Aug. 7, 1956 Z. J. JULIN 2,757,547

UNIVERSAL DOUBLE TORQUE ENGINE

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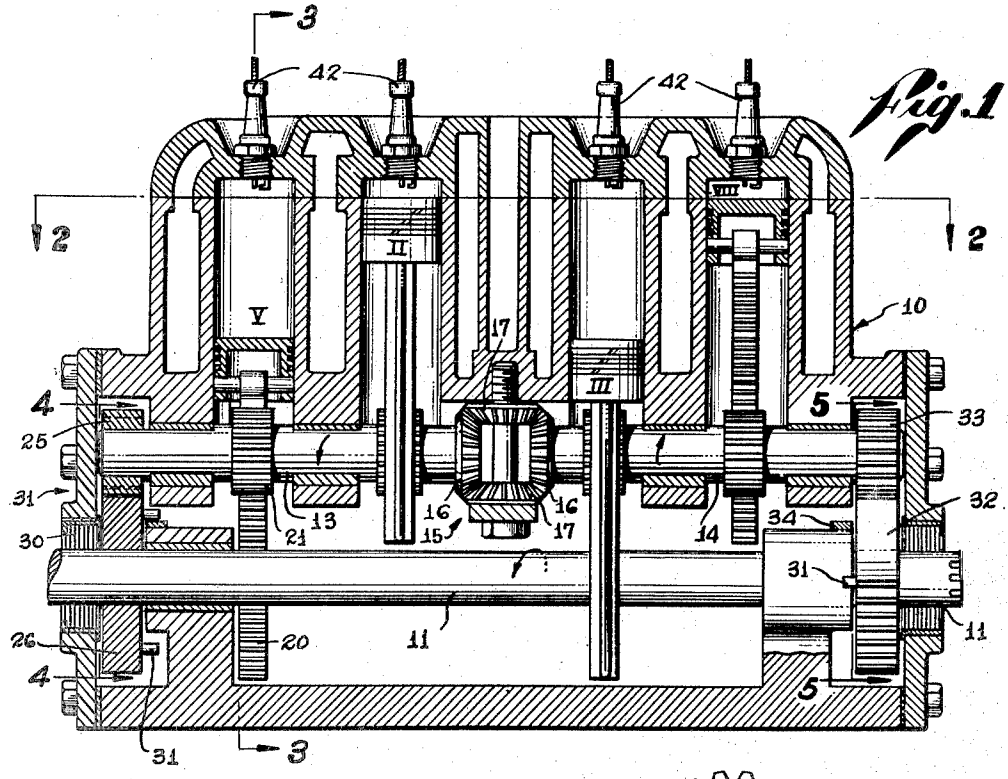


