June 21, 1960 P. F. BERGMANN 2,941,523

HYDRAULIC TAPPET

Filed Jan. 14, 1959

Fig. 1.

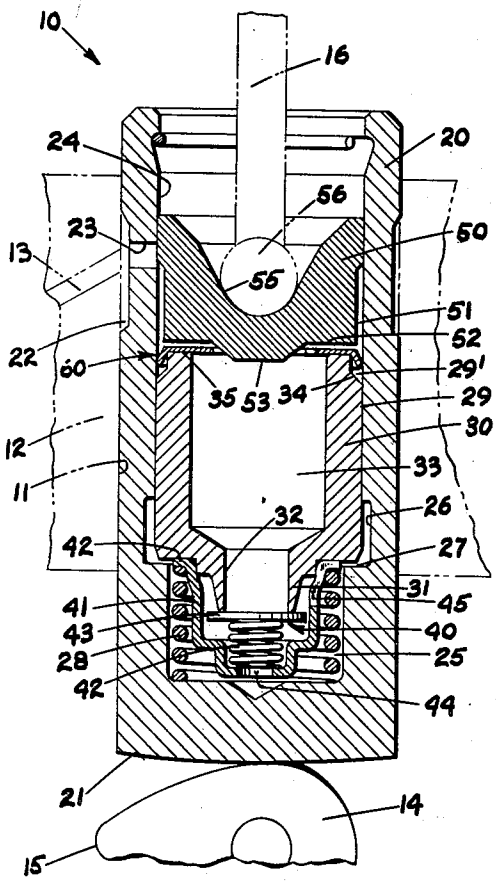


Fig. 2.

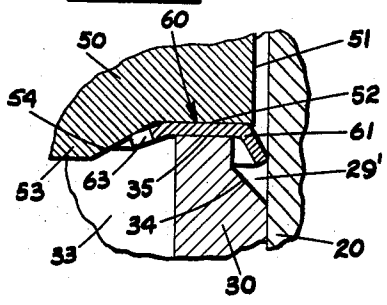


Fig. 3.

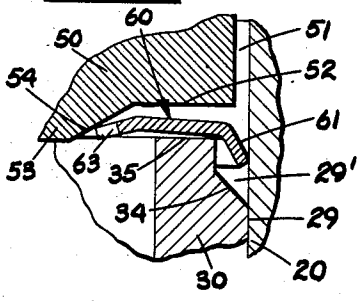
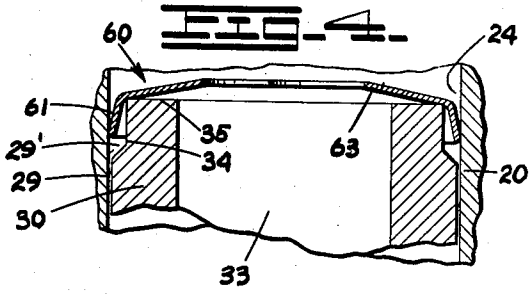


Fig. 4.



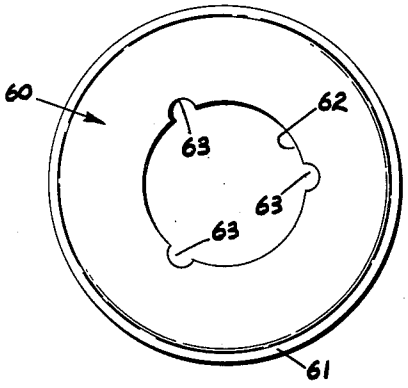


Fig. 5.

INVENTOR
PAUL F. BERGMANN

BY Price and Heneveld
ATTORNEY

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HYDRAULIC TAPPET

Paul F. Bergmann, North Muskegon, Mich., assignor to Johnson Products, Inc., Muskegon, Mich., a corporation of Michigan

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8 Claims. (Cl. 123—90)

This invention relates to tappets in general, and more particularly to hydraulic tappets.

