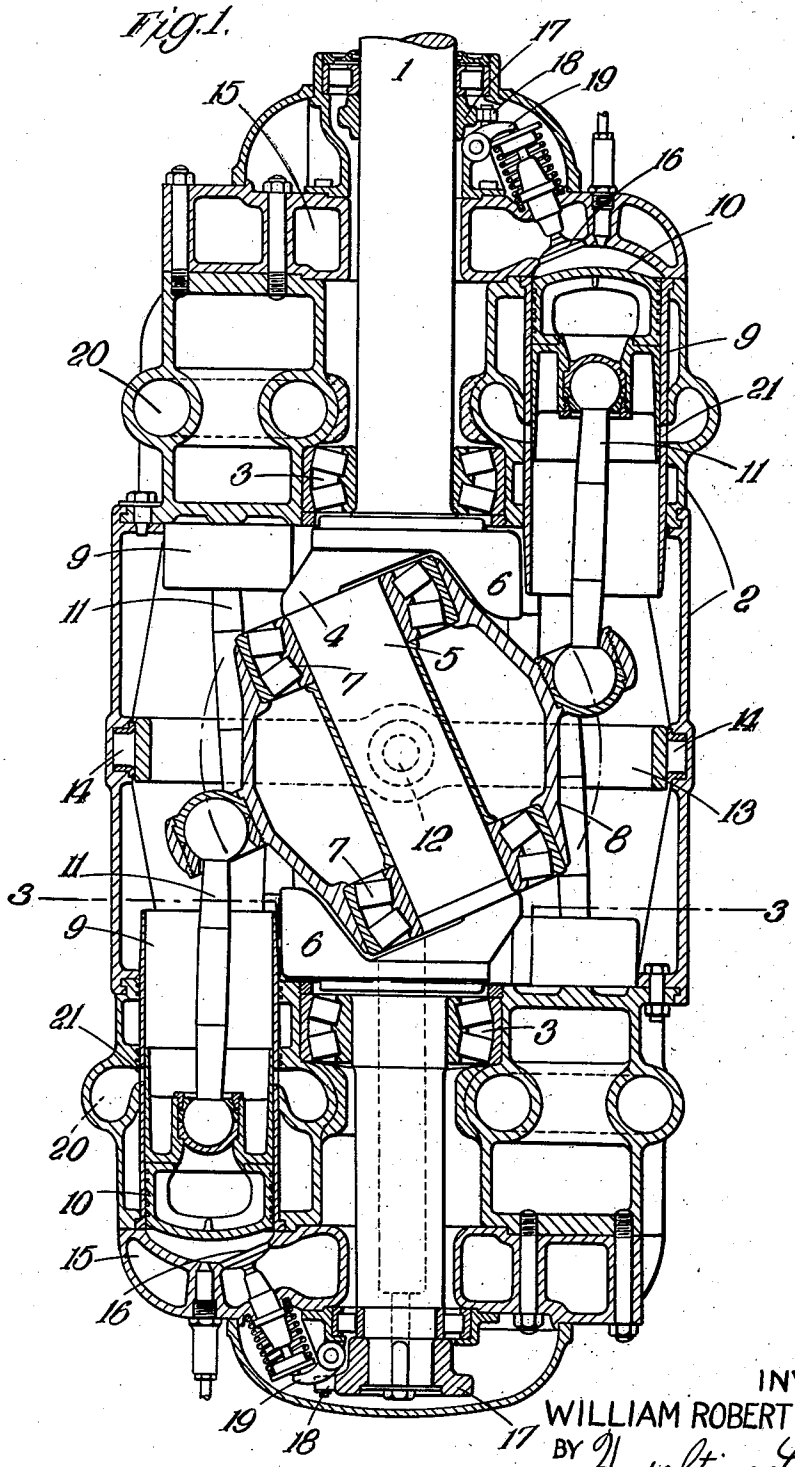
Oct. 26, 1937. W. R. STEELE 2,097,138

WOBBLE PLATE MECHANISM

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Fig. 1.



