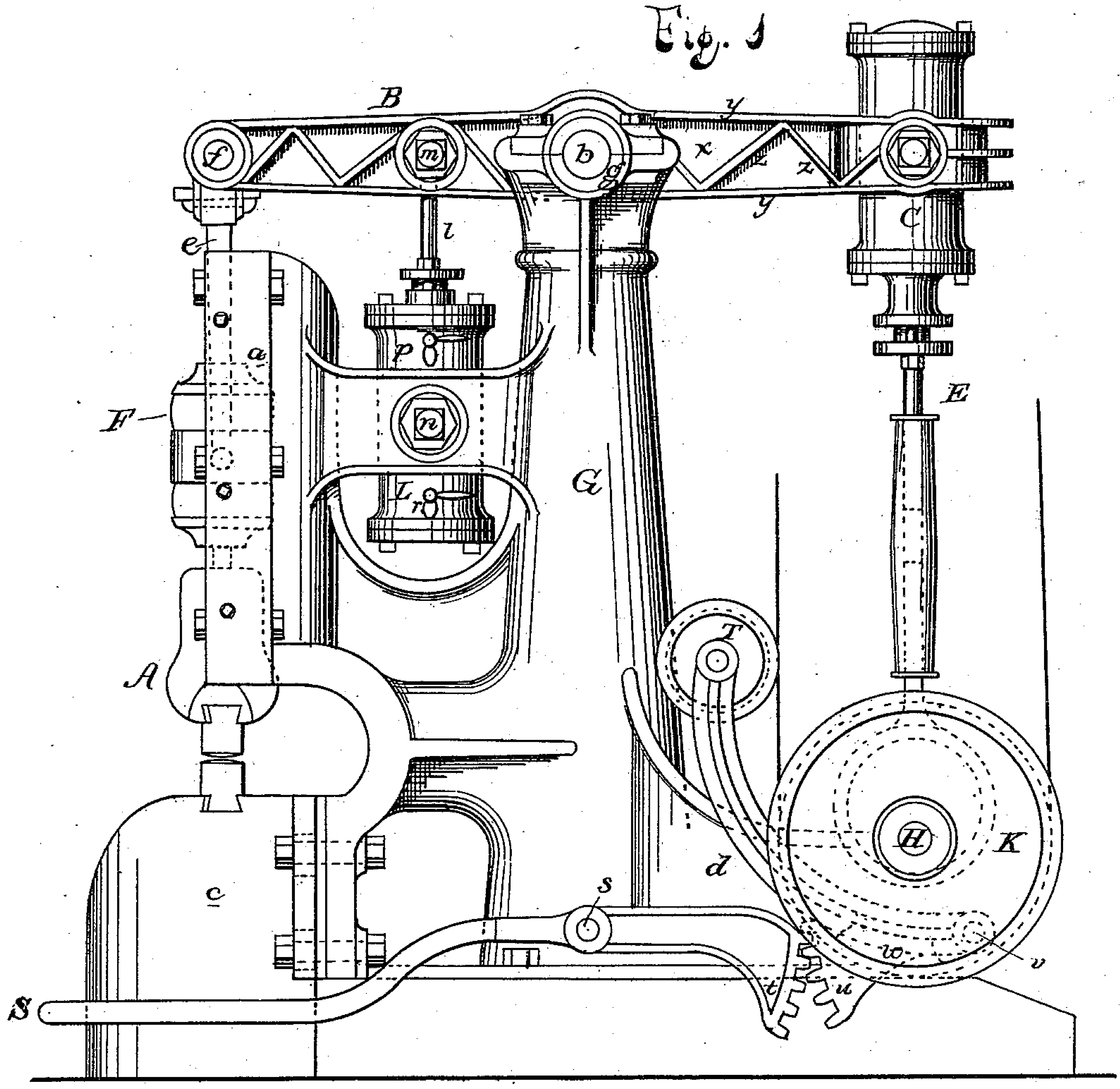
3 Sheets—Sheet 1.

J. C. BUTTERFIELD.

ATMOSPHERIC HAMMER.

No. 176,400. Patented April 18, 1876.

Fig. 1



—Witnesses—

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Fig. 3.

