(No Model.) 3 Sheets—Sheet 1.

G. H. REYNOLDS.

PNEUMATIC GUN.

No. 421,308. Patented Feb. 11, 1890.

Fig. 1.

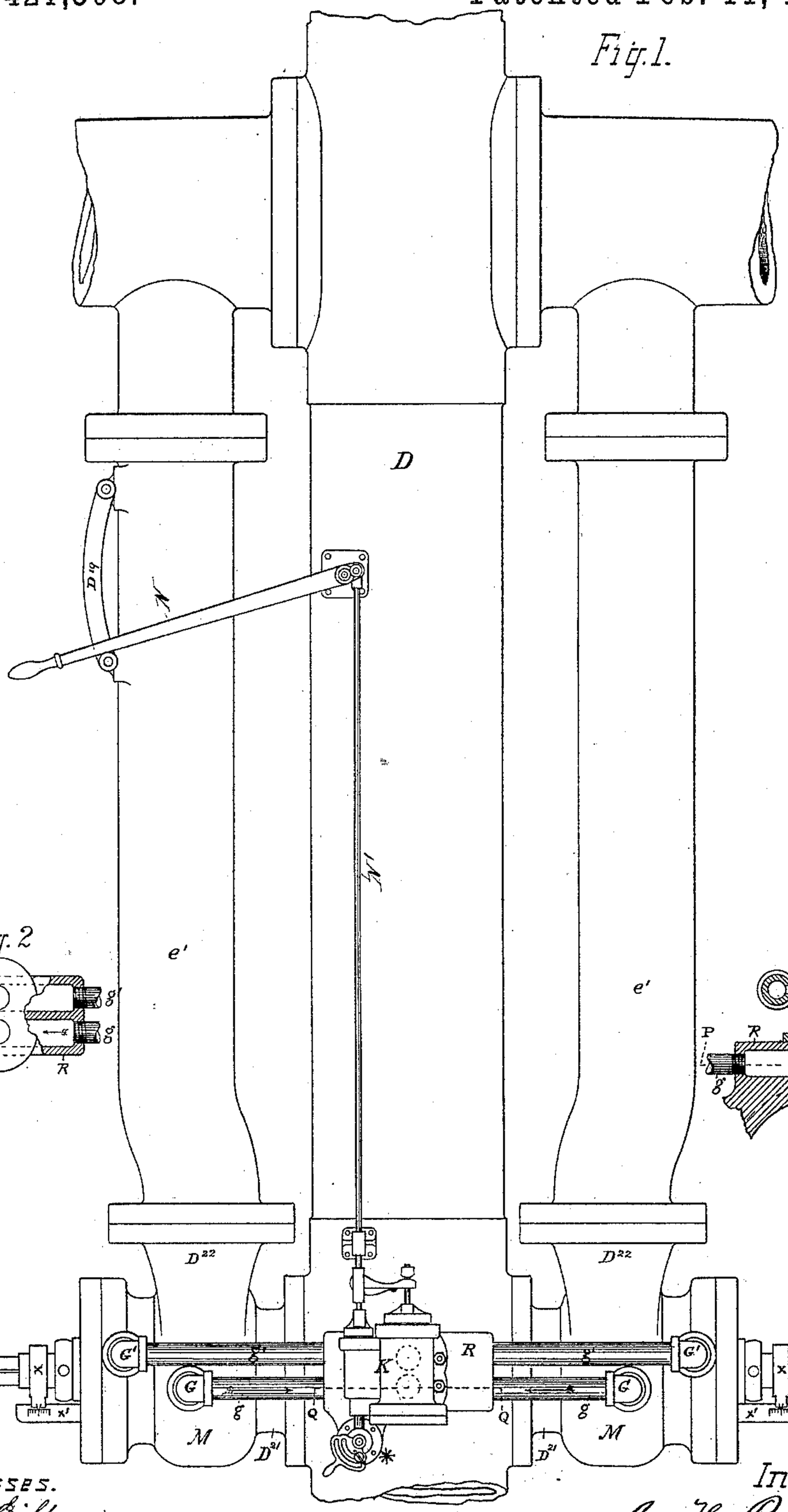
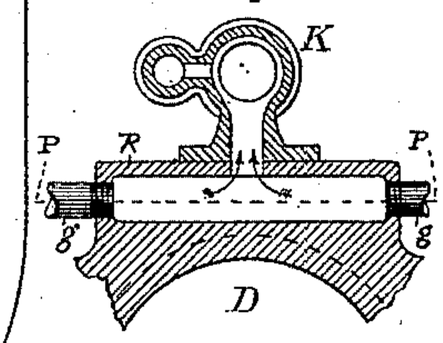


Fig. 2.

