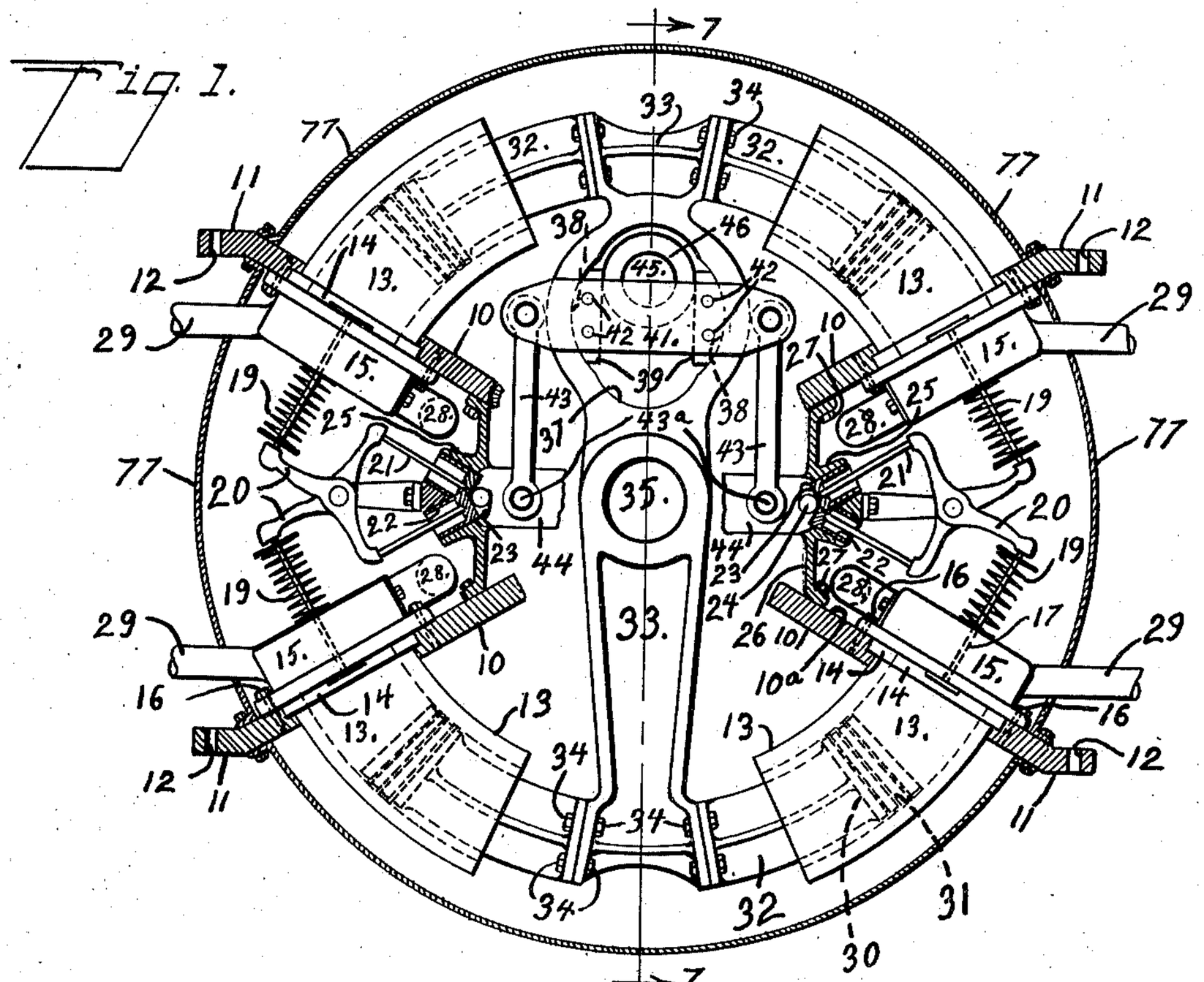
July 12, 1938. W. E. GEORGE ET AL 2,123,279

INTERNAL COMBUSTION ENGINE

Filed May 28, 1936 2 Sheets-Sheet 1

Fig. 1.



