No. 883,188. PATENTED MAR. 31, 1908.

C. GAUSE & P. CONRADY.

ROTARY ENGINE.

APPLICATION FILED OCT. 16, 1906.

3 SHEETS—SHEET 1.

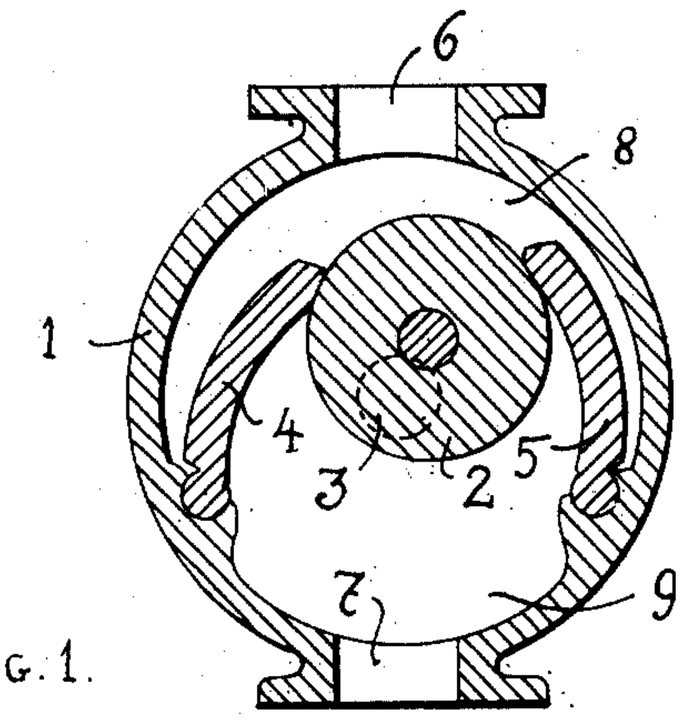

FIG. 1.

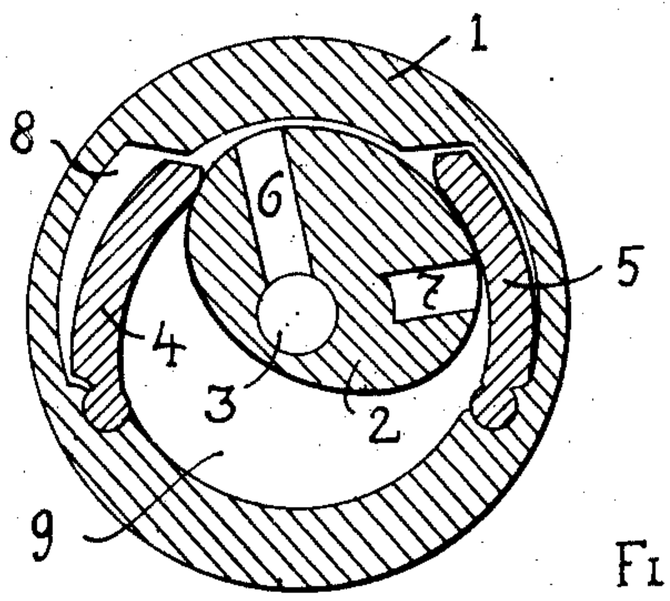

FIG. 2.

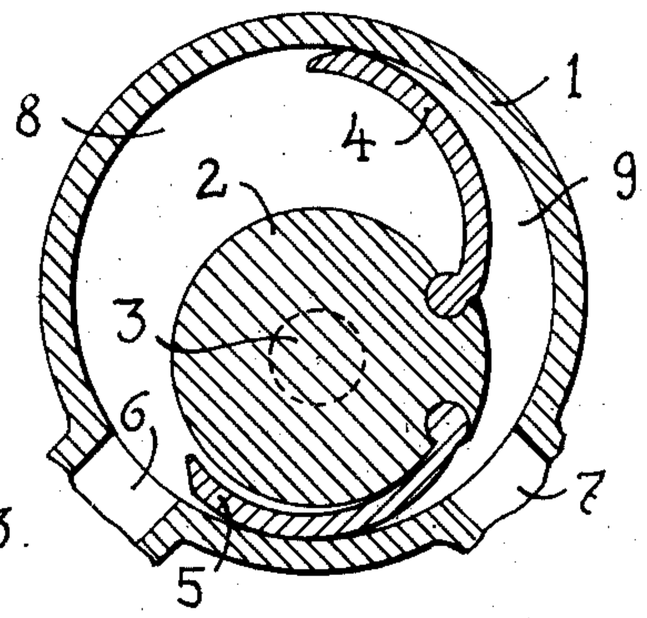

FIG. 3.