Fig. 3.



Witnesses.
Henry Eichbaum
Frank Bowin Jones

Inventor
Geo H Reynolds

(No Model.)

3 Sheets—Sheet 2.

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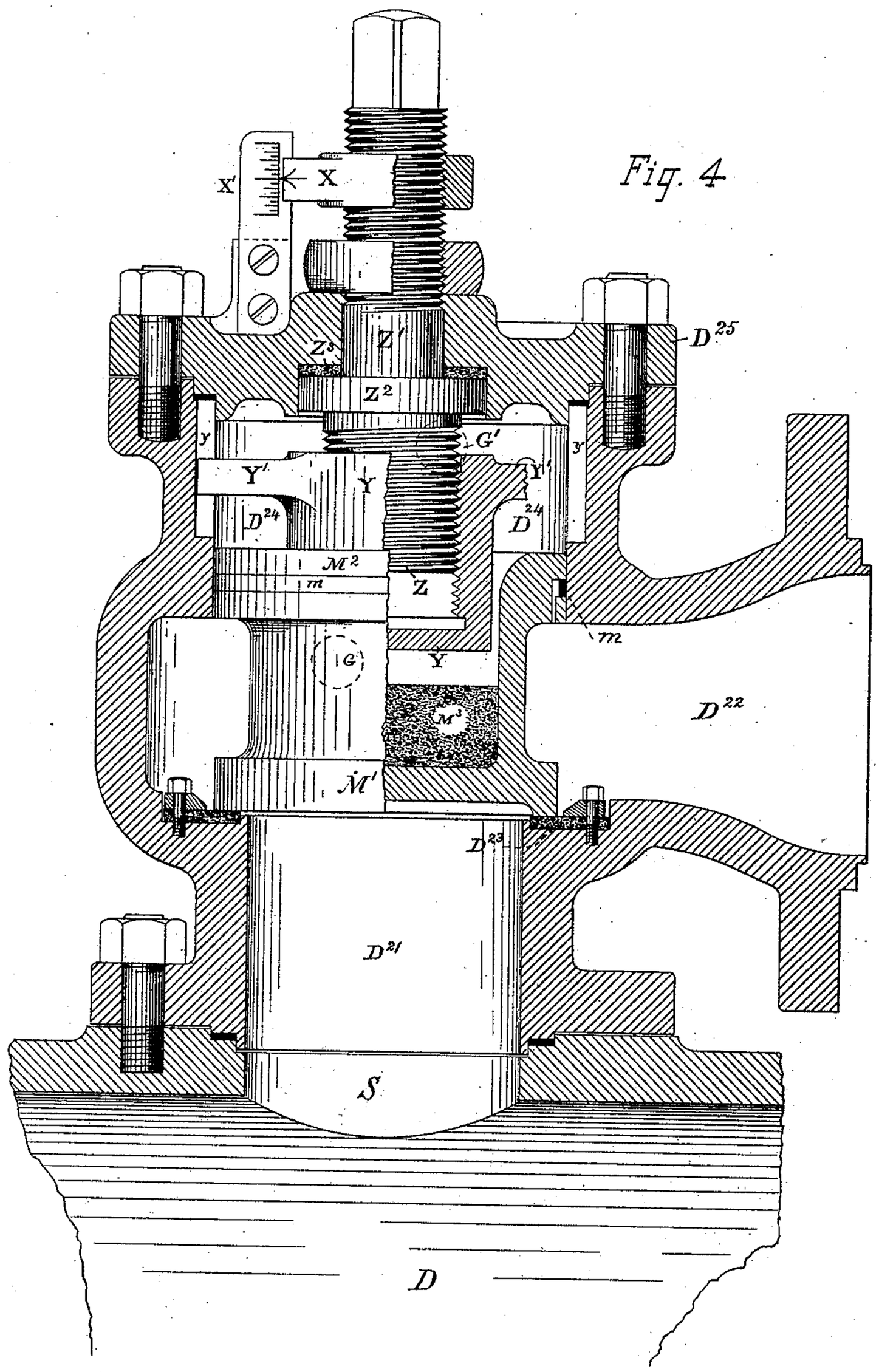
Fig. 4



