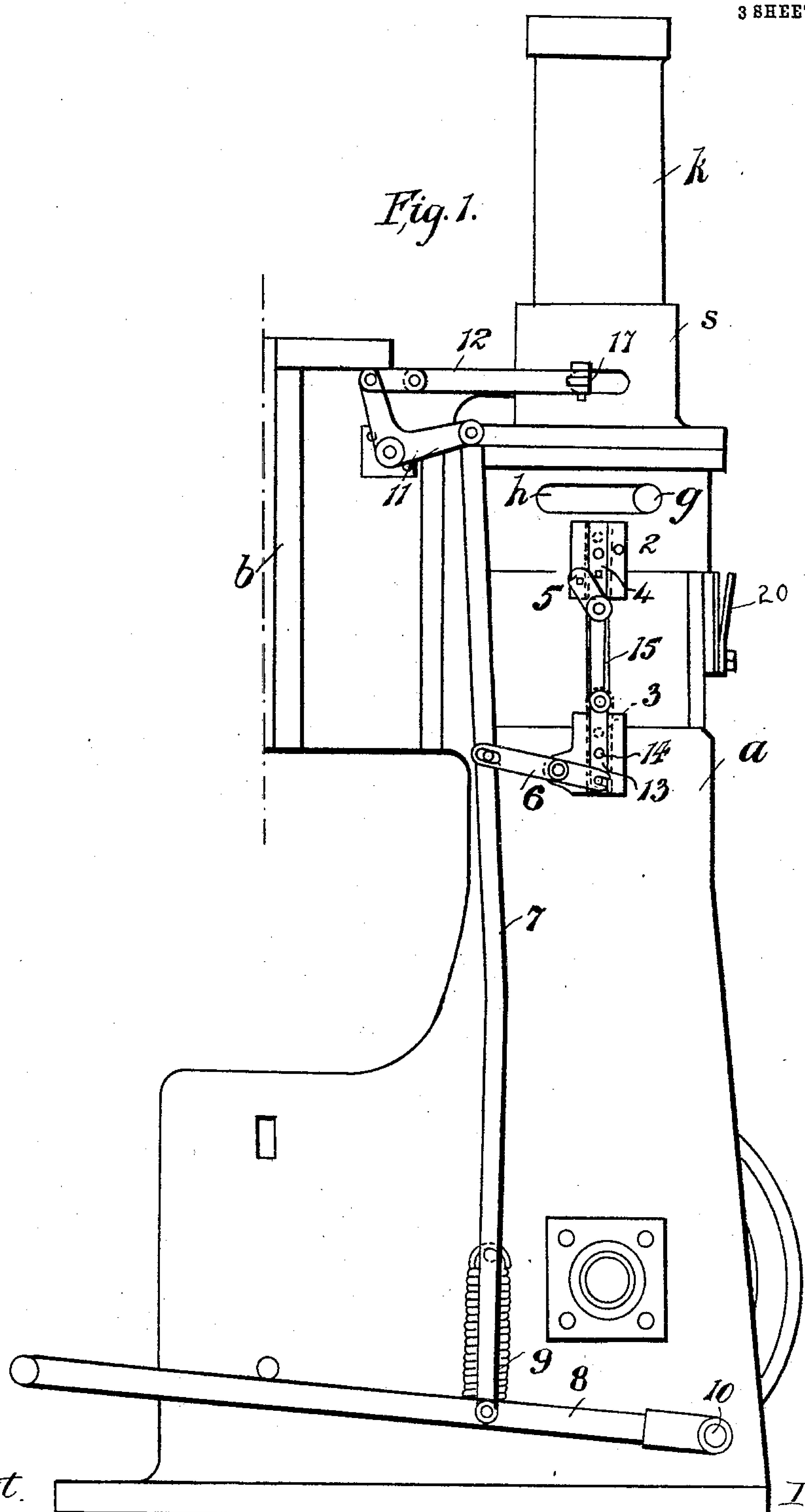
No. 797,055. PATENTED AUG. 15, 1905.

W. GRAHAM.
POWER HAMMER.
APPLICATION FILED JUNE 16, 1904.

3 SHEETS—SHEET 1.

Fig. 1.



Attest.
C. Middleton
Arthur Middleton

Inventor
William Graham
By Spear, Middleton, Donaldson & Spear
Attys.

ANDREW B. GRAHAM CO., PHOTO-LITHOGRAPHERS, WASHINGTON, D. C.