Fig. 1

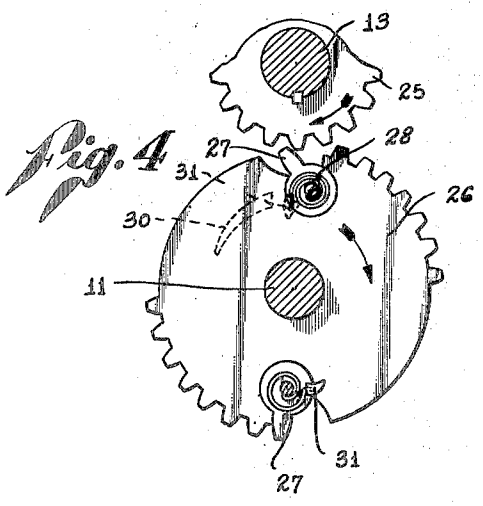


Fig. 4

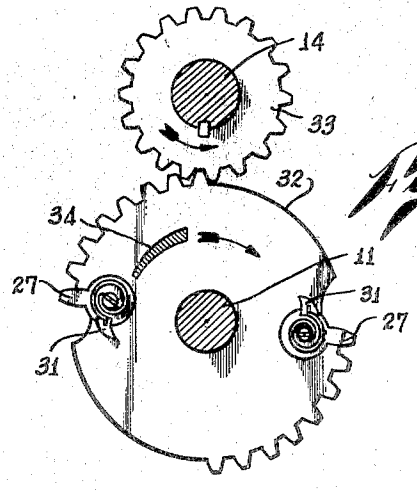


Fig. 5

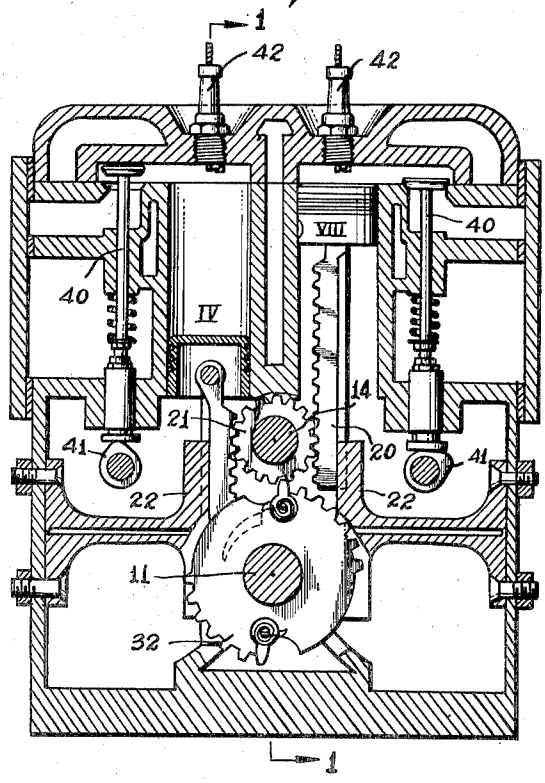
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Fig. 3



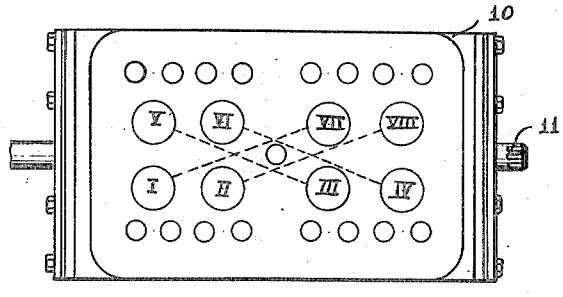


Fig. 2

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UNIVERSAL DOUBLE TORQUE ENGINE

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6 Claims. (Cl. 74—131)

This invention relates generally to engines of the reciprocating piston-type, and more particularly to a novel form of engine wherein power is simultaneously delivered to both sides of a shaft so that vibration is reduced to a minimum.

In my previous patent, No. 2,337,330, issued December 21, 1943, and entitled "Driving Mechanism," I have disclosed a reciprocating piston-type of engine in which a single shaft is alternately driven in opposite directions, its motion being transmitted through a suitable intermittent reversing mechanism to drive a power or output shaft continuously in one direction.

By my present invention, I have overcome the difficulties of the previous device, and have produced an engine that delivers a smooth and substantially vibrationless flow of power to an output shaft. Furthermore, by using a rack and pinion type of connection between the pistons and the driven or reciprocating shaft, the lever arm of the force delivered by the piston to the driven shaft is a constant, thereby overcoming one of the major disadvantages of the connecting rod and crank-type engine. In addition, I have developed an improved alternate reversing mechanism for use with this engine so that greater simplicity and higher power output is obtained.

It is therefore a major object of my invention to provide a reciprocating piston-type of engine in which pistons located on opposite sides of a driven shaft or shafts are fired in pairs, so that vibration is reduced to a minimum.

Another object of my invention is to provide an engine in which reciprocating pistons act upon a driven shaft with a constant lever arm, regardless of the position of the piston in its stroke.

It is a further object of my invention to provide an engine in which a driven shaft, alternating in forward and reverse directions, is coupled to a power-output shaft in a manner to provide a constant rotation of that output shaft in one direction.

Still another object of my invention is to provide an engine which, by appropriate design, may have a piston stroke that is comparatively long, with the piston acting upon the driven shaft with a constant but relatively small lever arm, or to provide an engine having a short stroke and a long lever arm.

It is a still further object of my invention to provide an engine of the type described that is greatly simplified over previous types, and has fewer parts that are likely to wear.

These and other objects and advantages of my invention will become apparent from the following description of one form thereof, and from the drawings illustrating that form, in which:

Figure 1 is a longitudinal sectional view through an engine constructed in accordance with my invention, showing pistons on both sides of the driven shaft, and taken along the line 1—1 of Figure 3;

Figure 2 is a plan view of the engine shown in Figure 1 with the cylinder head removed;

Figure 3 is a transverse sectional view taken on the line 3—3 of Figure 1 and showing one pair of pistons on opposite sides of the driven shaft;

Figure 4 is a view taken on the line 4—4 of Figure 1 showing the reversing mechanism at one end of the power-output shaft; and

Figure 5 is a view taken on the line 5—5 of Figure 1 and showing the reversing mechanism located at the other end of the power-output shaft, and taken at the same point in the cycle as in Figure 4.

