

Nov. 28, 1933.

J. O. ALMEN

1,936,653

SLACK ADJUSTING MECHANISM

Filed April 28, 1927

3 Sheets-Sheet 1

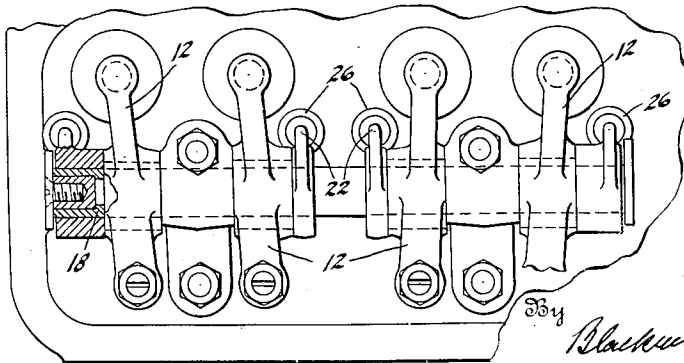
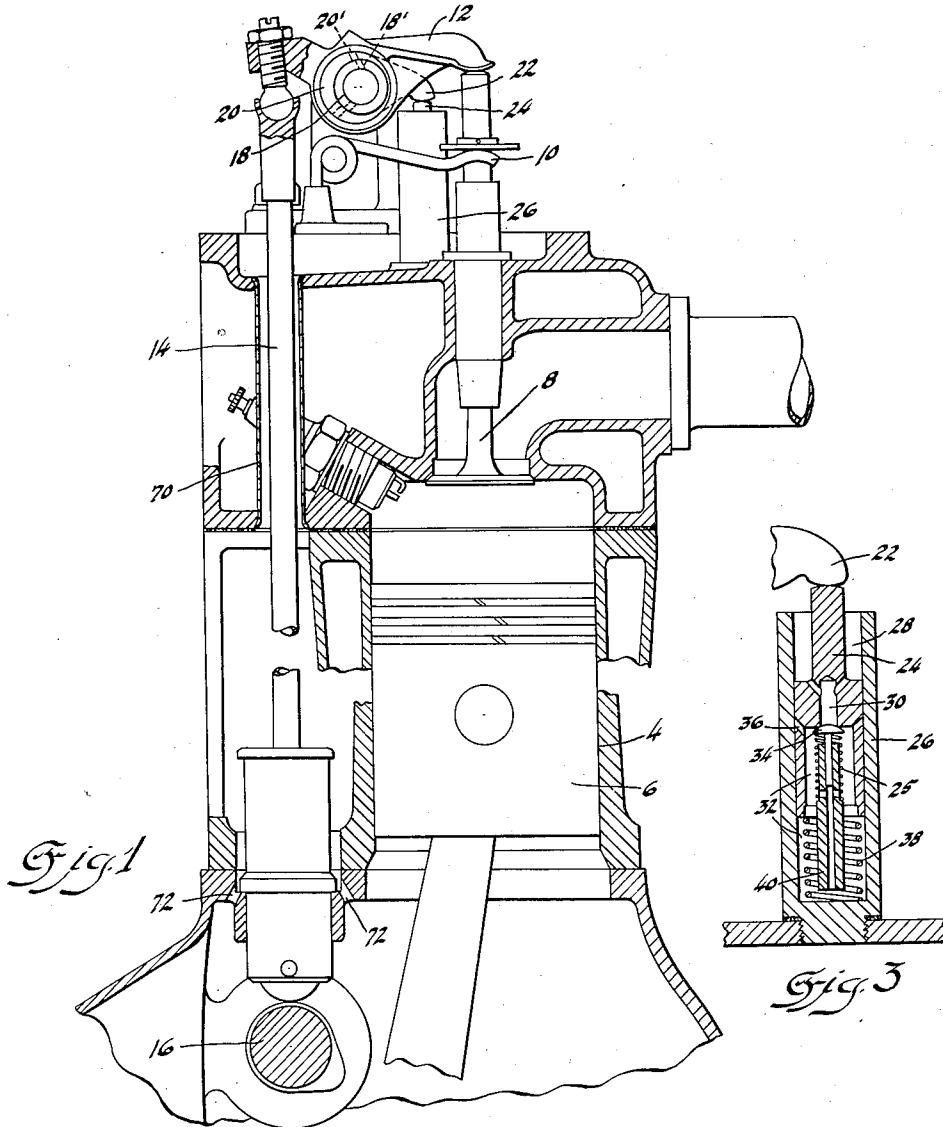


Fig. 2

Inventor
John O. Almen

By Blackmore, Spencer & Finch
Attorneys

Nov. 28, 1933.