No. 797,055. PATENTED AUG. 15, 1905.

W. GRAHAM.

POWER HAMMER.

APPLICATION FILED JUNE 16, 1904.

3 SHEETS—SHEET 2.

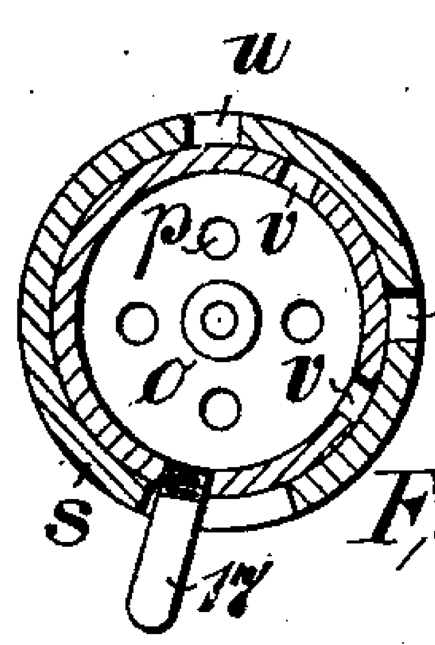


Fig. 7.

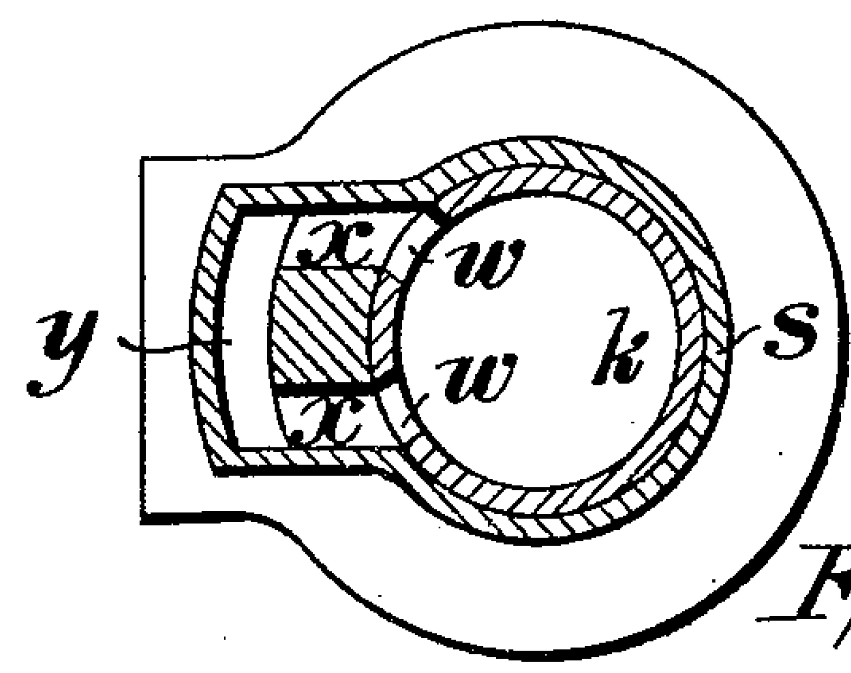


Fig. 6.

