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K. L. HERRMANN

2,243,822

INTERNAL COMBUSTION ENGINE

Filed Sept. 25, 1940

FIG. 1.

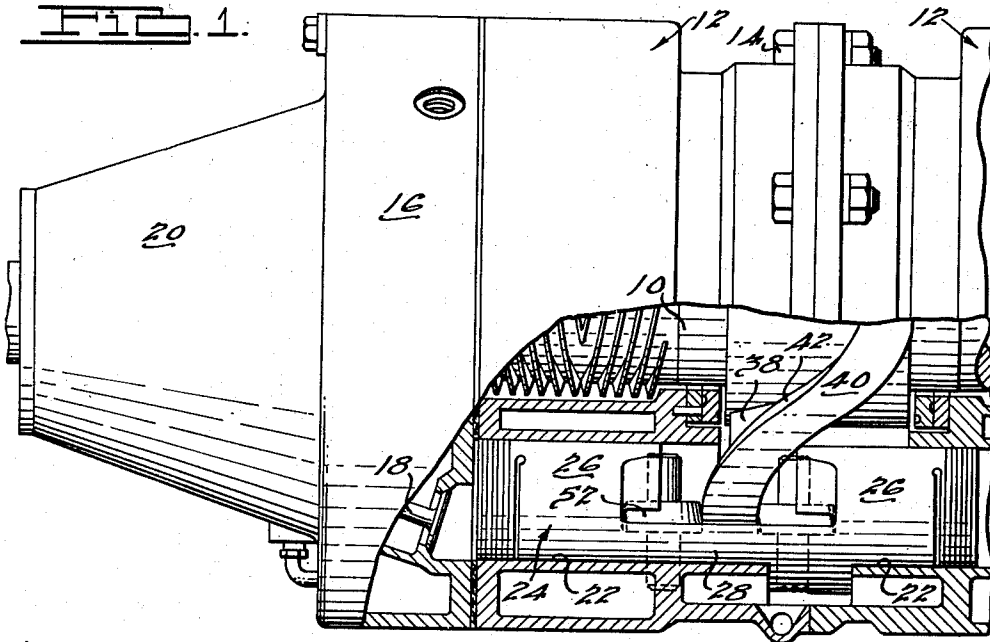
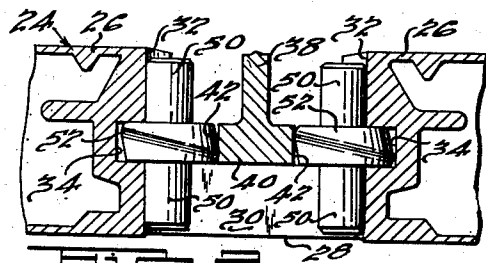


FIG. 2.

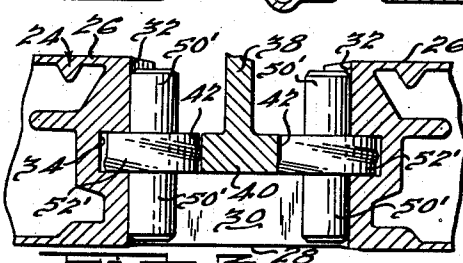


FIG. 3.

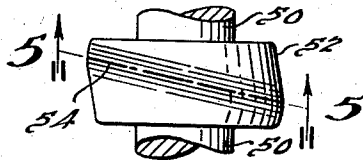


FIG. 4.

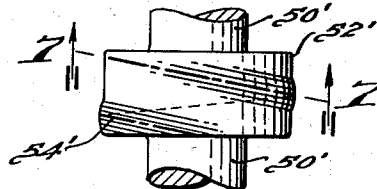


FIG. 5.

FIG. 6.

