Dec. 1, 1959 C. H. ALLEN 2,915,051

TAPPET

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FIG. 1

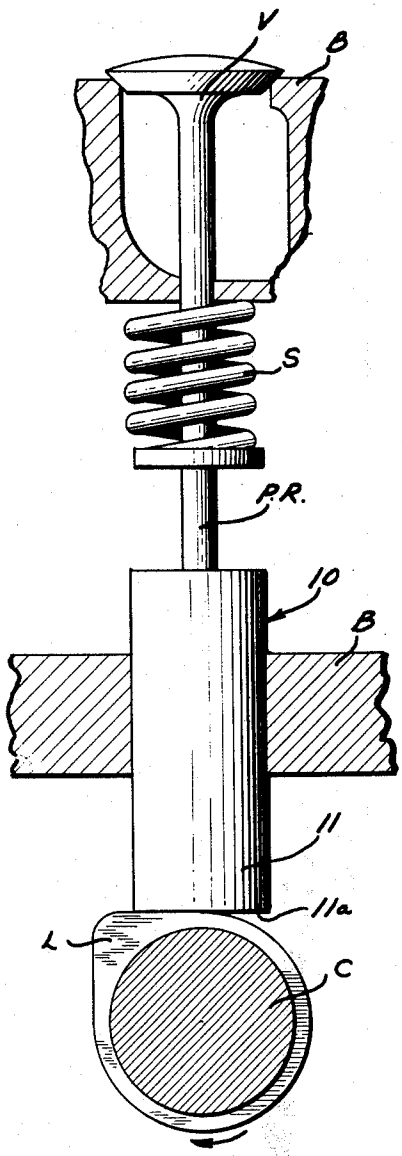
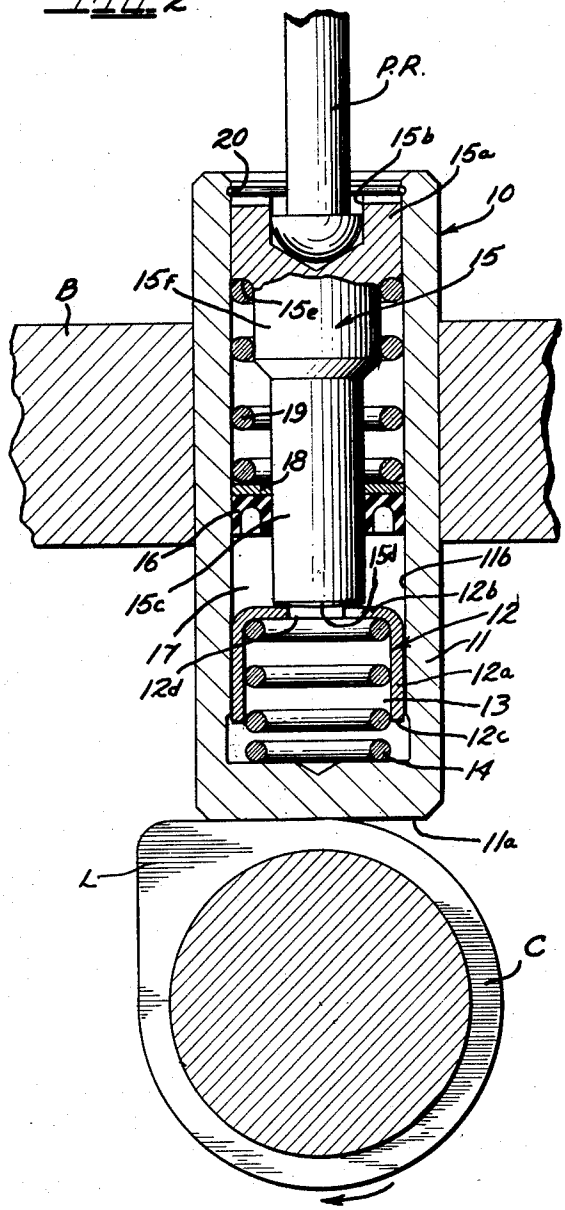


