May 30, 1944. R. B. DAVIDS 2,349,848

RELATIVE MOTION ROTATIVE MECHANISM

Filed Dec. 8, 1942 3 Sheets-Sheet 1

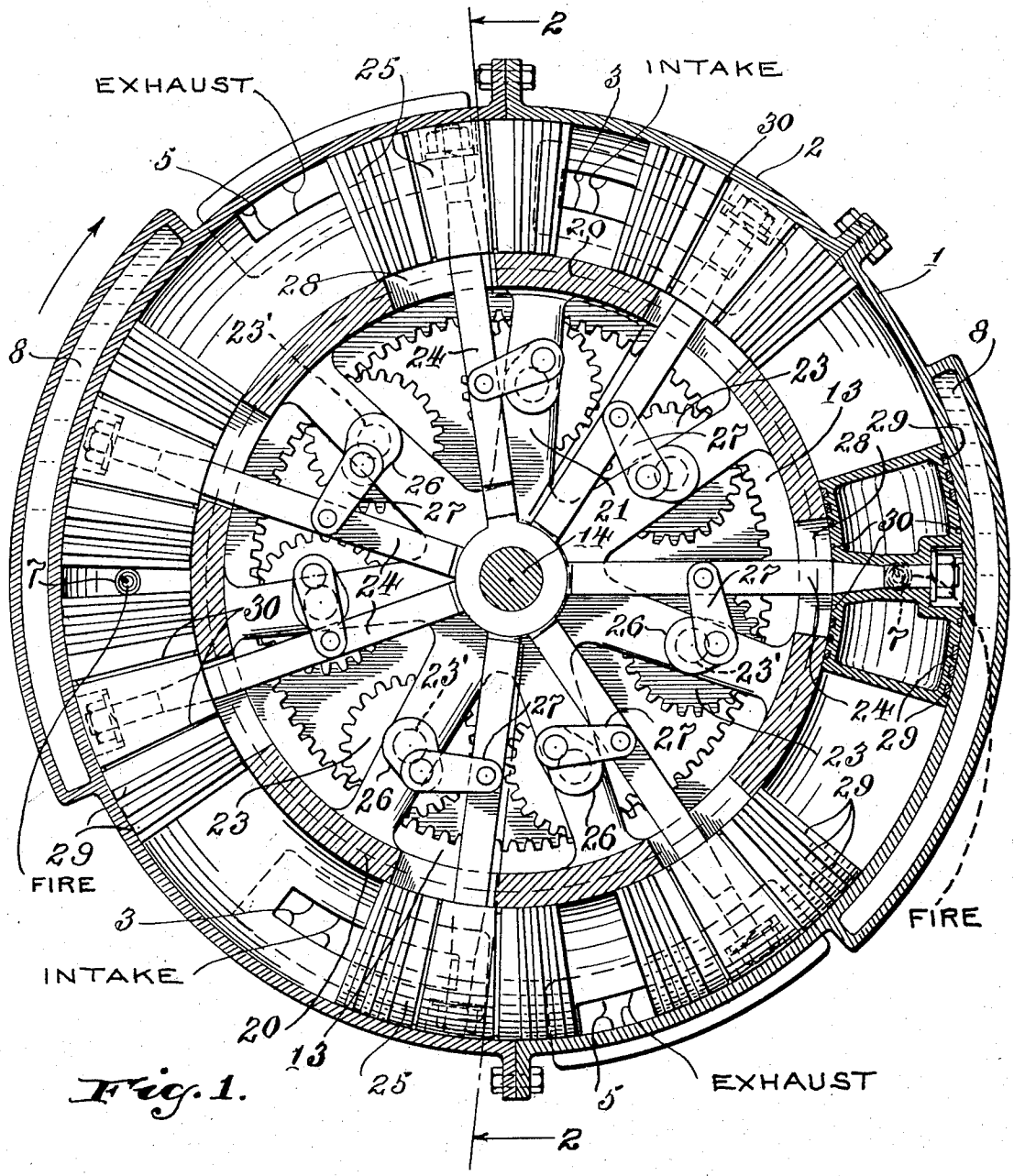


Fig. 1.

Inventor

ROBERT BREWSTER DAVIDS

By Thomas W. J. Clark

Attorney

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Fig. 3.