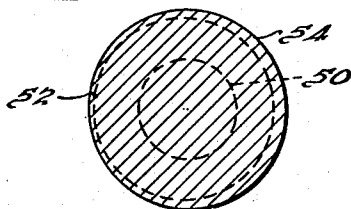
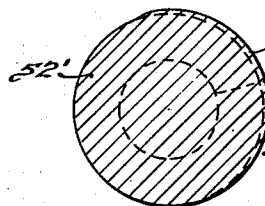


FIG. 8.

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UNITED STATES PATENT OFFICE

2,243,822

INTERNAL COMBUSTION ENGINE

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Application September 25, 1940, Serial No. 358,242

8 Claims. (Cl. 74-56)

This invention relates to internal combustion engines and particularly to those of the barrel type, the principal object being the provision of a new and novel form of connection between the piston and the cam which will reduce the amount of wear heretofore occurring at this point.

The invention relates to what is commonly known as a barrel type of engine, that is an engine in which the cylinders are arranged with their axes parallel to the shaft and equally angularly arranged about the shaft and with such axes lying in a cylindrical surface concentric with the axis of the shaft. The cylinders are arranged in two groups, one group at each end of the engine and each cylinder of each group is arranged in aligned and opposed relation to a corresponding cylinder of the other group and with a double ended piston associated with each opposed pair of cylinders, the shaft being provided with an axial cam received by the central portion of the piston and rollers being interposed between the opposite faces of the cam and the pistons to transmit the thrust between the pistons and the cam.

Objects of the invention include, in an engine of the type described, a roller construction which will take care of any mis-alignment between the rollers and the cam faces and yet will distribute the wear between the rollers and the cam over a desired width of the face of the cam; the provision, in an engine of the type described, of a roller construction which will have substantially point contact with the cam but in which the line of contact between the rollers and the cam will be in an approximate circle having a varying radius; the provision, in an engine of the type described, of rollers having curved or crowned faces, the high points of the crown on the rollers varying axially of the roller in extending around the periphery thereof; the provision of an engine of the type described in which the various rollers interposed between the cam and the pistons are crowned with the high points of the crowns of the various rollers so arranged that the line of contact between the rollers and the cooperating cam faces is a wavy or meandering line varying in radial distance from the center of the engine shaft at various points in the length thereof; the provision of an engine of the class described in which the rollers interposed between the cam and pistons are each provided with a crowned peripheral surface the high points of which are arranged in more or less helical formation about the axis of the roller; and the provision of an engine of the class described in which each of

the rollers interposed between the cam and the pistons is provided with a crowned peripheral surface so constructed and arranged that the high points of the crowned surface lie substantially in a plane inclined to a plane perpendicular to the axis of the roller.

The above being among the objects of the present invention, the same consists in certain novel features of construction and combinations of parts to be hereinafter described with reference to the accompanying drawing, and then claimed, having the above and other objects in view.

In the accompanying drawing which illustrates suitable embodiments of the present invention and in which like numerals refer to like parts throughout the several different views,

Fig. 1 is a fragmentary, partially sectioned, partially broken side elevational view of an internal combustion engine of the barrel type to which the present invention has been adapted;

Figs. 2 and 3 are similar enlarged, fragmentary sectional views of one of the pistons for the engine shown in Fig. 1, taken axially through the piston in a plane including the axis of the engine power shaft and each illustrating a different form of roller construction between the piston and the cam;

Fig. 4 is an enlarged, fragmentary side elevational view of one of the rollers shown in Fig. 2;

Fig. 5 is an enlarged transverse sectional view taken on the line 5-5 of Fig. 4;

Fig. 6 is an enlarged, fragmentary side elevational view of one of the rollers shown in Fig. 3; and,

Fig. 7 is an enlarged transverse sectional view taken on the line 7-7 of Fig. 6.