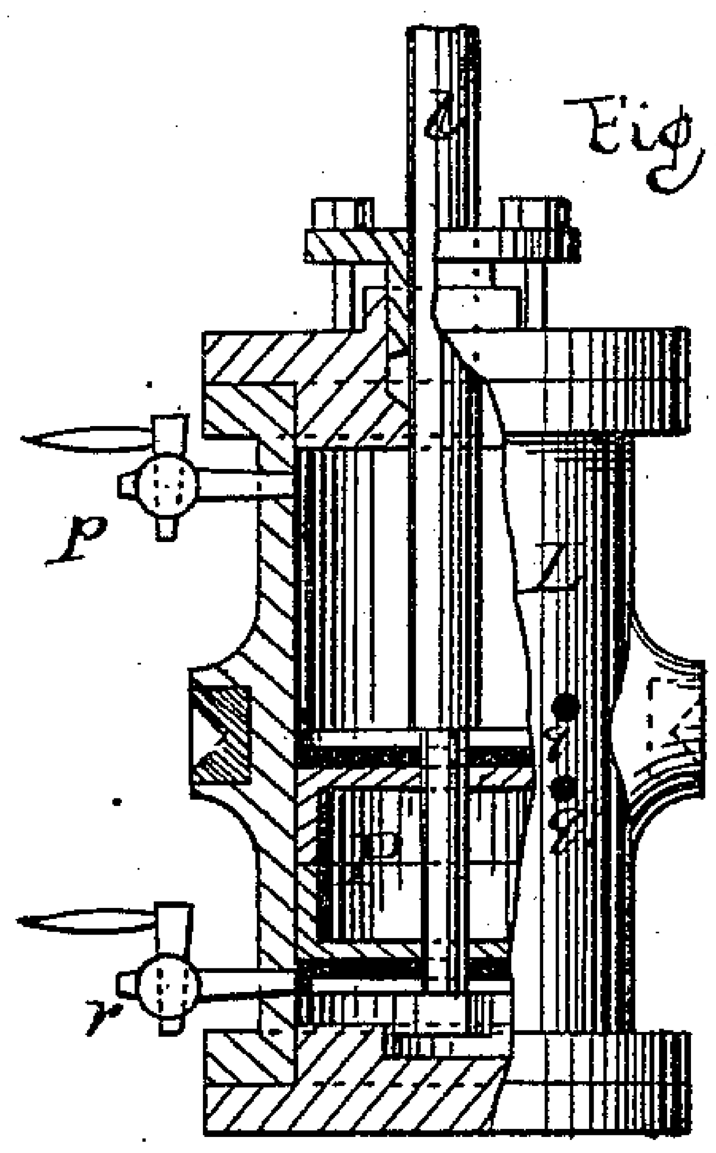

Fig. 2.

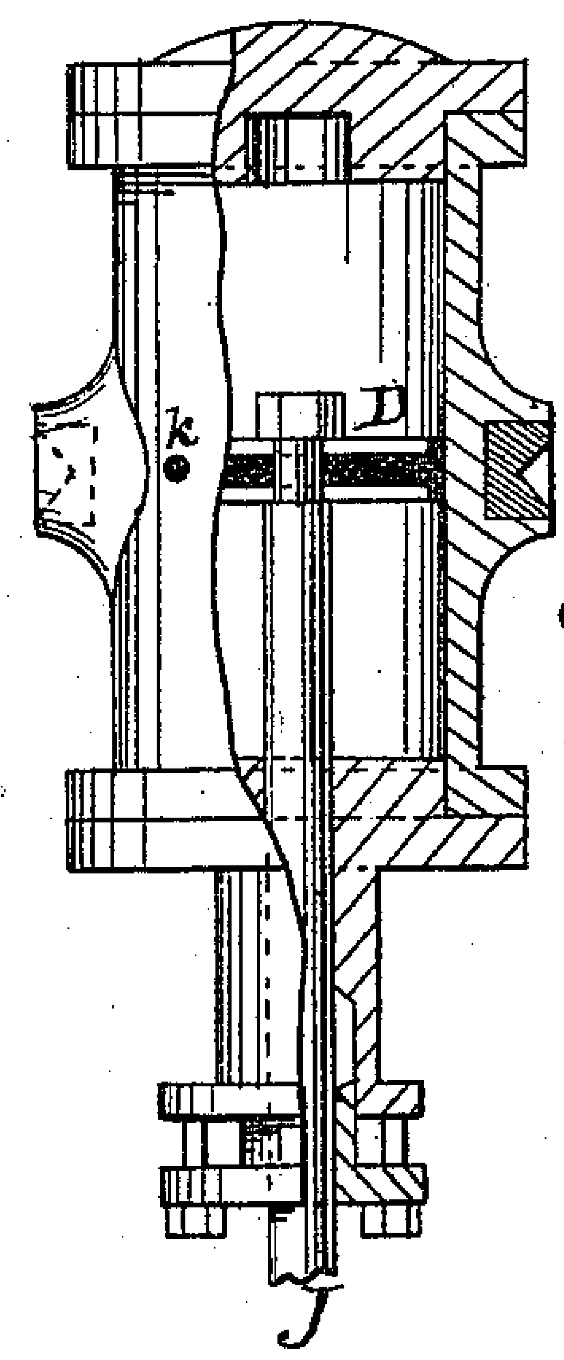

Fig. 5.