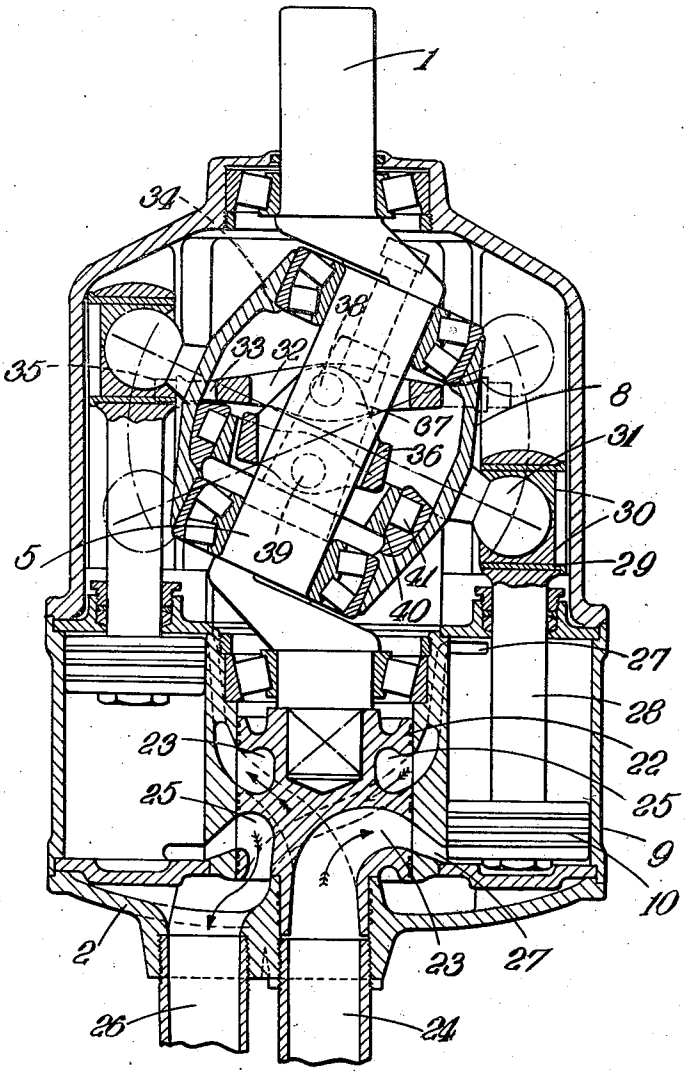
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WOBBLE PLATE MECHANISM

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Fig. 2.



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Fig. 3.

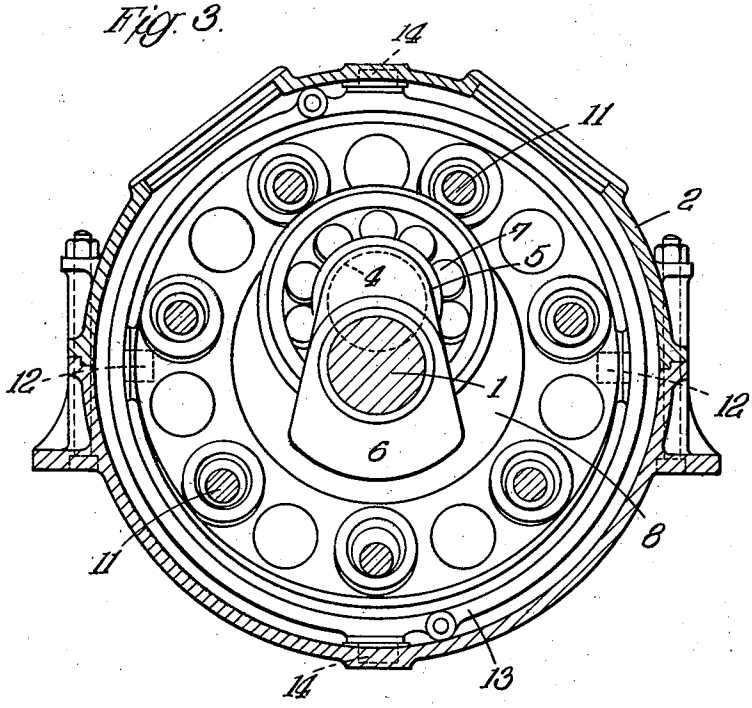


Fig. 4.