Hydraulic tappets are used in automotive and other engines as slack adjusters for the engine valve lifting means. When an engine is just being started, the parts on an engine valve lifter train are contracted and consequently of less length than under normal engine operating conditions. As an engine warms up and the engine temperatures rise, the valve train parts expand and increase in length. Tappets are self-adjusting means which are interposed in the engine valve operating train to compensate for the change which takes place.

The most commonly known and used type of hydraulic tappet is one in which a variable capacity fluid chamber space is used to transmit the valve lifting force. This may be accomplished by having a plunger member disposed within a blind end passage to form such a fluid chamber space. The volume of the chamber space is decreased to compensate for valve train growth by bleeding fluid off through the clearance space between the plunger and the blind end passage forming member.

The bleeding off of hydraulic fluid through the clearance space between the plunger and the plunger receiving member is commonly known as "leakdown." Leakdown control is entirely dependent upon holding close tolerances in the plunger and cylinder members of the tappet to obtain a minimal clearance space therebetween. Quite obviously, it is expensive to machine the parts to the required close tolerances, to inspect and sort the parts, and to later assemble them. Over or under sized clearance spaces will result in an ineffective tappet.

It is an object of this invention to provide a hydraulic tappet in which these close tolerances and minimal clearances are not required to be so closely maintained.

It is an object of this invention to disclose valve means which may be used to control the fluid bleed off from the pressure chamber space in hydraulic tappets. Accordingly, the close tolerances and minimal clearance spaces are no longer required to be so carefully maintained. There is also less stringency in the inspection and sorting of the tappets and no appreciable problem in the assembly of the tappet parts.

It is also an object of this invention to disclose a simple and relatively inexpensive form of relief valve means for the pressure chamber space and one which may be incorporated within presently known hydraulic tappets. No appreciably expensive tooling changes are necessary. The valve means is simply interposed between the plunger and push rod seat members.

Another object of this invention is to disclose a highly suitable pressure chamber valve means for use in hydraulic tappets. The relief valve hereinafter described provides a seal between the reservoir inlet to the tappet and the pressure chamber space. It also serves as a control valve between the reservoir inlet and reservoir chamber space.

Still another object of this invention is to disclose a relatively simple and inexpensive pressure chamber valve means, in and of itself. The valving member is a coned or dished annular ring having its outer edge formed as a sealing means and its inner edge notched for allowing fluid flow to the reservoir chamber under certain operating conditions.

Another problem prevalent in conventionally known tappets, particularly at high engine speeds, is a condition known as tappet pump-up.

The commonly known form of hydraulic tappet provides for continuous or almost continuous communication between the hydraulic fluid supply source and the reservoir chamber of the tappet. At high engine speeds this free communication of fluid to the reservoir chamber, the inherent resiliency in the valve train parts, engine valve spring fluctuations, etc., set up false requirements for tappet adjustment which cause a premature and generally incorrect exchange of fluid between the reservoir and pressure chambers.

In addition to the objects of this invention aforementioned, it is an object to disclose a tappet in which all adjustment of the effective length of the tappet occurs while the tappet is on the base circle of the actuating cam. This avoids the necessity for communication between the fluid supply source and the reservoir chamber during the tappet stroke. Accordingly the reservoir feed passage may be closed during the tappet stroke to avoid any false response attributable thereto.

Another object of this invention, with respect to avoiding tappet pump-up, is to provide a novel means of reservoir communication and one which may be readily shut off during tappet operation.

Still another object of this invention, with respect to tappet pump-up problems, is to disclose an anti-surge means for use within a tappet to compensate for resiliency in the valve train parts and engine valve spring fluctuations, which normally create false conditions for tappet adjustment.

A further object of this invention, in the same vein, is to disclose anti-surge means incorporated within another operable tappet part. Accordingly no extra tappet parts are required and the material and assembly costs of the tappet are not increased in providing such an additional feature.

These and other objects and advantages in the practice of this invention will be more apparent in the illustration and description of a working embodiment of the invention, as hereinafter set forth.

