N. E. DAVIES.

INTERNAL COMBUSTION ENGINE.

APPLICATION FILED FEB. 8, 1910.

986,552.

Patented Mar. 14, 1911.

4 SHEETS—SHEET 1.

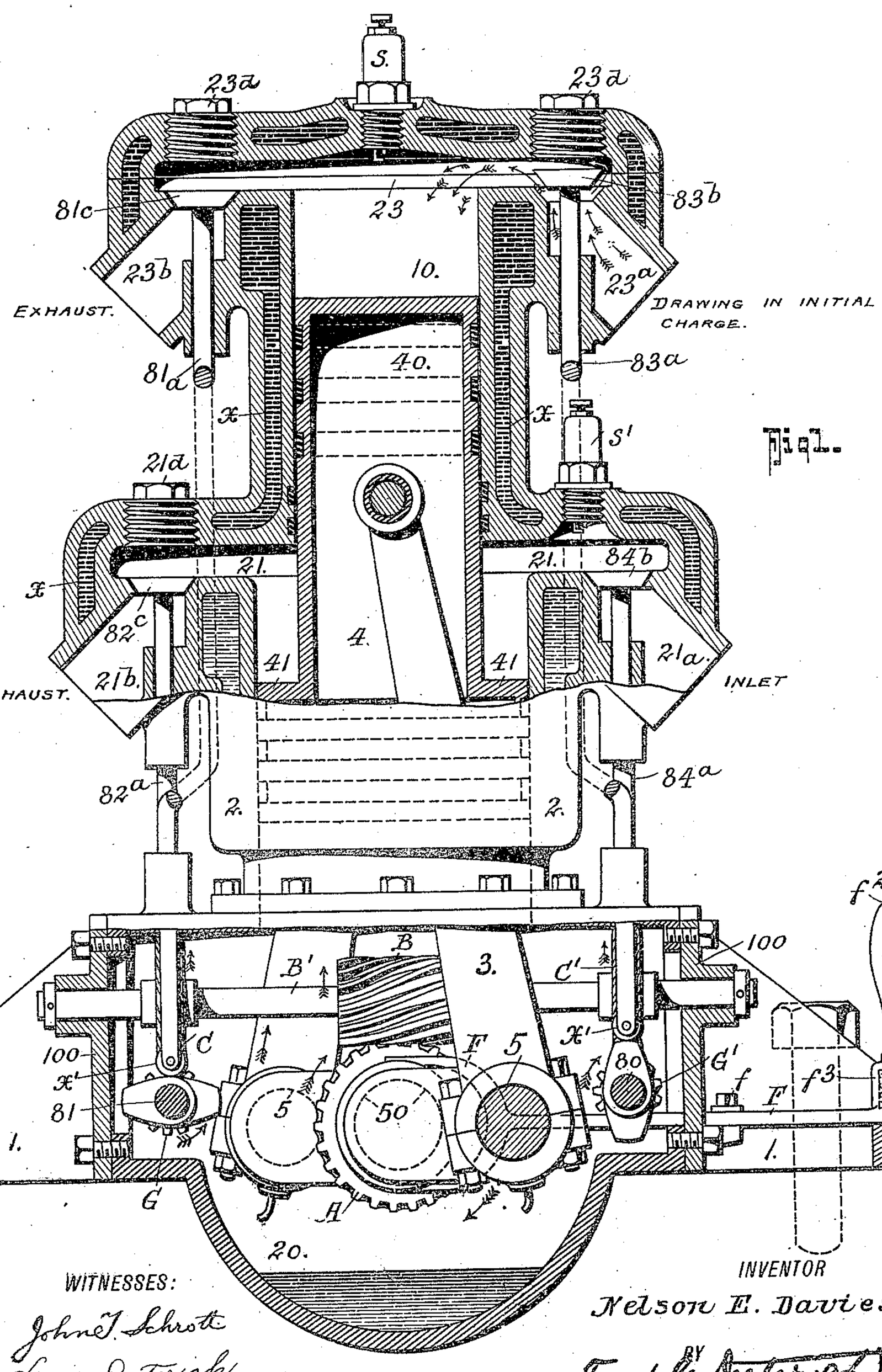

Fig. 1.

