(No Model.) 4 Sheets—Sheet 1.

# F. C. SOUTHWELL.

## EXPLOSIVE ENGINE.

No. 575,812. Patented Jan. 26, 1897.

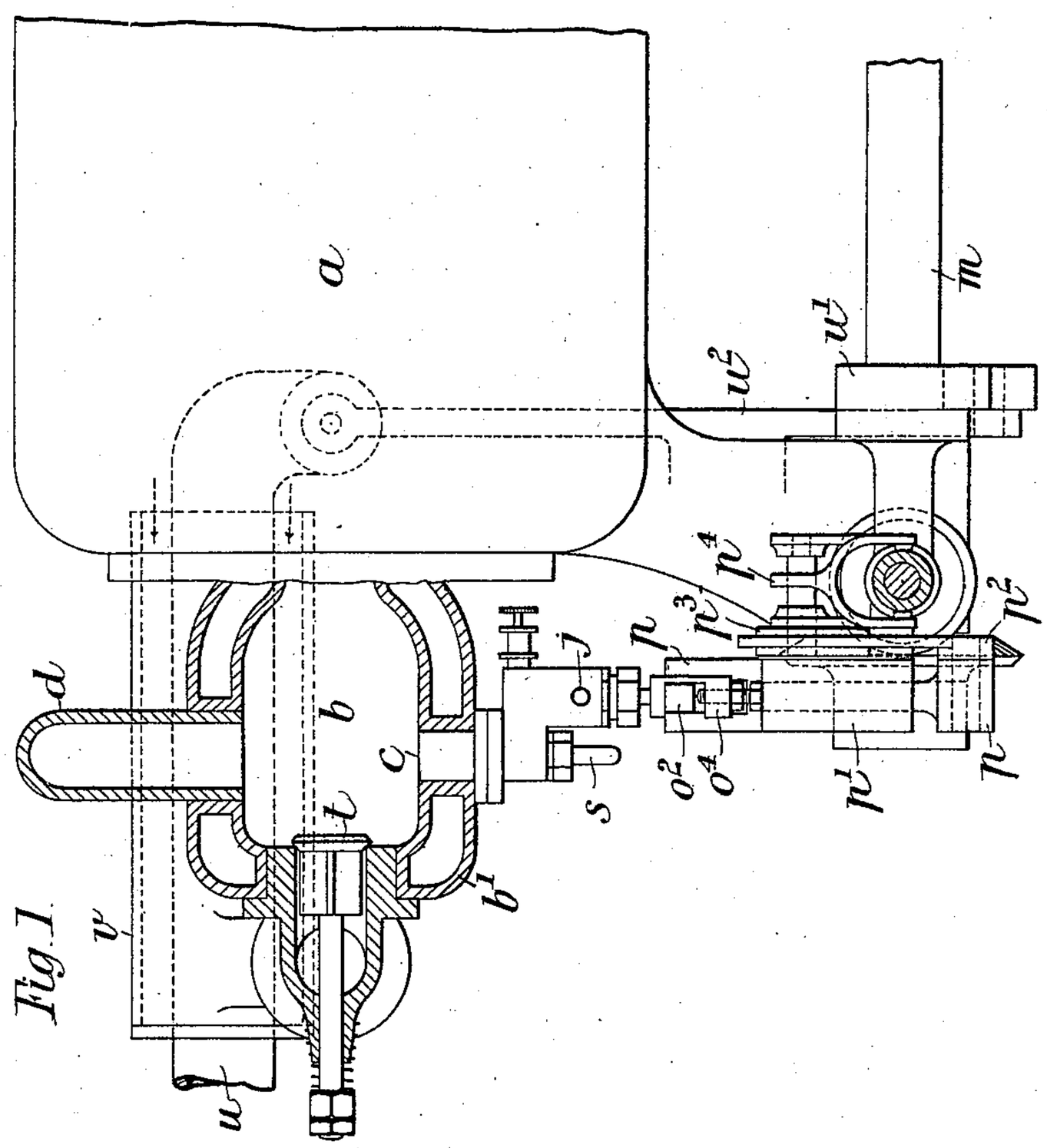


Fig. 1.