J. O. ALMEN

1,936,653

SLACK ADJUSTING MECHANISM

Filed April 28, 1927

3 Sheets-Sheet 2

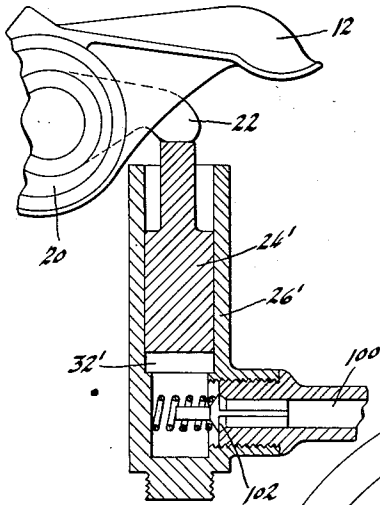


Fig. 6

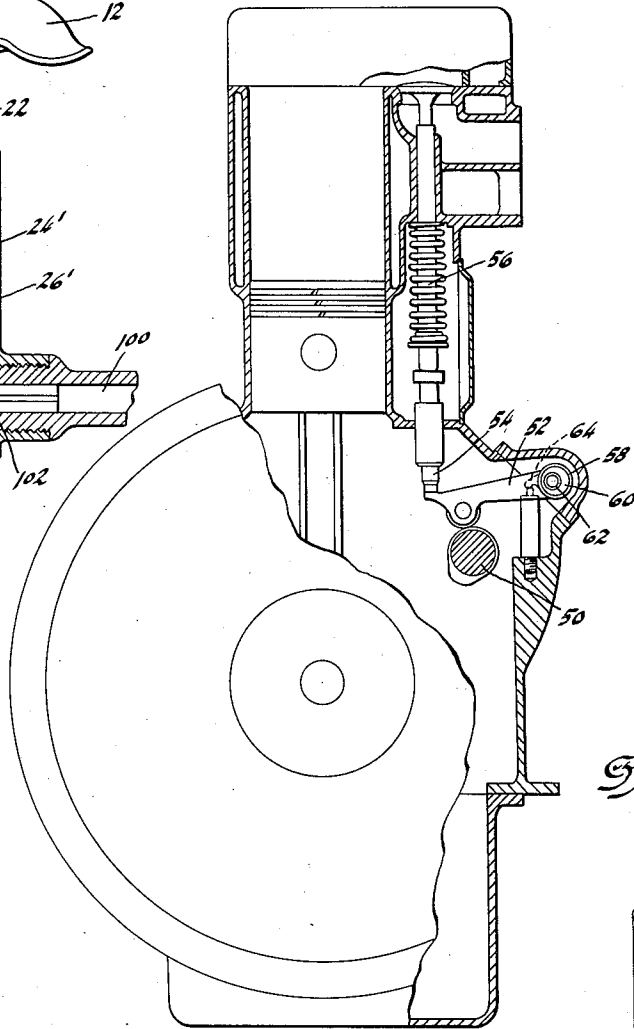


Fig. 4

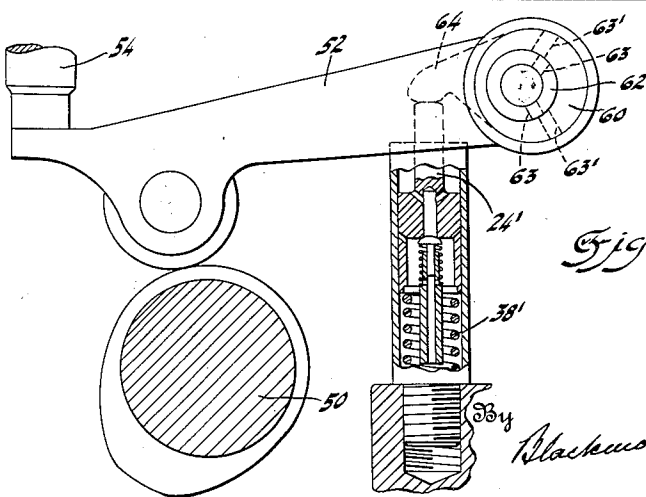
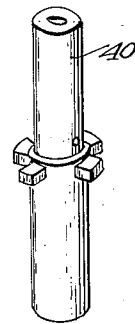


Fig. 5

Fig. 7.



Inventor

John O. Almen

Blackmore, Spencer & Flint

Attorneys

Nov. 28, 1933.