Referring now to the drawings and particularly to Figures 1 to 3 thereof, the embodiment illustrated in these views is a four-stroke-cycle internal combustion engine having a total of eight pistons and cylinders divided into two groups of four. As indicated in those figures, the numeral **10** indicates generally a cylinder block having a longitudinally extending power-output shaft **11** mounted at the base of the block and adapted to be connected by suitable means (not shown) to a member to be driven. As best seen in Figure 2, a plurality of pistons are mounted within the cylinder block **10**, these pistons being arranged in two groups of four, one group being located on one side of the power-output shaft **11**, and the other group being located on the opposite side thereof. Additionally, the pistons may be divided into two different groups of four each, one group being located adjacent one end of the power-output shaft **11** and the other group being located adjacent the opposite end of that shaft. As is customary in piston-type engines, the pistons may be numbered as indicated in Figure 2, with the numbers running consecutively from left to right, and starting with the group nearer the bottom of the page. The pistons on the opposite side of the power-output shaft **11**, nearer the top of the page, are likewise numbered in sequence, starting with V and continuing through Number VIII. Thus, piston No. V is adjacent piston No. I, but on the opposite side of the main power-output shaft **11**, and similarily, piston VI is adjacent piston II. Pistons I, II, V, and VI form a group of four pistons located on one side of the transverse center line of the cylinder block **10**, and the remaining pistons, Numbers III, IV, VII and VIII are located on the opposite side that center line to form the second group of four pistons.

Above the power-output shaft **11** and parallel thereto, are a pair of driven shafts **13** and **14**, coaxial with each other, and interconnected at their adjacent ends by a reversing gear means **15** so that rotation of the shaft **13** in one direction will cause the rotation of the shaft **14** in the opposite direction. While various forms of reversing gear means may be used, I have illustrated a form wherein beveled gears **16**, mounted upon the ends of the shafts **13** and **14** engage other beveled gears **17** supported by the cylinder block **10**.

The pistons, Numbers I through VIII may be of substantially conventional construction, but instead of being provided with the usual connecting rod that is attached to a crank shaft, each of the pistons is provided with a downwardly extending rack **20** that meshes with an aligned pinion **21** mounted upon the driven shaft **13** or **14**. From the previous description, it will be apparent that pistons Numbers I, II, V and VI are connected by the aforesaid racks and pinions to driven shaft **13** while pistons III, IV, VII, and VIII are connected to driven shaft **14**.

The racks **20** may be guided by supports **22** in the lower portion of the cylinder block **22**, and the pistons are so located that the racks **20** may project downward-

ly, on either side of the power-output shaft **11** without hitting against the latter.

When piston No. I, for example, is driven downwardly, piston No. V is driven upwardly, and shaft **13** is turned in the direction of the arrow thereon in Figure 1. To return the pistons to their original positions, the driven shaft **13** must be turned in the opposite direction, whereupon the cycle is again repeated. Additionally, because of the reversing gear means **15**, driven shafts **13** and **14** are turned in opposite directions, and as hereinafter more fully pointed out, these driven shafts each oscillate back and forth, with the two shafts always turning in opposite directions. To turn the power-output shaft **11** in only one direction, it must be connected to the driven shaft **13** when the latter is rotating in one direction, and disconnected therefrom when the driven shaft **13** is rotated in the opposite direction. During the time that the driven shaft **13** is disconnected from the output shaft **11**, the driven shaft **14**, which is then turning in the same direction as the driven shaft **13** first turned, is then connected to the output shaft **14** turns in the opposite direction. In this way, power is alternately delivered by the driven shafts **13** and **14** to the power-output shaft **11** and in the present embodiment, this power is alternately delivered to opposite ends of the power-output shaft **11**.

