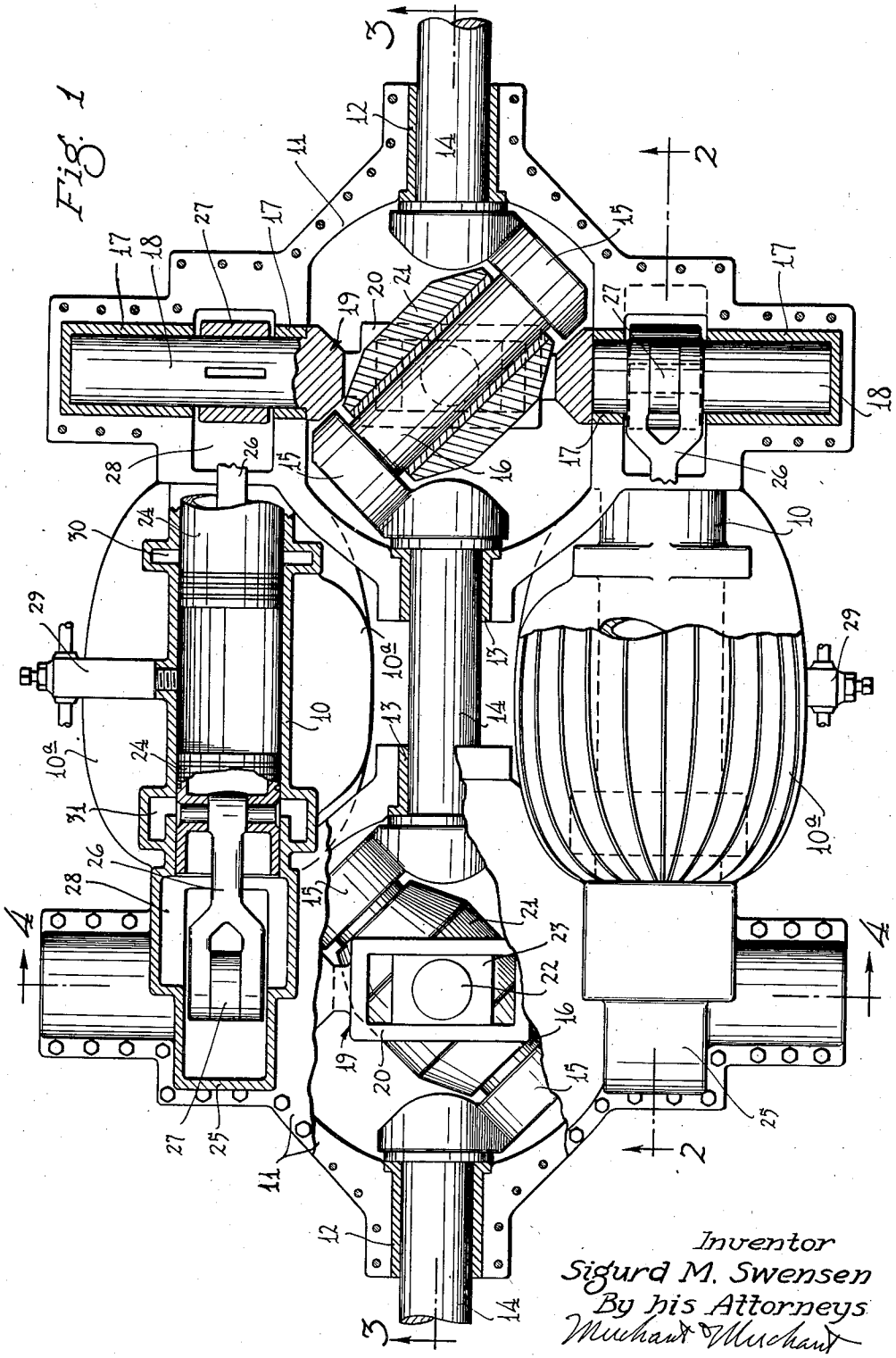
April 1, 1941. S. M. SWENSEN 2,236,738

ENGINE

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Fig. 1



