No. 780,812. PATENTED JAN. 24, 1905.

A. RADOVANOVIC.
EXPLOSIVE MOTOR.

APPLICATION FILED FEB. 16, 1904.

Fig.1.

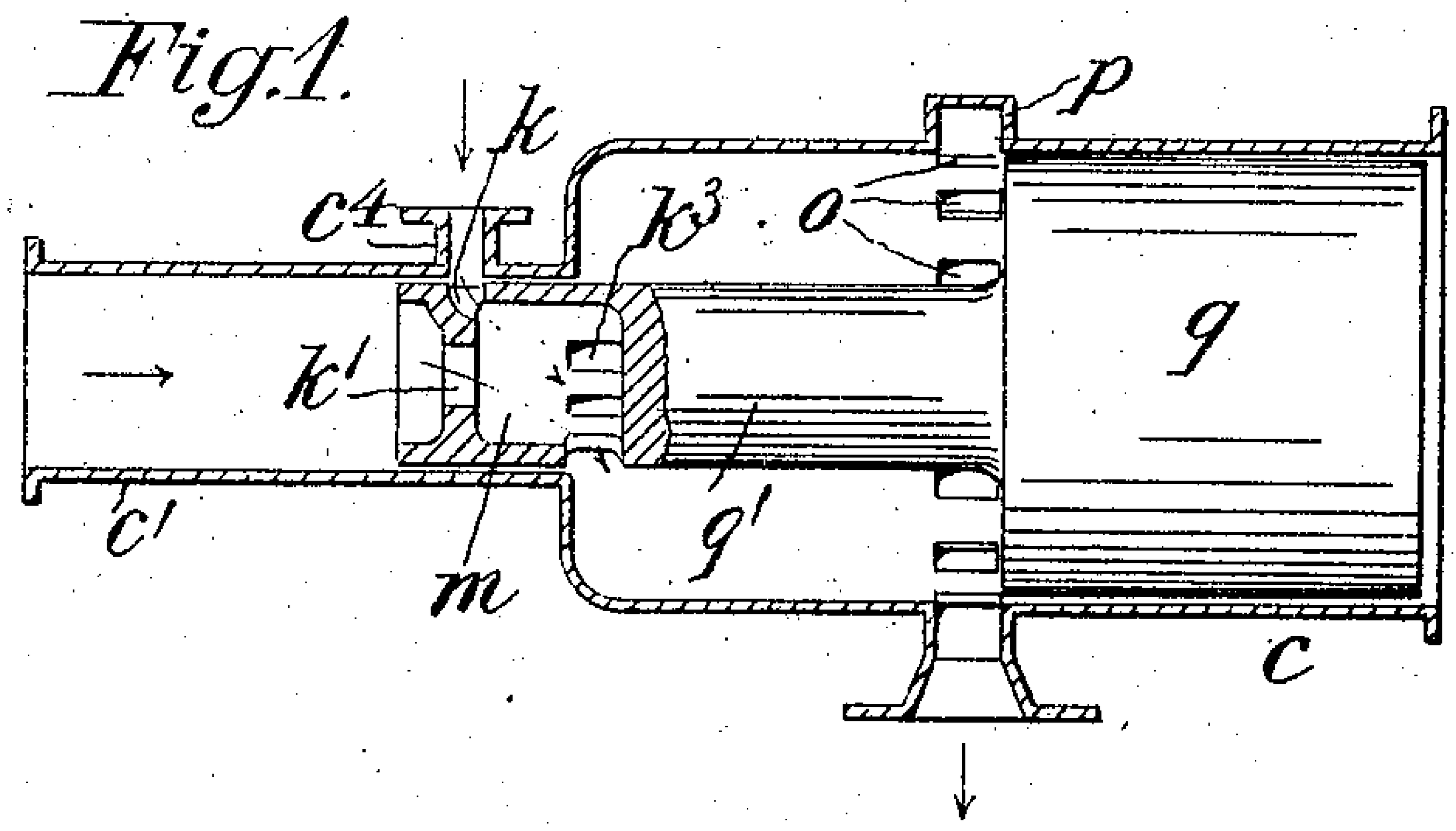


Fig.2.

