J. DEUBEL.

ROTARY GAS ENGINE.

APPLICATION FILED MAY 28, 1919.

1,362,400. **Patented Dec. 14, 1920.**

5 SHEETS—SHEET 1.

Fig. 2.

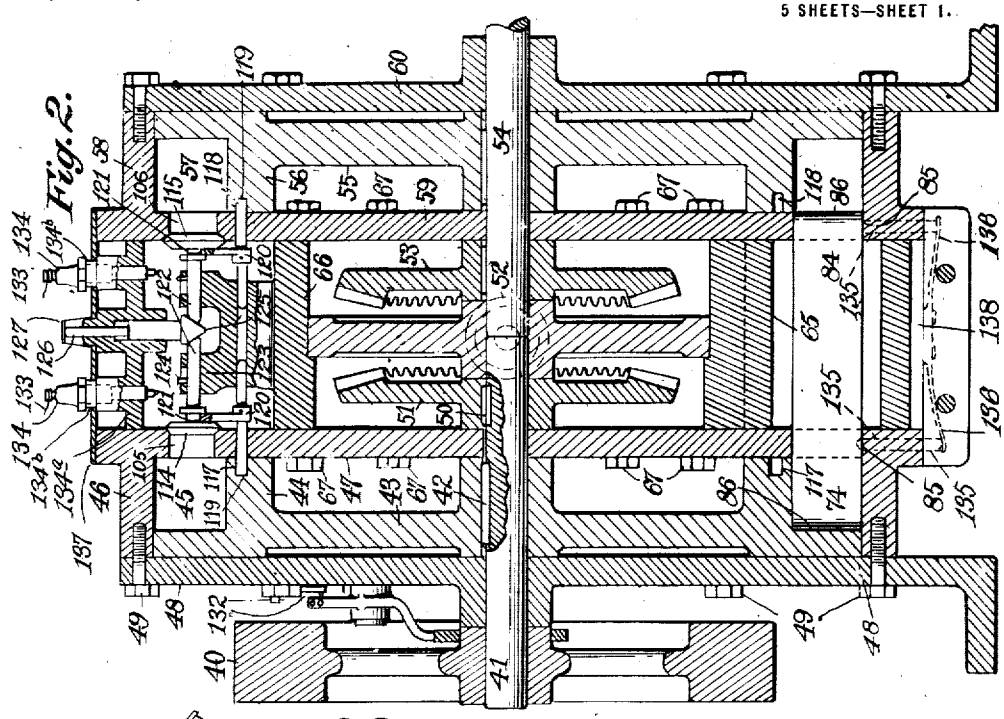
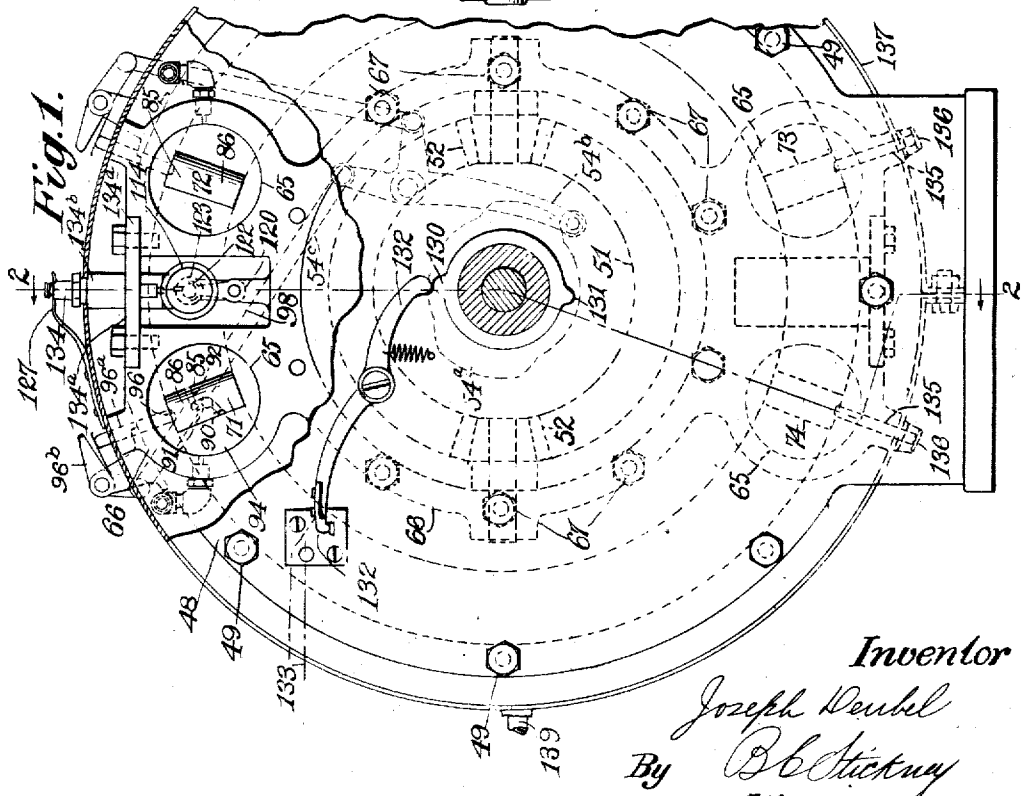


Fig. 1.



Inventor

Joseph Deubel

By D. C. Stickney

Attorney

J. DEUBEL.

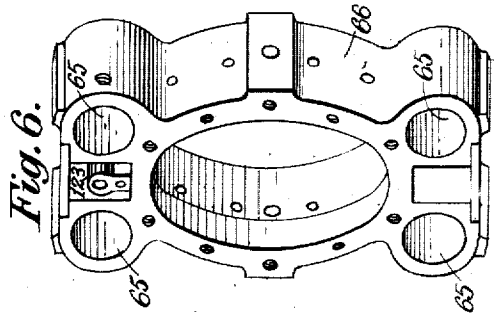
ROTARY GAS ENGINE.

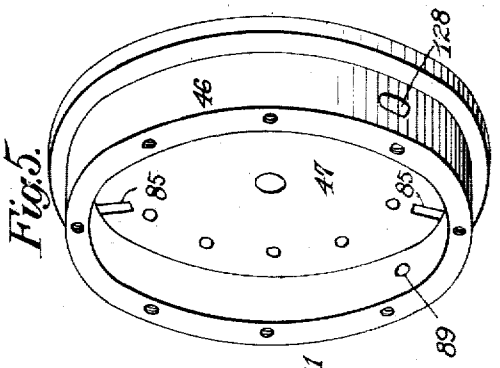
APPLICATION FILED MAY 28, 1919.

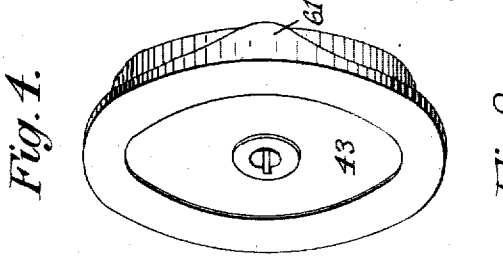
1,362,400.

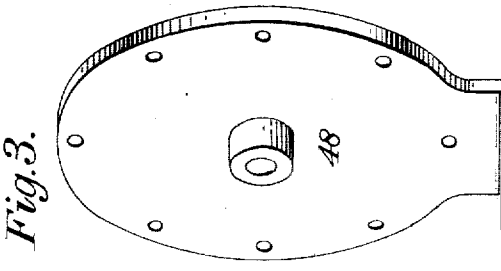
Patented Dec. 14, 1920.

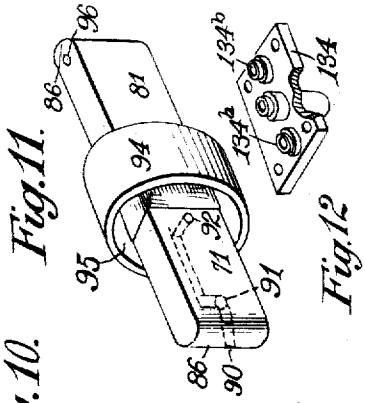
5 SHEETS—SHEET 2.