Witnesses
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(No Model.) 3 Sheets—Sheet 3.

G. H. REYNOLDS.

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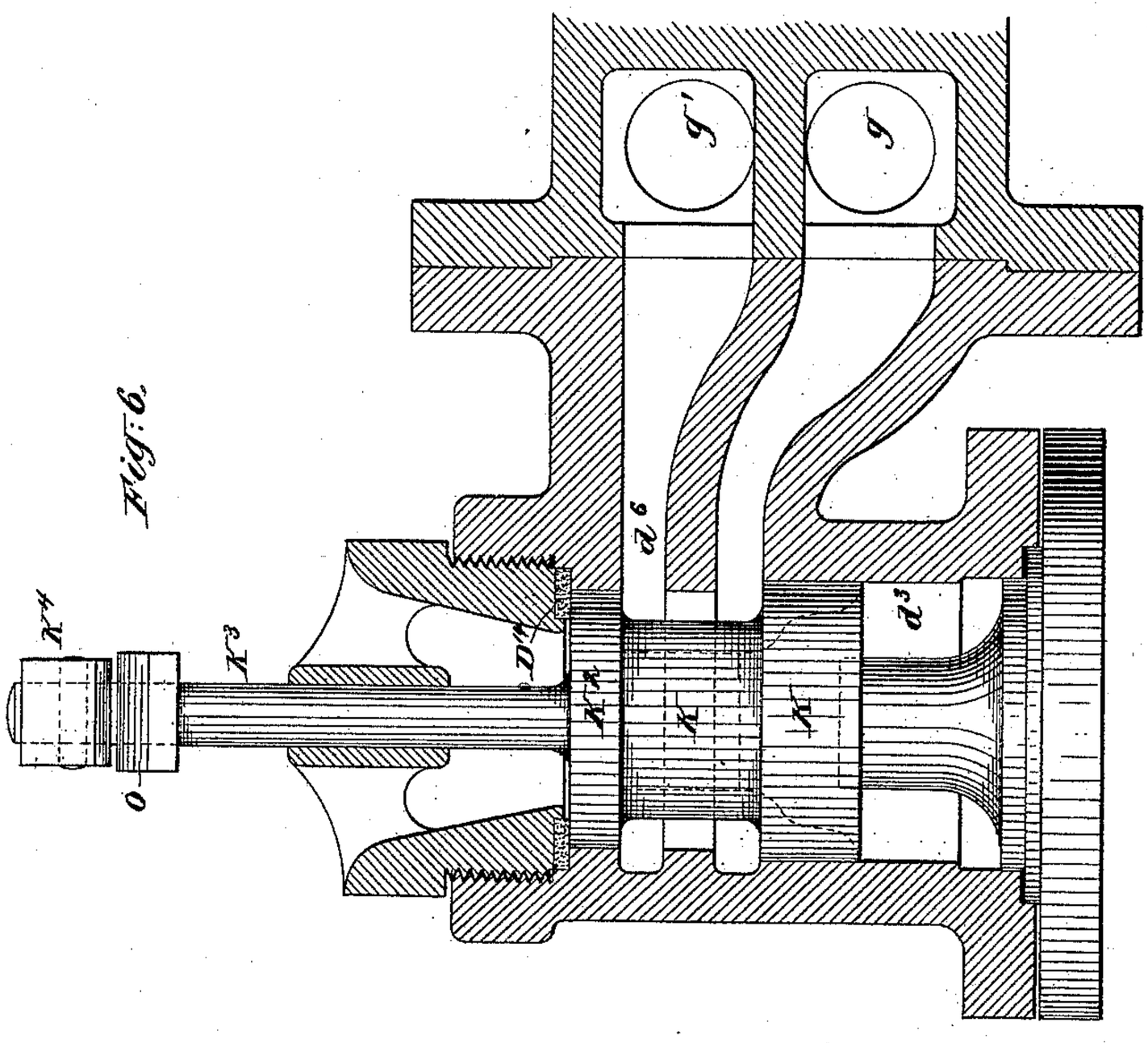

