(No Model.) 5 Sheets—Sheet 1.

J. KRONE.

HYDRAULIC BRAKE FOR ORDNANCE.

No. 462,970. Patented Nov. 10, 1891.

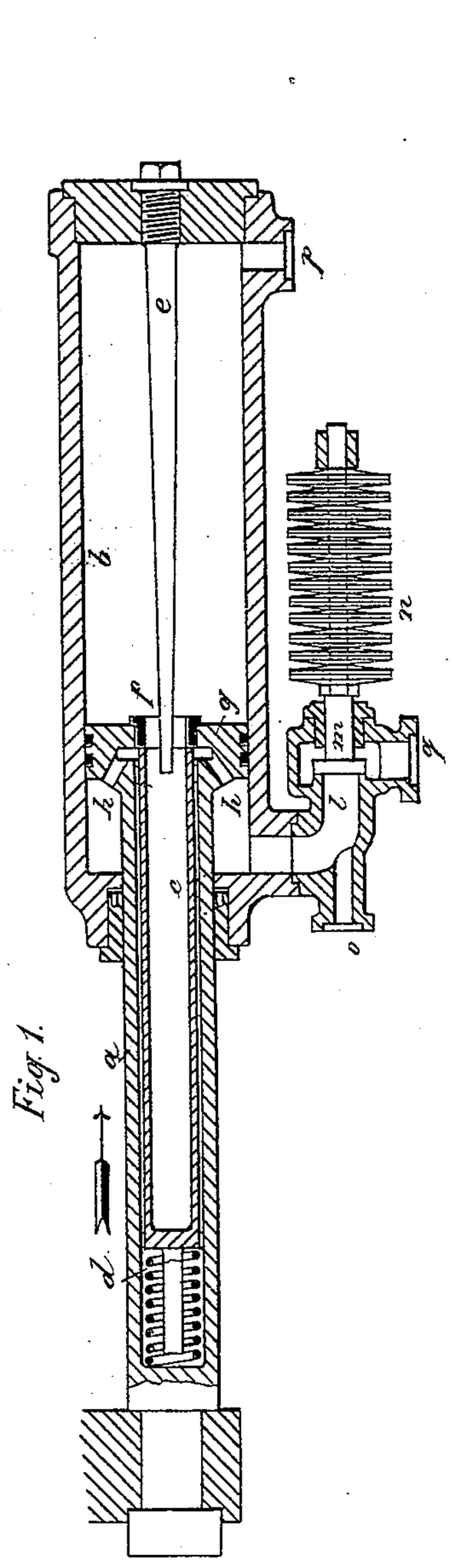

Fig. 1.