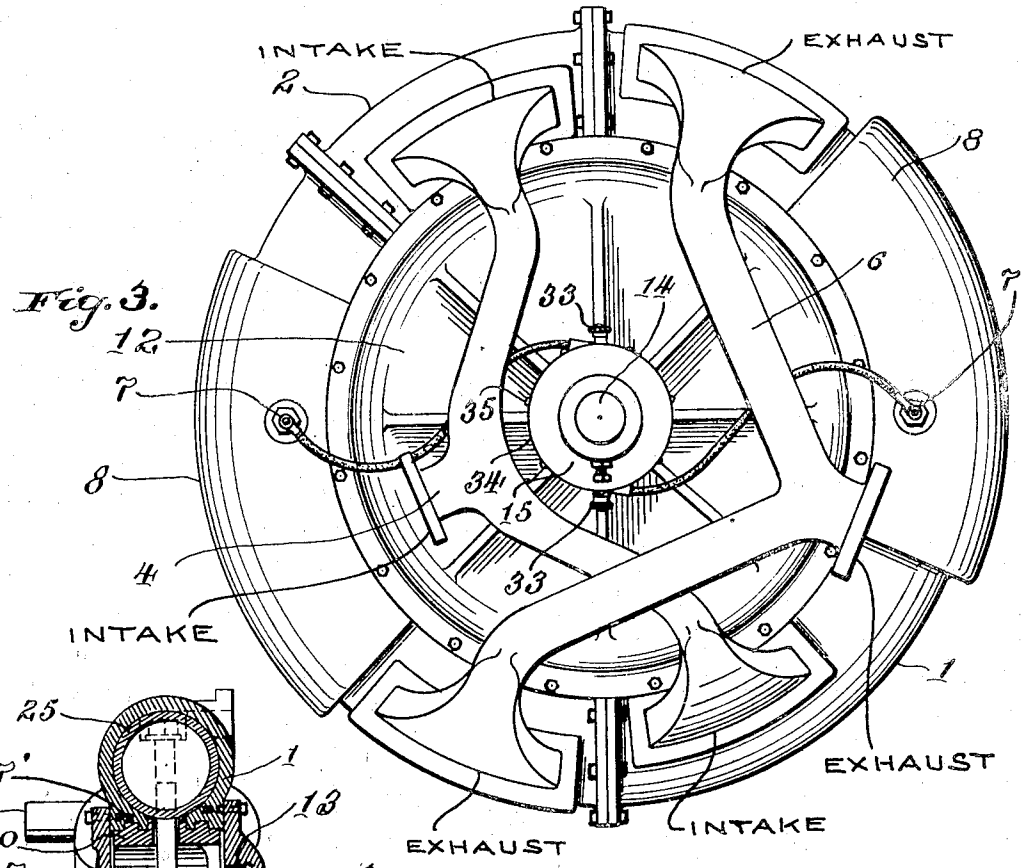
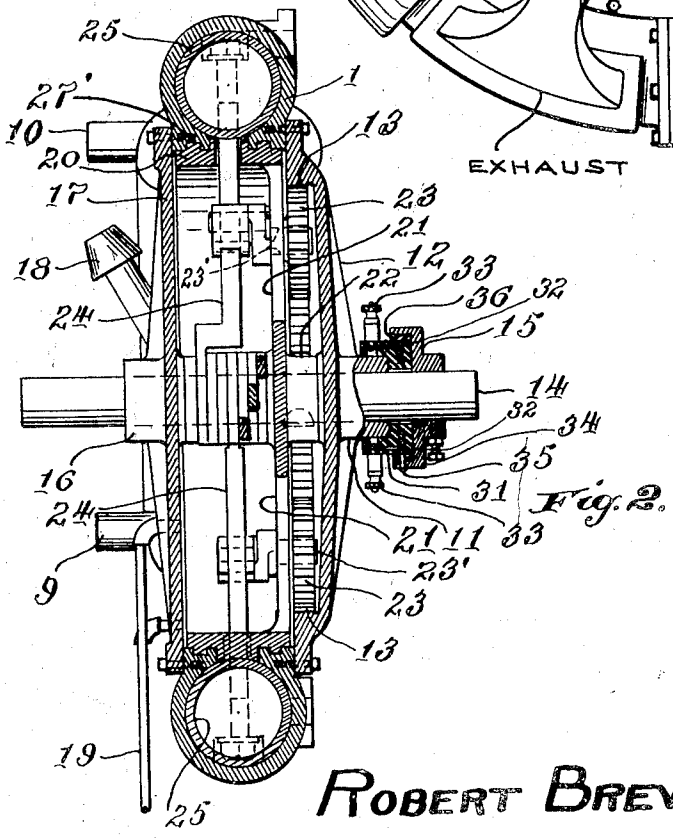


Fig. 2.



