No. 836,430. PATENTED NOV. 20, 1906.

M. ANGERMANN.

ROTARY ENGINE.

APPLICATION FILED MAR. 28, 1906.

3 SHEETS—SHEET 1.

Fig: 1.

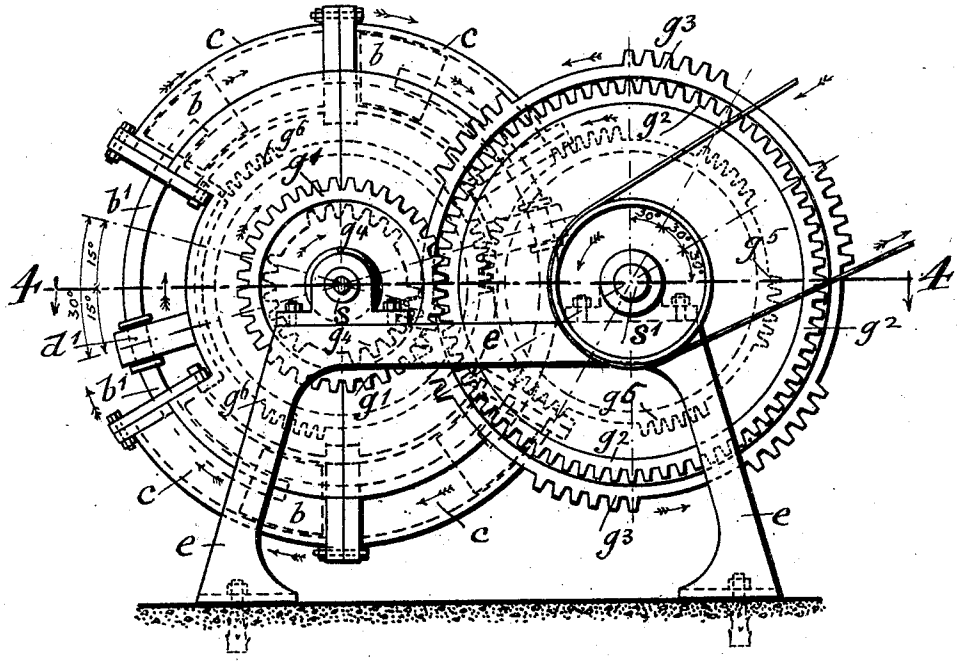
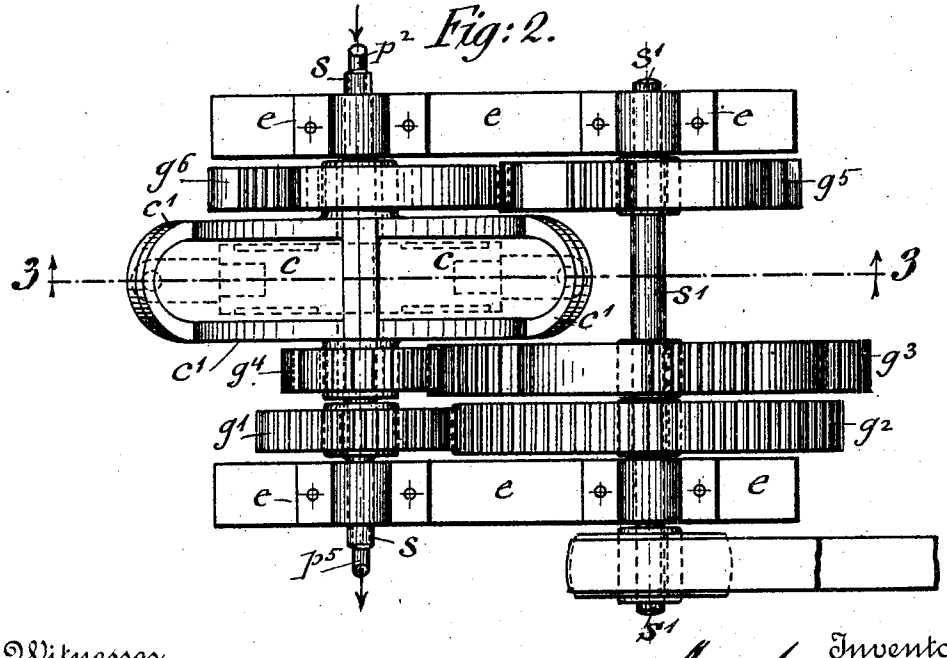


Fig: 2.