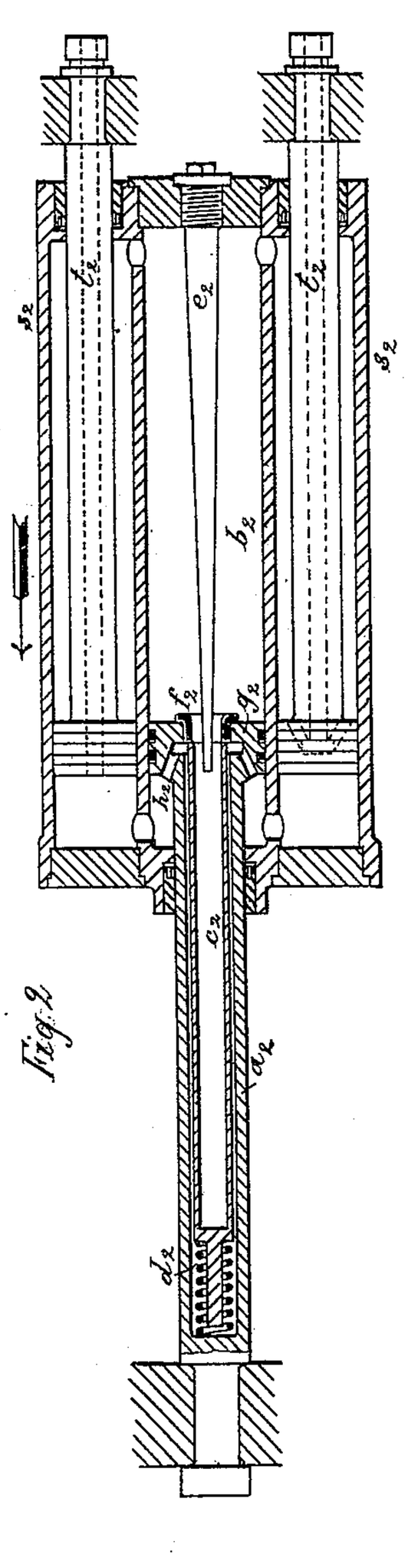

Fig. 2.

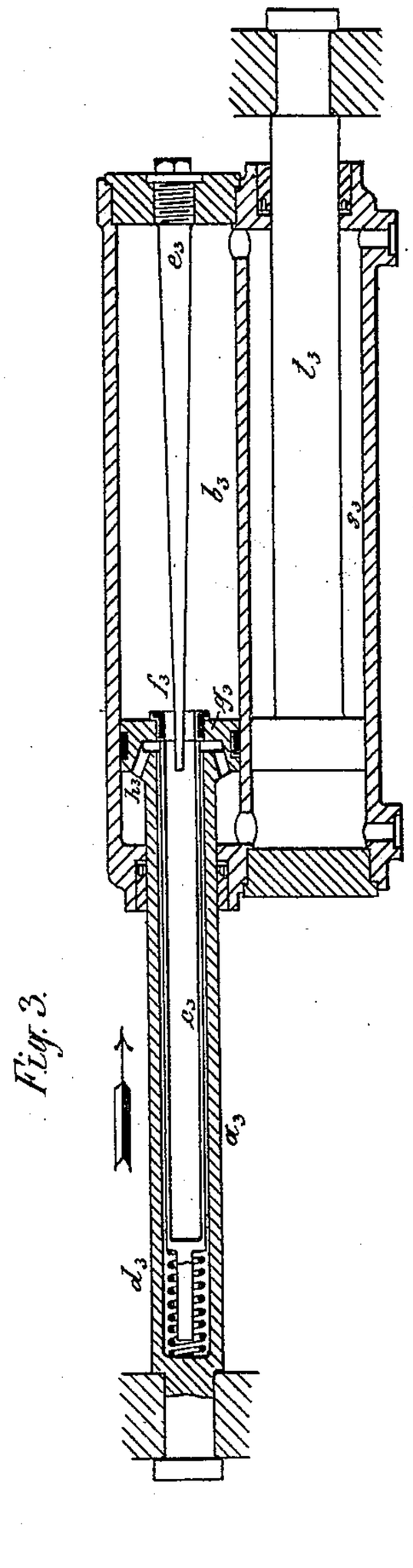

Fig. 3.

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HYDRAULIC BRAKE FOR ORDNANCE.

No. 462,970. Patented Nov. 10, 1891.

Fig. 4.

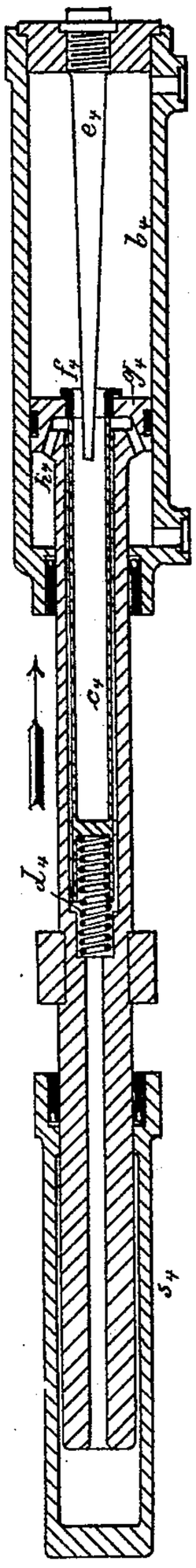


Fig. 7.