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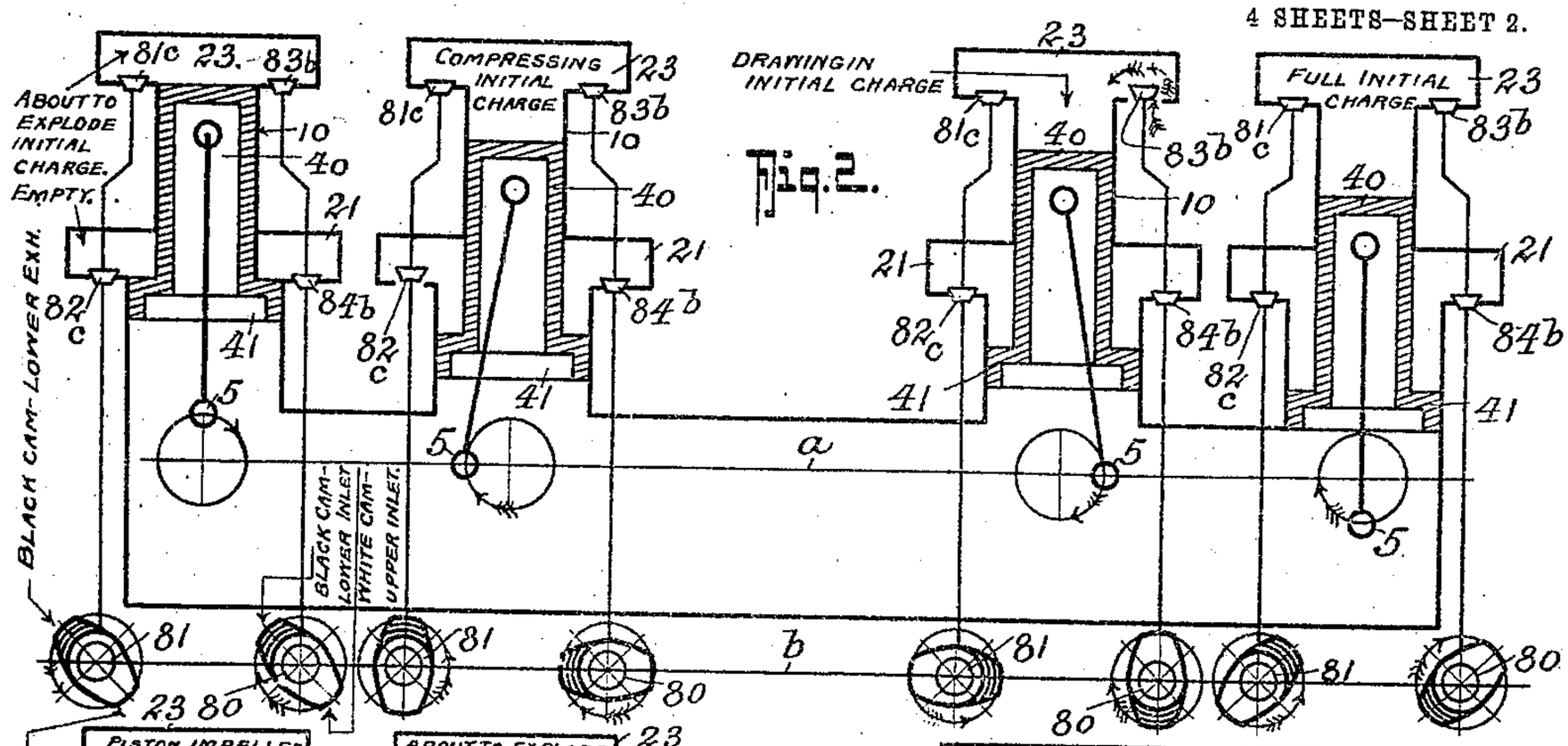

Fig. 2.