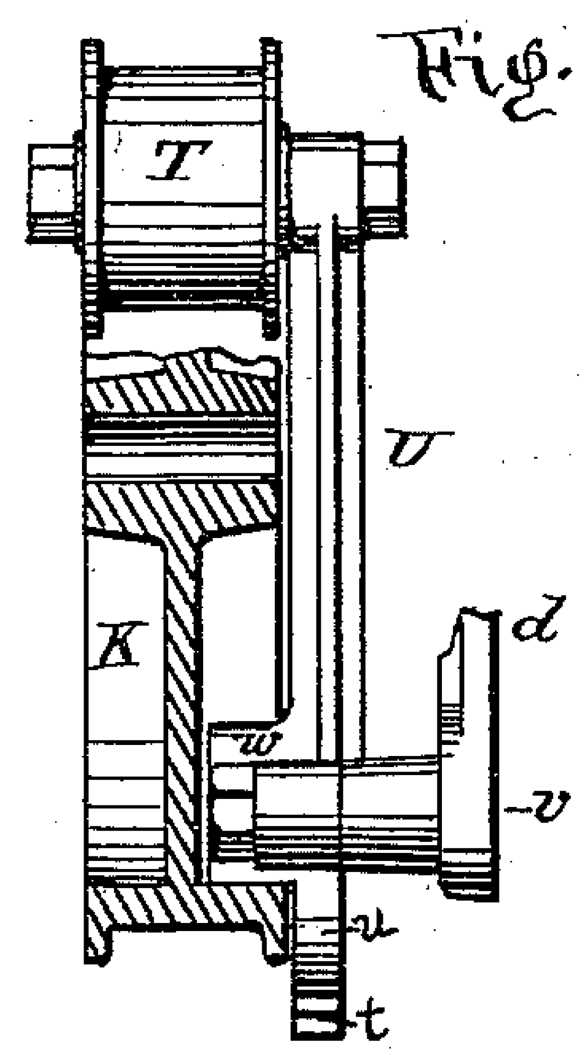

Fig. 4

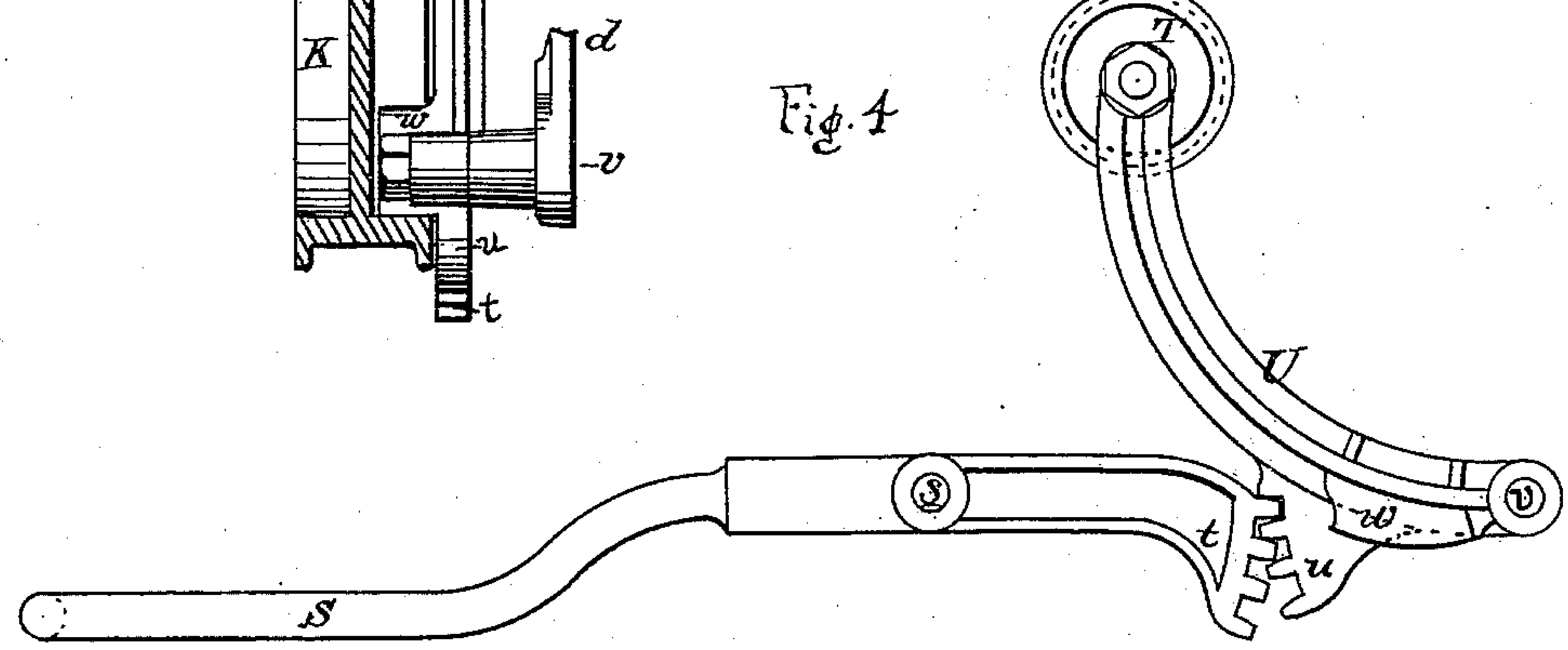

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Fig. 6

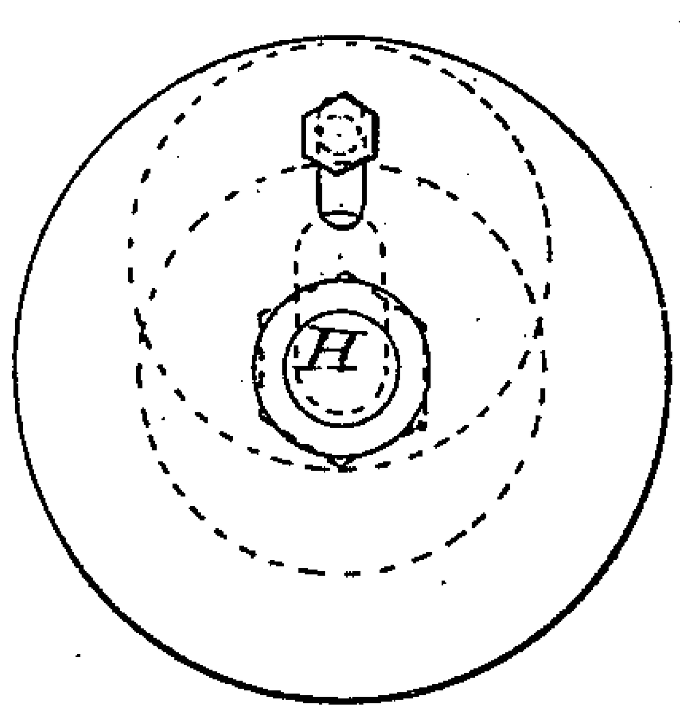


Fig. 7

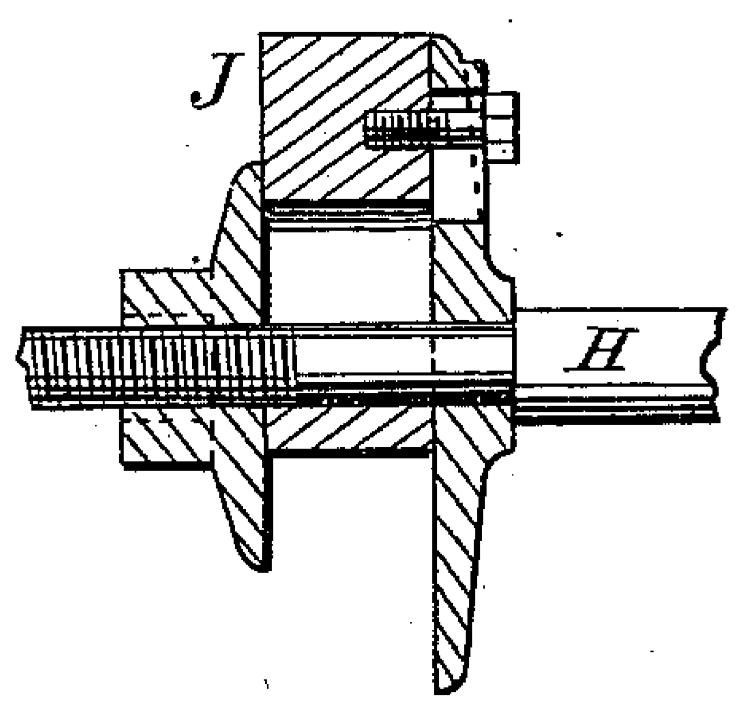


Fig. 8

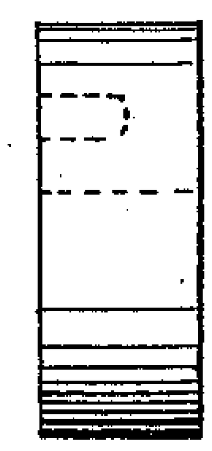


Fig. 9

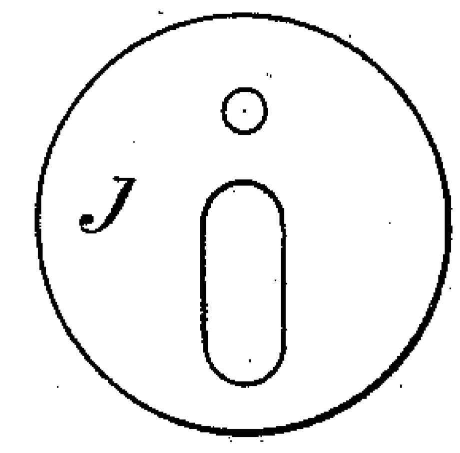


Fig. 10

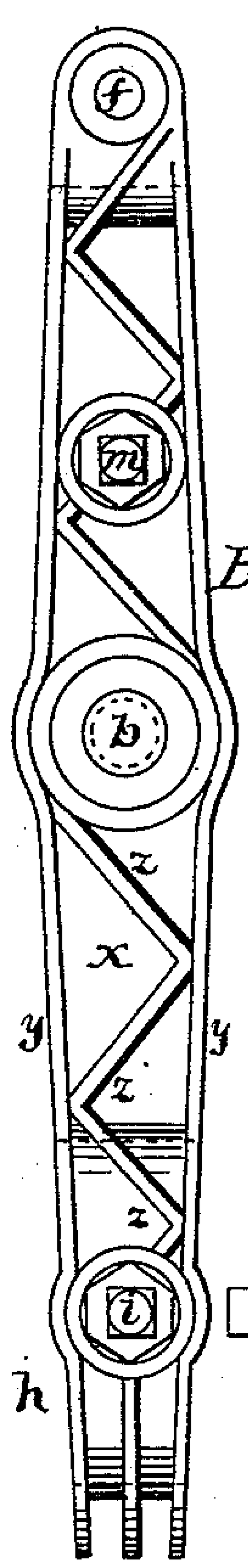


Fig. 11

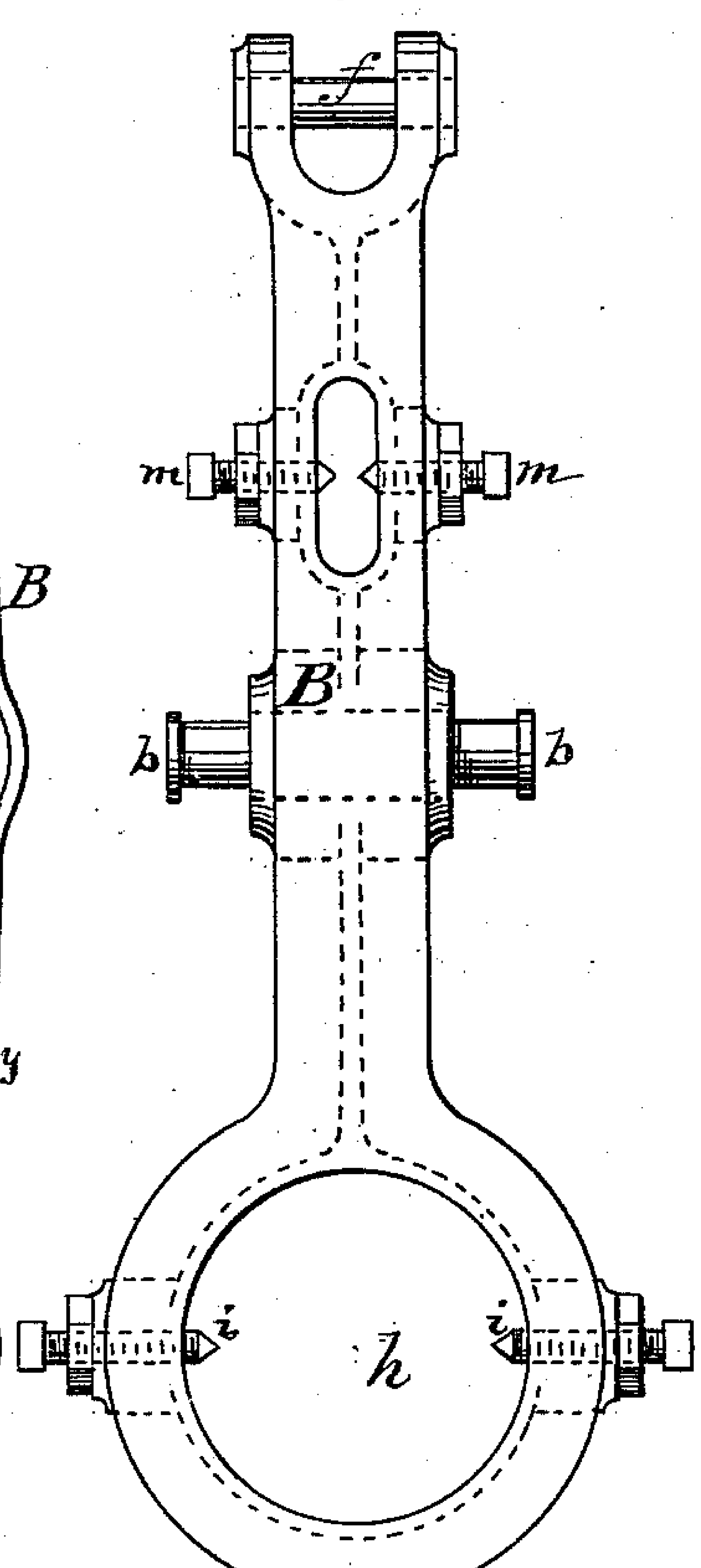


Fig. 12

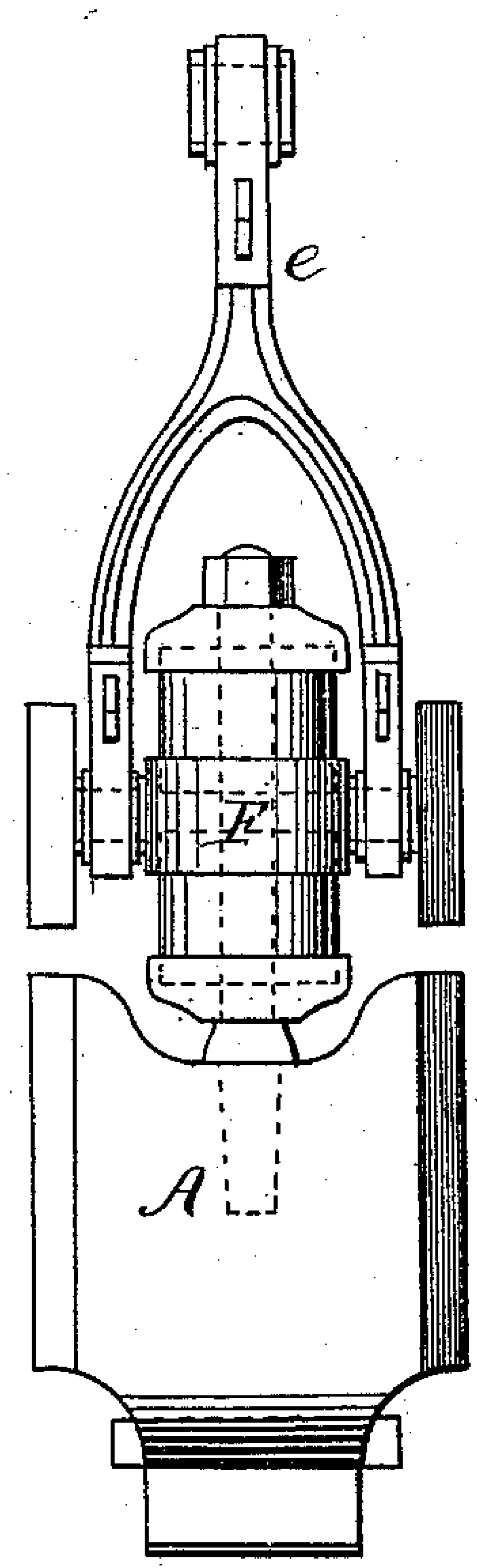
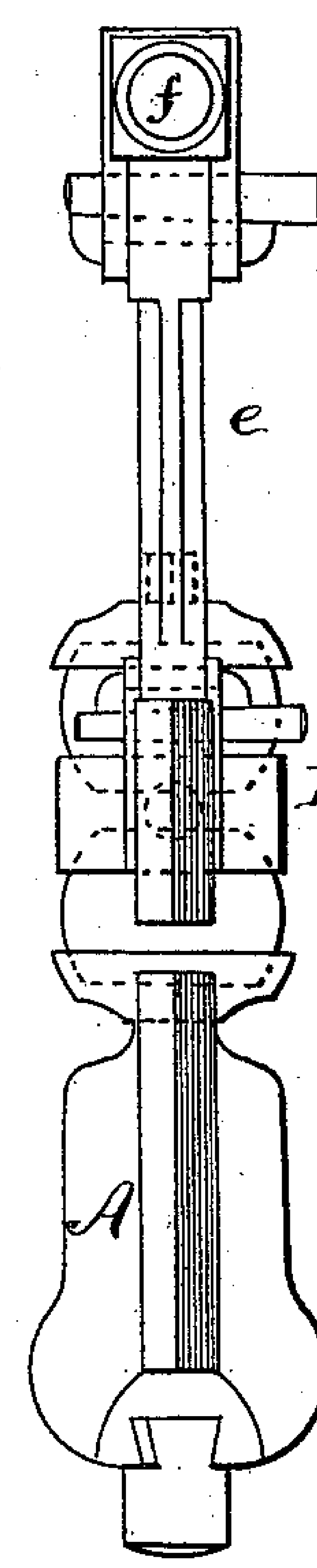


Fig. 13



—Witnesses—