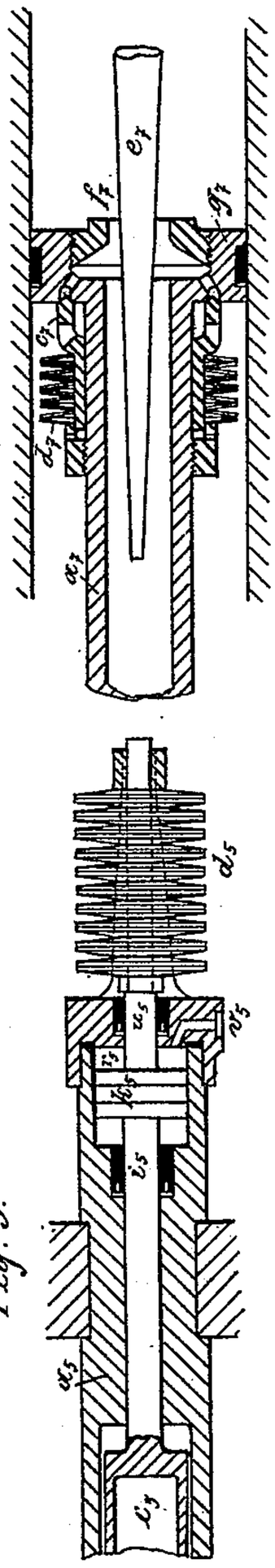


Fig. 9.

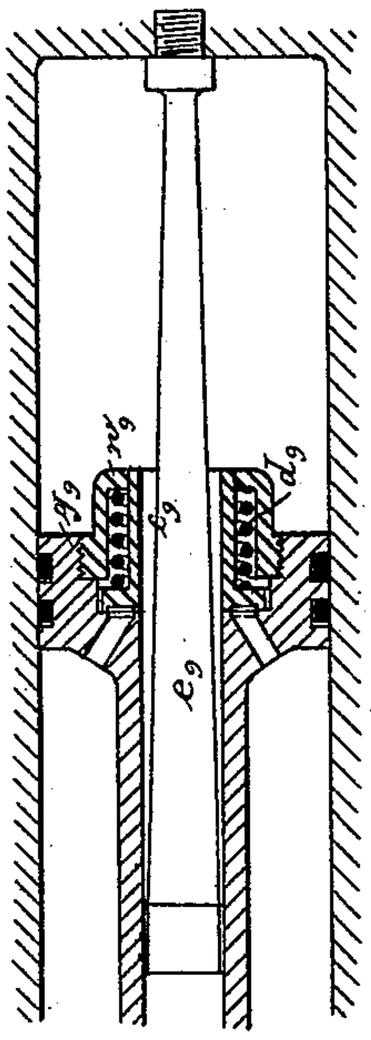


Fig. 5.

Fig. 8.

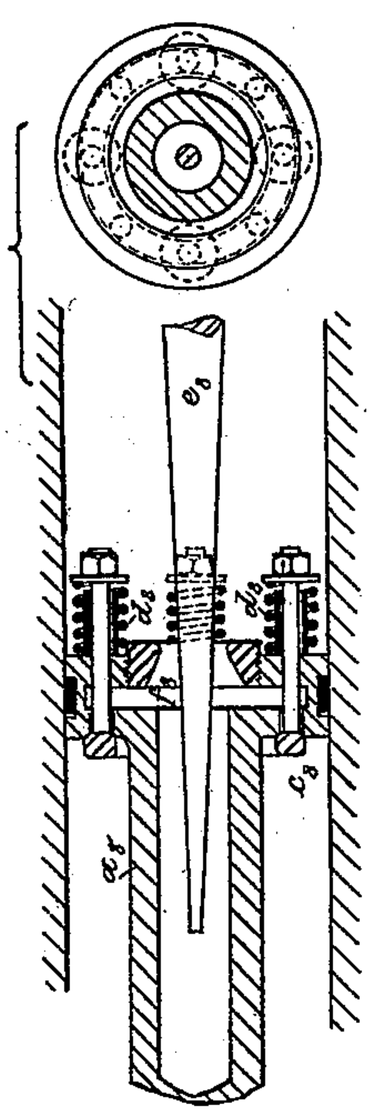
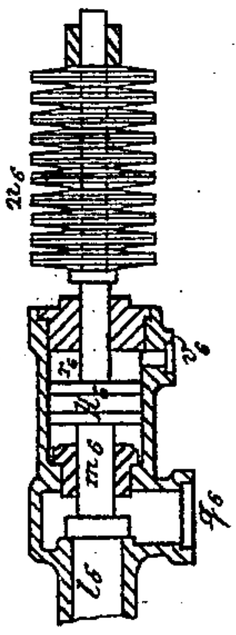