J. O. ALMEN

1,936,653

SLACK ADJUSTING MECHANISM

Filed April 28, 1927

3 Sheets-Sheet 3

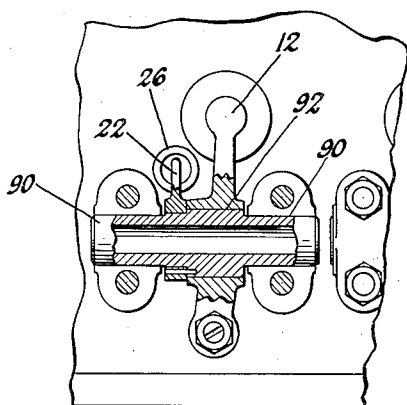


Fig. 8

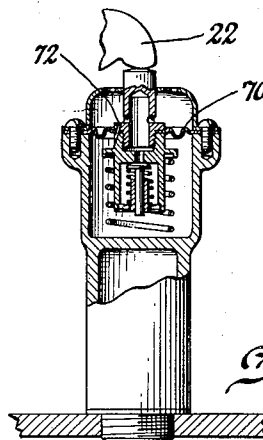


Fig. 9

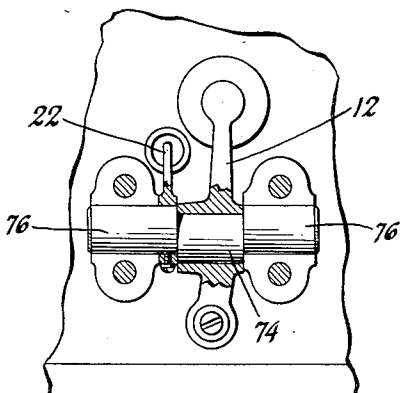


Fig. 10

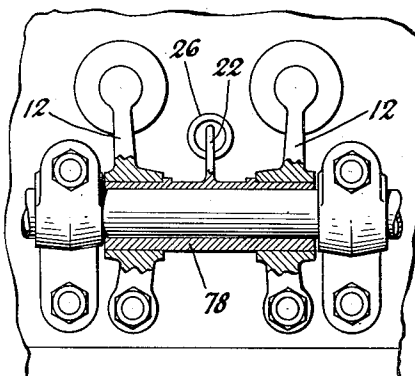


Fig. 11

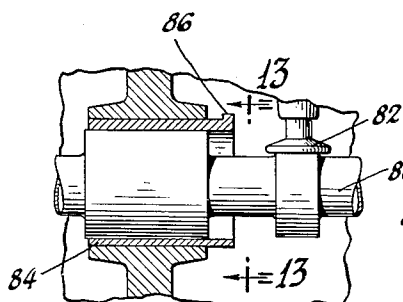


Fig. 12

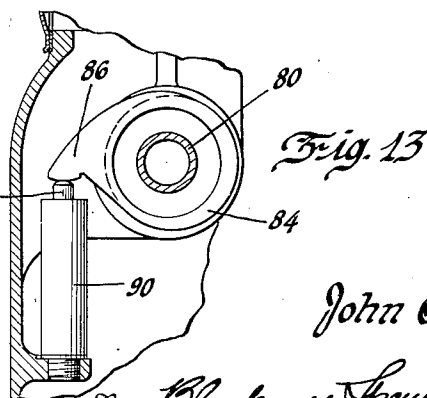


Fig. 13

Inventor
John O. Almen

By Blackmore, Spencer & Flick

Attorneys

UNITED STATES PATENT OFFICE

1,936,653

SLACK ADJUSTING MECHANISM

John O. Almen, Royal Oak, Mich., assignor to
General Motors Research Corporation, Detroit,
Mich., a corporation of Delaware

Application April 28, 1927. Serial No. 187,343

49 Claims. (Cl. 123—90)

In this application is disclosed an arrangement for taking up slack in a chain of mechanism to prevent noise and insure uniformly effective operation. The invention relates particularly to mechanism of this character employed in connection with the valves of engines, particularly those of the internal combustion type. A common fault in valve gear of this description is that when the parts are cold, the operation is noisy because of impact of cam on tappet, and tappet on valve or rocker and the like. If, on the other hand, the gear is adjusted to a nicety for operation when cold it is too tight for operation when heated with the result that the valve may be held off its seat when it should be closed and there may be binding of the parts. Likewise, the changes in temperature vary the degree of opening of the valves.

My invention is particularly applicable to valve gear in which a rocker is employed and is preferably applied to the pivot of the rocker to effect upward or downward movement of the axis of the rocker to compensate for temperature changes in the parts and insure operation at all times without slack and without binding. This is preferably accomplished by employing an eccentrically adjustable mounting for the rocker. This may be done either by the employment of an eccentrically adjustable shaft for the rocker or an eccentrically adjustable bearing on a fixed shaft and on which the rocker is mounted. This shaft or bearing is provided in my preferred form with an extension engaged by the movable wall of an hydraulic chamber. This wall may take the form of a conventional piston and a spring may be employed to urge the piston outwardly of the chamber or cylinder. Means is provided for supplying fluid, preferably lubricating oil, to the interior of the chamber. The clearance between the piston and cylinder is relied upon to permit the escape of excess oil from the chamber, although special provision may be made for this purpose.

The operation is very simple. The eccentric is normally urged by the spring in a direction to take up slack in the system and the consequent upward movement of the piston results in the flow of additional fluid into the cylinder. With the slack thus taken up, the valve gear operates in the normal way, the fluid in the hydraulic chamber acting substantially in the same manner as a fixed abutment for the arm of the eccentric. The expansion of the parts due to heating causes the eccentric to be rotated in reverse direction depressing the piston which slowly

forces oil out of the cylinder until the expansion has been completed. Thereafter, the piston is subject only to the normal operating pressures and again serves as a substantially fixed abutment for the eccentric. A more detailed description of the operation is given in the description which follows.

The construction has many advantages. It is designed so that no replenishment of the oil supply is necessary over long periods of time. It adds nothing to the weight of the moving parts of the valve gear. It is so constructed that the normal pressure to which the piston is subjected may be any desired fraction, for example one-fifth, of the force acting on the system. In other words, one-fifth of the pressure which the piston would be required to withstand were it connected directly to the pivot. The likelihood of too much oil being forced out of the dash pot is accordingly reduced. The construction is designed so that should there be no oil whatever in the hydraulic chamber, the only result would be noisy operation and this, in itself, would warn the operator to add lubricant.

The construction is simple and inexpensive to manufacture, and in actual tests has been found to take out all lash and provide silent operation and the other advantages accruing from perfect adjustment of the valve mechanism under all operating conditions.

In the drawings, Figure 1 is a longitudinal section thru an engine provided with over-head valves showing my improvements applied thereto. Figure 2 is a top plan view of a portion of Figure 1. Figure 3 is a section thru the hydraulic chamber. Figure 4 shows my invention applied to an engine of the "L-head" type. Figure 5 is an enlarged detail of the mechanism of Figure 4. Figure 6 discloses a modification of the construction of Figure 1.

Figure 7 is a perspective view of the guide which forms a part of the piston assembly of the dash pot.

Figure 8 is a fragmentary view, partly in section, showing a portion of an overhead valve engine equipped with a modification of my slack adjuster.

Figure 9 is a view corresponding to Figure 3, but showing a modified form of dashpot.

Figures 10 and 11 are views, similar to Figure 8, but each showing a further modification.

Figure 12 is a vertical section through a portion of an L-head engine showing my slack adjuster applied to a camshaft bearing.

Figure 13 is a view taken on line 13—13 of Figure 12.

The engine illustrated in Figure 1 is the well-known Buick motor. The piston 6 operates in cylinder 4 and in the head of the cylinder one of the usual valves 8 is illustrated. A spring 10 of the so-called "rat-trap" type is illustrated as urging the valve toward seated position although, if preferred, a coil spring may be used.

The valve is operated by rocker arm 12 the opposite end of which is actuated by push rod 14, the lower end of which is engaged by the usual cam shaft shown at 16. The construction so far described, other than the spring which is covered in a copending application of George E. A. Hallett, Serial No. 180,914 filed April 4, 1927, is conventional.

