(No Model.) 3 Sheets—Sheet 1.

H. H. VAUGHAN.

MOTOR.

No. 589,105. Patented Aug. 31, 1897.

Fig. 1.

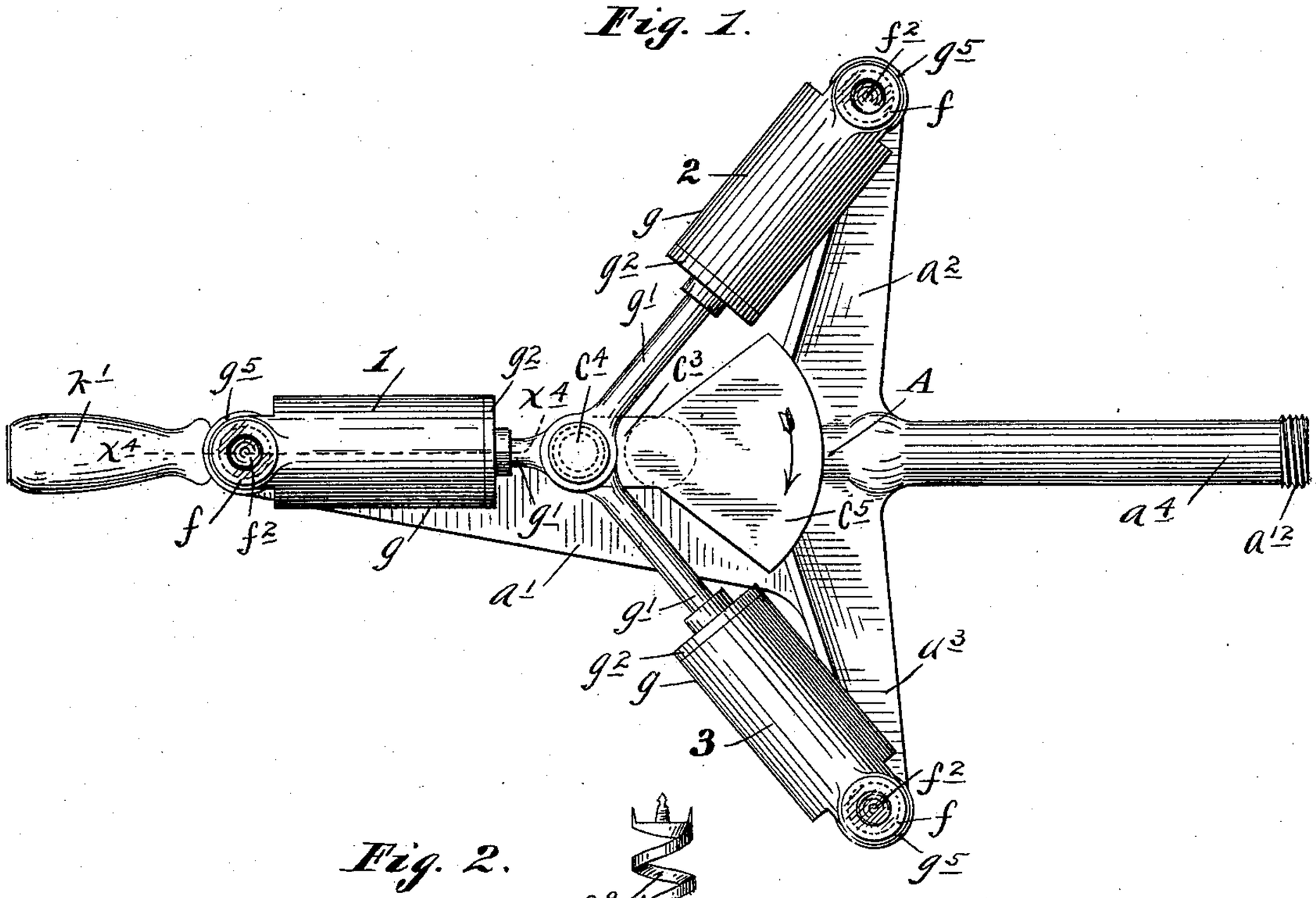
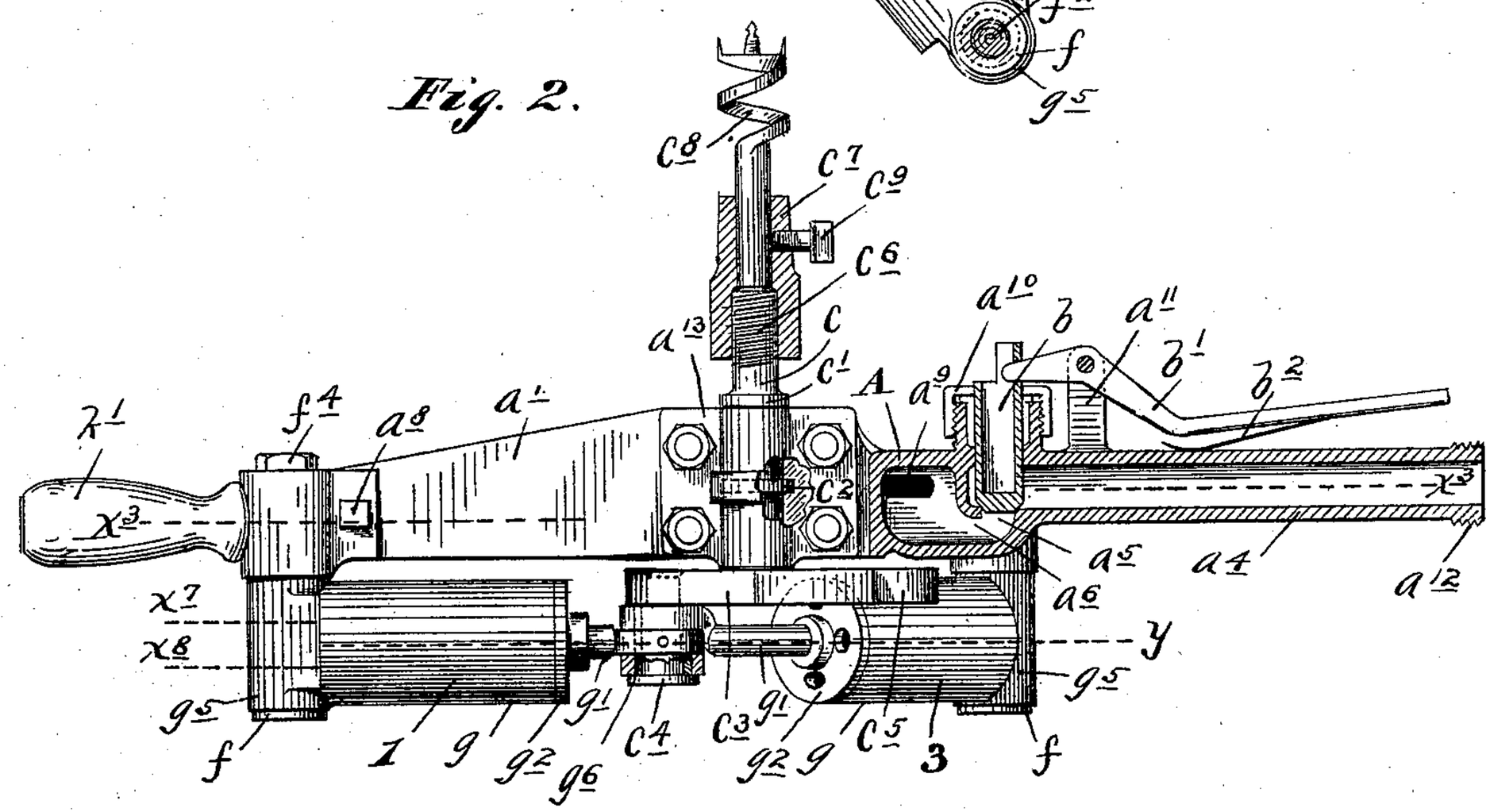


