May 12, 1942. E. S. HALL 2,282,722

CROSSHEAD MECHANISM

Filed Jan. 30, 1940

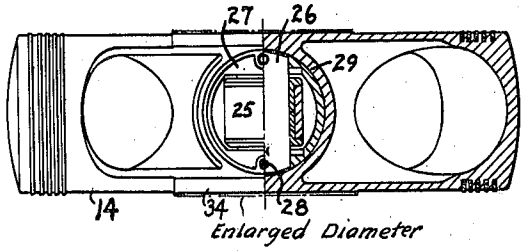


Fig-3-

Fig-1-

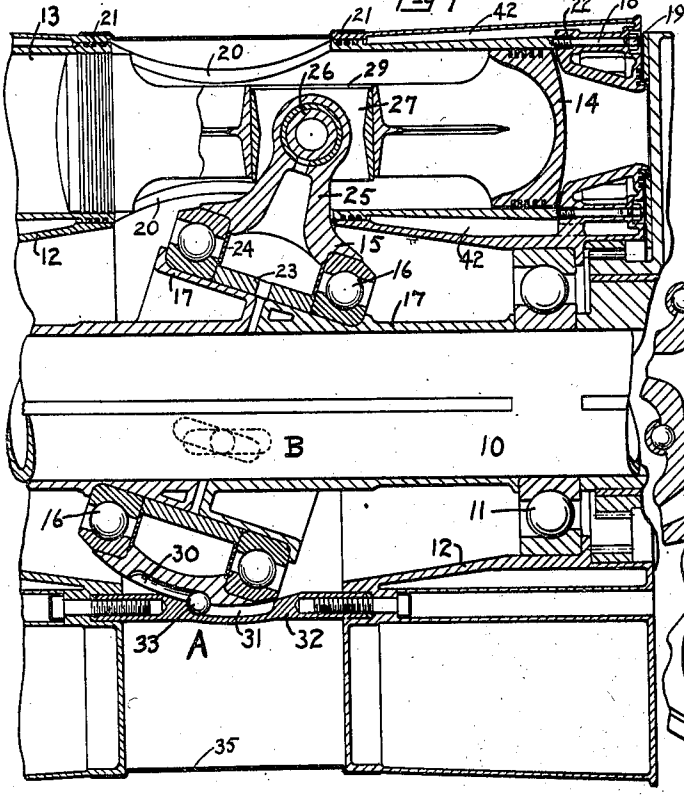
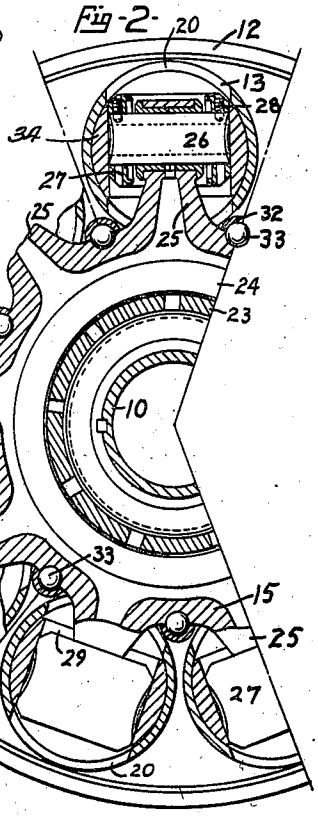


Fig-2-



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Patented May 12, 1942

2,282,722

UNITED STATES PATENT OFFICE

2,282,722

CROSSHEAD MECHANISM

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Application January 30, 1940, Serial No. 316,402

6 Claims. (Cl. 123—58)

This invention relates to crosshead mechanism in engines and pumps of types having two sets of cylinders facing each other in which it is possible to use double-ended piston members, for example: horizontal-opposed engines, and barrel type or round engines having cylinders parallel to the shaft. In discussing barrel engine mechanisms, it is convenient to distinguish between a cylindrical cam, a swashplate, and a wabbler. Both the cylindrical cam and the swashplate rotate relative to the cylinders, being ordinarily fixed upon the shaft; the cam has more or less sinusoidal working faces to coact with rolling followers, while the swashplate has plane working faces which may coact with slippers seated in the piston members. A wabbler does not rotate relative to the cylinders, being mounted on bearings on and inclined to the shaft. This invention is applicable to crank type, cylindrical cam, and swashplate mechanisms, but it is especially advantageous with the wabbler mechanism and may conveniently be described as applied thereto, it being understood that any of the other mechanisms may be used if desired. The salient object of the invention is to provide a crosshead type of piston mechanism of simple, compact, and light-weight construction.