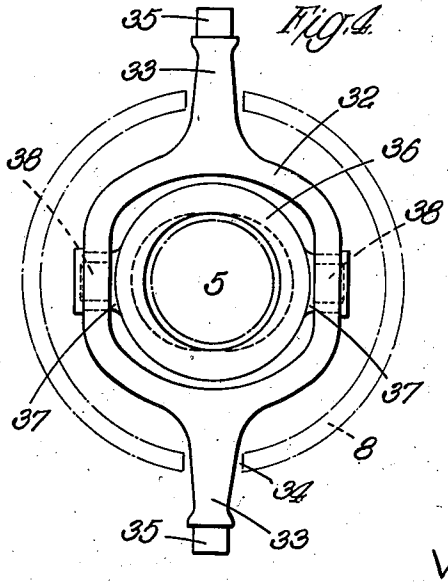
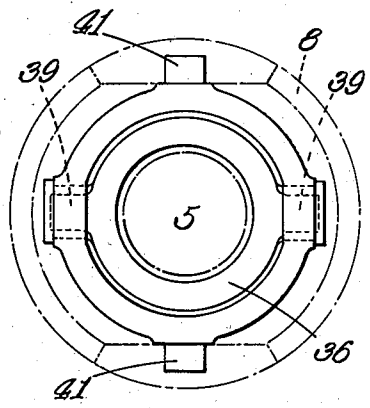


Fig. 5.



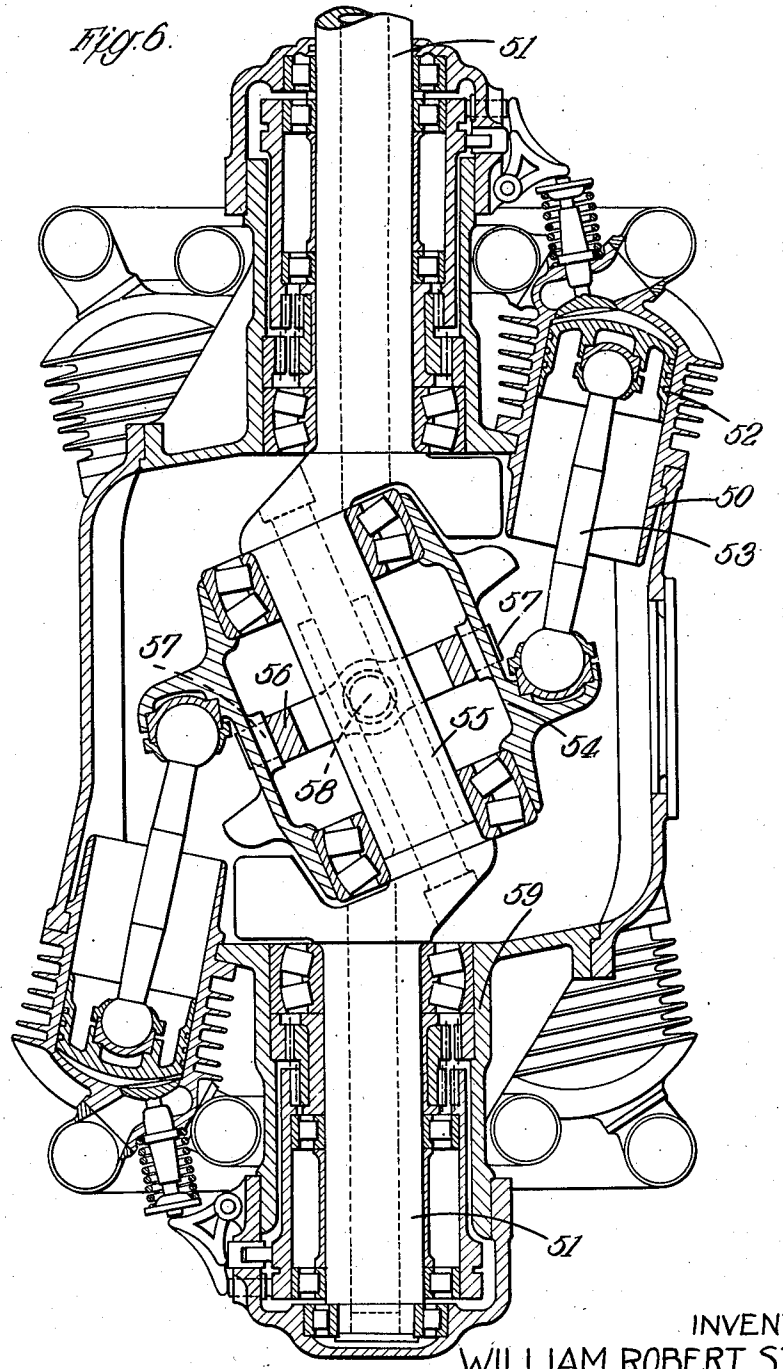
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WOBBLE PLATE MECHANISM