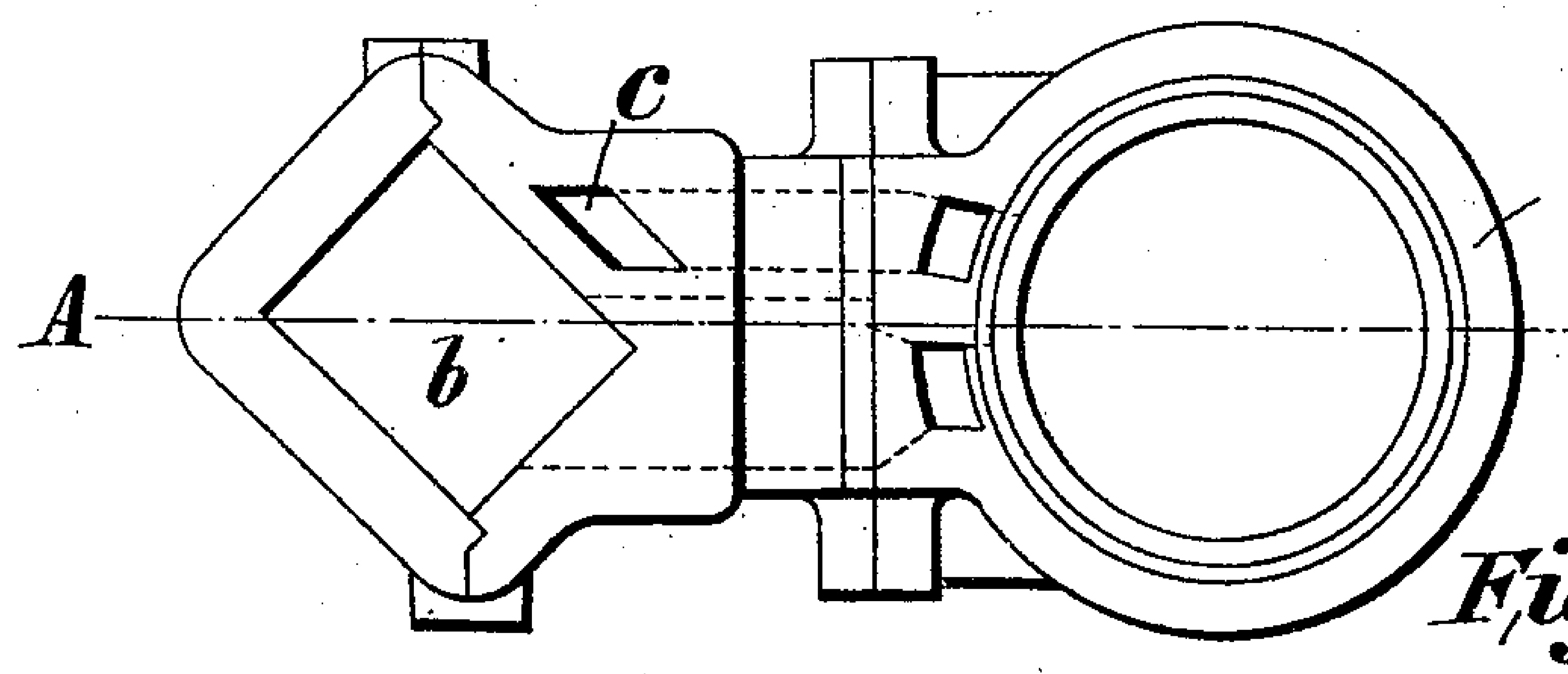


Fig. 2.