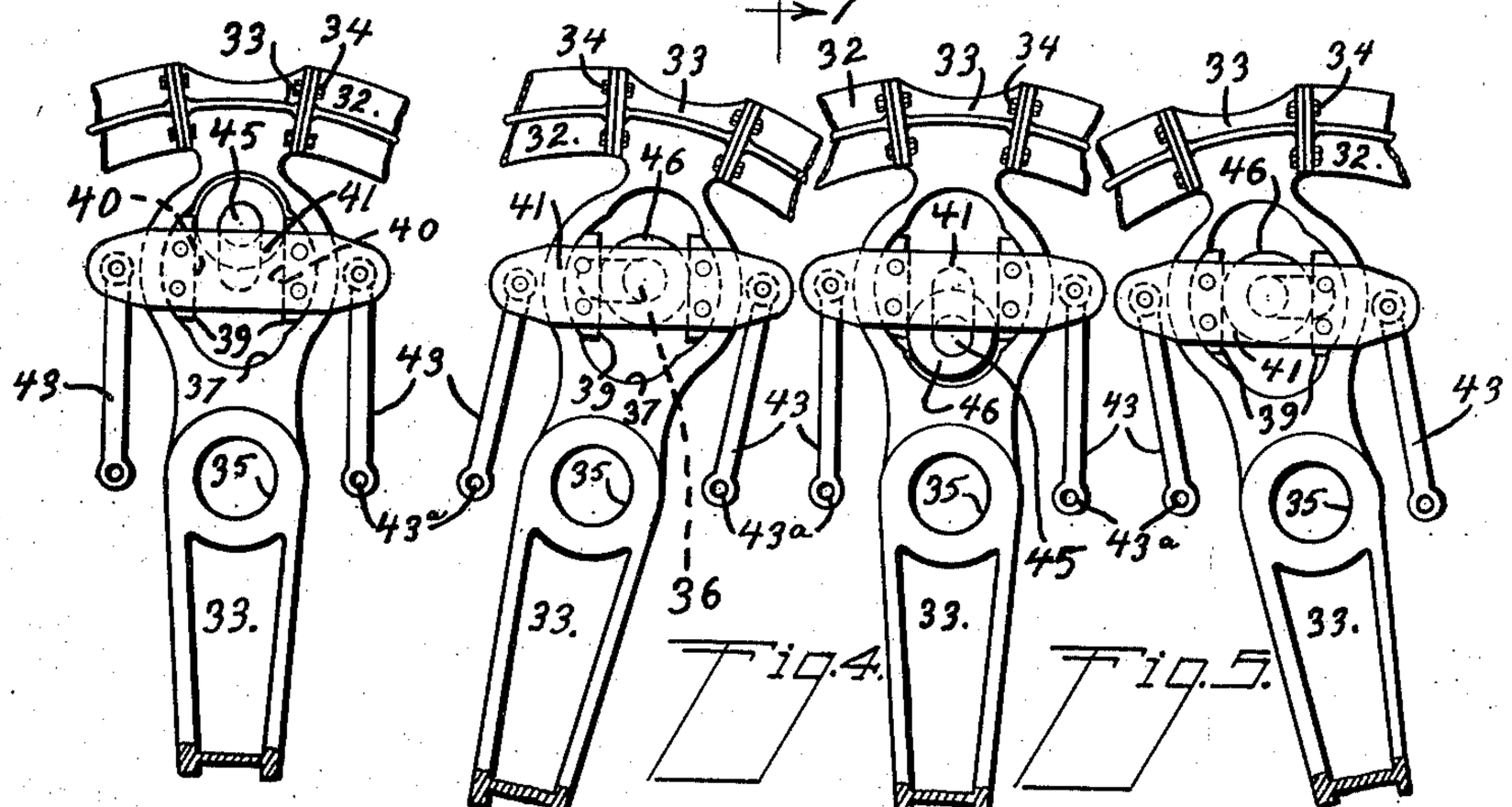


Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

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