Fig. 6.

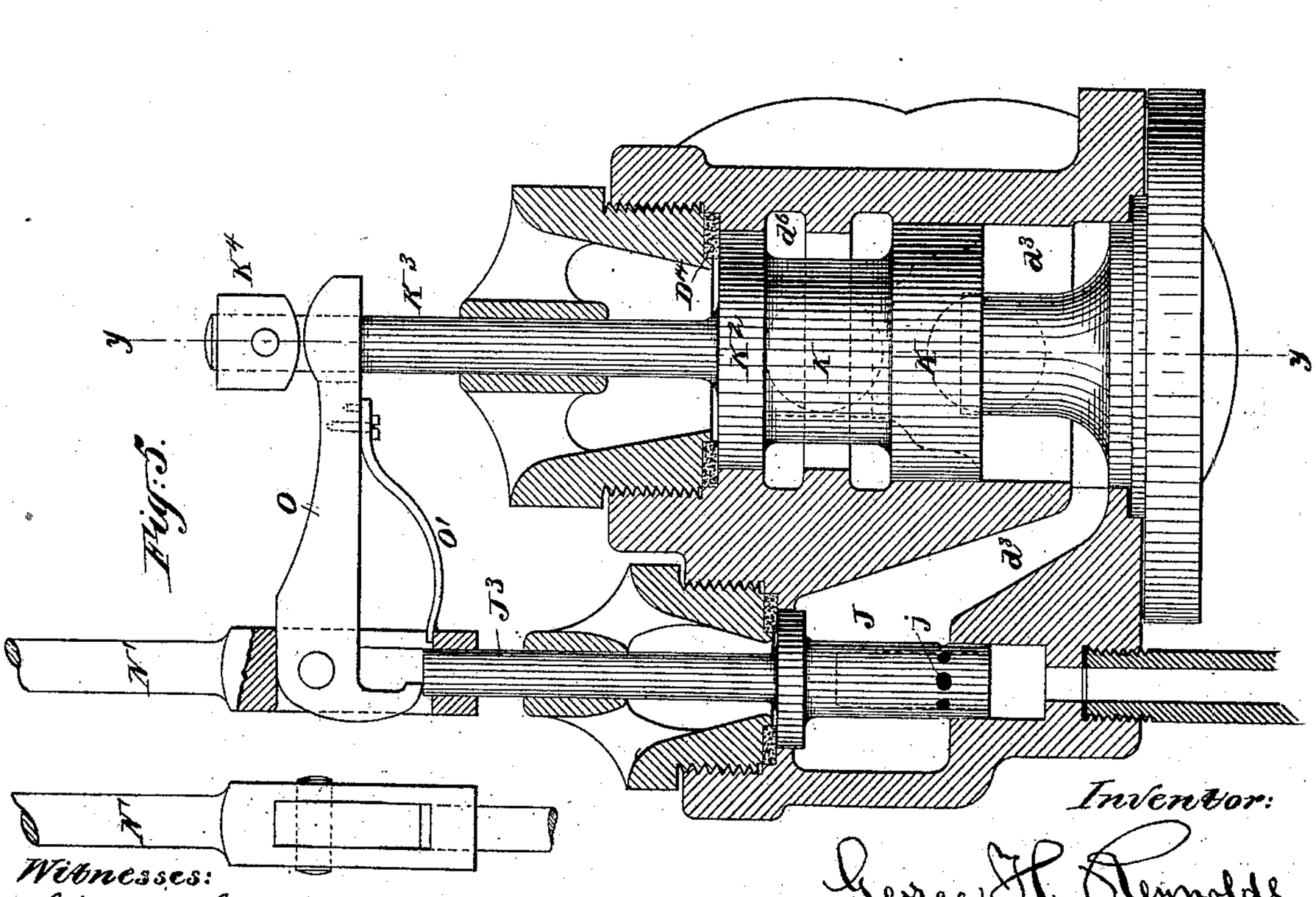

Fig. 5.