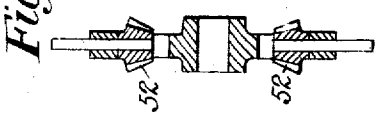


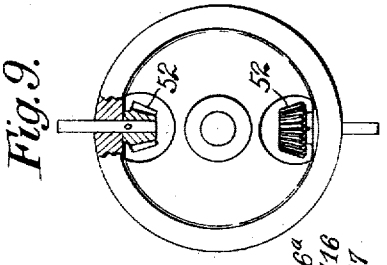


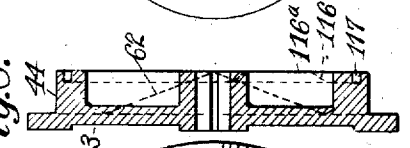


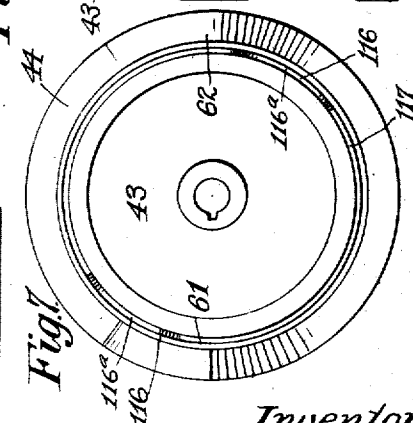












Inventor
Joseph Deubel
By R. L. Stickney
Attorney

J. DEUBEL.

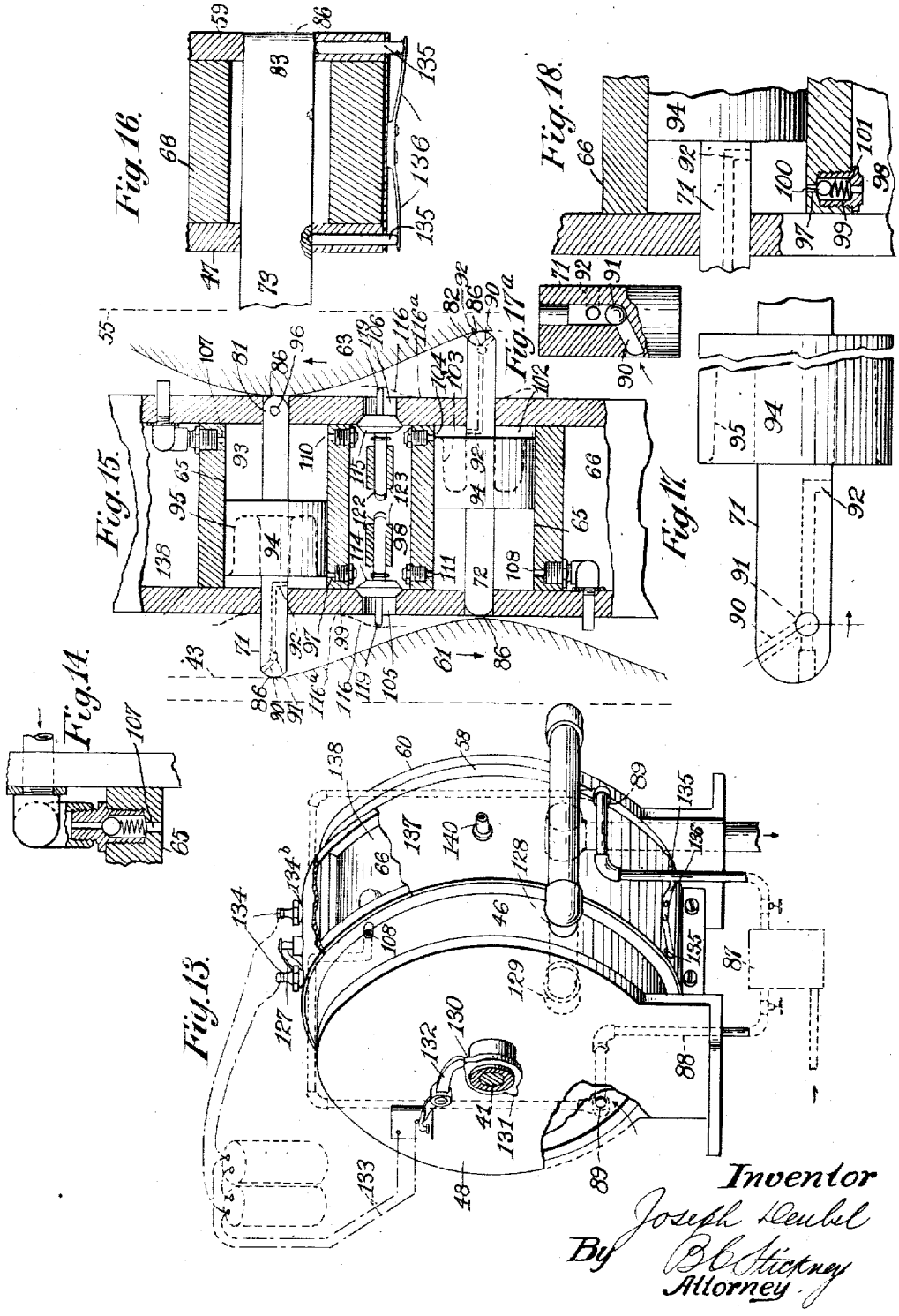
ROTARY GAS ENGINE.

APPLICATION FILED MAY 28, 1919.

1,362,400.

Patented Dec. 14, 1920.

5 SHEETS—SHEET 3.



Inventor
Joseph Deubel
By B. C. Stickney
Attorney.

J. DEUBEL.

ROTARY GAS ENGINE.

APPLICATION FILED MAY 28, 1919.

1,362,400.

Patented Dec. 14, 1920.

5 SHEETS—SHEET 4.

Fig.22.

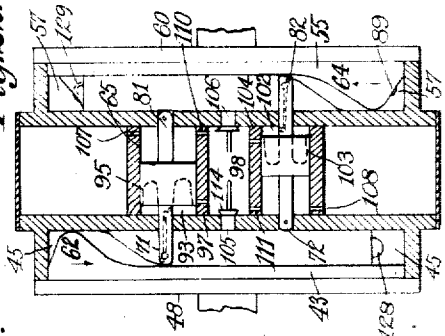


Fig.26.

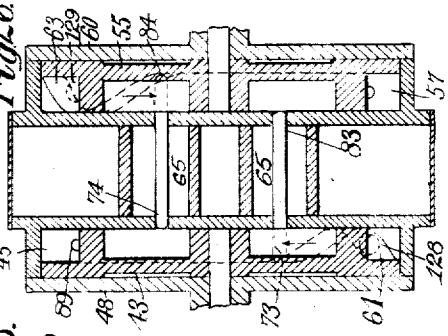


Fig.21.

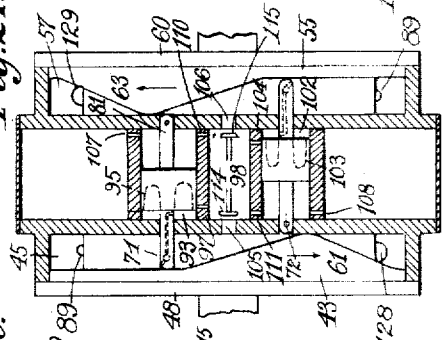


Fig.25.

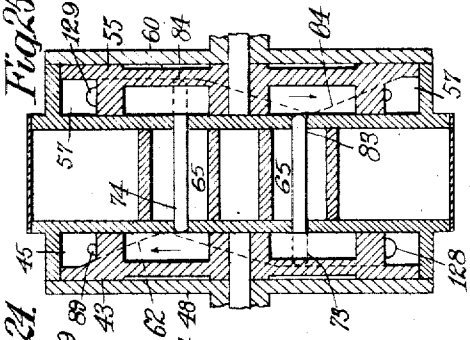


Fig.20.

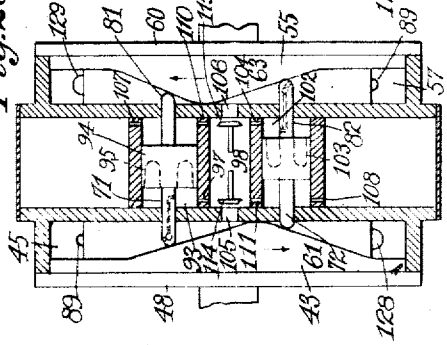


Fig.24.

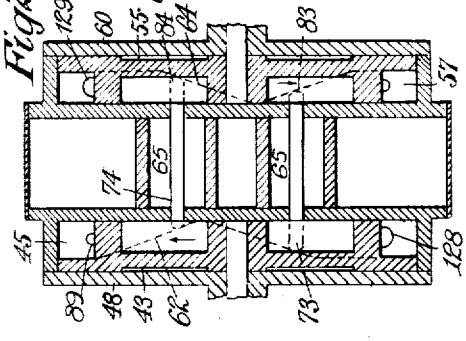


Fig.19.

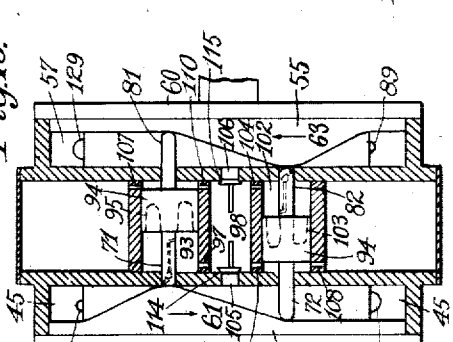
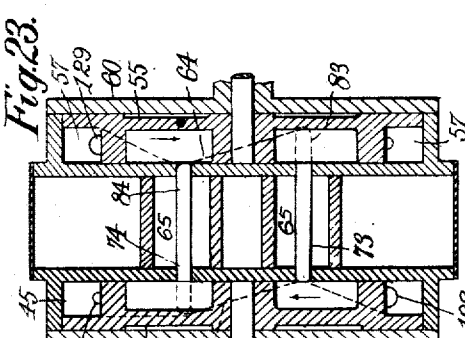


Fig.23.



