(No Model.)

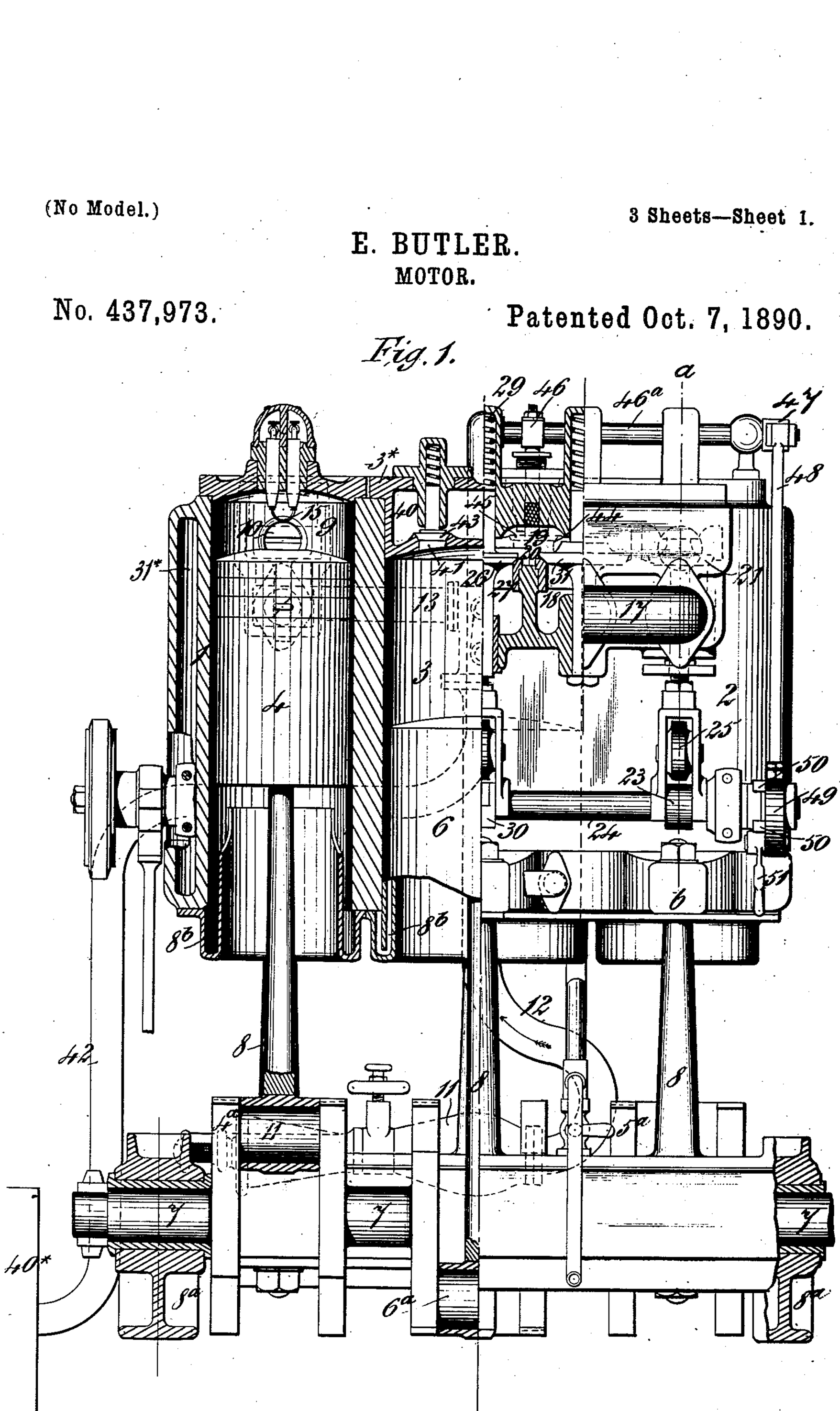
3 Sheets—Sheet 1.

E. BUTLER.

MOTOR.

No. 437,973. Patented Oct. 7, 1890.

Fig. 1.



Witnesses
W. Cross.
Wm. Frost.

Inventor.
Edward Butler.

(No Model.)