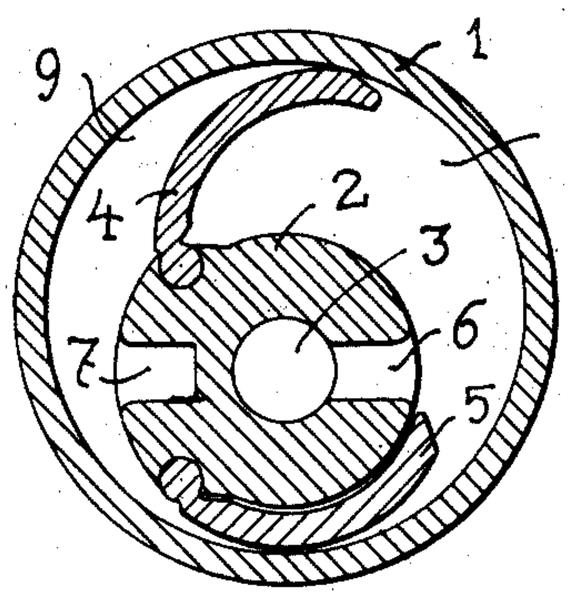

FIG. 4

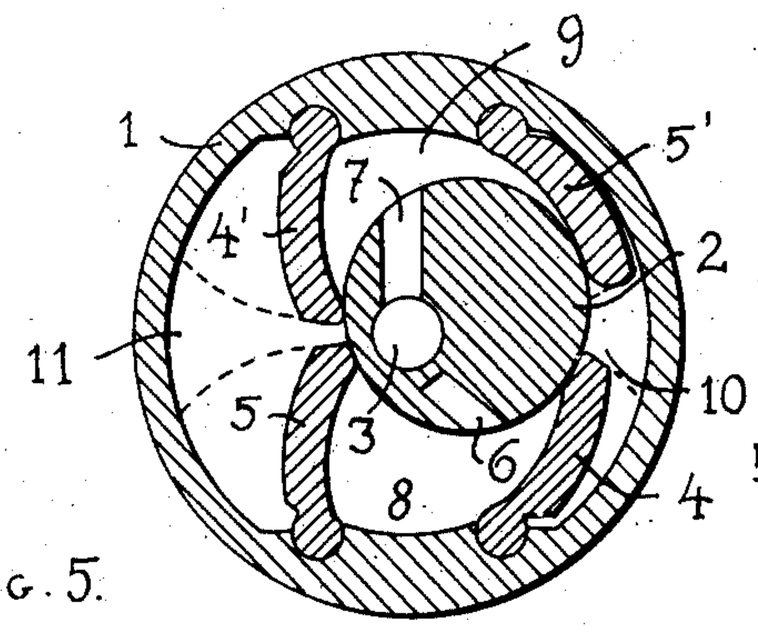

FIG. 5.

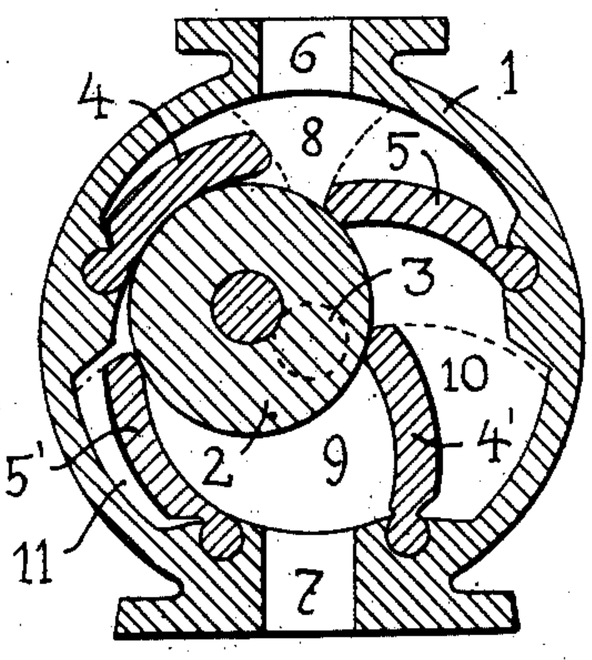

FIG. 6.

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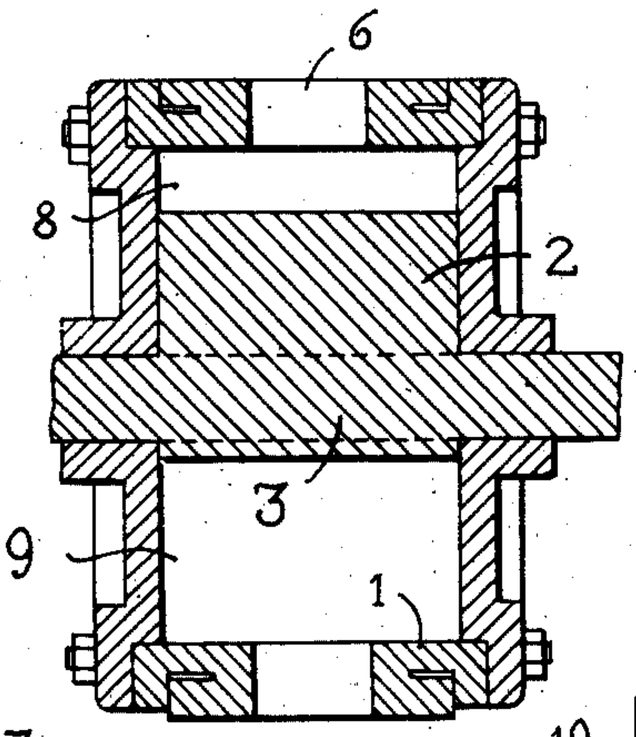

FIG. 7.