The mechanism for accomplishing this alternate delivery of power is illustrated in Figures 4 and 5. As seen in Figure 4, the driven shaft **13** is provided with a gear **25** on the end thereof remote from the reversing gear means **15**. Mounted on the output shaft **11** in a position to mesh with the gear **25** is a segmental gear **26**. In the form shown, the segmental gear is divided into quadrants, with opposite quadrants being toothed, while the alternate quadrants are without teeth, so that the gear **25** may rotate without engaging or touching the untoothed portions of the segmental gear **26**. Assuming that the power-output shaft **11** is to rotate in a clockwise direction, as seen in Figures 4 and 5, the last tooth in each toothed quadrant, measured in a counter-clockwise direction, is pivotally mounted so that it may be swung out of the way, as indicated generally in Figure 4, for a purpose hereinafter described. This last tooth, designated by the numeral **27** is mounted upon a cylinder inserted in the segmental gear **26** in a direction parallel to the axis thereof, and is normally urged by spring means **28** to a position against the tooth quadrant where it is spaced the proper distance from the adjoining teeth and normally acts as one of them. However, when necessary, the tooth **27** may be deflected from its normal position, as indicated in the upper portion of Figure 4, to permit the gear **25** to rotate in the reverse direction.

To retain the movable tooth **27** in the correct position when necessary, and to release it for movement from that position as soon as desirable, I provide a cam **30** mounted upon a support for the power shaft **11**, and adapted to be engaged by a finger **31** projecting from the cylinder carrying the tooth **27**. The cam **30** is positioned so that as the movable tooth **27** approaches engagement with gear **25**, arm **31** bears against cam **30** and is lifted thereby so that the movable tooth bears firmly against the end of the tooth quadrant with which it is associated. The uppermost end of the cam **30** is located so that just prior to the time when the movable tooth **27** will be moved away from the tooth quadrant by the reverse rotation of gear **25**, the arm **31** is released from the cam **30**, and the gear **25** is free to move as necessary.

In a similar manner, the opposite end of the power-output shaft **11** is provided with a segmental gear **32** similar to the gear **26**, and positioned to engage a cooperating gear **33** mounted upon the end of the driven shaft **14** remote from the reverse gear means **15**. As indicated in Figure 5, the segmental gear **32** is divided into quadrants that are alternately toothed and smooth, as is the gear **26**, and the segmental gear **32** is likewise provided with spring-biased movable tooth **27** at the counter-clockwise ends of the tooth quadrants. Like the teeth **27** shown in Figure 4, the teeth **27** are mounted upon the gear **32** by rotatable cylinders whose axes are parallel to the axis of the gear, the cylinders having arms **31** projecting therefrom that are adapted to ride upon a cam **34** mounted upon a support for the power-output shaft **11**. The segmental gear **32** is so positioned with respect to the segmental gear **26** that as the gear **25** leaves the toothed quadrant of gear **26**, gear **33** enters a corresponding toothed quadrant of gear **32**. Thus, either gear **25** or gear **33** is operatively connected to power-output shaft **11** at all times, but both gears are not simultaneously operatively connected thereto.

In addition to the elements described, the engine is provided with the necessary additional members, such as valves **40**, means **41** for operating the valves, and in the case of a gasoline powered engine, spark plugs **42** and the necessary timing and other equipment. If the engine is operated as a diesel engine, the spark plugs **42** normally will not be necessary, and other changes, obvious to those skilled in art, may be incorporated. Similarly, if the engine is operated as a steam engine, other modifications will be desirable.

Operation of engine

In the operating of my improved engine, two cylinders, on opposite sides of the power-output shaft **11** and on opposite sides of the reversing gear means **15**, are simultaneously fired. Thus, cylinders I and VII are simultaneously fired, piston No. I driving the driven shaft **13** in a clockwise direction, as seen in 4 and 5, and piston VII driving the driven shaft **14** in a counter-clockwise direction as seen in those figures. Power from the explosion in cylinder No. I is transmitted through the reversing gear means through the driven shaft **14**, where it is transmitted through the gears **33** and segmental gear **32** to the power-output shaft **11**. At the same time, power from piston VII is simultaneously delivered to driven shaft **14** for similar transmission to the power-output shaft **11**.

When pistons I and VII reach the lowermost points of their travel, cylinders III and V are then fired, driving the driven shafts **13** and **14** in the opposite directions, and transmitting power through the driven shaft **13** and gear **25** to segmental gear **26**, which in turn is connected to the power-output shaft **11**. Thereafter, cylinders II and VIII are then fired, and the various elements shown in Figure 1 are indicated as being at this point. Finally, cylinders IV and VI are fired, and thereafter the complete cycle is repeated.

As previously indicated, during this cycle power has simultaneously been applied on opposite sides of the driven shafts **13** and **14**, and simultaneously applied to both of those shafts, and power has alternately been delivered to opposite ends of the power-output shaft **11**. Thus, while pistons I and VII were delivering power, driven shaft **13** was turned in a clockwise direction and driven shaft **14** was turned in a counter-clockwise direction. At that time, gear **33** meshed with the toothed quadrant of gear **32**, and thus drove that gear in a clockwise direction. At the end of that stroke, gear **33** had reached the end of the toothed quadrant of gear **32**, and the driven shafts **13** and **14** were ready to reverse their directions of rotation.