In the drawings:

Fig. 1 is a cross sectional plan view of a hydraulic tappet including the features of this invention.

Fig. 2 is an enlarged fragmentary section of the tappet shown by Fig. 1 illustrating the relief valve in one of its operating positions.

Fig. 3 is an enlarged fragmentary section of the tappet shown by Fig. 1 illustrating the relief valve in another of its operating positions.

Fig. 4 is an enlarged fragmentary section of the tappet of Fig. 1 showing the plunger and valve means, per se.

Fig. 5 is an enlarged top plan view of the valve member itself.

The hydraulic tappet shown in the drawings includes a cylindrical member closed at its lower end and having a passage formed therein to receive a plunger member. The plunger member forms a pressure chamber space with the blind end of the cylinder body and is hollow to form a reservoir chamber space. A check valve is provided at the end of the plunger member between the reservoir and pressure chamber spaces. A compression spring is disposed within the pressure chamber space to bias the plunger away from the closed end of the cylinder body.

A push rod seat, for the push rod member of the engine valve train, is disposed within the open end of the cylinder body. It is disposed over the plunger member

and is formed to close the reservoir chamber space thereof.

The relief valve of this invention is provided between the push rod seat and plunger members. The push rod seat member includes an undercut annular groove to supply hydraulic fluid to the reservoir chamber space through the relief valve. The outer periphery of the relief valve forms a seal between the annular pressure chamber space, between the plunger and cylinder bodies, and the reservoir supply groove of the push rod seat member.

During the operation of the tappet the operating cam raises the cylinder body member and the fluid in the pressure chamber space, being incompressible, transmits such force to the plunger member. The plunger member acts against the relief valve, closing the reservoir feeding side thereof. It then acts through the push rod seat member to lift the valve operating push rod member. Any growth in the valve train parts during the rise and fall of the tappet is not immediately apparent. However, just prior to the return of the cylinder body member to the base circle of the operating cam the increase in the effective length of the valve train parts becomes apparent. At that moment the push rod member seeks to move the plunger member lower within the cylinder body, causing an increase in the pressure within the pressure chamber spaces, and results in the relief valve raising to permit a bleed off of fluid and the lowering of the plunger member.

The specific operation of the relief valve will be better understood in the following detailed description of structure and operation.

The hydraulic tappet **10** includes a cylindrical tappet body member **20** having its lower end **21** closed. The cylinder body member **20** is mounted for reciprocation within a guide passage **11** in an engine valve block **12** (shown in phantom). The outer surface of the cylinder body member **20** is formed to include a wide annular groove **22** near its upper end. The groove **22** cooperates with a reservoir feed galley **13** in the engine block **12**. A passage **23** is formed through the tappet body member **20**, within the annular groove **22**, for communication with the cylindrical chamber space **24** thereof.

An engine valve operating cam **14** is mounted under the blind end **21** of the tappet body member **20**. The eccentric end **15** of the cam is intended to lift the tappet body member **20** within the engine block guide passage **11**. An engine valve operating push rod member **16** is received within the open end of the cylindrical chamber space **24** and is engaged with certain parts of the tappet **10** to be described. The engine valve spring (not shown) acts through the push rod member **16** to keep the tappet engaged on the cam **14** at all times.

Within the cylindrical passage **24** of the tappet body member **20** there is disposed the tappet plunger member **30**. The plunger member **30** forms a pressure chamber space **25** with the blind end of the tappet body member **20**. The end of the plunger member **30** is necked down as at **31** and includes a passage **32** therethrough which is closed by a check valve **40**. The cylinder body member **20** is undercut at **26**, around the lower end of the plunger member **30**, and is formed to provide a bottoming shoulder **27** for the plunger member.

A check valve cage **41** is fitted on the end of the plunger member **30** within the pressure chamber space **25**. The cage **41** includes a flange **42** upon which is received the upper end of a coiled compression spring **28**. The compression spring **28** is disposel within the pressure chamber space **25** and bears against the blind end thereof. The valve cage **41** may be press fitted on the necked end **31** of the plunger **30** or may be held engaged thereto by the spring **28**.