Witnesses:
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Inventor:
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Thomas Drew Stetson

UNITED STATES PATENT OFFICE.

GEORGE H. REYNOLDS, OF NEW YORK, N. Y.

PNEUMATIC GUN.

SPECIFICATION forming part of Letters Patent No. 421,308, dated February 11, 1890.

Application filed March 14, 1889. Serial No. 303,220. (No model.)

To all whom it may concern:

Be it known that I, GEORGE H. REYNOLDS, of the city and county of New York, in the State of New York, have invented a certain new and useful Improvement in Pneumatic Cannon, of which the following is a specification.

The invention is intended more especially for cannon operated by compressed air of high tension and adapted to throw large projectiles containing high explosives; but it may be carried out with a wide range of sizes and of various proportions, and may serve with other gases than atmospheric air, and the pressure of the gas may be induced by other means than mechanical compression.

I will use the word "firing" in its technical sense as used by military men to define the act of discharging the gun, although in this gun there is no ignition of powder or other combustible. I will use the word "air" to designate the large volumes of gas under pressure employed to impel the projectile.

What I consider the best means of carrying out the invention are fully described below, and shown in the accompanying drawings, forming part of this specification. There are three sheets of the drawings.

Figure 1 represents that part of the barrel of the gun which is behind the trunnions, showing the breech arranged for two firing-valves with the auxiliary valves connected to them. It also represents the arrangement of the hand-lever with the quadrant and valve-rod by which the gun is fired. Fig. 2 is a plan view, partly in section, on the line P P in Fig. 3. Fig. 3 is a vertical section on the line Q Q in Fig. 1. Fig. 4 is a horizontal section on a larger scale. It shows the construction in detail of one of the firing-valves. Fig. 5 is a horizontal section on the line x x in Fig. 3 on a larger scale, and Fig. 6 is a vertical section on the line y y in Fig. 5.

Similar letters of reference indicate corresponding parts in all the figures where they appear.

In large guns it is not easy to safely admit the air to the barrel through one firing-valve on account of the great weight which such a valve would have. I have therefore devised for large guns the multiple arrangement here shown and described. I employ what may be called "double piston-valves," each valve having two pistons of different sizes, the smaller next the gun and opening and closing the aperture into the gun by an endwise movement, the smaller piston serving as a puppet-valve. There are two firing-valves mounted in corresponding casings M, which, having the inlet and outlet nozzles at right angles to each other, form the connection between the side pipes e' and the openings S for the admission of air into the gun-barrel. They are so connected and arranged as to be operated and controlled by one auxiliary valve J K. The pair of auxiliary valves are of different sizes. The smaller, operated by hand, controlling the action of the larger and the larger controlling the action of the firing-valves. The larger auxiliary valve K is like a firing-valve in form and in mode of operation, but, being smaller, is easier worked and serves as means of operating the firing-valves with the necessary force and promptness. The air-ducts leading from the air-belts, instead of being led to the side of the auxiliary-valve casing K, are in this arrangement exactly under it, opening into a chest R, which is connected by pipes to the chambers of the firing-valves. The hand-lever N, working against the quadrant D^{19}, operates the valve and the rod N′ operates the small auxiliary valve.

The force I employ to open and close the firing-valves is the pressure of the air stored up to impel the projectile. In the nozzle D^{22}, which may be equally considered a chamber surrounding each firing-valve and in free communication with the side pipes e', there is always the full pressure which is accumulated in the reservoirs, (not shown,)—say one thousand pounds per square inch. This pressure is also communicated through the ducts G and pipes g to the rearmost chamber under the auxiliary valves. (See Figs. 1, 2, and 3.)