Inventor
Joseph Deubel
By
Attorney

J. DEUBEL.

ROTARY GAS ENGINE.

APPLICATION FILED MAY 28, 1919.

1,362,400. **Patented Dec. 14, 1920.**

5 SHEETS—SHEET 5.

Fig.30.

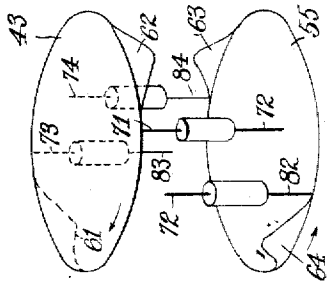


Fig.34.

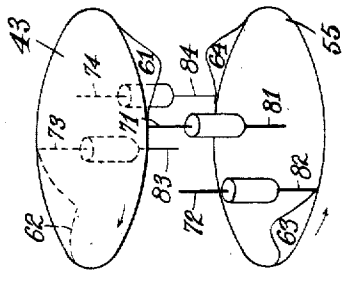


Fig.29.

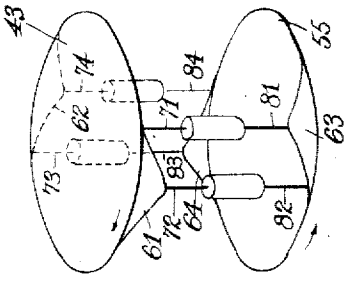


Fig.33.

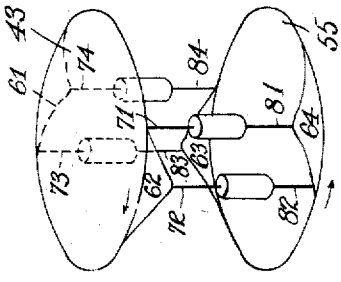


Fig.28.

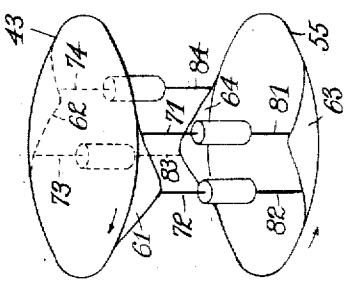


Fig.32.

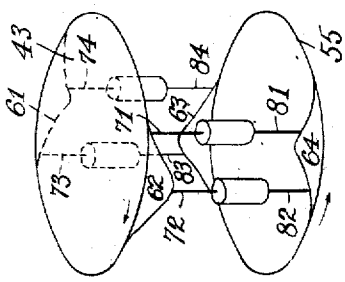


Fig.27.

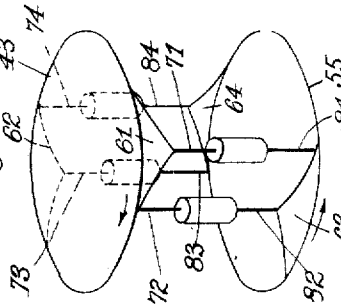
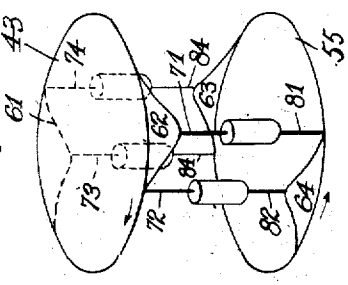


Fig.31.



Inventor
Joseph Deubel
By B. C. Stickney
Attorney

UNITED STATES PATENT OFFICE.

JOSEPH DEUBEL, OF NEW YORK, N. Y.

ROTARY GAS-ENGINE.

1,362,400. Specification of Letters Patent. Patented Dec. 14, 1920.

Application filed May 28, 1919. Serial No. 300,398.

To all whom it may concern:

Be it known that I, JOSEPH DEUBEL, a citizen of the United States, residing in New York city, in the county of New York and State of New York, have invented certain new and useful Improvements in Rotary Gas-Engines, of which the following is a specification.

This invention relates to rotary engines, blowers, pumps, compressors, etc., and is illustrated in the form of a gas engine, although it embodies a structure which is also suitable for use in either steam or compressed-air engines.

The engine operates upon the principle of a rotary disk having thereon a projection, which, since it corresponds in function to the piston of a reciprocating engine, is herein termed a piston. It receives the blow of the gas explosion and transmits the power to the rotary disk, and also drives out the exhaust gas, and draws in the charges from the carbureter and compresses them. To cooperate with the piston there is provided a head, which remains at one location, and corresponds to the head of the cylinder in a reciprocating engine; this head being in sliding contact with the face of the rotary disk, and disappearing to permit the piston to pass. The piston may be made of sloping form, or in the shape of a cam, to force its way past the head.

In carrying out this principle there are formed upon the rotary disk two or more pistons, with a corresponding number of heads; the drawings illustrating two pistons upon the disk. Each piston coöperates with one head to form a chamber, and at the same time coöperates with the other head to form another chamber. Thus there are four chambers, the functions of each corresponding with that of the cylinder in a reciprocating engine. In one of these chambers an explosion occurs, while in another occurs compression, in another intake, and in the fourth exhaust. All four of these functions may be performed twice during each complete revolution of the disk.

At this point is given, for the purpose of explanation, a diagram of the operations occurring in two revolutions of the fly wheel of a reciprocating gas engine of ordinary form having two pistons suitably connected to operate in each direction at the same time, the explosions, etc., occurring in proper sequence on both sides of each piston, which is represented by the letter "I."

Explosion	I	Compression.
Exhaust	I	Explosion.
Intake	I	Exhaust.
Compression	I	Intake.
Intake	I	Exhaust.
Compression	I	Intake.
Explosion	I	Compression.
Exhaust	I	Explosion.

With this diagram may be compared a cycle of operations performed by the diametrically opposite pistons on the rotary disk of my novel gas engine, which may be seen in the following diagram, which is a development of the rotary course of the pistons, viz.:

First half of revolution.

Piston A	Head B	Piston C
I. Exhaust	I. Intake	I.
	Head D	A
Compression	I. Explosion	I.

Second half of revolution.

C	B	A
I. Exhaust	I. Intake	I.
	D	C
Compression	I. Explosion	I.

In the last diagram, the pistons are marked "A" and "C," while the heads are marked "B" and "D."

In a reciprocating gas engine, the charge may be exploded upon the same side of the piston by which it has been drawn in and compressed; but in my rotary engine the piston is always advancing in the same direction, so that the charge cannot be exploded upon the same side of the piston where it was compressed, nor can the intake be at the same side of the piston that has just expelled the waste gases, nor can compression take place upon the same side of the piston where the charge has just been drawn in.

In order to carry out a proper cycle of operations in a motor of this kind, the charge is drawn in by one piston and compressed by the other, and then exploded upon the rear side of the advancing piston which has just effected the compression. To do this, the charge is compressed by the piston and thereafter forced into a pocket or lock. The piston then passes by the lock and after passing is exposed to the force of the explosion upon its rear face; the lock serving as an explosion chamber. This cycle of operations occurs twice in each revolution of the disk.

The heads are cammed in one direction by the advancing pistons, and in the opposite direction by means of cams provided upon a companion disk, which is geared to the first to run in the opposite direction. The cams upon one disk face those upon the other disk.

Preferably the cams upon this companion disk are also used as pistons, to operate in connection with the same lock in the manner already described in connection with the first disk. Two additional movable heads are used in connection with the second disk, to be moved in one direction by its cams, and in the opposite direction by the cams or pistons of the first disk; so that each disk partly operates both its own heads and those which appertain to the other disk. The heads appertaining to one disk are paired with those which belong to the other; the pairs being diametrically opposite, in case only two pistons are employed upon each disk. If three pistons are used on each disk, three pairs of heads will be required, the pairs separated by 120 degrees. In each pair, the heads are separated a distance which is equal to the distance from the top to the bottom of a cam, so that twice in each revolution all four heads may bear against the crowns or apices of their respective pistons simultaneously.

The engine is therefore of duplex construction, with multiple-piston disks facing each other and running in opposite directions, the pistons in the form of cams for reciprocating the heads or abutments which coöperate with the pistons to form work-chambers. The charges may be taken from any suitable carbureter, and the ignition of the charge may be effected by a spark producer. The explosions, of which there are two for each revolution of the engine, occur in an explosion chamber or lock which is common to the two disks.

Other features and advantages will hereinafter appear.

In the accompanying drawings,

Figure 1 is a front elevation, partly broken away, of a gas or gasolene motor, embodying my improvements in one form.

Fig. 2 is a sectional elevation of the same, taken about on the line 2—2 of Fig. 1.

Fig. 3 is a perspective view of one of two face-plates which form the outer walls of the motor.

Fig. 4 is a perspective view of one of the rotary piston-disks.

Fig. 5 is a perspective view of one of the casings in which rotate the disks, of which one is shown at Fig. 4.

Fig. 6 is a perspective view of the central portion of the framing of the engine.

Fig. 7 is a face view and Fig. 8 is a sectional view of one of the rotary piston-disks seen at Fig. 4.

Fig. 9 is a view of a disk-like bracket which forms part of the framing and supports the pistons which connect the piston-disk for opposite rotation.