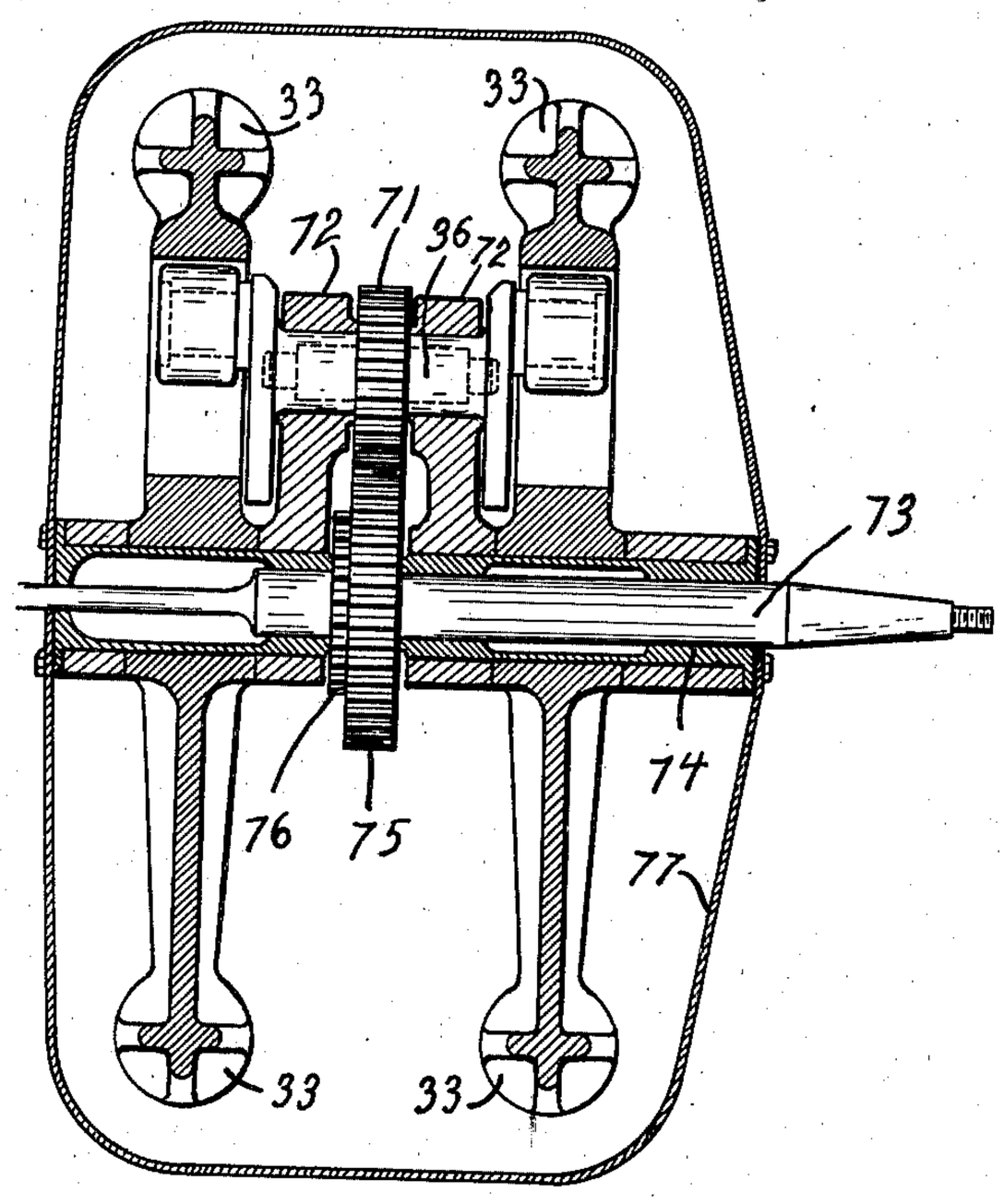
Fig. 7.



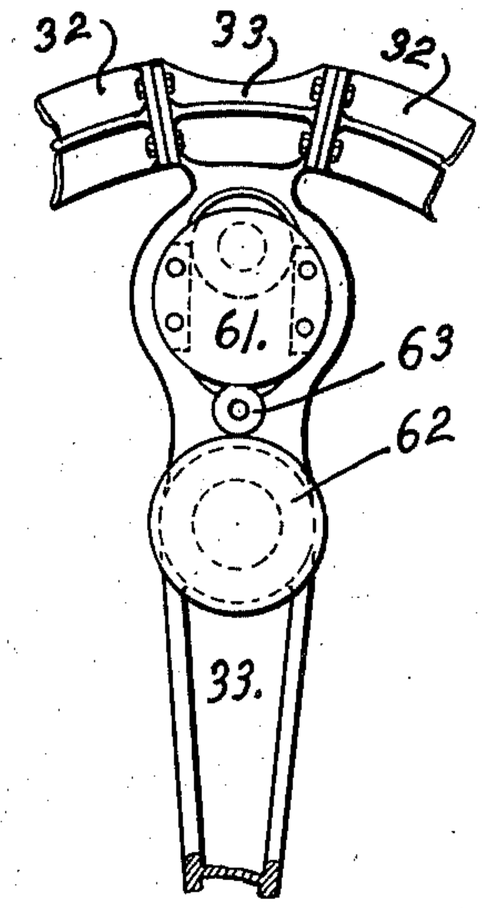


Fig. 8.