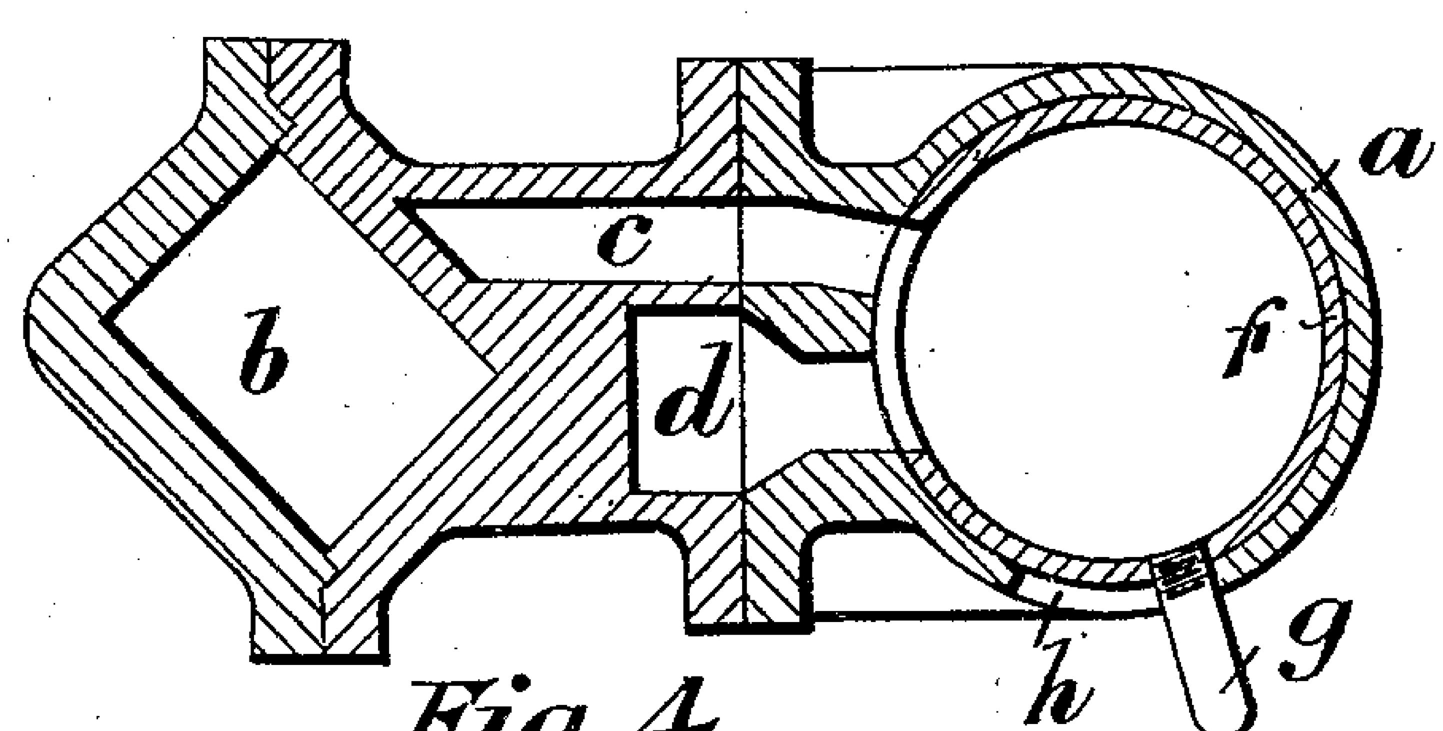


Fig. 4.

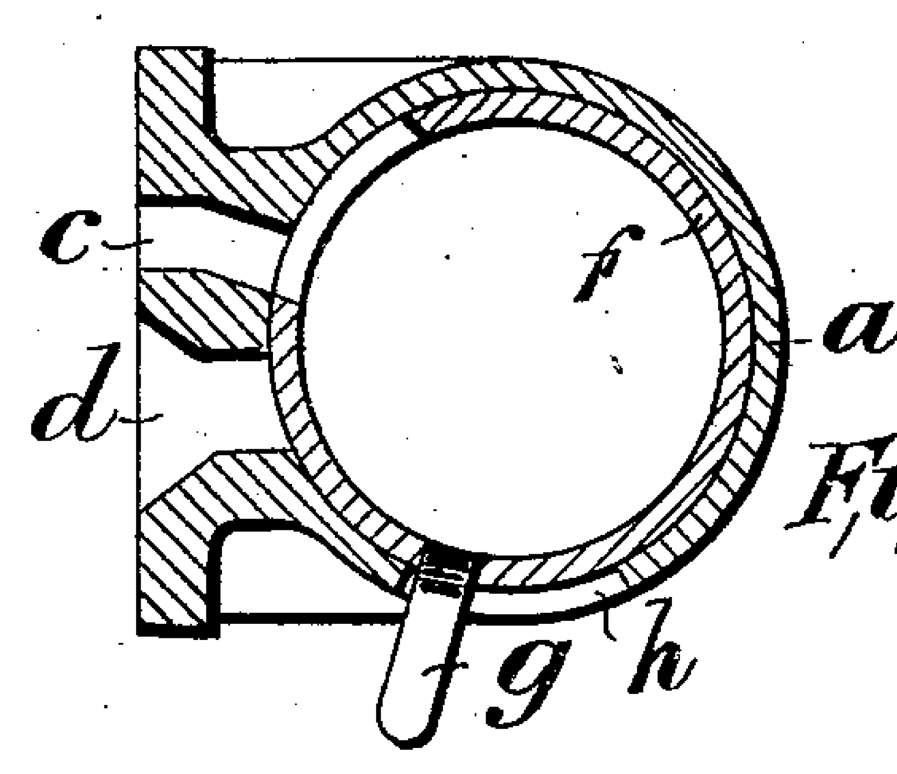


Fig. 5.

Attest
Arthur Middleton
Edward Saxton

Inventor
William Graham
by Spear, Middleton, Donaldson & Spear
Att'ys.

No. 797,055.

PATENTED AUG. 15, 1905.