3 Sheets—Sheet 2.

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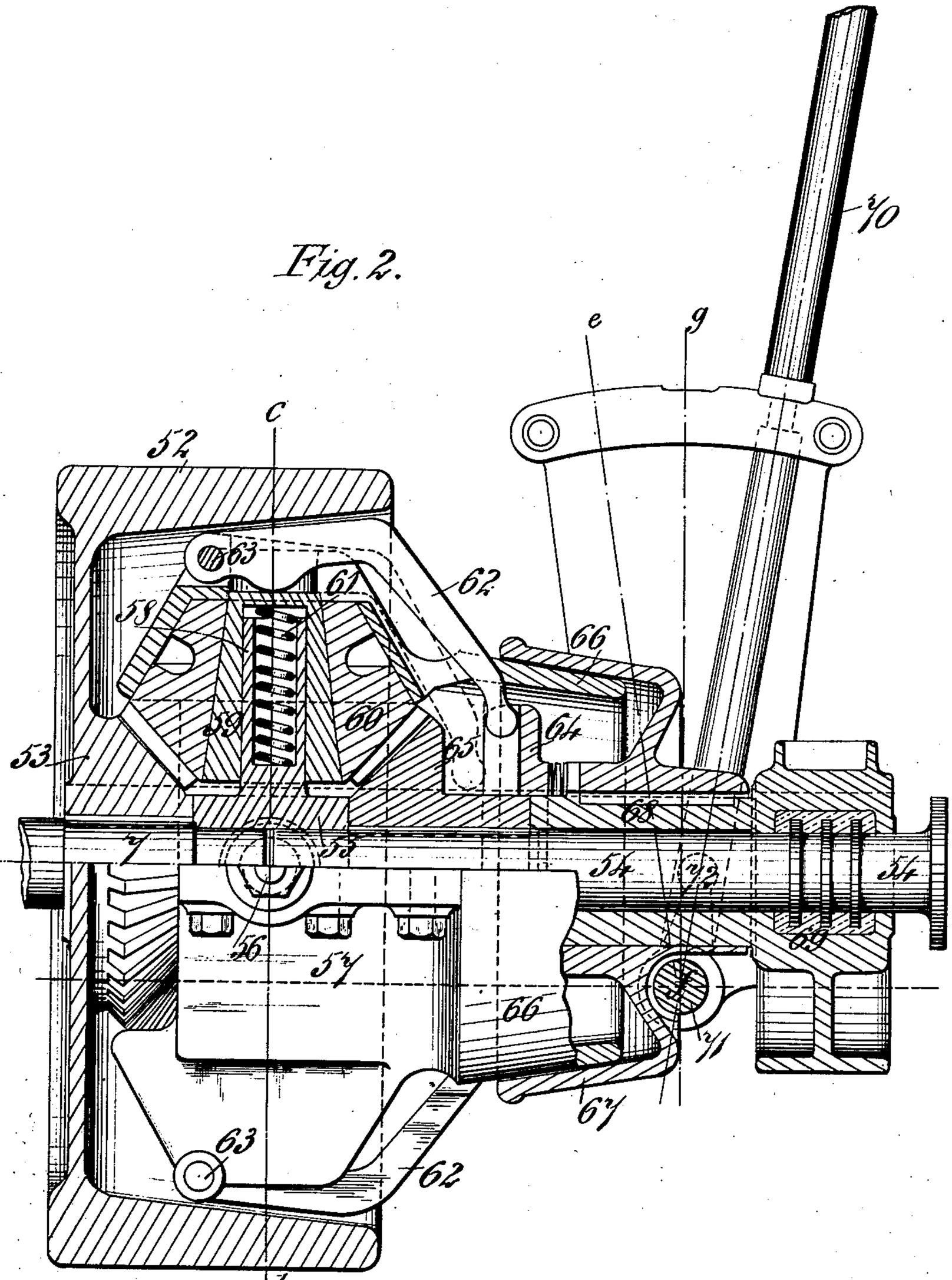
MOTOR.

No. 437,973. Patented Oct. 7, 1890.

Fig. 2.



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(No Model.) 3 Sheets—Sheet 3.

E. BUTLER.

MOTOR.