Fig. 2.



Witnesses.

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(No Model.) 3 Sheets—Sheet 2.

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Fig. 3.

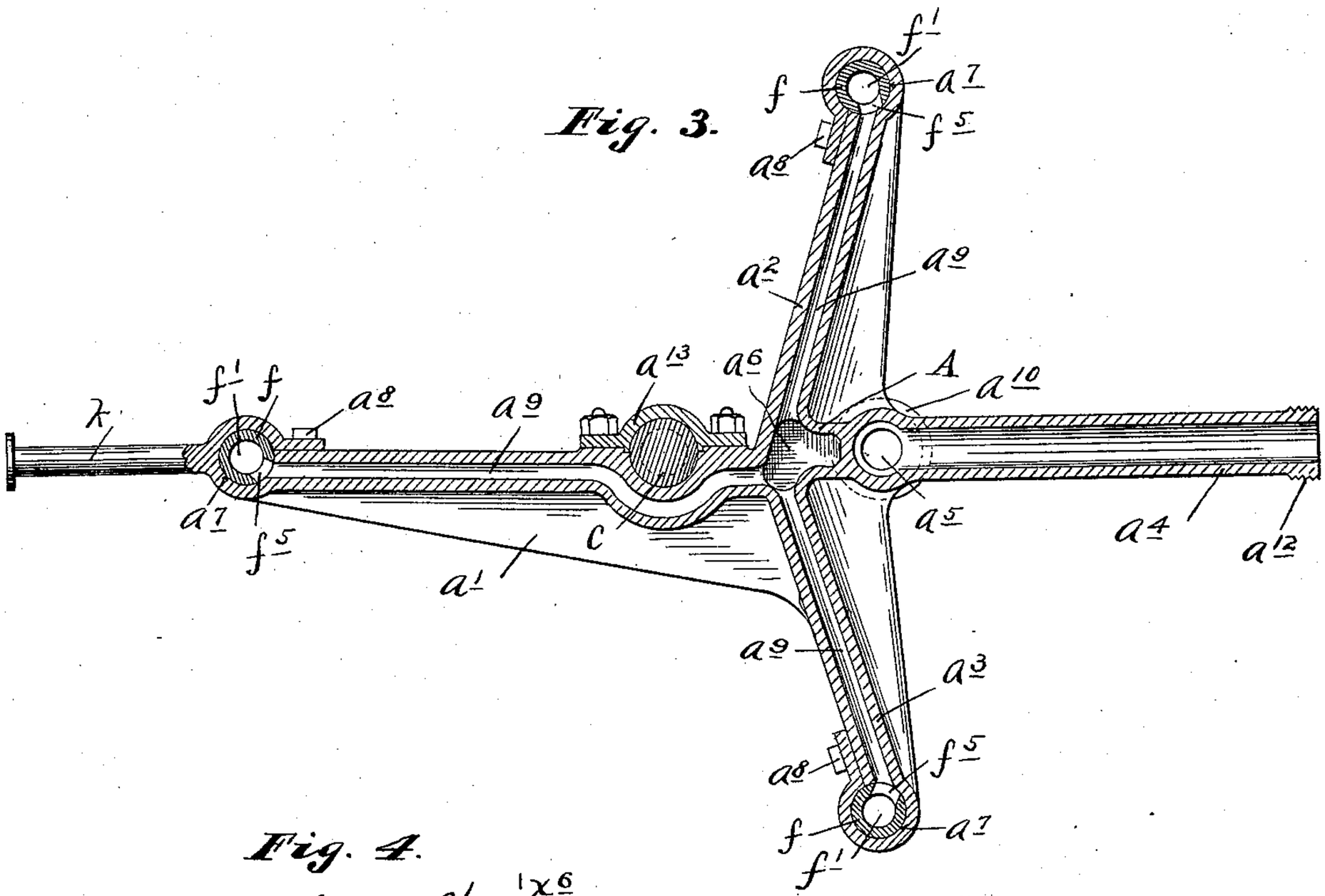


Fig. 4.

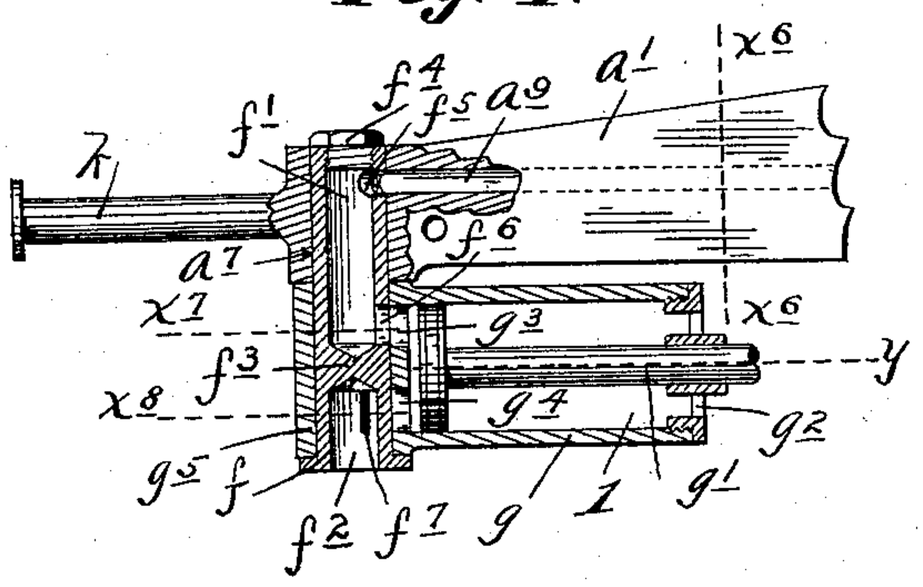


Fig. 5.