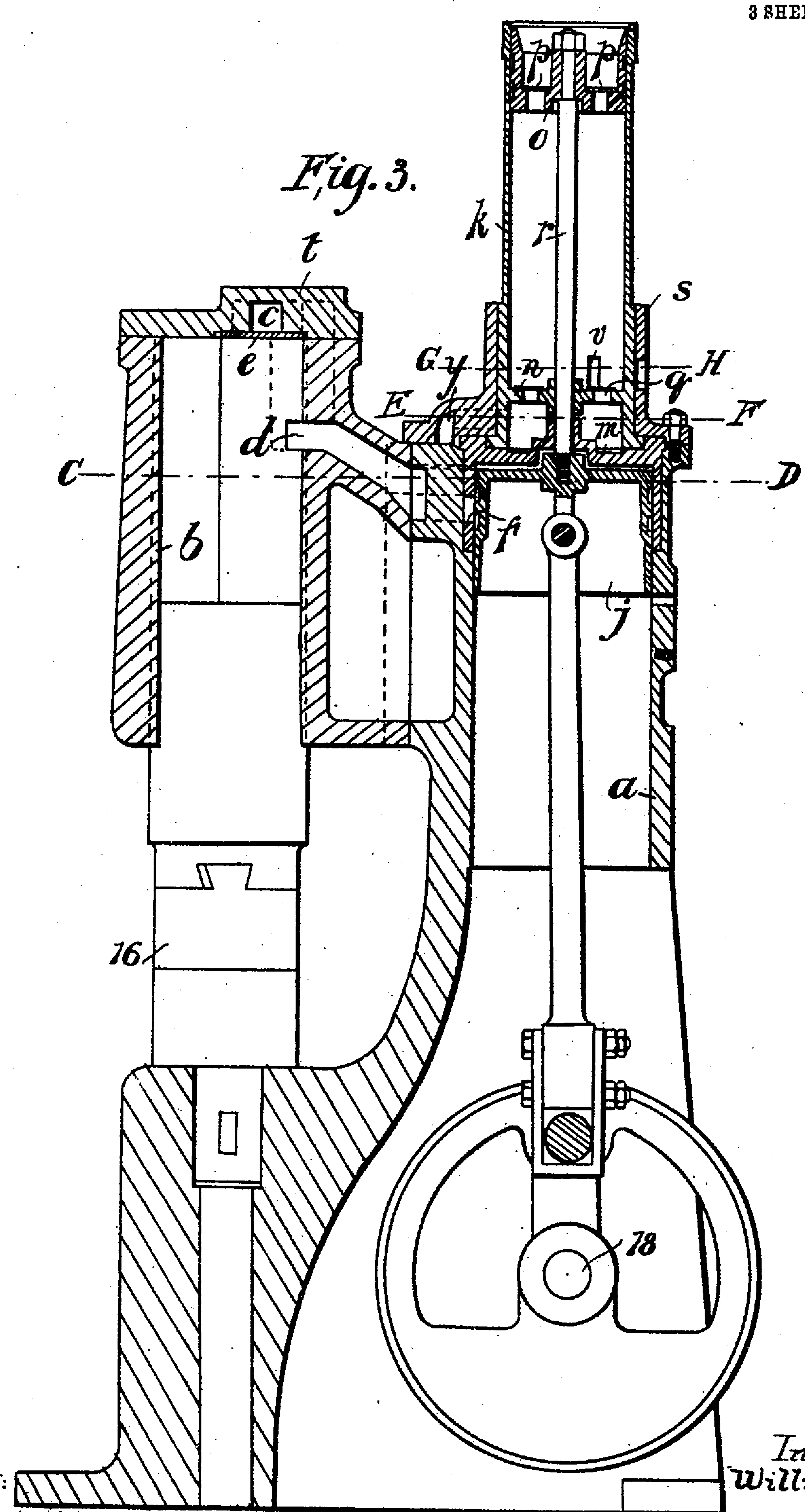
W. GRAHAM.

POWER HAMMER.

APPLICATION FILED JUNE 16, 1904.

3 SHEETS—SHEET 3.

Fig. 3.



Attest:
Arthur Middleton
Edward Sarton

Inventor
William Graham
by Spear, Middleton, Donaldson & Spear
attys.

ANDREW B. GRAHAM CO., PHOTO-LITHOGRAPHERS, WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

WILLIAM GRAHAM, OF WESTMINSTER, ENGLAND.

POWER-HAMMER.

No. 797,055. Specification of Letters Patent. Patented Aug. 15, 1905.

Application filed June 16, 1904. Serial No. 212,867.