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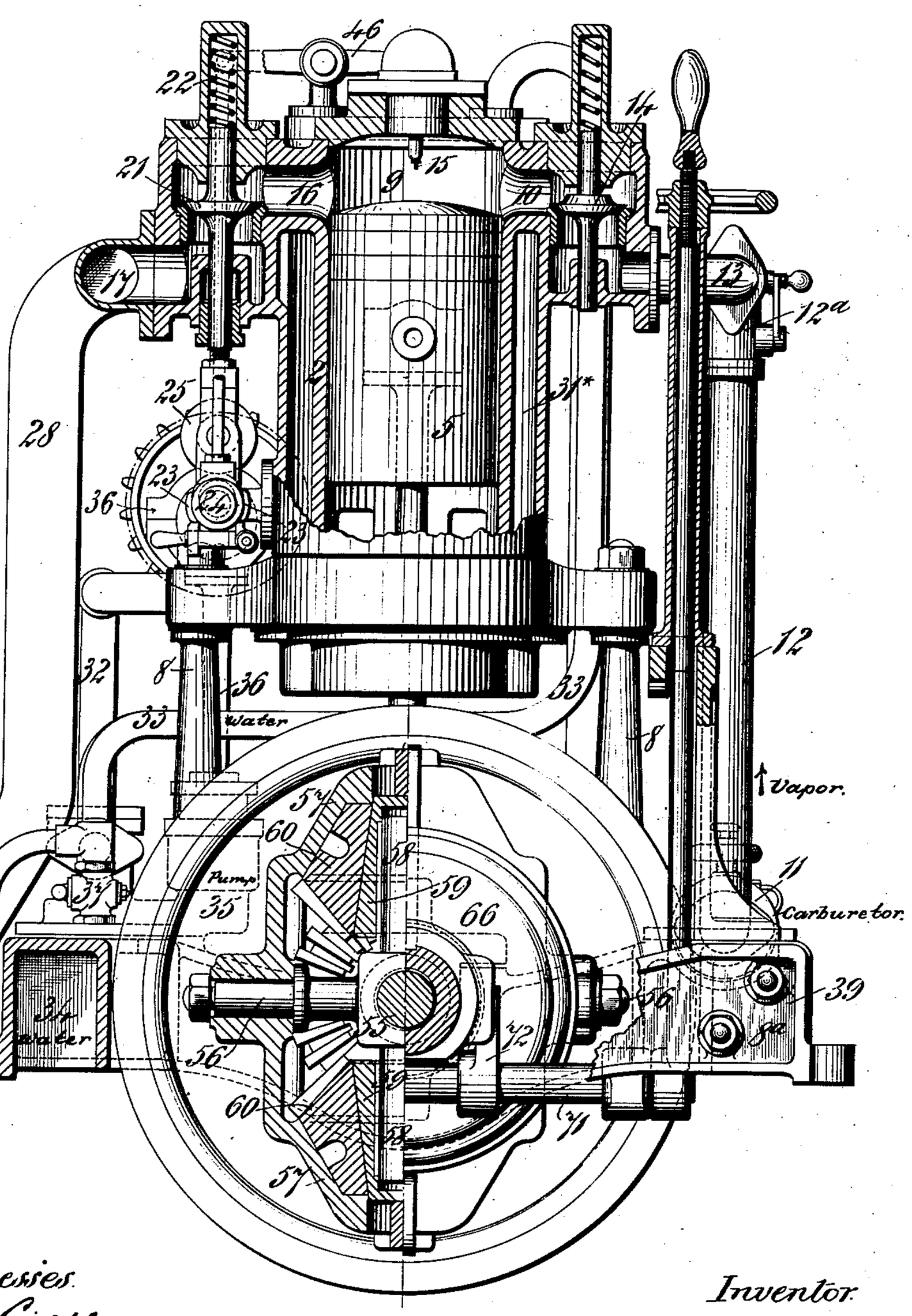
Fig. 3.



Witnesses.
W. Cross.
Wm. Frost.

Inventor.
Edward Butler

UNITED STATES PATENT OFFICE.

EDWARD BUTLER, OF LONDON, ENGLAND, ASSIGNOR TO THE BUTLER'S PATENT PETROL-CYCLE SYNDICATE, LIMITED, OF SAME PLACE.

MOTOR.

SPECIFICATION forming part of Letters Patent No. 437,973, dated October 7, 1890.

Application filed June 8, 1889. Serial No. 313,538. (No model.)

To all whom it may concern:

Be it known that I, EDWARD BUTLER, engineer, a subject of the Queen of Great Britain and Ireland, residing at 55 Old Broad Street, in the city of London, England, have invented Improvements in and Connected with Motors in which an Explosive Mixture of Air and Petroleum is Used, of which the following is a specification.

This invention relates to improvements in motors in which an explosive mixture of air and petroleum is used.

In a motor according to this invention two explosion-cylinders, each having a four-stroke cycle, are used with an expansion-cylinder, the arrangement being such that the said expansion-cylinder receives the exhaust-gases from the other cylinders in an alternate manner, as hereinafter described.