At 18 I have indicated a hollow shaft which, in the Buick design, is supplied with oil from the crankcase, a feature omitted from the drawing for simplicity. An eccentric 20 is journaled on the shaft 18 and on the eccentric rocker arm 12 is mounted. The shaft 18 and the eccentric 20 are provided with aligning apertures 18' and 20' to permit oil to reach the bearing surfaces. Eccentric 20 is provided with arm 22 the other end of which bears against piston 24 operating in cylinder 26 mounted in any suitable manner on the cylinder head. The upper portion of the piston 24 is reduced to provide in conjunction with the cylinder an annular reservoir 28. The reservoir 28 is connected by suitable passages 30 with the hydraulic chamber 32 formed between the closed end of the cylinder and the lower end of the piston. To the lower end of the piston 24 is secured a tubular guide 40 which may be of the construction shown in Figure 7. The guide 40 is a force fit within the lower end of the piston. In the upper end of the guide the valve 34 is slidably mounted, and the spring 25 yieldably urges the valve into sealing engagement with the lower end of passage 30. A relatively weak coil spring 38 surrounds the guide 40 and yieldingly urges the piston 24 in an upward direction. Passages 36 lead from the chamber 32 to the walls of the cylinder.

The operation is simple. The spring 38 at all times urges the piston 24 outwardly of its cylinder 26 and the piston 24 in turn engages the arm 22 on the eccentric 20 and tends continuously to rotate the eccentric in a direction to lower the pivot of rocker 12 and take up slack in the system. In a four cycle engine the valve mechanism is in operation only part of the time. During the operating part of the cycle the cam on the shaft 16 is first lifting the push rod 14, the push rod rocking the rocker 12, and the rocker unseating the valve against the resistance of the valve spring 10. As the high point of the cam passes out from under the tappet the valve spring 10 returns the valve to seated position and at the same time restores the rocker 12 and push rod 14 to their original positions with the push rod in contact with the base or clearance circle of the cam. During both the periods of unseating and seating of the valve the operating mechanism is under heavy stress, and the push of the cam at one end of the rocker and the resistance of the spring at the other end tend to move the rocker 12 bodily upward and consequently rotate eccentric 20 in clockwise direction. As the spring 38 is relatively weak it tends to yield under operating pressures and does yield slightly but the amount of yielding is cut down greatly by the inertia of the fluid in the cyl-

inder 26, and the fact that the clearance between the piston and its cylinder is so slight as to permit discharge of fluid at but a very slow rate. Another important factor in preventing too rapid discharge of oil from the dash pot and consequent noisy operation is the employment of the eccentric and lever arm which gives the dash pot the benefit of a favorable mechanical advantage, about 5 to 1 in the form shown, and reduces the pressure on the oil. During the non-operating portions of the cycle, that is, when the valve is on its seat and the tappet is riding on the base circle of the cam, the only pressure on the valve operating mechanism is that exerted by the spring 38 through the piston 24 and eccentric 20. This spring returns the piston and eccentric to the position they occupied before the operating stroke, drawing oil into the cylinder 26 past valve 34 to refill the cylinder.

During each complete cycle of valve movement the described operation takes place; that is, the piston 24 is forced downwardly and the eccentric 20 is rotated in clockwise direction (as viewed in Fig. 1) during the operating parts of the cycle and the piston and eccentric are returned by the spring to their former positions during the non-operating parts of the cycle. The amount of movement is very slight if the system is free of air as it normally is,—so slight as to be practically imperceptible. Now the expansion and contraction of the parts of the valve gear as a result of heating and cooling, takes place at a very slow rate compared with the rapid valve movements. In the case of expansion of the parts it is evident that the light spring 38 will not be able to return the piston and eccentric to quite their original positions but the piston will assume a position displaced downwardly by a very slight amount, this amount representing the amount of expansion of the parts during the cycle of movement. The next back and forth movement of the piston will take place from the newly established idle position, and so on. In the case of contraction of the parts the spring 38, in taking up slack, will be able to return the piston to a position beyond that which it had previously assumed, so that the next back and forth movement of the piston will take place from the new idle position. The eccentric is thus freshly adjusted during each cycle of movement of the valve gear to take up the varying slack in the gear. The slack to be taken up at any one time consists in that initially provided minus the amount taken up by expansion of the parts or plus the amount introduced by contraction of the parts. In addition, there is a slight increase in slack resulting from wear. The amount of adjustment at any one time is so limited by the damping action of the hydraulic mechanism as to be hardly perceptible. In view of the very minute character of the adjustment in some of the claims the hydraulically positioned piston is described as a substantially fixed abutment yielding only to the stresses resulting from contraction and expansion of the parts, for this, in the end is the function of the hydraulic mechanism, the minute reciprocations of the piston resulting solely from the cyclic character of the valve operation canceling out. From another point of view I have provided yielding means (here shown as spring 38 acting through piston 24 and bushing 20) operating to at all times take up slack in the system together with braking means (here shown in the form of a dash pot constituted by piston 24 and cylinder 26) to resist but not posi-

tively prevent reverse movement of the slack take up means, the arrangement permitting instantaneous adjustment of the slack taken up in accordance with the varying conditions of valve operation.

It will be noted that the slack take up means (in this form consisting of the eccentric and its lever arm operating through the rocker) embodies a mechanical advantage, and that the dash pot and also the spring 38 that tends to take up slack, are located at the end of the lever 22 so that they operate at a favorable mechanical advantage with respect to the operating forces transmitted through the slack take up mechanism. Since the force exerted against the spring 38 and the dash pot is thereby reduced the magnitude of the minute reciprocations of the piston 24 is greatly reduced and the possibility of the leakage of too much oil because of the heavy pressures is avoided.