Fig. 6.



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(No Model.) 5 Sheets—Sheet 3.

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No. 462,970. Patented Nov. 10, 1891.

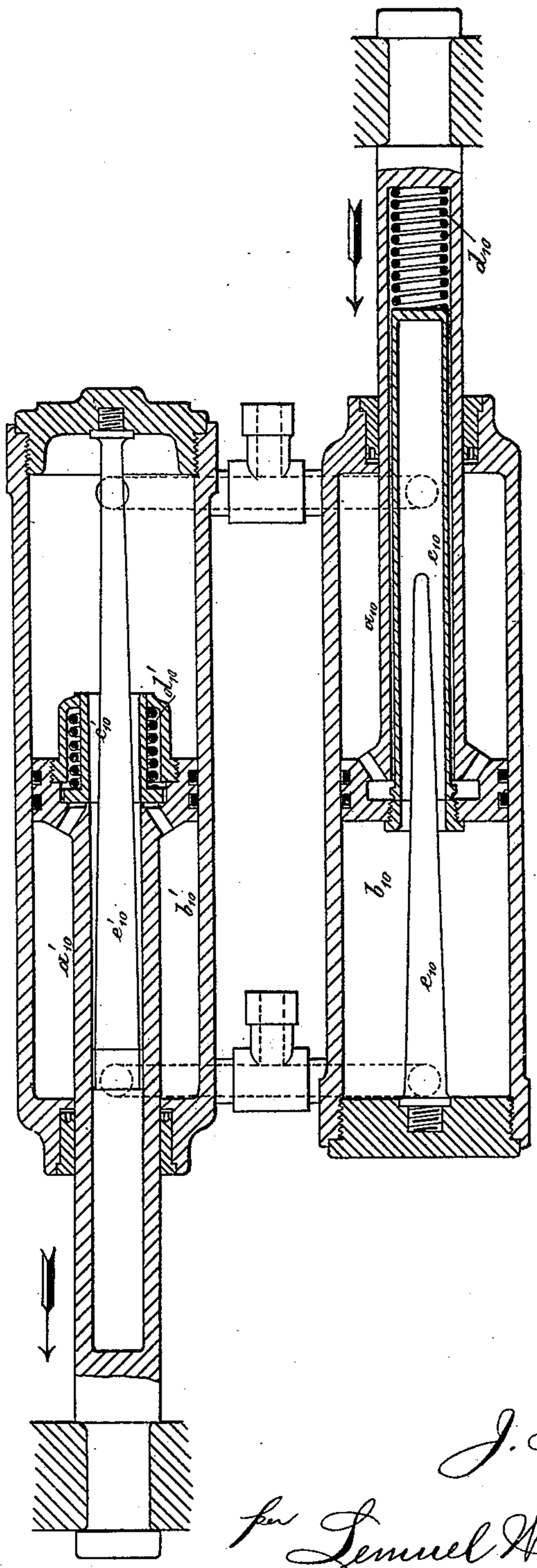

Fig. 10.