With double-ended pistons, it is desirable that their central portions function as crossheads on which to carry the lateral loading which, with the better mechanisms, comprises the torque reaction of the engine. When the central portion of the piston member serves as a crosshead, the member is not subject to beam loading, and the pistons are free to perform their primary function as ring carriers, without cocking or slap, and with less friction loss. In an engine having two sets of cylinders with the reciprocating-rotary mechanism between them, it has been common practice to split the engine on a plane either longitudinal or transverse relative to the cylinders. The longitudinal split is undesirable because of lack of symmetry of the major parts. The transverse split has the advantage of axial symmetry, but care must be used that the opposed cylinders be exactly coaxial for the proper operation of the common piston member therein. It would obviously be more desirable if the piston member, especially when it has a central crosshead, could operate in a single unbroken cylinder. An object of this invention is to provide, in an engine or pump mechanism split transversely and having double-ended pistons of the crosshead type, cylinder sleeves extending from one end of piston travel to the other, the central portions of the sleeves serving as crosshead guides. Further objects are to use the cylinder sleeves as means for fastening the casing members or cylinder blocks together, and to provide an approved "wet liner" cylinder construction, the sleeves serving this purpose as well as that of crosshead guides.

Further objects are to provide a wabbler mechanism of the type in which substantially no torque reaction is carried by the wabbler, the wabbler serving to distribute the torque reaction among the several piston members as lateral loading upon their respective crosshead surfaces, this useful loading being substantially the only lateral loading upon them; and to provide adequate wristpin bearing area in a piston member capable of passing straight thru the cylinder sleeve, the sleeve extending continuously from one end of piston travel to the other.

These and other objects of the invention will be clear from the following description in connection with the drawing in which

Fig. 1 is a longitudinal section of an engine or pump mechanism;

Fig. 2 is a transverse section on the mid-plane of the mechanism and on the mid-plane of the wabbler; and

Fig. 3 is a radial view, partly in section, of the piston member of Fig. 1 and associated parts.

Referring to the drawing, shaft 10 is mounted on bearings 11 in cylinder blocks 12. Wabbler 15 is mounted on bearings 16 whose inner races are clamped between boss members 17 with spacer sleeve 23 between them. Boss members 17 are fixed on shaft 10 in any suitable way. Wabbler 15 is provided with a series of longitudinal ball races 30; corresponding ball races 31 are formed longitudinally in members 32 fixed to cylinder blocks 12. One of the balls 33 is operable in each pair of races 30 and 31. In this manner wabbler 15 is prevented from rotating relative to cylinder blocks 12 while shaft 10 and boss members 17 can rotate in bearings 11 imparting the characteristic wabbling motion to wabbler 15.

Wabbler 15 has arms 25, one for each piston member 14. Each arm 25 has a cylindrical bore with its axis tangent to a circle in the plane of wabbler 15, the bore being rotatable and slidable on wristpin 26 which is fixed in radial crosshead or wristpin carrier 27 by setscrews 28. Wristpin carrier 27 is rotatable and slidable in bore 29 in piston member 14, the axis of bore 29 being radial to shaft 10.