Should cylinder 26 be entirely empty of oil, the lower end of piston 24 engages the end of the cylinder. In this position of the parts eccentric 20 is loose on the shaft and the valve action will be noisy but the valves will continue to operate and the noise will notify the driver that the cylinders 26 should be refilled.

In Figure 4 I have illustrated the application of my invention to an engine of the "L-head" type in which a lever is interposed between the cam shaft and the tappet. The engine chosen for purpose of illustration is the well-known Packard eight cylinder motor. The cam shaft 50 engages the rocker 52 which, in turn, engages tappet 54 which operates valve 56. Rocker 52 is pivoted at 58 and it will be noted that the point of engagement of the rocker with the cam shaft lies between the rocker pivot and the point of engagement of the rocker with the tappet. Consequently, the cam may be regarded as a fulcrum for the rocker as will later appear. The rocker is pivoted in the same manner as the rocker arm 12 shown in Figure 1. Thus, it is journaled upon eccentric bushing 60 which in turn is journaled upon stationary shaft 62. Shaft 62 may be hollow and serve as a reservoir for lubricant. The shaft as well as the eccentric 60 may be provided with aligning perforations 63, 63' to permit the passage of oil to the rubbing surfaces. The eccentric 60 is provided with arm 64 engaging plunger 24' of an hydraulic mechanism identical in principle with that shown in Figure 3. Referring to Figure 5, the spring 38' in the hydraulic cylinder constantly urges piston 24' upwardly, tending to rotate eccentric 60 in a clockwise direction thereby producing downward shifting in the axis of the rocker, which rocking now upon the cam as a fulcrum causes its tappet-engaging portion to rise thereby tending to take up slack in the system. Upon expansion of the valve stem and tappet, the innermost portion of the rocker is forced downwardly causing the cam 60 to be displaced in a counter-clockwise direction, a motion resisted by the spring 38' and the fluid in the hydraulic chamber. The exact details of the action of the hydraulic chamber are not repeated as they are the same as in the preferred form.

Attention is called to the fact that the proportion of the force applied to the valve gear which is normally transmitted to the piston 24 or 24' may be any desired fraction. In the form shown, the proportion is one-fifth. This is approximately the ratio of the eccentricity of the eccentric 60 to the length of the arm 64. By this reduction, the pressure is brought within practical limits.

In the modification shown in Figure 6, 12 indicates a portion of the rocker arm mounted on eccentric bushing 20. The bushing is provided with arm 22 engaging piston 24' in cylinder 26'. The construction so far described is the same as that shown in Figure 1. However, in this form of the invention provision is made for supplying lubricant to the hydraulic chamber 32' from an outside source, such as the engine oiling system, under the pressure of the usual pump. Thus, conduit 100 may lead from the pump to the chamber and at its connection therewith be supplied with spring pressed check valve 102. With this arrangement, the oil in the chamber 32' will, at all times, be at least at oil pump pressure and consequently the spring 38, illustrated in Figure 3, may be dispensed with. When the piston 24' is subjected to pressure, the valve 102 will seat and the oil in the hydraulic chamber will serve as an abutment to hold the eccentric 20 in proper position. In this form also, leakage between the piston and cylinder is relied upon to permit the escape of oil to take care of expansion due to heating, and the like. Conduit 100 may be provided with a suitable pressure relief valve so as to prevent the application of excessive pressures to the piston.

My invention is capable of many modifications.

As shown in Figure 8 instead of employing an eccentric bearing as shown in the preceding figures the shaft itself may be mounted for rocking movement in bearings 90 and may be formed with an eccentric 92. In this case the arm 22 is connected to the shaft and with its dashpot 26 performs the same functions in the adjustment of the valve rocker 12, as in the case of the preferred form, except that the entire shaft is rocked instead of simply the eccentric bushing.

As shown in Figure 9, a diaphragm 70 or equivalent may be used in place of the piston 24. The other details of this figure, such as the oil inlet valve, etc., are the same as shown in Figure 3, except that a special leak 72 is provided for the discharge of excess oil from below the diaphragm.

Figure 10 shows a further modification in which a crank 74 is employed in place of the eccentric shown in the other figures. A rocker arm 12 is journaled on the crank. The shaft carrying the crank is provided with journals 76 at its ends.

In Figure 11 I have illustrated a further modification in which a single eccentric bushing 78 is provided for a plurality of rockers 12. A single arm 22 with its dashpot 26 urges the eccentric in a direction to take up slack in both rockers.

In Figures 12 and 13 I have illustrated the application of my slack adjusting device to the camshaft 80 of an L-head engine. 82 indicates one of the valve tappets. The camshaft is journaled in an eccentric bushing 84 carrying an arm 86 bearing on the plunger 88 of a dashpot 90 of the same construction as that shown in Figure 3.

The arrangement shown in Figure 11, as well as that shown in Figures 12 and 13 have the disadvantage that an adjustment to take up slack is made at the same time for a plurality of valves owing, in the first case, to the common eccentric bushing, and, in the second case, to the fact that the common camshaft is adjusted by means of the eccentric bushings. No provision is made for unequal heating of the valve gear of adjacent cylinders so that such designs are likely to be somewhat noisy.

My arrangement is particularly desirable

where the rockers are mounted upon hollow shafts serving as lubricant reservoirs for, as previously described, this provides a convenient method for lubricating the rubbing surfaces. At the same time, particularly in the form shown in Figure 1, there is afforded opportunity for renewal of oil in the reservoir 28 by drip from the rocker bearings. In the construction of Figure 1, it may be stated that any excess oil is returned to the crankcase thru passage 70 surrounding the push rod and thru the usual passages, such as shown at 72, arranged about the push rod guides.