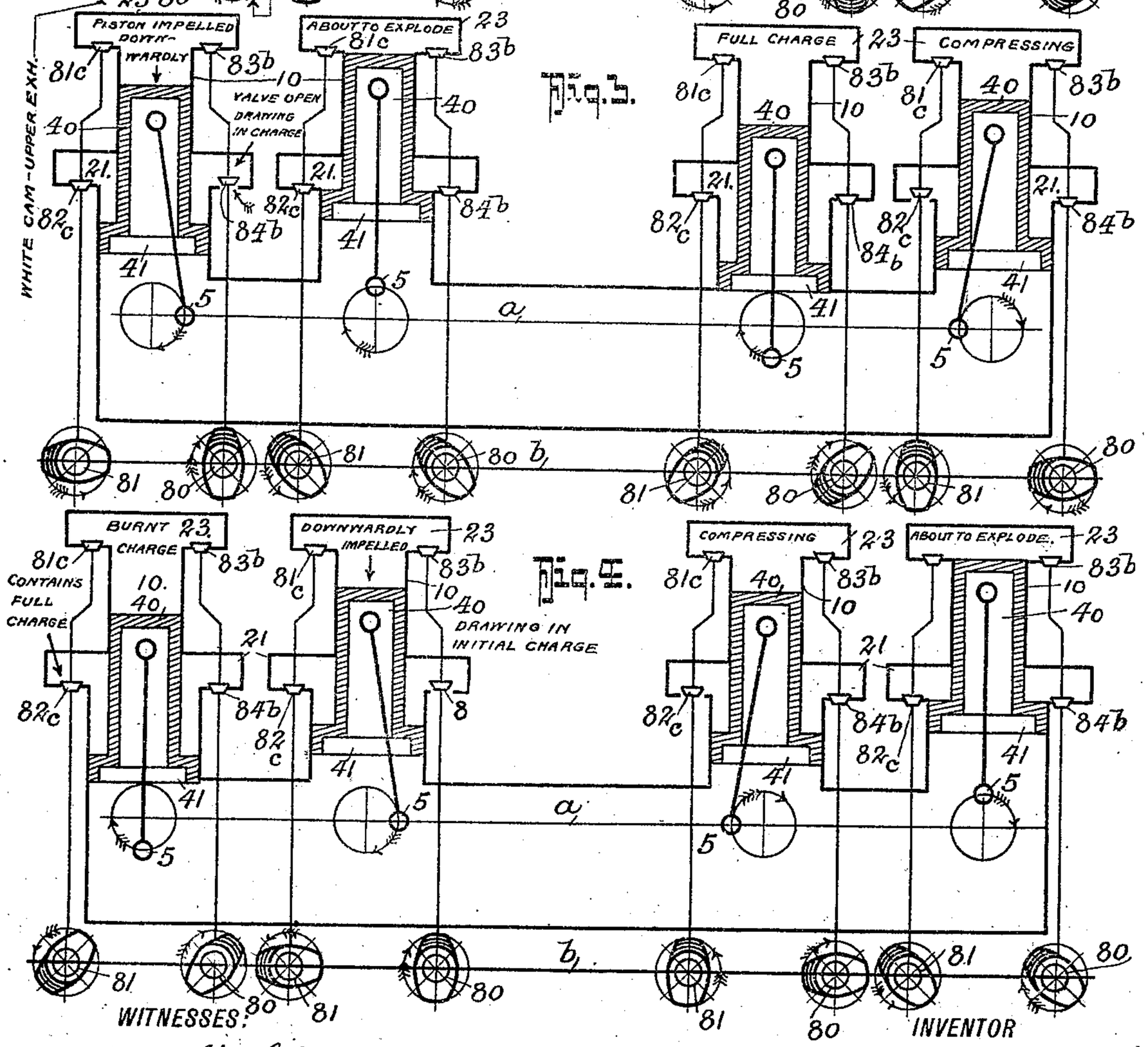

Fig. 3.

Fig. 4.