Inventor

ROBERT BREWSTER DAVIDS

By Thomas W. J. Clark

Attorney

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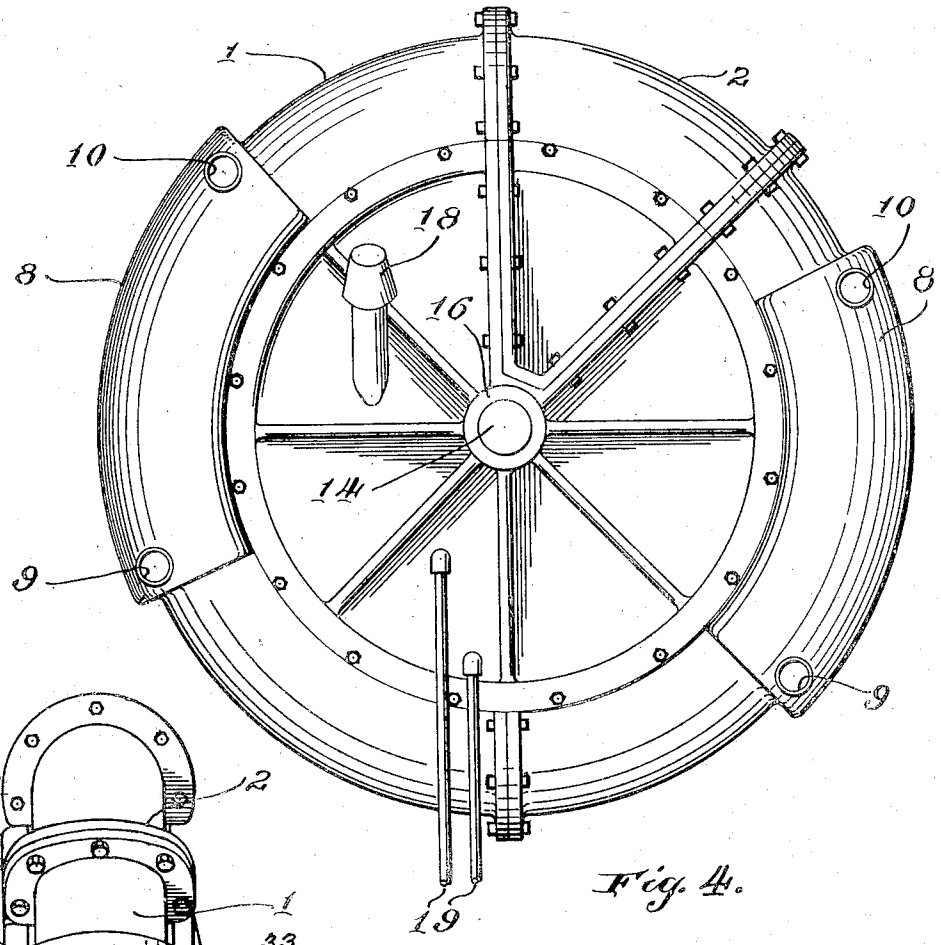


Fig. 4.

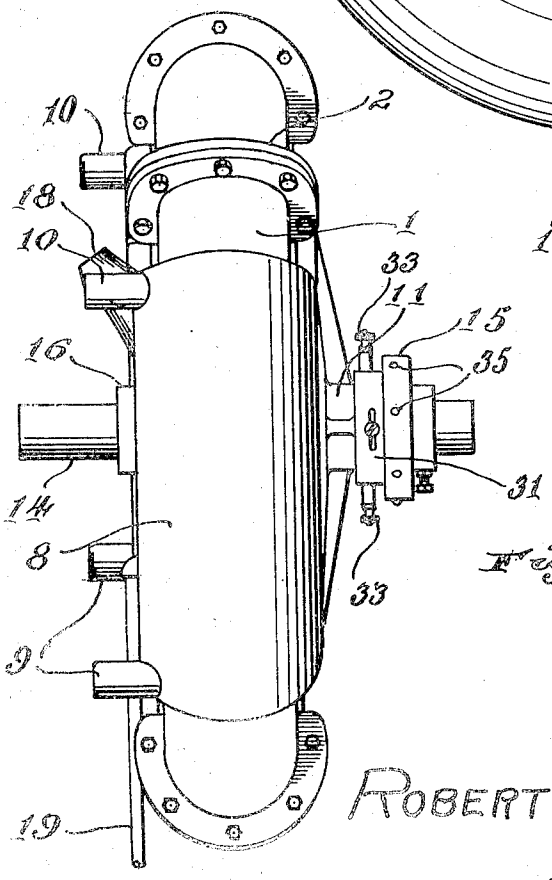


Fig. 5.

Inventor

ROBERT BREWSTER DAVIDS

By Thomas W. J. Clark

Attorney

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2,349,848

RELATIVE MOTION ROTATIVE MECHANISM

Robert Brewster Davids, Baltimore, Md.

Application December 8, 1942, Serial No. 468,242

20 Claims. (Cl. 123—11)

This invention relates to a mechanism for transforming energy from one form to another. It can be used as a steam or explosive gas or oil engine or as a pump or compressor.

