed upon the cam plate surface with slightly more force than the corresponding sealing land in a conventional piston shoe in which all of the cam plate engaging surfaces are finished to lie on a single plane.

The neck 59 of the piston shoe 46 also includes a recess 71 which is symmetrical about its axis and which opens to the bottom of the hemispherical portion 65 of the cavity 64 and is connected by a central bore or passage 72 with the grooves in the sole surface 58 which are surrounded by the sealing land 68 and lie between the deflection pads 70. This recess 71 and central bore or passage 72 have the well known function of conducting fluid under pressure derived through the piston to the pocket formed within the confines of the sealing land 68 and between the sole portion 57 and the cam or swash plate surface 43.

The particular piston illustrated includes a cylindrical portion 73 (see FIGS. 3, 6 and 7) which is received by and reciprocates in a cylinder in the cylinder barrel of a pump or motor and a generally spherical or ball-like portion 74 connected to the cylindrical portion 73 through a neck 75. The piston is also provided with a stepped bore for reducing its weight and for conducting fluid therethrough to the recess 71.

Steps in our improved method of permanently attaching the piston shoe described to a piston are illustrated in FIGS. 3, 4 and 5 of the drawings and this method includes

placing a thick lubricant, preferably grease, on one or both of the spherical surfaces of the piston shoe and the piston ball **74**, inserting the piston ball **74** in the cavity **64** and into the hemispherical portion **65** of the piston shoe and, as thus assembled, placing the piston and piston shoe in the punch and die apparatus seen in FIG. 3 in the positions illustrated.

The apparatus seen in FIG. 3 of the drawings includes a shrinking die **76** having a bore **77** which tapers downwardly and inwardly from its open mouth **78** to a cylindrical portion **79** at its bottom. The diameter of the mouth **78** is such that the piston shoe can be inserted therethrough and positioned in the die as shown in FIG. 3 of the drawings and the diameter of the bottom cylindrical portion **79** is only slightly larger than that of the sole portion **57** of the piston shoe to permit this portion of the shoe to pass through the die without being deformed. After the piston shoe and piston have been inserted in the shrinking die **76**, a hollow punch **80** is placed over the cylindrical portion **73** of the piston **41** and forced, as by a press, toward the piston shoe and through the die **76**. Punch **80** includes a spring and plunger **81** which engages the end of the piston **41** as the punch **80** moves toward the piston shoe and forces its balled end **74** tightly into the hemispherical portion **65** of the piston shoe. This action will force all but a film of the lubricant from between the abutting surfaces of the ball **74** and the portion **65** of the piston shoe.

When the end of punch **80** engages the end of the skirt portion **60** of the piston shoe, it begins to force the latter through the shrinking die and since the ball end **74** of the piston is held seated in the portion **65**, the die elongates the skirt portion **60** of the piston shoe slightly and reduces or shrinks its outside diameter to swage or form its walls **66** around the ball **74**. This swaging or shrinking operation is completed when the punch **80** forces the piston shoe **42** completely through the bottom cylindrical portion **79** of the shrinking die whereupon the piston and piston shoe are removed from the apparatus.

After the piston shoe **42** has been permanently attached to the piston as above described, the swivel connection between it and the piston will be tight and will require loosening. The loosening operation is accomplished by mounting the piston shoe **42** in a lathe chuck and turning the outside of skirt **60** as by a cutting tool **82** (FIG. 4). This turning operation insures that the outside walls of the skirt form a true cylinder the walls of which extend at right angles to the sole surface **59** and it also prepares the skirt **60** for the second step in the loosening operation in which the skirt **60** is rolled, as by the rolls **83** of the rolling apparatus seen in FIG. 5 to knead and stretch the skirt slightly whereby the walls **66** of the socket in the piston shoe **42** are caused to relax their grip on the ball **74** sufficient to permit free nutating, universal or swivel motion of the piston shoe **42** upon the ball **74**.

It will be obvious from the foregoing that we have devised an improved one-piece piston shoe of swagable material, preferably high strength bronze, which is designed to have its center of gravity on or substantially on a point about which the shoe will spin while being required to oscillate and which point will rotate in or follow a circular path as the device in which the piston shoe is employed is operated and that this point is the origin of the radii of the arcuate or spherical surfaces of the ball and socket elements of the piston and piston shoe. It will also be seen that since the piston shoe is substantially balanced dynamically and statically about the above-mentioned point that centrifugal forces acting upon it when it is operating in a hydraulic fluid pressure energy translating device will have little or no tendency to cause it to tilt or tip with respect to the cam or swash plate of the apparatus and that therefore hese cenrifugal forces are, for practical purposes, not a factor limiting high speed operation of the device.