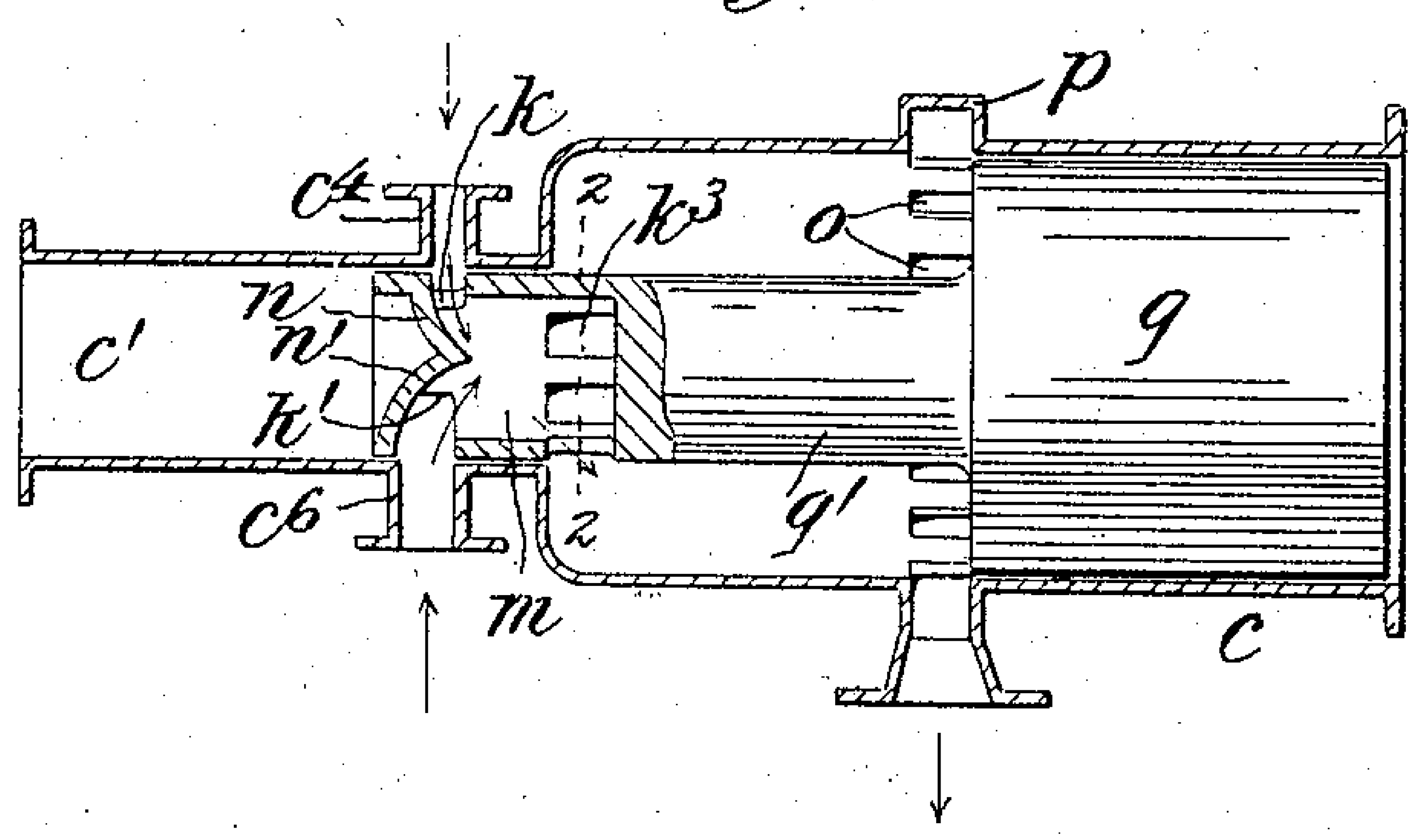


Fig.3.