The mechanism comprises a continuous annular chamber with a plurality of pistons therein associated together and with the chamber so that each two adjacent pistons in moving around the chamber alternately approach one another and are then expanded a distance apart. This cycle of contraction and expansion of the pistons may be repeated several times in each revolution through the chamber depending upon the ratio of gears employed.

When the mechanism is used as a gasoline or oil engine it will produce far greater power per unit of weight or space.

There is great simplicity of design and operation. There are no valves, springs, or cams; no reduction gear ignition' timing, no compound crank shaft with heavy bearings, no intricate oil system. A small number of spark plugs and injection devices is required. The ports for the intake and exhaust of combustible fuel are simple in design and are opened and closed automatically by the revolving pistons. The rotor serves as its own flywheel. Oiling is accomplished by splash and centrifugal action. Liquid or air cooling are readily available.

The maximum expansion of gases is obtained. The simplicity of the intake pipe and port insure a full charge without cylinder starvation.

There is complete absence of piston slap and side thrust. The pistons are held exactly concentric by radial piston arms as well as by the curvature of the annular chamber.

There is a complete absence of vertical and tortional vibration and structural stresses such as obtain in engines having straight cylinders in line or in radial pattern.

The engine can be placed in a vertical, horizontal or other position without modification of essential structure.

The mechanism can be adapted to the use of steam by the substitution of additional sets of intake and exhaust ports and the omission of ignition devices. The mechanism can be employed as a compressor or pump with the same general arrangements of ports as when adapted for steam use.

The basic principle underlying the mechanism can be best understood by considering a wheeled truck with forward and rear wheels of the same diameter. If two points on the circumference of the forward and rear wheels nearest to each other are considered, as the truck is moved forward, these points rotate about the axis of the wheels. The movement of the point on the forward wheel relative to a fixed point on the ground is forward at a rapid rate whereas the movement of the point on the rear wheel is forward at a rather slow rate, that is the rate of motion of the vehicle accelerates the rate of movement of the forward point and it decelerates the rate of the rear point. Of course relative to each other the points move toward or away from each other at a uniform rate. This principle has been employed in the mechanism of the invention.

In the drawings forming a part hereof Figure 1 represents a front elevation of the mechanism partly in section.

Figure 2 is a sectional view on line 2—2 of Figure 1 but with the front of the chamber and mechanism housing in place.

Figure 3 is a rear elevational view of the mechanism.

Figure 4 is a front elevation of the mechanism and Figure 5 is a side view thereof, with the intake and exhaust ducts removed.

In the drawings similar numerals refer to similar parts throughout the several views.

The mechanism consists of two primary assemblies, one fixed and one movable.

The fixed assembly consists of three sub-assemblies. A partial annular chamber 1 of circular cross-section can be made up in several sections to permit its assembly around the rotor and which can have a final section 2 to be lastly inserted after the rotor assembly is complete. In the side walls of the chamber are diametrically spaced intake ports 3 supplied from a common intake duct 4 and exhaust ports 5 joined by common duct 6. Spark plugs 7 likewise have their entrance to the chamber at diametrical points. As shown the chamber can have cooling jackets 8 partially around its circumference with water inlets and outlets 9 and 10 respectively. Fins can, of course be substituted for the cooling jackets.

Another sub-assembly consists of one of the two main bearings 11 which forms the rear part 12 of the housing which is attached to the circular chamber 1. On the inside of housing 12 is a master gear 13 concentric with the bearing 11 and through which the main arbor or shaft 14 passes to the outside of this housing 12. The intake and exhaust ducts 4 and 6 and the spark plugs 7 and the ignition timing device 15 are on this housing 12.

The third sub-assembly consists of the front bearing 16 and the front 17 of the housing which

is likewise attached to chamber 1. This front 17 of the housing has a removable sector, attached to the above mentioned final section 2, to permit the introduction of the parts of the rotor assembly. It also has in it the oil inlet and drain pipes 18 and 19 respectively.

The movable assembly consists of a master rotor with outer slotted rim 20 offset from a web or spokes 21 joined together by a hub 22 fixedly mounted on shaft 14 and of a plurality of small planetary gears 23 fixed on arbors 23' rotatably mounted in the master rotor, and the gears mesh with the stationary master gear 13.

Pivotally and radially mounted on the shaft 14 are a plurality of radial arms 24 and attached to these arms are pistons 25 rotating within the annular chamber 1.

The planetary gears 23 rotate or are rotated by their main arbors 23' mounted in the web or spokes 21 of the master rotor. These arbors have fixed thereon cranks 26 by the pinion of which a link 27 joins the crank to an adjacent radial arm 24. The rim 20 of the rotor has flanges 27' turning in grooves in the annular chamber and making a gas tight seal therewith and it completes the inner circumference of this chamber. The rotor rim 20 has therein slots 28 through which the arms 24 operate. The pistons have piston rings 29 to insure their gas tight fit with the chamber. They have oil grooves 30 for the flow of oil therearound.