Fig. 10 is a sectional view, showing the pinions.

Fig. 11 is a perspective view of one of the heads which coöperate with the pistons to take in the charge, compress the charge, drive the pistons and expel the charge.

Fig. 12 is a perspective view of the plate which closes an explosion chamber and forms the seat for spark-plugs.

Fig. 13 is a perspective view of the motor, with parts broken away.

Fig. 14 is a sectional detail of one of the inlet-ports, with back-check-valve, used for drawing auxiliary charges from the carbureter.

Fig. 15 is a sectional diagram to illustrate the relation of the cam-like pistons and certain of the heads at about the time the charge is exploded, or is to be exploded, that drives the motor.

Fig. 16 is a sectional detail of one of the heads, showing the method of detaining the same in its opposite extreme positions.

Fig. 17 is a side elevation of one of the heads, showing a port through which charge is compressed into the chamber which carries the heads.

Fig. 17ª is a sectional detail of a ball valve used in the heads seen at Fig. 17.

Fig. 18 is a sectional detail, showing a port with a check-valve to close the same, this port opening into the general explosion chamber to permit enough auxiliary charge to be forced thereinto.

Figs. 19 to 26, inclusive, are central sectional views, to illustrate a cycle of operations of the pistons and heads; Figs. 19 and 23 being read together; Fig. 19 showing the near side of the motor, while Fig. 23 shows the far side with the parts in the positions which they occupy when the motor is in the position indicated at Fig. 19. Figs. 20 and 24 are similarly to be read together, and the same is true of Figs. 21 and 25, and also of Figs. 22 and 26.

Figs. 27 to 34 are perspective diagrams with the piston-disks separated to an exaggerated extent for the sake of clearness. Fig. 27 may be regarded as showing the beginning of a cycle which continues through Figs. 28–34 until the position at 27 is again reached.

A fly wheel 40 may be fast upon a shaft 41, to which is keyed at 42 a disk 43. At a short distance from its outer edge the disk has a face flange 44. An annular piston-chamber 45 is formed partly by said flange, partly by the face of the disk 43, partly by the cylindrical wall of the drum 46 within which the disk is fitted, and partly by a vertical face or wall 47 of the drum. The disk is confined by means of a cap 48 which forms the outer vertical wall of the drum, being bolted thereto at 49. The disk and its flange fit closely between the vertical walls of the drum, and within the cylindrical portion 46 thereof, which may be integral with wall 47.

Also keyed at 50 upon said shaft 41 is a bevel gear 51, which is connected by bevel pinions 52 with an opposite concentric bevel gear 53, keyed upon a shaft 54 in line with 41 but turning in the opposite direction at the same speed, and provided if desired with a fly wheel. In correspondence with shaft 41, shaft 54 carries a disk 55, having face flange 56; an annular piston chamber 57 being formed by flange 56, disk 55, cylindrical portion of drum 58, and vertical wall 59 of the latter; said drum 58 also comprising a cap or outer vertical wall 60. The disks 43 and 55 revolve in opposite directions at equal speeds.

The pistons upon disks 43 are designated as 61 and 62, and those upon disk 55 as 63 and 64. The heads or movable abutments to cooperate with the pistons, extend through guide-openings 65, of which four are formed upon an annular casting or framework 66, Fig. 6, to the opposite parallel vertical faces of which are bolted at 67 the drums 46 and 58; said framework occupying the middle portion of the engine, and containing the train of bevel gears which connects the two piston disks.

Each movable head or abutment is double, that is, it comprises two heads moving as one piece, one for engagement with the pistons or cams of one disk, and the other for engagement with the pistons or cams of the opposite disk. The heads which in rotation engage with each of the pistons 61 and 62 on disk 43, are designated as 71, 72, 73 and 74; while those which correspondingly engage the pistons on disk 55, are designated as 81, 82, 83 and 84. These heads fit in the annular piston-chambers 45, 57, to close the same, so that the segmental space between any two pistons may be subdivided into sub-chambers; the operations of inspiration, compression, explosion and exhaust occurring at the same time in the appropriate sub-chambers during each half-revolution of each disk. Each double head is in the form of a bar oblong in cross-section, being fitted in guide-slots 85 in the opposite inner drum walls 47, 59, Fig. 5; and the ends of the bar may be rounded, as at 86, Fig. 11, to render it easily operable by the cams.

As seen at Fig. 19, the oppositely revolving pistons 43 and 55 may come to such relative positions that each double head stands at the apex of one piston and at the base of the other; the double heads in each pair being separated a distance equal to the length of the sloping side of a piston. A double head may hence be forced aside by one cam or piston while at its other end it rides down the slope of the cam upon the opposite disk.

The engine may be started into action either manually or in any suitable way; and in explaining the operation it will be understood that the engine is under way, so that the compression of each charge takes place automatically.

To follow the cycle of actions taking place in connection with one of the revolving disks 43, it will be seen that from any suitable carbureter 87 the gas may be led through a pipe 88 to an inlet orifice 89, Figs. 5 and 13, adjacent to one of the heads 73. As the piston 61 advances upon this head, the latter is forced aside, but is caused to recover its effective position as the piston passes. Said piston 61 immediately passes the inlet port 89; and it will be understood that said head temporarily divides the segmental space between this piston and the following piston into two sub-chambers, in one of which is located the inlet port 89, so that a charge of gas mixture from the carbureter 87 is drawn into this sub-chamber. This continues until the piston advances beyond the next head 71. This charge of a gas-and-air mixture now occupies a position between head 71 and the following piston marked 62. Said charge is compressed between said head 71 and said advancing piston 62, and forced by said piston through a passage 90 in the head, Fig. 17, and into a small cylinder 93 formed in the middle frame 66.

In said gas passage 90 in the head 71 is provided a ball valve 91, Fig. 17, for closing the passage against flow in the opposite direction. At its inner end the passage terminates at 92 within said cylinder 93, the double head passing through said cylinder from end to end, and having at its middle a piston 94 reciprocating in said cylinder.

During the compression of the fresh charge, that is, during the advance of piston 62 toward the head 71, such charge is forced into the left-hand end of the cylinder 93,

at Fig. 15; and the left-hand end of the piston 94 may be cupped out at 95, to increase the capacity of this end of the cylinder, so that the charge may not be too highly compressed. To prevent endwise displacement of the double head 71, 81 toward the right on the pressure of the charge, the head 81 may be provided with a recess 96 to cooperate with a spring-pressed detent 96^a. When the head 81 is in the position seen in Fig. 15, the detent may be locked down to firmly hold the head 81 in this position. This is done by a rock arm 96^b being forced downward on the detent pin 96^a and held in this locked position by a cam 54^a on the shaft 54, through the medium of a follower arm 54^b mounted on the side cap 60, and link 54^c connecting the rock arm 96^b. The double head 72, 82 is likewise provided with a recess, a spring-pressed detent, and a rock arm to lock it against displacement (see Figs. 1 and 15).

At Fig. 15, the cross-piston 94 serves as a valve to close a port 97 leading from the compression cylinder 93 into a pocket or lock 98, which serves as an explosion chamber. This port 97 is not opened until the previous charge in lock 98 has been exploded and fully expanded, that is, until a chamber between the rear side of the revolving piston 61 and the head 71 has about reached its maximum dimensions. Said cross-piston or valve 94 is caused to move to uncover said port by means of the engagement of the advancing piston 62 with the head 71, the latter being forced to the right at Fig. 15, while the corresponding head 81 descends the advancing side of the opposite piston 63.

The compressed charge enters through said port 97 and occupies said pocket 98; and a valve 99 prevents escape of the compressed gas from said lock 98; said valve device or valve-box being in the form of a screw, Fig. 18, and having a passage endwise therethrough and containing a back-check 100 and a spring 101.

The gas remains momentarily confined in the lock 98, which is located at a point between the pairs of heads 71, 72, and imprisons the compressed charge until the advancing piston 62 has advanced just beyond said lock 98; the explosion of the compressed charge then serving to drive the piston 62 and thereby give an impulse to the engine.

At Fig. 15 the piston 61 is shown as in the vicinity of the position at which a charge in lock 98 is about to be let into the newly formed chamber between 61 and 71 and exploded; although the passage between said lock 98 and said newly formed chamber may be opened at a little earlier stage, before the chamber is of such great capacity.

It is noted at this point that the cross-piston or valve 94, which is reciprocated by the cams or pistons on the opposite disks 43, 55, may if desired be also utilized for drawing in charges of either air alone, or a gas-and-air mixture from the carbureter main 88, and compressing these charges, forcing them through the ports 97 into the lock 98, to increase the efficiency of the engine. Said lock 98 is the general recipient of all the charges, including both those that are compressed thereinto by the revolving pistons, and also those that are forced thereinto by the reciprocating pistons.

It will be further noticed that while the aforesaid charge of air and fuel was being compressed between piston 62 and head 71 and forced into cylinder 93, a similar charge was being compressed on the opposite side of the engine, between piston 64 thereon and head 82, and forced through said head into cylinder 102, in which the cross-piston or valve is cupped out at 103; and further that said head 82 is forced aside by the advancing piston 64 while 71 is being shifted by piston 62, and hence that port 104 in cylinder 102 is admitting the compressed charge into the lock 98 at the same time that the charge is admitted thereinto through port 97.

