Sept. 4, 1956 C. R. KILGORE 2,761,433

SELF-CONTAINED HYDRAULIC TAPPET

Filed April 4, 1955 2 Sheets-Sheet 1

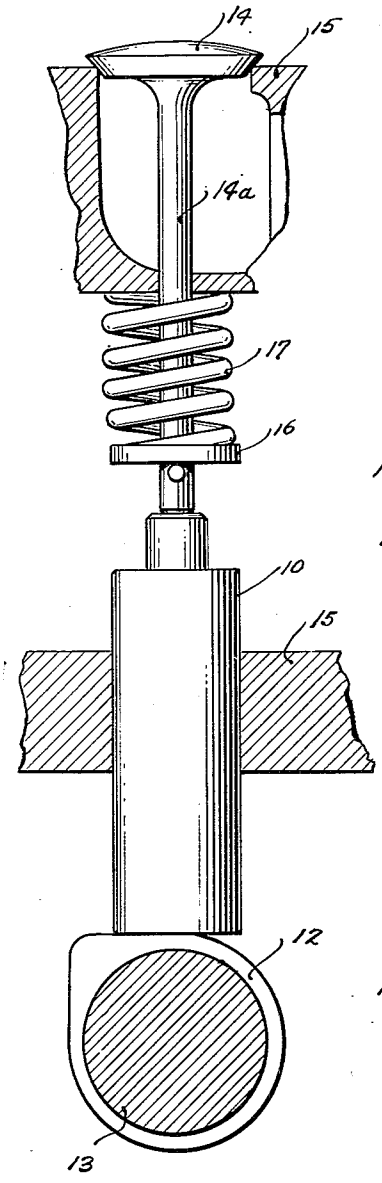


Fig. 1

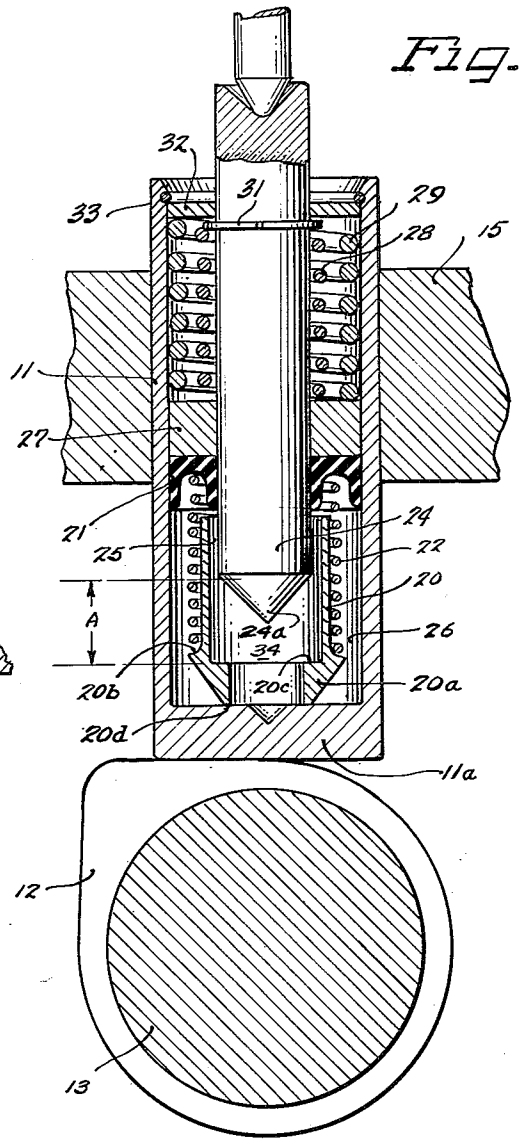


Fig. 2

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Fig. 3

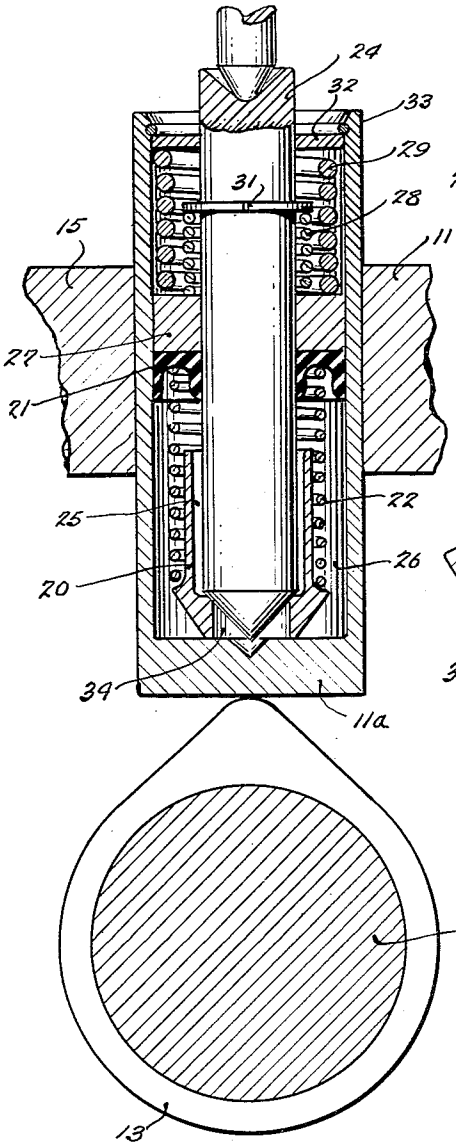
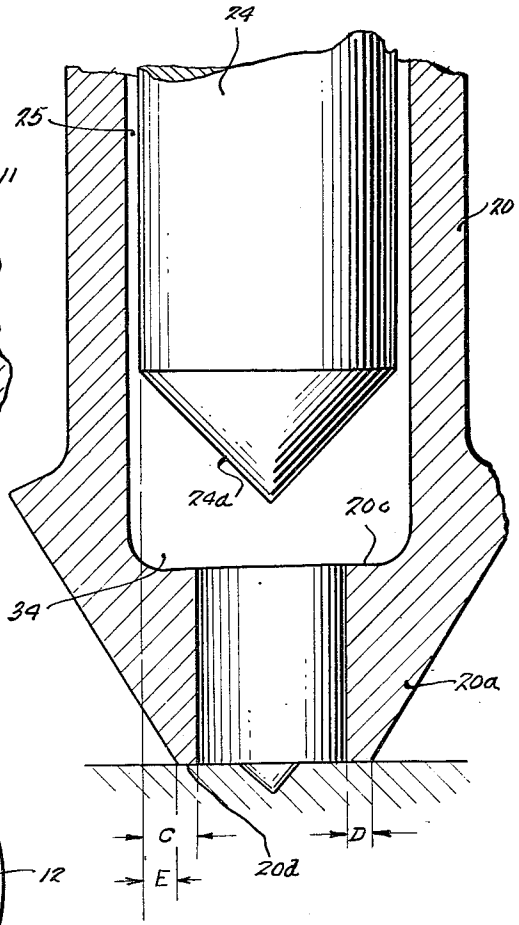


Fig. 4



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SELF-CONTAINED HYDRAULIC TAPPET

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7 Claims. (Cl. 123—90)

The present invention is directed to improvements in automatic clearance regulators of the type exemplified by tappet mechanisms used in internal combustion engines.

Automatic clearance regulators are designed primarily to respond to irregularities in the mechanism in which they are operating to take up any looseness or play in that mechanism. Such irregularities may occur, for example, by mechanical means or by thermal expansion and contraction. For the most effective operation of valve operating mechanisms, the system must be capable of adjusting itself to these irregularities in order that the valve operating mechanism may operate smoothly and satisfactorily.

Any compensating system of the type described should not be over-compensating in that it should not over control the linkage and produce an undesired tightness. In the case of poppet valve operating tappets, such tightness would prevent full seating of the poppet valve.

Two factors of prime importance in the design of hydraulic type automatic tappets are (1) rapid response to changes in engine operating conditions and (2) functional stability over reasonably wide speed and temperature operating ranges. Heretofore, automatic tappets of the hydraulic type have not always been completely satisfactory, for the most part, on both counts. This inability to respond properly to existing conditions was most pronounced when the engine was started from a cold condition.

With the foregoing in mind, an object of the present invention is to provide an improved automatic tappet assembly with a combined rapid recovery characteristic and an extended operating range.

A further object of the invention is to provide a hydraulic type automatic tappet of the self-contained type which requires less circulating hydraulic fluid, thereby contributing to a more rapid recovery time.

A further object of the present invention is to provide an improved hydraulic tappet assembly which can be manufactured with a minimum of expensive machining operations being required.