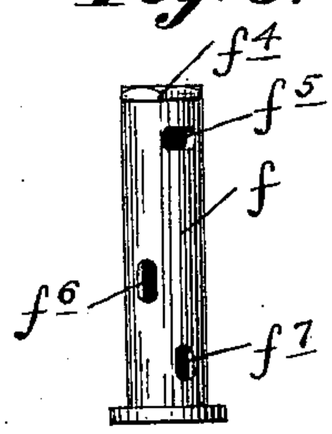
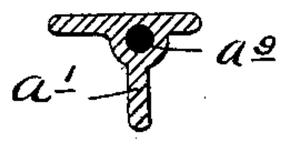


Fig. 6.



Witnesses.

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Fig. 7.

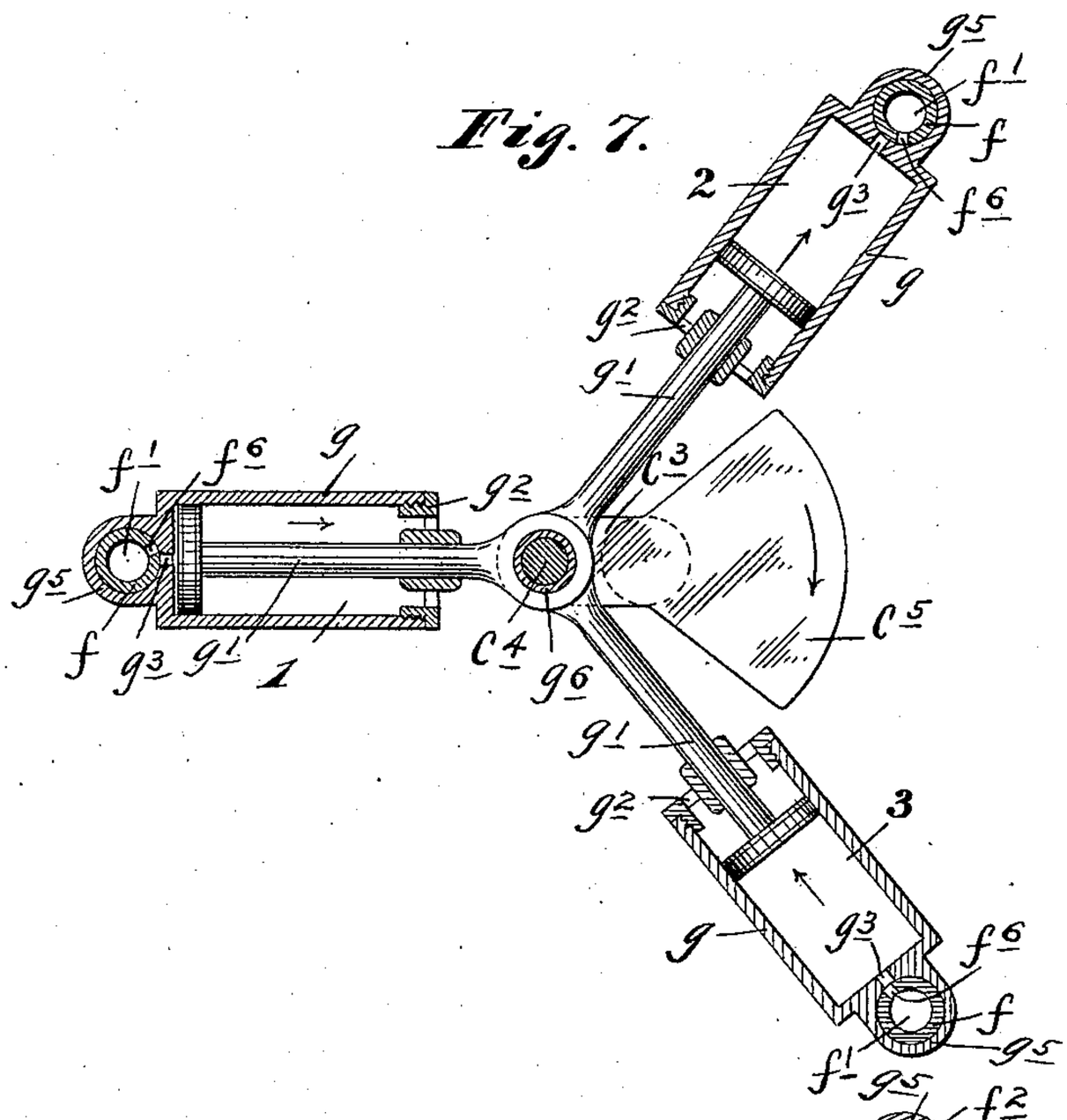
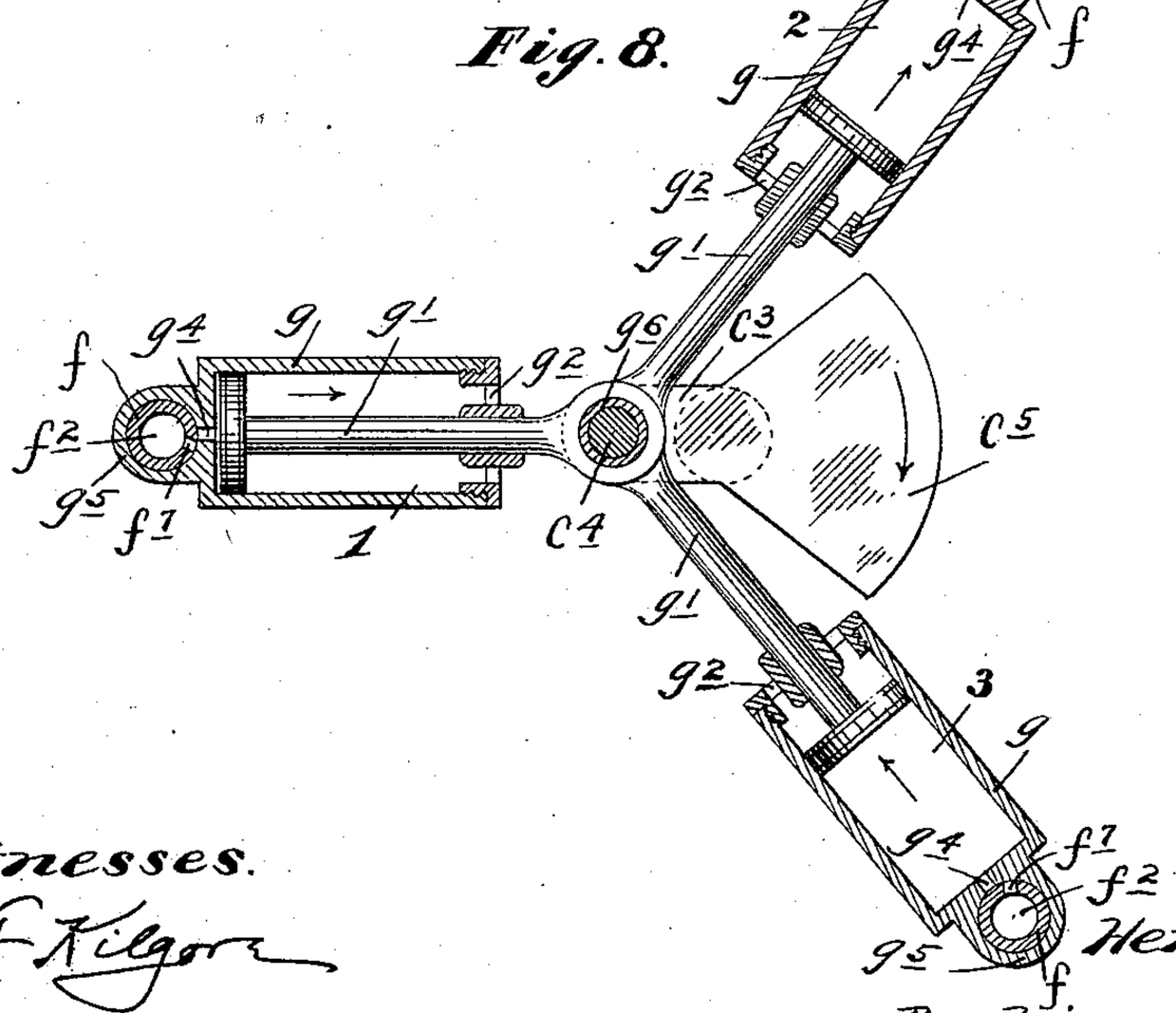


Fig. 8.