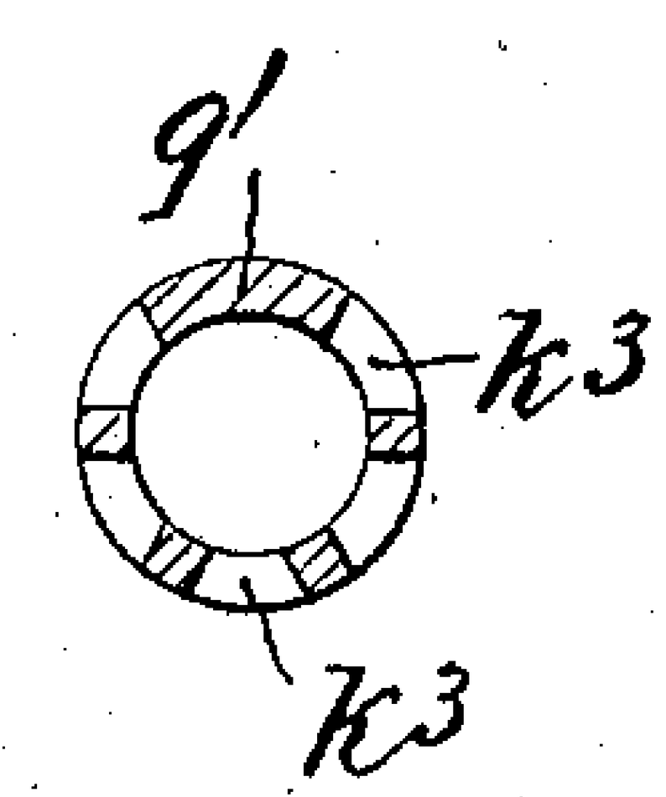


Fig.4.