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3 SHEETS—SHEET 2.

Fig: 3.

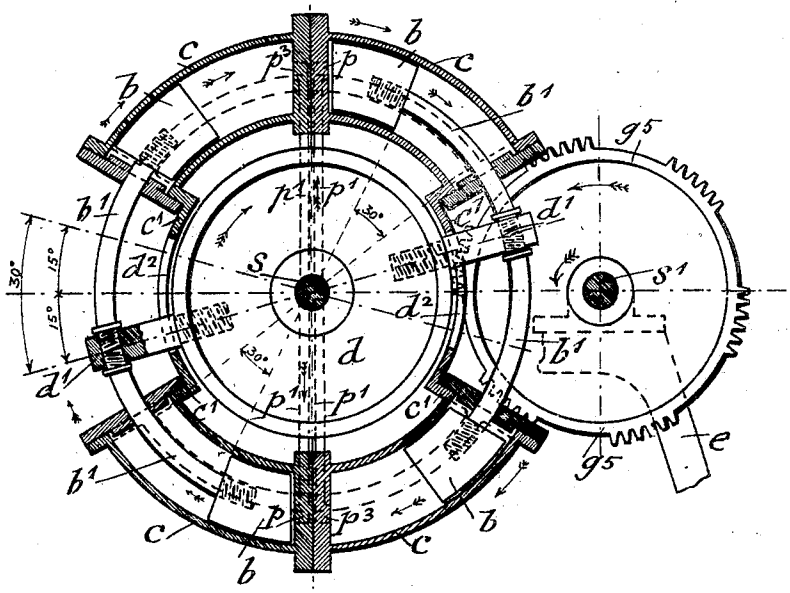
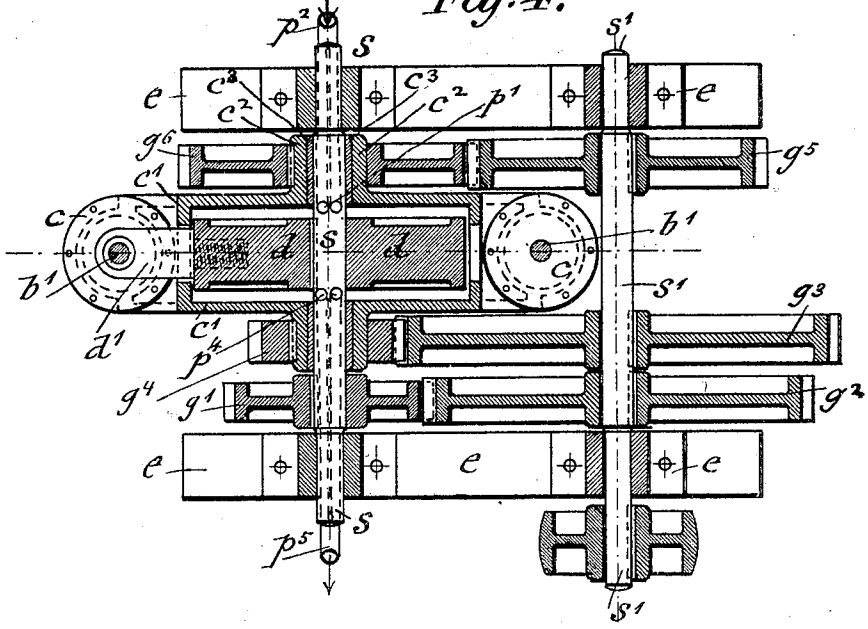


Fig: 4.



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3 SHEETS—SHEET 3.

Fig: 5.