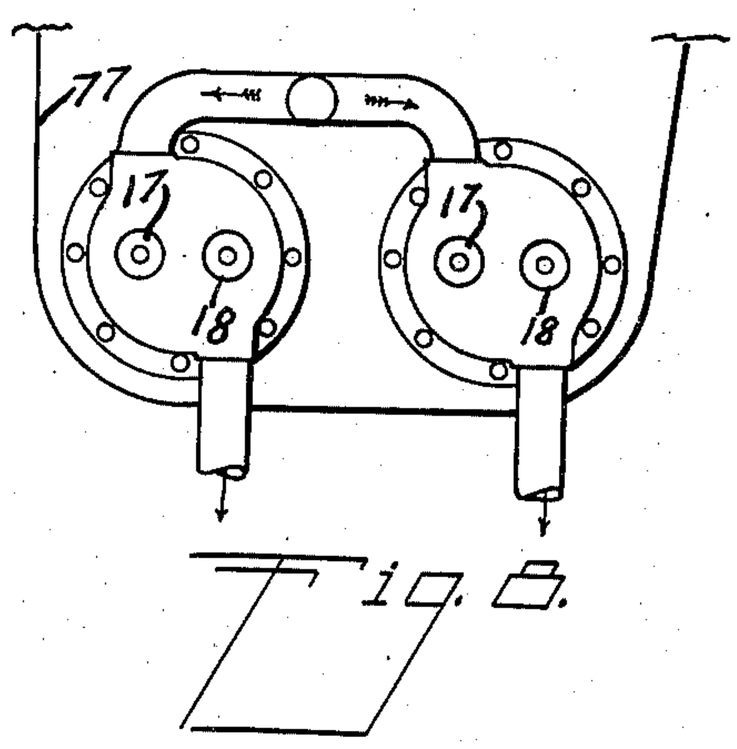


Fig. 9.

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UNITED STATES PATENT OFFICE

2,123,279

INTERNAL COMBUSTION ENGINE

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Application May 28, 1936, Serial No. 82,356

5 Claims. (Cl. 74—48)

This invention relates to internal combustion engines generally and particularly to engines of the oscillating type wherein the pistons are carried rigidly on an oscillating lever or arm, said piston reciprocating arcually in curved or toroidal-shaped cylinders disposed about a common axis which is also the axis of the oscillating arm, the latter being operatively connected with a crank by mechanism embodying the harmonic motion principle for converting the oscillating or reciprocating motion of the lever into rotary motion.

One of the important objects of the invention is to provide an engine of this character employing a simple harmonic motion to convert reciprocating motion of the lever into rotary motion of the crank to substantially eliminate vibration in the engine.

Another object of the invention is to provide an engine of this character having valves in the heads of the cylinders operated by short, simple valve actuating parts.

Another object is to provide an engine of this character in which the heat of the pistons is conducted to the arms and from there dissipated into the ventilated crankcase.

Another object is to provide an engine of this character in which is eliminated eccentricity of the linkage, excessive angular velocity, and excessive pressures in the harmonic motion mechanism.

Another object is to provide an engine of this character in which various parts are interchangeable respectively with other corresponding parts thereof.

Another object is to provide an engine of this character in which the cylinder, case and engine head have a common bolting.

Another object is to provide an engine of this character that can be enlarged by duplication of banks of cylinders while keeping the frontal area to a minimum.

Another object is to provide an engine of this character in which the weight per horse power is very low.

Still further objects of the invention are to provide an engine of this character that is structurally simple and sturdy and that is relatively low in manufacturing cost.

Other objects, advantages and novel details of construction of the engine will be made more apparent as this description proceeds, especially when considered in connection with the accompanying drawings, wherein:

Figure 1 is an elevational view of the engine with portions of the frame broken away and the casing in section to show the arrangement of the cylinders and operative parts of the engine.

Figure 2 is a partial elevation of the oscillating lever with the crank and the mechanism of the harmonic motion operatively associated therewith, the crank being shown in its upper position wherein the oscillating lever is vertically disposed.