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R. D. O. Smith

—Inventor—

J. C. Butterfield

UNITED STATES PATENT OFFICE.

JOHN C. BUTTERFIELD, OF CHICAGO, ILLINOIS,

IMPROVEMENT IN ATMOSPHERIC HAMMERS.

Specification forming part of Letters Patent No. **176,400**, dated April 18, 1876; application filed April 6, 1876.

To all whom it may concern:

Be it known that I, JOHN C. BUTTERFIELD, of the city of Chicago, county of Cook and State of Illinois, have invented a new and useful Improvement in Atmospheric Hammers, which is fully set forth in the following specification.

Atmospheric hammers have heretofore been constructed, and their characteristics may be classed as follows: *a*, atmospheric pressure added to the weight of the hammer to increase the impact; *b*, expansion of compressed air to increase the impact; *c*, compression above and below the piston, the former to elevate the hammer, and the latter to increase the impact. *a* and *c* also propose to regulate the force of the blow by air cushioning; *a* and *b* elevate the hammer by mechanism; *c* elevates by compressed air.

For the purpose of clearly explaining my invention, I will point out the material differences between it and atmospheric hammers heretofore made.

A principal desideratum in hammers of this class is to intercept the shock of the hammer-blow, so that it shall not be transmitted to the frame of the machine. In the hammer *c*, alluded to above, this is accomplished by the interposition of a body of air between the hammer and its motive mechanism, but shock is nevertheless transmitted through the close packings required to prevent the escape of air under pressure. In my machine the transmission of shock is prevented by the interposition of cushions of an elastic solid, like india-rubber.