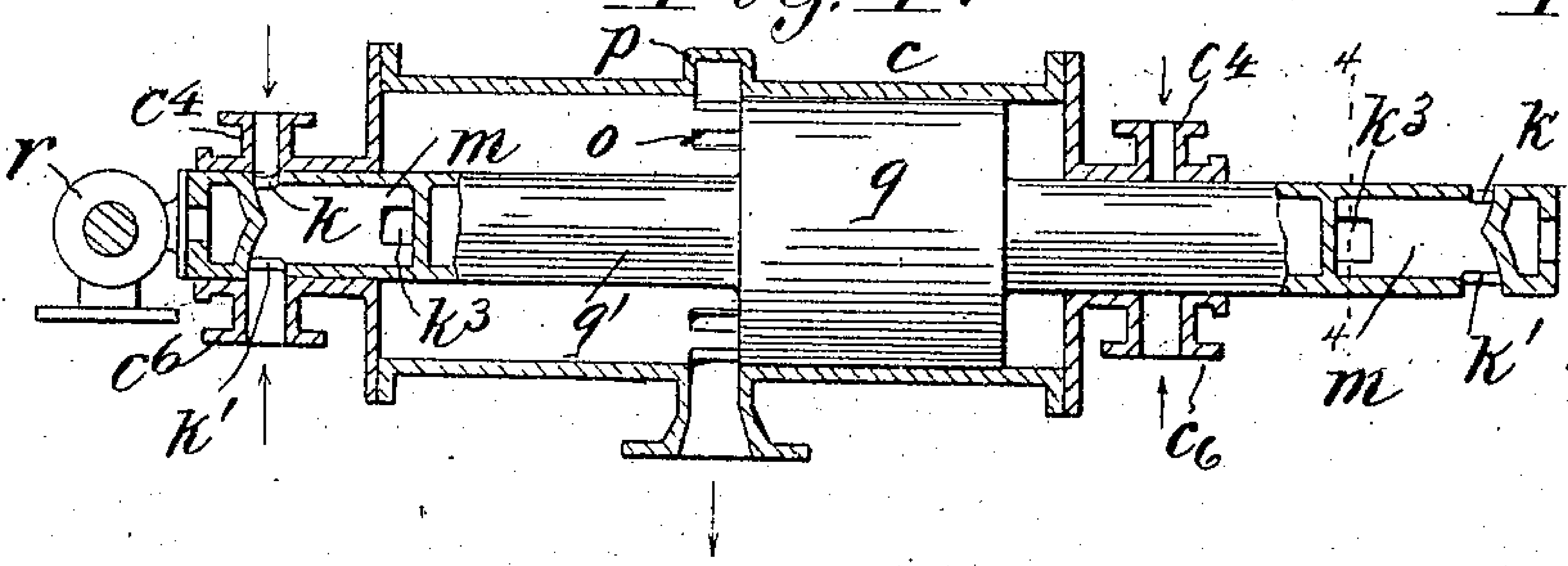
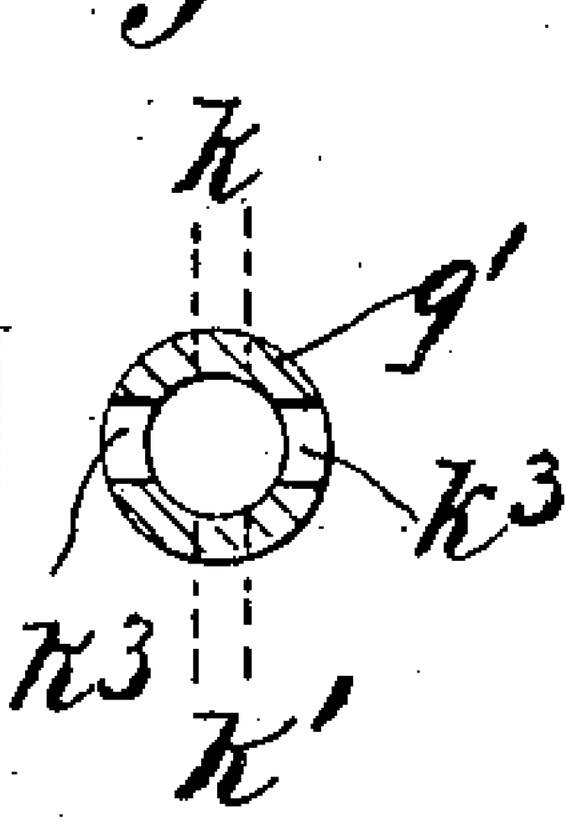


Fig.5.



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No. 780,812. Patented January 24, 1905.

UNITED STATES PATENT OFFICE.

ANDREAS RADOVANOVIC, OF ZURICH, SWITZERLAND.

EXPLOSIVE-MOTOR.

SPECIFICATION forming part of Letters Patent No. 780,812, dated January 24, 1905.

Application filed February 16, 1904. Serial No. 193,834.

To all whom it may concern:

Be it known that I, ANDREAS RADOVANOVIC, a subject of the Emperor of Austria-Hungary, residing at Zurich, in the Republic of Switzerland, have invented certain new and useful Improvements in Explosion-Motors, of which the following is a specification.

My invention has relation to two-cycle explosion-motors devoid of admission and exhaust valves.

A characteristic feature of my invention lies in the provision in the piston-rod of a mixing-chamber or receiver for the gas and air, from which they pass to the cylinder, and in the arrangement of the exhaust-ports so as to be controlled by the piston.

A further characteristic feature of my invention lies in the arrangement of the air and gas admission ports so as to be controlled by the piston-rod and opened successively in the order named when the piston is about to reach the limit of its effective stroke and uncover the exhaust-ports, the object being to cause the inflowing air to sweep out the products of combustion before gas is admitted to the mixing-chamber, for purposes hereinafter referred to.