FIG. 2



Inventor
CLIFFORD H. ALLEN

By Hill, Sherman, Meroni, Gross & Simpson Attys

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Fig. 3

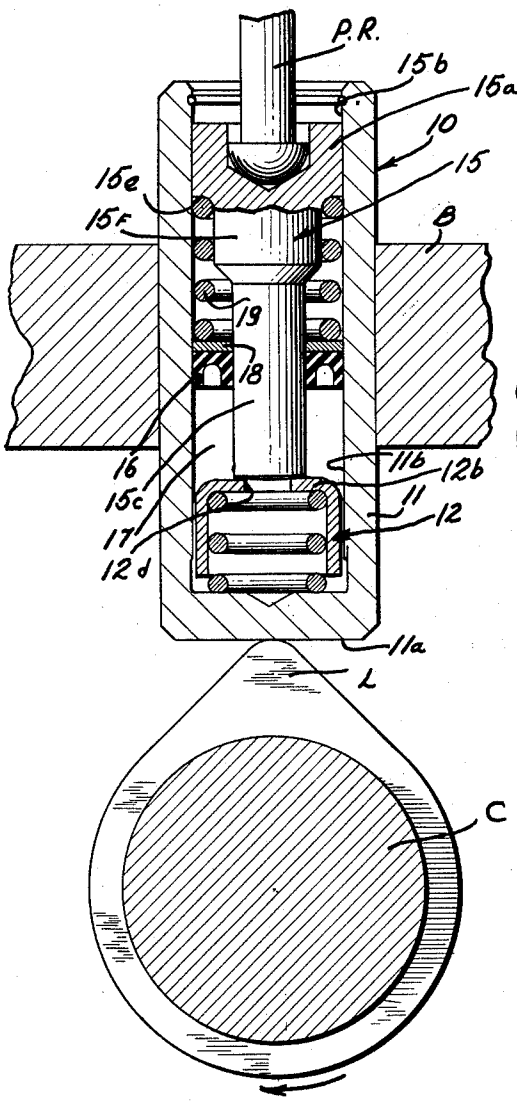
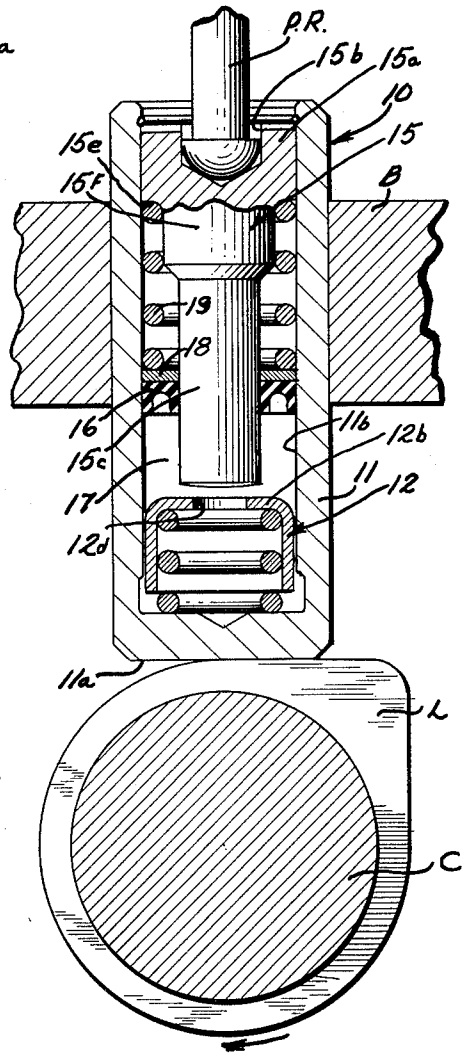


Fig. 4



Inventor
CLIFFORD H. ALLEN

By Hill, Sherman, Meroni, Gross & Simpson Attys

United States Patent Office

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2,915,051

TAPPET

Clifford H. Allen, Cleveland, Ohio, assignor to Thompson Ramo Wooldridge Inc., a corporation of Ohio

Application July 21, 1955, Serial No. 523,561

8 Claims. (Cl. 123—90)

This invention relates to a hydraulic automatic adjuster for taking up clearances in a linkage assembly without, however, causing the linkage to become too tight so as to interfere with the proper operation thereof. The invention more particularly deals with a self-contained hydraulic valve lifter or tappet for maintaining zero valve lash or tappet clearance having an elongated choke ring for maintaining a more consistent leakdown rate under load.

In accordance with the invention, the tappet assembly includes a body closed at one end having a choke ring received in the bore of the body and resiliently biased away from the closed end thereof. The choke ring coacts with the closed end of the body to define a force transmitting chamber and is generally cup-shaped having an elongated length coacting with the body bore to provide a more consistent leakdown rate. An aperture or passage is provided in the closed end of the choke ring. Also slidably received in the bore of the body is a valve having a reduced lower section terminating in a spherical or conically shaped end to define a valve face and for coacting with the valve seat of the choke ring. A resilient or flexible cup seal encircles the reduced section of the valve and engages the bore to define above the choke ring a fluid supply chamber or reservoir. A thin washer rests on the top surface of the cup seal and a spring is provided to urge the seal towards the closed end of the body and load the reservoir. It is seen the instant tappet assembly incorporates a simplified construction, and in operation thereof, the choke ring normally abuts against the valve to separate the force transmitting chamber from the reservoir. The hydraulic fluid in the transmitting chamber acts on the choke ring to maintain it in position against the valve during upward travel of the body, thus, when the body is lifted by the operating cam, fluid in the transmitting chamber will be trapped to force the choke ring and valve to move with the body. However, fluid leakdown will occur through the clearance between the choke ring and the body bore, and, when the body reaches its highest position after opening the valve, the assembly will be somewhat shorter than its original height due to this leakdown. Then when the valve spring load is relieved from the linkage after the valve is seated, the fluid pressure in the force transmitting chamber will drop below the pressure in the reservoir and allow the choke ring to move away from the valve thereby opening the passaged choke ring, whereupon the fluid pressures in the reservoir and the force transmitting chamber are again balanced by the flow of fluid into the force transmitting chamber for the refilling cycle.