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Fig. 2

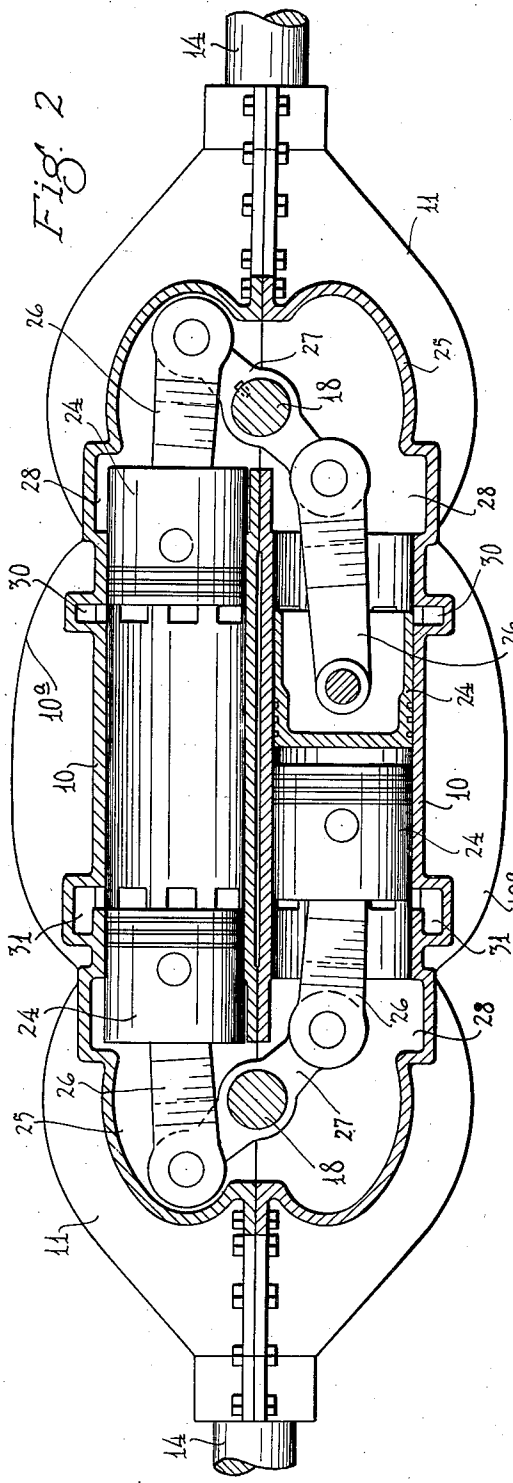
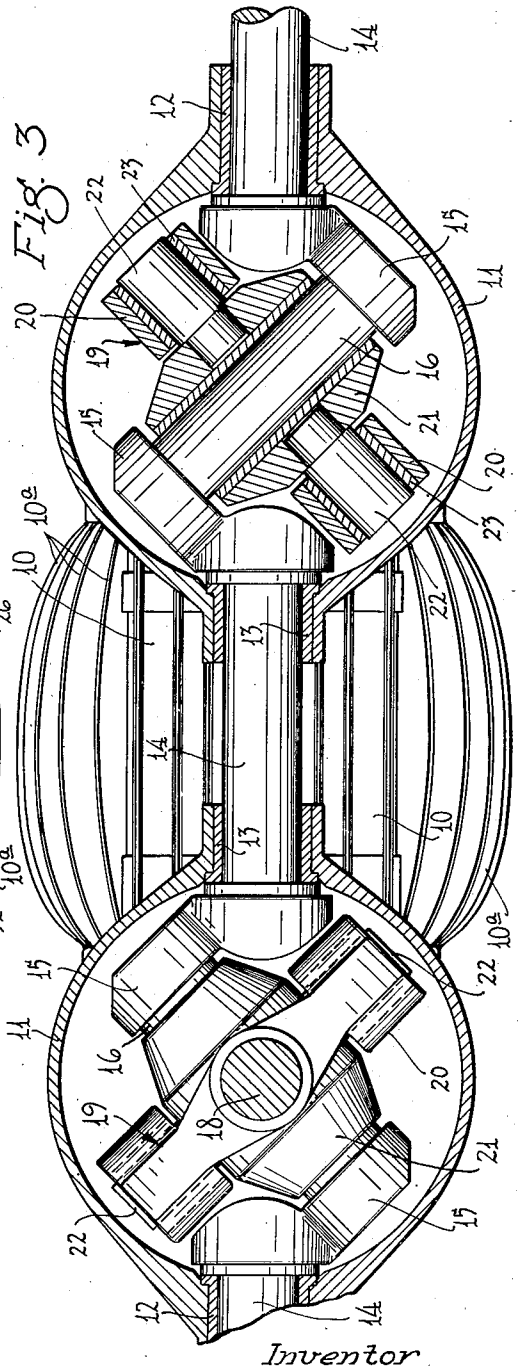