The small gears 23 are equally spaced from each other around the main shaft 14 and their centers are equidistant from this shaft. The master gear can have a ratio to them of any power of the number 2. When the mechanism is used as an explosive engine, in order to have the explosions overlap in their driving effect upon the main shaft, and to attain smoothness of operation in other uses, the number of small gears should be one under or one over the number of half revolutions a small gear makes in one complete revolution of the rotor. As shown in the drawings, the ratio of the gears is four to one and the number of gears is seven, thus each small gear will rotate four complete times with one revolution of the rotor and the pistons will each oscillate eight times with one such complete revolution. The arc of the oscillations is determined by the length of the small gear crank 26 and links 27 which must be short enough to permit the oscillating pistons to cover the slots 28 in the rim of the main rotor at all times. Complete gas sealing of the slots 28 can be obtained by cupping the pistons at their ends if desired.

As shown there are two diametrically placed spark plugs 7. These are connected with the timing mechanism 15. This mechanism is comprised of the insulating member 31 rotatably adjustable on bearing 11 and having therein two spring projected diametrically opposed timing points each electrically connected with spark plugs 7, through contact members 33. On the shaft 14 is mounted the contact holding member 34 with as many separate contact making members 35 as pistons. These members 35 pass through insulating ring 36 in member 34. The timing mechanism is so arranged as to give two diametrically opposite firing points between each pair of pistons for each revolution of the main rotor and the spark can be advanced or retarded by rotary adjustment of members 31 or 34 or both. The spark plugs will fire alternately thus breaking the step and producing a smooth continuous flow of power.

The exact locations of the firing points and of the centers of the intake and exhaust ports and of the cranks on the arbors of the small gears can be determined by mathematical calculation, they depend upon the number of small or planetary gears and their ratio with the master gear or they can be determined empirically. In the mechanism shown with the ratio of four to one and seven small gears, each two adjacent pistons will reach their position of closest approach four times when the main rotor passes through one complete revolution. They are at this position one of these times when they pass the ignition points. At any one point in the revolution of the main rotor the crank on the arbor of any one small gear will have the same angularity with respect to a radius of the rotor as the preceding crank.

As the rotor revolves the pistons all being geared together through the plurality of epicyclic gear trains will follow the same series of operations. There will be twice as many oscillations of each piston in one revolution of the rotor as the ratio of the small gears is to the master gear. The backward oscillation will be a variable deceleration and the forward oscillation a variable acceleration. Thus after the closest approach of any two pistons at an ignition point, the one ahead, number 1, will move forward rapidly while the one following, number 2, will move forward relatively slowly and will lag behind until another charge of gas mixture is compressed against it by the next following piston, number 3. Pistons numbers 2 and 3 now move relatively slowly to the ignition point and the second ignition takes place. In the meantime number 1 piston has uncovered the exhaust port at the end of its oscillation, decelerates and slowly moves forward while the number 2 piston scavenges the burnt gas and covers the exhaust port. Number 1 piston has by now uncovered the intake port and drawn in the gas mixture to the end of its oscillation, whereupon number 2 piston moves forward rapidly covering the intake port and compressing the gas against number 1 piston. The Otto cycle has now been completed. In the four to one ratio mechanism shown this cycle takes place twice for each piston in one revolution of the rotor. Thus in a seven piston mechanism, there will be fourteen power impulses in one rotor revolution, requiring two ignition devices and two sets of intake and exhaust ports. The power impulses will be in both directions and will be uniform in force and turning rate relative to the moving rotor.

When the mechanism is used as a pump or compressor, ports will take the place of the ignition devices and the rotor will be turned by its shaft. Ports will be placed so that fluids will be drawn in as the pistons are spread apart and the fluid will be forced out through other ports as the pistons come together.

Were it desired to use the mechanism as an oil engine suitable injection apparatus could be attached with an air intake and the device built with a suitable compression ratio for that purpose.

The mechanism is usable as a steam engine by the installation of suitable intake and exhaust ports and the omission of the ignition devices. In the seven piston engine there would be 28 double power impulses in one rotor revolution, approximating turbine smoothness with high or low pressures.

Only one form of the mechanism has been il-

lustrated, many variations may be made in structure and arrangement without departing from the invention.

What is claimed as new and is desired to be secured by Letters Patent is:

1. An energy transforming mechanism comprising an annular chamber, an axis shaft coaxial therewith and rotatable relatively thereto, a plurality of double faced pistons each having a rigidly attached arm connecting the same rotatably to said shaft, said pistons rotating in said chamber and during part of their revolution, every two adjacent faces of said pistons forming with said annular chamber an energy transforming chamber, and gearing associated with said arms, shaft and annular chamber to move adjacent pistons successively toward and away from one another.