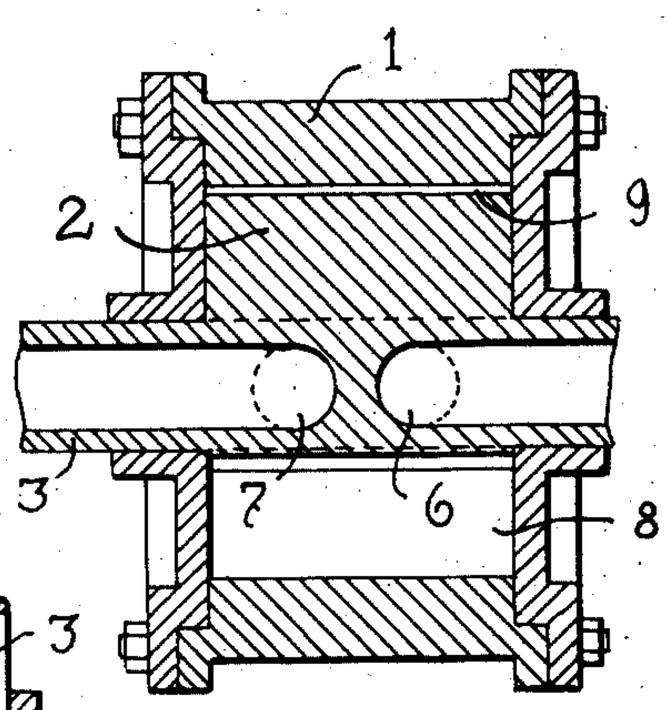

FIG. 8.

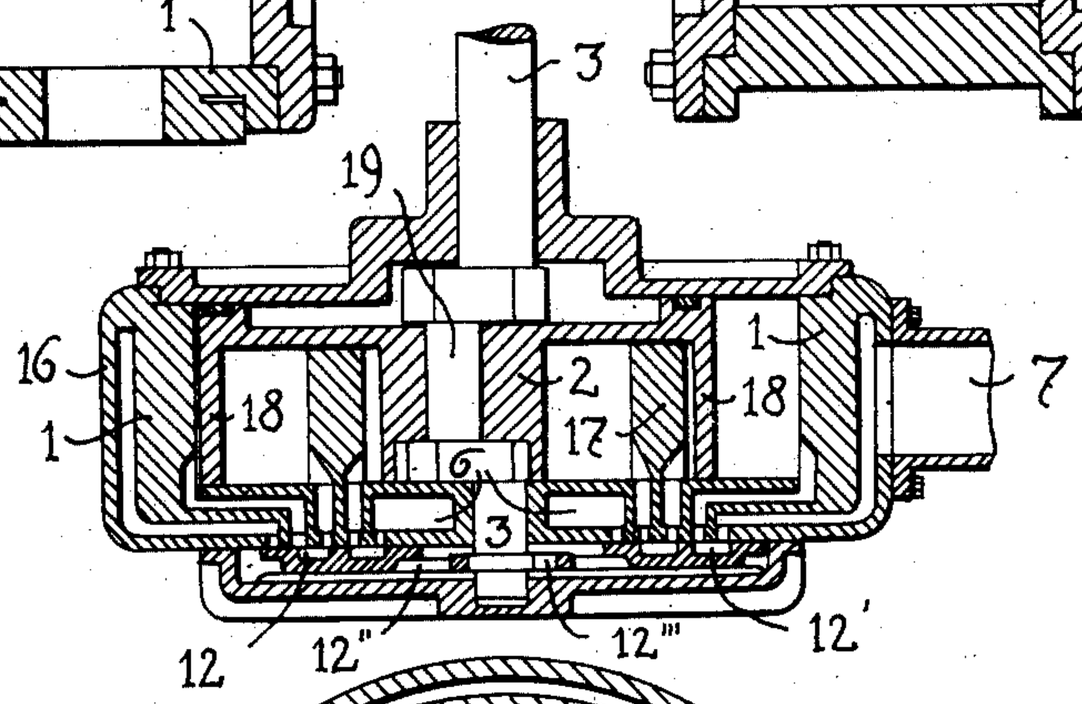

FIG. 9.