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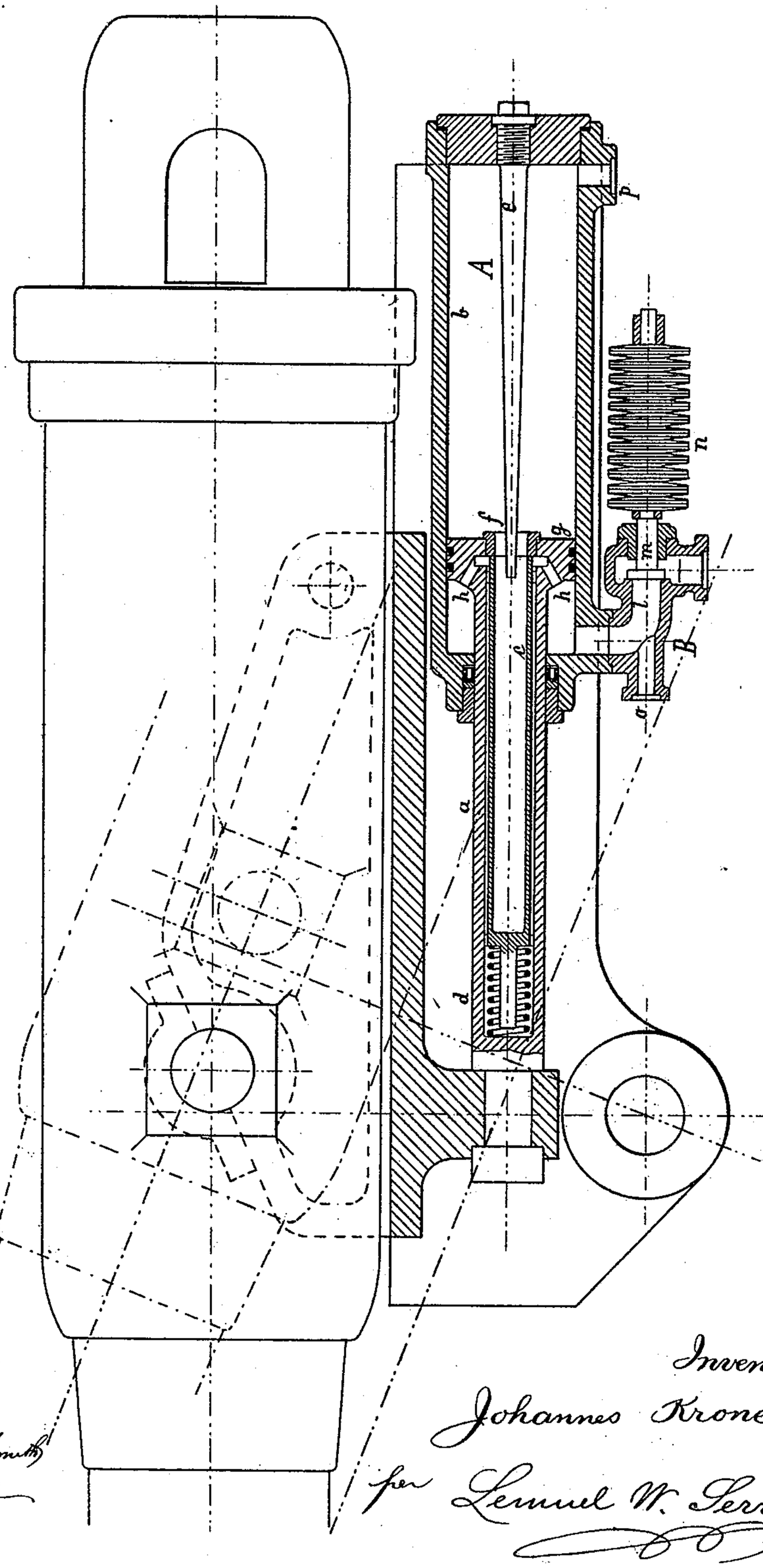

Fig. 1.

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HYDRAULIC BRAKE FOR ORDNANCE.