2. An energy transforming mechanism comprising an annular chamber, an axis shaft coaxial therewith and rotatable relatively thereto, a plurality of double faced pistons each having a rigidly attached arm connecting the same rotatably to said shaft, said pistons rotating in said chamber and during part of their revolution, every two adjacent faces of said pistons forming with said annular chamber an energy transforming chamber, and gearing associated with said arms, shaft and annular chamber to move adjacent pistons successively toward and away from one another upon the rotation of said shaft relative to said annular chamber.

3. An energy transforming mechanism comprising an annular chamber, an axis shaft coaxial therewith and rotatable relatively thereto, a plurality of double faced pistons each having a rigidly attached arm connecting the same rotatably to said shaft, said pistons rotating in said chamber and during part of their revolution, every two adjacent faces of said pistons forming with said annular chamber an energy transforming chamber, and gearing associated with said arms, shaft and annular chamber to move adjacent pistons successively toward and away from one another and to turn said shaft relatively to said annular chamber upon the movement of adjacent pistons in certain portions of said annular chamber away from one another.

4. An energy transforming mechanism comprising an annular chamber, an axis shaft coaxial therewith and rotatable relatively thereto, a plurality of double faced pistons each having a rigidly attached arm connecting the same rotatably to said shaft, said pistons rotating in said chamber and during part of their revolution, every two adjacent faces of said pistons forming with said annular chamber an energy transforming chamber, and means extending between said arms, shaft and annular chamber to move adjacent pistons successively toward and away from one another, through cycles of contraction and expansion.

5. An energy transforming mechanism comprising an annular chamber, an axis shaft coaxial therewith and rotatable relatively thereto, a plurality of double faced pistons each having a rigidly attached arm connecting the same rotatably to said shaft, said pistons rotating in said chamber and during part of their revolution, every two adjacent faces of said pistons forming with said annular chamber an energy transforming chamber, and means extending between said arms, shaft and annular chamber to move adjacent pistons successively toward and away from one another, through cycles of contraction and expansion, upon the rotation of said shaft relative to said annular chamber.

6. An energy transforming mechanism comprising an annular chamber, an axis shaft coaxial therewith and rotatable relatively thereto, a plurality of double faced pistons each having a rigidly attached arm connecting the same rotatably to said shaft, said pistons rotating in said chamber and during part of their revolution, every two adjacent faces of said pistons forming with said annular chamber an energy transforming chamber, and means extending between said arms, shaft and annular chamber to move adjacent pistons successively toward and away from one another, through cycles of contraction and expansion and to turn said shaft relatively to said annular chamber upon the movement of adjacent pistons in certain portions of said annular chamber away from one another.

7. An energy transforming mechanism comprising an annular chamber, an axis shaft coaxial therewith and rotatable relatively thereto, a plurality of double faced pistons each having a rigidly attached arm connecting the same rotatably to said shaft, said pistons rotating in said chamber and during part of their revolution, every two adjacent faces of said pistons forming with said annular chamber an energy transforming chamber, and means extending between said arms, shaft and annular chamber to move adjacent pistons successively toward and away from one another, through cycles of contraction and expansion, and means to admit an expansive fluid between certain adjacent pistons near the beginning of their expansion cycle to push them away from one another.

8. An energy transforming mechanism comprising an annular chamber, an axis shaft coaxial therewith and rotatable relatively thereto, a plurality of double faced pistons each having a rigidly attached arm connecting the same rotatably to said shaft, said pistons rotating in said chamber and during part of their revolution, every two adjacent faces of said pistons forming with said annular chamber an energy transforming chamber, and means extending between said arms, shaft and annular chamber to move adjacent pistons successively toward and away from one another, through cycles of contraction and expansion and to turn said shaft relatively to said annular chamber upon the movement of adjacent pistons in certain portions of said annular chamber away from one another and means to admit an expansive fluid between adjacent pistons in portions of their revolution in said annular chamber to move said pistons away from one another to turn said shaft relatively to said annular chamber.

9. An energy transforming mechanism comprising an annular chamber, an axis shaft coaxial therewith and rotatable relatively thereto, a plurality of double faced pistons each having a rigidly attached arm connecting the same rotatably to said shaft, said pistons rotating in said chamber and during part of their revolution, every two adjacent faces of said pistons forming with said annular chamber an energy transforming chamber, and means extending between said arms, shaft and annular chamber to move adjacent pistons successively toward and away from one another, through cycles of contraction and expansion and means to admit an expansive fluid between adjacent contracted pistons to impart a rotary motion in one direction to said pistons in said annular chamber.