Piston members 14 are reciprocable in cylinder

sleeves 13, each sleeve 13 extending from the cylinder head of one block 12 to that of the other block 12 and forming a "wet liner" in both cylinder blocks 12. The central portion of cylinder sleeve 13 is provided with symmetrical openings 20 one for inspection purposes and the other to accommodate the movement of wabbler arm 25; on either side of openings 20 the walls of sleeve 13 serve as crosshead guides for piston member 14. The piston member 14 may pass straight thru sleeve 13, and its central portion serves as a crosshead 34 in sleeve 13, the skirts of the pistons being of smaller diameter so as to reduce oil shear area and to avoid beam loading on the piston member 14, the lateral loading on piston member 14, comprising its share of the engine torque reaction, being carried on crosshead 34. The central portion of sleeve 13 is thickened to carry packing rings 21 of any suitable material to seal the coolant in jackets 42 and to make up in strength for the material removed by openings 20. The ends of sleeve 13 are also thickened to withstand the higher gas pressures and to provide for the attachment of studs 18, preferably screwed into the thickened ends of sleeve 13, and spaced evenly about the ends of sleeve 13 in ample number to carry the tension loads imposed upon sleeve 13 by gas pressures acting on the piston and cylinder heads. Suitable packing is used in grooves 22 of cylinder blocks 12 which receive the ends of cylinder sleeves 13, to insure that the joint be tight against leakage of gas from within the cylinder or coolant from the jacket space 42. Studs 18 may be furnished with nuts 19.

It is desirable that a continuous oil passage be provided from within shaft 10, or from within boss members 17, to the crosshead surfaces 34 of piston members 14 thru wabbler arms 25 and associated parts. To prevent leakage of excess oil thru ball bearings 16 from this oil passage, sealing plates 24 are provided.

In assembly, bearings 16 are assembled with wabbler 15, sleeve 23 and plates 24 upon boss members 17. This assembly is then mounted on shaft 10. Wristpins 26 and carriers 27 are then assembled on arms 25 and locked by setscrews 28. Piston members 14 are inserted in their several cylinder sleeves 13, and then assembled radially upon their several wristpin carriers 27, and inserted longitudinally into one of the cylinder blocks 12 with suitable packing and sealing rings 21 in place. Then the other block 12 may be drawn on, and the two blocks fastened together upon sleeves 13 by nuts 19 drawn down on studs 18, after which the wabbler case may be closed by oil pan 35 extending from one cylinder block 12 to the other.

In operation, rotation of shaft 10 is accompanied by reciprocation of piston members 14, and the oscillatory combined rotation and axial sliding of wristpin carrier 27 within the bore 29 in piston member 14 and of wabbler arm 25 on wristpin 26. Displacement of the center of arm 25 from the plane of the cylinder axis, as that center follows its lemniscate path, causes a slight oscillatory rotation of piston member 14 during its reciprocation, tending to improve its lubrication in cylinder 13 and tending also to prevent piston ring sticking.

Rotation of shaft 10 is also accompanied by the rolling of balls 33 in their races 30 and 31. Balls 33 are maintained with their centers always in the plane which bisects the angle between the mid-plane of the wabbler and the plane normal to the shaft thru the center of the wabbler by the interaction of races 30 and 31. At the position shown at A in Fig. 1, the two races are coplanar, but the ball is positively located by the ends of races 30 and 31 as shown. At all other positions, the ball 33 is positively located at the intersection of the two races 30 and 31, as indicated diagrammatically at B in Fig. 1.

Most of the proposed wabbler mechanisms have the objectionable characteristic of imposing the engine torque reaction upon the wabbler. For example, when the wabbler is connected to the pistons by ball-jointed connecting rods, it is readily understood that the wabbler must be held against rotation in order to turn the shaft at all. (If not so held, the thrust of the rods would merely turn the wabbler on its bearings and tangle up the rods.) In other words, the torque reaction is on the wabbler, and the restraint must be adequate for carrying this heavy load. It is clearly not desirable to load the wabbler restraint so heavily.

The wabbler mechanism shown, having wristpins 26 with their axes tangent to a circle in the plane of the wabbler, imposes practically no torque reaction on the wabbler. This is apparent from the fact that all working surfaces of the wabbler are surfaces of revolution about the wabbler axis or tangent to such surfaces of revolution, so that, essentially, only frictional forces can act to turn the wabbler. The torque reaction is distributed among the several piston members 14, and is carried by their crosshead surfaces 34 sliding within the central portions of cylinder sleeves 13. This useful lateral loading constitutes the only side thrust carried by piston members 14, and this is one of the reasons for the high efficiency of this particular wabbler mechanism. While in this mechanism, crosshead portion 34 of piston member 14 is kept small enough to pass thru cylinder sleeve 13, nevertheless, the bearing area of wristpin 26 in wabbler arm 25 is of ample size, being about twice that of wristpin bearing areas in engines of the same bore now in production.