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Fig. 6.



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WOBBLE-PLATE MECHANISM

William Robert Steele, Lee-on-the-Solent, England

Application May 10, 1934, Serial No. 724,954
In Great Britain May 13, 1933

9 Claims. (Cl. 74—60)

The present invention relates to wobble-plate mechanism, that is to say, to mechanism of the type wherein a series of pistons are connected with a plate or its equivalent, mounted on an inclined crank pin of the main shaft and capable of performing an oscillating movement. This type of mechanism is, by virtue of these features, distinguished from a somewhat similar type wherein the plate or its equivalent with which the pistons are associated actually revolves. The main objects of the invention are to obtain increased output for a given size and weight, this being largely due to the elimination of end thrust between the wobble plate and revolving or shaft members of this type of mechanism and to the compact symmetrical relative disposition of the several parts; also to secure increased mechanical efficiency as a result of the elimination of this end thrust and of side load on the piston or reciprocating members.

According to the invention the cylinders, the pistons of which are connected to the wobble plate, are even in number and are disposed in pairs in each of which the individual cylinders are located diametrically on opposite sides of the main shaft axis and fluid pressure is generated in, admitted to or withdrawn from them substantially simultaneously, so that the thrusts exerted on the wobble plate are equal and opposite and therefore balanced about its centre of oscillation. Likewise the reciprocating and oscillating masses are balanced or symmetrically disposed with respect to the centre of oscillation, so that the thrusts due to inertia of moving parts are also balanced. This results in the elimination of end thrust and unbalanced forces between the wobble plate and the rotating member, which, in combination with the elimination of side load on the pistons, promotes increased efficiency; it follows that, having regard to the compact relative disposition of the several parts, the employment of larger cylinders, with corresponding increase in the power development within the limits of given overall dimensions, becomes possible.

In order that the invention may be clearly understood and readily carried into effect, it will now be described more fully with reference to the accompanying drawings, which illustrate by way of example two mechanisms to which the invention is applied, and wherein:

Figure 1 is a central longitudinal section of a two-stroke-cycle internal-combustion engine, and

Figure 2 is a similar view of a fluid-pressure motor,

Figure 3 is a cross-sectional view on the line 3—3, of Figure 1,

Figures 4 and 5 are detailed views of a double universal joint employed in Figure 2, and

Figure 6 is a longitudinal section of an air cooled motor in which the cylinders thereof are inclined to the axis of the main shaft.

Referring to Figure 1, the mechanism comprises a shaft 1 mounted in a frame or casing 2 by means of roller bearings 3 and formed with two inclined cranks 4 connected by a crank pin 5. If desired, balance weights 6 may be fitted on the shaft 1. Mounted on the crank pin 5 by means of roller bearings 7 is a barrel-shaped member 8 constituting the wobble plate. The cylinders 9, of which, in this example, there are fourteen, are equally spaced around the shaft 1 in two groups of seven at opposite ends of the wobble plate, the angular relation between the cylinders in the respective groups being, as indicated, such as to form pairs, the cylinders of each pair being disposed in the same diametrical plane, but on opposite sides of the main shaft. The pistons 10 are connected with the wobble plate 8 by means of connecting rods 11 having universal socket bearings in the pistons and wobble plate respectively. Rotation of the wobble plate is prevented owing to the fact that it is pivoted at 12 on a transverse diameter to a ring 13, itself pivoted at 14 to the frame or casing 2, this mechanism constituting a universal joint permitting of the oscillatory motion necessary for the wobble plate.