Fig. 3



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Fig. 4

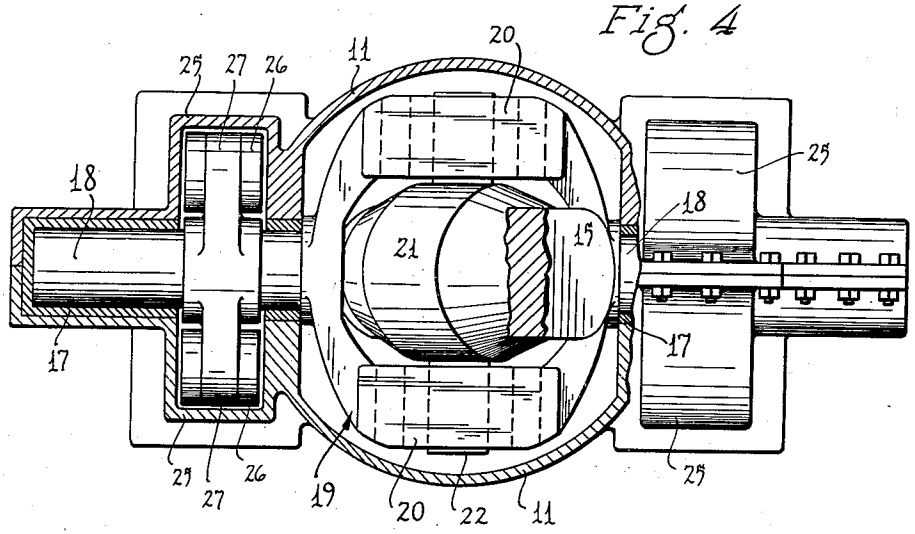
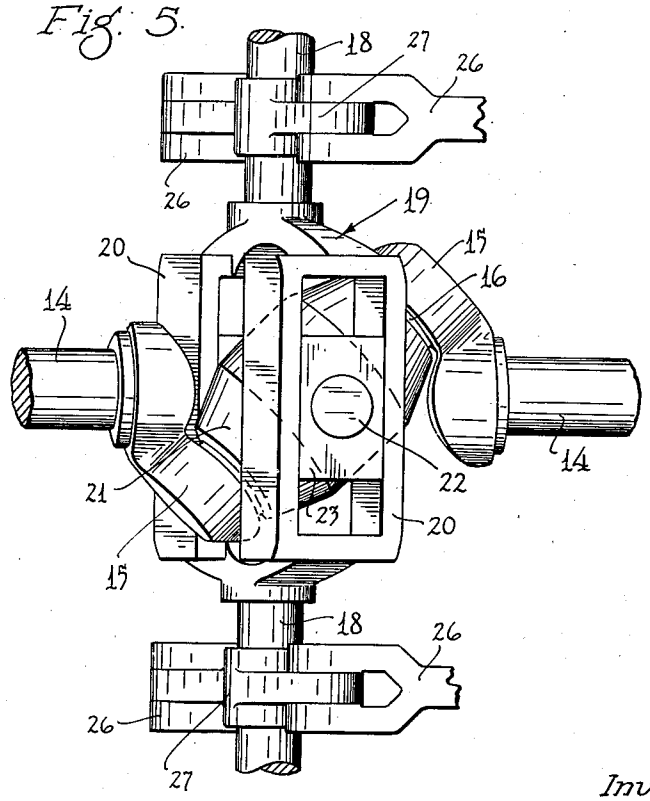


Fig. 5.