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Inventor:
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By Whittaker & Prevost Attys

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# F. C. SOUTHWELL.

## EXPLOSIVE ENGINE.

No. 575,812. Patented Jan. 26, 1897.

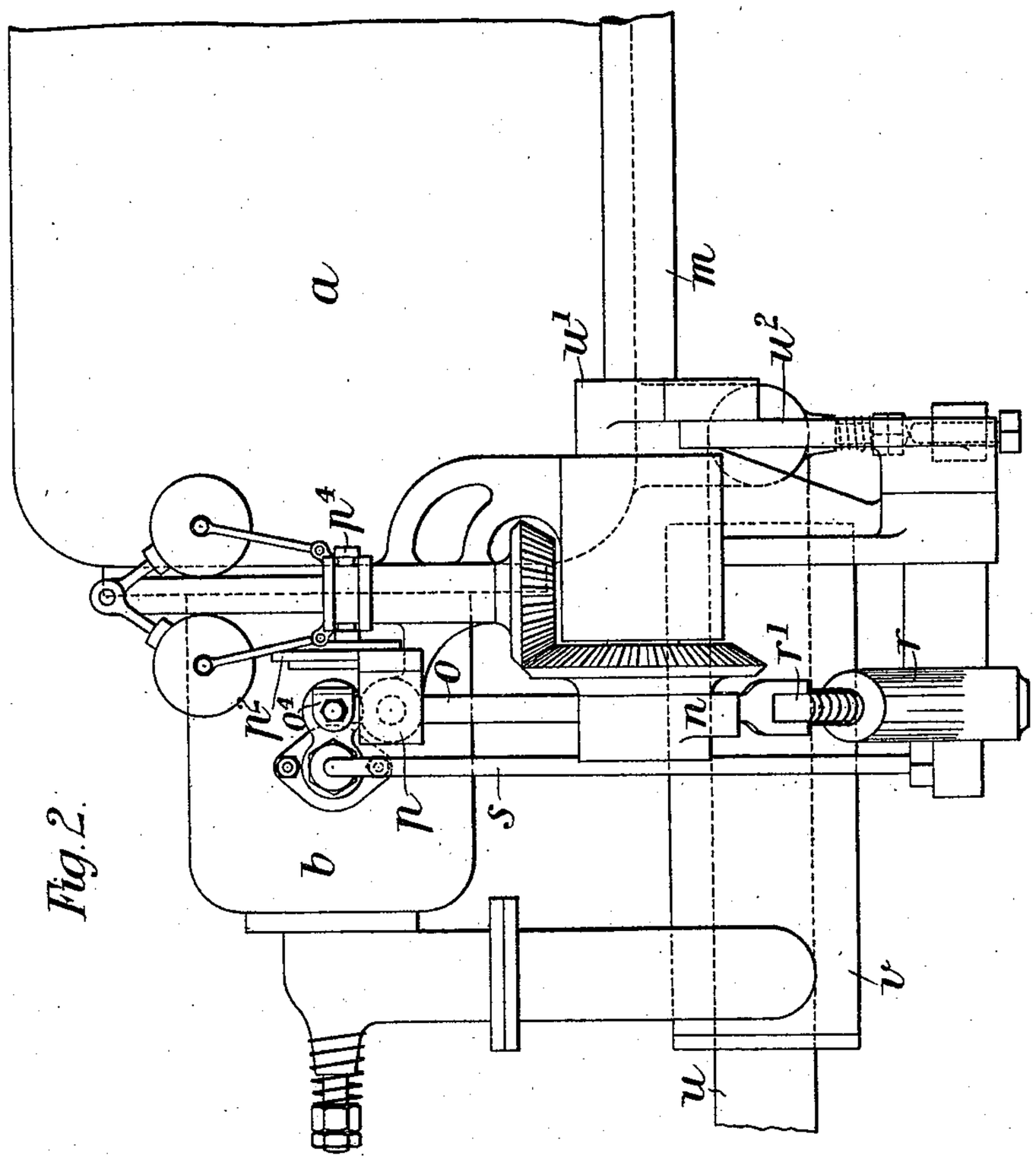


Fig. 2.