That my invention may be fully understood I will now describe the same, reference being had to the accompanying drawings, in which—

Figure 1 is a longitudinal sectional view of a single-acting explosion-engine embodying my invention. Fig. 2 is a similar view of such an engine, showing a modification in the location of the air-inlet port; and Fig. 3 is a cross-section of the piston-rod on line 2 2 of Fig. 2. Fig. 4 is a longitudinal sectional view of a double-acting explosion-motor embodying my improvements, and Fig. 5 is a cross-section on line 4 4 of Fig. 4.

Similar symbols of reference indicate like parts in all the figures of the drawings.

Referring to Fig. 1, which shows the piston at the limit of its power-stroke, *c* indicates the cylinder, which has a tubular extension or trunk *c'* at one end and of less cross-sectional area and provided with a gas-supply branch c^4 near its inner end. Midway of its length the cylinder *c* has an external peripheral exhaust-channel *p* and internal ports *o*, opening into said channel. In cylinder *c* works a piston *q*, whose rod *q'* has a chamber *m* at its outer end, which chamber has peripheral outlet-ports k^3 at its inner end, a peripheral gas-admission port *k* near its outer end, and an air-admission port *k'* in its said outer end or head.

It will be observed that the length (parallel to the axis of the cylinder *c*) of the outlet-ports k^3 of the mixing-chamber is greater than that of the gas-admission port *k* and that the exhaust-ports *o* are of substantially the same length as that of said ports k^3.

The object of the described arrangement of ports is to admit air to the cylinder *c* behind the piston *q* as soon as the latter begins to uncover the exhaust-ports *o* to sweep the products of combustion from the cylinder *c* before gas is admitted to the mixing-chamber *m*, which admission takes place when ports k^3 and *o* are fully uncovered and the piston begins its return or compression stroke. I thus provide an ample supply of air to the gas admitted, effect a mixture of the two in chamber *m*, and prevent escape of gas through the exhaust-ports *o*, which latter will be covered by the piston before any gas can reach said ports, as will be readily understood.

The difference between the construction described and that shown in Fig. 2 lies, essentially, in providing the extension *c'* of the cylinder *c* with an air-inlet branch c^6 approximately opposite the gas-inlet branch c^4, but of greater internal cross-sectional area than that of said gas-inlet branch, and in providing the piston-rod *c'* at its outer end with an air-inlet port *k'* of a length at least equal to the internal diameter of said branch c^6, and consequently of greater length than that of the gas-inlet port *k*, for the purposes above explained. A further difference lies in forming on the inner face of the head or outer wall of the air-chamber *m* deflecting or directing surfaces *n n'* to deflect and direct the inflowing gas and air, respectively, toward the longitudinal center of said chamber *m*, to be there admixed before they flow through the outlet-ports k^3 into the cylinder *c*.

In Fig. 4 I have shown a double-acting engine embodying the structural features shown

in Fig. 2 by simply duplicating the piston-rod, the mixing-chamber, and the air and gas admission ports and branches, or, in other words, the cylinder c has a tubular extension c' at each end, each provided with gas and air supply branches c^4 c^6, respectively. The piston q has a chambered piston-rod q' projecting from either face, the mixing-chambers m having outlet-ports k^3 at their inner end and gas and air admission ports k and k', respectively, at their outer end. The extensions c' of the cylinder c are, however, much shorter, so that one of the piston-rods can be connected directly to the cross-head r, as shown on the left of Fig. 4.

In the construction shown in Figs. 1 and 2 the right-hand end of the cylinder c is open, and the piston in either construction or the piston-rod Fig. 2 is connected to the driving element as a cross-head or crank (not shown) in any well-known manner.

In the construction shown in Figs. 1 and 2 the piston is at the limit of its power-stroke and about to make its return or compression stroke, exhaust-ports o being still open, but about to be closed, air and gas being admitted to chamber m of the piston extension q' through ports k and k', respectively. As soon as ports o are closed compression begins, the air and gas inlets being closed as soon as the piston extension q' has moved into cylinder extension c' sufficiently first to bring gas-port k beyond gas branch c^4 and then ports k^3 of mixing-chamber m into said extension, and at or about at the completion of the stroke of the piston q ignition of the charge takes place and said piston is driven back to the left into its position shown in Figs. 1 and 2, and so on.