In the accompanying three sheets of drawings, Figure 1 shows, partly in elevation and partly in vertical section taken in two different planes, a motor constructed according to this invention. Fig. 2 shows, partly in elevation and partly in central vertical section, reversing-gear suitable for use with such a motor when the direction of motion of the body driven thereby—such, for example, as a propeller-shaft—is required to be reversed from time to time. Fig. 3 shows the motor, partly in end elevation and partly in transverse section, on the line *a b*, Fig. 1. It also shows the reversing-gear partly in end elevation and partly in transverse section on the line *c d*, Fig. 2.

Referring to Figs. 1 and 3 of the drawings, 1, 2, and 3 are the working-cylinders provided with trunk-pistons 4, 5, and 6, that are coupled in the ordinary manner by connecting rods to cranks 4^a, 5^a, and 6^a, respectively, on the shaft 7. The cranks 4^a and 5^a are arranged at the same angle and not one in advance of the other, while the crank 6^a is arranged at an angle of about one hundred and eighty degrees from the others. The cylinders, which are carried by pillars 8 from the base-plate 8^a, may be provided with the usual receptacles 8^b for oil, whereby they and their pistons are lubricated.

The cylinders 1 and 2, which are the explosion-cylinders and work with a four-stroke cycle, are each provided with a charge-chamber 9 for the explosive mixture of air and petroleum-vapor which is admitted thereto, as hereinafter described, through a port 10, from an inspirator or air-carbureting device 11, main pipe 12, and branch pipe 13, the admission of the explosive mixture being controlled by a non-return lift-valve 14. The inspirator or air-carbureting device 11, (hereinafter called a "carbureting device,") may advantageously be of the kind described and shown in the specification of another application for Letters Patent, filed June 8, 1889, Serial No. 313,539. At each suction-stroke of the pistons 4 and 5 air is drawn through the carbureting device in which it is carbureted and becomes an explosive mixture.

The pipe 12 is provided with a throttle-valve 12^a for regulating the speed and power of the motor.

Into each charge-chamber 9 project insulated terminals 15, across which an electric current may be passed at the proper periods for firing the explosive mixture. Any other suitable means—such as the ordinary heated tube—may be used, if desired, for firing the mixture.

The cylinder 3, into which the gases after performing work in the explosion-cylinders 1 and 2 are allowed to pass and become further expanded, is of greater diameter than the other cylinders, and is of such a length that there is practically no clearance space at its upper end when its piston is at the end of the inward stroke. The cylinder 3 is, according to this invention, so proportioned in capacity that a partial vacuum will be produced therein just before the completion of the outstroke of its piston, and while the exhaust-valve of the cylinder from which the heated products of combustion last came is open, so that the remainder of such products in the charge-chamber of the latter cylinder will be drawn out, and a corresponding quantity of carbureted air will be caused to enter such cylinder by the lifting of its admission-valve 14, and act as a scavenging-charge. By this means purer explosive charges will be obtained and more powerful effects produced

from their explosion than is the case when they are mixed with products of combustion from a previous explosion.

The cylinders 1 and 2 are each arranged to be placed in communication with the cylinder 3 by a passage 16, pipe 17, passage 18, chamber 19, and port 20, the communication being controlled by an exhaust-valve 21, normally held closed upon its seat by a spring 22, but is lifted at the proper periods by a cam 23. The cams 23 (one for each exhaust-valve 21) are carried by a shaft 24, and are so arranged as to bear directly against anti-friction wheels or rollers 25, journaled in frames secured to the spindles of the said valves.

26 is an exhaust-valve that controls the communication between the expansion-cylinder 3 and the exhaust-chamber 27 and exhaust-pipe 28. This exhaust-valve is normally held upon its seat by a spring 29, and is lifted at the proper periods to permit the cylinder 3 to exhaust by cams 30, secured on the shaft 24, and acting on the valve-spindle in a similar manner to the cams 23 on the spindles of the valves 21.

Non-return lift-valves 31, one only of which can be seen in Fig. 1, serve to prevent the gases when exhausting from one explosion-cylinder to the expansion-cylinder 3 from passing to the other explosion-cylinder.

The shaft 24 is driven from and at half the speed of the crank-shaft 7.

The pistons 4 and 5, which make their inward and outward strokes together, receive a working impulse at every fourth stroke and alternately with each other. The cylinder 3 consequently receives the exhaust from each explosion-cylinder alternately, and thus its piston receives an impulse at each outstroke, thereby equalizing the power transmitted to the crank-shaft.