In actual test, I have found the mechanism herein described and claimed to operate satisfactorily over long periods of time without lash and, consequently, without noise.

The scope of the invention is set out in the following claims and to some extent the range of equivalents is thereby suggested.

I claim:

1. Operating mechanism including a rocker member, an eccentrically mounted support for said rocker member, and resiliently urged means for automatically adjusting the position of said support to take up slack in said mechanism and a substantially stationary abutment against which said last named means reacts.

2. Operating mechanism including a rocker member, a bearing for said rocker member in the form of an eccentric, and means for holding said eccentric in any position of adjustment, said means being normally stationary but automatically variable in response to changes in stresses in said mechanism to change said positioning and thereby take up slack in said system.

3. In the combination as defined in claim 2, said means including an hydraulic chamber, a movable part in engagement with said eccentric and extending into said chamber, and means for permitting flow of oil to and from said chamber.

4. Valve operating mechanism including a rocker arm, an eccentric on which the rocker arm is journaled, an arm on said eccentric, a plunger engaging said arm, a cylinder in which said plunger is fitted, a body of fluid in said cylinder, means for urging said plunger outwardly of said cylinder, and means for permitting restricted flow of oil to and from said chamber.

5. In the combination as defined in claim 4, said last named means including as a part a passage for admitting oil to said chamber and a non-return valve in said passage.

6. Valve operating mechanism including a rocker arm, a shaft, an eccentric bushing on the shaft serving as a bearing for said rocker arm, and means for automatically controlling the position of said eccentric bushing to take up slack in said system, said last named means comprising an arm on said bushing, an hydraulic chamber having a movable wall bearing against said arm, and means for varying the volume of oil in said chamber in accordance with changes in the position of said wall.

7. Valve operating mechanism including a rocker arm, a shaft, an eccentric bushing on the shaft supporting said rocker arm, an arm on said bushing, an hydraulic chamber having a movable wall bearing against said arm, a spring in said chamber urging said wall outwardly, means for admitting oil to said chamber so that the chamber is maintained full during outward movement of said wall, and means for permitting escape of oil from the chamber to allow for inward movement of said wall.

8. Valve operating mechanism including a

rocker member, an adjustable bearing for said rocker member, means for urging said bearing in a direction to take up slack in said mechanism, means for holding said bearing in any position of adjustment, said means being automatically adjustable as a result of application thereto of pressures resulting from temperature changes in said mechanism, said last named means embodying devices operating at a greater leverage than the force exerted by the said pressures transmitted thru the rocker member.

9. Operating mechanism including a plurality of rocker members, an eccentrically mounted support for each of said rocker members, and normally substantially stationary individual automatic means for each of said rocker members cooperating with said eccentric mounting for at all times maintaining the parts of the mechanism in contact with each other without lash and without binding.

10. Valve operating mechanism including a cam shaft, a plurality of rocker members adapted to be actuated by the cam shaft, a common shaft upon which said rockers are mounted a plurality of valves one arranged for actuation by each of said rocker members, an eccentric bushing for each of the rocker members mounted on said common shaft, and normally substantially stationary independent means associated with each of said eccentric bushings for automatically adjusting the position thereof to at all times take up slack in the mechanism and prevent binding thereof.

11. Valve operating mechanism comprising a rocker member, an eccentric serving as a pivot for said rocker member and hydraulic means for automatically positioning said eccentric so as to at all times take up slack in said system.

12. Valve operating mechanism including a turnable part, an eccentric serving as a pivot for said turnable part, and a normally substantially stationary automatically variable positioning means for at all times positioning said eccentric so as to take up slack in the mechanism.

13. In the combination as defined in claim 12 said positioning means comprising a displaceable member and a fluid abutment for said member adapted to automatically displace said member in response to changes in slack in said system.

14. Valve operating mechanism comprising a turnable member, a pivot for said turnable member, an angularly adjustable support for the pivot to variably position the turnable member to take up slack in the system, and an hydraulic abutment for said pivot variable to maintain said pivot in adjusted position.

15. Valve operating mechanism comprising a rocking member for transmitting movement from one part of the operating mechanism to the other, an angularly adjustable support for the pivot of the rocker member to increase or decrease the amount of slack in the system, means for urging said pivot in a direction to take up slack in the system and an hydraulic abutment automatically variable to maintain said pivot in adjusted position.

16. Operating mechanism comprising an operating member, an operated member, a rocker arranged to transmit motion between the members, an angularly adjustable support for the pivot of said rocker to increase or decrease the amount of slack in the mechanism, means for yieldingly urging the support in a direction to take up slack in the system and braking means for re-

sisting reverse rotation of the support under operating stresses.

17. Operating mechanism comprising an operating member, an operated member, a rocker arranged to transmit motion between the members, an eccentric support for the rocker, means for yieldingly urging the support in a direction for taking up slack in the system, and means arranged to resist reverse movement of the support under operating stresses.

18. Operating mechanism comprising an operating part, an operated part, yieldingly operated means cooperating with said parts and acting at a favorable mechanical advantage with respect to the operating forces tending to at all times take up slack in the mechanism, and means for resisting reverse movement of said first named means.

19. A power transmitting system comprising a train of power transmitting elements and slack take up means for said train embodying mechanical advantage, yielding means operating on said slack take up means for urging it in a direction to take up slack in the system, a fluid dash pot connected to the slack take up means for preventing rapid reverse movement of said slack take up means, said dash pot being connected to the slack take up means so that it operates at a favorable mechanical advantage with respect to the operating forces transmitted there-through.

20. A power transmitting system comprising a train of power transmitting elements and slack take up means for said train embodying mechanical advantage, means operating on said slack take up means for yieldingly urging it in a direction to take up slack in the system, braking means for resisting reverse movement of said slack take up means, said braking means being connected to the slack take up means so that it operates at a favorable mechanical advantage with respect to the operating forces transmitted through the slack take up means.