As shown in Fig. 4, the piston q is at the limit of its stroke to the right, during which stroke air and gas has been drawn into the cylinder on the left of said piston. The charge of explosive fluid on the right of the piston being now exploded drives said piston to the left, first cutting off the gas and air supply by the movement of the left-hand piston extension q' into the cylinder extension c', when compression begins and continues until the piston reaches the limit of its stroke to the left, when the charge of explosive is ignited to again drive the piston to the right. Before the piston reaches the limit of its stroke from right to left the exhaust-ports o are being uncovered by said piston to exhaust the products of combustion. At the same time the air-port k' in the right-hand piston extension will partly communicate with the air-inlet branch c^6 to admit air to the cylinder and sweep out the products of combustion, and as the piston is about to complete its stroke to the left the air and gas ports k' k will be in full register with their respective supply branches c^6 c^4 to admit air and gas to chamber m and thence to the cylinder on the right of the piston. The compressed charge of explosive on the left of the piston is now ignited and the piston driven to the right, when the described operations are repeated, the charge on the right of the piston being compressed, the products of combustion on the left of the piston exhausted, and a charge of air and gas admitted to the cylinder on the left of the piston, and so on.

By admitting the air and gas first to a mixing-chamber and causing it to flow through narrow ports k^3 the two fluids are thoroughly mixed, and this is more effectually attained by providing the deflecting or directing surfaces n and n', the streams of air and gas drawn or flowing into the mixing-chamber m being deflected or directed toward each other, and thereby commingled.

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

1. In combination, a cylinder having midway of its length internal peripheral exhaust-ports, a piston controlling said ports, a piston extension, a mixing-chamber therein having ports adapted to place the cylinder in communication with said chamber, the latter provided with air and gas admission ports and means to supply air and gas to said ports respectively, said supply and the admission of the mixture to the cylinder controlled by the movements of the piston extension, for the purpose set forth.

2. In combination, a cylinder having midway of its ends internal peripheral exhaust-ports, and a tubular extension at one end having air and gas supply branches, a piston controlling the exhaust-ports, a piston extension having a mixing-chamber therein provided with distributing-ports adapted to place the cylinder in communication with said chamber, the latter provided with a peripheral longitudinal air-admission port and a similar gas-port shorter than and diametrically opposite said air-port and adapted to be brought into and out of register with the air and gas supply branches, respectively, by the movements of the piston extension, for the purpose set forth.

3. The combination with a cylinder provided midway of its length with internal, peripheral, longitudinal exhaust-ports and with a tubular extension at one end provided with air and gas supply branches diametrically opposite each other; of a piston controlling the exhaust-ports, a piston extension provided with a mixing-chamber having distributing-ports of substantially the same length as the aforesaid exhaust-ports and with a longitudinal air-admission port and a like shorter gas-admission port adapted to be brought into and out of register with the air and gas supply branches, respectively, by the movements of the piston extension, for the purpose set forth.

4. The combination with a cylinder provided with internal peripheral exhaust-ports and with a tubular short extension at either end, each of said extensions provided with a lon-

gitudinal air-supply port and diametrically opposite thereto with a similar but shorter gas-admission port; of a piston controlling the exhaust-ports, a piston extension at either end of said piston longer than the cylinder extensions, said piston extensions provided at their outer ends with a mixing-chamber having ports adapted to be brought into and out of communication with the cylinder by the movements of the piston, said mixing-chambers having each a longitudinal air and a like gas admission port corresponding in length to the aforesaid air and gas supply ports, respectively, and adapted to be moved into and out of register with their respective supply-ports by the movements of the piston, for the purpose set forth.

In testimony whereof I have hereunto set my hand in presence of two subscribing witnesses.

ANDREAS RADOVANOVIC.

Witnesses:

A. LIEBERKNECHT,

JOHANNES FISCHER.