The chamber surrounding the larger auxiliary valve K (see Fig. 5) is in communication through the duct G′ and pipe g' with the chamber D^{24} at the end of each firing-valve farthest from the barrel of the gun. In this system of chambers and pipes the pressure is ordinarily the full pressure of the reservoirs; but I provide means for suddenly reducing it for a brief period and again im-

mediately restoring it. When it is reduced, the strong pressure in each chamber D^{22}, acting with more force against the larger piston M^2 of its firing-valve by reason of its larger area than the piston M′, causes each firing-valve to move endwise away from the barrel D and from the seat D^{23}, allowing the air to flow freely at its full pressure from the chamber D^{22} into the barrel and impel the projectile, (not shown.) It is important that it be opened with great rapidity and that it remain open only so long as is required, as otherwise too much air will escape from the reservoirs. I provide for graduating the period which the firing-valves remain open, so as to determine the range of the projectile with a given pressure of the air and a given elevation of the gun, and also for operating the large firing-valves with only a moderate amount of effort by the gunner.

The smaller firing-valve J has a connection with the rod N′, so that it can be opened by turning the lever N in the direction of the arrow, (see Fig. 1,) moving the valve J rearward. This movement lifts it away from its seat and allows all the compressed air in the chamber surrounding it, and also that in the communicating chamber d^3 at the outer end of the larger auxiliary valve K, to be exhausted into the atmosphere, the holes *j* in the valve J, through which air is admitted to these spaces from the side pipes *e′*, being closed by this movement. The larger auxiliary valve K is also a double-piston valve working in corresponding cylinders, the larger piston K′ being rearward in the chamber and the forward and smaller piston K^2 being in the chamber before referred to and holding the compressed air in that chamber, and consequently pressing on the outer ends of each firing-valve M so long as the auxiliary valve K is pressed tightly upon its seat D^{14}; but the moment the pressure is discharged from the chamber d^3 at the rear end of the larger auxiliary valve K this valve moves rearward in obedience to the pressure within it acting with most force on the larger piston K′, and this movement opens its front end and allows the air to escape from the passage d^6, with the effect to relieve the firing-valves from the pressure on their larger outer ends and cause them to open and the projectile to be expelled with the required velocity.

I have provided means for insuring that the firing-valves shall be closed automatically after the requisite brief period of remaining open.

The rear portion of the rod N′ is enlarged and slotted and receives the end of the valve-stem J^3 loosely. In the slot is pivoted a lever O, having a long arm which extends out and is forked and embraces the stem K^3 of the valve K just within the collar K^4. A short arm of this lever is hook-formed (see Fig. 5) and presses against the end of the valve-stem J^3 when the gunner operates the firing-lever N, and thus opens the valve J by pressing it forcibly rearward; but so soon as it has opened and relieved the pressure in rear of the larger valve K the latter moves rearward and acts with its collar K^4 to turn the lever O against the force of spring O′. So soon as this movement has progressed to sufficient extent the short arm of the lever O releases the end of the valve-stem J^3, thus allowing the valve J to instantly close if the cock which admits compressed air from the reservoirs through the holes *j* be wide open and to close more slowly if this cock be partially closed. So soon as the valve J has closed compressed air entering through the holes *j* again restores the high pressure on the rear end of the larger auxiliary valve K, urging it again forward into its closed position and again allowing the strong pressure to flow through the passage d^8 and fill the chamber D^{24} and shut the firing-valves.