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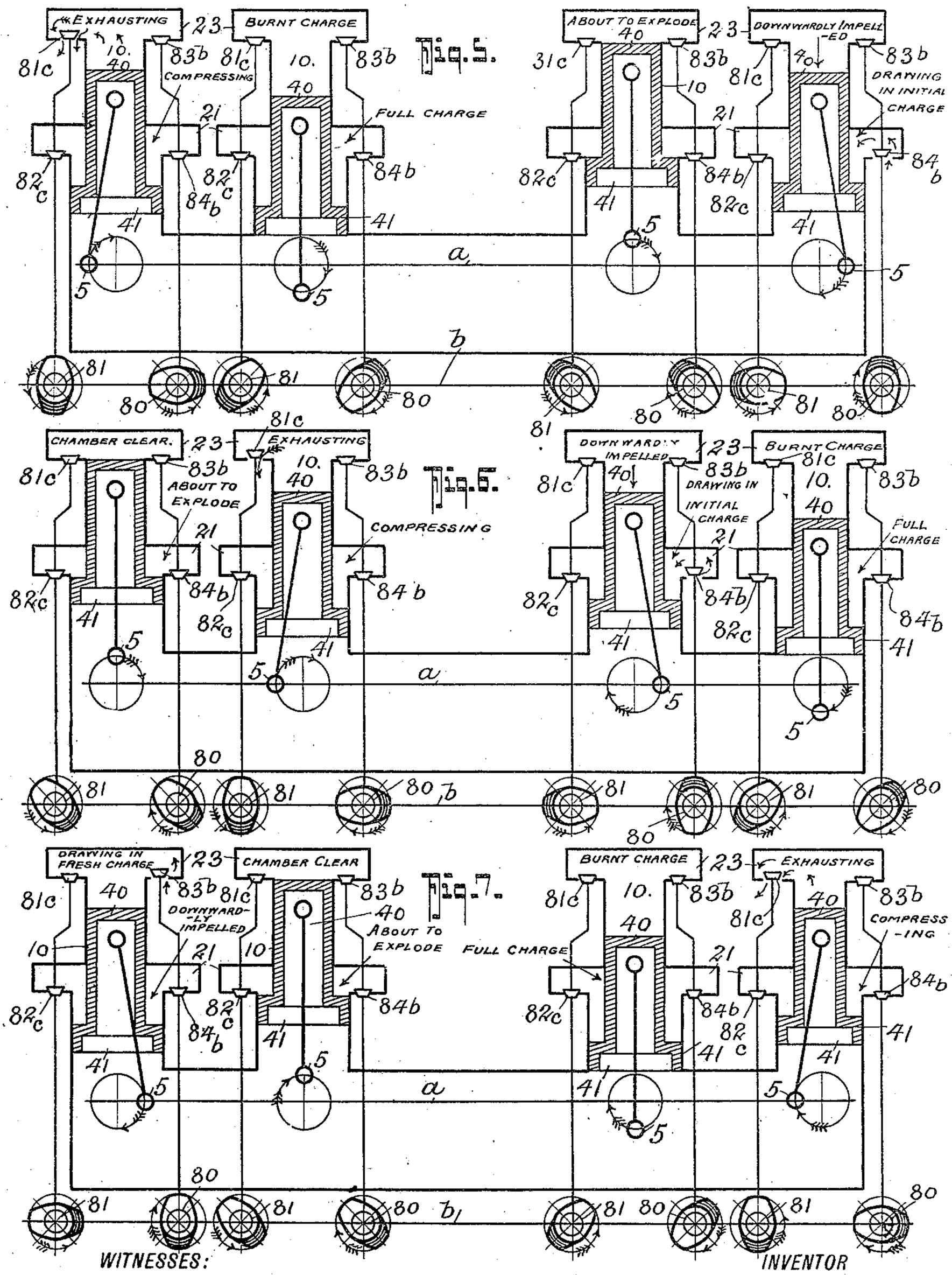