In the improved tappet assembly of the present invention, there is provided a substantially cylindrical barrel closed at one end, the barrel being substantially of uniform diameter throughout its length. Slidably mounted within the barrel is a plunger member with a tapered face which is received within a substantially cylindrical choke sleeve. A small annular clearance is provided between the outer periphery of the plunger and the inner periphery of the choke sleeve to permit gradual leakdown when a thrust load is applied to the plunger. A shoulder is provided on the inner surface of the choke ring to limit the axial travel of the plunger within the barrel.

A more or less conventional seal ring is provided within the barrel cavity in spaced relation to the choke sleeve. The seal ring, the choke sleeve, the lower end of the plunger, and the inner wall of the cavity thereby provide two chambers for hydraulic fluid. This type of structure has the advantage of localizing the areas of high fluid pressure inside the choke sleeve, rather than against the wall of the tappet barrel as have heretofore been common. Additionally, this type of tappet structure reduces the total amount of liquid flow accompanying tappet recovery so that the recovery time is made more rapid and the required amount of hydraulic fluid is decreased.

Other objects and features of the invention will be apparent to those skilled in the art from the following description of the attached sheet of drawings which illustrate a preferred embodiment of the invention.

In the drawings:

Figure 1 is a fragmentary view in elevation of the tappet mechanism of the present invention in combination with the engine valve;

Figure 2 is a cross-sectional view of one type of tappet assembly employing the improvements of the present invention showing the tappet in operating position;

Figure 3 is a view similar to Fig. 2 but showing the tappet in a collapsed position such as occurs upon engine shutdown with a valve being held open; and

Figure 4 is a greatly enlarged fragmentary view of the plunger and choke sleeve assembly.

As shown in the drawings:

In Fig. 1, the tappet mechanism of the present invention is illustrated at reference numeral **10** and includes a cylindrical hollow barrel **11** arranged to ride on the surface of a cam **12** connected to a cam shaft **13** of an internal combustion engine.

The movement of the tappet mechanism **10** is arranged to open and close a poppet or engine valve **14** arranged to be seated within a valve seat provided in an engine block **15**. The valve **14** includes an elongated valve stem **14***a* to which a spring cap **16** is secured. A valve spring **17** has one end bottomed against the cap **16** and its other end against a stationary part of the engine block **15** thereby providing a spring return mechanism for seating the valve.

The particular tappet assembly illustrated in the drawings includes a cylindrical barrel **11** of substantially uniform inner diameter, the barrel **11** being provided within a closed bottom **11***a*.

Disposed within the barrel **11** is a substantially cylindrical choke sleeve **20** having a tapered end face **20***a* and an annular shoulder **20***b* formed thereon. The choke sleeve **20** has a flat seat **20***d* on the bottom of its tapered end. Disposed immediately above the choke sleeve **20** is a resilient seal ring **21** composed of rubber or similar material in sealing relationship with the inner wall of the barrel **11** and the plunger **24**. A relatively light choke sleeve spring **22** is received between the seal ring **21** and the annulus shoulder **20***b* on the choke sleeve **20** to urge the choke ring into seated relationship against the bottom **11***a*.

Slidably received within the choke sleeve **20** is a plunger **24** having a conical end face **24***a* disposed within the choke sleeve **20**. As seen in Fig. 2, the diameter of the plunger **24** is slightly less than the inner diameter of the choke sleeve **20**, leaving a small annular clearance **25** between the two elements forming a leakdown passage for the hydraulic fluid. A reservoir chamber **26** for the hydraulic fluid is defined by the annular space between the choke sleeve **20** and the wall of the barrel **11**, the plunger **24**, and the seal ring **21**.

Any one of a number of hydraulic fluids may be employed in the device, but I prefer to employ a "silicone" type fluid having a viscosity of approximately 100,000 centistokes at room temperature.

The plunger **24** is freely movable axially within the choke sleeve **20** until a portion of the conical face **24***a* strikes an internal shoulder **20***c* formed in the choke sleeve **20**. The extent of downward movement of the plunger **24** within the choke sleeve is identified at letter A in Fig. 2.