At the time that cylinders I and VII were fired, pistons I, II, VII, and VIII were at the upper ends of their strokes, and pistons III, IV, V, and VI were at the lower ends of their strokes. Similarly, at the end of the power stroke just described, pistons I, II, VII and VIII were at the lower ends of their strokes, and pistons III, IV, V and VI were at the upper ends of their strokes. Thereupon, cylinders III and V are simultaneously fired, driving driven shaft **13** in a counter-clockwise direction, and driving driven shaft **14** in a clockwise direction. Because of the reversing gear means

15, the power delivered to driven shaft 14 is transmitted, in a reverse direction, to driven shaft 13, and gear 25 meshes with a toothed quadrant of gear 26 on the end of the power output shaft 11 remote from gear 32.

As this transfer of driving power from one end of the output end 11 to the other occurs, and as the driven shafts 13 and 14 reverse their directions of rotation, gear 33, which has previously been driving the movable tooth 27 in the clockwise direction, reverses its direction of rotation and drives the movable tooth out of its path in a counter-clockwise direction. At the same time, gear 25 engages and drives segmental gear 26, thereby providing an uninterrupted supply of power to the power-output shaft 11.

When pistons 3 and 5 have reached the downward limit of their strokes, they are in the position shown in Figure 1, and cylinders 2 and 8 are next to be fired. At this time, gear 33 again engages segmental gear 32, and gear 25 is simultaneously disengaged from segmental gear 26. In the form of the engine shown, and as previously described, the segmental gears 26 and 32 are divided into quadrants, but if the power output shaft 11 is to rotate at some other speed, the gears 26 and 32 may be divided into some other even number of divisions, alternately toothed and untoothed, and a different output speed will be obtained for the same speed of rotation of the driven shafts 13 and 14. In any event, it is desirable to have the toothed segments of the gears 26 and 32 equal to the circumference of the gears 25 and 33 respectively.

In a similar manner, the gears or pinions 21 mounted upon the driven shafts 13 and 14 should be so correlated to the stroke of the pistons that each of the driven shafts is turned one complete revolution for each stroke of a piston. By changing the size of the pinions 21 and adjusting racks and guides, it is possible to correspondingly vary the stroke of the pistons, and while this is normally not a procedure that would be followed in the case of completed engines, it does make it possible to manufacture a number of different engines having different power ratings, with a minimum number of parts.

With this form of construction and method of operation, it is possible to provide an engine capable of delivering a large amount of power in proportion of the size and weight of the engine. In addition, the simultaneous firing of pairs of cylinders on opposite sides of the main power output shaft 11, and on opposite sides of the reversing gear means 15, insures that vibration of the engine is greatly reduced.

From the foregoing, it will be seen that I have provided an engine fully capable of achieving the objects and securing the advantages herein set forth. Certain changes and modifications will occur to those skilled in the art, and insofar as they do not depart from the broad aspects of my invention, are to be included herein. Consequently, while I have shown and described one form of engine, I do not wish to be restricted to the particular form or arrangement of parts herein described and shown, except as limited by my claims.

I claim:

1. An engine of the class described which includes: a cylinder block having cylindrical bores therein; a power output shaft connected to said block for rotation with respect thereto; a pair of substantially coaxial driven shafts connected to said block for rotation with respect thereto; reversing means interconnecting said pair of shafts to transmit power therebetween, so that rotation of one of said pair of shafts in one direction causes reverse rotation of the other of said pair of shafts; a plurality of pairs of pistons, the pistons of each pair being located on opposite sides of said driven shafts, and half of said pairs of pistons being connected to one of said driven shafts and the other half of said pairs of pistons being connected to the other of said driven shafts, said pistons being slidable within said bores; and

a pair of driving means each intermittently connecting one of said driven shafts to said power output shaft, said driving means being synchronized so that only one of said driven shafts is operatively connected to said output shaft at any time.