Heretofore, self-contained tappet assemblies have included an upper plunger and a lower plunger coacting with the tappet valve and an enlarged head on the valve coacting with the choke ring to function as a valve face. In the instant invention, in the construction of the valve member, the upper plunger is eliminated by using the straight shafted valve member with the end of the shaft functioning as a valve seating surface. Also, in the instant invention, by incorporating a spherical surface on the end of the valve shaft, or a conical surface approaching such spherical surface, the need for a lower plunger is thereby eliminated since any misalignment of the valve shaft will not cause the corresponding leakage at the valve seating surface. Thus, in the present invention, the lower plunger is thereby replaced with a simple flat washer which acts to transmit the force of a return spring to the cup seal and thereby maintain the pressure on the fluid reservoir.

In the past, difficulty has been experienced in assembly of self-contained tappet structures, but such assembly has been simplified in the instant invention by limiting the length of the return spring so that its free length is sufficiently short to prevent this spring from pushing the cup seal off the end of the valve in a free position prior to final assembly of the tappet.

Difficulty has been experienced in the construction of the choke ring of heretofore developed tappet assemblies in providing a relatively inexpensively manufactured choke ring capable of providing a consistent leakdown rate. However, in the present invention, the choke ring is cup-shaped permitting its manufacture as a simple stamping, and the choke spring is fitted inside the choke ring which permits the length of the choke ring to be longer thereby providing a more consistent leakdown rate under load. Thus, an increased length of the leakdown clearance between the choke ring and the bore of the tappet is provided which will permit greater production tolerances on the outside diameter of the choke ring without a corresponding variation in leakdown rates under load. Where production tolerances of the choke ring are held thus sufficiently close, the increased length of the leakdown clearance makes possible a reduction in silicone polymer viscosity used as a hydraulic fluid, thereby contributing to the ease of handling the silicone polymer. In assembly of a tappet, this makes possible a cost reduction since a lower viscosity silicone polymer is known to be less expensive than a heavier viscosity polymer. Inasmuch as the choke spring nestles inside the choke ring of the instant invention, the choke spring is provided of such a length that when the choke ring rests against the bottom of the tappet barrel, the choke spring will not go solid. Thus a simplified means of providing a stop for the tappet in the collapsed position is provided.

Heretofore, the use of a lower plunger on the tappet valve shaft necessitated close tolerances of the shaft. Since the lower plunger in the instant invention is eliminated, greater tolerances on the tappet valve shaft are permitted, as it is only necessary that a sufficiently smooth surface be provided on the shaft to allow the cup seal to perform efficiently as a sealing member. Thus, any variations in the shaft diameter, within limits, are accommodated by the resiliency of the cup seal.

Accordingly, it is an object of this invention to provide an improved tappet assembly of simplified construction having a relatively small number of parts, which may be manufactured with greater production tolerances, and easily assembled, thereby providing a relatively inexpensive tappet assembly.

Another object of this invention is to provide a tappet assembly of such construction, wherein the heretofore upper and lower plungers have been eliminated.

Still another object of this invention resides in the provision of a hydraulic valve lifter having a tappet valve using a straight shaft with the end of the shaft functioning as the tappet valve seating surface of generally spherical or conical shape, wherein any misalignment of the valve shaft will not cause a corresponding leakage at the valve seating surface.

A further object of this invention is to provide a self-contained hydraulic valve lifter, which in the assembly

stage provides a sub-assembly including a tappet valve, a return spring, a thrust washer, and a cup seal utilizing the frictional resistance of the cup seal on the tappet valve shaft to retain these parts in the one sub-assembly stage prior to insertion of the sub-assembly into the tappet barrel, thereby simplifying the assembly operation thereof.

A further feature of this invention resides in the provision of a self-contained hydraulic valve lifter including a choke ring of generally cup-shape which may be manufactured as a simple stamping of increased length without correspondingly increasing the overall tappet length, thereby permitting a more consistent leakdown rate under load. The increased length of the choke ring, of course, increases the length of the leakdown clearance between the choke ring outside diameter and the tappet barrel bore.

Still another object of this invention resides in the provision of a self-contained hydraulic valve lifter having an increased length of leakdown clearance due to a cup-shaped choke ring, wherein greater production tolerances on the outside diameter of the choke ring are permitted without a corresponding variation in leakdown rates under load. However, where these production tolerances are held sufficiently close, the increased length of the leakdown clearance makes possible a reduction in silicone polymer viscosity of the particular fluid used in the tappet, thereby contributing to the ease of handling the fluid in assembly and making possible a cost reduction since lower viscosity silicone polymers are known to be less expensive than the heavier viscosity polymers.