The present invention relates to a barrel type engine. As is well understood in the art these engines comprise a rotating shaft about which is grouped a plurality of equally angularly spaced cylinders arranged with their axes lying in the surface of a cylinder concentric with the shaft. The cylinders in the present case, and as is usual, are arranged in two groups, one at each end of the engine with their open ends opposed to each other and each cylinder of one group in alignment with one cylinder of the opposite group. Each opposed pair of cylinders receives therein a double ended piston, and a cam fixed to the rotating shaft is received within or by the central portion of each piston. Usually, and as in the case of the present invention, the pistons support rollers which engage the opposite faces of the cam so as to reduce the friction between the piston

and the cam when the thrust of the pistons under explosions in the cylinders is exerted upon the cam to induce a rotational effect thereon.

While the present invention is applicable to any satisfactory type of barrel type engine, it is particularly applicable to the engine construction shown, described and claimed in my co-pending application for Letters Patent of the United States for improvements in Internal combustion engine, filed May 14, 1937, and serially numbered 142,653. Also, while the rollers may be supported in the pistons in any suitable manner in accordance with the present invention, the preferred method of supporting them is that shown and described in my co-pending applications for Letters Patent of the United States for improvements in Internal combustion engine, filed October 29, 1938, and serially numbered 237,625, and filed May 6, 1940, and serially numbered 333,519, respectively. Early experiments with this type of engine illustrated the difficulty of so accurately machining the various parts that all of the rollers between the pistons and the cams, when provided with cylindrical peripheral surfaces, will bear against the cam with true line contact, the surfaces of the rollers often being found to be cocked with respect to the engaged face of the cam, resulting in a condition of contact between the roller and the cam destructive to both. To avoid this disadvantage and as disclosed in the last two co-pending applications above referred to, the peripheral surfaces of the rollers were slightly crowned so as to provide, in theory at least, point contact with the faces of the cam intermediate the width of the same, the crowning being uniform in all sections taken axially through the rollers. Such crowning of the peripheral surfaces of the rollers satisfactorily accomplished the results sought to be obtained, that is eliminating the disadvantages formerly occurring because of a cocked condition between the rollers and the cam. Further experiments have indicated, however, that, with this crowned construction above described, because all of the rollers are made identical, the wear between the rollers and the cam is concentrated upon a substantially narrow circular path upon the face of the cam and, due to the high pressures existing between the rollers and the cams at full engine operation, premature wearing and breaking down of the cam surface sometimes results, and it is the principal object of the present invention to eliminate this further disadvantage.

This disadvantage is overcome in accordance with the present invention by employing crowned rollers, but arranging the crowning so as to distribute the contact between the rollers and the cam over the width of the cooperating cam faces. Briefly stated, this is accomplished by so crowning the rollers that the high points of the crown of each roller varies axially of the rollers around the periphery thereof. This effect may, of course, be obtained in a number of different ways. For instance, the peripheries of the rollers may be so crowned that the high points of the crowns form a helical line extending around the periphery of the roller with the ends of such lines preferably overlapping axially so as to provide continuous, smooth and unbroken contact between the roller and the cam surface. On the other hand, the periphery of the rollers may be so crowned that the high points of the crown form a wavy or meandering line curved axially of the roller first in one direction and then in the opposite

direction about the periphery of the same. Another method of crowning the rollers to obtain this effect is to so crown them that the high points of the crown all lie substantially in a single plane passing through the center of the roller but inclined to a plane passing through the center of the roller and perpendicular to the axis of the roller. In any event, because the high points of the crown of each roller simulate a line which curves back and forth axially of the roller upon the periphery thereof, the contact between each roller and its corresponding cam face will vary radially of the cam face over the circular extent of the same. It will be appreciated that by properly proportioning the diameter of the rollers with respect to the circular length of the cooperating cam face the line of contact between these rollers and the cam face will be ever changing and seldom will the line of contact between the roller and the cam during one relative rotation of the cam with respect thereto ever be repeated. Accordingly, by the practices of the present invention the wear between the rollers and the cam will be distributed over substantially the entire width of the cams thereby eliminating the possibility of break down of any narrow surface portion of the cam and at the same time eliminating any disadvantages that might otherwise occur because of any slight misalignment between the axes of the rollers and the cooperating faces of the cam.