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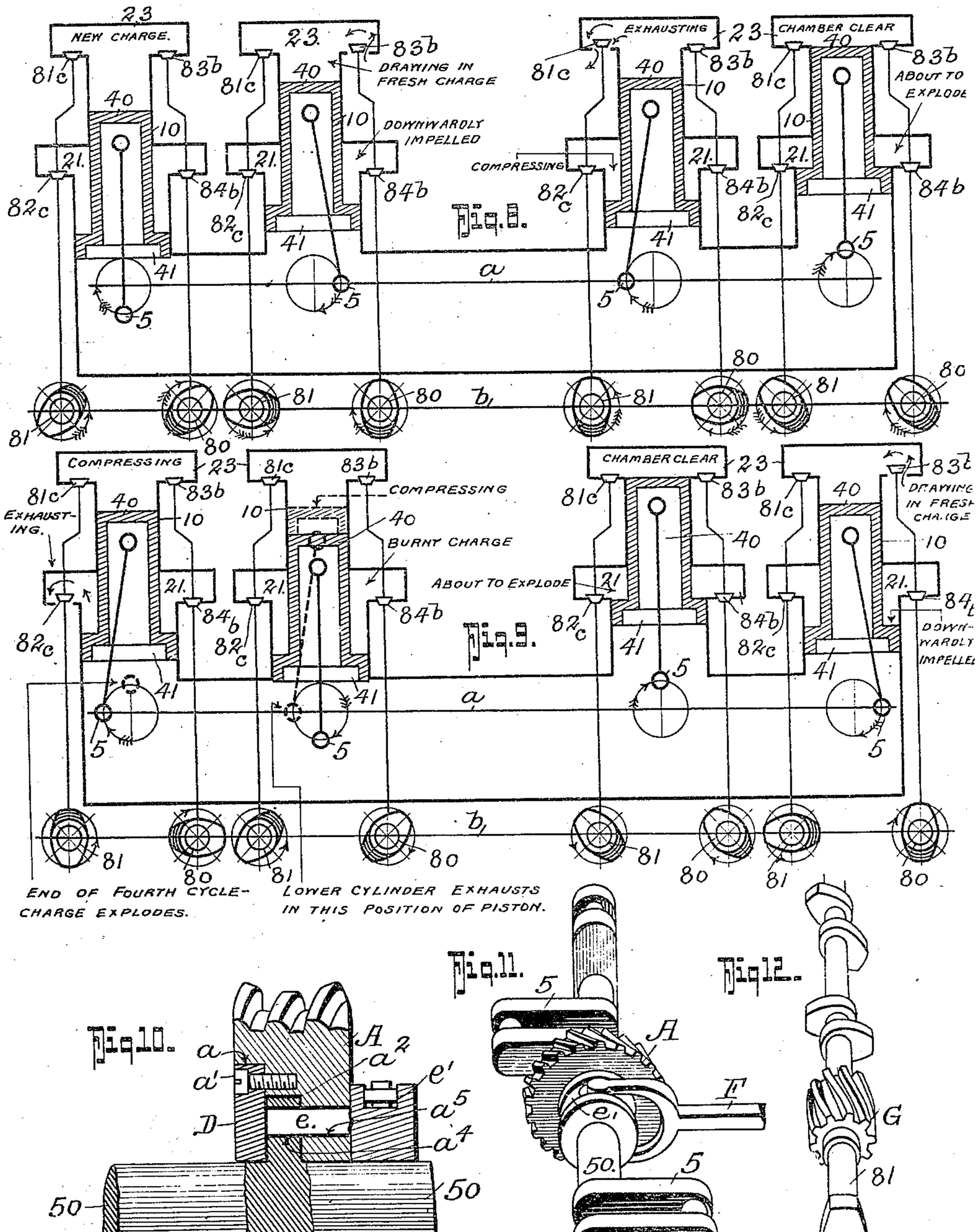

Fig. 10.

Fig. 11.

Fig. 12.

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UNITED STATES PATENT OFFICE.

NELSON EDWARD DAVIES, OF SAN FRANCISCO, CALIFORNIA.

INTERNAL-COMBUSTION ENGINE.

986,552.

Specification of Letters Patent. **Patented Mar. 14, 1911.**

Application filed February 8, 1910. Serial No. 542,776.

To all whom it may concern:

Be it known that I, NELSON EDWARD DAVIES, residing at San Francisco, in the county of San Francisco and State of California, have invented a new and Improved Internal-Combustion Engine, of which the following is a specification.

This invention, which relates to gas engines and other explosive or internal combustion motors operated by the explosion of gaseous or liquid combustibles, such as gas, gasolene, oil, naphtha or admixtures thereof with air for the motive charges, more particularly refers to that type of gaseous fuel engines known as four cycle engines, and my invention has for its object to provide an improved construction of four cycle engine of a simple and compact construction, in which the cylinders and pistons are so designed and coöperatively combined with the improved arrangement of the working agent intakes and the exploded mixture exhausts together with a crank shaft actuated valve mechanism for controlling the intake and exhaust valves, that a compact construction of parts is provided and designed for obtaining an impulse at every quarter revolution of the crank shaft.

Another object of my invention is an improved arrangement of mechanically actuated intakes and exhausts combined with especially designed, practically noiseless spiral gear driven reversing mechanism and of such character that it cannot strip should the engine fire backward, and coupled with the crank shaft for positively operating the valves for the inlets and exhausts at required times, the motor mechanism also including the peculiar coöperative arrangement of the cylinders and the pistons whereby as the latter are traveling under the impulse from one end of the cylinder they gather the working charge of the other end of the cylinder to be exploded at that end, and vice versa.

In its still more subordinate features, my invention consists in certain details of construction and peculiar combination of parts, all of which will be hereinafter fully described, pointed out in the appended claims and illustrated in the accompanying drawings, in which:—

Figure 1, is a central, vertical cross section through one of the cylinders of the engine. Figs. 2 to 9 are diagrammatic views illustrating the operation of the engine. Fig. 10, is a vertical cross section of my improved reversing clutch. Fig. 11, is a detail perspective view of the crank shaft. Fig. 12, is a detail perspective view of a part of one of the cam shafts.