Witnesses.
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R. D. Merchant.

Inventor:
Henry H. Vaughan
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UNITED STATES PATENT OFFICE.

HENRY H. VAUGHAN, OF ST. PAUL, MINNESOTA.

MOTOR.

SPECIFICATION forming part of Letters Patent No. 589,105, dated August 31, 1897.

Application filed October 17, 1896. Serial No. 609,238. (No model.)

To all whom it may concern:

Be it known that I, HENRY H. VAUGHAN, a citizen of Great Britain, residing at St. Paul, in the county of Ramsey and State of Minnesota, have invented certain new and useful Improvements in Air-Motors; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to multicylinder oscillating engines, and has for its especial object to provide an engine of the above class adapted to run at very high speed and especially adapted for operating a portable boring-tool or similar device.

To this end my invention consists of the novel devices and combinations of devices hereinafter described, and defined in the claims.

The preferred form of my invention, shown as designed to be held in the operator's hands and to operate an auger or similar tool, is illustrated in the accompanying drawings, wherein, like letters referring to like parts throughout the several views—

Figure 1 is a view in side elevation, showing my improved engine designed for the purpose above set forth. Fig. 2 is a view, principally in plan, but with some parts broken away and others shown in horizontal section, of the device illustrated in Fig. 1. Fig. 3 is a vertical section taken substantially on the line X^3 X^3 of Fig. 2. Fig. 4 is a view taken principally on the section-line X^4 X^4 of Fig. 1, but with some parts shown in full, others broken away, and still others removed. Fig. 5 is a plan view of one of the chambered trunnions removed from the framework. Fig. 6 is a transverse vertical section through one of the radial arms of the spider-like machine-frame, taken on the line X^6 X^6 of Fig. 4; and Figs. 7 and 8 are views in transverse vertical section, taken, respectively, on the irregular lines X^7 y and X^8 y of Figs. 2 and 4, some parts being shown in full.

Referring in detail to the construction shown, A indicates a spider-like frame formed with three radial arms a' a^2 a^3 and a hollow feed-stem or supply-pipe a^4. The feed-stem or supply-pipe a^4 terminates at its inner end in the valve-seat a^5, which opens into a chamber a^6, formed in the frame A at the junction of its radial arms. At their outer ends the radial arms a' a^2 a^3 terminate in trunnion-seats a^7, which, as shown, are formed by half-split sections, the inturned ends of which are clamped to the body of the arm by means of machine-screws a^8. Each of the said radial arms a' a^2 a^3 is formed with an internal passage a^9, which runs longitudinally through the same from the chamber a^6 to the trunnion-seat a^7 thereof.

The passage in the valve-seat a^5 is adapted to be opened and closed at will by means of a throttle-valve b, which works through a stuffing-box a^{10}, secured on one side of the feed stem or pipe a^4. The throttle-valve is operated by means of a throttle-lever b', pivoted to lugs a^{11}, projecting from the hollow stem a^4. This throttle-lever works at its inner end through a perforation or seat formed in the outer end of the plunger b and at its outer end runs close to said tube a^4. A spring b^2, secured to the outer end of the lever b' and bearing against the tubular section a^4, serves normally to hold the throttle-valve b in its closed position. As shown, the outer end of the tubular section a^4 is provided with screw-threads a^{12}, to which by a union (not shown) an ordinary hose or other flexible fluid-conveying connections may be attached.

In a suitable bearing or seat formed partly in the casting A and partly in a removable box-section a^{13} is rotatively mounted a crank-shaft c. This crank-shaft c is fixed against endwise movement by means of a pair of collars c' c^2, formed thereon and working, the former against the forward edge of the box-section a^{13} and the latter in a suitable grooved seat formed partly in the casting A and partly in the box-section a^{13}. On the rear end of the crank-shaft c is formed or rigidly secured a crank-arm c^3, which carries a crank-pin c^4 and a counterbalance c^5. On its forward end the shaft c is shown as provided with screw-threads c^6, which are adapted to engage corresponding threads cut in a bit-stock c^7. As shown, a bit or auger c^8 is removably secured in the bit-stock c^7 by means of a set-screw c^9.

In each trunnion-seat a^7 of the radial supporting-arms a' a^2 a^3 is rigidly secured one end of a cylindrical chambered trunnion f.