When by the action of the auxiliary valve K the piston M′ is lifted from its seat, the air flows into the barrel D, and the amount of air admitted is governed by the lift of the valve, this lift being determined by the adjustable buffer Y, which projects into the interior of the double piston M′ M^2, which is hollowed out to receive it, and provided with a seat of fibrous material M^3, which stops against the buffer. This buffer acts as a nut for the screw Z, being prevented from turning by the arms Y′, which slide in longitudinal grooves *y* in the interior of the chamber D^{24}. The screw Z passes through the bonnet by the stem Z′, the end of which is squared to receive a wrench, by which it may be turned. It is evident that by means of this screw the buffer Y may be forced down upon the valve, so that the latter could not leave its seat at all, or it may be raised to admit of any degree of opening of the valve that may be desired, the amount of such opening being shown by the index X upon the scale X′, and the same made a matter of record, if desired. This method of regulating the lift of the firing-valve, and thereby determining the period it remains open, obviates the necessity of a stop-cock regulator between the auxiliary valve K and the two or more firing-valves M, the lift being governed absolutely and not merely checked in its movement by the rush of inflowing air from the auxiliary valve in the duct by which pressure is restored to the back of the piston M^2; but a cock in such situation can also be used, if desired, in any case. By means of the small regulating stop-cock * the time in which the auxiliary valve J is returned to its seat can be very accurately adjusted. It is shown in Figs. 1 and 5 of the present specification.

I have found that the ordinary stuffing-box and gland are incapable of preventing leakage by the stems of valves under the heavy pressure necessarily used in pneumatic guns, and I have devised a specially-efficient method of packing such stems. (Shown in Fig. 4, where I employ it for packing the stem of the regu-

lating-screw Z.) It consists of a ring of leather or other flexible material Z^3, held between the face of the collar Z^2 on the stem and the bottom of the recess into which the collar fits. The internal pressure of the air in the chamber D^{24} keeps the collar tightly against the leather seat, the pores of which are filled with paraffine or some such medium, and the joint is therefore absolutely tight against the passage of air. The form of firing-valve here used needs no hydraulic packing to prevent the leakage of air, the nozzle D^{21} forming the only opening by which air can pass, and that being absolutely closed when the piston M′ is upon the seat D^{23}.

Modifications may be made without departing from the principle or sacrificing the advantages of the invention. I can use more than two firing-valves; but I esteem it important to arrange whatever number may be used so that each shall be substantially balanced by another or others on the opposite side of the barrel, and that all shall be operated by the same auxiliary valve or valves.

I claim as my invention—

1. In a pneumatic gun, a reservoir for compressed air, a barrel, a firing-valve, and means for operating it by the action of the air, in combination with an adjustable buffer Y, located within the firing-valve and arranged to limit the opening of the valve, as herein specified.

2. In a pneumatic gun having a quickly-opening firing-valve operated by the force of the compressed air, an adjustable buffer Y, located within the firing-valve and arranged to limit its opening, in combination with a fibrous seat M^3 within the valve, and with a device Z, carrying the buffer and adjustable in the bonnet for adjusting the position of the buffer, and consequently the extent to which the valve is allowed to open, substantially as herein specified.

3. In a pneumatic gun, in combination with the firing-valve M, operated by the force of the compressed air, and an adjustable buffer Y, located within the valve and arranged to limit the opening of the valve, the index X, outside of the bonnet adapted to show the position of the buffer, as herein specified.

4. In a pneumatic gun, the packing Z^3 in a recess in the bonnet, in combination with the firing-valve, the stem Z, and collar Z^2 on said stem, having a rotary motion and arranged to serve to adjust the buffer Y, as herein specified.

5. In a pneumatic gun, the multiple firing-valves M M on opposite sides of the breech, in combination with the hand-lever N, the auxiliary valves, and its connections with said auxiliary valves arranged for operating them simultaneously, as herein specified.

6. In a pneumatic gun, the multiple firing-valves M M, arranged on opposite sides of the breech, and suitable operating means for said valves, in combination with two air-pipes *e′*, leading from the trunnions to said valves, and with provisions for supplying compressed air through the latter and arranged to operate substantially as herein specified.

7. In a pneumatic gun, the multiple firing-valves M M, arranged on opposite sides of the breech, in combination with adjustable buffers Y, located within the valve and with an auxiliary valve K, located between and having connection with each of said valves, and means for operating them by compressed air, all arranged to serve as herein specified.

In testimony whereof I have hereunto set my hand at New York city, New York, this 13th day of March, 1889, in the presence of two subscribing witnesses.

GEO. H. REYNOLDS.

Witnesses:

CHARLES R. SEARLE,

CHAS. F. BARTER.