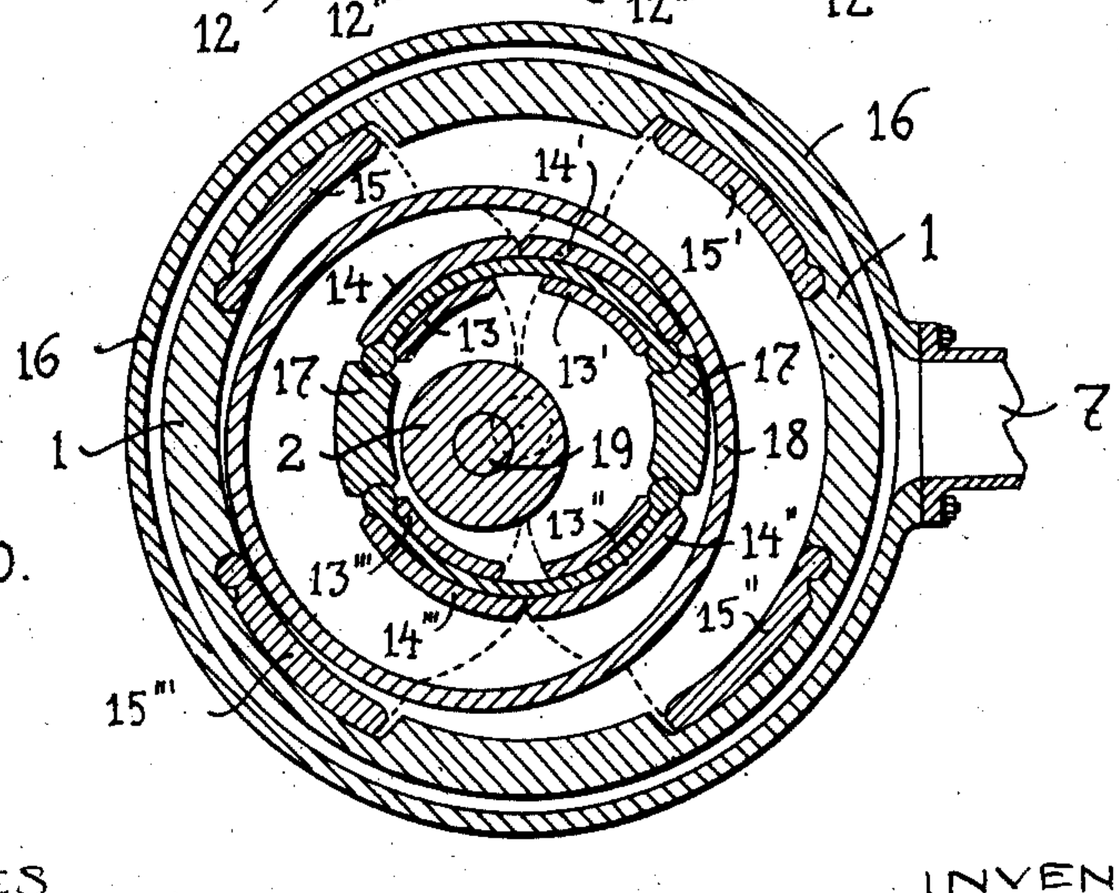

FIG. 10.

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3 SHEETS—SHEET 3.

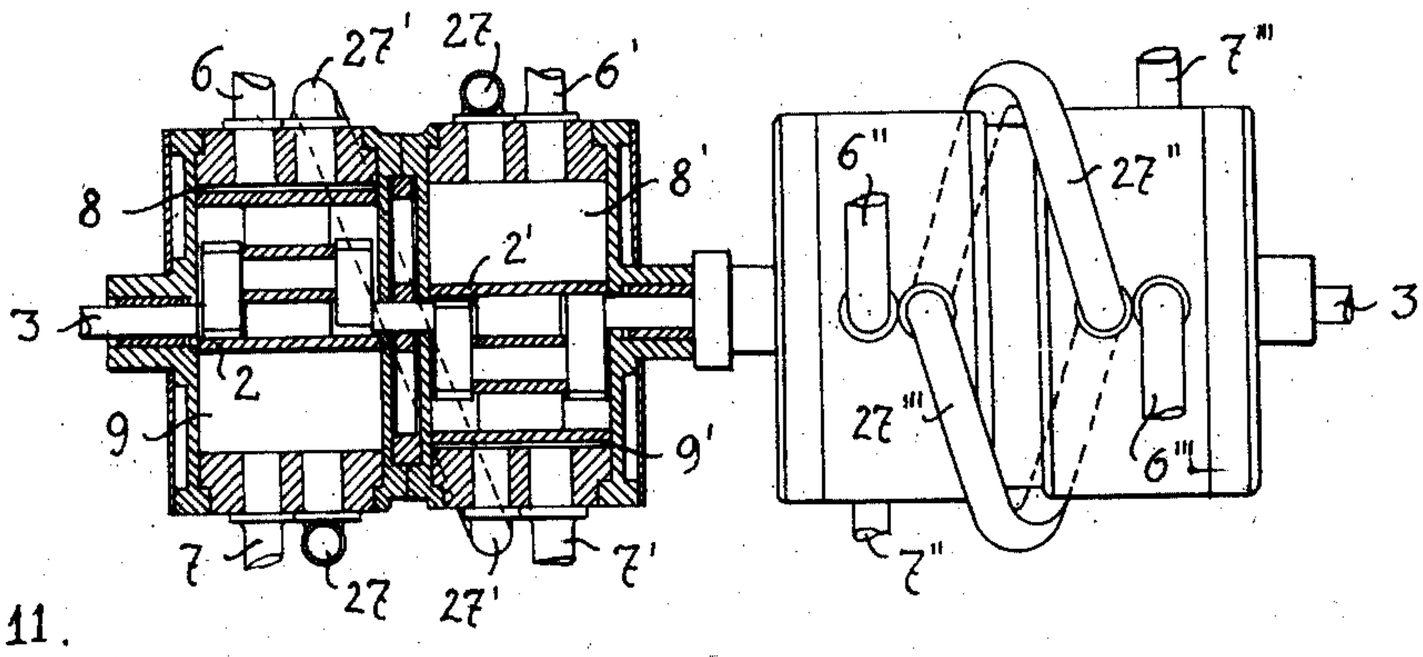

FIG. 11.

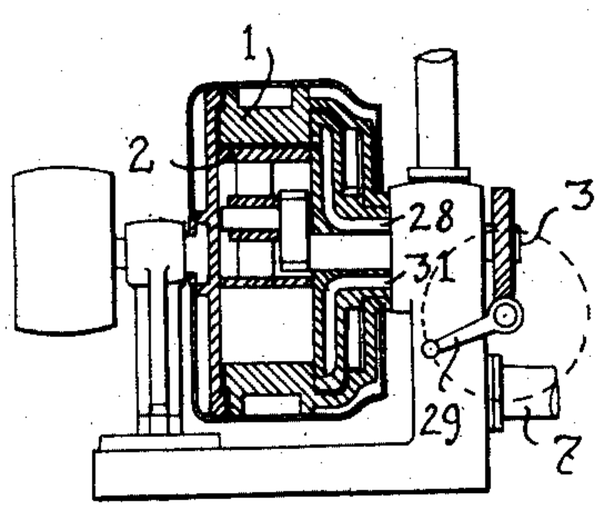

FIG. 12.