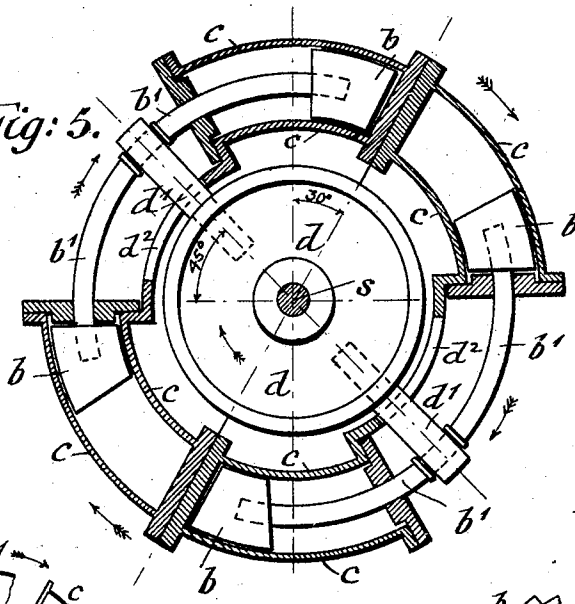


Fig: 8.

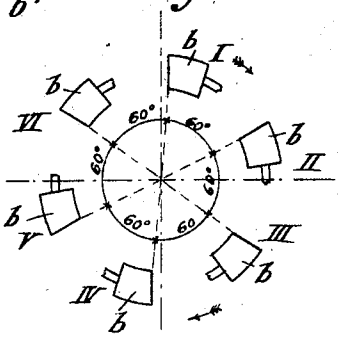


Fig: 7.

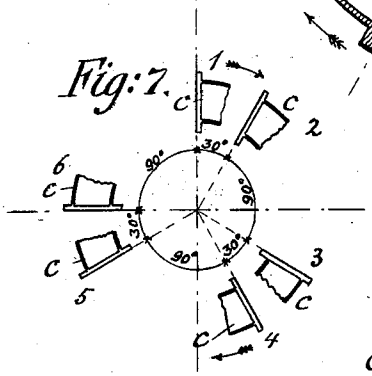


Fig: 6.

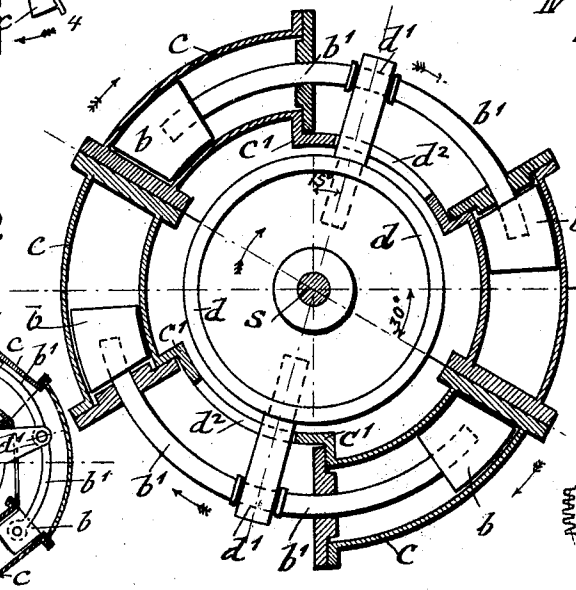


Fig: 9.

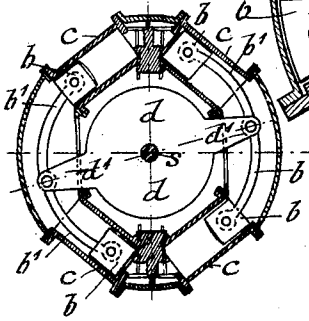
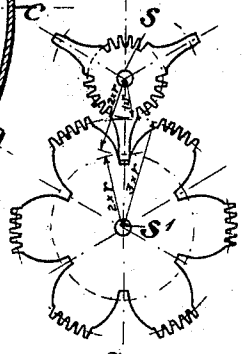


Fig: 10.



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UNITED STATES PATENT OFFICE.

MAX ANGERMANN, OF NEW YORK, N. Y.

ROTARY ENGINE.