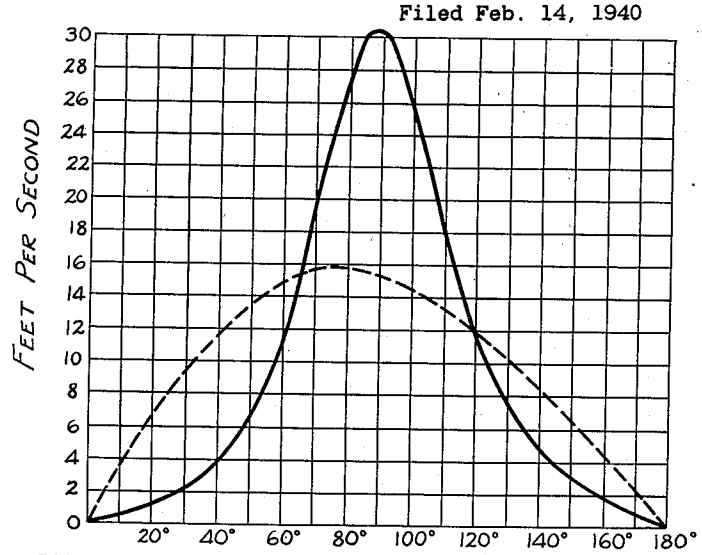
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Fig. 6

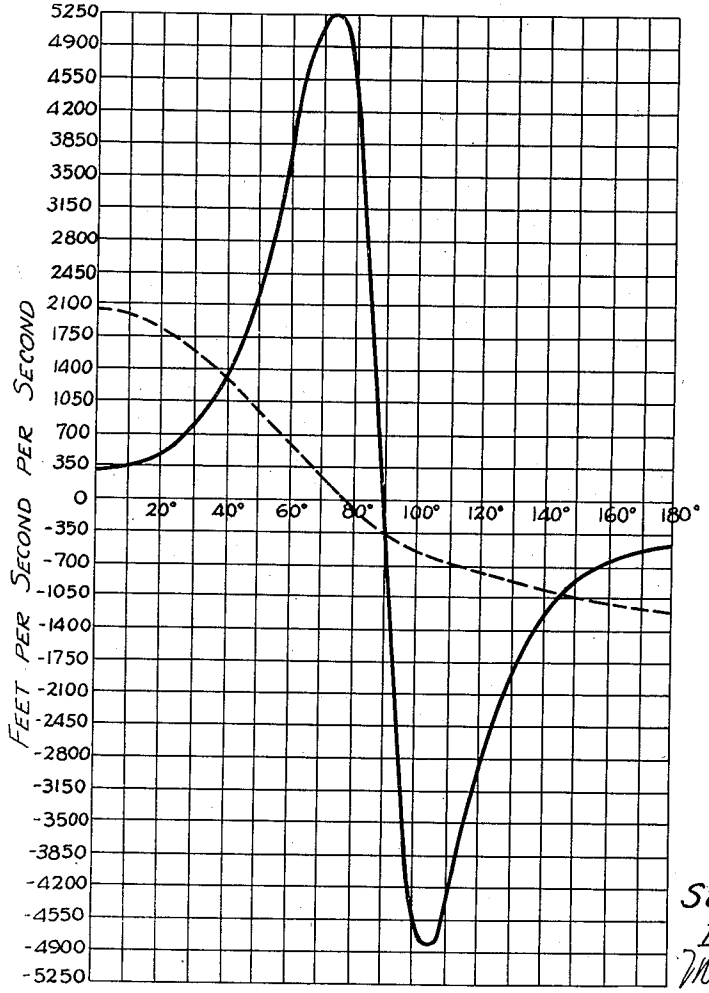


VELOCITY OF PISTON

CONVENTIONAL GAS ENGINE

SWENSEN ENGINE

Fig. 7



ACCELERATION OF PISTON

CONVENTIONAL GAS ENGINE

SWENSEN ENGINE

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Patented Apr. 1, 1941

2,236,738

UNITED STATES PATENT OFFICE

2,236,738

ENGINE

Sigurd M. Swensen, Minneapolis, Minn.