It will also be understood that when compressed charge is admitted to the newly formed chamber between piston 62 and head 71, it is simultaneously admitted between piston 64 and head 82; and that a single spark explodes the entire charge both in the lock 98 and in each of said newly formed chambers.

Thus the companion disks receive impulses simultaneously, twice in each revolution; and it will be understood that the operations of exhaust, inspiration and compression and explosion occur with one disk the same as with the other, except that the direction of rotation of the disks is one the reverse of the other, and that the exhaust and intake ports are correspondingly placed.

At Fig. 19 is shown the position of the parts at a slightly earlier stage than at Fig. 15. At Fig. 19 the charges which have been compressed into the cylinders 93 and 102 have been admitted to lock 98, by the opening of the ports 97 and 104, said ports having been opened by the advancing pistons 61 and 63, which have just completed forcing aside the heads 71, 82 which coöperated with the pistons or valves 94, 103 in opening said ports. Thus the pistons first cooperate with the heads to compress the charges, forcing the charges through the heads into the cylinders, and then to open the ports which admit the charges into the explosion chamber. The pistons and heads then coöperate to reverse the action of the cross-pistons, to effect a final forcing of the compressed charges into the lock 98 just previous to the explosion, which may be timed to occur when the parts are at the Fig. 20 position, the rotary pistons having

just passed the ports 105 and 106 leading from the explosion chamber or pocket 98 into the chambers in which the pistons rotate. At the same time the cross-pistons draw in fresh auxiliary charges from the carbureter through ports 107 and 108, preparatory to forcing them through ports 110 and 111 into the lock 98 at the next stroke. Since the cross-pistons may have considerable area and length of stroke, and since they supply charges of fresh gas and air unmixed with the products of combustion, it will be seen that the lock 98 may be supplied from all sources with a satisfactory explosive charge under compression.

The explosion may be timed to occur either at the Fig. 20 position, or at the position seen at Fig. 21, or at some other point, according to the speed of the engine and to secure any desired result. When the parts have reached the Fig. 19 position, the pistons have been cammed endwise and forced fresh explosive mixture into the lock through the ports 110, 111. At Fig. 19 the cross-pistons and heads are seen at the opposite extremes of their movements from Fig. 21. They remain in the Fig. 21 position during the compression of the succeeding charge by each of the rotating pistons 62 and 64. Head 72 has an offset or thickening 112 to ride upon a cam 113 corresponding with 96 and 97.

Just previous to said explosion, valves 114 and 115, closing ports 105 and 106 in the opposite ends of the lock 98, are automatically opened by means of face cams 116 formed in grooves 117, 118 cut in the inner faces of the piston flanges 44, 56, Fig. 2; these face cams engaging the ends of projecting pins 119 carrying arms 120 engaging grooves 121 in the valves. The latter have stems 122 sliding in guides 123 provided upon the inner frame 66, Figs. 2 and 6, as well as guide-pins 124 working in slots in said guides, to prevent rotation of the valves. After the face cams 116 have passed the projections 119, the valves are thrust out by a common cam, in the form of a cone 125 upon the end of a stem 126, the latter forced by a compression spring 127 in a direction to wedge the stems 122 and hence the valves apart; said stem 126 being loosely guided, to enable the cone to force both valves 114 and 115 to their seats.

Said face cams 116 have long dwell portions or faces 116^a, and therefore continue to hold the valves 114, 115 open until the pistons reach or pass the succeeding heads 73, 84. Thereafter the succeeding pistons 62, 64 coöperate with said heads 73, 84 to expel the waste gas from the sub-chambers formed between said pistons and said heads; the gas escaping through exhaust ports 128, 129.

The engine may be started by forcing the disks to rotate by any suitable means, to draw in and compress charges; and to trace the cycle of operations from the point shown at Figs. 19 and 27, for example, it will be seen that cylinders 93 and 102 contain charges of compressed gas and air, which has just been forced thereinto by advancing pistons 61 and 63. As the disks continue to rotate, the heads 71 and 82 are forced in thereby, reducing the size of the small sub-chambers between said pistons and the heads 72 and 81, and forcing a little more compressed charge through the yieldable valves 105 and 106 into the lock 98. As soon as 61 and 63 pass the lock, Fig. 20, the valves 105 and 106 are automatically opened, and the charge is exploded by the use of one of two opposite cams 130, 131 mounted on disk shaft 41, and operating a circuit-closing switch 132 to close battery circuit 133, having cables to spark plugs 134 in said pocket 98, said plugs (one or more) screwed into sockets 134^b on a cap plate 134^a, Figs. 2 and 12. The positions of the parts shortly after the explosion are seen at Fig. 21, the exploded charge now expanding in the pocket 98 and between piston 61 and head 71, as well as between piston 63 and head 82. Fig. 21 may be read together with Fig. 25, in which the disks are in the same position, but in which the pistons 62, 64 are shown in dotted lines; and it will be understood that a fresh charge is being compressed between piston 62 and head 71, as well as between piston 64 and head 82. The charge that was previously exploded and fully expanded is being forced out through exhaust ports 128 and 129 by pistons 61 and 63 advancing toward heads 73 and 84. New charges are being drawn in from the carbureter through intake ports 89 by pistons 62 and 64, which for this purpose are coöperating with heads 73 and 84, respectively.

The heads 73, 83 and 74, 84 may be detained at either extreme of movement by beveled detents 135 pressed by springs 136 into seats in the heads. As is clear at Figs. 19–21, as soon as any piston reaches a head, it presses the head to one side, and immediately the head is restored by the other piston. The pistons 62, 64 pass idly from the Fig. 23 position, through the Fig. 24 position, to the Fig. 25 position. The heads are normally in the positions seen at Figs. 22 and 23, but twice in each revolution are shifted as at Figs. 19 and 23, by the advancing pistons, and immediately returned to normal positions, their return movements being indicated at Figs. 20 and 24, and the completion of such movements at Figs. 21 and 25.

At Fig. 27, pistons 61, 63 have just completed compression, in coöperation with heads 71 and 82, which are now seen as

forced aside by these pistons. Said pistons have also just completed drawing in fresh charges from the carbureter, having for this purpose coöperated with heads 74 and 83. Pistons 62 and 64 are shown at the completion of the impulse stroke, that is, at the end of the stage through which they are driven by the expanding gas, having for this purpose coöperated with heads 71 and 82. Said pistons 62 and 64 are also shown as having completed the expulsion of the spent gases from which the engine received its previous impulse, having for this purpose coöperated with heads 73 and 84.

Fig. 28 shows the parts in positions between Figs. 27 and 29. At Fig. 29, the piston 61 is shown as having restored head 82 to normal position, and piston 63 as having restored head 71 to normal position; the pistons 62 and 64 respectively having also restored 84 and 71 to normal. At Fig. 29 the charge is expanding between head 71 and piston 61, to drive the latter; and 61 is coöperating with head 73 to expel the spent gas of the previous explosion. Piston 62 is coöperating with head 73 to draw in a fresh charge of air and fuel; and said piston 62 is also coöperating with head 71 to compress a charge. Corresponding work is being performed by pistons 63 and 64 in coöperation with heads 82 and 84. At Fig. 30, the pistons have advanced nearly a half revolution from the Fig. 29 position, and the various operations initiated at Fig. 29 are now nearly completed.

At Fig. 31, the parts are advanced a little beyond the Fig. 30 position, and are half a revolution beyond the Fig. 27 position, so that pistons 61 and 62 have changed places, and 62 is now beginning to perform the work described in connection with 61 at Fig. 27; and a similar reversal exists as to the pistons 63 and 64.

Figs. 32, 33 and 34 correspond respectively with Figs. 28, 29 and 30, except that the pistons on each disk have changed places; and it will be seen that the parts in advancing a little beyond the Fig. 34 position, reach the Fig. 27 position, thus completing the cycle.

A water-jacket 137, Figs. 1 2, is shown surrounding the flanges of the drums 46, 58 and the framework 66, forming a chamber 138. A supply of cool water may be circulated therein to keep the mechanism from overheating, and for this purpose there is provided inlet and outlet pipes 139 and 140, Fig. 13.

Variations may be resorted to within the scope of the invention, and portions of the improvements may be used without others.

Having thus described my invention, I claim:

1. The combination of a rotary disk having pistons projecting therefrom, an annular channel in which said pistons travel, means to coöperate with said pistons to draw in charges, to compress the charges, to cause the pistons to be driven at the explosions of the charges, and to expel the waste gas after the explosions, said pistons being equally separated upon the disk, and sets of movable heads to correspond with the pistons, each set comprising two heads.

2. The combination of a rotary disk having pistons projecting therefrom, an annular channel in which said pistons travel, means to coöperate with said pistons to draw in charges, to compress the charges, to cause the pistons to be driven at the explosions of the charges, and to expel the waste gas after the explosions, said pistons being equally separated upon the disk, and sets of movable heads to correspond with the pistons, each piston coöperating with a head to form a sub-chamber on one side of the piston, and at the same time coöperating with another head to form a sub-chamber on the other side of the piston.