21. A power transmitting system comprising a train of power transmitting elements and slack take up means for said train embodying mechanical advantage, yielding means operating on said slack take up means for urging it in a direction to take up slack in the system, means for preventing rapid reverse movement of said slack take up means, said yielding means and said reverse movement preventing means being arranged so that they operate at a favorable mechanical advantage with respect to the operating forces.

22. In combination a motion transmitting system including a pivoted member, a movable support for the pivot of said member and positioning means for said support arranged to adjust the position of said support to automatically take up slack in said operating mechanism, said positioning means comprising a variable volume hydraulic chamber.

23. In an engine the combination of a valve, a push rod, a rocker arm transmitting motion from the push rod to the valve, a movable support for the pivot of said rocker arm and a self-adjusting positioning means for said support arranged to take up slack in said mechanism, said positioning means comprising an hydraulic chamber and said support comprising a piston extending into said chamber.

24. The combination of an operating member, an operated member, a pivoted member transmitting motion from the operating member to the operated member, and hydraulic means for

adjusting the position of the pivot of said member to take up slack in the system.

25. A motion transmitting system having a cycle including operating and non-operating periods, spring means for returning the system to normal position, said system including a movable member, and stationary hydraulic positioning means for said member including a hydraulic chamber, a piston working in the chamber, means yieldingly urging the piston outwardly of the chamber in a direction to move said part to take up slack in the system, said yielding means being of less strength than said spring means so that it is effective only during the non-operating positions of the cycle.

26. In an engine the combination of a valve, a tappet, a rocker arm for transmitting motion from the valve to the tappet, a pivot for the rocker arm, and hydraulic positioning means for said pivot comprising a hydraulic chamber, a piston working in the chamber, a spring for urging the piston outwardly of the chamber in a direction to take up slack in the system in case of contraction of the gear, and means for admitting additional fluid to the chamber upon outward movement of the piston, the clearance between said piston and its guide permitting escape of excess fluid in case of expansion of the gear.

27. In a valve actuating mechanism for internal combustion engines, a rocker arm having a valve actuating end and an end arranged to be moved to rock the arm about an axis disposed intermediate of the ends, and means movably supporting the arm adjacent its axis, including means resiliently urging the arm axis toward the valve parts and capable of rapid movement, and means interposing an additional strong resistance to the movement of the arm axis away from the valve part.

28. In combination a motion transmitting system including a pivoted member, a movable support for the pivot of said member and positioning means for said support arranged to adjust the position of said support to automatically take up slack in said operating mechanism, said positioning means comprising a hydraulic chamber and means for periodically replenishing said chamber to insure that it is filled with fluid at all times.

29. Valve mechanism for internal combustion engines comprising a valve, an operating member, and a pivoted member adapted to transmit motion from the operating member to the valve, and hydraulic means for automatically adjusting the position of said pivot in accordance with variations of pressure in the system as slack develops therein for at all times taking up slack in the system.

30. A motion transmitting system including operating and operated members between which slack at times develops, stationary hydraulic means for positioning one of said members, and means automatically operative when slack develops in the system for adjusting said hydraulic means to shift said member in a direction to take up slack.

31. In an engine the combination of a valve gear comprising an operating member, an operated member, and a rocker transmitting motion from the operating member to the operated member, said gear being subjected to contraction and expansion as a result of changes in temperature of the engine, means for taking up slack in the gear comprising a hydraulic chamber, a piston in the chamber arranged to position the pivot of

said rocker, a spring for urging the piston outwardly of the chamber to move the pivot to take up slack developed as a result of contraction of the gear, means for supplying the chamber with additional fluid upon outward movement of the piston, the clearance between the piston and its bore affording escape for excess fluid upon expansion of said gear.

32. In a train of mechanism subject to variations in slack during operation, the combination of a plurality of motion transmitting members, means interposed between said members to compensate for variations in slack in said train, said means comprising a device embodying mechanical advantage, means yieldingly urging said device in a direction to take up slack in the system, said means operating at the mechanical advantage provided by said device, and means in addition to said members and first named means for damping the reverse movement of said device.

33. In a train of mechanism subject to variations in slack during operation, the combination of a plurality of motion transmitting members, means for adjusting the position of one of said members to compensate for variations in slack, said means comprising a device embodying mechanical advantage, means yieldingly urging said device in a direction to take up slack in the system, said means operating at the mechanical advantage provided by said device, and means in addition to said members and first named means for damping the reverse movement of said device.

34. In a valve actuating mechanism for internal combustion engines, and the like, a rocker arm, and a floating support for the arm intermediate its ends, including means whereby the axis of the arm is moved resiliently without material resistance toward the valve parts, and means in addition to said first named means whereby the axis encounters material yielding resistance to movement away from the valve parts.

35. An engine valve operating mechanism comprising a valve, a push rod, a rocker arm transmitting motion from the push rod to the valve, a piston positioning the pivot for said rocker arm, an hydraulic chamber into which said piston extends for determining the position of said piston and means for supplying oil under pressure to said chamber to maintain in the chamber the necessary volume of oil to at all times take up the slack in the system.

36. An engine valve operating mechanism comprising a valve, a push rod, a rocker arm transmitting motion from the push rod to the valve, a piston positioning the pivot for said rocker arm, an hydraulic chamber into which said piston extends for determining the position of said piston and means for supplying oil under pressure to said chamber to maintain in the chamber the necessary volume of oil to at all times take up the slack in the system, said hydraulic chamber being provided with a valved passage arranged at the highest point in the chamber.