The check valve **40** is disposed within the valve cage **41**. The check valve **40** includes a light coiled compression spring **42** seated on the valve cage and holding a valve plate **43** against the end of the passage **32** which is formed through the plunger member **30**. The valve cage **41** includes an end opening **44** and side openings **45** to allow fluid flow therethrough.

The tappet plunger member **30** is formed to include a reservoir chamber space **33**. The passage **32** is in open communication with the reservoir **33**. The upper end of the plunger member **30** is formed to include an annular groove **34** about its outer periphery and to provide a valve seat face **35** at the terminal end thereof.

Between the plunger member **30** and the cylinder body **20** is an annular clearance space **29**. This clearance space is in the order of .004. As compared to the .0002 clearance space previously required to be maintained between these parts, for leakdown controlled tappets, such space is in effect part of the pressure chamber space **25**. The annular space **29'** about the upper end of the plunger member **30** is similarly to be considered part of the pressure chamber space **25** since it is in open communication therewith through the clearance space **29**.

A push rod seat member **50** is disposed within the upper end of the blind end passage **24** of the tappet body member. The push rod seat member **50** includes a wide annular groove **51** within its outer periphery and extending to its lower end. A valve seat face **52** is provided on its lower terminal end. The valve seat face **52** is annular and includes a boss **53** with a coned side wall **54** centrally thereof. The boss **53** extends within the reservoir space **33** of the plunger **30** when the push rod seat **50** is seated thereover.

The upper end of the push rod seat **50** is formed to include a spherical seat **55** for the ball headed end **56** of the push rod member **16**.

Between the valve seat face **52** of the push rod seat **50** and the valve seat face **35** of the plunger **30** is disposed the valve member **60**. The valve member **60** is a dished and preferably thin metallic annular disk, as shown in Figs. 4 and 5, in a substantially free state. The outer peripheral edge of the valve disk **60** is formed downwardly and out, as at **61**. The inner peripheral edge **62** forms an opening which is smaller than the boss **53** on the end of the push rod seat member **50**. Notches **63** are provided in the inner edge **62** of the valve plate at circumferentially spaced intervals.

As shown by Fig. 4, the outer peripheral edge **61** of the valve member normally bears against the side wall of the cylinder passage **24**. When the push rod seat member **50** and the plunger member **30** have the valve **60** seated therebetween, as in Fig. 2, the outer edge **61** is held against the cylinder wall with a resilient force resulting from forcibly straightening out the dished disk. Further, the inner peripheral edge **62** of the valve member is bent down by the coned wall **54** of the push rod seat boss **53** extending beyond the plunger valve seat face **53**. This cuts off and closes communication between the reservoir feed groove **51** and the reservoir space **33** via the notches **63**.

The different dispositions of the valve member **60** will be further described in the discussion of tappet operation which follows.

A snap ring groove **18** is formed internally within the upper end of the chamber space **24**, of the tappet body member, and a snap ring **19** is received therein to keep the parts mentioned assembled as described.

OPERATION

The tappet **10** is shown in Fig. 1 with the engine valve closed. The push rod member **16** is in its lower extended position. The valve member **60** holds the push rod seat member **50** and plunger member **30** spaced apart. The resilient strength of the inner periphery **62** of the valve plate **60** is sufficiently greater than the plunger return spring **28** to hold the push rod seat and plunger members separated. However, it is of less strength than the engine valve spring, to be assured that the engine valve is closed. The return spring **28** is of sufficient strength

to hold the valve seat 35 closed on the valve plate and the outer peripheral edge under compression against the cylinder space wall.

When the engine is started, hydraulic fluid at engine operating pressure is supplied to the reservoir chamber space 33. The fluid flow is through the galley passage 13, groove 22, and passage 23 into the cylinder body. The flow continues through the annular groove 51 about the push rod seat 50, under the end face 52 thereof, and through the valve plate notches 63 into the reservoir.