Disposed immediately above the seal ring **21** is a slidable washer **27** axially movable within the barrel **11** with

sufficient clearance being provided to permit the plunger **24** to slide freely therethrough. The washer **27** serves to bottom the lower ends of a pair of springs **28** and **29**. The outer spring **29** maintains a positive pressure in the reservoir **26** and the inner return spring provides the necessary operating force. The inner return spring **28** extends between the washer **27** and a lock ring **31** which fits into a groove formed at the upper end of the plunger **24**. The outer spring **29** extends between the washer **27** and an upper washer **32**. The upward movement of the plunger **24** is limited by the engagement of the lock ring **31** with the washer **32** which in turn abuts against a snap ring **33** which is received in a suitable groove in the wall of the barrel **11**.

The characteristics of the inner return spring **28** are such that sufficiently rapid recovery for the small amount of leakdown occurring during engine operation is accomplished without imposing a high return force on the valve train. On the other hand, when the tappet is completely collapsed during the engine shutdown period, very rapid recovery is required to prevent excessive clatter on starting. In the tappet of the present invention this rapid recovery is achieved by utilizing only a low volume of circulated fluid.

During the operation of the engine, the tappet operates as follows. As the tappet moves toward the nose of the cam **12**, the force of the engine valve spring **17** moves the plunger **24** downwardly, thereby compressing the inner return spring **28** and displacing fluid from the compression chamber **34** along the leak-down passage **25**. The pressure in the compression chamber **34** acts on an area C indicated in the drawings (Figure 4), this area being the annular space whose width is determined by the projection of the outer surface of the plunger **24** against the annular shoulder **20***c* of the choke sleeve **20**. The pressure seats the choke sleeve **20** firmly on its flat seat **20***d*, the width of the seat being designated by the letter D in the drawings. The seating of the choke sleeve **20** creates a pressure tight seal at the bottom of the barrel **11**. The displaced fluid which flows from the leakdown passage **25** into the reservoir **26** causes the seal ring **21** and the lower washer **27** to move slightly upward. This action further compresses the inner return spring **28** and the outer spring **29**. As the engine valve **14** is seated, the force of the valve spring **17** acting on the plunger **24** reduces to zero. Immediately thereafter, the inner return spring **28** moves the plunger **24** upwardly. At the same time the pressure in the reservoir **26** developed by the outer spring **29** acting on an area designated at letter E in the drawings forces the choke sleeve **20** upward, compressing the choke spring **22**. Fluid flow then occurs from the reservoir **26** past the flat seat **20***d* and into the compression chamber **34**. Flow continues until the plunger **24** has moved sufficiently to remove lash in the valve train, at which time the pressures in the reservoir **26** and the compression chamber **34** become nearly equal. The choke spring **22** then forces the choke sleeve **20** downward until it seats on the flat seat **20***d* on the bottom of the barrel cavity.

When the engine is stopped, some of the tappets will be on the nose of their cams, holding the valves open. The force of the valve spring **17** will then move the plunger **24** slowly downward until the tapered end of the plunger **24** stops on the shoulder **20***c* of the choke sleeve **20** (Figure 3). When the engine is started the tappet recovers in a manner similar to that previously described.

In any hydraulic tappet, the time for tappet recovery should be as short as possible to prevent objectionable noise. The time for tappet recovery, in the tappets of the present invention, has been found to be much less than in previous types of hydraulic tappets because of the very low volume of displaced fluid and the comparatively large orifice area in the choke sleeve for fluid transfer.

With the type of tappet assembly illustrated in the drawings, the region of high fluid pressure can be confined to the interior of the choke sleeve **20**. Consequently, the walls of the barrel are not subjected to high fluid pressures and therefore need not be designed to withstand such elevated pressures.

It will be evident that various modifications can be made to the described embodiment without departing from the scope of the present invention.

I claim as my invention:

1. An automatic clearance regulator which comprises a housing having a side wall and a closed end, a hollow choke sleeve in the closed end of the housing and spaced from the side wall of the housing, seal means engaging the side wall and confining a body of fluid in said closed end of the housing for filling and surrounding the choke sleeve, a thrust load transmitting plunger having an end portion extending into said choke sleeve in leakdown clearance relationship therewith, a tappet elongating spring compressed between said seal means and said plunger, a second spring compressed between said seal means and said choke sleeve for urging said choke sleeve against the closed end of the housing, said choke sleeve providing a trapped fluid chamber in the body of fluid connected with the main body of fluid surrounding the choke sleeve through the passageway provided by the leakdown clearance relationship between the plunger and choke sleeve, said elongating spring being effective to retract the plunger and reduce pressure in the trapped fluid chamber when thrust load on the plunger is relieved whereupon fluid from the main body will raise the choke sleeve off of the closed end of the housing to replenish the trapped fluid chamber until the pressures in the main body and trapped chamber are equalized whereupon said second spring will reseat the choke sleeve on the closed end of the housing.