When adapted as an upright engine, my invention comprises a suitable base or foundation to which is attached a pendent semi-circular casing 20 that forms the lower part of the crank chamber and the holder for the crank shaft lubricant.

While my present construction of engine embodies, as before stated, four working cylinders coupled to operate on a single crank shaft, I shall proceed to describe but one of the said cylinders in detail, since all are of like construction and operate alike, the explosive action of each being timed relatively to the others by the peculiar setting of the actuating cams on the crank shaft, as will hereinafter be more fully explained.

The engine cylinder is firmly secured to and mounted in an upright position on the base 1 and comprises a lower portion 2 of suitable diameter and in open communication with the crank casing below it, so as to provide for a proper swing of the crank rod 3 that joins with the trunk shaped piston 4, and with the crank pin or member 5 on the crank shaft 50, which, in practice is journaled in suitable bearings in the base 1, or elsewhere.

The full height of cylinder portion 2 is of uniform diameter and the upper end merges with a horizontally disposed combustion chamber 21 that extends annularly of the cylinder portion 2 and which is at all times cut off from the upper cylinder portion by a working cylinder piston 4, as is clearly understood from Fig. 1, by referring to which it will be also seen that from chamber 21 extends the upper cylinder portion 10, which is of a diameter somewhat less than the lower part 2, the said upper portion 10 merging with the upper combustion chamber 23 in a plane parallel with the lower chamber 21 and likewise annularly extended with respect to the cylinder portion 10.

It should be stated that while cylinder portions 10 and 20 are relatively of different diameters they have the same cubical capacity.

The piston 4 comprises an upper portion 40 of a diameter to fit cylinder portion 10

and a lower portion 41 for snugly fitting the cylinder portion 2, the said lower part of the piston, by reason of its increasing diameter, acting, as it were, as a separate and distinct piston and serves, as does the other end of the piston, as a pump and compression member, it being understood that the two parts of the piston coöperate with the combustion chambers 21 and 23 and the valved intake and outlets that coact therewith.

The upper and lower combustion chambers 23 and 21 each have a valved intake 23^a and 21^a at one side and valved exhausts 21^b and 23^b at the other side, the positions of the intakes and outlets of the said upper and lower chambers 21 and 23 being alternately disposed for the proper positioning thereof with the tripper or actuating cam device presently described, and in my present construction of engine, screw plugs 21^a and 23^d are located on the casings of the chambers 21 and 23 directly over the valve seats, see Fig. 1, the purpose of which is to provide for easy access to the said seats and valves which makes it handy to scrape the carbon out of the chambers 21 and 23 and also to grind the valves. The engine cylinder is provided with a water jacket x that also surrounds the chambers 21 and 23, as is clearly shown in Fig. 1, which also illustrates, in cross section, the two cam shafts 80 and 81 that are geared with the crank shaft 50 and which carry the cam devices for actuating the upper and lower valves at their respective sides, the inlet valves at one side that are controlled by the shaft 80 being designated 83^b and 84^b while the exhaust valves at the opposite sides controlled by shaft 81 are designated 81^c and 82^c, valve 81^c having a pendent rod 81^a, valve 82^c having a similar rod 82^a and valves 84^b and 83^b have like rods 84^a and 83^a, respectively, the positions of which will be readily apparent from Figs. 2 to 9 of the drawings.

One of the essential features in my present complete type of engine is the combining with the crank shaft, of a reversing mechanism that forms a part of the cam actuating means, the construction of which is shown in detail in Figs. 10, 11 and 12 of the drawing and essentially consists of a spiral toothed gear A that meshes with a worm spiral B, fixedly held on a shaft B′, suitably journaled in side walls 100 of the crank casing, see Fig. 1, and which carries at each end a spiral gear C—C′, each of which gears is held in mesh with a worm gear G—G′ fixedly mounted on the cam shafts 81 and 80, one of the said gears G, and the attached cam shaft 80 being shown in detail in Fig. 12. The several spiral gears are proportioned on the "two to one" basis so that uniform rotations of the cam shafts 81 and 80 and crank shaft 50 is provided for.

When it is desired to reverse the engine, the operator shifts the clutch members E out of connection with the disk a^3 of the shaft 50, whereupon when the engine is at rest the fly wheel may be turned one-half revolution and the clutch members E again clutched with the disk a^3, thereby setting the valves for a reverse operation of the engine upon starting up again. A skilled operator can reverse the engine while running in the same way, namely,—while the engine is running, the operator shifts the members E out of the holes a^4, whereupon the friction of the parts will hold the pinion A practically stationary. As soon as the shaft 50 has made a half turn, the operator quickly shoves the members 3 back into the holes a^4 to lock the gear c and shaft 50 together again, it being understood that the shifting of the members E out of the holes a^4 and back again is done very quickly during the time the shaft is making one-half turn and naturally the engine would have to be throttled down to a slow speed before reversal takes place.