As the valve operating cam 14 rotates and brings its eccentric end 15 under the blind end 21 of the cylinder body member 20, the tappet body member begins its rise. The hydraulic fluid within the chamber spaces 25, 29 and 29' is trapped by the valve 60 seated on the plunger end 35. The fluid, being incompressible, transmits the lift force to the plunger member 30 and raises it with the cylinder body member 20. The plunger 30 lifts the valve plate 60 towards the push rod seat 50 and causes the inner periphery 62 thereof to fold down and allow the valve to seat on the push rod seat 52. This closes the reservoir feed passage. The plunger member 30 acts through the valve plate 60 and against the push rod seat 50 to raise the push rod member 16 and initiate the opening of the engine valve (not shown).

The resistance offered by the engine valve spring (not shown), to allowing the engine valve to be opened, is an increasingly greater resistant force as the engine valve spring is compressed. The increasing resistant force to tappet movement (as part of the valve actuating train) is counterbalanced by a greater fluid pressure force built up within the pressure chamber space 25. During the rise of the tappet and the increase in this fluid pressure condition there is an equalization of fluid pressure within the pressure chamber connected spaces 29 and 29'. The larger clearance in the annular space 29 enables a more ready response to a change in the fluid pressure condition of the pressure chamber space 25 than in conventionally known leakdown type tappets.

As the crest of the eccentric end 15 of the valve operating cam 14 passes under the end of the tappet body 20, the tappet begins its descent. There is no appreciable change in the relationship of the tappet parts. As the engine valve operating spring expands in closing the engine valve, and its resistant force depreciates, the fluid pressure condition in the pressure chamber space 25 also drops off. Any growth in the effective length of the valve train parts is not yet apparent in effecting any change in the operation of the tappet 10.

During the descent of the tappet to the base circle of the cam 14, it will be appreciated that the pressure condition in the annular chamber space 29' is falling off as is the pressure condition in the pressure chamber 25.

As the tappet body member 20 approaches the base circle of the cam 14, any growth in the valve train parts will become apparent. The push rod member 16 returns to a lower relative position than it previously occupied. The push rod seat member 50 also assumes a lower relative position. The valve member 60, through the resiliency of its inner periphery 62 acting against the push rod seat member 60, urges the plunger 30 and the cylinder body 20 toward the base circle of the cam 14.

Because of the lower relative disposition of the push rod seat 50 the valve member 60 is not afforded sufficient space to open as before. Consequently the resiliency of the valve plate 60 acts against the plunger 30, creating an increased fluid pressure condition in the pressure chamber spaces 25, 29 and 29'. This pressure, in the annular space 29', lifts the valve 60 off the valve seat 35 to bleed sufficient fluid from the pressure chamber spaces to allow the plunger to assume a lower relative position within the cylinder body, as it is required to do.

When the plunger member 30 has assumed its properly readjusted position, within the cylinder body 20, the reservoir chamber space 33 is open to the annular feed groove 51 through the notches 63 in the valve 60.

Should the fluid pressure condition in the pressure chamber spaces fall below that of the reservoir chamber 33, the check valve 40 will open to permit an equalization of fluid pressure therebetween. This will occur only while the tappet is on the base circle of the cam 14 since the reservoir chamber 33 is normally closed during the tappet stroke.

The resilient character of the valve member 60 enables it to serve as an anti-surge means and to prevent false pressure conditions in the reservoir space 33 which might otherwise open valve 40 and create a tappet pump-up problem. The spring strength of the valve plate member 60 is greater than that of the plunger return spring 28. Thus, any variance in the engine valve spring resistance, on the push rod seat 50, due to engine valve spring fluctuations, will be countered by the valve member 60 rather than the plunger return spring 28. Otherwise, the plunger 30 would adjust its axial position upward in the cylinder body 20, the valve 40 would open to allow fluid to flow into the pressure chamber spaces, and a pump-up problem would exist. The resilient character of valve 60, through its inner peripheral edge 62, prevents premature adjustment of the plunger by exerting a restraining force on its upper end which compensates for the resistance lost in the fluctuation of the engine valve spring, or whatever cause, and which is greater than the plunger return spring force at its lower end.