At each end of the frame or casing 2 there is formed an inlet chamber 15 between which and each of the cylinders of one group there is an opening controlled by an inlet valve 16. These inlet valves are opened sequentially against the action of springs by means of a cam 17 on the shaft 1 acting through tappets 18 and pivoted rockers 19. Outlet of the products of combustion to an exhaust chamber 20 is by means of ports 21 adapted to be covered or uncovered by motion of the pistons 10. It will be realized that the particular means adopted for inlet, ignition and exhaust are immaterial to the present invention, provided the sequence of these actions is such that, in respect of the cylinders in each pair, impulses are imparted to the pistons simultaneously, thus exerting equal and opposite thrusts on the wobble plate with the resultant action and advantages above mentioned.

While it is feasible to employ any number of cylinders, with an odd number of cylinders at each end of the wobble plate, the above construc-

tion having seven in each group has advantages, since it may be demonstrated that, having regard to the overall diameter of the mechanism, maximum piston displacement is thereby attainable. With an internal combustion engine operating on the four stroke cycle the use of an odd number of cylinders in the group enables a uniformly spaced even turning moment to be maintained by suitable firing order (i. e. a seven cylinder group would fire on every alternate cylinder, one, three, five, seven, two, four, six).

The above-described arrangement of the cylinders in two groups is appropriate whether the cylinders be single- or double-acting. If, however, double-acting cylinders be employed it is possible to arrange all the cylinders at one end of the wobble plate. If this be done, in order to secure the desired equal and opposite action on the wobble plate in respect of each pair, fluid pressure is caused to act on one of the pistons during its outward stroke, while it acts on the other piston during its inward stroke, and vice versa.

An example of such a construction is afforded by the fluid-pressure motor illustrated in Figure 2, which is adapted to be actuated either by incompressible fluid, such as water or oil, or by compressible fluid, such as air. The cylinders 9 (six in number) are all arranged to one side of the wobble plate 8 and are double-acting. The shaft 1 is fitted with a rotary valve member 22 having passages 23 leading from a fluid-pressure inlet conduit 24 fitted in the frame or casing 2. Similarly, the valve 22 is provided with passages 25 adapted to co-operate with an exhaust outlet 26. Ports 27 at opposite ends of each cylinder 9 afford, on rotation of the valve 22, communication between the inlet passages 23 or the exhaust passages 25 and the cylinders 9 in the desired sequence. For instance, considering the position of the mechanism illustrated, it will be seen that fluid pressure is about to be admitted from the conduit 24 via one of the passages 23 and a port 27 to the under side of the right-hand piston as seen in the figure; similarly, the port 27 at the upper end of the corresponding cylinder is in communication via one of the passages 25 with the exhaust conduit 26. Correspondingly, in respect of the left-hand cylinder, fluid pressure is about to be admitted to the upper side of the piston while exhaust takes place from its lower side. When the pistons have completed their stroke, rotation of the valve 22 which has occurred will result in the above conditions being reversed, but it will be seen that in all circumstances equal and opposite impulses are simultaneously imparted to the wobble plate.

Figure 2 also depicts a slightly different method of connection between the pistons and the wobble plate. In this instance the pistons 10 are rigidly connected to piston rods 28, the outer ends of which are formed with apertures fitted with transverse slides 29 for the reception of blocks 30 constituting sockets for ball members 31 carried by the wobble plate 8 the construction shown preventing rotation of the pistons during operation of the engine.