The hammers alluded to have their air-cylinders in line with the hammer, and the power required is sufficient to lift said hammer as dead weight. My hammer is counterbalanced, and therefore moved with a minimum expense of power.

The hammers alluded to propose only to cushion in one direction, and can only control the force of the blow with variations of the rapidity of delivery. My hammer cushions in either or both directions, and the force of the blow can be controlled perfectly irrespective of the rapidity of delivery.

From the above it will be perceived that I do not employ air-springs for the purpose of intercepting shock, but solely for the purpose of operating and controlling the action of the hammer, as will more fully appear in the following description.

My invention, therefore, consists, first, in a balanced atmospheric or air spring hammer; second, in a supplemental air-cylinder, capable of cushioning in either or both directions and to any desired extent; and also, third, in tightener-treadle and brake; and, fourth, in the cast-metal hammer-beam.

The leading elements of my invention are a hammer, A, moving in upright guides, a horizontal oscillating hammer-beam, B, mounted on journals about midway of its length, an air-cylinder, C, attached to said beam, at the end opposite the hammer, and a piston, D, in said cylinder, operated by the crank or eccentric rod E. The intercepting cushions F form the subject of Letters Patent No. 156,276, granted to me October 27, 1874. The frame G supports all of the working parts of this hammer, and without intending to limit myself to the exact details of construction and arrangement, but for convenience only, I will describe the machine as it is shown in the accompanying drawings, wherein—

Figure 1 is a side elevation. Fig. 2 is a sectional elevation of the principal air-cylinder. Fig. 3 is a sectional elevation of the supplemental air-cylinder. Fig. 4 is a side elevation of the treadle and tightener. Fig. 5 is a front elevation of the tightner. Figs. 6, 7, 8, and 9, are details of the eccentrics. Fig. 10 is a side elevation of the hammer-beam. Fig. 11 is a plan of the same. Figs. 12 and 13 are front and edge elevations of the hammer and hammer-rod.

1. The frame G has at its top the boxes *g g*, one on either side for the reception of the journals *b b* of the hammer-beam B. The guide-frame *a* and anvil-block *c* are upon the front side of said frame, and two arms, *d d*, project from the rear side near the base to support the boxes in which the crank-shaft H revolves. The hammer rod or piston *e* is joined to the front end of the beam B by a wrist-pin, *f*, which is driven transversely through the end of said beam. At the rear end the hammer-beam B is expanded, and forms a circular loop, *h*, having center-screws *i* in its opposite sides,

and transverse to the beam whereon the oscillating cylinder C is suspended. The piston D works in the cylinder C, and its piston-rod E is coupled to the crank or eccentric rod, which is actuated by the eccentrics J. The cylinder C is closed at each end, and has a vent-hole, *k*, in its side about midway of its length. Power is transmitted to the pulley K on the shaft H by means of a belt, in the usual manner. It will be perceived that I have a horizontal oscillating hammer-beam, with fulcrum about midway of its length, and from the front end of this beam the hammer B is suspended, and the cylinder C is attached to its rear ends. This cylinder and its attachments are constructed to equal in weight the hammer B and its attachments, so that said hammer and its working-connections are balanced upon the hammer-beam journals *b*, and to move said hammer requires only sufficient power to overcome the inertia and friction of the parts, whereas with all atmospheric hammers heretofore, the required power must be sufficient not only to overcome inertia and friction, but to raise the dead weight of the hammer in addition. These hammers, therefore, require a maximum power, while mine requires only the the minimum. When the piston D descends, the compression of the air in the bottom of the cylinder C begins as soon as said piston passes the vent *k*, and said cylinder will begin to descend and the hammer will begin to rise as soon as the compression is sufficient to overcome the inertia and friction of the moving parts. When the movement of the piston is reversed, expansion of the compressed air and momentum will cause a slight continuance of the upward motion of the hammer, but this will be quickly checked by compression of air in the top of the cylinder C as the piston D moves upward, and the hammer will thereby be driven downward upon the anvil, the intensity of the impact being proportionate to the rapidity of the reciprocation of the piston.

As the eccentric or crank passes its lower center, the weight of the piston D, with its rod E and attachments, is sustained by the compressed air in the bottom of the cylinder C, and therefore the eccentric is entirely relieved of thrust in reversing the motion of said piston and rod. The same effect in a reverse direction takes place as the eccentric passes its upper center.