The operation of the motor is as follows: Assuming the parts to be in the positions shown in Figs. 1 and 3, that there is an explosive charge in the charge-chamber 9 of cylinder 1, that the pistons 4 and 5 have each completed their inward stroke and the piston 6 its outward stroke, and that the motor is running, then just as the crank 4^a passes its dead-center the explosive mixture in cylinder 1 is fired. The piston 4 then makes its outward working-stroke, the piston 5 its outward induction-stroke, drawing in an explosive charge through the carbureting device, main and branch pipes 12 and 13, and port 10, the valve 14 lifting, and the piston 6 its inward or exhaustion stroke, the exhaust-valve 26 being at this time lifted by the cam 30 to place the cylinder 3 in communication with the atmosphere. Upon the instroke of the piston 4 the heated products of combustion pass from cylinder 1 to cylinder 3, causing the piston therein to make its working-outstroke, the communication between the two cylinders being opened by the lifting of the exhaust-valve 21 by its cam 23, while the explosive mixture previously drawn into cylinder 2 is compressed on the instroke of piston 5. This mixture is then fired, the piston 5 making its working-stroke, the piston 4 its outward induction-stroke, and drawing in a fresh explosive charge, and the piston 6 its inward or exhaustion stroke. Upon the instroke of the pistons 4 and 5 the mixture in cylinder 1 will be compressed, the gases in cylinder 2 will be forced into cylinder 3, the exhaust-valve 21 of cylinder 2 being lifted by its cam 23, and the piston will again make an outward stroke, the compressed charge in cylinder 1 is then fired, as before, and the above-described cycle of operations repeated.

The cylinders 1 and 2 are each provided with a water-jacket $31^\times$, through which and through inlet and outlet pipes 32 and 33 water is caused to flow from a reservoir 34, formed in one side of the base-plate 8^a by a plunger-pump 35, operated by an eccentric 36 on the shaft 24. By means of a cock 37 on the pipe 33 a portion of the heated water may be returned to the reservoir, the remainder escaping by a pipe 38. The other side of the base-plate may be formed with a reservoir 39 for petroleum, supplied from another vessel, and the height of which is maintained approximately constant by any suitable means.

To assist its restarting, the motor may be so constructed that part of the exhaust products of combustion stored under pressure in a reservoir during the previous operation of the motor may be admitted to the cylinder 3. For this purpose the cover $3^\times$ of cylinder 3 may be formed with a chamber 40 and with an opening 41, through which and a pipe 42 part of the exhaust products under pressure from the explosion-cylinders may pass to the reservoir $40^\times$ until the pressure therein is equal to that of said products when passing into cylinder 3. The opening 41 is controlled by a non-return lift-valve 43. The exhaust products thus stored under pressure may be readmitted to cylinder 3 through another opening 44 in cover $3^\times$. This opening is controlled by a valve 45, that can be lifted by means of a lever 46 and shaft 46^a, that is caused to oscillate by a lever 47 and rod 48. The lower end of this rod 48 is formed with a stirrup 49, that embraces cams 50 on the shaft 24. To the stirrup is hinged a hand-catch lever 51, so arranged that when it is secured in the position shown and the crank-shaft is pulled round to start the motor, thereby rotating the shaft 24, one or other of the cams 50 will actuate the lift-valve 45 and enable part of the stored exhaust products to enter the cylinder 3, actuating the piston therein and causing the motor to continue to revolve, the said valve 45 being lifted at each downstroke of the piston 6. When the motor is set properly in operation by the drawing in and explosion of combustible mixture, the catch-lever 51 is released by hand, so as to

hang vertically, and the lift-valve 45 is thereby thrown out of action.

The reversing-gear shown in Fig. 2 comprises a dished fly-wheel 52, carrying a bevel-wheel 53, and secured upon the driving-shaft 7 of the motor.

54 is the shaft to be driven, and the direction of motion of which it is required to occasionally reverse.

Upon the adjacent ends of the shafts 7 and 54 is mounted a block 55, provided with two arms 56, that carry a frame 57. The block 55 is also provided with two hollow projections 58, upon each of which is mounted, so as to move endwise thereon but not to rotate, a friction-cone 59, that serves as a bearing for a correspondingly-bored bevel-wheel 60. The two bevel-wheels 60 are carried in chambers that serve as bearings within the frame 57. which, to admit of the insertion of such wheels, is constructed in two parts that can be bolted together.