Gear A is held on the crank shaft 50 by a collar D which seats in a socket a in one side of the gear A and to which it is fixedly held by the screws a'—a', the said gear also having an annular groove a^2 to receive the annular flange a^3 on the crank axle. At this point it should be stated that except when clutched with the axle in the manner presently stated, gear A, with its collar D, runs loose upon the shaft 50. Axle flange a^3 has a number of apertures a^4 and gear A is also provided with apertures a^5, the said apertures a^4 and a^5 being disposed at the same distance from the center of the shaft 50, the purpose of which will be understood by referring to Fig. 10, which also shows a clutch collar E that has pins e—e that normally seat in the apertures a^5 in the gear A, and which, when the clutch member E is shifted to lock the gear A to the shaft 50, enters the apertures a^4 and thereby holds the gear to the axle 50 to turn therewith, it being obvious that as clutch member E is loosely mounted it also runs with the gear A.

F designates a shifting lever that takes in the annular groove e^2 of the clutch E and is fulcrumed at f to swing in the horizontal plane, see Fig. 1, and it has a handle f^2 that is provided with a spring latch f^3 for locking the lever to its set positions.

By reason of gearing up the cam shafts 81 and 80 with the crank shafts 50 in the manner described and shown, the said cam shafts are always in proper correlative arrangement for actuating the valves, since in reversing the engine the spiral gear on shaft 50 will slip around on the said shaft 50 to the proper point of turning for the reversing of the engine, when by retarding the ignition or sparking means, the engine can

be readily started to run in the opposite direction, and when thus started, the clutch is again locked to the shaft to carry the spiral gear with it, it being also understood from the drawing that the valves and actuating means therefor, are so combined and operated that the valves are positively opened mechanically at proper predetermined times during the intake stroke of the piston. The construction of the piston and cylinder in my present invention are such that as the piston travels under the explosive impulse at the upper or smaller end, it is acting as a bottom closure for the lower combustion chamber and while on the down stroke, as stated, the intake valve is mechanically opened, the same mechanical action of the intake valve for the upper chamber 23 taking place when the piston is descending under the explosion that occurred in the lower chamber 21.

As hereinbefore stated, in the preferred form of my present type of engine, it embodies four cylinders, each of like construction and operation and that the general arrangement of said collars and other coacting pistons may be understood especially with respect to their connection with the crank or driven axle 50, attention is now directed to Fig. 2 of the drawings which diagrammatically shows the four working cylinders and pistons, the several cam shafts with their cams, two for each cylinder, being also diagrammatically illustrated, the long line *a* indicating the proper position of the single drive or crank shaft common to all the pistons and cylinders, and the long line *b* indicating the longitudinal direction of the cam shafts, it being understood the identical circles indicating the crank shaft in each cylinder represent the same identical shaft 50 shown in Fig. 1.

Assuming the parts to be positioned as in Fig. 2, cylinder 10 will have the working agent as compressed in chamber 23 with the piston just ready to be impelled under the explosion of said charge, all of the several valves for the intakes and exhausts for the cylinder 10 being now closed, piston in No. 2 cylinder yet compressing a working charge in its top chamber 23, the valve for said chamber being closed and the exhaust valve 81^c for the lower chamber being open, the crank connection of the piston for cylinder No. 2 being one-fourth of a circle or 90° back of the crank connection for the piston in cylinder 10.

The piston in cylinder No. 3 will be still in the act of drawing in a new charge, the valve 84^b for top chamber being still open, while the valves in the lower chamber 21 are now held closed by the combustion pressure therein that has driven piston for the cylinder 3 down, it being observed that the crank connection of the piston last mentioned with the crank shaft is one-fourth of a circle forward of connection for cylinder 2 and it is diametrically opposite the connection for No. 1 cylinder, whereas the connection for piston No. 4 is one-fourth of a circle forward of the connection for cylinder 3 and it is diametrically opposite to the connection for cylinder 2, the piston in No. 4 at this time also drawing a charge in the top chamber 21 as its lower end is still under the impelling force of the exploded charge in chamber 23.