Figure 2 and Figures 4 and 5 also illustrate the use of a double universal joint to constitute the connection between the wobble plate and the frame or casing, the members of this double universal joint being to a large extent located within the barrel-shaped member constituting the wobble plate. For this purpose a ring 32 is provided with arms 33 which extend radially through slots 34 in the barrel-shaped member 8 and are provided at their outer ends with pivots 35, having bearings in the frame or casing 2. These bearings are arranged on a diameter intermediate between the planes containing two pairs of opposite cylinders, this being indicated in Figure 2 by the representation of one of the arms 33 and its pivot 35 in chain-dotted lines. A second ring 36 encircles the crank pin 5 and is provided with lugs 37 having pivotal connections 38 with the ring 32. Similarly, there are pivotal connections 39 between the ring 36 and a further ring 40 carried by means of pivots 41 in the barrel-shaped member 8.

The pairs of cylinders may be of unequal diameter and radius of action from their neighbours when necessary to provide for compound or multistage expansion of the fluid or of two or more independent fluids, or pairs of pistons of unequal diameter may be balanced one against the other, provided their piston loads, weight and inertia masses are equal and opposite. Further, the cylinders are not necessarily parallel to the shaft, but may be inclined thereto.

An example of an inclined cylinder arrangement is shown in Figure 6 of the drawings which illustrates an air cooled internal combustion engine. It will be seen that the cylinders 50 are inclined to the axis of the shaft 51, the pistons 52 which are adapted to reciprocate in the cylinders being connected by rods 53 to the wobble plate 54. The wobble plate is mounted on the inclined crank pin 55 and is restrained from rotational movement by the provision of a universal joint comprising a ring 56 mounted within the wobble plate 54 on trunnions 57. The ring 56 is also connected to the casing of the motor by trunnions indicated in dotted lines by the numeral 58, these trunnions extending through oppositely disposed slots in the wobble plate 54. It will be appreciated that by inclining the cylinders of the engine as shown in Figure 6, it is possible to space the cylinders from the casing 59 surrounding the shaft 51 whereby a flow of air around the cylinders for cooling purposes can be obtained.

While in the above description the application of the invention to an engine has been exemplified, it will be realized that the improvements according to the present invention are equally applicable to a compressor or to the generating unit of a hydraulic power-transmission system, wherein power is communicated to the main shaft from some outside source and the cylinders serve to supply compressed air or gas or liquid under pressure, as the case may be.

What I claim and desire to secure by Letters Patent of the United States is:—

1. A balanced wobble plate mechanism comprising a shaft, a crank on said shaft inclined to the longitudinal axis thereof, a practically barrel shaped wobble plate mounted on said crank, a plurality of cylinders, pistons in said cylinders connected to said wobble plate, the pistons and cylinders being even in number and disposed in pairs in each of which the individual cylinders are located diametrically on opposite sides of the main shaft axis and fluid pressure is generated in, admitted to, or withdrawn from them substantially simultaneously so that the thrusts from the several pistons which are exerted on the wobble plate are equal and opposite, likewise the reciprocating and oscillating masses are balanced or symmetrically disposed with respect to the

centre of oscillation and combine with the piston thrusts to form equal couples opposed by equal and opposite crank pin moments, the wobble plate being restrained from a rotational movement by the provision of a universal joint disposed between the said plate and a relatively fixed part of the apparatus.

2. A balanced wobble plate mechanism for internal combustion engines, steam engines, fluid pressure motors, pumps or compressors of the single acting types, comprising a shaft, a crank on said shaft, inclined to the longitudinal axis thereof, a practically barrel shaped wobble plate mounted on said crank means positively preventing rotation of the wobble plate, a plurality of cylinders, pistons in the said cylinders connected to said wobble plate, an odd number of cylinders (at least three) being provided at the opposite ends of the said wobble plate, the cylinders being arranged in pairs, with one cylinder of each pair at one end of the wobble plate and the other cylinder of the pair at the opposite end of the wobble plate, the cylinders of each pair being disposed in the same diametrical plane, but on opposite sides of the main shaft and arranged so that their working strokes are simultaneous, whereby the thrusts on the wobble plate from the cylinders of each pair are opposite and equal and therefore balanced.