Referring now to the accompanying drawing, it may be noted that the engine there shown is, except for the feature of the present invention, identical to that shown in my co-pending applications above referred to and reference to which may be made for greater detail of the construction of such engine if desired. As far as the present invention is concerned it is sufficient to understand that the engine is provided with a central shaft 10 suitably mounted for rotation within a pair of cylinder blocks indicated generally at 12 which are arranged with their ends in axially abutting relationship and secured together by means of bolts 14. The axially outer ends of the cylinder blocks 12 are each closed by a suitable cylinder head indicated generally at 16 which supports suitable inlet and/or exhaust valves such as 18 controlling the admission of combustible mixture to and the exhaust of burnt gases from the various cylinders of the corresponding block. Suitable valve actuating mechanism is driven from the shaft 10 at each end of the engine and each is normally enclosed by a housing indicated generally at 20 carried by the corresponding cylinder head 16. In the particular construction shown by way of illustration each cylinder block 12 is internally formed to provide six cylinders 22 arranged with their axes in the surface of a cylinder concentric with the axis of the shaft 10 and equally angularly spaced with respect to each other about the axis of such shaft. The cylinders 22 of one cylinder block 12 are arranged in axial alignment with the corresponding cylinders of the other cylinder block and in each opposed pair of the cylinders 22 a double ended piston indicated generally at 24 is reciprocally received.

A piston 24 employed in the particular engine shown and which is preferable, but not necessary to the practices of the present invention is shown in greater detail in Figs. 2 and 3 from which it will be noted that it includes opposite end portions 26 integrally connected together by means of a central strut 28 substantially wholly disposed

on one side of a diametrical plane passing through the axis of the piston. This strut 28 is centrally slotted as at 30, the central axis of the slot lying in a plane including the axis of the piston 24 and the opposite ends of the slot 30 comprising semi-cylindrical surfaces arranged with their axes perpendicular to the axis of the piston. A corresponding semi-cylindrical surface 32 is formed on the opposite side of the piston in alignment with the semi-cylindrical surfaces first described and the corresponding piston portions 26 are centrally cut away as at 34 between each aligned pair of semi-cylindrical surfaces. These semi-cylindrical surfaces form bearing surfaces for the trunnions of the rollers which themselves are received in corresponding pockets 34 and project outwardly toward one another therefrom.

A cam member 38 is fixed to the shaft 10 on line with the joint between the cylinder blocks 12. The cam member 38 is formed with a rim 40 which is circular in axial view but the axial faces 42 of which curve axially of the shaft 10 in a simple harmonic curve to provide a cam surface on each side thereof having two axial high points disposed on diametrically opposite sides of the cam, over its length. The width of the rim 40 is such as to be closely received between the rollers received in the opposed pockets 34 of each piston 24 thus constraining each piston to reciprocate in its corresponding cylinders as the rim 40 passes between its corresponding rollers and such rollers acting upon the corresponding faces 42 of the rim 40 under the force of explosions in the corresponding cylinders to impart a rotational effect to the cam member 38 and consequently the shaft 10.

In the broader aspects of the present invention it makes no difference whether the rollers are formed integrally with their trunnions or not, or whether the rollers turn with their trunnions, or whether the trunnions are fixed and the rollers turn on the trunnions. Where the semi-cylindrical bearing surfaces for the trunnions are employed as described in the construction shown, the rollers, here indicated in Figs. 1, 2, 4 and 5 at 52, are preferably formed integrally with the trunnions and one trunnion 50 thus projects from each side of each roller 52 when the latter is received in the corresponding pocket 34, the one trunnion 50 being received by the corresponding semi-cylindrical bearing surface 32 and the opposite trunnion 50 being received by the corresponding semi-cylindrical bearing surface formed at the corresponding end of the slot 30. As previously stated, in my second and third corresponding applications above referred to, the rollers were formed with crowned peripheries which, technically at least, therefore, contacted the corresponding cam surfaces 42 in point engagement, and inasmuch as all of the rollers were identical and the high point of the crown occurred at substantially the identical axial position of each roller, all of the rollers on each side of the cam member 38 contacted the corresponding face 42 of the cam along a single line on such face. While from a practical standpoint despite the fact that theoretically the point contact occurs between each of the rollers and the cam, there is sufficient resiliency in the metal of the rollers and the cam to effect a small surface contact between these parts but nevertheless the width of this area of contact between the rollers and the cam surfaces is so limited that when all of the rollers on one side of the cam contact the cam only over