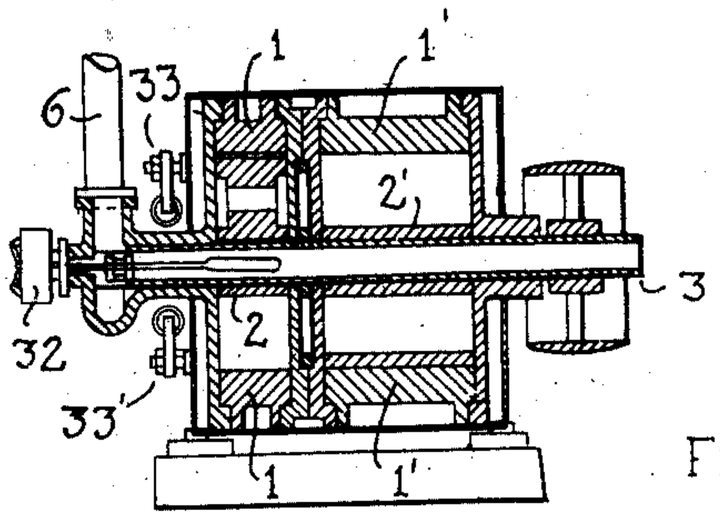

FIG. 13.

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UNITED STATES PATENT OFFICE.

CARL GAUSE AND PHILIPP CONRADY, OF BERLIN, GERMANY.

ROTARY ENGINE.

No. 883,188. Specification of Letters Patent. Patented March 31, 1908.

Application filed October 16, 1906. Serial No. 339,270.

To all whom it may concern:

Be it known that we, CARL GAUSE and PHILIPP CONRADY, subjects of the German Emperor, residing at Berlin, Germany, have invented new and useful Improvements in Rotary Engines, of which the following is a specification.

The present invention relates to rotary engines, having rotating pistons or cylinders, and in which a plurality of flaps are employed which are hinged on the piston or cylinder. These flaps effect a rotation of said parts under the action of the propellant. On the other hand, if either cylinder or piston is driven, these flaps move a liquid or gaseous fluid through the apparatus. Such machines may therefore be used both as prime movers as well as motors, or as pumps, or as measuring devices. Steam, compressed air, water under pressure, explosive gases or other suitable means may be used as propellant. Hitherto, in similar machines, the flaps were arranged in such a manner at the periphery either of the piston or of the cylinder, that the rotating parts always slid over each of the flaps in the same direction. In such an arrangement the flaps may be described as being arranged one behind the other or in series. In other machines the flaps have been situated in the same cylinder, some being mounted on the cylinder, and some on the piston. In that case the flaps had to slide one over another when the machine moved, an arrangement which, in any case, is not advantageous. If, moreover, flaps have also been occasionally arranged situated opposite one another in machines in which the flaps are hinged only on the cylinder or only on the piston, the sole purpose of this was to effect a rotation of the engine in a different direction, either the flaps lying in the one direction or those lying in the other direction working, whereas the flaps situated opposite to one another were not simultaneously operative. Or the flaps were arranged two and two, so that of each pair of flaps the individual flaps were situated one opposite another. The flaps then worked in such a manner that every pair of flaps imparted motion to the piston in the same direction. The space between the cylinder and piston was divided in that case into a number of spaces which were not equivalent one with another. For only the space between two flaps of a pair of flaps were working spaces; the space between two flaps belonging to different pairs of flaps were empty and therefore noxious.

Now according to the present invention the flaps are arranged also two and two, one opposite another, in pairs, so that the same work in pairs. But the spaces inclosed by these pairs of flaps are not the only working spaces, in which case the other spaces, namely those between the pairs of flaps, would be idle and empty. On the contrary, all the spaces between the different flaps are usefully employed, either under pressure or suction as the case may be. Hereby all the disadvantages of the last mentioned kind of machines are avoided, and the advantages are for the first time really obtained which result from the arrangement of flaps situated one opposite another.

In order that the invention may be more clearly understood reference is made to the accompanying drawings in which

Figures 1 to 8 represent various embodiments of the invention somewhat diagrammatically and Figs. 9 to 14 in various more exactly drawn forms, and in which Fig. 1 shows a cross-section through a machine of the kind in which the flaps are mounted revolubly on the cylinder; Fig. 2 is a section through a similar form in which the supply of the fluids passing through the machine does not take place through openings in the sides of the cylinder, but through corresponding holes bored through the piston; Fig. 3 is a section of a form with flaps which are journaled at the circumference of the piston, and in which the supply and discharge of the propellant is effected through the side of the cylinder; Fig. 4 is a section of a machine in which the flaps are journaled on the sides of the piston, the supply and exhaust of the propellant taking place through the revoluble shaft of the piston; Fig. 5 is a section of a form with two pairs of flaps placed one opposite another and revoluble on the side of the cylinder; Fig. 6 is a section of a form similar so that in Fig. 5, in which, however, the concerned fluids are not admitted and exhausted through borings in the piston, but through channels in the cylinder; Fig. 7 is a longitudinal section of a form of machine corresponding to those shown in Figs. 1 and 6; Fig. 8 is a longitudinal section of a machine corresponding to the forms according to Figs. 2 and 5; Fig. 9 is a longitudinal section of a

triple expansion engine according to the system in accordance with the present invention, in which the different engines lie one in another, and the cylinders of the interior engines serve simultaneously as pistons of the exterior engines; Fig. 10 is a cross-section through a machine as shown in Fig. 9; Fig. 11 is an elevation, partly in section of a quadruple machine composed of four single cylinders each cylinder having a piston. The four cylinders are coupled two and two in a common casing; Fig. 12 is an elevation partly in section of a machine in which the piston is stationary and the cylinder rotates; Fig. 13 is an elevation partly in section of a quadruple machine with two cylinder spaces of unequal size.