A further object of this invention is to provide a self-contained hydraulic valve lifter, wherein the choke spring nestles inside the cup-shaped choke ring and is of such length as to prevent it from going solid in the collapsed position of the tappet due to the construction of the choke ring.

Still another feature of this invention is to provide a choke ring of cup-shape for a self-contained hydraulic valve lifter, wherein the choke ring is of such length as to be greater than the solid height of the choke spring nestled therein, thereby providing a simplified means of providing a stop for the tappet assembly in the collapsed position.

Still another object of this invention is to provide a tappet valve for a self-contained hydraulic valve lifter, wherein the valve shaft of the valve need not be machined to close tolerances since the lower plunger is now eliminated and it is only necessary that a sufficiently smooth surface be provided on the shaft to allow the cup seal to perform efficiently as a sealing member. Thus, any variations in shaft diameter are accommodated by the resiliency of the cup seal.

Other objects, features and advantages of the invention will be apparent from the following detailed description of the drawings, which, by way of a preferred embodiment, illustrate the invention.

On the drawings:

Figure 1 is a fragmentary sectional view of an engine, with parts in elevation, illustrating a tappet valve constructed in accordance with the invention in operative association with other engine parts;

Figure 2 is a longitudinal cross sectional view, with parts in elevation, of the hydraulic valve lifter according to the invention showing the position of the parts just prior to the valve opening operation;

Figure 3 is a view similar to Figure 2 but illustrating the positions of the parts as the valve is fully opened; and

Figure 4 is a view similar to Figure 2 but showing the position of the parts as the valve is fully closed or just subsequent to the valve opening operation.

As shown on the drawings:

In Figure 1, the tappet assembly of the instant invention is generally indicated by the reference numeral **10** and includes a tappet barrel **11** having a bottom **11*a*** riding on a cam C. The cam C has the majority of the periphery thereof concentrically disposed about its axis to provide a base circle for the cam. The tappet assembly or valve lifter **10** is slidably mounted in the engine block B, and a lobe L on the cam C serves to actuate the lifter **10** upon rotation of the cam for reciprocating a push rod P.R. to open and permit closing of a poppet valve V in the valve train linkage. The poppet valve V is arranged to be seated on a valve seat provided in the engine block, and is biased into seating position by a valve spring S which is locked to the stem of the poppet valve V by a suitable locking means.

The tappet barrel or hollow body is closed at one end and open at the other end and provided with an elongated internal bore **11*b***. A cup-shaped choke ring **12** is slidably received in the barrel bore **11*b*** to coact with the closed end of tappet barrel **11** in providing a hydraulic compression or thrust transmitting chamber **13**. The choke ring **12** includes an elongated substantially cylindrical side wall **12*a*** coacting with the tappet barrel bore **11*b*** to provide an increased leakdown clearance length therebetween which permits a more consistent leakdown rate under load. In other words, a greater restriction is provided by the lengthier leakdown clearance.

The choke ring may be inexpensively manufactured as a simple stamping. The increased length of the leakdown clearance permits greater production tolerances on the outside diameter of the choke ring **12** without a corresponding variation in leakdown rates under load. And, where production tolerances are held sufficiently close, the increased length of the leakdown clearance makes possible a reduction in silicone polymer viscosity of the fluid employed in the lifter of the present invention, thereby contributing to the ease of handling the fluid in assembly and making possible a cost reduction since lower viscosity silicone polymers are known to be less expensive than the heavier viscosity polymers.

The choke ring **12** is resiliently biased away from the closed end of the tappet barrel **11** by a choke spring **14**. The choke spring **14** is bottomed on the closed end of the barrel at one end and nestles within the cup-shaped choke ring **12** to be bottomed on the inside of the closed end **12*b*** of the choke ring. Fitting the choke spring **14** inside of the choke ring **12** permits the length of the choke ring to be longer than in previous designs without a corresponding increase in overall tappet length. The choke ring **12**, in the collapsed position of the valve lifter **10** will rest against the bottom of the tappet barrel **11**, wherein the bottom edge **12*c*** of the choke ring **12** provides a simplified stop for the tappet in the collapsed position. The distance from the bottom edge **12*c*** of the choke ring **12** to the bottoming surface within the choke ring for the choke spring **14** is greater than the solid height of the choke spring **14**. Thus, the choke spring **14** will not go solid when the valve lifter **10** is in a collapsed position.

A valve member **15** is received within the bore of the tappet barrel **11**. The valve member **15** is provided at its upper end with an enlarged guiding section **15*a*** that is cylindrically shaped to slidably engage the barrel bore **11*b***. The enlarged section **15*a*** is recessed at **15*b*** to receive the semi-spherical end of the push rod P.R.