such limited width it has been found that the surface of the cam, while standing up sufficiently long to render the construction commercial, does not stand up for a length of time commensurate with the length of time which other parts of the engine stand up in service. To obviate this premature breaking down of the cam surfaces it is the object of the present invention to provide a roller construction which will distribute wear between the rollers and the cam surfaces over an increased width of the cam surfaces. In accomplishing the desired results by the practice of the present invention the rollers are crowned, but the line formed by the high points of the crown around the periphery of the roller instead of lying in a plane perpendicular to the axis of the roller forms a line which varies or curves axially of the roller in extending around the same. In the construction illustrated in Figs. 2, 3 and 4 it will be observed that the roller 52 is crowned in such a manner that the high points of the crown, that is those points thereof located at a maximum distance from the axis of the roller, theoretically form a line such as the line 54 extending around the periphery of the roller 52 and lying in a plane passing through the center of the roller 52 but disposed at an angle with respect to a plane passing through the center of the roller and perpendicular to the axis thereof. This line is, therefore, of continuous and unbroken circular conformation. With this construction it will be appreciated from an inspection of Fig. 2 that when the roller 52 is in one position of rotation it will contact the corresponding cam face 42 adjacent the radially outer edge of the same and that when turned through 180° of rotation from the first mentioned position it will contact the corresponding cam face 42 adjacent the radially inner edge of the same. The first position will be similar to that of the lefthand roller 52 illustrated in Fig. 2 and the second mentioned position will be similar to that illustrated in connection with the righthand roller illustrated in Fig. 2. Intermediate these positions of rotation of the rollers they will contact corresponding cam faces 42 intermediate the above described maximum and minimum radial positions on the cam face so that the resulting line of contact between the rollers 52 and the corresponding cam face 42 will be a generally circular line but one which is wavy and which winds back and forth between the outer and inner radial edges of the corresponding cam face in extending thereabout. As previously mentioned, unless the length of the line of contact of a roller on its corresponding cam face 42 during one complete rotation of the cam member 38 is an exact multiple of the maximum circumferential dimension of a roller 52, the line of contact between a roller and its corresponding cam face 42 during one revolution of the cam will not be the same line of contact, or in other words it will not be superposed by the line of contact between the same roller and the cam face during the next rotation of the cam member and, where the diameter of the rollers are suitably proportioned with respect to the normal length of line of contact between the roller and the cam face during one revolution, the path of contact between any one roller and its corresponding cam face will change a small amount during each revolution of the cam member 38 so that eventually each roller will have contacted substantially every point on the surface of the cooperating cam face during continued operation of the engine. The

effect of such a construction will obviously be to distribute the wear between the rollers and the cam faces substantially evenly and substantially over the entire width of the cam faces, thus eliminating the concentration of the wear on a narrow width of the cam faces as in the case of the construction shown in my last two co-pending applications above referred to and at the same time, because the contact between the rollers and the cam face is through a crowned surface, will eliminate any disadvantages which may otherwise be present because of any slight misalignment of the intended relation between the axis of the rollers and the corresponding cam faces.