Springs 61, within the projections 58, serve to normally force the cones 59 into frictional contact with the bevel-wheels 60.

62 62 are levers pivoted to the frame 57 at 63, and arranged to bear upon the outer ends of the cones 59. Against the free ends of these levers bears a longitudinally-movable collar 64.

65 is a bevel-wheel secured to the shaft 54, and in gear with the bevel-wheels 60.

66 is a friction-cone carried by the frame 57, and 67 is another friction-cone able to slide but not to rotate upon a tubular extension 68 of the thrust-block bearing 69 of the shaft 54.

70 is a hand-lever mounted upon a rock-shaft 71, that is provided with lever-arms 72, arranged to engage with the cone 67, and move the same endwise when the hand-lever is operated.

When the parts are in the positions shown in Fig. 2, the bevel-wheels 60 will be locked in their frame 57 by the cones 59 under the action of the spring 61, and if the shaft 7 be revolved these wheels and frame, together with the fly-wheel and bevel-wheels 53 and 65, which will be all locked together, will revolve as one part and rotate the shaft 54 in the same direction without noise. If the hand-lever 70 be moved to the position indicated by the dotted line *e f*, the friction-cone 67 will engage the cone 66 and lock the frame 57 in position, and also cause the collar 64 to depress the cones 59 against the action of the springs 61, and unlock the bevel-wheels 60. These wheels will then be rotated by the bevel-wheel 53, and drive the bevel-wheel 65 and shaft 54 in the reverse direction.

To disengage the shaft 7 from the shaft 54 while the former is revolving, the hand-lever must be placed in the central position *f g*. The cones 66 and 67 and cones 59 and bevel-wheels 60 will not then be rigidly held together by friction, but can revolve relatively to each other without imparting any motion to the bevel-wheel 65 and shaft 54, which will then remain stationary.

It will be obvious that this reversing-gear may be variously modified without departing from the essential features thereof. Thus the springs 61 may be dispensed with, the arrangement of the levers being correspondingly modified to actuate the cones 59; also, one bevel-wheel 60 may be used instead of two.

What I claim is—

1. In a motor constructed to be worked with an explosive mixture of petroleum and air, the combination of two explosion-cylinders 1 and 2, each having a charge-chamber 9, fitted with a piston coupled to a crank and provided with an igniting device, inlet-valves 14 for said cylinders, an air-carbureting device 11, pipe 12, for conveying carbureted air from said device to each of said cylinders, an expansion-cylinder 3, fitted with a piston coupled to a crank at an angle of one hundred and eighty degrees from the other cranks, an exhaust-valve 26 for said expansion-cylinder, passages connecting each of said explosion-cylinders with said expansion-cylinder, a valve 21, located in each of said passages, a non-return valve 31, also located in each of said passages, a shaft 24, and cams carried on said shaft and arranged to operate said valves 21 and 26, substantially as herein described, for the purposes specified.

2. The combination of a motor constructed to be worked with an explosive mixture of petroleum and air, a crank or driving shaft, such as 7, driven by said motor, a second driven shaft, such as 54, and reversing mechanism comprising wheels secured to said driving and driven shafts 7 and 54, respectively, a frame capable of rotation around said shafts, a wheel or wheels carried by and capable of revolving in said frame and arranged to gear with the wheels on said shafts, and means for holding and releasing the frame, and for holding and releasing the wheel or wheels carried by the frame, the whole arranged and operating substantially as herein described.

3. The combination of a motor constructed to be worked with an explosive mixture of petroleum and air, a crank or driving shaft, such as 7, driven by said motor, a second driven shaft, such as 54, and reversing mechanism comprising toothed wheels 53 and 65, secured to the shafts 7 and 54, respectively, a rotary block 55, provided with one or more hollow arms 58, a frame 57, carried by said block and provided with a friction-cone 66, a friction-cone 59, arranged to slide on each of said hollow arms 58, and a spring 61, interposed between the two, one or more toothed wheels 60, carried by said frame 59, in gear with said toothed wheels 53 and 65, and each

centered on one of said cones 59, a friction-cone 67, means for moving same into contact with said friction-cone 66, and means, such as levers 62, adapted to disconnect the friction-cones 59 from the toothed wheels 60, all substantially as herein described, for the purpose specified.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

EDWARD BUTLER.

Witnesses:

WILLIAM CROSS,

EDW. W. OCKENDEN,

Both of 46 *Lincoln's Inn Fields, London, W. C.*