10. An energy transforming mechanism comprising an annular chamber, an axis shaft coaxial therewith and rotatable relatively thereto, a plurality of double faced pistons each having a rigidly attached arm connecting the same rotatably to said shaft, said pistons rotating in said chamber and during part of their revolution, every two adjacent faces of said pistons forming with said annular chamber an energy transforming chamber, and means extending between said arms, shaft and annular chamber to move adjacent pistons successively toward and away from one another, through cycles of contraction and expansion and to turn said shaft relatively to said annular chamber upon the movement of adjacent pistons in certain portions of said annular chamber away from one another and means to admit an explosive mixture between adjacent pistons in certain portions of said annular chamber, and thereafter to explode the same, the explosion taking place near the beginning of an expansion cycle.

11. An energy transforming mechanism comprising an annular chamber, an axis shaft coaxial therewith and rotatable relatively thereto, a plurality of double faced pistons each having a rigidly attached arm connecting the same rotatably to said shaft, said pistons rotating in said chamber and during part of their revolution, every two adjacent faces of said pistons forming with said annular chamber an energy transforming chamber, and means extending between said arms, shaft and annular chamber to move adjacent pistons successively toward and away from one another, through cycles of contraction and expansion and to turn said shaft relatively to said annular chamber upon the movement of adjacent pistons in certain portions of said annular chamber away from one another and means to admit an explosive mixture between adjacent pistons in certain portions of said annular chamber and means to thereafter explode the same, said pistons, between said mixture admission and explosion, passing through a contraction cycle to compress the mixture.

12. An energy transforming mechanism comprising an annular chamber, an axis shaft coaxial therewith and rotatable relatively thereto, a plurality of double faced pistons each having a rigidly attached arm connecting the same rotatably to said shaft, said pistons rotating in said chamber and during part of their revolution, every two adjacent faces of said pistons forming with said annular chamber an energy transforming chamber, and means extending between said arms, shaft and annular chamber to move adjacent pistons successively toward and away from one another, through cycles of contraction and expansion and to turn said shaft relatively to said annular chamber upon the movement of adjacent pistons in certain portions of said annular chamber away from one another and means to admit an expansive fluid between adjacent contracted pistons to impart a rotary motion in one direction to said pistons in said annular chamber.

13. An energy transforming mechanism comprising an annular chamber, a wheel having a slotted rim closely fitting within and forming the inner circumferential wall of said chamber and being rotatable relative to said chamber, an axis shaft passing through and fast to the hub of said wheel, a plurality of double faced pistons rotatably movable in said chamber and attached rigidly by radius arms passing through the slots in said wheel rim rotatably to said shaft and during part of their rotatable movement, every two adjacent faces of said pistons forming with said annular chamber an energy transforming chamber, and means extending between said arms, shaft and annular chamber to move adjacent pistons successively toward and away from one another, through cycles of contraction and expansion.

14. An energy transforming mechanism comprising an annular chamber, a wheel having a slotted rim closely fitting within and forming the inner circumferential wall of said chamber and being rotatable relative to said chamber, an axis shaft passing through and fast to the hub of said wheel, a plurality of double faced pistons rotatably movable in said chamber and attached rigidly by radius arms passing through the slots in said wheel rim rotatably to said shaft and during part of their rotatable movement, every two adjacent faces of said pistons forming with said annular chamber an energy transforming chamber, a gear coaxial with said shaft and fixed relative to said annular chamber, a plurality of equal gears, each spaced on said wheel an equal distance from said shaft, each forming an epicyclic train with said fixed gear, and each connected by a crank to one of said arms, said cranks being so placed on their gears as to move adjacent pistons toward and away from each other during the rotation of said shaft relative to said annular chamber.

15. An energy transforming mechanism comprising an annular chamber, a wheel having a slotted rim closely fitting within and forming the inner circumferential wall of said chamber and being rotatable relative to said chamber, an axis shaft passing through and fast to the hub of said wheel, a plurality of double faced pistons rotatably movable in said chamber and attached rigidly by radius arms passing through the slots in said wheel rim rotatably to said shaft and during part of their rotatable movement, every two adjacent faces of said pistons forming with said annular chamber an energy transforming chamber, a gear coaxial with said shaft and fixed relative to said annular chamber, a plurality of equal gears, each spaced on said wheel an equal distance from said shaft, each forming an epicyclic train with said fixed gear, and each connected by a crank to one of said arms, said cranks being so placed on their gears as to move adjacent pistons toward and away from each other during the rotation of said shaft relative to said annular chamber and to turn said shaft relatively to said annular chamber upon the movement of adjacent pistons in certain portions of said annular chamber away from one another.