A valve shank or shaft **15*c*** forms the lower end of the valve member **15** and terminates in a spherical shaped end **15*d*** which functions as a valve face. The upper peripheral edge of a centrally disposed aperture or passage **12*d*** in the closed end of the choke ring **12** functions as a valve seat to coact with the valve face **15*d*** in the operation of the lifter assembly. The valve face **15*d*** is preferably formed as a spherical surface, but may be formed as the conical surface approaching such spherical surface. Thus, the need for a lower plunger is thereby eliminated since any misalignment of the valve shaft **15*c*** will not cause the corresponding leakage on the valve seating

surface provided the radius of the spherical valve face 15*d* has its center approximately at the central portion of the enlarged upper end 15*a* of the tappet valve member 15.

A resilient cup seal 16 constructed of any suitable material, such as rubber, encircles the valve shaft 15*c* in intimate engagement therewith, and intimately engages the barrel bore 11*b* to effectively function as a sealing member. A substantially annular fluid supply chamber or reservoir 17 is defined between the ring-shaped cup seal 16 and the choke ring 12, and serves to replenish the compression chamber 13 during the operation of the valve lifter 10.

The diameter of the valve shaft 15*c* need not be machined within close tolerances. It is only necessary that a sufficiently smooth surface be provided on the valve shaft 15*c* to allow the cup seal to perform efficiently as a sealing member. Thus, any variations in shaft diameter, within limits, are accommodated by the resiliency of the cup seal 16.

A relatively thin flat washer 18 overlies the top of the cup seal 16 to function as a bottoming member and to transmit the force of a return spring 19 to the cup seal 16. In other words, the washer 18 serves to transmit the forces of the return spring 19 equally to the entire upper surface of the cup seal 16. The upper end of the return spring 19 is bottomed on a shoulder 15*e* formed by the enlarged end 15*a* of the valve member 15 and a cylindrical section 15*f* that is slightly enlarged from the diameter of the valve shaft 15*c*. It is noted that the section 15*f* is sized to engage the inside diameter of the return spring 19 and provide a guiding section at the upper end thereof to prevent unnecessary shifting of the return spring 19 during the operation of the valve lifter 10.

The assembly of the valve lifter 10 in accordance with the invention is simplified inasmuch as a sub-assembly incorporating the valve member 15, the return spring 19, the thrust washer 18, and the cup seal 16 is now made possible. The free length of the return spring 19 is sufficiently short to prevent this spring from pushing the cup seal 16 off the end of the valve shaft 15*c* in the free position prior to assembling of the tappet, wherein the frictional resistance of the cup seal 16 on the valve shaft 15*c* retains these parts in a single sub-assembly. Thus, after the choke ring 12 and choke spring 14 have been inserted in the tappet barrel 11, and a measured amount of fluid of any suitable type is poured into the barrel, the sub-assembly is then inserted. A locking ring 20 maintains the valve lifter assembled prior to installation in an engine. Upon installation of the sub-assembly, the return spring 19 resiliently biases the cup seal 16 to maintain a pressure on the fluid reservoir 17.

In operation, the parts of the lifter 10 take substantially the positions as shown in Figure 2 before the operation of the lifter begins. The choke spring 14 acting on the push rod P.R. through the choke ring 12 and the valve member 15 takes up all the slack in the valve train and the valve face 15*d* of the valve 15 will be seated on the valve seat of the choke ring 12.

As the cam C rotates in the clockwise direction shown by the arrow to move the lobe L against the bottom 11*a* of the tappet barrel, the lifter moves upwardly. The fluid compression chamber 13, having trapped the solid column of fluid below the choke ring 12 will raise the push rod P.R. through the medium of the valve member 15.

During the upward movement of the lifter 10 and the opening of the poppet valve V, some of the trapped fluid in the compression chamber 13 will leak out between the outside diameter of the choke ring 12 and the barrel bore 11*b* into the reservoir 17. This action will cause the valve member 15 and the choke ring 12 to move downwardly into the barrel bore 11*b* and compress the choke spring 14 as shown in Figure 3. Due to the decrease of volume at the lower end of the tappet barrel 11 by the valve shaft 15*c*, the cup seal 16 will be forced upwardly to slightly compress the return spring 19. Thus, the valve train assembly is shortened. Subsequent to the valve opening operation when the cam lobe L has passed the bottom 11*a* of the body 11, the parts of the lifter 10 take the position as shown in Figure 4. As the tappet barrel 11 lowers, the valve member 15 will unseat from the valve seat of the choke ring 12, and the force of the return spring 19 against the cup seal will force the fluid in the reservoir 17 to flow around the valve face 15*d* and through the passage 12*d* of choke ring 12 into the compression chamber 13. This allows choke ring 12 to move upwardly and to again seat on the spherical end 15*d* of valve 15 to complete the cycle.

Thus, it is seen that the present invention provides a self-contained hydraulic valve lifter or tappet having a minimum number of parts which may be easily assembled to attain a highly efficient lifter of relatively low cost.

It will be understood that modifications and variations may be effected without departing from the scope of the novel concepts of the present invention, but it is understood that this application is to be limited only by the scope of the appended claims.