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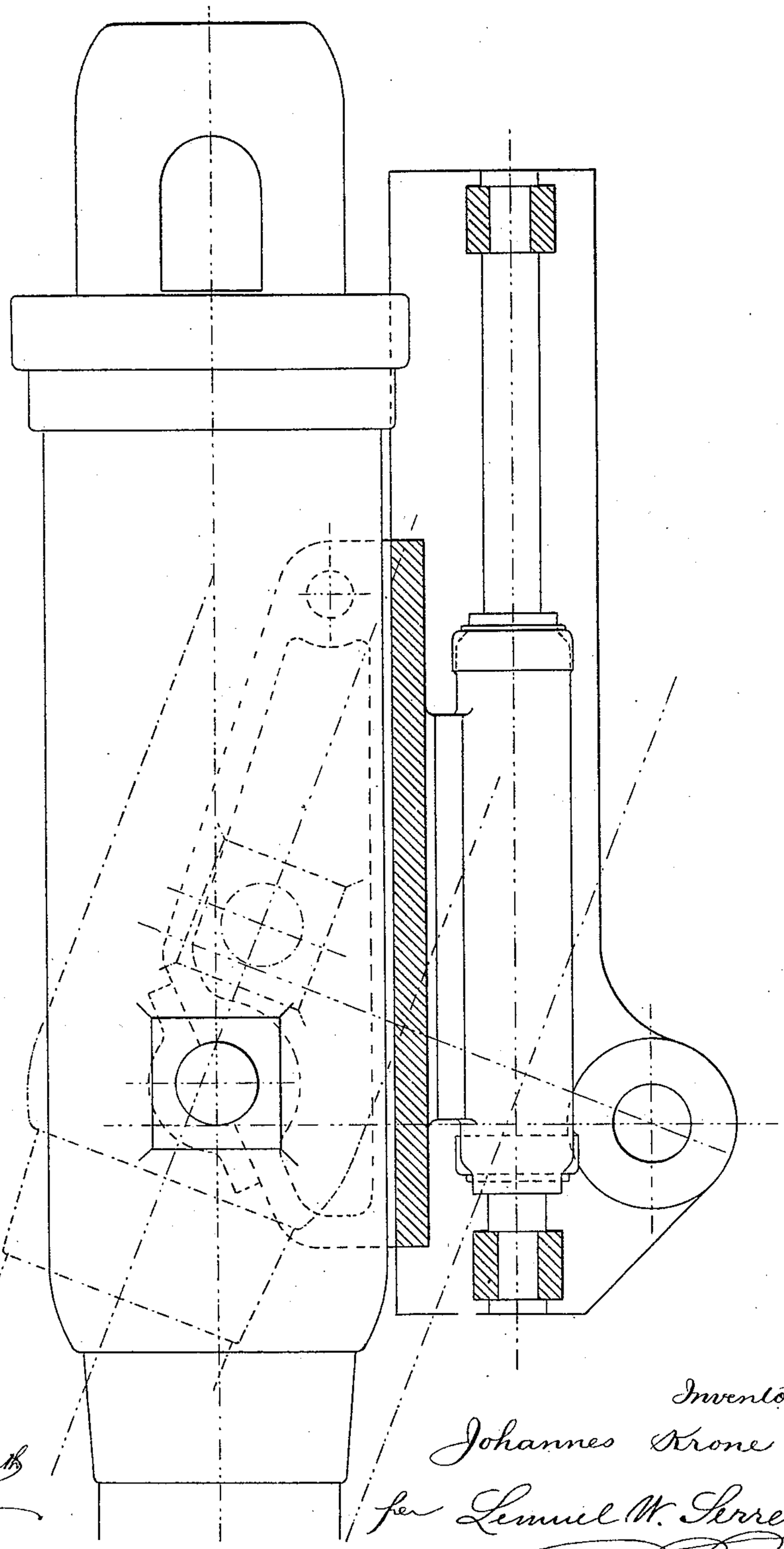

Fig. 2.

Witnesses
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J. Staib

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Johannes Krone
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UNITED STATES PATENT OFFICE.