With the engine torque reaction distributed among the several piston members and substantially no torque imposed on wabbler 15, the wabbler restraint comprising balls 33 and their races 30 and 31 have only the duty of preventing rotation of wabbler 15 against the frictional drag of bearings 16. This restraint comprises a uniform velocity universal joint connecting wabbler 15 with cylinder blocks 12.

From the foregoing description, it is evident that the objects of the invention as stated have been attained in a practical manner. While I have shown a particular embodiment of the invention, and its application to the wabbler mechanism, it is obvious that the invention could be adapted to serve with a cylindrical cam mechanism or other types, and it is understood that changes may be made in the structure and in the arrangement of the parts without departing from the spirit and scope of the invention as expressed in the following claims.

I claim:

1. In a parallel cylinder mechanism of the class described, in combination, a shaft, casing members comprising a pair of cylinder blocks, bearings for said shaft in said casing members, cylinder heads associated with said blocks, cylinder sleeves open at both ends and entering

both said casing members as wet cylinder liners and extending from the cylinder heads of one of said blocks to those of the other, studs in the ends of said cylinder sleeves for securing them in said casing members thereby fastening said casing members together with said sleeves in tension during operation, means for sealing the joints between said cylinder sleeves and said casing members to prevent leakage of cylinder gases or coolant, piston members each including a pair of pistons and a central crosshead portion larger in diameter than said pistons, the central portion of one of said sleeves serving as a crosshead guide for said crosshead, and mechanism operably connecting said crossheads with said shaft.

2. In mechanism of the class described, a shaft, casing members comprising cylinder blocks, bearings for said shaft in said casing members, cylinder heads associated with said cylinder blocks, cylinder sleeves entering both of said casing members as cylinder liners and extending parallel to said shaft from the cylinder heads of one of said blocks to those of the other, means securing said sleeves in said casing members and fastening said casing members together with said sleeves in tension during operation of said mechanism, piston members operable in said sleeves and each including a pair of pistons and a central crosshead of larger diameter than said pistons, the central portion of one of said sleeves serving as a crosshead guide for said crosshead, and mechanism operably connecting said piston members with said shaft.

3. In a parallel cylinder engine of the class described, a frame comprising two similar parts facing each other, cylinder heads associated with said parts, a shaft, bearings for said shaft in said frame parts, seats formed in said frame parts, cylindrical members mounted in said seats and extending from the cylinder heads of one of said parts to those of the other, piston members operable in said cylindrical members and operably connected to said shaft, and means securing said frame parts to said cylindrical members with said cylindrical members in tension whenever gas interacts with the heads of said piston members and said cylinder heads.

4. In an engine mechanism, a shaft, casing members comprising cylinder blocks, bearings for said shaft in said casing members, cylinder heads associated with said cylinder blocks, cylinder sleeves entering both of said casing members as cylinder liners and extending parallel to said shaft from the cylinder heads of one of said blocks to those of the other, means securing said sleeves in said casing members and fastening said casing members together with said sleeves in tension during operation of said mechanism, piston members each including a pair of pistons and a central crosshead of larger diameter than said pistons, and mechanism operably connecting said piston members with said shaft.

5. In a parallel cylinder engine mechanism of the class described, a shaft, casing members comprising a pair of cylinder blocks, bearings for said shaft in said casing members, cylinder heads associated with said blocks, cylinder sleeves entering both said casing members as cylinder liners and extending from the cylinder heads of one of said blocks to those of the other, means securing said sleeves in said casing members said means comprising a series of studs in the ends of said sleeves, piston members each including a central crosshead, the central portion of one of said sleeves serving as a crosshead guide for said crosshead, and mechanism operably connecting said crossheads to said shaft, said sleeves being in tension axially whenever gas pressure interacts between the heads of said piston members and said cylinder heads.

6. In mechanism of the class described, a shaft, casing members including cylinder heads, bearings for said shaft in said casing members, cylinder sleeves extending parallel to said shaft and from one of said casing members to the other, means securing said sleeves to said casing members thereby fastening said casing memzers together with said sleeves in tension during operation of said mechanism, piston members each including a piston at each end thereof and a central crosshead operable in the central portion of one of said cylinder sleeves, and mechanism operably connecting said crossheads with said shaft.

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