2. A lash adjuster which comprises a housing having a closed end, seal means slidably mounted in said housing adapted to confine a body of fluid in said closed end, a plunger slidable through said seal means into said fluid, a choke sleeve bottomed on the closed end, submerged in said body of fluid and receiving the end of the plunger therein, said choke sleeve being appreciably smaller than said housing to receive fluid therearound, said plunger being slightly smaller than said choke sleeve to provide a leakdown passageway from a trapped fluid chamber in the choke sleeve, a tappet elongating spring operating between said seal means and said plunger, a choke sleeve spring compressed between the seal means and the choke sleeve urging the choke sleeve against the closed end of the housing for isolating fluid in said trapped fluid chamber, said elongating spring being effective to retract the plunger relative to the choke sleeve upon release of thrust load on the plunger, and said choke sleeve spring accommodating unseating of the choke ring off of the closed end of the housing whenever fluid pressure in the isolated trapped fluid chamber is less than fluid pressure in the chamber surrounding the choke sleeve.

3. A hydraulic valve lash regulator which comprises a barrel having a closed end, a small diameter choke sleeve in the bottom of the barrel, a plunger extending into said choke sleeve and having leakdown clearance relationship therewith, the bottom of the barrel, the choke sleeve and the plunger providing an isolated trapped fluid chamber in the central portion of the bottom of the barrel, an elongating spring acting on the plunger to retract the plunger from the choke sleeve, and a weaker choke sleeve spring urging the choke sleeve against the bottom of the barrel, fluid in said trapped fluid chamber supporting said plunger, and said choke sleeve spring accommodating unseating of the choke whenever fluid pressure in the choke sleeve is less than fluid pressure surrounding the choke ring.

4. In a tappet assembly, a cylindrical barrel having a closed end, a cylindrical hollow choke sleeve disposed

in said barrel in spaced relation to said barrel thereby providing a fluid reservoir therein, a spring urging said choke sleeve against said closed end, and a plunger having a tapered end face received within said choke sleeve, said choke sleeve having an internal stop limiting the extent of movement of said plunger, and said plunger having a diameter smaller than the inner diameter of said barrel, thereby providing a space accommodating leakdown clearance between said plunger and said choke sleeve.

5. A tappet assembly comprising a cylindrical barrel having a closed end, a cylindrical hollow choke sleeve slidable in said barrel, a seal ring about the periphery of said choke sleeve and sealingly engaging the wall of said barrel, a spring urging said choke sleeve against said closed end, a plunger having a conical end received within said choke sleeve, said choke sleeve having an internal stop limiting the extent of movement of said plunger, said plunger being spaced from said choke sleeve to provide an annular clearance between said plunger and said choke sleeve, said closed end, said choke sleeve, and said plunger defining a trapped fluid chamber in said barrel, said spring accommodating unseating of said choke sleeve whenever fluid pressure in said choke sleeve is less than fluid pressure surrounding said choke sleeve.

6. A tappet assembly comprising a barrel having a closed end, a cylindrical hollow choke sleeve slidable in said barrel in spaced relation to said barrel leaving a hydraulic fluid reservoir within said barrel, a seal ring

closing the top of said fluid reservoir, a plunger having a conical end received within said choke sleeve, said plunger being of smaller diameter than said choke sleeve thereby leaving an annular space therebetween to provide for fluid leakdown therebetween, and a spring urging said choke sleeve against said closed end.

7. A tappet assembly comprising a barrel having a closed end, a cylindrical hollow choke sleeve slidable in said barrel, a plunger having a conical end received within said choke sleeve, a pair of springs coaxially mounted about a portion of said plunger, said plunger being received in said choke sleeve with a slight annular clearance therebetween, a seal ring disposed between said choke sleeve and said pair of springs in sealing relation to said barrel, and a return spring urging said choke sleeve against said closed end, said closed end, said choke sleeve and said plunger defining a trapped fluid chamber in said barrel, said return spring accommodating unseating of said choke sleeve whenever fluid pressure in said choke sleeve is less than fluid pressure surrounding said choke sleeve.

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