To all whom it may concern:

Be it known that I, WILLIAM GRAHAM, a subject of the King of Great Britain and Ireland, residing at 3 Rochester Row, Westminster, London, S. W., England, have invented certain new and useful Improvements in and Relating to Power-Hammers, of which the following is a specification.

My invention relates to power-hammers in which vacuum and pressure are respectively used for the raising of the hammer-head and for the striking of the blow. It has for its object to provide an improved form of hammer of simple construction.

My invention consists in employing for the operation of the hammer a cylinder connected by one or more short passages with the hammer-cylinder and adapted to produce alternate suction and compression, whereby the hammer is reciprocated, and a second cylinder, having a piston adapted to produce vacuum only, the operations of the hammer being controlled either by hand or automatically by opening or closing the passage connecting the two operating-cylinders and opening the second cylinder to or closing it from atmosphere.

Referring now to the accompanying drawings, Figure 1 shows an outside elevation of one form of the improved pneumatic hammer. Fig. 2 is a plan of the arrangement shown in Fig. 1 with the cover *t* and the top cylinder *k* removed. Fig. 3 is a section on the line A B of Fig. 2. Fig. 4 is a sectional plan on the line C D of Fig. 3. Fig. 5 is a similar view showing the movable liner in position for cramping or holding down. Fig. 6 is a sectional plan on the line E F of Fig. 3, and Fig. 7 is a sectional plan on the line G H of Fig. 3.

In carrying the invention into effect according to one form, as illustrated in the accompanying drawings, I provide a pump-cylinder *a*, Figs. 1 and 3, arranged alongside a hammer-chamber *b*, to which it is connected by the passages *c* and *d*. The passage *c* passes to the top of the hammer-chamber and is formed near its extremity in the cover *t* of the hammer-chamber. A non-return valve *e* is placed at the opening of the passage *c* into the hammer-chamber. The other passage *d*, which connects the pump *a* to the hammer-chamber *b*, enters near the top of the chamber and is controlled by means of a liner *f*, which can be rotated for a short distance by means of the handle *g*, which works in the slot *h*, formed in the barrel of the pump *a*.

Above the pump *a* and arranged coaxially with it there is a second pump-cylinder *k*, which is rotatably mounted in a fixed sleeve *s*. The sleeve *s* and cylinder *k* are provided with belts of ports arranged in zones, between which there is a disk *n*, which is preferably cast with the cylinder *k* and in which non-return valves *q* are placed. The ports *u* and *v* in the upper zone are adapted when in register to communicate with the atmosphere, while the ports *w* and *x* in the lower zone are adapted to open a passage *y* connecting the pump *a* to the pump *k*.

The pumps *a* and *k* are provided with pistons *j* and *o*, respectively, which are connected by the rod *r* passing through a bush formed in the division *m* between the two pump-cylinders. The power for driving the pumps is obtained from the power-shaft 18 in any convenient way.

The piston *o* is provided with non-return valves *p*, which are arranged along with the non-return valves *q* in the disk *n* to cause the pump *k* to act as a vacuum-pump. The pumps are both left open to the atmosphere at one end. I also provide an arrangement of atmospheric ports 2 and 3 on the pump-cylinder *a*. These ports are positively controlled by means of the slides 4 and 13, which are actuated from the treadle 8 by means of the link 7 and the lever 6. Short links 15 and 5 connect the two slides, the link 5 being adapted to be thrown out of engagement with the slide 4 when this is not required to be operated by the treadle 8.

A non-return or flap valve 20 is inserted in the pump-cylinder *a* about midway in the pump-stroke. The function of this valve is to allow some of the air to escape during each compression-stroke, so that in the suction-stroke rarefaction will take place. This valve also has the effect of keeping the cylinders cool, as the escape of air through the port 3 tends to cool the working air which becomes heated owing to the compression.

The two belts of ports in the upper pump are opened and closed by means of the rotation of the cylinder *k*. This rotation is effected by means of the treadle 8, pivoted about the pin 10 and connected to a bell-crank lever 11 by means of a link 7. A spring 9 is provided to maintain the treadle in the "up" position. (Shown in Fig. 1.) The one end of the bell-crank lever is connected by one or more suitable links 12, adapted to effect the movement of a pin 17, which is screwed into the barrel of the pump *k*.