3. The combination of a rotary disk having pistons projecting therefrom, an annular channel in which said pistons travel, means to coöperate with said pistons to draw in charges, to compress the charges, to cause the pistons to be driven at the explosions of the charges, and to expel the waste gas after the explosions, said pistons being equally separated upon the disk, and sets of movable heads to correspond with the pistons, each set comprising two heads, said pistons coöperating with said heads to form four sub-chambers for simultaneous intake, compression, explosion and exhaust, all four of these functions being performed twice during each revolution of the disk.

4. A gas-engine comprising a rotary disk, a piston thereon, a channel in which the piston travels, movable heads, and means to enable said heads to coöperate with said piston to draw in and compress a charge, and to cause the compressed charge to be exploded upon the opposite side of the piston, said means including a companion disk, and means connecting said disk to rotate in the opposite direction, said companion disk having a cam to coöperate with the piston on the first disk to control the heads.

5. In a gas-engine, the combination with a rotary disk and pistons thereon and a channel in which the pistons travel, of means to coöperate with said pistons to enable the pistons, one after another, to draw in and compress charges, each piston compressing the charge that is drawn in by the other piston; and means for exploding the charge upon the rear side of the advancing piston by which the compression has been effected, means being provided for temporarily confining the compressed charge, for admitting the compressed charge into a lock,

and for opening the lock to explode the charge upon the rear side of the advancing piston twice in each revolution of the disk; said coöperating means including a companion disk, and means connecting said disk to rotate in the opposite direction from the first disk, said companion disk having cams to coöperate with the pistons on the first disk to control the heads.

6. In a gas-engine, the combination with a rotary disk and pistons thereon, and a channel in which the pistons travel, of means to coöperate with said pistons to enable the pistons, one after another, to draw in and compress charges, each piston compressing the charge that is drawn in by the other piston, and means for exploding the charge upon the rear side of the advancing piston by which the compression has been effected, means being provided for temporarily confining the compressed charge, for admitting the compressed charge into a lock, and for opening the lock to explode the charge upon the rear side of the advancing piston twice in each revolution of the disk; said coöperating means including a companion disk, and means connecting said disk to rotate in the opposite direction from the first disk, said companion disk having cams to coöperate with the pistons on the first disk to control the heads, said cams upon the companion disk serving also as pistons to operate in connection with the same lock.

7. The combination of a rotary disk having pistons projecting therefrom, an annular channel in which said pistons travel, means to coöperate with said pistons to draw in charges, to compress the charges, to cause the pistons to be driven at the explosions of the charges, and to expel the waste gas after the explosions, said pistons being equally separated upon the disk, and said coöperating means including sets of heads to correspond with the pistons, and a coöperative disk having similar pistons and connected to rotate in the opposite direction.

8. The combination of a rotary disk having pistons projecting therefrom, an annular channel in which said pistons travel, means to coöperate with said pistons to draw in charges, to compress the charges, to cause the pistons to be driven at the explosions of the charges, and to expel the waste gas after the explosions, said pistons being equally separated upon the disk, and said coöperating means including sets of heads to correspond with the pistons, and a coöperative disk having similar pistons and connected to rotate in the opposite direction, each set comprising two double heads, one for each disk.

9. The combination of a rotary disk having pistons projecting therefrom, an annular channel in which said pistons travel, means to coöperate with said pistons to draw in charges, to compress the charges, to cause the pistons to be driven at the explosions of the charges, and to expel the waste gas after the explosions, said pistons being equally separated upon the disk, and said coöperating means including sets of heads to correspond with the pistons, and a coöperative disk having similar pistons and connected to rotate in the opposite direction, each set comprising two double heads, one for each disk, each piston coöperating with a head to form a chamber on one side of the piston, and at the same time coöperating with another head to form a chamber on the other side of the piston.

10. The combination of a rotary disk having pistons projecting therefrom, an annular channel in which said pistons travel, means to coöperate with said pistons to draw in charges, to compress the charges, to cause the pistons to be driven at the explosions of the charges, and to expel the waste gas after the explosions, said pistons being equally separated upon the disk, and said coöperating means including sets of heads to correspond with the pistons, and a coöperative disk having similar pistons and connected to rotate in the opposite direction, each set comprising two double heads, one for each disk, each piston coöperating with a head to form a chamber on one side of the piston, and at the same time coöperating with another head to form a chamber on the other side of the piston, said pistons coöperating with said heads to form four chambers in each channel for simultaneous intake, compression, explosion and exhaust, all four of these functions being performed twice during each revolution of each disk.

11. A gas-engine comprising a rotary disk, a piston thereon, a channel in which the piston travels, movable heads, and means to enable said heads to coöperate with said piston to draw in and compress a charge, and to cause the compressed charge to be exploded upon the opposite side of the piston, said means including a companion disk and means connecting said disk to rotate in the opposite direction, said companion disk having a piston to coöperate with the piston on the first disk to control the heads, heads being provided for said piston upon said companion disk.

12. A gas-engine comprising a rotary disk, pistons thereon, a channel in which the pistons travel, movable heads, and means to enable said heads to coöperate with said pistons to draw in and compress charges, and to cause the compressed charges to be exploded upon the opposite sides of the pistons, said means including a companion disk, and means connecting said disk to rotate in the opposite direction, said companion disk having pistons to coöperate with the pistons on the first disk to control

the heads, heads being provided for said pistons upon said companion disk, the heads for the pistons upon one disk being connected to those for the pistons upon the opposite disk, to form double heads to be cammed to and fro by the opposite pistons, so that each disk partly operates both its own heads and those which coöperate with the pistons of the other disk.

13. A gas-engine comprising a rotary disk, pistons thereon, a channel in which the pistons travel, movable heads, and means to enable said heads to coöperate with said pistons to draw in and compress charges, and to cause the compressed charges to be exploded upon the opposite sides of the pistons, said means including a companion disk, and means connecting said disk to rotate in the opposite direction, said companion disk having pistons to coöperate with the pistons on the first disk to control the heads, heads being provided for said pistons upon said companion disk, the heads for the pistons upon one disk being connected to those for the pistons upon the opposite disk, to form double heads to be cammed to and fro by the opposite pistons, so that each disk partly operates both its own heads and those which coöperate with the pistons of the other disk, the heads which appertain to one disk being paired with those which appertain to the other.

14. A gas-engine comprising a rotary disk, pistons thereon, a channel in which the pistons travel, movable heads, and means to enable said heads to coöperate with said pistons to draw in and compress charges, and to cause the compressed charges to be exploded upon the opposite sides of the pistons, said means including a companion disk, and means connecting said disk to rotate in the opposite direction, said companion disk having pistons to coöperate with pistons on the first disk to control the heads, heads being provided for said pistons upon said companion disk, the heads for the pistons upon one disk being connected to those for the pistons upon the opposite disk, to form double heads to be cammed to and fro by the opposite pistons, so that each disk partly operates both its own heads and those which coöperate with the pistons of the other disk, the heads which appertain to one disk being paired with those which appertain to the other, the pairs being diametrically opposite.

15. A gas-engine comprising a rotary disk, pistons thereon, a channel in which the pistons travel, movable heads, and means to enable said heads to coöperate with said pistons to draw in and compress charges, and to cause the compressed charges to be exploded upon the opposite sides of the pistons, said means including a companion disk, and means connecting said disk to rotate in the opposite direction, said companion disk having pistons to coöperate with the pistons on the first disk to control the heads, heads being provided for said pistons upon said companion disk, the heads for the pistons upon one disk being connected to those for the pistons upon the opposite disk, to form double heads to be cammed to and fro by the opposite pistons, so that each disk partly operates both its own heads and those which coöperate with the pistons of the other disk, the heads which appertain to one disk being paired with those which appertain to the other, the pairs being diametrically opposite, the heads in each pair being separated a distance which is equal to the distance from the top to the bottom of a cam or piston, so that, twice in each revolution, all four heads bear against crowns or apices of their respective pistons simultaneously.

16. A rotary engine comprising multiple-piston disks facing each other and running in opposite directions, annular channels in which the pistons travel, the pistons in the form of cams for reciprocating the heads or abutments which coöperate with the pistons to form work-chambers.

17. A rotary engine comprising multiple-piston disks facing each other and running in opposite directions, annular channels in which the pistons travel, the pistons in the form of cams for reciprocating the heads or abutments which coöperate with the pistons to form work-chambers, an explosion chamber or lock being provided which is common to the two disks.

18. The combination of a shaft, a piston disk thereon having a face flange forming part of an annular piston channel or chamber, said chamber being also formed partly by the face of said disk, and partly by a cylindrical wall of a drum within which the disk is fitted, and partly by a vertical face or wall of the drum, a bevel gear upon said shaft, a bevel pinion meshing with said gear, an opposite bevel gear also meshing with said pinion, and a piston disk connected to the last-mentioned bevel gear to revolve in the opposite direction from the first disk.