Figure 3 is a view of the same with the crank pin at one side and the oscillating lever swung correspondingly toward one side.

Figure 4 is a view of the same with the crank pin in its downward position and the oscillating lever in a vertically disposed position.

Figure 5 is a view of the same with the crank at the side opposite that shown in Figure 3 and the oscillating lever swung correspondingly toward said side.

Figure 6 is a partial elevation of the oscillating lever with the crank and a modified embodiment of the mechanism of the harmonic motion operatively associated therewith.

Figure 7 is a vertical section through the engine taken on line 7—7 of Figure 1 showing a double bank of cylinders and the gearing connecting the crank shaft with the main drive shaft, each of said cylinder-banks having four cylinders to provide an eight cylinder engine. The rocking parts of the harmonic motion are not shown.

Figure 8 is a view showing the ends of the heads of a pair of cylinders, one from each bank, of an eight cylinder two bank engine.

Referring more particularly to the drawings the engine is provided with a frame X-shaped in cross-section and having outwardly extending arms or supports 10 terminating in horizontal portions 11 adjacent the free ends thereof, said portions 11 having bolt holes 12 therein for bolting the frame to the frame of an airplane or the like. Each arm or support 10 of the X-shaped frame is provided with a shouldered opening in which is received a curved cylinder 13, the axis of said cylinders being common. Each cylinder is provided with a shoulder 14 adjacent one end and said shoulder 14 is received in said shouldered opening of the respective arms 10 and abuts thereagainst. The fixed ends of the cylinders are flush with the surface 10*a* of the supports 10.

Cylinder heads 15 are fixed on supports 10 by bolts 16, said cylinder heads securing the cylinders firmly in said supports 10. Each head 15 is provided with intake and exhaust valves 17 and 18 respectively, normally kept closed by springs 19 and openable by rocker arms 20 actuated by push

rods 21 through mushroom valve lifters 22, the latter being actuated by cams 23 on cam shafts 24 operably mounted in the frame. The valve lifters 22 are slidably received in guides 25 formed integrally with plates 26 secured between two supports 10 by means of bolts 27. Each cylinder head 15 is provided with an intake manifold 28 and an exhaust pipe 29 and where two banks of cylinders are provided, as in an eight cylinder engine, two adjacent cylinders are supplied with combustible fuel by means of a common intake manifold as shown in Fig. 8; the exhaust being carried away from the cylinders by individual pipes.

Pistons 30 are reciprocatingly received in the cylinders, said pistons being of the short-headed, toroidal-sector type with radial piston rings 31, the axis of said rings being substantially the same as that of the cylinders. The piston arms 32 are curved and shaped like a cross-beam in section and are carried in pairs adjacent the ends of an oscillating arm 33, being bolted thereto by bolts 34. The oscillating arm or power lever 33 is mounted on a shaft 35, the axis of which is also the axis of the cylinders, pistons, piston arms and piston rings.

The oscillating power arm 33 is connected with a crank shaft 36 by harmonic motion mechanism, said oscillating arm 33 being provided with an elliptical slot 37 extending longitudinally thereof between the axis and one oscillating arm end, and each side of said slot is provided with a laterally extending arcuate portion 38 adapted to receive crank pin guide members 39 therein, said members 39 having flat, vertical sides 40 facing each other and spaced apart, the opposite sides thereof being arcuate and slidably fitting in the portions 38 of the slot 37. The members 39 are secured to a plate 41 by means of rivets 42, said plate 41 being horizontally disposed adjacent one side of the oscillating arm and pivotally receiving the upper ends of rocking arms or rods 43, said rocking rods 43 being also pivoted at their lower ends on pivots 43*a* in a cross-piece 44 of the engine frame, said pivots 43*a* being fixed in the cross-piece.

A crank pin 45, carrying a roller 46 thereon, is operatively received between the vertical or flat sides of the guide members 39, the crank being adapted to be rotatably operated by oscillation of the power arm 33, said crank being operably mounted in the frame of the engine. Various positions of the harmonic motion mechanism are shown in Figures 2 to 5 inclusive wherein four crank positions are shown. The flat, vertical sides 40 of the guides 39 are at all times maintained in a vertical position by movement of rocking arms 43 which oscillate coordinately with the oscillating arm 33, the planes of said flat sides being at all times parallel regardless of the operative positions of the mechanism.