The operation of this hammer is as follows: Normally the hammer is held up while the pumps are working and the top cylinder *k* is in the position shown in Figs. 6 and 7. Fig. 6 shows a section through the bottom zone of ports, which when the hammer-tup 16 is being held up are full open, so that the passage between the top and bottom cylinders is open while the atmospheric ports, Fig. 7, are closed. The top pump *k* will thus in the upstroke draw air from the hammer-cylinder *b* and pump-cylinder *a*, which during the downstroke shall be exhausted through the non-return valves *p*. In this way a vacuum is obtained in the hammer cylinder or chamber and the tup is held up. For striking full blow the cylinder *k* is moved round so that the ports *w* and *x* are closed, while the atmospheric ports *u* and *v* register. The vacuum-pump *k* will then be inoperative and will be shut off from the pump *a*, so that all the air displaced by the piston *j* of the pump *a* will pass to the hammer-cylinder and the maximum blow will be obtained. The small atmospheric port 3 will allow additional air into the pump *a* at the end of each suction-stroke, thus providing for any loss due to leakage. For striking light blows while still maintaining the full stroke of the hammer the treadle 8 is depressed so as to bring the cylinder *k* to the position midway between the two positions mentioned above. In this way the maximum vacuum is obtained in the downstroke of the pump-piston *j*, whereas during the upstroke of the pump—*i. e.*, when the hammer-tup 16 is descending—the pump *k* draws some of the air displaced from the cylinder *a*, and thus causes a reduced pressure on the hammer-tup, whereby the force of the blow is reduced. For striking a snap-blow—*i. e.*, a blow of short stroke yet comparatively great force—the link 5 is put into engagement with the slide 4 and the treadle 8 is depressed. This opens the atmospheric port 2 in the cylinder *a* and causes the top or vacuum pump to be shut off, so that only the pump *a* effects the operation of the hammer-tup. In the downstroke of the piston *j* air is exhausted from the hammer-chamber *b* until the piston has overrun the port 2. After this and during the rest of the suction-stroke the vacuum remains constant and the hammer is hung a short distance up. Immediately the upstroke commences the hammer-tup falls down, while when the piston *j* has once more overrun the port 2 the air above the hammer is compressed and the hammer forced with a moderate pressure upon the article placed upon the anvil.

It will be understood that the operations described shall be repeated at every revolution of the crank or every back and forward motion of the pistons *j* and *o*. During all the operations which have just been described the liner *f* is maintained in the position shown in Fig. 4, so that both the passages *c* and *d*, leading from the pump *a* to the hammer-chamber, are open.

When it is desired to hold the hammer-tup down, the liner *f* is moved around by means of the handle *g*, so as to close the passage *d*, as shown in Fig. 5. The treadle 8 is then depressed, so as to shut off the vacuum-pump from the lower pump *a*. In this position the pump *a* on the upstroke compresses air into the hammer-chamber through the passage *c*. On the downstroke of the pump this air is prevented from escaping from the hammer-chamber by means of the non-return valve *e*. During holding down the link 5 should be connected to the slide 4, so as to cut out a part of the pump-stroke by allowing the displaced air to escape until the piston *j* has overrun the port 2.

It will be seen that this hammer is simple in construction and it offers the facility of snap-blows in addition to the usual facilities offered by such hammers. The valves are few in number, and they are exceedingly accessible. The ports may be controlled by simultaneously-operated valves instead of by the movement of the cylinder.

In some cases the cylinders *a* and *b* may be connected together by one passage only, uncontrolled by valves, but the holding-down power is then limited practically to the weight of the tup. Also the two pump-cylinders may be arranged side by side with both their open ends downward.

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

1. A pneumatic hammer, comprising a hammer tup and chamber; a pump arranged to produce alternate suction and compression and connected to the tup-chamber through short passages; a second pump adapted to produce vacuum only and in communication with the first-mentioned pump through a controlled passage, and means for controlling said passage, substantially as and for the purposes described.

2. A pneumatic hammer, comprising a hammer tup and chamber; a pump adapted to produce alternate suction and compression and connected to the tup-chamber by short passages; a second pump adapted to produce vacuum only, and rotatable in a fixed sleeve; ports

in the sleeve arranged so that in one position the vacuum-pump is in communication with the atmosphere while in another it is in communication with the first-mentioned pump, substantially as described.