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# F. C. SOUTHWELL.

## EXPLOSIVE ENGINE.

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*Fig. 3.*

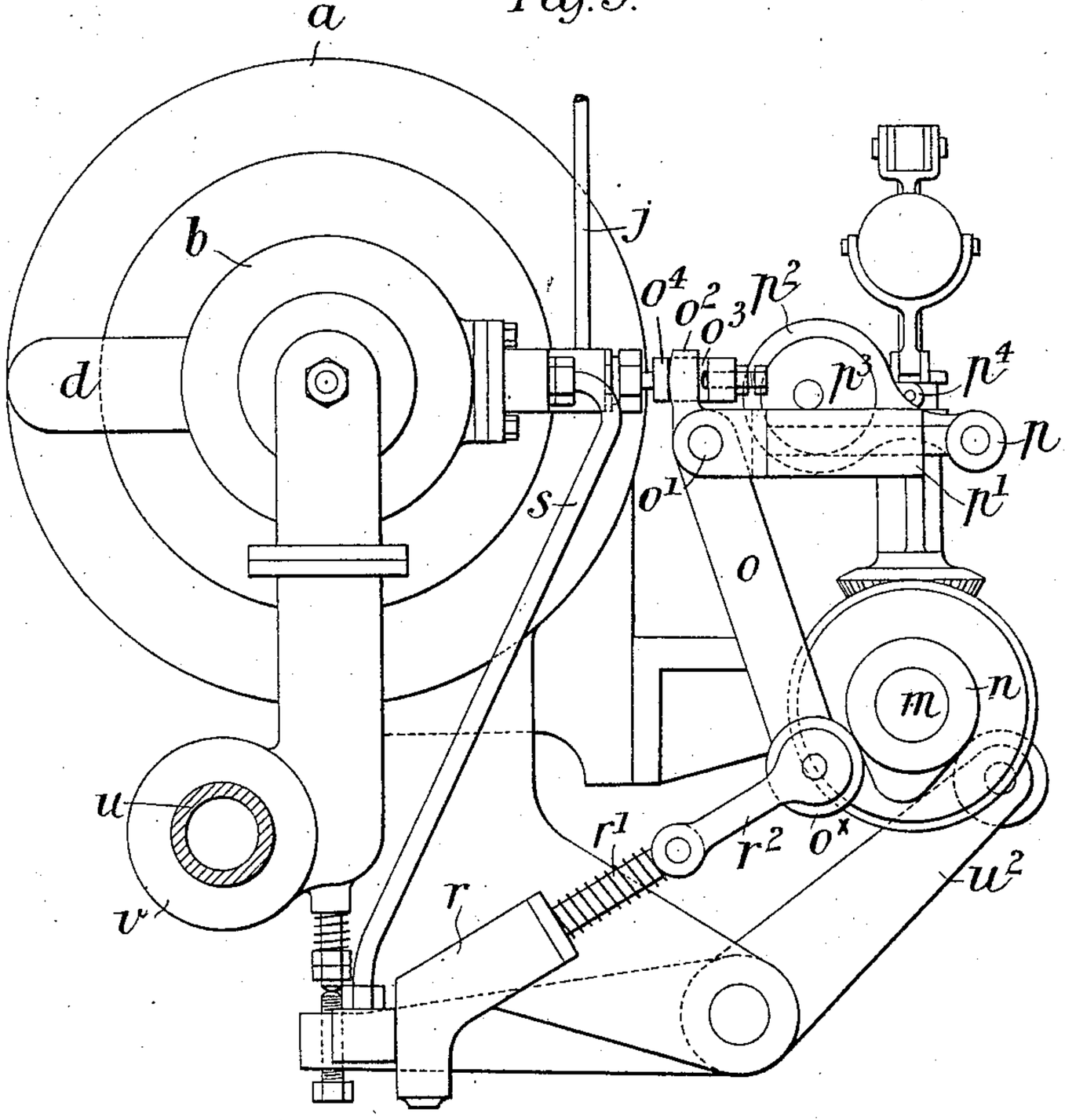



*Fig. 5.*

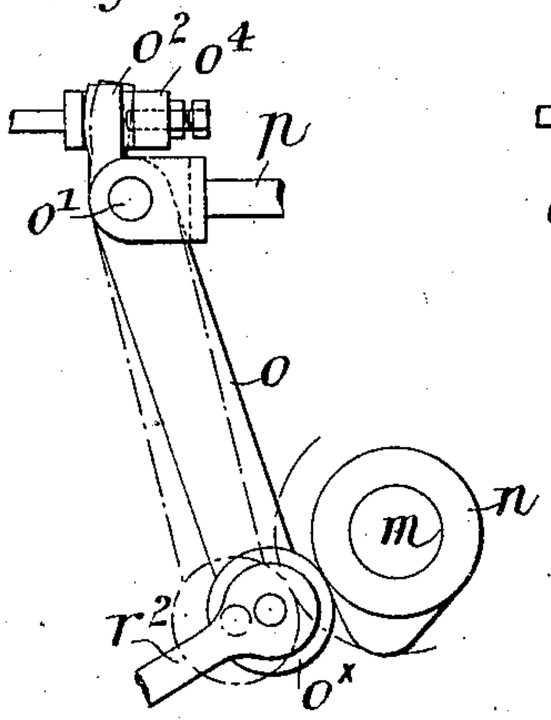



*Fig. 6.*

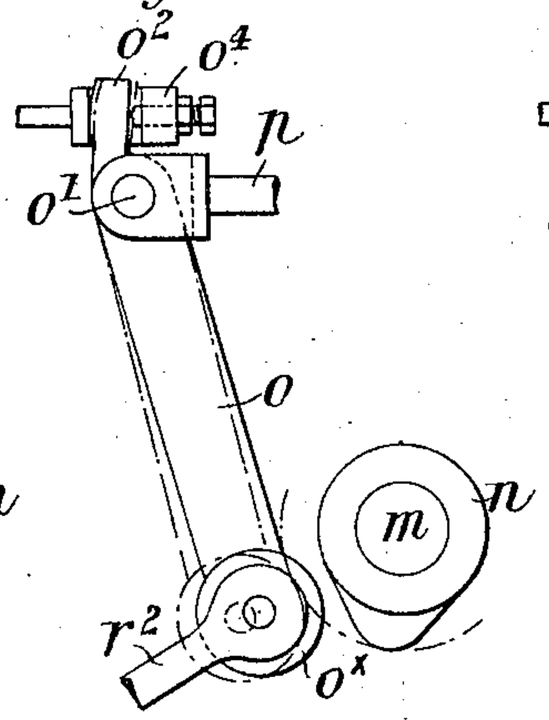
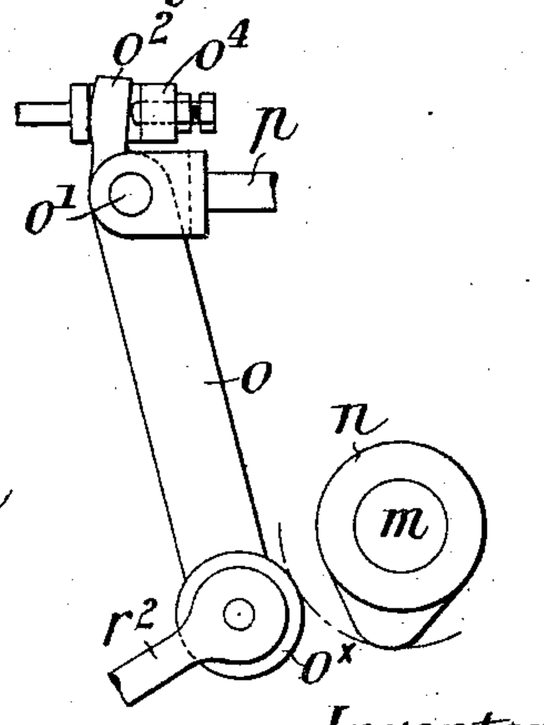