JOHANNES KRONE, OF ESSEN, GERMANY, ASSIGNOR TO THE FIRM OF FRIEDRICH KRUPP, OF SAME PLACE.

HYDRAULIC BRAKE FOR ORDNANCE.

SPECIFICATION forming part of Letters Patent No. 462,970, dated November 10, 1891.

Application filed September 24, 1888. Serial No. 286,191. (No model.) Patented in Germany May 31, 1888, No. 47,039; in England June 26, 1888, No. 9,313; in Norway June 26, 1888, No. 922; in France June 26, 1888, No. 191,450; in Belgium June 26, 1888, No. 82,335; in Italy June 30, 1888, XXII, 23,730, XLVII, 33; in Portugal August 30, 1888, No. 1,269; in Spain September 28, 1888, No. 8,420, and in Austria-Hungary November 8, 1888, No. 26,707 and No. 43,953.

To all whom it may concern:

Be it known that I, JOHANNES KRONE, a subject of the King of Saxony, residing at Essen, in the Kingdom of Prussia, Germany, have invented new and useful Improvements in Hydraulic Brakes for Ordnance, (which have been patented to me in Germany, No. 47,039, May 31, 1888; in England, No. 9,313, June 26, 1888; in Norway, No. 922, June 26, 1888; in France, No. 191,450, June 26, 1888; in Belgium, No. 82,335, June 26, 1888; in Italy, Reg. Genl., Vol. XXII, No. 23,730, and Reg. Att., Vol. XLVII, No. 33, June 30, 1888; in Spain, No. 8,420, September 28, 1888; in Portugal, No. 1,269, August 30, 1888; in Austria-Hungary, No. 26,707, Tom. 38, Fol. 2,957, and No. 43,953, Tom. 22, Fol. 2,950, November 8, 1888,) of which the following is a specification.

This invention refers to improvements in hydraulic brakes for ordnance, whereby the resistance to the recoil is made more uniform than heretofore, and the running out and running in of the said piece of ordnance can be effected, while the recoil can be utilized for the storage of power. These objects are obtained in and by the employment of a hydraulic cylinder or cylinders, as particularly hereinafter described in connection with a delivery-valve for the liquid, such liquid being forced through the brake-piston by the action of the recoil, which liquid can be conducted into a waste-pipe or an accumulator, or be in connection with one or more of what are hereinafter referred to as "equalizing-cylinders," the contents of which also serve for the working of the brake. Similar results may be obtained, but without the storage of power, by the employment of two hydraulic cylinders of particular construction, as hereinafter described, one of which serves as an equalizing-cylinder for the other.

The invention will be best understood by describing the same with reference to the accompanying drawings.

Figure 1 is a longitudinal section through the hydraulic brake-cylinder, piston-rod, brake-valve, and the delivery-valve connected with the cylinder. Fig. 2 is a section showing the hydraulic brake-cylinder and two equalizing-cylinders. Fig. 3 represents the combination of a brake-cylinder with an equalizing-cylinder. Fig. 4 shows a similar arrangement, but having an equalizing-cylinder arranged in the axis of the brake-cylinder. Fig. 5 shows a counter-pressure cylinder for the keeping closed of the brake-valve. Fig. 6 shows a counter-pressure cylinder in in connection with the delivery-valve. Figs. 7, 8, and 9 show modifications of the brake-valve. Fig. 10 shows a modified arrangement of the hydraulic brake, in which two hydraulic cylinders are connected with the brake-valve and provided with regulating-rods, one rod being fastened at the larger end and the other at the smaller end, one cylinder serving to equalize the other. Fig. 11 shows in sectional elevation an application of the invention to a piece of ordnance where the piston moves on the recoil, and Fig. 12 is a sectional elevation of a similar piece of ordnance, but where the invention is so applied that the cylinder moves on the recoil.