No. 836,430. Specification of Letters Patent. Patented Nov. 20, 1906.

Application filed March 28, 1906. Serial No. 308,506.

To all whom it may concern:

Be it known that I, MAX ANGERMANN, a citizen of the Empire of Germany, residing in New York, in the borough of Manhattan, county and State of New York, have invented certain new and useful Improvements in Rotary Engines, of which the following is a specification.

This invention relates to improvements in rotary engines in which a plurality of cylinders is arranged concentrically around a common shaft, in connection with a corresponding number of pistons in said cylinders, both cylinders and pistons turning in the same direction, in connection with an auxiliary shaft and suitable transmitting mechanism, so that rotary motion in one and the same direction is imparted to the auxiliary shaft, from which the power is taken off, the dead-points overcome, and a constant force in all positions of the movable parts of the engine obtained; and the invention consists of a rotary engine in which a plurality of cylinders is arranged in groups around a center shaft and operated in connection with pistons located in the same and connected with said shaft by a disk mounted thereon and suitable supply and exhaust channels for the fluid driving medium, said channels being located in said shaft and an auxiliary shaft provided with gear-wheels meshing with special gear-wheels on the center shaft and the hubs of the cylinder-supporting frame, as will be more fully described hereinafter and finally pointed out in the claims.

In the accompanying drawings, Figure 1 represents a side elevation of my improved rotary engine. Fig. 2 is a plan view of the same. Fig. 3 is a vertical longitudinal section on line 3 3, Fig. 2. Fig. 4 is a horizontal section on line 4 4, Fig. 1. Figs. 5 and 6 are vertical longitudinal sections through the cylinders, showing the position of the cylinders and pistons after two successive admissions of the driving medium. Figs. 7 and 8 are diagrams for illustrating, respectively, the motion of the cylinders and the motion of the pistons during one full rotation of the engine. Fig. 9 shows a vertical section of a modified arrangement of the cylinders with straight axes for the cylinders and pistons, and Fig. 10 shows a modified construction of a pair of transmitting gear-wheels with varying angular velocity to be used in place of the pairs of gear-wheels for transmitting motion between the auxiliary shaft and the cylinder-supporting casing.

Similar letters of reference indicate corresponding parts in the different figures of the drawings.

My improved rotary engine consists of a plurality of cylinders c, which are arranged in groups of two around a center shaft s, and of a corresponding number of pistons b, one in each cylinder, which are connected in pairs by piston-rods b', the center portions of which are attached to diametrical arms d' of a disk d, that is keyed to the center shaft s. The two adjacent cylinders c of each group are made to abut against each other by their adjacent heads and are supported by a cylindrical casing c', the hubs c^2 of which turn freely on bushings c^3 placed on the center shaft s, as shown clearly in Fig. 4. The cylinders, pistons, and piston-rods are curved so as to form arcs of a circle concentric with the axis of the center shaft s, one pair of cylinders being separated from the other diagonally opposite pair by open spaces, so as to permit the connection of the piston-rods with the radial arms of the disk d, the connecting-walls of the supporting-casing between the heads of the two pairs of cylinders being provided with openings d^2 for the arms d' of the disk d. The center shaft s is supported in journal-bearings of two upright standards e, which are attached to a common bed-plate or to the floor of the building. The standards e are made of sufficient width to support also the journal-bearings for a second auxiliary shaft s', which is located parallel with the center shaft and to which a pulley is applied for transmitting the power generated by the rotary engine to a counter-shaft for further transmission.

In the adjacent heads of the cylinders c of each pair or group are arranged the admission-ports p for the steam or other driving medium, said admission-ports being connected by radial channels p' in the supporting-casing c' of the cylinders c with the ports in the abutting heads and with an ingoing bore p^2 in the center shaft s for the admission of the driving medium, while the exhaust-ports p^3 are likewise connected with radial channels p^4 in the casing c', with a bore p^5 in the opposite end of the center shaft s for the exhaust of the driving medium, as shown clearly in Figs. 2, 3, and 4. The pistons b are moved by the driving medium in the cyl-

inders c from one end to the other and impart thereby intermittent rotary motion to the supporting-disk d, with which they are connected by the radial arms d'. The disk d is keyed to the shaft s and serves to rotate the same. The driving medium is admitted to one cylinder of each pair of cylinders c at the same time, so that at one admission of steam or other fluid driving medium in a four-cylinder engine two diametrically opposite pistons are moved, while by the second or successive admission of the driving medium to the other two cylinders the cylinders are actuated by the same.