19. The combination of a shaft, a piston disk thereon having a face flange forming part of an annular piston channel or chamber, said chamber being also formed partly by the face of said disk, and partly by a cylindrical wall of a drum within which the disk is fitted, and partly by a vertical face or wall of the drum, a bevel gear upon said shaft, a bevel pinion meshing with said gear, an opposite bevel gear also meshing with said pinion, and a piston disk connected to the last-mentioned bevel gear to revolve in the opposite direction from the first disk, the second piston having a face flange forming part of an annular piston chamber, and a cylindrical drum portion and a vertical

drum wall forming the remainder of said chamber.

20. The combination of a shaft, a piston disk thereon having a face flange forming part of an annular piston channel or chamber, said chamber being also formed partly by the face of said disk, and partly by a cylindrical wall of a drum within which the disk is fitted, and partly by a vertical face or wall of the drum, a bevel gear upon said shaft, a bevel pinion meshing with said gear, an opposite bevel gear also meshing with said pinion, and a piston disk connected to the last-mentioned bevel gear to revolve in the opposite direction from the first disk, the second piston having a face flange forming part of an annular piston chamber, and a cylindrical drum portion and a vertical drum wall forming the remainder of said chamber, each of said disks provided with a plurality of pistons at equal circumferential intervals.

21. In an engine of the character designated, the combination of two oppositely revolving disks each having a plurality of equi-distant duplex-cam shaped face pistons, annular channels in which said pistons travel, and movable abutment heads coöperating with said pistons.

22. In an engine of the character designated, the combination of two oppositely revolving disks each having a plurality of equi-distant duplex-cam shaped face pistons, medially positioned movable abutment heads mounted in the frame between the disks and coöperating with the latter, for the purpose described.

23. The combination of a shaft, a piston disk thereon having a face flange forming part of an annular piston channel or chamber, said chamber being also formed partly by the face of said disk, and partly by a cylindrical wall of a drum within which the disk is fitted, and partly by a vertical face or wall of the drum, a bevel gear upon said shaft, a bevel pinion meshing with said gear, an opposite bevel gear also meshing with said pinion, a piston disk connected to the last-mentioned bevel gear to revolve in the opposite direction from the first disk, and heads or movable abutments to coöperate with the pistons, guide-openings being provided for said heads in a framework between said disks, said train of bevel gears mounted upon said framework.

24. The combination with two oppositely-revolving disks, each having a plurality of pistons, and annular channels in which said pistons travel, of heads or movable abutments to coöperate with the pistons, guide-openings being provided for said heads, each of said heads being double or comprising two heads which move as one piece, one for engagement with the pistons or cams of one disk, and the other for engagement with the pistons or cams of the opposite disk.

25. The combination with two oppositely-revolving disks, each having a plurality of pistons, and annular channels in which said pistons travel, of heads or movable abutments to coöperate with the pistons, guide-openings being provided for said heads, each of said heads being double or comprising two heads which move as one piece, one for engagement with the pistons or cams of one disk, and the other for engagement with the pistons or cams of the opposite disk, said heads fitting in said annular piston channels to close the same and divide the segmental space between any two pistons into sub-chambers.

26. The combination with two oppositely-revolving disks, each having a plurality of pistons, and annular channels in which said pistons travel, of heads or movable abutments to coöperate with the pistons, guide-openings being provided for said heads, each of said heads being double or comprising two heads which move as one piece, one for engagement with the pistons or cams of one disk, and the other for engagement with the pistons or cams of the opposite disk, said heads fitting in said annular piston channels to close the same and divide the segmental space between any two pistons into sub-chambers, and means to coöperate with said pistons and said channels, to cause inspiration, compression, explosion and exhaust to occur at the same time in the appropriate sub-chambers during each half revolution of each disk.

27. The combination with two oppositely-revolving disks, each having a plurality of pistons, and annular channels in which said pistons travel, of heads or movable abutments to coöperate with the pistons, guide-openings being provided for said heads, each of said heads being double or comprising two heads which move as one piece, one for engagement with the pistons or cams of one disk, and the other for engagement with the pistons or cams of the opposite disk, said heads fitting in said annular piston channels to close the same and divide the segmental space between any two pistons into sub-chambers, and means to coöperate with said pistons and said channels, to cause inspiration, compression, explosion and exhaust to occur at the same time in the appropriate sub-chambers during each half revolution of each disk, each double head being in the form of a bar fitted in the guide-slots in opposite inner drum walls.

28. The combination with two oppositely-revolving disks, each having a plurality of pistons, and annular channels in which said pistons travel, of heads or movable abutments to coöperate with the pistons, guide-

openings being provided for said heads, each of said heads being double or comprising two heads which move as one piece, one for engagement with the pistons or cams of one disk, and the other for engagement with the pistons or cams of the opposite disk, said heads fitting in said annular piston channels to close the same and divide the segmental space between any two pistons into sub-chambers, and means to coöperate with said pistons and said channels, to cause inspiration, compression, explosion and exhaust to occur at the same time in the appropriate sub-chambers during each half revolution of each disk, said heads being so separated that when any double head stands at the apex of one piston, it stands at the bottom of a piston upon the opposite disk.

29. The combination with two oppositely-revolving disks, each having a plurality of pistons, and annular channels in which said pistons travel, of heads or movable abutments to coöperate with the pistons, guide-openings being provided for said heads, each of said heads being double or comprising two heads which move as one piece, one for engagement with the pistons or cams of one disk, and the other for engagement with the pistons or cams of the opposite disk, said heads fitting in said annular piston channels to close the same and divide the segmental space between any two pistons into sub-chambers, and means to coöperate with said pistons and said channels, to cause inspiration, compression, explosion and exhaust to occur at the same time in the appropriate sub-chambers during each half revolution of of each disk, the double heads in each pair being separated a distance equal to the length of the sloping side of a piston, so that a double head may be forced aside by a cam or piston, while at its opposite end it rides down the slope of the cam or piston upon the opposite disk.

30. The combination of a rotary disk having a plurality of pistons thereon formed with sloping sides, a movable head, means to enable said head to coöperate with said pistons successively to draw in explosive charges, a second head, means to enable the second head to coöperate with said pistons successively to compress the charges, means to enable the same heads to coöperate with said pistons to explode the compressed charges, and expel the exploded gases, a cylinder or chamber into which each charge is compressed, said cylinder having an outlet port, a valve in said cylinder to close said port, said valve connected to one of said heads, to be moved thereby to open the port, and a lock into which the compressed charge is received through said port.

31. The combination of a rotary disk having a plurality of pistons thereon formed with sloping sides, a movable head, means to enable said head to coöperate with said pistons successively to draw in explosive charges, a second head, means to enable the second head to coöperate with said pistons successively to compress the charges, means to enable the same heads to coöperate with said pistons to explode the compressed charges, and expel the exploded gases, a cylinder or chamber into which each charge is compressed, said cylinder having an outlet port, a valve in said cylinder to close said port, said valve connected to one of said heads, to be moved thereby to open the port, and a lock into which the compressed charge is received through said port, said lock having an outlet-valve, means to open and close the valve, and means to explode the compressed charge.

32. The combination of oppositely revolving disks provided with pistons, annular channels in which said pistons travel, and movable heads to close said channels and cooperate with the pistons, each channel provided with an inlet port and an exhaust port, and each channel also in communication with a chamber in which the charge is compressed, together with said compression chamber, for the purpose described.

33. The combination of oppositely revolving disks provided with pistons, annular channels in which said pistons travel, movable heads to close said channels and coöperate with the pistons, each channel provided with an inlet port and an exhaust port, and each channel also in communication with a chamber in which the charge is compressed, a lock common to said chambers and out of communication with them while the charges are being subjected to compression, and means for automatically opening communication between the chambers and said lock at the conclusion of the compression operation.

34. The combination of oppositely revolving disks provided with pistons, annular channels in which said pistons travel, movable heads to close said channels and coöperate with the pistons, each channel provided with an inlet port and an exhaust port, and each channel also in communication with a chamber in which the charge is compressed, a lock common to said chambers and out of communication with them while the charges are being subjected to compression, means for automatically opening communication between the chambers and said lock at the conclusion of the compression operation, and reciprocating piston valves in said chambers and connected to said heads, said chambers having ports to communicate with said lock, said ports closed by said valves at the compression operation, but opening automatically at the movements of the corresponding heads.

35. The combination of oppositely revolv-

ing disks provided with pistons, annular channels in which said pistons travel, movable heads to close said channels and coöperate with the pistons, each channel provided with an inlet port and an exhaust port, and each channel also in communication with a chamber in which the charge is compressed, a lock common to said chambers and out of communication with them while the charges are being subjected to compression, means for automatically opening communication between the chambers and said lock at the conclusion of the compression operation, said lock provided with valves opening into said channels, and means for automatically controlling the opening and closing of said valves.

36. The combination of oppositely revolving disks provided with pistons, annular channels in which said pistons travel, movable heads to close said channels and coöperate with the pistons, each channel provided with an inlet port and an exhaust port, and each channel also in communication with a chamber in which the charge is compressed, a lock common to said chambers and out of communication with them while the charges are being subjected to compression, means for automatically opening communication between the chambers and said lock at the conclusion of the compression operation, said lock provided with valves opening into said channels, means for automatically controlling the opening and closing of said valves, said controlling means including cams provided upon said rotating disks, and means for enabling said cams to operate said valves.