*Fig. 7.*

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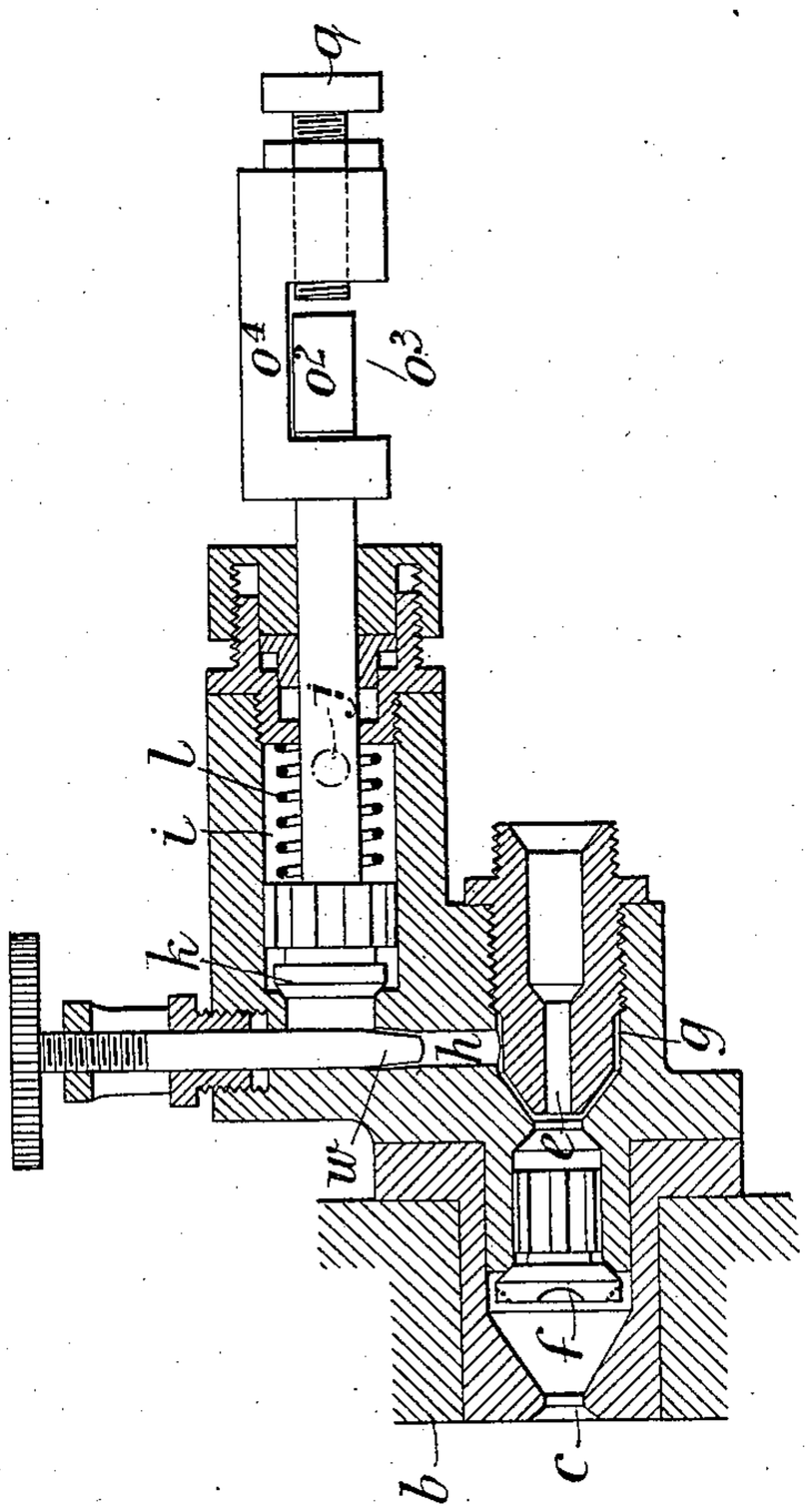
(No Model.) 4 Sheets—Sheet 4.