After the engine valve train parts have expanded to full length, under normal engine operating conditions, there is no necessity for the valve 60 to lift off the plunger seat 35.

The valve member 60 serves to prevent the leakage of hydraulic fluid past the plunger 30 during the operation of the engine valve. Tappet adjustment takes place upon the return of the tappet to the base circle of the operating cam 14. This is a more stable time for adjustment than at the peak of the cam as with conventional leakdown type tappets.

The member 60 also serves as a spring element to effect the separation of the push rod seat member 50 and the plunger 30 to both control the leakdown of hydraulic fluid from the pressure chamber spaces, and the entrance of fluid into the reservoir space. In all instances the valve member 60 serves as a seal separating the reservoir feed passage 51 from the pressure chamber space 29'.

While a preferred embodiment of this invention has been described, it will be understood that other modifications and improvements may be made thereto. Such of these modifications and improvements as incorporate the principles of this invention are to be considered as included in the hereinafter appended claims unless these claims by their language expressly state otherwise.

I claim:

1. A hydraulic tappet, comprising; a tappet body member having reservoir and pressure chamber defining parts relatively reciprocal therein, a check valve member disposed between one of said parts and said body member for passing fluid from the reservoir chamber to the pressure chamber defined by said parts, and a resilient valve member disposed between said chamber defining parts for opening and closing said reservoir chamber to a fluid supply source and for closing and venting said pressure chamber to said reservoir chamber.

2. A hydraulic tappet, comprising; a tappet body member having reservoir and pressure chamber defining parts relatively reciprocal therein, a check valve member disposed between one of said parts and said body member for passing fluid from the reservoir chamber to the pressure chamber defined by said parts, and a resilient valve member disposed between said chamber defining parts for opening and closing said reservoir chamber to a fluid supply source and for closing and venting said pressure

chamber to said reservoir chamber, said valve member having a valve seat face provided on one side thereof for engaging one of said chamber defining parts and closing one of the chambers defined thereby and another valve seat face provided on the other side thereof for engaging the other of said chamber defining parts and closing the other of the chambers defined thereby.

3. A hydraulic tappet, comprising; a tappet body member having a reservoir and pressure chamber defining parts relatively reciprocal therein, a check valve member disposed between one of said parts and said body member for passing fluid from the reservoir chamber to the pressure chamber defined by said parts, and a resilient valve member disposed between said chamber defining parts for opening and closing said reservoir chamber to a fluid supply source and for closing and venting said pressure chamber to said reservoir chamber, said valve member having a valve seat face provided on one side thereof for engaging one of said chamber defining parts and closing one of the chambers defined thereby and another valve seat face provided on the other side thereof for engaging the other of said chamber defining parts and closing the other of the chambers defined thereby, and said valve member further having its outer peripheral edge formed and disposed to provide a seal between said chamber definding parts precluding the exchange of fluid between said pressure chamber and the supply source for said reservoir chamber.

4. A hydraulic tappet, comprising; a tappet body member having reservoir and pressure chamber defining parts relatively reciprocal therein, a check valve member disposed between one of said parts and said body member for passing fluid from the reservoir chamber to the pressure chamber defined by said parts, and a resilient valve member disposed between said chamber defining parts for opening and closing said reservoir chamber to a fluid supply source and for closing and venting said pressure chamber to said reservoir chamber, said valve member comprising a dished annular ring for holding said chamber defining parts apart under certain operating conditions of said tappet to provide fluid flow access therethrough from a reservoir supply source to said reservoir, said dished ring yielding to external forces urging said chamber defining parts together for receiving said parts in chamber sealing engagement on opposite sides thereof, and upon the relief of said external forces said sealing ring being responsive to an excessive pressure condition within said pressure chamber to lift and provide fluid flow access from said pressure chamber to said reservoir.