Application February 14, 1940, Serial No. 318,881

17 Claims. (Cl. 74—60)

My invention relates particularly to novel power transmission mechanism whereby the reciprocating movement of the cylinder and piston engine will be converted into rotary motion, or conversely, rotary motion of the power-driven shaft may be converted into reciprocating movement in a cylinder and piston machine, such as a pump or air compressor.

This invention may be employed in connection with a single cylinder and piston engine or in connection with a multi-cylinder and piston engine. However, the invention lends itself to uses in connection with a multiplicity of cylinder and piston engines and, in the preferred embodiment of the invention, I employ a plurality of such engines in connection with a rotary shaft having a plurality of oblique cranks set in such a way that the endwise thrust on the rotary shaft will be neutralized.

The novel features of the invention will be fully described and made clear in connection with a preferred embodiment of the invention illustrated in the accompanying drawings, wherein like characters indicate like parts throughout the several views.

Referring to the drawings:

Fig. 1 is a view chiefly in plan, but with some parts in horizontal section, some parts broken away, and others removed;

Fig. 2 is a vertical section taken on the line 2—2 of Fig. 1;

Fig. 3 is a vertical section taken on the line 3—3 of Fig. 1;

Fig. 4 is a transverse section taken on the line 4—4 of Fig. 1 with some parts broken away;

Fig. 5 is a plan view showing particularly the connection between the oscillating or rocking engine-driven shaft and the continuously driven constant direction rotary shaft; and

Figs. 6 and 7 are graph sheets illustrating the action of the improved engine.

In this multi-cylinder engine structure, there is a sort of framework made up of a multiplicity of cylinders 10 rigidly connected to crank casings 11 in a substantially rectangular arrangement. The cylinders 10 are in parallel arrangement and, in the structure illustrated, there are four double-ended cylinders, preferably horizontally disposed two on each side of the crank casing 11. Midway between the laterally spaced cylinders, the crank casings 11 are provided with axially aligned shaft bearings 12 and 13.

A rotary shaft 14 is extended through and journaled in the bearings 12 and 13 and within the crank casings are provided oblique crank arms 15 connected by oblique cranks 16. It is important to note that the cranks 16 are in converging relation so that, as will presently appear, end thrust on the shaft 14 will be eliminated. At its opposite sides, the crank casings 11 are provided with transverse bearings 17 in which oscillatory shafts 18 are journaled. Each rock shaft 18 is made up of axially separated portions, and the ends of which are formed integrally with or otherwise secured to yokes or double-ended crank arms 19, the outer ends of which are rigidly connected by rectangular guide heads or frames 20, the guide slots of which are parallel to but radially offset from the axis of the respective rock shafts 18.

Journaled in the oblique cranks 16, with freedom for sliding axial movements, are crank sleeves 21 that are provided with diametrically opposite projecting trunnion-like wrist pins 22 that are journaled in bearing blocks 23 slidably mounted in the guide frames 20.

In this particular arrangement of cylinders and pistons, each of the four cylinders 10 is provided with two opposite pistons 24. The ends of the said cylinders are provided with extended housings 25 that are directly but rigidly connected to the sides of the crank casings 11. The pistons 24 are connected to the inner ends of crank rods 26, the outer or extended ends of which are pivotally connected to rockers or oscillatory levers 27 that are intermediately secured to the oscillatory shaft sections 18 to afford clearance for the rockers 27. Those portions of the crank casings 11 carrying the bearing 17 are formed with large notches or clearance passages 28.

These reciprocating engines or motors may be of either the gas or steam-actuated type, but will be assumed to be of the Diesel type; hence the fuel intake or injector is indicated at 29, the intake ports by the numeral 30 and the exhaust ports by the numeral 31.

So far as this invention is concerned, the engines may be of the air-cooled or water-cooled type, but are assumed to be of the air-cooled type and hence the cylinders are shown as provided with radiating fins 10a.