The motion imparted to the center shaft s is transmitted to the auxiliary shaft s' by means of a pair of gear-wheels g' g^2. The gear-wheel g' is keyed to the shaft s, while the gear-wheel g^2 is keyed to the auxiliary shaft s'. Two additional gear-wheels g^3 g^5 are likewise keyed to the auxiliary shaft s', while two gear-wheels g^4 g^6, intermeshing with the gear-wheels g^3 g^5, are keyed to the hubs of the casing c', supporting the cylinders c As soon as the driving medium is admitted to one pair of diametrically opposite cylinders c in the position shown in Figs. 1 and 3 the pistons of the same are moved forward and carry thereby the disk d and the gear-wheel g' along in the direction indicated by the arrows. From the gear-wheel g' motion is transmitted by the gear-wheel g^2 to the auxiliary shaft s' and thereby to the gear-wheels g^3 and g^5. The gear-wheels g' g^2 are provided with teeth along their entire circumference, so as to be continuously in mesh with each other, while the gear-wheels g^3 g^5 and the gear-wheels g^4 g^6 intermeshing therewith are provided alternately with toothed and untoothed portions, but in such a manner that the toothed portions of the gear-wheel g^3 alternate with the toothed portions of the gear-wheel g^5 and engage alternately with each other the intermeshing gear-wheels g^4 g^6. The gear-wheels g^4 g^6 are also provided with alternately toothed and untoothed portions, as shown clearly in Figs. 1 and 2, so as to impart successively motion to the cylinders or pistons, according as the gear-wheels g^5 g^6 or g^3 g^4 are in mesh with each other. The alternating intermeshing of the gear-wheels g^3 g^4 and g^5 g^6 corresponds to the length of the strokes of the pistons. The motion of the cylinders follows the advance motion imparted to the pistons by the driving medium, and after a new admission of the driving medium the motion of the pistons follows the advance motion imparted to the cylinders. This is illustrated in Figs. 5 and 6, Fig. 5 showing the position of the cylinders and pistons after the first admission of the driving medium and Fig. 6 the position of the same after the second admission. When the cylinders and pistons arrive in the position shown in Fig. 5, the second admission of the driving medium takes place, but through the admission-ports leading to the second pair of diametrically opposite cylinders, the force of the admission of the driving medium acting on the heads of both pairs of cylinders, so that the cylinders are moved quicker in the direction of the arrow shown in Fig. 5, the pistons following immediately the advance motion of the cylinders until both pairs of cylinders and the pistons assume the position shown in Fig. 6. In this position the first pair of diametrically opposite cylinders is again supplied with the driving medium so as to actuate their pistons, which are then moved again in the same manner through the next sixth of a rotation, until after six successive admissions the cylinders as well as the pistons arrive again in the starting position. (Shown in Fig. 3.) During the successive motions of the pistons around the center shaft s they move successively through angles of sixty degrees, as shown in Fig. 8, their successive positions being indicated by the Roman numerals I to VI in Fig. 8, while the successive positions of the cylinders are indicated by the ordinary numerals 1 to 6—that is to say, the cylinders are moving after the first admission through an angle of thirty degrees in following the pistons, while at the second admission they are moved through an angle of ninety degrees, moving in advance of the corresponding motion of the pistons, and so on. The alternating advance of the pistons, followed by the motion of the cylinders, and the advance of the cylinders, followed by the pistons, produces for every six admissions of the driving medium one full rotation of the pistons and cylinders. When the toothed portions of the gear-wheels g^5 g^6 are in mesh, motion is transmitted to the cylinders in the direction of the arrows from the auxiliary shaft s', driven by the pistons and the intermeshing gear-wheels g' g^2, the cylinders following, therefore, the advance motion of the pistons. When the toothed portions of the gear-wheels g^3 g^4 are in mesh, the motion of the cylinders in the direction of the arrows is produced directly by the driving medium and the cylinders are driving by the gear-wheels g^3 g^4 the auxiliary shaft s', from which the pistons are driven by the gear-wheels g' g^2 so as to follow the advance motion of the cylinders. The power may be taken off from the auxiliary shaft by means of a pulley-and-belt transmission or by other means or from the center shaft, as desired. It is preferable to take the transmission from the auxiliary shaft, as the center shaft is used for the admission and exhaust of the driving medium and rotated with variable angular velocity.