3. A pneumatic hammer having in combination, a hammer tup and chamber; a pump adapted to produce alternate suction and compression and connected to the tup-chamber by short passages; a second pump adapted to produce vacuum only; a fixed sleeve inside which the vacuum-pump can be rotated for a limited distance; two zones of ports in said sleeve and vacuum-pump cylinder, the ports in one zone opening to the atmosphere when in register and the ports in the other zone when in register communicating through a passage to the pump adapted to produce alternate vacuum and compression, the positions of registration of the two sets of ports being at different parts in the travel of the vacuum-pump cylinder, substantially as and for the purposes described.

4. A pneumatic hammer comprising a hammer tup and chamber, a pump adapted to produce alternate suction and compression, and in communication with the tup-chamber through one short clear passage without valves and also through an independent passage having a non-return valve, means for closing the clear passage while the passage with the non-return valve remains open, a second pump adapted to produce vacuum only and in communication with the first-mentioned pump through a controlled passage, and means for controlling said passage, substantially as and for the purposes described.

5. A pneumatic hammer having in combination a hammer tup and chamber; a pump adapted to produce alternate suction and compression and in communication with the tup-chamber through one short clear passage without valves and also through one passage having a non-return valve; a rotatable sleeve having a port which in one position of the sleeve leaves both of said passages open and in another leaves only the passage with the non-return valve open; a second pump adapted to produce vacuum only and connected to the first pump by a controlled passage, and means for controlling said passage, substantially as described.

6. A pneumatic hammer having in combination, hammer tup and chamber; a pump adapted to produce alternate suction and compression; atmospheric ports in said pump; valves controlling said ports the ports being situated so that when open they allow air to pass into the pump-cylinder for a considerable portion of the suction-stroke; a second pump adapted to produce vacuum only and in communication with the first-mentioned pump through a controlled passage, and means for controlling said passage, substantially as and for the purpose described.

7. A pneumatic hammer having in combination a hammer tup and chamber; a pump adapted to produce alternate suction and compression; two sets of atmospheric ports in said pump; slides operable from a treadle controlling said ports; one set of said ports being opened each time the treadle is depressed, the treadle having a link which may when desired be put into gear with the slide controlling the other set of atmospheric ports; a second pump adapted to produce vacuum only and connected to the first-mentioned pump by a controlled passage, and means for controlling said passage, substantially as and for the purposes described.

8. A pneumatic hammer, comprising a hammer tup and chamber; a single-acting pump in close proximity to the tup-chamber and arranged to produce alternate vacuum and pressure; short passages connecting the pump to the hammer-chamber; a vacuum-pump arranged coaxially with the first pump and rotatable in a fixed sleeve; a passage connecting the two pumps; two sets of ports in the sleeve communicating one with the passage connecting the two pumps and the other with the atmosphere; ports in the rotatable vacuum-pump cylinder adapted to register alternately with the two sets of ports in the sleeve; substantially as described.

9. A pneumatic hammer, comprising a hammer tup and chamber; a single-acting pump arranged in close proximity to the tup-chamber and adapted to produce alternate suction and compression; two passages connecting the tup-chamber and the pump, one leading to a point in the tup-chamber a short distance from the end of the tup-stroke, the other leading to the top of the tup-chamber and having a non-return valve at its mouth; a rotatable sleeve in said pump; ports in said sleeve adapted in one position of the sleeve to leave both of said passages open and in another to leave only that one open which leads to the top of the tup-chamber; a second pump arranged coaxially with the first pump and adapted to produce vacuum only; a controlled passage connecting said pumps; and means for controlling said passage, substantially as described.

10. A pneumatic hammer comprising a hammer tup and chamber; a single-acting pump in close proximity to the tup-chamber; short passages connecting said pump to the hammer-chamber; a rotatable sleeve controlling said passages; a second pump with a rotatable cylinder adapted to produce vacuum only and arranged coaxially with the first pump-cylinder; atmospheric ports on the first-mentioned pump-cylinder; slides controlling said ports; a spring-controlled treadle; links connecting

said treadle to the rotatable cylinder and to such of the slides which it is desired to operate; substantially as described.

11. A pneumatic hammer comprising a hammer tup and chamber, a pump for creating compression in the said hammer-chamber, a second pump adapted to produce a vacuum, and in communication with the first-mentioned pump through a controlled passage, and means for controlling said passage, the suction-stroke of the second pump to create vacuum being simultaneous with the compression-stroke of the first pump, substantially as described.

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

WILLIAM GRAHAM.

Witnesses:
ALBERT E. PARKER,
FRANCIS J. BIGNELL.