37. The combination of oppositely revolving disks provided with pistons, annular channels in which said pistons travel, movable heads to close said channels and cooperate with the pistons, each channel provided with an inlet port and an exhaust port, and each channel also in communication with a chamber in which the charge is compressed, a lock common to said chambers and out of communication with them while the charges are being subjected to compression, means for automatically opening communication between the chambers and said lock at the conclusion of the compression operation, said lock provided with valves opening into said channels, means for automatically controlling the opening and closing of said valves, said controlling means including cams provided upon said rotating disks, means for enabling said cams to operate said valves, said valves mounted in the opposite ends of said lock, and yielding means being provided common to said valves for returning the valves to their seats.

38. The combination of oppositely revolving disks provided with pistons, annular channels in which said pistons travel, movable heads to close said channels and cooperate with the pistons, each channel provided with an inlet port and an exhaust port, and each channel also in communication with a chamber in which the charge is compressed, a lock common to said chambers and out of communication with them while the charges are being subjected to compression, means for automatically opening communication between the chambers and said lock at the conclusion of the compression operation, and reciprocating piston valves in said chambers and connected to said heads, said chambers having ports to communicate with said lock, said ports closed by said valves at the compression operation, but opening automatically at the movements of the corresponding heads, the heads for one channel being rigid with those for the other channel.

39. The combination of oppositely revolving disks provided with pistons, annular channels in which said pistons travel, movable heads to close said channels and cooperate with the pistons, each channel provided with an inlet port and an exhaust port, and each channel also in communication with a chamber in which the charge is compressed, a lock common to said chambers and out of communication with them while the charges are being subjected to compression, means for automatically opening communication between the chambers and said lock at the conclusion of the compression operation, and reciprocating piston valves in said chambers and connected to said heads, said chambers having ports to communicate with said lock, said ports closed by said valves at the compression operation, but opening automatically at the movements of the corresponding heads, the heads for one channel being rigid with those for the other channel, and said piston valves being fixed upon certain of said heads.

40. The combination of oppositely revolving disks provided with pistons, annular channels in which said pistons travel, movable heads to close said channels and cooperate with the pistons, each channel provided with an inlet port and an exhaust port, and each channel also in communication with a chamber in which the charge is compressed, a lock common to said chambers and out of communication with them while the charges are being subjected to compression, means for automatically opening communication between the chambers and said lock at the conclusion of the compression operation, and reciprocating piston valves in said chambers and connected to said heads, said chambers having ports to communicate with said lock, said ports closed by said valves at the compression operation, but opening automatically at the movements of the corresponding heads, the heads for one channel

being rigid with those for the other channel, and said piston valves being fixed upon certain of said heads, certain of said heads having ports for the passage of the compressed charges through the heads into the compression chamber.

41. The combination of oppositely revolving disks provided with pistons, annular channels in which said pistons travel, movable heads to close said channels and cooperate with the pistons, each channel provided with an inlet port and an exhaust port, and each channel also in communication with a chamber in which the charge is compressed, a lock common to said chambers and out of communication with them while the charges are being subjected to compression, means for automatically opening communication between the chambers and said lock at the conclusion of the compression operation, and reciprocating piston valves in said chambers and connected to said heads, said chambers having ports to communicate with said lock, said ports closed by said valves at the compression operation, but opening automatically at the movements of the corresponding heads, the heads for one channel being rigid with those for the other channel, and said piston valves being fixed upon certain of said heads, certain of said heads having ports for the passage of the compressed charges through the heads into the compression chamber, said compression ports provided with back-check valves.

42. The combination of oppositely revolving disks provided with pistons, annular channels in which said pistons travel, movable heads to close said channels and cooperate with the pistons, each channel provided with an inlet port and an exhaust port, and each channel also in communication with a chamber in which the charge is compressed, a lock common to said chambers and out of communication with them while the charges are being subjected to compression, means for automatically opening communication between the chambers and said lock at the conclusion of the compression operation, reciprocating piston valves in said chambers and connected to said heads, said chambers having ports to communicate with said lock, said ports closed by said valves at the compression operation, but opening automatically at the movements of the corresponding heads, the heads for one channel being rigid with those for the other channel, and said piston valves being fixed upon certain of said heads, certain of said heads having ports for the passage of the compressed charges through the heads into the compression chamber, said compression ports provided with back-check valves, and means to enable said piston valves to draw in charges of mixed fuel and air and force said charges into said lock to augment the explosive charge therein.

43. The combination of oppositely revolving disks provided with pistons, annular channels in which said pistons travel, movable heads to close said channels and cooperate with the pistons, each channel provided with an inlet port and an exhaust port, and each channel also in communication with a chamber in which the charge is compressed, a lock common to said chambers and out of communication with them while the charges are being subjected to compression, means for automatically opening communication between the chambers and said lock at the conclusion of the compression operation, reciprocating piston valves in said chambers and connected to said heads, said chambers having ports to communicate with said lock, said ports closed by said valves at the compression operation, but opening automatically at the movements of the corresponding heads, the heads for one channel being rigid with those for the other channel, and said piston valves being fixed upon certain of said heads, certain of said heads having ports for the passage of the compressed charges through the heads into the compression chamber, said compression ports provided with back-check valves, means to enable said piston valves to draw in charges of mixed fuel and air and force said charges into said lock to augment the explosive charge therein, said chambers for this purpose having ports in their ends, and back-check valves in said ports, in communication with said lock.

44. The combination of oppositely revolving disks provided with pistons, annular channels in which said pistons travel, movable heads to close said channels and cooperate with the pistons, each channel provided with an inlet port and an exhaust port, and each channel also in communication with a chamber in which the charge is compressed, a lock common to said chambers and out of communication with them while the charges are being subjected to compression, means for automatically opening communication between the chambers and said lock at the conclusion of the compression operation, and reciprocating piston valves in said chambers and connected to said heads, said chambers having ports to communicate with said lock, said ports closed by said valves at the compression operation, but opening automatically at the movements of the corresponding heads, the heads for one channel being rigid with those for the other channel, and said piston-valves being fixed upon certain of said heads, certain of said heads having ports for the passage of the compressed charges through the heads into the compression chamber, said piston-

valves being cupped out to increase the capacity of the chambers to receive the compressed charge.

45. A gas-engine comprising a rotary disk, pistons thereon, a channel in which the pistons travel, movable heads, and means to enable said heads to coöperate with said pistons to draw in and compress charges, and to cause the compressed charges to be exploded upon the opposite sides of the pistons, said means including a companion disk, and means connecting said disk to rotate in the opposite direction, said companion disk having pistons to coöperate with the pistons on the first disk to control the heads, heads being provided for said pistons upon said companion disk, the heads for the pistons upon one disk being connected to those for the pistons upon the opposite disk, to form double heads to be cammed to and fro by the opposite pistons, so that each disk partly operates both its own heads and those which coöperate with the pistons of the other disk, and yielding detents to hold said double heads in extreme positions.

46. The combination of oppositely revolving disks provided with pistons, annular channels in which said pistons travel, movable heads to close said channels and cooperate with the pistons, each channel provided with an inlet port and an exhaust port, and each channel also in communication with a chamber in which the charge is compressed, a lock common to said chambers and out of communication with them while the charges are being subjected to compression, means for automatically opening communication betwen the chambers and said lock at the conclusion of the compression operation, reciprocating piston-valves in said chambers and connected to said heads, said chambers having ports to communicate with said lock, said ports closed by said valves at the compression operation, but opening automatically at the movements of the corresponding heads, the heads for one channel being rigid with those for the other channel, and said piston-valves being fixed upon certain of said heads, certain of said heads having ports for the passage of the compressed charges through the heads into the compression chamber, said compression ports provided with back-check valves, means to enable said piston-valves to draw in charges of mixed fuel and air and force said charges into said lock to augment the explosive charge therein, said piston-valves being cupped out to increase the capacity of the chambers to receive the compressed charge, and means for automatically locking said detents and releasing them.

47. The combination of oppositely revolving disks provided with pistons, annular channels in which said pistons travel, movable heads to close said channels and coöperate with the pistons, each channel provided with an inlet port and an exhaust port, and each channel also in communication with a chamber in which the charge is compressed, and a lock for compressed charges, said lock common to said channels.

48. The combination of oppositely revolving disks provided with pistons, annular channels in which said pistons travel, movable heads to close said channels and coöperate with the pistons, each channel provided with an inlet port and an exhaust port, and each channel also in communication with a chamber in which the charge is compressed, a lock for compressed charges, said lock common to said channels, and means for admitting the compressed charges to said lock at the conclusion of the exploding and expanding operation.

49. The combination with oppositely rotating disks having pistons on their faces, of annular channels in which said pistons travel, and means coöperating with said pistons and channels to effect intake, compression, explosion, expansion and exhaust twice in each rotation.

50. The combination with oppositely rotating disks having pistons on their faces, of annular channels in which said pistons travel, an exploding lock or chamber common to said channels, and means coöperating with said pistons and channels to effect intake, compression and exhaust.

JOSEPH DEUBEL.

Witnesses:
JENNIE P. THORNE,
EDITH B. LIBBEY.