In place of arranging the groups of cylinders in arcs of a circle concentric with the center shaft s they may be arranged with

straight axes at an angle toward each other, in the form of a hexagon in case four cylinders are used, as shown in Fig. 9, in which case, however, the connecting piston-rods have to be pivoted to the pistons and to the radial arms of the disk, so as to provide for the required flexibility of the parts. In this case the adjacent heads of the cylinders instead of being parallel to each other are located at an angle to each other, as shown in Fig. 9. In place of the steam or other fluid driving medium the engine can be driven by the force of an explosive gas-and-air mixture, in which case the engine is constructed as an explosion-engine and the explosive mixture supplied to the different cylinders in the same manner as the steam, the advance of the pistons alternating with that of the cylinders, followed by the motion of the respective cylinders and pistons, as before described. The explosion-engine, however, requires the arrangement of suitable igniters and other accessories in addition to the admission and exhaust ports. In place of the pairs of transmitting gear-wheels g^3 g^4 and g^5 g^6, provided with alternating toothed and untoothed portions, gears with varying angular velocity may be employed, as shown in Fig. 10, or any other transmitting mechanisms may be used by which the required motion is alternately imparted from the auxiliary shaft to the hubs of the cylinder-supporting casing and from the cylinders to the auxiliary shaft s'.

The operation of the improved rotary engine is as follows: When the driving medium is introduced between the cylinder-heads and pistons of two pairs of diametrically opposite cylinders, as shown in the initial position in Fig. 3, then the pressure in the cylinders imparts by the pistons to the connecting-disk and to the supporting-casing of the cylinders an equal but oppositely-acting turning moment of the value M, the turning moment of the pistons being in the direction of the arrows on the disk. In the position shown in Figs. 1 and 3 the gear-wheels g^5 g^6 are in mesh and the gear-wheels g^3 g^4 are out of mesh. The disk d, to which the pistons are connected, transmits by the gear-wheels g' g^2, whose diameters are in the proportion of one to two, a turning moment to the auxiliary shaft s' of the value of $2 \times M$ in the direction indicated by the arrows on the auxiliary shaft s', Figs. 1 and 3. The cylinder-supporting casing c' transmits simultaneously to the auxiliary shaft s' by the gear-wheels g^5 g^6, whose diameters are equal or one to one, an oppositely-acting turning moment $1 \times M$. The difference between the two turning moments $2 \times M - 1 \times M = 1 \times M$ is the effective turning moment or force obtained in the direction of the arrow shown on the auxiliary shaft s', Figs. 1 and 3. In consequence of the larger ratio of the gear-wheels g' g^2 the casing of the cylinders is compelled to follow by the intermediate pairs of gear-wheels g^5 g^6 in the same direction of rotation as the disk, but with a retardation which corresponds to the proportion of the transmitting gear-wheels. The advance motion of the disk d takes place as long as the smaller gear ratio g^5 g^6 is operating—that is to say, for a length equal to the stroke of the piston. When cylinder and piston arrive at the end of a stroke, they are in the position shown in Fig. 5. Then the larger gear ratio g^4 g^3 is called into action and the gear-wheels g^6 g^5 are placed out of mesh, a new admission of the driving medium takes place between the other diametrically opposite cylinder-heads and pistons, and the pressure in the cylinders imparts to the supporting-disk of the piston-rods and to the supporting-casing of the cylinders an equal but oppositely-acting turning moment of the value M, now the moment of the cylinders having the direction of the arrows on the cylinders, Figs. 3 and 1. The casing c' transmits by the gear-wheels g^3 g^4, whose diameters are in the proportion of one to three, a turning moment to the auxiliary shaft s' of the value $3 \times M$, having the direction of the arrows on the auxiliary shaft s', Figs. 1 and 3. The disk d, supporting the pistons, transmits simultaneously to the auxiliary shaft s' by the gear-wheels g' and g^2, whose diameters are in the proportion of one to two, the oppositely-acting turning moment equals $2 \times M$. The difference between the two moments $(1 \times M)$ is the effective turning moment obtained and acts in the direction of the arrow on the auxiliary shaft s', Figs. 1 and 3—that is to say, this difference has the same direction as before the difference $2M - 1M$. In consequence of the larger ratio of the gear-wheels g^3 g^4 the disk of the pistons is compelled to follow by the gear-wheels g' g^2 in the same direction of rotation as the casing of the cylinders, but with a retardation which corresponds to the proportion of the transmitting gear-wheels. The advance motion of the cylinders takes place as long as the gear ratio g^3 g^4 is operating—that is to say, for a length equal to the stroke of the piston. When the cylinders and pistons arrive at the end of the stroke, they are in the position shown in Fig. 6, the smaller gear ratio g^5 g^6 being called into action and the gear-wheels g^4 g^3 placed out of mesh. Then again follows the action of the gear-wheels g^5 g^6, a new admission of the driving medium, and the same actuation of the pistons, disk, and intermediate transmitting gear-wheels.