2. An engine of the class described which includes: a cylinder block having cylindrical bores therein; a power output shaft connected to said block for rotation with respect thereto; a pair of substantially coaxial driven shafts connected to said block for rotation with respect thereto; reversing means interconnecting said pair of shafts to transmit power therebetween, so that rotation of one of said pair of shafts in one direction causes reverse rotation of the other of said pair of shafts; a plurality of pairs of pistons, the pistons of each pair being located on opposite sides of said driven shafts, and half of said pairs of pistons being connected to one of said driven shafts and the other half of said pairs of pistons being connected to the other of said driven shafts, said pistons being slidable within said bores; a pinion connected to each of said pair of driven shafts; a rack connected to each of said pistons for movement therewith, each of said racks engaging a pinion on a driven shaft, thereby connecting said piston to said shaft; and a pair of driving means each intermittently connecting one of said driven shafts to said power output shaft, said driving means being synchronized so that only one of said driven shafts is operatively connected to said output shaft at any time, whereby power is alternately delivered to opposite ends of said power output shaft.

3. An engine of the class described which includes: a cylinder block having cylindrical bores therein; a power output shaft connected to said block for rotation with respect thereto; a pair of substantially coaxial driven shafts connected to said block for rotation with respect thereto, said shafts being capable of reverse rotation with respect to each other; reversing means interconnecting said pair of shafts to transmit power therebetween from either shaft to the other, and with either direction of rotation, said means acting to drive one of said shafts in one direction when the other is driven in the reverse direction; a plurality of pistons each connected to one of said pair of driven shafts in such a manner that movement of said piston in one direction is accompanied by rotation of the driven shaft connected thereto in one direction, and movement of said piston in the opposite direction is accompanied by rotation of said shaft in the opposite direction, said pistons being slidable within said bores; and a pair of driving means each intermittently connecting one of said driven shafts to said power output shaft, said connection being operatively effective only so long as said driven shaft turns in one direction, and being operatively ineffective when said driven shaft turns in the opposite direction, whereby each of said driven shafts is alternately operatively connected to said power output shaft to deliver power thereto, and one but not both of said driven shafts is connected to said power output shaft at all times.

4. An engine of the class described which includes: a cylinder block having cylindrical bores therein; a power output shaft connected to said block for rotation with respect thereto; a pair of substantially coaxial driven shafts connected to said block for rotation with respect thereto; reversing means interconnecting said pair of shafts to transmit power therebetween, so that rotation of one of said pair of shafts in one direction causes reverse rotation of the other of said pair of shafts; a plurality of pairs of pistons, the pistons of each pair being located on opposite sides of said driven shafts, and half of said pairs of pistons being connected to one of said driven shafts and the other half of said pairs of pistons being connected to the other of said driven shafts, said pistons being slidable within said bores; a pair of driving means each intermittently connecting one of said driven shafts to said power output shaft, each of said driving means

comprising a gear connected to said power output shaft and having alternate toothed and smooth segments, and a pinion connected to one of said driven shafts and adapted to mesh with said segmental gear, said segmental gears being indexed with respect to each other so that as a toothed segment of one gear engages its pinion, a toothed segment of the other of said gears disengages its corresponding pinion, and said driving means are timed in relation to said pistons so that movement of a piston throughout its stroke is coincident with the engagement of one of said pinions with a toothed segment of the associated segmental gear.

5. A device for translating oscillating rotary motion into continuous rotary motion, which includes: a first driven shaft adapted to rotate first in forward direction and then in reverse direction; a second driven shaft substantially coaxial with said first driven shaft adapted to rotate first in reverse direction and then in forward direction; reversing gear means interconnecting said first and second driven shafts so that rotation of either shaft in forward direction is accompanied by reverse rotation of the other of said shafts; a first pinion mounted on said first shaft; a second pinion mounted on said second shaft; a power output shaft adapted to rotate continuously in one direction; a first segmental gear mounted on said power output shaft in position to mesh with said first pinion, said first segmental gear and said first pinion being correlated so that during forward rotation of said first driven shaft, said first pinion meshed with the toothed portion of said first segmental gear, and

during reverse rotation of said first driven shaft, said first pinion is aligned with the untoothed portion of said first segmental gear; and a second segmental gear mounted on said power output shaft in position to mesh with said second pinion, said second segmental gear and said second pinion being correlated so that during forward rotation of said second driven shaft, said second pinion meshes with the toothed portion of said second segmental gear, and during rotation of said second driven shaft, said second pinion is aligned with the untoothed portion of said second segmental gear.

6. A device as defined in claim 5 in which each of said segmental gears is provided with a movable tooth at the end of each toothed segment, said tooth normally being held in driving position while the pinion associated with the segmental gear is turning in a forward direction, but is movable out of driving engagement with said pinion when the latter starts its reverse movement.

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