Operation

The operation of the mechanism or machine described summarized, is as follows:

The properly timed explosive charges in the several cylinders will, of course, force the respective pistons outward, the two pistons of the same cylinder simultaneously moving in opposite directions. As best illustrated in Fig. 2, the pistons in an upper cylinder will be moved simultaneously

outward while the pistons in the immediately lower cylinder will be moved simultaneously inward. This movement, of course, follows from the rocking movements of the rockers 27. The power and motion imparted from the reciprocating engines through the rockers 27 will simultaneously impart oscillatory movements to the shafts 18 and to the double-ended cranks 19 and guide heads 20. The oscillatory movements of the guide heads 20, acting on the bearing blocks 23 and trunnions 22 will cause the crank sleeves 21 to wobble around the axis of the crank shaft 14, and under such rotation, the sleeves 21 will wobble on the oblique cranks 16 and cause shaft 14 to rotate in a continuous direction. Here it is important to note that under the forces thus transmitted, the simultaneous connections on the reversely inclined crank 16 will be neutralized and shaft 14 will be relieved from endwise thrusts. Under the above action, the oscillating movement of the shafts 18 will be converted into rotary motion in the shaft 14.

A transmitting action reverse from that just described would be produced if shaft 14 were power-driven in a constant direction. Otherwise stated, if shaft 14 should be rotated in a constant direction, its oblique cranks, acting on the sleeves 21 and through the other connections to the pistons would reciprocate the said pistons as would be required if a pumping action was to be produced. Under motions transmitted either from the engines to the shaft 14 or conversely, the bearing blocks 23 will slide freely in their guides 20 and journaled sleeve 21 will slide axially to crank 16. This combined float feature is highly important.

Theoretically, the axes of the shafts 14 and 18, of the cranks 15 and of the trunnions 22 should intersect at an exact common point, but that perfect accuracy is practically impossible to obtain in commercial practice. However, such great accuracy is not required because the sliding movements of the blocks 23 and the guides 20 in conjunction with sliding axial movements of the sleeves 21 on crank 16 will compensate for any reasonable inaccuracies or play in the parts and with the minimum of power loss due to friction, will transmit the power to be converted either from reciprocating to rotary or from rotary to reciprocating motion.

Attention is further called to the fact that sleeves 21 are also free for limited sliding movements on the crank 16 and that the revolving cranks 16 wobble sleeves 21 at points intermediate of their ends, so that even with a single crank there will be an equalization of the end thrusts. Also, it will be understood that a crank shaft with a single crank could be driven from a single engine. The engines shown are illustrated as of the two-cycle type, but as already indicated, may take various forms and might be four-cycle gas engines, steam engines or air-actuated engines. However, the multiplicity of engines distributes the power evenly and keeps up a continuous application of power which will carry the crank shaft past dead centers under momentum when the power is transmitted from reciprocating engines to the constant-direction rotary shaft.

The drawings show the cranks 16 at an angle of 45 degrees to the axis of shaft 14, but this angle can be varied. The practical limits of variation are approximately from 20 degrees to 70 degrees of the cranks to the axis of shaft 14.

With the cranks at 45 degrees, oscillation of shaft 18 will be through 90 degrees;

With the cranks at 20 degrees, oscillation of shaft 18 will be through 40 degrees;

With the cranks at 60 degrees, oscillation of shaft 18 will be through 120 degrees; and

With the cranks at 70 degrees, oscillation of shaft 18 will be through 140 degrees.

However, the angle of the cranks may, in some instances, be greater or less than stated. Generally stated, the oscillation of shaft 18 will be twice that of the angle of the cranks 16 to the axis of shaft 14, but, of course, the oscillation of shaft 14 cannot too closely approach 180 degrees.

When the framework of the device made up of the engine cylinders, crank casings and bearings for the running parts are anchored to a fixed base or chassis at main motor bearing supports, all structural stresses and strains, otherwise passing through stationary engine structure, are directly and evenly absorbed by motor anchorage base, due to the fact that the forces are counter-balanced or set the one against the other in the mechanism. The opposed and counter-balanced or oppositely operating engines as well as the arrangement of the oblique cranks and connections are features that accomplish elimination of all ordinary mechanical unbalance.

Attention is now called to the diagram illustrated in Figs. 6 and 7. Fig. 6 is a charted diagram of piston velocity, and Fig. 7 is a charted diagram of piston acceleration. In Fig. 6, the full line indicates the piston velocity of the Swensen engine, and the dotted line indicates the piston velocity of a conventional gas engine. In Fig. 7, the full line indicates the acceleration of the Swensen engine, and the dotted line indicates the piston acceleration of a conventional gas engine. These diagrams represent the results at 1000 R. P. M. with piston strokes of three and a half (3½) inches, and with the oblique cranks at 60 degrees to the axis of the continuously rotated shaft. The advantages of the Swensen engine, as shown by these diagrams, over that of the conventional gas engine, it is thought, will be obvious to engineers familiar with this art.