By the mechanism described the pistons and cylinders and the parts connected with the same are set into rotary motion, which takes place always at a variable angular velocity, so that by properly-proportioned transmissions between the center shaft and auxiliary shaft a constant turning moment, which corresponds to the pressure of the

driving medium in the cylinders, may be transmitted to the auxiliary shaft. It is obvious that the engine can also be used, when driven by suitable power, as a compressor or pump analogous with other rotary engines. As the engine has no dead-points and as the turning moments obtained are constant and of the same direction and value, the engine transmits the different motions of the pistons and cylinders into effective and uniform rotary motion.

The motion of the pistons after every two admissions of the driving medium is always of the same length and direction and equal with the motion of the cylinders after two admissions. The motion results from the two different angular velocities with which the pistons and cylinders are alternately moved and depends on the chosen ratios of the transmitting gear-wheels. Other ratios must naturally give other positions of the cylinders and pistons than those shown in the diagrams, Figs. 7 and 8, and also another resulting motion after every two admissions of the driving medium. Other ratios of the gear-wheels will also give turning moments of different values on the auxiliary shaft. It follows, therefore, that the smaller the rotary motion of the pistons or cylinders resulting from two admissions of the driving medium the larger will be the resulting turning moments on the auxiliary shaft. It is obvious that the smallest amount of said resulting motion will be obtained when pistons and cylinders are simultaneously moved in opposite directions, which motion may be obtained by using gear-wheel transmission giving reciprocating motion.

Having thus described my invention, I claim as new and desire to secure by Letters Patent—

1. A rotary engine comprising a center shaft, pairs of cylinders arranged in groups around the same, a casing connecting the cylinders with the center shaft, pistons in said cylinders, a disk on the center shaft connected with the piston-rods of the pistons, an auxiliary shaft, and a transmitting mechanism between the cylinders, pistons and the auxiliary shaft, said transmitting mechanism being so arranged that at each stroke of the pistons the proportion between the two different ratios of the transmitting mechanism connecting simultaneously the cylinders with the auxiliary shaft and the pistons with the auxiliary shaft is suddenly changed, and that said changes take place for a number of times for each rotation of the engine.

2. A rotary engine comprising a center shaft, pairs of cylinders arranged in groups around said shaft, pistons in said cylinders, means for connecting the cylinders with the center shaft, means for connecting the pistons with the center shaft, an auxiliary shaft, and a transmitting mechanism between the cylinders, pistons and the auxiliary shaft, said transmitting mechanism being so arranged that with the admission of the driving medium to the cylinders rotary motion of different angular velocity is simultaneously imparted to the cylinders and to the pistons, and that during the action of the driving medium the speed of the pistons in no moment is equal to the speed of the cylinders, whereby dead-points are avoided.