I claim as my invention:

1. A self contained valve tappet assembly comprising a tappet barrel having a closed bottom, an open top with a cylindrical bore between the open top and closed bottom, a cup-shaped choke ring slidably received in said barrel, said cup-shaped choke ring having an upper end wall and a depending cylindrical wall, said end wall having an aperture therein forming a port, a coil spring bottomed with its lower end upon the bottom of said tappet barrel, the under side of the end wall of said choke ring resting and coacting with the upper end of said coil spring, the side wall of said choke ring separating said coil spring from said cylindrical bore of the tappet barrel, said coil spring biasing said choke ring away from the closed end of said tappet barrel, a slidable thrust load transmitting valve member provided at its upper end with an enlarged guiding section, a central section of reduced diameter below said guiding section, an end section of a still further reduced diameter below said central section and a valve face formed at the lowermost free end of said end section, said enlarged guiding section cylindrically shaped to slidably engage the tappet barrel bore, a return spring assembled below said guiding section and arranged between said central section and said tappet bore, said central section engaging the inside diameter of said return spring for guiding same within said tappet bore, a resilient cup seal encircling the cylindrical surface of said end section of said valve member and in intimate engagement therewith and intimately engaging the tappet barrel cylindrical bore to effectively function as a sealing member, a washer overlying the top of said seal to function as a bottoming member for said return spring and to transmit the force of said return spring to the entire upper surface of said cup seal, said cup seal defining with said choke ring an annular hydraulic fluid supply chamber therebetween, said coil spring below said choke ring biasing said choke ring upwardly whereby said valve face upon the lower end of said valve member will resiliently close said port in said choke ring, the end wall of said choke ring with its port closed by said valve face defining with the closed end of said tappet barrel a cylindrical hydraulic fluid compression chamber therebetween, said port in said choke ring providing communication between said hydraulic fluid chamber and the space encircling the lower end portion of said thrust valve member, said valve face on said valve member coacting with said port to control the flow of fluid therethrough, an annular groove in the cylindrical bore of the tappet barrel adjacent the open end thereof, and a locking ring assembled in said annular groove to prevent said valve

member from passing outside said tappet barrel thereby providing a self contained unit.

2. A self contained valve tappet assembly comprising a tappet barrel having a closed bottom and an open top with a cylindrical bore between the open top and closed bottom, a cup-shaped choke ring slidably received in said barrel, said cup-shaped choke ring having an upper end wall and a depending cylindrical wall, said end wall having an aperture therein forming a port, a coil spring bottomed with its lower end upon the bottom of said tappet barrel, the under side of the end wall of said choke ring resting and coacting with the upper end of said coil spring, the side wall of said choke ring separating said coil spring from said cylindrical bore of the tappet barrel, said coil spring biasing said choke ring away from the closed end of said tappet barrel, a slidable thrust load transmitting valve member provided at its upper end with an enlarged guiding section, a central section of reduced diameter below said guiding section, an end section of a still further reduced diameter below said central section, and a spherical valve face formed at the lowermost free end of said end section, said enlarged guiding section cylindrically shaped to slidably engage the tappet barrel bore, a return spring assembled below said guiding section and arranged between said central section and said tappet bore, said central section engaging the inside diameter of said return spring for guiding same within said tappet bore, a resilient cup seal encircling the cylindrical surface of said end section of said valve member and in intimate engagement therewith and intimately engaging the tappet barrel cylindrical bore to effectively function as a sealing member, a washer overlying the top of said seal to function as a bottoming member for said return spring and to transmit the force of said return spring to the entire upper surface of said cup seal, said cup seal defining with said choke ring an annular hydraulic fluid supply chamber therebetween, said coil spring below said choke ring biasing said choke ring upwardly whereby said spherical valve face upon the lower end of said valve member will resiliently close said port in said choke ring, the end wall of said choke ring with its port closed by said spherical valve face defining with closed end of said tappet barrel a cylindrical hydraulic fluid compression chamber therebetween, said port in said choke ring providing communication between said hydraulic fluid chamber and the annular fluid supply chamber encircling the lower end portion of said thrust valve member, said spherical valve face on said valve member coacting with said port to control the flow of fluid therethrough, a narrow passage between the cylindrical wall of said choke ring and the cylindrical wall of said tappet bore forming a fluid leakage passage for the fluid in the compression chamber to pass out into the fluid reservoir allowing the valve member and the choke ring to move downwardly into the bore of the tappet barrel, an annular groove in the cylindrical bore of the tappet barrel adjacent the open end thereof, and a locking ring assembled in said annular groove to prevent said valve member from passing outside said tappet barrel thereby providing a self contained unit.