From the foregoing description and statements made, it will be understood that the device described is capable of a large range of modification within the scope of the invention herein disclosed and claimed.

What I claim is:

1. In a device of the kind described, the combination with an oscillatory shaft and a constant-direction rotary shaft, the latter having an oblique crank, of a sleeve applied on said crank and having an intermediately located laterally projected trunnion, said oscillatory shaft having a crank arm equipped with a guide head in which the trunnion of said sleeve is mounted for travelling movements longitudinally of said oscillatory shaft.

2. In a device of the kind described, the combination with an oscillatory shaft and a constant-direction rotary shaft, the latter having an oblique crank, of a sleeve applied on said crank and having an intermediately located laterally projected trunnion, said oscillatory shaft having a crank arm equipped with a guide head in which the trunnion of said sleeve is mounted for travelling movements longitudinally of said oscillatory shaft, and power means applied to one of

said shafts for transmitting power to the other of said shafts.

3. In a device of the kind described, the combination with an oscillatory shaft and a constant-direction rotary shaft, the latter having an oblique crank, of a sleeve applied on said crank and having an intermediately located laterally projected trunnion, said oscillatory shaft having a crank arm equipped with a guide head in which the trunnion of said sleeve is mounted for travelling movements longitudinally of said oscillatory shaft, and in further combination with a cylinder having therein a reciprocating piston with connection to said crank arm for oscillating said oscillatory shaft.

4. In a device of the kind described, the combination with an oscillatory shaft and a constant-direction rotary shaft, the latter having an oblique crank, of a sleeve applied on said crank and having an intermediately located laterally projected trunnion, said oscillatory shaft having a crank arm equipped with a guide head in which the trunnion of said sleeve is mounted, and in which structure said constant-direction shaft has axially spaced portions with projecting crank arms to which the ends of said oblique crank are directly secured with the said sleeve working between said crank arms.

5. In a device of the kind described, the combination with an oscillatory shaft and a constant-direction rotary shaft, the latter having an oblique crank, of a sleeve applied on said crank and having an intermediately located laterally projected trunnion, said oscillatory shaft having a crank arm equipped with a guide head in which the trunnion of said sleeve is mounted, and in further combination with a cylinder having therein a reciprocating piston with connection to said crank arm for oscillating said oscillatory shaft, and in which structure said oscillatory shaft has axially spaced portions provided each with a crank arm connected at their ends by substantially rectangular guide heads in which the trunnions of said sleeve are mounted.

6. In a device of the kind described, the combination with oscillatory approximately parallel shafts and a constant-direction rotary shaft, the latter having reversely oblique cranks, of sleeves applied to said cranks and having oppositely projecting trunnions, said oscillatory shaft having axially spaced portions provided with laterally spaced crank arms, bearing heads connecting the ends of said laterally spaced arms and in which heads said bearing blocks are slidably mounted, and power means operative on one of said shafts to transmit a converted motion, and in which structure said power means includes a reciprocatory motor having connections to said rock shafts for oscillating the same.

7. In a device of the kind described, the combination with oscillatory approximately parallel shafts and a constant-direction rotary shaft, the latter having reversely oblique cranks, of sleeves applied to said cranks and having oppositely projecting trunnions, said oscillatory shaft having axially spaced portions provided with laterally spaced crank arms, bearing heads connecting the ends of said laterally spaced arms and in which heads said bearing blocks are slidably mounted, and power means operative on one of said shafts to transmit a converted motion, and in which structure said power means includes opposed cylinder piston engines with connections to said oscillatory shafts constructed and arranged to simultaneously oscillate the said shafts in reverse directions.