37. In combination with a mechanical movement adapted to have a variable amount of slack develop therein, and stationary hydraulic means for taking up slack in the movement comprising a hydraulic chamber, a member exposed to the fluid in the chamber, and arranged to take up slack in the movement, and means for automatically varying the volume of fluid in the chamber in accordance with variations in slack

in the system to shift the position of said member so as to at all times take up slack.

38. In combination with a mechanical movement adapted to have a variable amount of slack develop therein, stationary hydraulic means for taking up slack in the movement comprising a hydraulic chamber, a member exposed to the fluid in the chamber and arranged to take up slack in the movement, means for yieldingly urging the member outwardly of the chamber, and means for supplying the chamber with fluid upon outward movement of said member.

39. In combination with a mechanical movement adapted to have a variable amount of slack develop therein, stationary hydraulic means for taking up slack in the movement comprising a hydraulic chamber, a piston guided for sliding movement in the chamber and exposed to the fluid therein, means for yieldingly urging the piston outwardly of the chamber, means for supplying the chamber with fluid upon outward movement of said piston, the clearance between the piston and its guide serving for the escape of fluid to permit return movement of the piston upon reduction in slack in the system.

40. In combination with a mechanical movement adapted to have a variable amount of slack develop therein, stationary hydraulic means for taking up slack in the movement comprising a hydraulic chamber, a piston guided for sliding movement in the chamber and exposed to the fluid therein, means for supplying the chamber with fluid under pressure to force the piston outwardly to take up slack in the system, the clearance between the piston and its guide serving for the escape of fluid to permit return movement of the piston upon reduction in slack in the system.

41. In a motion transmitting system including a pivoted member having a shiftable pivot, a stationary hydraulic positioning device for said pivot including a hydraulic chamber, a movable member exposed to the pressure in the chamber, said member being arranged to position said pivot, and means for yieldingly urging said member outwardly of the chamber to move said pivot to take up slack in the system, and means for supplying the chamber with additional fluid upon outward movement of said member.

42. In an engine having valve gear including a rocker member through which motion is transmitted, spring means for returning the gear to normal position, a pivot for said rocker member, and means for intermittently operating the gear, a stationary hydraulic positioning means for said pivot comprising a hydraulic chamber, a piston working in the chamber and adapted to position the pivot, a spring for urging the piston outwardly of the chamber in a direction to take up slack in the system in case of contraction of the gear, means for admitting additional fluid to the chamber upon outward movement of the piston, the clearance between said piston and its guide permitting escape of excess fluid in case of expansion of the gear, said spring being of less strength than said spring means so that adjustment can take place only during non-operating portions of the cycle.

43. A power transmitting system comprising a train of power transmitting elements and slack take up means for said train embodying mechanical advantage, yielding means operating on said slack take up means for urging it in a direction to take up slack in the system, a fluid dash pot connected to the slack take up means for pre-

venting rapid reverse movement of said slack take up means, said dash pot being connected to the slack take up means so that it operates at a favorable mechanical advantage with respect to the operating forces transmitted therethrough, said dash pot comprising a cylinder, a piston in the cylinder, said piston being provided with a passage for admission of fluid to the dash pot, and a non-return valve in said passage.

44. A motion transmitting system including operating and operated members between which slack at times develops, stationary hydraulic means for positioning one of said members, and means automatically operative when slack develops in the system for adjusting said hydraulic means to shift said member in a direction to take up slack, said stationary hydraulic means comprising a cylinder, a piston in the cylinder, a spring urging the piston outwardly of the cylinder, said piston being provided with a passage for the admission of fluid to the cylinder, and a non-return valve in said passage.

45. In valve mechanism for internal combustion engines and the like the combination of a camshaft, a rocker arm engaged by the camshaft, a valve actuated by the rocker arm, said rocker arm having a shiftable pivot, a stationary hydraulic positioning device for said pivot including a hydraulic chamber, a movable member exposed to the pressure in the chamber, said member being arranged to position said pivot, and means for yieldingly urging said member outwardly of the chamber to move said pivot to take up slack in the system, and means for supplying the chamber with additional fluid upon outward movement of said member.

46. In an engine comprising a crankcase, a cylinder, a piston in the cylinder, a valve controlling communication with the cylinder, a rocker arm adapted to actuate the valve, a camshaft mounted in the crankcase and engaging the rocker arm, means movably supporting the arm

adjacent its axis including means yieldingly urging the arm toward the valve and capable of rapid movement and means interposing an additional strong resistance to the movement of the arm away from the valve.

47. In an engine comprising a crankcase, a cylinder communicating with the crankcase, a head for the cylinder defining therewith a combustion chamber, a valve controlling communication with the chamber, a camshaft in the crankcase, a rocker arm adapted to actuate the valve and having a part engaged by the camshaft, yieldingly operated means positioning the pivot of said rocker arm and acting at a favorable mechanical advantage with respect to the operating forces, said means tending to at all times take up slack in the system, and means in addition to said valve and first named means for resisting reverse movement of said yieldingly operated means.

48. In a motion transmitting system including a pivoted member having a shiftable pivot, a stationary hydraulic positioning device for said pivot including a hydraulic chamber, a movable member exposed to the pressure in the chamber, said member being arranged to position said pivot, and means for yieldingly urging said member outwardly of the chamber to move said pivot to take up slack in the system, and means for supplying the chamber with additional fluid upon outward movement of said member, said chamber being provided at the highest point therein with an outlet for air.

49. In a valve actuating mechanism for internal combustion engines, a rocker arm, a pair of telescoping members, one connected to the arm adjacent its axis and movable with respect to the other member, means resiliently urging the members apart, and means interposing a large yielding resistance to the telescoping movement.

JOHN O. ALMEN.

45 120

50 125

55 130

60 135

65 140

70 145

75 150