It is to be noted that the forms illustrated only represent the principal forms in which the invention may be employed. The number of flaps in each case may be varied as required, also the cross-section of the cylinder on the piston may be made, say, oval, instead of circular, according to requirements (see Fig. 2.)

The axis of rotation of the piston lies in the geometrical axis of the piston itself, if the flaps are hinged or revoluble on it; if the flaps are hinged on the cylinder the axis of rotation of the piston lies in the geometrical axis of the cylinder.

It is to be noted that the arrangements here drawn, work, generally speaking, not only as described in each case, when, for example, in a given case, the piston rotates and the cylinder is stationary, but that they also as a rule permit the reverse method of working, for example, in the latter case, the piston may be stationary and the cylinder rotate.

In order to describe in detail the manner in which the machine works it is supposed in the first place that Figs. 1 and 7 represent a construction which is preferably employed as a pump. In these figures 1 is the cylinder, and 2 the piston which rotates round the shaft 3. 4 and 5 are two flaps which are hinged on the side of the cylinder. 6 is the port or opening for the admission and emission of the propellant. 7 is the port or opening for the admission and emission of the fluid to be pumped. The cylinder is divided by the two flaps 4 and 5 into the two spaces 8 and 9.

The cycle of operations in the motor is as follows; The steam entering in the first place at 6, presses on the flap 4 and the piston 2, in the position shown in the drawing, and drives the latter in a clockwise direction. This motion is continued until the piston arrives in front of the opening 7, an enlargement of the space 8 continually taking place. On the way from 6 to 7 the piston has pushed the fluid in the space 9 out through the opening 7. When this opening is reached the admission of steam at 6 is cut off and this opening is connected with an exhaust conduit. Vice versa the connection of the opening 7 with the supply pipe is simultaneously cut off and this opening is connected with the section pipe for the liquid which is to be pumped. The piston which now approaches the opening 6 again reduces the space 8, whereas it increases the space 9 and sucks up liquid here. When the piston is again pushed so far that it has passed the opening 6 and has approached the position shown in Fig. 1 again, the connection of the pipes with the openings 6 and 7 is again reversed. Thus this form represents a machine with a simple action which in itself does not advantageously perform work, but which however is preferably employed by combining several such machines one with another, as will be described later. (See particularly Fig. 11).

Two such machines as just described may be so driven that, instead of their being employed as pumps, they are used as combustion motors; the space 9 of the one motor may be then used for the intake and compression of the gas mixture which then undergoes combustion in the space 8 of another motor connected with it (see Fig. 13).

If the form represented in Figs. 1 and 7 is used as a steam engine, the two spaces 8 and 9 are both working spaces. Space 8 is under pressure when steam enters from pipe 6, the steam working on the flaps 4 and 5. When the piston has commenced its motion and has passed the dead point, pipe 7 is open and connects space 9 with a condensing apparatus. A partial vacuum is then formed in space 9 so that the piston is subjected to suction in said space.

Fig. 2 represents a form of the engine in cross-section in which a piston is employed which has an oval cross-section. When the machine is used as a steam engine, steam enters through a pipe situated in the shaft of the piston. This is shown particularly in Fig. 8 in longitudinal section. The steam which comes through the pipe 6 into the cylinder space 8 presses on the flaps 4 and 5 and drives the piston. Before the opening of pipe 6 passes flaps 5, steam admission is cut off. The pipe 7 is already connected with a condenser so that a partial vacuum exists in space 9 and this space works as a suction space. When the outlet of pipe 6 has passed flap 4 again, steam is again allowed to enter through pipe 6 into space 8. Accordingly this engine works double-acting.

Fig. 3 is a cross-section of an engine, the axis of rotation of which does not coincide with the axis of the cylinder, but is arranged eccentric to the same in the shaft of the piston. The propellant which enters through 6 into space 8 presses the flaps 4 and 5 against the side of the cylinder and thereby rotates the piston. Pipe 7 is connected with the con-

denser so that a partial vacuum is present in space 9. Before flap 5 passes over pipe 6, the admission of steam to space 8 is cut off and is only effected again when flap 4 has also passed over port 6.

Fig. 4 is a cross-section through a form which corresponds exactly with that according to Fig. 3, except that the admission and exhaust conduits are not situated in the cylinder, but in the piston.