5. A hydraulic tappet, comprising; a tappet body member having reservoir and pressure chamber defining parts relatively reciprocal therein, a check valve member disposed between one of said parts and said body member for passing fluid from the reservoir chamber to the pressure chamber defined by said parts, and a resilient valve member disposed between said chamber defining parts for opening and closing said reservoir chamber to a fluid supply source and for closing and venting said pressure chamber to said reservoir chamber, said valve member comprising a dished annular ring having its outer periphery received in sealing engagement with said tappet body member and its inner periphery engageable with one of said chamber definding parts, said inner periphery including notches permitting fluid flow therethrough between a fluid supply source and said reservoir chamber, and the other of said chamber defining parts being received in valve seat engagement with said valve member between said outer and inner peripheries.

6. In a hydraulic tappet including a tappet body member having a blind end passage formed therein, a plunger member received in said passage and forming a pressure chamber space with the blind end thereof, a push rod seat member received in said passage and forming a reservoir chamber space with said plunger member, means provided within said tappet body member for biasing said plunger and push rod seat members in engagement, check valve means provided between said reservoir and pressure chamber spaces for the uni-directional flow of fluid from said reservoir to said pressure chamber space, fluid supply means provided through said tappet body member, and control means provided between said plunger and push rod seat members for the opening and closing of said reservoir with respect to said fluid supply means and with respect to said pressure chamber space: said control means comprising; a dished annular sealing ring having fluid flow accesses formed within the inner peripheral edge thereof, said sealing ring having sufficient resilience when said tappet is stationary to hold said plunger and push rod seat members separated against the opposition of said biasing means for the flow of fluid from said fluid supply means through said accesses to said reservoir and insufficient resilience to resist the seating of said ring in sealing engagement on the end of said plunger member for closing said pressure chamber.

7. In a hydraulic tappet comprising a tappet body member having a blind end passage formed therein and relatively reciprocal plunger and push rod seat members disposed within said passage, said plunger being formed to provide a reservoir chamber space, said push rod seat member being disposed relative to said plunger for closing said reservoir space, and control means between said plunger and push rod seat members for controlling fluid flow to said reservoir therebetween, said control means comprising; a dished annular sealing ring having reservoir feeding accesses provided in the inner peripheral edge thereof and a sealing flange provided about the outer peripheral edge thereof, said sealing ring having valve seating faces provided on opposite side faces thereof between said peripheral edges, and said sealing ring having such resilience as is sufficient to hold said plunger and push rod seat members separated when said tappet body member is separated, to allow fluid flow through the accesses in the inner peripheral edge thereof, and is insufficient to resist the compression of said ring between said plunger and push rod seat members for closing said accesses when said tappet body member is in motion.

8. In a hydraulic tappet including a tappet body member having a blind end passage formed therein, a plunger member received in said passage and forming a pressure chamber space with the blind end thereof, a push rod seat member received in said passage and forming a reservoir chamber space with said plunger member, means provided within said tappet body member for biasing said plunger and push rod seat members in engagement, check valve means provided between said reservoir and pressure chamber spaces for the uni-directional flow of fluid from said reservoir to said pressure chamber space, fluid supply means provided through said tappet body member, and control means provided between said plunger and push rod seat members for the opening and closing of said reservoir with respect to said fluid supply means and with respect to said pressure chamber space: said control means comprising; a dished annular sealing ring having reservoir feeding accesses provided in the inner peripheral edge thereof and a sealing flange provided about the outer peripheral edge thereof, said sealing ring having valve seating faces provided on opposite side faces thereof between said peripheral edges, and said sealing ring having such resilience as is sufficient to hold said plunger and push rod seat members separated when said tappet body member is separated, to allow fluid flow through the accesses in the inner peripheral edge thereof, and is insufficient to resist the compression of said ring between said plunger and push rod seat members for closing said accesses when said tappet body member is in motion.

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