16. An energy transforming mechanism comprising an annular chamber, a wheel having a slotted rim closely fitting within and forming the inner circumferential wall of said chamber and being rotatable relative to said chamber, an axis shaft passing through and fast to the hub of said wheel, a plurality of double faced pistons rotatably movable in said chamber and attached rigidly by radius arms passing through the slots in said wheel rim rotatably to said shaft and during part of their rotatable movement, every two adjacent faces of said pistons forming with said annular chamber an energy transforming chamber, and means extending between said arms, shaft and annular chamber to move adjacent pistons successively toward and away from one another, through cycles of contraction and ex-

pansion and to turn said shaft relatively to said annular chamber upon the movement of adjacent pistons in certain portions of said annular chamber away from one another and means to admit an explosive mixture between adjacent pistons at certain portions of said annular chamber, and to explode the same, the explosion taking place near the beginning of an explosion cycle.

17. An energy transforming mechanism comprising an annular chamber, a wheel having a slotted rim closely fitting within and forming the inner circumferential wall of said chamber and being rotatable relative to said chamber, an axis shaft passing through and fast to the hub of said wheel, a plurality of double faced pistons rotatably movable in said chamber and attached rigidly by radius arms passing through the slots in said wheel rim rotatably to said shaft and during part of their rotatable movement, every two adjacent faces of said pistons forming with said annular chamber an energy transforming chamber, a gear coaxial with said shaft and fixed relative to said annular chamber, a plurality of equal gears, each spaced on said wheel an equal distance from said shaft, each forming an epicyclic train with said fixed gear, and each connected by a crank to one of said arms, said cranks being so placed on their gears as to move adjacent pistons toward and away from each other during the rotation of said shaft relative to said annular chamber, through cycles of contraction and expansion and to turn said shaft relatively to said annular chamber upon the movement of adjacent pistons in certain portions of said annular chamber away from one another and means to admit an explosive mixture between adjacent pistons in certain portions of said annular chamber, and thereafter to explode the same, the explosion taking place near the beginning of an expansion cycle.

18. An energy transforming mechanism comprising an annular chamber, a wheel having a slotted rim closely fitting within and forming the inner circumferential wall of said chamber and being rotatable relative to said chamber, an axis shaft passing through and fast to the hub of said wheel, a plurality of double faced pistons rotatably movable in said chamber and attached rigidly by radius arms passing through the slots in said wheel rim rotatably to said shaft and during part of their rotatable movement, every two adjacent faces of said pistons forming with said annular chamber an energy transforming chamber, a gear coaxial with said shaft and fixed relative to said annular chamber, a plurality of equal gears, each spaced on said wheel an equal distance from said shaft, each forming an epicyclic train with said fixed gear, and each connected by a crank to one of said arms, said cranks being so placed on their gears as to move adjacent pistons toward and away from each other during the rotation of said shaft relative to said annular chamber, through cycles of contraction and expansion and to turn said shaft relatively to said annular chamber upon the movement of adjacent pistons in certain portions of said annular chamber away from one another and means to admit an explosive mixture between adjacent pistons in certain portions of said annular chamber and means to thereafter explode the same, said pistons, between said mixture admission and explosion, passing through a contraction cycle to compress the mixture.

19. An energy transforming mechanism comprising an annular chamber, a wheel having a slotted rim closely fitting within and forming the inner circumferential wall of said chamber and being rotatable relative to said chamber, an axis shaft passing through and fast to the hub of said wheel, a plurality of double faced pistons rotatably movable in said chamber and attached rigidly by radius arms passing through the slots in said wheel rim rotatably to said shaft and during part of their rotatable movement, every two adjacent faces of said pistons forming with said annular chamber an energy transforming chamber, and means extending between said arms, shaft and annular chamber to move adjacent pistons successively toward and away from one another, through cycles of contraction and expansion, and to turn said shaft relatively to said annular chamber upon the movement of adjacent pistons in certain portions of said annular chamber away from one another.

20. An energy transforming mechanism comprising an annular chamber, a wheel having a slotted rim closely fitting within and forming the inner circumferential wall of said chamber and being rotatable relative to said chamber, an axis shaft passing through and fast to the hub of said wheel, a plurality of double faced pistons rotatably movable in said chamber and attached rigidly by radius arms passing through the slots in said wheel rim rotatably to said shaft and during part of their rotatable movement, every two adjacent faces of said pistons forming with said annular chamber an energy transforming chamber, and means extending between said arms, shaft and annular chamber to move adjacent pistons successively toward and away from one another, through cycles of contraction and expansion, and to turn said shaft relatively to said annular chamber upon the movement of adjacent pistons in certain portions of said annular chamber away from one another and means to admit an expanding fluid between certain adjacent pistons near the beginning of their expansion cycle to push them away from one another.

ROBERT BREWSTER DAVIDS.