In Fig. 5 there are four flaps hinged on the side of the cylinder, the flaps 4 and 5 on the one side and the flaps 4′ and 5′ on the other side. Each pair of flaps is arranged according to those shown in Fig. 2. The separate flaps which appertain to one another are, however, closer together than in that case. An important result arising from this arrangement of two pairs of flaps is that there is no dead point for the piston. In the arrangement according to Fig. 1 there is a dead point when the piston is in the center line through the ports 6 and 7, that is when the flaps 4 and 5 are both situated at the same angle with regard to the cylinder. But as there are four working spaces in the forms according to Figs. 5 and 6, as the piston is mounted eccentrically in the cylinder, it is impossible for all the flaps in these four spaces to be placed at the same angle with regard to the cylinder. Referring to Fig. 5, when the piston has moved a little further than the position in which it is shown, the flaps inclosing spaces 10 and 11 are symmetrically placed, but the flaps inclosing spaces 8 and 9 are not at equal angles with regard to the cylinder. If in Fig. 5 steam enters through port 6, it throws back the flaps 4 and 5 and presses on the flaps 4′ and 5′. In the position shown in the figure however, the turning moment on 4′ is much greater than that on 5′. The piston therefore rotates in a clockwise direction. If on the contrary steam is allowed to flow in through 7, the steam pressure will become effective on the flaps 4 and 5, and the piston will rotate in the opposite direction. The emission of the steam is effected through the opposite port, thus either through 7 or through 6. Instead of working with only one port for the admission of steam and the like, and only one port for its emission, in such machines which have four cylinder spaces as shown in Figs. 5 and 6, two ports may be provided for the admission and two for the emission of the propellant corresponding to the four cylinder spaces. Such an arrangement is particularly suitable when these ports are not arranged in the piston but in the cylinder as shown in Fig. 6.

Fig. 8 may be considered a longitudinal section of the machine shown in Fig. 5.

Fig. 6 represents the cross-section of a pump with four flaps; Fig. 7 may be used as a longitudinal section of the same. By the rotation of the piston 2 round the shaft 3 in a clockwise direction from below upwards, the spaces 9, 10 and 11 become in the first place filled with liquid which is sucked through the admission port 7. In the meantime the space 8 is diminished and the liquid contained in it is supplied to the exhaust pipe 6. When the piston goes further downwards during its rotation, the liquid to be supplied is pressed out of the spaces 10 and 11 into space 3, in order to be supplied later from here through 6.

Both forms, both that according to Fig. 5, as well as that according to Fig. 6, require no distributing mechanism and valves even when they are worked alone without being coupled with another machine of the same kind. They are therefore particularly suitable for continuously pumping muddy liquids.

Figs. 9 and 10 represent, as already remarked, a triple expansion engine, the three single machines of which it is composed being situated one in another. The manner in which the entire machine works is easily understood from the description which follows hereafter. All the numerals have the significations already attaching to them with reference to Figs. 1 to 8, in so far as they denote corresponding parts. In this case the steam which is to drive the engine enters through the pipe 6 shown in cross-section in Fig. 9, and is in the first place conducted from there by means of slide valves 12 and 12′ into the interior of the cylinder 17, in which the piston 2 is driven round the shaft 3 by means of flaps 13. The slide valves 12 and 12′ are controlled by means of the eccentrics 12″ and 12‴. The steam passes from cylinder 17 into cylinder 18, its passage being regulated by the slide valves 12 and 12′. The cylinder 17 rotates in the cylinder 18 and operates as the piston belonging to cylinder 18. The flaps 14 cause the rotation of 17 in the inner space of 18 under the action of the steam. The steam goes from cylinder 18 again through the slide valve 12 and 12′ into the outermost cylinder 1, in which latter cylinder the cylinder 18 acts as piston and is moved by means of the flaps 15. Lastly, the steam goes from cylinder 1 into the space serving as a steam jacket inclosed by cylinder 16 and from here into the exhaust pipe 7. It is to be noted here that 19 is a crank of the shaft 3 situated in the inner piston 2 and that the work done in the cylinders in rotating the same and the piston is transmitted to the crank causing the shaft to rotate.

Fig. 11 shows a form in which four engines in all are arranged, of which each pair acting on one crank forms one group. In each group the concerned motors are displaced 180° relatively to one another. The two groups are displaced 90° relatively to one another so that the prime lever can start with certainty from all positions. It may be driven with any suitable propellant; also it

may serve as a pump without varying the kind of build, in which case, of course, the ports are otherwise connected.

In the following description the machine is considered as working as a gas motor. The gases to be employed enter into the first motor at 7, are compressed in the chamber 9, go through the pipe 27 into the second motor where they are exploded in the chamber 8′, and are exhausted through the pipe 6′. The second motor sucks the gases in at 7′. These are compressed in the chamber 9′ and pass through the pipe 27′ into the first motor in which they are exploded in the chamber 8. Lastly they are exhausted out of this chamber through 6. The cycle of events in the second group of motors is similar where the chambers 6, 6′, etc. correspond to the spaces 6″, 6‴, etc. in the drawings.

Fig. 12 represents a form in which the piston is stationary and the cylinder moves. In this case it is preferably worked with steam. This enters at 6, then goes through the channel 28 into the hollow cover of the cylinder which does not rotate with this but remains stationary. It then enters through ports into the cylinder which may be regulated by means of a slide valve. This is effected by means of the crank 29 and the worm-wheel 30, in such a manner that the piston is rotated somewhat in the cylinder and thus the steam admission ports are hereby varied more or less. The steam exhaust is effected in a similar manner through the channel 31 into the exhaust pipe 7. This engine according to Fig. 12 corresponds to that according to Fig. 3 as regards its construction. The admission and emission ports for the propellant are not situated in the side of the cylinder however, but in one end of the same. This arrangement is necessary here because the cylinder of the engine according to Fig. 13 rotates and not the piston.