It will also be obvious from the foregoing that we have

devised a new and improved method of permanently attaching our new and improved piston shoe for nutating or universal movement with the ball element of a piston.

While the form of embodiment of the present invention as herein disclosed constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

We claim:

1. The method of permanently attaching a piston shoe of a fluid pressure energy translating device to a piston thereof for universal movement with respect to the latter through a ball and socket joint including the steps of forming a piston shoe to include a shrinkable skirt portion surrounding a ball socket; forming a piston to include a ball end upon which said shoe is to be mounted; inserting the ball end of said piston in said socket; applying pushing force directly to the end of said skirt portion to force said shoe through the tapered bore of a shrinking die to shrink said skirt portion around said ball end while holdings said ball end in said socket; reducing the outside diameter of said skirt portion; and rolling said skirt portion to loosen the connection produced by said shrinking operation, said shoe thereby being connected to said ball end so that the center of gravity of the shoe coincides with the geometrical center of the ball end.

2. The method of permanently attaching a piston shoe of a fluid pressure energy translating device to a piston thereof for universal movement with respect to the latter through a ball and socket joint including the steps of forming a piston shoe to include a shrinkable skirt portion surrounding a ball socket; forming a piston to include a ball end upon which said shoe is to be mounted; inserting the ball end of said piston in said socket; applying pushing force directly to the end of said skirt portion to force said shoe through the tapered bore of a shrinking die to shrink said skirt portion around said ball end while holding said ball end in said socket; and rolling said skirt portion to loosen the connection produced by said shrinking operation, said shoe thereby being connected to said ball end so that the center of gravity of the shoe coincides with the geometrical center of said ball end.

3. The method of permanently attaching a piston shoe of a fluid pressure energy translating device to a piston thereof for universal movement with respect to the latter through a ball and socket joint including the steps of forming a piston shoe to include a shrinkable skirt portion surrounding a ball socket; forming a piston to include a ball end upon which said shoe is to be mounted; placing a thick lubricant on one of the joint elements; inserting the ball end of said piston in said socket; applying pushing force directly to the end of said skirt portion to force said shoe through the tapered bore of a shrinking die to shrink said skirt portion around said ball end while holding said ball end in said socket; reducing the outside diameter of said skirt portion; and rolling said skirt portion to loosen the connection produced by said shrinking operation, said shoe thereby being connected to said ball end so that the center of gravity of the shoe coincides with the geometrical center of the ball end.

4. The method of permanently attaching a piston shoe of a fluid pressure energy translating device to a piston thereof for universal movement with respect to the latter through a ball and socket joint including the steps of forming a piston shoe to include a shrinkable skirt portion surrounding a ball socket; forming a piston to include a ball end upon which said shoe is to be mounted; placing a thick lubricant on one of the joint elements; inserting the ball end of said piston in said socket; applying pushing force directly to the end of said skirt portion to force said shoe through the tapered bore of a shrinking die to shrink said skirt portion around said ball end wall holding said ball end in said socket; and rolling said skirt portion to loosen the connection produced by said shrinking operation, said shoe thereby being con-

nected to said ball end so that the center of gravity of the shoe coincides with the geometrical center of said ball end.

References Cited in the file of this patent

UNITED STATES PATENTS

1,316,877	Clarkson	Sept. 23, 1919
1,693,748	Fiegel et al.	Dec. 4, 1928
1,798,738	Hoern	Mar. 31, 1931
2,182,601	Venditty	Dec. 5, 1939

2,365,067	Gauld	Dec. 12, 1944
2,462,138	Spangenberg	Feb. 22, 1949
2,476,728	Heim	July 19, 1949
2,626,841	Potter	Jan. 27, 1953
2,724,172	Potter	Nov. 22, 1955

OTHER REFERENCES

Ser. No. 238,270, Molly (A.P.C.), published Apr. 27, 1943.

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,049,800 August 21, 1962

Darby B. Neff et al.

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 4, line 20, for "holdings" read -- holding --; line 73, for "wall" read -- while --.

Signed and sealed this 5th day of March 1963

(SEAL)
Attest:

ESTON G. JOHNSON
Attesting Officer

DAVID L. LADD
Commissioner of Patents