# F. C. SOUTHWELL.

## EXPLOSIVE ENGINE.

No. 575,812. Patented Jan. 26, 1897.

Fig. 4.




Witnesses
John E. Bousfield.
F. C. Hawtin.

Inventor.
F. C. Southwell

# UNITED STATES PATENT OFFICE.

FREDERICK CHARLES SOUTHWELL, OF GRANTHAM, ENGLAND.

## EXPLOSIVE-ENGINE.

SPECIFICATION forming part of Letters Patent No. 575,812, dated January 26, 1897.

Application filed May 13, 1895. Serial No. 549,122. (No model.)

*To all whom it may concern:*

Be it known that I, FREDERICK CHARLES SOUTHWELL, a subject of the Queen of Great Britain, residing at Grantham, in the county of Lincoln, England, have invented new and useful Improvements in Explosive-Engines, of which the following is a specification.

My invention relates to engines operated by the explosion of mixtures of hydrocarbon vapor and air and in which the ignition of such mixtures is effected with or without an ignition-tube.

In most spontaneous-combustion motors the heat attained by the vaporizer is such as to necessitate a moderately low compression and therefore a low mean pressure. To obviate this, I employ a water-jacketed combustion-chamber, with or without a contracted neck, open to the cylinder, or, if desired, I may arrange that the air for the explosive mixtures should be drawn through the jacket. At a suitable angle to the combustion-chamber, preferably at right angles, on the one side I place a vaporizing tube or pocket, with or without a contracted neck, and on the other side, opposite to the said pocket, a nozzle through which the oil enters. I sometimes arrange in conjunction with this nozzle another nozzle through which air can be forced to inject the oil, thereby allowing an oil-pump to be dispensed with.

In practice I make use of an air-pump arranged in conjunction with the engine-governor, the valve for controlling the admission of oil to the vaporizer being also arranged in conjunction with the governor, whereby I regulate the amount of oil admitted each cycle, at the same time regulating the air. In a suitable arrangement for carrying out this part of my invention I connect the air-pump and oil-valve to a lever common to both, and in connection with this lever I arrange an eccentric moved by the governor, which eccentric enables the governor to vary the position of the fulcrum of the said lever relatively with an operating-cam. If desired, I can also regulate the supply of the oil and air by mechanism operated by hand in addition to the mechanism operated by the governor.

To start the engine, I heat the vaporizing-tube with a lamp, which I may continue to use during working.

To enable my invention to be fully understood, I will describe the same by reference to the accompanying drawings, in which—

Figure 1 is a plan, and Fig. 2 a side elevation, of so much of an explosive-engine as is necessary to illustrate my invention. Fig. 3 is an end view of the cylinder and the parts immediately connected therewith; and Fig. 4 is a sectional plan, drawn to an enlarged scale, of the oil-regulating mechanism. Figs. 5, 6, and 7 are detail views of portions of the mechanism.

*a* is the engine-cylinder, which is jacketed in the usual manner, and *b* is the combustion-chamber, which is attached to the end of the cylinder and provided with a water-jacket *b'* in order to prevent it from becoming overheated.

*c* is the nozzle, through which the oil is delivered into the vaporizing-chamber, and *d* the vaporizing tube or pocket immediately opposite to the said nozzle and adapted to have the oil injected directly into it, the said tube or pocket being heated by means of a lamp or (after preliminary heating) by the heat due to successive explosions.

*e* is the nozzle, through which air is forced in order to drive the oil across the combustion-chamber into the pocket *d*. The arrangement of the said nozzle *e* relatively with the nozzle *c* will be readily understood by reference to Fig. 4, in which figure it will be noticed that a vavle *f* is arranged between the nozzles *e* and *c*, the said valve being so arranged that it will open under the pressure behind it, but close against its seat by each explosion.