3. A self contained valve tappet assembly comprising a tappet barrel having a closed bottom and an open top with a cylindrical bore between the open top and closed bottom, a cup-shaped choke ring slidably received in said barrel, said cup-shaped choke ring having an upper end wall and a depending cylindrical wall, said end wall having an aperture therein forming a port, a coil spring bottomed with its lower end upon the bottom of said tappet barrel, the underside of the end wall of said choke ring resting and coacting with the upper end of said coil spring, the side wall of said choke ring separating said coil spring from said cylindrical bore of the tappet barrel, said coil spring adapted to bias said choke ring away from the closed end of said tappet barrel, a slidable thrust load transmitting valve member provided at its upper end with an enlarged guiding section, a central section of reduced diameter below said guiding section, an end section of a still further reduced diameter below said central section, and a spherical valve face formed at the lowermost free end of said end section, said enlarged guiding section cylindrically shaped to slidably engage the tappet barrel bore, a return spring assembled below said guiding section and arranged between said central section and said tappet bore, said central section engaging the inside diameter of said return spring for guiding same within said tappet bore, a resilient cup seal encircling the cylindrical surface of said end section of said valve member and in intimate engagement therewith and intimately engaging the tappet barrel cylindrical bore to effectively function as a sealing member, the top surface of said cup seal receiving and withstanding the entire biasing force of said return spring, said cup seal defining with said choke ring an annular hydraulic fluid supply chamber therebetween, said coil spring below said choke ring biasing said choke ring upwardly whereby said spherical valve face upon the lower end of said valve member will resiliently close said port in said choke ring, the end wall of said choke ring with its port closed by said spherical valve face defining with closed end of said tappet barrel a cylindrical hydraulic fluid compression chamber therebetween, said port in said choke ring providing communication between said hydraulic fluid chamber and the annular fluid supply chamber encircling the lower end portion of said thrust valve member, said spherical valve face on said valve member coacting with said port to control the flow of fluid therethrough, a narrow passage between the cylindrical wall of said choke ring and the cylindrical wall of said tappet bore forming a fluid leakage passage for the fluid in the compression chamber to pass out into the fluid reservoir allowing the valve member and the choke ring to move downwardly into the bore of the tappet barrel, an annular groove in the cylindrical bore of the tappet barrel adjacent the open end thereof, and a locking ring assembled in said annular groove to prevent said valve member from passing outside said tappet barrel thereby providing a self contained unit.

4. A hydraulic tappet assembly for transmitting reciprocating forces to operate a valve comprising in combination an elongated tubular tappet barrel having a cylindrical hollow inner chamber open at the upper end and closed at the lower end for engagement with a cam and to close said inner chamber, a hollow inverted cup-shaped choke ring having an upper end wall and a downwardly extending tubular side wall slidably engaged with the inner surface of the lower end of said inner chamber to form a compression chamber bounded by the inside of the choke ring and the closed end of the tappet barrel with a relatively long annular leakdown passage defined between the tubular side wall and the inner wall of said chamber to permit substantial manufacturing tolerances, said choke ring having a centrally located passage through the upper end wall with an upwardly facing valve seat surrounding said passageway, an elongated one-piece tappet valve plunger slidably housed within the tappet barrel above said choke ring, said valve plunger having an enlarged upper end adapted at the top to connect to a push rod and with an outer surface slidable within the upper end of the tappet barrel, said valve plunger having a straight shanked lower end of smaller diameter than the upper end and being of substantially uniform diameter to the terminal lower end with a lower terminal self-aligning valve face for seating on said valve seat on the choke ring, a resilient annular cup seal frictionally mounted on said straight shanked lower end of the valve plunger accommodating variance in diameter of said straight shanked lower end, said seal having a central opening to accommodate said lower end and sized so that the seal must be slid over the lower end and will frictionally hold its position on said end, a coil compression return spring above said cup seal and below said enlarged upper end of the valve plunger and being

of a length less than said straight shanked end so that the cup seal is not pushed off the end of said straight end during operation and during assembly, and a coiled compression choke spring housed within the choke ring and bearing upwardly against the end wall of the choke ring and downwardly against the lower end of said tappet barrel and having a compressed length less than the length of the side wall of the tappet barrel so that the spring will not go solid when the choke ring is forced to the bottom of the tappet barrel.

5. A hydraulic tappet assembly for transmitting reciprocating forces to operate a valve comprising in combination an elongated tubular tappet barrel having a cylindrical hollow inner chamber open at the upper end and closed at the lower end for engagement with a cam and to close said inner chamber, a choke ring slidably located within the lower end of the tappet barrel to form a compression chamber between the closed end of the tappet barrel and the ring, said ring having a flow passageway therethrough with an upwardly facing self-aligning valve seat, an elongated tappet valve plunger slidably housed within the tappet barrel above said choke ring, said valve plunger having an enlarged upper end adapted at the top to connect to a push rod and with an outer surface slidable within the upper end of the tappet barrel, said valve plunger having a straight shanked lower end of smaller diameter than the upper end and being of substantially uniform diameter to the terminal lower end with a lower terminal self-aligning valve face for seating on said valve seat on the choke ring, a resilient annular cup seal frictionally mounted on said straight shanked lower end of the valve plunger accommodating variance in diameter of said straight shanked lower end, said seal having a central opening to accommodate said lower end and sized so that the seal must be slid over the lower end and will frictionally hold its position on said end, and a return choke ring biasing means connected to urge the choke ring upwardly against the valve plunger, and spring means above said cup seal and below said enlarged upper end of the valve plunger for urging said seal downwardly on the lower end of the plunger.