In Figs. 3, 6 and 7 a different method of crowning the rollers to obtain the effect desired in accordance with the present invention is illustrated. The rollers and their trunnions are illustrated by the same numerals in these figures as in the previously described figures, the only difference being that such numerals in this case bear a prime mark. As in the case of the construction illustrated in Figs. 2, 4 and 5 it may be assumed for the purpose of illustration that the rollers 52' are formed integrally with their trunnions 50'. The rollers 52' are also crowned in this case but in this case the high points of the crown form a line, here indicated at 54', extending about the periphery of the roller and helically arranged about the axis of the roller, the crown of the roller being such that the opposite ends of the helical line formed by the high points thereof preferably overlap one another a slight amount axially of the roller as indicated in Fig. 6. It will be appreciated that with this construction the path of contact between each roller and the corresponding cam face 42 is not a continuous line of contact as in the roller construction illustrated in Figs. 2, 4 and 5, but in this case the path of contact of the rollers on their corresponding cam face will be a series of lines beginning adjacent one radial edge of the cam face and ending adjacent the opposite radial edge of the cam face, the travel or direction being either radially inward or outward depending upon whether the helix formed by the high points of the crown is a righthand or a lefthand helix. In any event the same general effect is obtained as in the first described construction inasmuch as each roller has a path of contact with the corresponding cam face that varies between the radially opposite edges of the cam face and, where the diameter of the rollers is properly selected as mentioned in connection with the previously described rollers, the resulting wear between the rollers and the cam faces will be distributed evenly over the entire area of the cam faces, or at least a desired wide strip of the same between the radially opposite edges of the same.

It will, of course, be appreciated that for the purpose of illustration the amount of crowning of the rollers as shown in the drawings has been greatly exaggerated, and that in actual practice the amount of crowning will ordinarily be no greater than required to realize the purposes of the invention as described.

It will be understood that the two different roller constructions above described are merely illustrative of the broad features of the present invention and that rollers having other specific formation of crowned surfaces thereon to provide a radially varying path of contact between them on the cooperating face of the cam surfaces may be substituted if desired and, accordingly,

formal changes may be made in the specific embodiment of the invention described without departing from the spirit and substance of the broad invention, the scope of which is commensurate with the appended claims.

What I claim is:

1. In an engine of the class wherein a group of cylinders are arranged about each end of a rotatable power shaft with their axes parallel to said shaft and each cylinder of each group is aligned with and opposed to a cylinder of the other group, a double ended piston is reciprocally received by each opposed pair of cylinders, and an axial cam is fixed to the power shaft and is provided with curved cam faces on axially opposite sides of the rim portion thereof for cooperative engagement with the pistons, the combination with said pistons and cam of a roller rotatably carried by each of said pistons on each side of said cam for engagement with the corresponding cam face of said cam, said rollers having crowned peripheries so constructed and arranged that the path of contact between a roller and its cooperating cam face varies radially with respect to the axis of said power shaft during relative rotation of said roller on said cam face.

2. In an engine of the class wherein a group of cylinders are arranged about each end of a rotatable power shaft with their axes parallel to said shaft and each cylinder of each group is aligned with and opposed to a cylinder of the other group, a double ended piston is reciprocally received by each opposed pair of cylinders, and an axial cam is fixed to the power shaft and is provided with curved cam faces on axially opposite sides of the rim portion thereof for cooperative engagement with the pistons, the combination with said pistons and cam of a roller rotatably carried by each of said pistons on each side of said cam for engagement with the corresponding cam face of said cam, said rollers being so crowned that a line formed by the high points of the crown around the periphery of the roller varies axially of the roller from one position on the periphery thereof to another position on the periphery thereof.

3. In an engine of the class wherein a group of cylinders are arranged about each end of a rotatable power shaft with their axes parallel to said shaft and each cylinder of each group is aligned with and opposed to a cylinder of the other group, a double ended piston is reciprocally received by each opposed pair of cylinders, and an axial cam is fixed to the power shaft and is provided with curved cam faces on axially opposite sides of the rim portion thereof for cooperative engagement with the pistons, the combination with said pistons and cam of a roller rotatably carried by each of said pistons on each side of said cam for engagement with the corresponding cam face of said cam, said rollers being so crowned that a line formed by high points of the crown peripherally of each roller varies axially thereof whereby to provide on the cam faces a path of contact with the rollers which varies in radial distance measured from the axis of said power shaft.