Fig. 13 shows a form of engine by way of example of the kind shown in Fig. 2 in which two cylinders of unequal length work together. The steam enters at 6 and first flows through the one cylinder 1, and then the other cylinder 1′, and lastly passes out through the shaft 3 at the other end again. All the details correspond with those previously described. It may be added that 32 represents a governor which regulates the supply of steam through the shaft 3; further, 33, 33′ represent springs which are attached to the revoluble axles on which the flaps are mounted inside the machine, the purpose of said springs being to make the operation of the flaps more certain. These springs 33, 33′ are only shown diagrammatically. They operate by acting on levers arranged on extensions of the axles on which the flaps are mounted. It is also possible to use an engine according to Fig. 13 so that this does not serve as a compound engine but as a gas engine with two distinct like machines. The shorter cylinder 1 is then only used for the suction and compression of the gases, whereas the cylinder 1′ is used as the generator of power proper. Such arrangements are recommended if it is wished to work with a specially good utilization of the expanding gases. All engines here described may generally speaking run both forwards as well as backwards. This occurs, for example, in engines with four flaps, according as the steam or other propellant is allowed to enter through the openings 6 and 7, and to exhaust through the openings 7 and 6.

Engines which have two flaps may be run forwards or backwards according to the position of the pistons when the same are started. This may be explained more fully by reference to Fig. 1. If, as in this case, the piston 2 is situated in the position in which it is drawn, when the engine begins to run by steam being admitted through port 6, it will rotate in a clockwise direction. If on the other hand at the commencement of running the piston be situated to the left of the line which may be thought of as passing through the center of the machine, it will rotate in a counter clockwise direction. Further, in all the engines represented it is possible to assist the rotary movement of the flaps in the direction desired by arranging a spring, such as, for example, is represented in Fig. 13. These springs may be placed both inside the engine, as also, if the engines should become too hot, they may be so arranged that they engage outside by means of a lever on the axles of the flaps concerned.

If the machines should become too hot it is likewise permissible to cover their interior chambers with a suitable layer of insulation. This insulation may, of course, only be arranged where the separate parts do not slide over one another; it is particularly for use in the explosion chambers of engines employed as gas motors.

It is true that in many cases the machines do not require valve-gear, but in part they must be driven with such gearing. In this case the valve-gear may be arranged, generally speaking, either as represented in Fig. 12, for displacing the stationary part, or it may be so arranged, as shown in Fig. 13, for controlling a regulating device inside the shaft which varies the admission or emission of the propellant. Lastly, it is to be noted that the engines of the present kind which are used as gas engines may be set working again in a simple manner, after they have not remained stationary for too long a time, by closing the exhaust pipe shortly before the conclusion of working, or by causing the stoppage of the same by shutting the exhaust pipe. In order to set the machine going again, it is then only necessary to open the exhaust pipe, whereby the pressures existing

in the spaces which are not connected with it, occasion a rotation of the piston.

What we claim as our invention and desire to secure by Letters Patent is:

1. Engine of the type described, comprising in combination a cylinder, a drum-shaped piston not touching the periphery of said cylinder, a pair of hinged flaps forming partition-walls between the cylinder and the piston, said flaps being arranged opposite one another and being able to turn in an opposite direction and channels arranged in such a manner that each cylinder space will be connected to the corresponding channels.

2. Engine of the type described, comprising in combination a cylinder, a drum-shaped piston not touching the periphery of said cylinder, a plurality of pairs of hinged flaps, every two of said flaps being situated opposite one another and being able to turn in an opposite direction, whereby the cylinder-space is divided into two parts which receive the different pressures, and channels arranged in such a manner that each cylinder space will be connected to the corresponding channels.

3. Engine of the type described, comprising in combination a plurality of cylinders and drum-shaped pistons, hinged flaps in each cylinder, every two of said flaps being situated opposite one another and being able to turn in an opposite direction, whereby the space of each cylinder is divided into two parts which receive the different pressures, and channels or pipes connecting the single spaces of the different cylinders.

4. Engine of the type described, comprising in combination a stationary cylinder, a crank-shaft, a drum-shaped piston in, and a ring-shaped piston around the said cylinder, another stationary cylinder around the latter piston, both pistons connected to each other and to the crank of the said shaft, flaps hinged to the cylinders and sliding on the pistons, in each cylinder every two of said flaps being situated opposite one another and being able to turn in an opposite direction, whereby the space of each cylinder is divided into two parts which receive the different pressures, openings leading to the single spaces of the cylinders, and slide-valves working on the said openings.

5. Engine of the type described, comprising in combination two cylinders arranged in juxtaposition, a crank-shaft the cranks of which being rotated 180° relatively to one another, two drum shaped pistons not touching the periphery of the said cylinders and attached to the cranks of the said shaft in each cylinder, pairs of hinged flaps in the cylinders, every two of said flaps being situated opposite one another and being able to turn in an opposite direction, channels arranged in such a manner that each cylinder space will be connected to the corresponding channels, and pipes connecting the emission channel of the one and the admission channel of the other cylinder.

In testimony whereof we have signed our names to this specification in the presence of the two subscribing witnesses.

CARL GAUSE.
PHILIPP CONRADY.

Witnesses:
WOLDEMAR HAUPT,
HENRY HASPER.