6. A hydraulic tappet assembly for transmitting reciprocating forces to operate a valve comprising in combination an elongated tubular shaped tappet barrel having a cylindrical hollow inner chamber open at the upper end and closed at the lower end for engagement with a cam and to close said inner chamber, a choke ring slidably located within the lower end of the tappet barrel to form a compression chamber between the closed end of the tappet barrel and the ring, said ring having a flow passageway therethrough with an upwardly facing self-aligning valve seat, an elongated tappet valve plunger slidably housed within the tappet barrel above said choke ring, said valve plunger having an enlarged upper end adapted at the top to connect to a push rod with an outer surface slidable within the upper end of the tappet barrel, said valve plunger having a straight shanked lower end of smaller diameter than the upper end and being of substantially uniform diameter to the terminal lower end with a lower terminal self-aligning valve face for seating on said valve seat on the choke ring, a resilient annular cup seal frictionally mounted on said straight shanked lower end of the valve plunger accommodating variance in diameter of said straight shanked lower end, said seal having a central opening to accommodate said lower end and sized so that the seal must be slid over the lower end and will frictionally hold its position on said end, a coil compression return spring above said cup seal and below said enlarged upper end of the valve plunger, a flat relatively thin annular washer encircling said plunger and located between the lower end of said spring and the upper face of said cup seal and relatively freely fitting the plunger so that wide manufacturing tolerances may be used for the lower end of the plunger, and a return choke ring biasing means connected to urge the choke ring upwardly against the valve plunger.

7. A hydraulic tappet assembly for transmitting reciprocating forces to operate a valve comprising in combination an elongated tubular tappet barrel having a cylindrical hollow inner chamber open at the upper end and closed at the lower end for engagement with a cam and to close said inner chamber, a choke ring slidably located within the lower end of the tappet barrel to form a compression chamber between the closed end of the tappet barrel and the ring, said ring having a flow passageway therethrough with an upwardly facing valve seat, an elongated tappet valve plunger slidably housed within the tappet barrel above said choke ring, said valve plunger having an enlarged upper end adapted at the top to connect to a push rod and with an outer surface slidable within the upper end of the tappet barrel, said valve plunger having a straight shanked lower end of uniform diameter smaller than the upper end with a valve face at the lower end for coaction with said valve seat on the choke ring, a resilient annular cap seal frictionally mounted on said straight shanked lower end of the valve plunger accommodating variance in diameter of said straight shanked lower end, said seal having a central opening to accommodate said lower end and sized so that the seal may be slid over the lower end and will frictionally hold its position on said end, a coil compression return spring above said cup seal and below said enlarged upper end of the valve plunger and being of a length less than said straight shanked end so that the cup seal is not pushed off the end of said straight end during operation and during assembly, and a return choke ring biasing means connected to urge the choke ring upwardly against the valve plunger.

8. A hydraulic tappet assembly for transmitting reciprocating forces to operate a valve comprising in combination an elongated tubular tappet barrel having a cylindrical hollow inner chamber open at the upper end and closed at the lower end for engagement with a cam and to close said inner chamber, a hollow inverted cup-shaped choke ring having an upper end wall and a downwardly extending tubular side wall slidably engaged with the inner surface of the lower end of said inner chamber to form a compression chamber bounded by the inside of the choke ring and the closed end of the tappet barrel with a relatively long annular leakdown passage defined between the tubular side wall and the inner wall of said chamber to permit substantial manufacturing tolerances, said choke ring having a centrally located passage through the upper end wall with an upwardly facing valve seat surrounding said passageway, an elongated one-piece tappet valve plunger slidably housed within the tappet barrel above said choke ring, said valve plunger having an enlarged upper end adapted at the top to connect to a push rod with an outer surface slidable within the upper end of the tappet barrel, said valve plunger having a straight shanked lower end of smaller diameter than the upper end and being of substantially uniform diameter to the terminal lower end, a convex self-aligning valve face at the terminal lower end of said valve plunger for seating on said valve seat on the choke ring, a resilient annular cup seal frictionally mounted on said straight shanked lower end of the valve plunger accommodating variance in diameter of said straight shanked lower end, said seal having a central opening to accommodate said lower end and sized so that the seal may be slid over the lower end and will frictionally hold its position on said end, a coil compression return spring above said cup seal and below said enlarged upper end of the valve plunger and being of a length less than said straight shanked end so that the cup seal is not pushed off the end of said straight end during operation and during assembly, and a coiled compression choke spring housed within the choke ring and bearing upwardly against the end wall of the choke ring and downwardly against the lower end of said

tappet barrel and having a compressed length less than the length of the side wall of the tappet barrel so that the spring will not go solid when the choke ring is forced to the bottom of the tappet barrel.

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