8. In a device of the kind described, the combination with approximately parallel oscillatory shafts and a constant-direction rotary shaft, the latter having reversely oblique cranks, of sleeves applied to said cranks and having oppositely projecting trunnions, said oscillatory shafts having axially spaced portions provided with laterally spaced rocker arms projecting radially in opposite directions therefrom, box-like guide heads rigidly connecting the ends of said oscillating crank arms, bearing blocks slidable in said guide heads, and in which the trunnions of said sleeves are journaled, and power means applied to one of said shafts and operative to apply motion thereto.

9. In a device of the kind described, the combination with approximately parallel oscillatory shafts and a constant-direction rotary shaft, the latter having reversely oblique cranks, of sleeves applied to said cranks and having oppositely projecting trunnions, said oscillatory shafts having axially spaced portions provided with laterally spaced rocker arms projecting radially in opposite directions therefrom, box-like guide heads rigidly connecting the ends of said rocker arms, bearing blocks slidable in said guide heads, and in which the trunnions of said sleeves are journaled, and reversely-acting cylinder and piston motors having connections to said rock shafts for simultaneously operating the same in reverse directions.

10. In a device of the kind described, the combination with approximately parallel oscillatory shafts and a constant-direction rotary shaft, the latter having reversely oblique cranks, of sleeves applied to said cranks and having oppositely projecting trunnions, said oscillatory shafts having axially spaced portions provided with laterally spaced rocker arms projecting radially in opposite directions therefrom, box-like guide heads rigidly connecting the ends of said rocker arms, bearing blocks slidable in said guide heads, and in which the trunnions of said sleeves are journaled, said oscillatory shafts having rocker arms projecting upwardly and downwardly therefrom, upper and lower laterally spaced pairs of cylinder and piston motors, the cylinders of which are fixed and the pistons of which are connected to the upper and lower ends of said rocker arms for simultaneously oscillating said oscillatory shafts.

11. In a device of the kind described, the combination with an oscillatory shaft and a constant-direction rotary shaft, the latter having an oblique crank, of a sleeve applied on said crank and having an intermediately located laterally projected trunnion, said oscillatory shaft having a crank arm equipped with a guide head in which the trunnion of said sleeve is mounted, and in which structure said oscillatory shaft is provided with a rocker arm extended diametrically in opposite directions therefrom, and reversely acting cylinder and piston motors, the movable elements of which are connected one to the upper and the other to the lower end of said rocker arm.

12. The combination with a continuously rotatable shaft having an oblique crank, of an oscillatory shaft having a crank arm, and a sleeve on said crank connected to said crank arm by a pivot, the axis of which transversely intersects the axis of said sleeve at a point radially offset from the axis of said sleeve and oscillatory shaft, and which sleeve is mounted for limited axial sliding movements on said oblique crank.

13. The combination with a continuously rotatable shaft having an oblique crank, of an oscillatory shaft having a crank arm extended diametrically in both directions from the axis thereof and provided at outer ends with bearing heads, bearing blocks slidably mounted in said bearing heads, and a sleeve on said crank having diametrically extended trunnions journaled in said bearing blocks, and which sleeve is mounted for limited axial sliding movement on said oblique crank.

14. The combination with a continuously rotatable shaft having an oblique crank, of an oscillatory shaft having a crank arm, and a sleeve on said crank connected to said crank arm by a pivot, the axis of which transversely intersects the axis of said sleeve at a point radially offset from the axis of said sleeve and oscillatory shaft, and in which structure said bearing heads are substantially rectangular frames having parallel slots in which said bearing heads are slidably mounted.

15. The structure defined in claim 3 in which said sleeve is mounted for limited axial sliding movements on said oblique crank.

16. The structure defined in claim 9 in which said sleeves are mounted for limited axial sliding movements on said oblique cranks.

17. In a device of the kind described, the combination with approximately parallel oscillatory shafts and a constant direction rotary shaft, the latter having reversely oblique cranks, of sleeves applied to said cranks and having oppositely projecting trunnions, said oscillatory shafts having axially spaced portions provided with laterally spaced rocker arms projecting radially in opposite directions therefrom, box-like guide heads rigidly connecting the ends of said rocker arms, bearing blocks slidable in said guide heads, and in which the trunnions of said sleeves are journaled, and reversely-acting cylinder and piston motors having connections to said rock shafts, whereby said rock shafts will be given substantially simultaneous oscillations in substantially reverse directions.

SIGURD M. SWENSEN.