The oil to be driven forward by the air-current enters the space *g* around the nozzle *e* through the passage *h* from the chamber *i*, which chamber is connected by a pipe *j* with an oil-reservoir arranged at a sufficient height to cause the oil to flow by gravity into the said chamber.

*k* is a valve which normally prevents the oil from passing out of the chamber *i*, the said valve being held against its seat by a spring *l*. This valve *k* is operated from the side shaft *m* of the engine through the medium of the cam *n* and the lever *o*, provided with the roller $o^{\times}$, the said lever being pivoted at *o'* and having its upper end $o^2$ pro-

jecting into a recess $o^3$ in a stirrup $o^4$, secured to the stem of the valve $k$, the arrangement being such that when the lever $o$ is operated by the cam $n$ the valve $k$ will be drawn away from its seat and allow the oil to flow from the reservoir through the pipe $j$ to the chamber $i$ and thence through the passage $h$ into the space $g$, whence it is driven by the air-current past the valve $f$ and through the nozzle $c$ into the pocket $d$, where, owing to the heat of the said pocket, it will be vaporized and ignited.

The arrangement for enabling the governor to control the movements of the valve $k$ to allow more or less oil to pass, according to the duty of the engine, is as follows: The fulcrum $o'$ of the lever $o$ is carried at one end of a bar $p$, adapted to slide in a guide $p'$ on the governor-bracket, the other end of the said bar $p$ being connected to the strap $p^2$ of an eccentric $p^3$, which is adapted to be rotated more or less upon its axis under the action of the governor through the medium of a lever $p^4$, Fig. 1, whereby the bar $p$, and consequently also the fulcrum $o'$ of the lever $o$, will be moved more or less, as the case may be. For instance, when the engine is running at the normal speed the roller $o^\times$ will run in contact with the whole of the periphery of the cam $n$, as indicated in Fig. 5. If, however, the speed of the engine increases, the governor will move the fulcrum $o'$ toward the combustion-chamber and, the upper end of the lever $o$ fulcruming against the stirrup $o^4$, the roller $o^\times$ will be moved to a greater or less extent from the cylindrical part of the cam $n$, as indicated in Figs. 6 and 7, whereby less or more of the projecting part of the cam will come into contact with the roller $o^\times$ and operate upon it.

Fig. 6 indicates the governor as having moved the fulcrum $o'$ so that the cam $n$ can only operate upon the roller $o^\times$ to deliver about half the normal quantity of oil, while Fig. 7 indicates that the governor has moved the said fulcrum so that the roller $o^\times$ is out of range of the said cam, and consequently no oil is delivered.

The end $o^2$ of the lever $o$ does not fit between the ends of the recess $o^3$, but has a certain amount of play or freedom therein, so that it will be obvious that if the end $o^2$ is against the outer end of the said recess $o^3$ it will impart a greater amount of movement to the valve $k$ than if the said lever has to make a certain part of its movement before it comes into contact with the outer end of the recess.

$q$ is a set-screw which is introduced into the outer end of the recess $o^3$ and serves to regulate the amount of play or freedom of the end $o^2$ of the lever $o$, the said end $o^2$ striking the said set-screw when the lever is operated by the cam $n$.

The compressed air for injecting the oil into the cylinder may be obtained from a reservoir, a valve being opened at the required time to allow the air to escape. In practice, however, I prefer to make use of a small air-pump driven by the engine and arranged in conjunction with the air-supply valve in such a manner that the pump will only deliver a quantity of air suitable for the quantity of oil being introduced.

$r$ indicates the air-pump, which is of ordinary construction and the plunger $r'$ of which is connected by a link $r^2$ to the lever $o$ in such a manner that when the said lever is operated by the cam $n$ to admit a charge of oil into the cylinder the air-pump will be similarly operated to produce the necessary amount of compressed air for injecting the oil. By connecting the air-pump to the lever $o$ the action of the governor is also utilized for regulating the supply of compressed air proportionately to the supply of oil.