3. A balanced wobble plate mechanism for use in steam engines, internal combustion engines, fluid pressure motors, compressors, pumps of the double acting type, comprising a shaft, a crank on said shaft inclined relatively to the longitudinal axis thereof, a practically barrel shaped wobble plate mounted on said crank, a plurality of cylinders, pistons in said cylinders connected to said wobble plate, the said pistons being even in number and provided at one side of the end wobble plate, the cylinders at said end being grouped in pairs, the cylinders of each pair being disposed in the same diametrical plane but on opposite sides of the main shaft and the working strokes of the pistons of the pairs are so arranged that the thrusts on the wobble plate are opposite and equal and therefore balanced, the wobble plate being positively restrained from a rotational movement by the provision of a universal joint disposed between the said wobble plate and a relatively fixed part of the apparatus.

4. A balanced wobble plate mechanism as in claim 2, wherein seven cylinders and pistons are provided on one side of the wobble plate and seven cylinders and pistons are provided on the other side.

5. A balanced wobble plate mechanism as in claim 1, wherein the wobble plate is positively restrained from rotational movement by a double universal joint.

6. A balanced wobble plate mechanism comprising a shaft, a crank on said shaft inclined to the longitudinal axis thereof, a substantially barrel shaped wobble plate mounted on said crank, a plurality of cylinders, pistons in said cylinders connected to said wobble plate, the pistons and cylinders being even in number and disposed in pairs in each of which the individual cylinders are located diametrically on opposite sides of the main shaft axis and fluid pressure is generated in, admitted to, or withdrawn from them substantially simultaneously so that the thrusts from the several pistons which are exerted on the wobble plate are equal and opposite, likewise the reciprocating and oscillating masses are balanced or symmetrically disposed with respect to the centre of oscillation and combine with the piston thrusts to form equal couples opposed by equal and opposite crank pin moments, the wobble plate being positively restrained from a rotational movement by the provision of a double universal joint, comprising a ring mounted on trunnions in a fixed part of the apparatus, a second ring connected to said first ring by trunnions disposed at right angles to the trunnions of the first ring, and a third ring mounted on trunnions disposed in bearings on the wobble plate, the second ring also being connected by trunnions to the third ring, the last mentioned trunnions being disposed at right angles to the trunnions connecting the third ring to the wobble plate.

7. The combination of a balanced wobble plate mechanism as in claim 3, wherein the piston rods are rigidly connected to the pistons and the pistons are connected to the wobble plate by ball and socket joints, the outer ends of the piston rods being provided with apertures within which are housed sliding blocks constituting sockets for connection to the wobble plate, means being provided for preventing rotation of the pistons.

8. A balanced wobble plate mechanism for use in steam engines, internal combustion engines, fluid pressure motors, compressors, pumps of the double acting type, comprising a shaft, a crank on said shaft inclined relatively to the longitudinal axis thereof, a substantially barrel shaped wobble plate mounted on said crank, a plurality of cylinders, pistons in said cylinders connected to said wobble plate, the said pistons being even in number and provided at one end of the said wobble plate, the cylinders at said end being grouped in pairs, the cylinders of each pair being disposed in the same diametrical plane but on opposite sides of the main shaft and the working strokes of the pistons of the pairs are so arranged that the thrusts on the wobble plate are opposite and equal and therefore balanced, the wobble plate being positively restrained from a rotational movement by the provision of a double universal joint, comprising a ring mounted on trunnions in a fixed part of the apparatus, a second ring connected to said first ring by trunnions disposed at right angles to the trunnions of the first ring, and a third ring mounted on trunnions disposed in bearings on the wobble plate, the second ring also being connected by trunnions to the third ring, the last mentioned trunnions being disposed at right angles to the trunnions connecting the third ring to the wobble plate.

9. A balanced wobble plate mechanism as in claim 1 wherein the universal joint comprises a ring mounted on trunnions in the wobble plate, and also mounted on trunnions in a relatively fixed part of the apparatus, the last mentioned trunnions being disposed at right angles to the first mentioned trunnions.

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