Fig. 3 shows the position of the four cylinders and their pistons with their crank connections advanced 90° or one-fourth of a circle, the piston of cylinder No. 1 when the above action occurs being still impelled by the explosion in chamber 21 with each of its valves 83^b mechanically opened for allowing for drawing in a working charge into the lower chamber 21, the relative positions of the pistons 23 and 4 being clearly as presented by said Fig. 3, all of the cranks being one quarter ahead of the former or front position.

Fig. 4 illustrates what might be termed the fourth position of the pistons and cranks and in this arrangement the burned charge in cylinder 1 has spent itself, the crank being now at its farthest down position and just ready to be moved upwardly under the explosive force of the full or compressed charge in compartment 23, the piston in No. 3 cylinder being at this time directly opposite to that of piston in the cylinder 1.

In Fig. 5 the several cylinders are in another position, piston in cylinder 4 being now in position to impart a final quarter turn to complete the revolution of the axle 5 that was started by the explosive down thrust of the piston in cylinder 1, before referred to.

In Figs. 6, 7, 8 and 9 the pistons in the cylinders 1, 2, 3 and 4 are shown as assuming proper positions, they being on the up stroke to compress the charges in their respective cylinders in the lower chamber 23 whereby to receive impulse, as clearly indicated on the drawing.

The several valve lifting rods have friction rollers x'—x' for engaging their respective cams and each of the chambers 21 and 23 has a sparking plug s'—s', see Fig. 1 of the drawing, of any approved construction.

From the foregoing description, taken in connection with the accompanying drawings, the complete construction, operation and general advantages of my invention will be readily understood by those skilled in the art to which it appertains.

In practice, my engine is oiled throughout by the splash feed system, and by reason of coupling the cylinders with one crank shaft as stated and shown, the thrusts on the

crank shaft are made in quarters, and since the engine fires on quarters there is a quarter revolution lapse in every impulse of the engine's explosion, the connections being such that it fires from the top center of the crank downwardly and with two successive impulses alternately applied at opposite ends of the shaft, thereby obtaining a more steady power and greatly increased efficiency since by reason of a four cycle engine adapted for firing on quarters, I produce, as it were, two cycle results, but producing twice the power and speed for corresponding weight and size.

It should be stated that in my present construction of engine, since the entire gearing for actuating the valve rods is inclosed within the casing 20, the said gearing is not alone protected against dirt or dust and compactly held so that a practical coöperative arrangement of the cam shafts 80 and 81 is provided for, and a practical positioning of the reverse devices with the cam shafts is also obtained and all positioned to be in the oil splash or zone within the casing 20.

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

1. In an explosive engine, having an oil holding crank casing, the combination with the working cylinder and piston and the valve for controlling the intakes and exhausts for the working cylinders; of devices actuated from the crank shaft for opening the valves for the said intakes and exhausts at predetermined times, said devices being located within the crank casing, a reversing gear mechanism that coöperates with the crank shaft located within the crank casing, and means extended externally of the casing for operatively connecting and disconnecting said gear mechanism to and from said crank shaft.

2. In an explosive engine, having an oil holding crank casing, the combination with the working cylinder and piston, and the valves for controlling the intake and exhaust valves for the working cylinder; of devices actuated from the crank shaft for opening the valves for the several intakes and exhausts at predetermined times, said devices being located within the crank casing and means operable from without the crank casing for altering the position of the actuating parts to reverse the engine.

3. In an explosive engine, the combination with a working cylinder and piston, the crank shaft connected with the piston, an oil holding casing that incloses the crank shaft, and the intake and exhaust valves for the working cylinder, each of said valves having a pendent member that extends into the crank chamber; of independent shafts in the casing, each having cams for coöperating with the said pendent members at their respective sides, another shaft in the casing geared with both cam carrying shafts, and direct gear connections that connect the said other shaft with the crank shaft.

4. In an explosive engine, the combination with a working cylinder and piston, the crank shaft connected with the piston, an oil holding casing that incloses the crank shaft, and the intake and exhaust valves for the working cylinder, each of said valves having a pendent member that extends into the crank chamber; of independent shafts in the casing, each having cams for cooperating with the said pendent members at their respective sides, another shaft in the casing geared with both cam carrying shafts, and direct gear connections that connect the said other shaft with the crank shaft, and shifting clutch mechanism on the crank shaft operable from outside the casing for bringing said gear connections into and out of operative connection with said crank shaft.

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Witnesses:
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