$s$ is the pipe through which the air is delivered from the pump to the nozzle $e$.

$t$ is the air-inlet valve to the engine-cylinder, which valve opens automatically under the action of the suction during the outstroke of the piston, and $u$ is the pipe through which the exhaust escapes, the exhaust-valve in connection with the said pipe being operated by a cam $u'$ on the shaft $m$ through the medium of a lever $u^2$ in a manner which will be readily understood. In order that the air which enters the combustion-chamber through the valve $t$ shall be more or less warmed, I advantageously arrange around the exhaust-pipe $u$ a casing or jacket $v$, open at one end to the atmosphere and at the other end connected with the air-inlet valve $t$, so that the air drawn through the said valve has first of all to come into contact with the heated exhaust-pipe $u$.

In order to provide for regulating the supply of oil to the combustion-chamber independently of the governor, I arrange in the passage $h$ the valve $w$. (Shown most clearly in Fig. 4.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is—

1. In an explosive-engine, the combination with the combustion-chamber, an injector communicating therewith, means for supplying oil to said injector, an air-supply for said injector, an operating device operated by the engine for intermittently admitting air and oil to said injector, a governor operated by the engine and an operative connection between the said operating device and the governor for varying the amount of air and oil admitted to the injector, substantially as described.

2. In an explosive-engine, the combination with the combustion-chamber, of an injector communicating therewith, an oil-supply communicating with said injector provided with a movable controlling-valve, an air-supply communicating with said injector and provided with a controlling device, an operating-shaft driven by the engine, operative con-

nections between said shaft and the controlling devices for the oil and air supplies, a governor operated by the engine, operatively connected with said connecting devices for varying the amounts of air and oil admitted to the injector, substantially as described.

3. In an explosive-engine, the combination with the combustion-chamber, of an injector communicating therewith, an oil-supply for said injector provided with a controlling-valve, an air-supply for said injector provided with a controlling device, an operating-shaft driven by the engine and provided with a cam, a lever in the path of said cam operatively connected with the controlling devices for the oil and air supplies, a governor operated by the engine and an operative connection between the governor and said lever substantially as described.

4. In an explosive-engine the combination with the combustion-chamber, of an injector communicating therewith, air and oil inlets for said injector and controlling devices for said inlets, an operating-shaft driven by the engine, a pivoted lever operatively connected with said controlling devices and adapted to engage a part connected with said shaft, a movable support carrying the fulcrum of said lever, a governor operated by the engine, and operative connections between the governor and said movable support for shifting the fulcrum of said lever to vary the movements of said controlling devices, substantially as described.

5. In an explosive-engine the combination with the combustion-chamber, of an injector therefor, an oil-supply for said injector provided with a controlling-valve, an air-pump communicating with said injector, a cam-shaft driven by the engine, a lever operatively connected with the oil-controlling valve and with said air-pump, said lever having a part in operative relation to said cam-shaft, a governor operated by the engine and operating connections between the governor and said lever for varying the movements of said air-pump and oil-controlling valve, substantially as described.

6. In an explosive-engine, the combination with the combustion-chamber, of an oil-supply therefor, a controlling-valve for said oil-supply, means for operating said valve intermittently, including a pivoted lever, a governor operated by the engine, and a connection between said governor and the fulcrum of said lever, whereby the stroke of said lever and the movement of said controlling-valve are varied, substantially as described.

7. In an explosive-engine the combination with the combustion-chamber, of an oil-supply therefor provided with a controlling device, an air-pump communicating with said injector, a cam-shaft operated by the engine, an operating-lever pivoted to a movable support having a part engaging the cam on the cam-shaft, and parts operatively connected with said air-pump and the oil-controlling device, a governor operated by the engine, and a connection between said governor and the said movable support, whereby the fulcrum of said lever may be changed to vary the amount of oil and air admitted to the injector, substantially as described.

FREDERICK CHARLES SOUTHWELL.

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