4. In an engine of the class wherein a group of cylinders are arranged about each end of a rotatable power shaft with their axes parallel to said shaft and each cylinder of each group is aligned with and opposed to a cylinder of the other group, a double ended piston is reciprocally received by each opposed pair of cylinders,

and an axial cam is fixed to the power shaft and is provided with curved cam faces on axially opposite sides of the rim portion thereof for cooperative engagement with the pistons, the combination with said pistons and cam of a roller 5 rotatably carried by each of said pistons on each side of said cam for engagement with the corresponding cam face of said cam, said rollers being so crowned that a line formed by high points of the crown peripherally of each roller varies axially thereof whereby to provide on the cam 10 faces a path of contact with the rollers which varies in radial distance measured from the axis of said power shaft, the diameter of the rollers being such with respect to the circular length of the corresponding cam face that the path of contact between a roller and the cam face during one revolution of the cam member is not superposed by the path of contact between the roller and said cam face during the next succeeding 20 revolution of the cam member.

5. In an engine of the class wherein a group of cylinders are arranged about each end of a rotatable power shaft with their axes parallel to said shaft and each cylinder of each group is aligned with and opposed to a cylinder of the 25 other group, a double ended piston is reciprocally received by each opposed pair of cylinders, and an axial cam is fixed to the power shaft and is provided with curved cam faces on axially opposite sides of the rim portion thereof for cooperative engagement with the pistons, the combination with said pistons and cam of a roller 30 rotatably carried by each of said pistons on each side of said cam for engagement with the corresponding cam face of said cam, said rollers being so crowned that their line of contact on the corresponding cam face during operation is a wavy line.

6. In an engine of the class wherein a group of cylinders are arranged about each end of a rotatable power shaft with their axes parallel to said shaft and each cylinder of each group is aligned with and opposed to a cylinder of the 40 other group, a double ended piston is reciprocally received by each opposed pair of cylinders, and an axial cam is fixed to the power shaft and is provided with curved cam faces on axially opposite sides of the rim portion thereof for cooperative engagement with the pistons, the com- 50

bination with said pistons and cam of a roller rotatably carried by each of said pistons on each side of said cam for engagement with the corresponding cam face of said cam, said rollers being so crowned that the contact between each of them and its corresponding cam face during operation forms a series of disconnected lines extending from a point adjacent one radial edge of said cam face to a point adjacent the opposite edge thereof.

7. In an engine of the class wherein a group of cylinders are arranged about each end of a rotatable power shaft with their axes parallel to said shaft and each cylinder of each group is aligned with and opposed to a cylinder of the 15 other group, a double ended piston is reciprocally received by each opposed pair of cylinders, and an axial cam is fixed to the power shaft and is provided with curved cam faces on axially opposite sides of the rim portion thereof for cooperative engagement with the pistons, the combination with said pistons and cam of a roller 20 rotatably carried by each of said pistons on each side of said cam for engagement with the corresponding cam face of said cam, said rollers being so crowned that a line formed by the high points of the crown is a generally circular and unbroken line lying in a plane disposed at an angle perpendicular to the axis of said rollers.

8. In an engine of the class wherein a group of cylinders are arranged about each end of a rotatable power shaft with their axes parallel to said shaft in each cylinder of each group is aligned with and opposed to a cylinder of the 35 other group, a double ended piston is reciprocally received by each opposed pair of cylinders, and an axial cam is fixed to the power shaft and is provided with curved cam faces on axially opposite sides of the rim portion thereof for cooperative engagement with the pistons, the combination with said pistons and cam of a roller 40 rotatably carried by each of said pistons on each side of said cam for engagement with the corresponding cam face of said cam, said rollers being so crowned that a line formed by the high points of the crown and extending about the periphery of said roller forms a helix about the axis of said roller.

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