These trunnions f are all identically alike and are each formed into two chambers f' and f^2 by means of dividing-partitions f^3. The chamber f^2 is left open to the atmosphere, while the forward end of the chamber f' is tightly closed by means of a plug f^4. Three ports or peripheral fluid-passages f^5, f^6, and f^7 are formed in each trunnion f, as clearly shown in Fig. 5, of which passages f^5 and f^6 open into the chamber f', while the passage f^7 opens into the chamber f^2. The exact relations and relative location of these ports with respect to each other will be more particularly pointed out later on in the description of the operation of the device, and it is only necessary to here note that when the trunnions are secured in working position in the seats a^7 the ports f^5 will register with the coöperating passage a^9 of the particular supporting-arm.

Supported by the arms a' a^2 a^3, respectively, are oscillating engines marked 1, 2, and 3, and involving each a cylinder g and a piston-rod g'. The inner ends of these cylinders are provided with perforated heads g^2, which open to the atmosphere, and the outer heads of said cylinders are each provided with a pair of ports g^3 and g^4. The cylinders g are also formed with cylindrical laterally-disposed bearing-heads g^5, which, as shown, are formed integral with the cylinder and project outward from the rear heads of the cylinder. The perforated cylinder-heads g^2, working on the piston-rods g', serve to hold the inner ends of the cylinders g concentric to the said piston-rods throughout the reciprocating movements of the pistons.

When the oscillatory cylinders are placed in position, their bearing-heads g^5 are pivotally mounted on the projecting portions of the trunnions f', as shown in the drawings, and the inner ends of the piston-rods are all connected to the common crank-pin c^4. This connection of the piston-rods to the crank-pin c^4 is not direct, but is made to a sleeve g^6, which in turn is loosely mounted on said crank-pin c^4. As shown, the inner end of the piston-rod of the engine marked 1 is left straight and is pinned to the loose collar g^6, while the inner ends of the piston-stems of the other two engines (marked 2 and 3) are loosely secured on said sleeve and are bent, respectively, one toward and the other from the crank-arm c^3.

It will be noted that the projecting ends of the hollow trunnions f and the projecting end of crank-pin c^4 are flanged, so as to hold the parts mounted thereon in working position or against lateral movement.

It will be noted that the arm a' projects from the casting A in an opposite direction from but in line with the hollow supply pipe or tube a^4. A rod or stem k, which, as shown, is formed integral with the arm a', projects outward from the end of said arm and is covered by a handpiece k'.

The device is adapted to be handled by taking hold of the handpiece k' with the left hand and gripping the feed pipe or stem a^4 with the right hand. When thus held, the operator's fingers will embrace the outer portion of the throttle-lever b', so that he is at liberty by pressing on the same to operate the throttle-valve b at will.

As already indicated, the device is adapted to be held in the operator's hand by gripping the handpiece k' with one hand and the combined handpiece and supply-pipe a^4 with the other. When thus held, the auger or bit c^8 may be held and guided to its work and may be readily moved from one point to another, the only limitation being of course the length of the flexible fluid-supply hose, (not shown,) but which, as already indicated, extends from some suitable source of fluid-supply under pressure and is connected to the end of the said feed-stem a^4.

As indicated by the arrows marked on Figs. 1, 7, and 8, the oscillating engines when in action are adapted to turn the crank-shaft c in the proper direction to operate a boring-tool which is formed with a right-hand spiral or cutter.

The operation of the device is substantially as follows: It is probable that compressed air would usually be employed to operate this device, and we may assume this to be the case in the present illustration. The operator, having properly positioned the auger or other tool for work, throws the engines into action by pressing on the outer end of the throttle-valve lever b', thereby opening the valved passage a^5 and letting in the compressed air to the chamber a^6, from whence the said air passes through the radial passages a^9 of the supporting-arms into the closed chambers f' of the trunnions f. Let it be assumed that when the air is thus admitted the engines stand in the positions shown in the drawings. Attention is here recalled to the fact that in Fig. 7 the section is taken through the coöperating admission-ports f^6 and g^3, formed in the trunnions f and cylinders g, respectively, while in Fig. 8 the section is taken through the coöperating exhaust-ports f^7 and g^4 of said trunnions f and cylinders g, respectively.