By means of the above described harmonic motion mechanism elimination of linkage or connecting rods is effected; the eccentricity, excessive angular velocity and excessive pressures thereof being thereby also eliminated.

Figure 6 shows a modified embodiment of our harmonic motion mechanism, the guides 39 being maintained in their vertical position by a chain of gears; a large gear 61 having the guides 39 fixed thereto by rivets 39*a*. A similar gear 62 is fixed to the frame of the engine, the axis of said gear 62 being the same as the axis of oscillating power arm shaft 35. A small gear 63, operatively secured to the oscillating arm or lever 33, and adapted for rotatable motion, is interposed between the gears 61 and 62 so that upon oscillation of arm 33 the rocking movement of the chain of gears maintains the inner sides of the guides 39 in a vertical position regardless of the oscillating positions of said arm 33. It should be noted that in both embodiments of the harmonic motion mechanism the guides are maintained in operative planes that are at all times parallel by a rocking motion of said mechanisms.

In Figure 7 the crank shaft 36 is provided with a gear 71 secured thereon by any suitable means, said gear being positioned between two crank supporting arms 72 of the frame. A main drive shaft 73 is provided within sleeves 74 on which arms 33 are operably mounted and said shaft 73 is provided with a gear 75 secured thereon and meshed with gear 71 of the crank shaft. Means is thus provided for operating the main drive shaft of an engine having two banks of cylinders. Additional banks of cylinders may be added similarly or by duplicating the previously described mechanism. Reference numeral 76 indicates the driving gear for the cam shaft and numeral 77 indicates the crank case of the engine.

It will be readily understood from the above description that we have provided an engine wherein the objects thereof, above set forth, are effected.

It is, of course, to be understood that the invention may be constructed in other manners and the parts associated in other relations, and, therefore, we do not desire to be limited in any manner except as set forth in the claims hereunto appended.

Having thus described our invention what we claim is:

1. In an oscillating internal combustion engine having curved cylinders fixed in a frame and having valves and valve actuating means therefor, an oscillating power arm upon which are rigidly mounted pistons reciprocatingly received in their respective cylinders, said arm having a slot therein adjacent an oscillating end, crank pin guides operable in the slot of the oscillating arm, the inner faces of said guides being flat and parallel to each other, a crank operatively mounted in the frame and having its crank pin operably received between the flat faces of said guides, and rocking means adapted to maintain the flat faces of the guides parallel to each other and parallel to any plane of said faces regardless of their position as they are actuated upon oscillation of the oscillating power arm.

2. In an oscillating internal combustion engine having curved cylinders fixed in a frame and having valves and valve actuating means therefor, an oscillating power arm upon which are rigidly mounted pistons reciprocatingly received in their respective cylinders, crank pin guides operatively associated with said oscillating arm, said guides having flat, parallel adjacent faces spaced apart, a crank operatively mounted in the frame and having its crank pin operably received between the guides, and means adapted to maintain the parallel faces of the guides parallel to each other and parallel to any plane of their operative movement.

3. Crank operating mechanism for an oscillating engine having an oscillating power arm, crank pin guides operatively associated with said oscillating arm for oscillating movement therewith, said guides having flat, parallel sides facing each other between which the crank pin of a crank is operatively received, and means adapted to main-

tain the parallel faces of the guides parallel to each other and parallel to any plane thereof regardless of their position upon oscillation of said oscillating power arm.

4. Harmonic crank operating mechanism for an oscillating engine having an oscillating power arm with an elliptical slot adjacent an oscillating end of said arm, said slot extending longitudinally of said arm, crank pin guides slidably received in the slot, the inner sides of said guides being flat and parallel to each other and spaced apart and operably receiving therebetween the crank pin of the crank, and rocking means adapted to maintain the parallel faces of the guides parallel to each other and parallel to any plane to which same may be oscillated.

5. Crank operating mechanism for an oscillating engine having an oscillating power arm with an elliptical slot adjacent an oscillating end of said arm, said slot extending longitudinally of said arm and having lateral arcuate portions in the sides thereof, crank pin guides slidably received in the lateral arcuate portions of the slot, the inner sides of said guides being flat and parallel to each other and operably receiving the crank pin of the crank therebetween, a plate to which the guides are fixed, and swingable support rods for the plate, one end of each rod being pivoted to the plate adjacent each end thereof and the opposite ends of the rods being swingable on fixed pivots.

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