3. A rotary engine comprising a center shaft, groups of cylinders arranged around said center shaft, pistons in said cylinders, means for connecting said cylinders and pistons with the center shaft, an auxiliary shaft, and transmitting mechanism between the cylinders and pistons and the auxiliary shaft, said transmitting mechanism being so arranged that with the successive admissions of the driving medium to the cylinders a relative greater angular velocity is alternately imparted to the cylinders and to the pistons, and that at each new admission a change of speed takes place suddenly so as to avoid any dead-points of the engine.

4. A rotary engine comprising a center shaft, groups of cylinders arranged around said center shaft, pistons in said cylinders, means for connecting said cylinders and pistons with the center shaft, an auxiliary shaft, and transmitting mechanism between the cylinders and pistons and the auxiliary shaft, said transmitting mechanism being so arranged that with the admission of the driving medium rotary motion of different angular velocity is imparted simultaneously to the pistons and to the cylinders and that the proportion between the speed of the cylinders and the speed of the pistons remains constant, so as to obtain thereby during the admission of the driving medium a resulting turning moment of constant value on the auxiliary shaft if the pressure in the cylinders is constant.

5. A rotary engine comprising a center shaft, groups of cylinders arranged around said center shaft, pistons in said cylinders, means for connecting said cylinders and pistons with the center shaft, an auxiliary shaft, and transmitting mechanism between the cylinders and pistons and the auxiliary shaft, said transmitting mechanism being so arranged that by the successive admission of the driving medium to the cylinders a relative greater angular velocity is alternately imparted to the pistons and to the cylinders, whereby the proportion of the different velocities remains constant, but changing suddenly at each successive admission of the driving medium, thus causing resulting turning moments on the auxiliary shaft in the same direction and of a constant value if the pressure in the cylinders is constant.

6. In a rotary engine, the combination of a center shaft, cylinders arranged in pairs

around said center shaft, a casing connecting the cylinders with the center shaft, pistons in said cylinders, piston-rods, a disk connecting the piston-rods with the center shaft, a continuous gear-wheel connection between the pistons and the auxiliary shaft, gear-wheels having toothed and untoothed portions in connection with the cylinders, and gear-wheels having toothed and untoothed portions on the auxiliary shaft, meshing alternately with the gear-wheels on the cylinder-casing, or the opposite arrangement, the continuous gear-wheel connection between the cylinders and the auxiliary shaft and the special gear-wheels between the pistons and the auxiliary shaft.

7. In a rotary engine, the combination of a center shaft, cylinders arranged around the center shaft, a casing supporting the cylinders thereon, pistons in said cylinders, a disk on the center shaft connected with the piston-rods of the pistons, an auxiliary shaft, a continuous gear-wheel connection between the pistons and the auxiliary shaft, and a set of special gear-wheels between the cylinder-supporting casing and the auxiliary shaft, said set of gear-wheels containing different ratios, which change suddenly and several times for one revolution their value, or the opposite arrangement, the continuous gear-wheel connection between the cylinders and the auxiliary shaft and the special gear-wheels between the pistons and the auxiliary shaft.

8. In a rotary engine, the combination of a center shaft, cylinders arranged around the center shaft, a casing supporting the cylinders thereon, pistons in said cylinders, a disk on the center shaft connected with the piston-rods of the pistons, an auxiliary shaft, a set of special gear-wheels between the auxiliary shaft and the cylinder-supporting casing, said set of gear-wheels containing different ratios, which change suddenly and several times for one revolution their value, a set of special gear-wheels between the pistons and the auxiliary shaft, said set of gear-wheels containing different ratios, which change suddenly and several times for one revolution their value.

In testimony that I claim the foregoing as my invention I have signed my name in presence of two subscribing witnesses.

MAX ANGERMANN.

Witnesses:
PAUL GOEPEL,
HENRY J. SUHRBIER.