Referring to Figs. 7 and 8, it will be noted that the engine marked 1 stands with its piston-stem on a dead-center with the crank-arm c^3, in which position the coöperating exhaust-ports f^7 and g^4 have just been closed, while the coöperating admission-ports f^6 g^3 still remain closed, but stand in such position that they will be immediately opened by the oscillatory movement of the cylinder under the advance movement of the crank-shaft. Again, it will be noted that the coöperating admission-ports of the engine marked 2 are closed, while the coöperating exhaust-ports f^7 g^4 of the same are open, so as to permit the free outstroke of the piston; and, again, it will be noted that the coöperating exhaust-ports f^7 g^4 of the engine marked 3 are closed, while the coöperating admission-ports f^6 g^3 of the same are open, so as to ad-

mit air to the cylinder thereof back of the piston.

From the above it will be seen that in the exact positions illustrated the engine marked 3 is alone active—that is, acting to force the movement of the crank-shaft. At this particular interval, however, the crank-arm c^3 stands in such relation to the piston-stem of the engine 3 that nearly the maximum power of the engine is applied on the crank-shaft, and at the next succeeding interval as the effective power of the engine 3 on the crank-shaft diminishes the engine 1 is rendered active, and its force on the crank arm and shaft is applied with an accelerating action, which gradually increases as the effective force of the engine 3 decreases. When the piston of the engine 3 reaches the dead-center of its inward stroke, both the admission and the exhaust ports of the same will for the instant be closed, but at this interval the engine 1 will be applying substantially its maximum effective force on the crank-shaft, and will continue to so act until the engine 2 has been moved by the dead-center of its outward piston stroke, and in turn caused to commence its accelerated action on the crank-shaft. It will thus be seen that the combined action of the engines produces substantially an unvarying rotating force on the crank-shaft, and that the proper actions of the admission and exhaust ports are effected automatically by the oscillating movements of the engines under the movement of said crank-shaft.

It is exceedingly important to note that the coöperating admission and exhaust ports of the hollow trunnions f and of the cylinders g are so located that they will be tightly pressed together by the reaction of the piston's strokes. Hence a tight joint between the coöperating ports of the trunnions and the cylinders is always insured, and a considerable wear of the said parts will be compensated by this action. Attention is also called to the fact that by loosening the machine-screw a^8 so as to relieve the tension of the trunnion-seat a^7 the said trunnion f may be rotatively adjusted, so as to bring the ports f^6 f^7 thereof into the proper relation with the ports g^3 g^4 of the coöperating cylinder.

It will also be noted that the ports f^6 f^7 of the trunnions f and the ports g^3 g^4 of the cylinders g are laterally elongated, so as to give very quick port-openings and cut-off under the oscillatory motion of the said cylinders.

The purpose and action of the sleeve g^6 on the crank-pin c^4 should also be further considered. As this sleeve g^6 is secured to one of the piston-rods it will be caused to make one complete revolution on the crank-pin under each revolution of the crank-shaft, while the two piston-rods, which are loose on said sleeve, have but a very slight oscillatory movement thereon. Hence the main wear will be between said sleeve g^6 and the crank-pin g^4. This of course is desirable, as the comparatively long collar affords a much better wearing-surface than the thin heads of the piston-rods.

While the above-described device is especially adapted to be operated by compressed air or steam, it may be operated by any fluid under pressure.

It will also be understood that various alterations in the details of construction above set forth may be made without departing from the spirit of my invention.

What I claim, and desire to secure by Letters Patent of the United States, is as follows:

1. In a multicylinder oscillating engine, the combination with the frame formed with radial supporting-arms, one of which is provided with an extended handpiece, of a combined handpiece and feed-stem extending diametrically opposite to said projecting handpiece, and a throttle-valve in said combined feed-stem and handpiece, operated substantially as described.

2. In a multicylinder oscillating engine, the combination with the spider-like frame, formed with radial arms which terminate in trunnion-seats formed by half-split sections, the inturned ends of which are adapted to be clamped to the body of the arms, and the chambered trunnions clamped in said seats and serving as pivots for the oscillating engine, substantially as described.

3. In a multicylinder oscillating engine, the combination with the spider-like frame, formed with three radial supporting-arms, one of which is provided with a projecting handpiece, and all of which terminate in trunnion-seats formed by half-split sections with inturned clamping ends, of the hollow trunnions mounted in said seats and constituting pivots for the oscillating engines, the combined handpiece and feed-stem projecting from said spider-like frame, diametrically opposite to said projecting handpiece, and a throttle-valve in said combined handpiece and feed-stem, operated substantially as described.

In testimony whereof I affix my signature in presence of two witnesses.

HENRY H. VAUGHAN.

Witnesses:
JAS. F. WILLIAMSON,
F. D. MERCHANT.