The above-described operation is effective, but is subject to a single disadvantage, viz: an upward thrust upon the bearings *b*, occasioned by the continued upward movement of the hammer, as above mentioned, and this effect is counteracted by the second part of my invention, (2d,) which relates to a supplemental air-cylinder, L, the piston-rod *i* of which is jointed to the hammer-beam B, by the center screws *m* in front of the fulcrum *b*. The cylinder L is mounted upon center screws *n*, so that it is capable of the required oscillation as the beam B moves upon its fulcrum. The cylinder L is smaller in caliber than the cylinder C. As its piston is moved from end to end in the cylinder L, its effect is in opposition to said cylinder C, as follows: When the cylinder C descends under the force of the compressed air in the bottom of said cylinder, the piston *l* is drawn to the top of the cylinder L, and the tension of the compressed air therein is opposed to the downward movement of the said cylinder C; but this effect may be graduated so as to equal only the power necessary to overcome the upward thrust of the hammer, and then, by the expansion or reaction of the air compressed in the top of the cylinder L, to impart to the hammer its initial downward movement.

By the proper graduation of these opposing forces, all upward thrust of the journals *b* against the caps of the boxes *g* may be prevented, and the operation of the hammer-beam will be unaccompanied by jar or shock.

The required control of the resistance in the cylinder L is obtained by means of the valves *p*, which enables the attendant to regulate the amount of air cushioning by adjusting said valve to permit a greater or less escape of the compressed air. The piston D passes the vent *k* at mid-stroke; but it is necessary that the piston P in the cylinder L shall cut off its vent *q* almost as soon as the movement of said piston commences. Therefore it is possible to secure about double the compression in cylinder L as compared with cylinder C, and a corresponding ease and delicacy of adjustment at the valve *p*. I therefore make said piston P very long, nearly equal to half the length of said cylinder L, and provide two vents, *q*, so that air may enter both top and bottom ends of said cylinder.

In atmospheric hammers heretofore the force of the blow could only be controlled by regulating the speed of the hammer, and it is of considerable importance to control the blow without varying the speed. This is readily effected by means of a valve, *r*, at the bottom of the cylinder L. When this valve is closed the air compressed under the piston P takes up the force of the hammer-stroke downward, and without in any degree affecting the speed, and this effect may be graduated at will by adjusting said valve *r* to permit an escape of a greater or less portion of the confined air.

3. The machine is provided with the usual treadle S and tightener T, whereby the speed may be regulated in the common manner. The treadle connection, however, is peculiar. The treadle S has its fulcrum upon pins *s* driven into the sides of the frame G near its base, and extends to the rear of said fulcrum-pins. On one side it is provided with a counterweight, and on the other it is provided with a segment-rack, *t*, which meshes with a similar segment-rack, *u*, on the front end of the tightener-arm U, which is journaled at its rear ends upon a pin, *v*, driven into the extremity of the arm *d* on the same side of the frame with the pulley K. A projecting shoe, *w*, on the side

of the tightener-arm U enters within the rim of the pulley K, and acts as a brake thereon, when the tightener falls down out of action, to stop the motion of the driving-shaft H.

4. The hammer-beam B requires sufficient strength and stiffness to move the hammer with the requisite speed, and at the same time it is desirable to reduce its weight as much as may be compatible with the requisite rigidity.

I have therefore devised a cast-metal trussed beam, which, upon trial, has been found to answer excellently.

Said beam B consists of a web, *x*, with top and bottom flanges *y*, and angular ribs or trusses *z* extending from end to end, as shown.

The web *x* is in the center longitudinally, and the flanges *y* and ribs *z* are arranged on each side of said web.

This beam is cast in a single piece.

Having described my invention, what I claim as new is—

1. A hammer, A, attached to one end of a hammer-beam mounted on journals about midway of its length, combined with an air-cylinder, C, attached to the opposite end of said beam, and a piston, D, in said cylinder, actuated by an eccentric or crank rod, E, operating in the manner and for the purpose set forth.

2. An oscillating hammer-beam, B, mounted upon journals about midway of its length, and attached to opposite ends of the same, a hammer, A, and an air-cylinder, C, the piston whereof is actuated by a crank or eccentric, combined with a supplemental cylinder, L, with an adjustable valve, *p*, near its upper end, and its piston-rod joined to said beam between its fulcrum and the hammer, for the purpose of arresting the upward thrust of said hammer, as set forth.

3. An oscillating hammer-beam, B, mounted upon journals about midway of its length, and attached to opposite ends of the same, a hammer, A, and an air-cylinder, C, the piston whereof is actuated by a crank or eccentric combined with a supplemental air-cylinder, L, provided with an adjustable valve, *r*, near its lower end for the purpose of cushioning the downward blow of the hammer to regulate the impact thereof without affecting the speed of delivery.

4. The air-cylinder L provided with adjustable valves *p* and *r* near its upper and lower ends respectively, and with a piston, P, in length nearly equal to the length of stroke, combined with a hammer, A, and its operative mechanism.

5. The treadle S, provided with the rack *t*, combined with the tightener-arm U, provided with the rack *u*, for the purpose of operating said tightener, as set forth.

6. The combination of the tightener-arm U, substantially as described, and the laterally-projecting shoe *w* adapted to enter within the rim of the pulley K, and act as a break thereon.

7. A hammer-beam for power-hammers, constructed of cast metal with a central longitudinal web, *x*, flanges *y*, and angular truss-ribs *z*, as set forth.

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Witnesses:
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