The arrangement and mode of connection of this new hydraulic brake with the gun are effected in such manner that the carriage is firmly connected with the piston or with the cylinder, while the other part of the brake, the cylinder, or the piston is fastened to the slide. The recoil of the gun is by the carriage transferred to the movable part of the brake, and, in fact, if the cylinder is fixed works the movable piston, or if the piston is fixed works the movable cylinder.

The piston-rod *a* of the brake-cylinder *b* (shown in Fig. 1) is bored out to receive the tubular valve *c*, which is loaded with the spring *d*, and in which tubular valve the conically-formed regulating-rod *e* enters, it being fastened in the cylinder-cover, the degree of conical form of the regulating-rod *e* being fixed according to calculations. The seat *f* of the tubular valve *c* is situated in the body of the piston *g*, which latter contains an annular cavity which is in connection with the front portion of the brake-cylinder through ports *h*. When the gun is fired, the pressure of the

fluid caused by the recoil acts upon the inner end of the tubular valve *c* and raises the same from its seat, the piston (with the carriage) moving from the left to the right hand in the direction of the arrow, Fig. 1, the connection between the two sides of the piston being effected, as aforesaid, by the lifting of the valve *c*. The fluid can then flow by the passage and ports before mentioned through from the back side of the piston *g* toward the front, the passage for the liquid during the recoil being decreased in proportion to the increasing thickness of the fixed conical rod *e*. By this means the pressure is kept constant during the whole of the recoil, and the strain caused upon the gun-carriage and its foundation is considerably lessened. The loading of the brake-valve *c* is so arranged as not to be greater than would correspond with the piston-pressure that is necessary to keep the gun with the carriage in firing position on each elevation. As shown at Fig. 11, upon elevation the slide is inclined, and therefore there results a pressure in the cylinder by the weight of the gun and carriage. This arrangement necessitates that upon giving forward motion to the piece of ordnance, and consequently upon the advance of the piston-rod *a* out of the cylinder *b*, the liquid moves both before and behind the piston *g* of the brake-cylinder *b* out of and into the cylinder by the passages *o* and *p*, and the area of the piston-rod serves as a resisting-surface. The valve *c* is kept closed by the spring *d*. The passages *o* and *p* are preferably connected by a pipe having any usual form of slide-valve, (not shown,) and such connection is to be left open during the operation of running out.

Upon the running in of the piece of ordnance the liquid under pressure is admitted before the piston *g*, while the back portion of the cylinder *b* is connected with the exit, the piston *g* being thereby drawn back and the valve *c* forced upon its seat *f* by the working pressure. The working surface consists of the annular area of the piston. The water flowing through the piston *g* will, upon firing, on account of the entrance of the piston-rod *a* into the cylinder *b*, be partly pressed out of the same corresponding with the volume of the ingoing piston-rod *a*. The front of the brake-cylinder is therefore connected with the delivery-valve B, which serves to allow the water during the recoil free exit from the front side of the brake-piston *g* and to keep closed the waste under ordinary circumstances.

The valve B is a kind of ordinary safety-valve, consisting of the valve-chamber *l* and the valve *m* loaded by a spring *n*. The amount of loading corresponds to the working pressure in the pressure-pipes. Upon firing, the valve *m* is opened by the water forced from the front parts of the cylinder. At the end of the recoil it is closed by the spring *n*, and also remains closed during the operations of running in and running out. The entrance or exit of water upon running in and running out is effected by tubular connections *o* and *p* and the exit of the liquid forced out by the recoil passes by the passage *q*. The water flows from the delivery-valve *q* either into the waste-pipe, or, if an accumulation of power during the recoil is intended, into an accumulator.

In the arrangement as shown at Fig. 2 the cylinder b^2 is movable with the carriage, as shown at Fig. 12, upon a fixed frame from the right toward the left in the direction of the arrow, Fig. 2.

The water which is forced out of the cylinder b^2 upon firing is, in the arrangement shown at Fig. 2, taken up by two equalizing-cylinders s^2, the volume of the piston-rods of these latter being together equal to the volume of the brake-piston rod. The brake-cylinder b^2 works in a similar manner to that hereinbefore described, excepting, however, that there is no expulsion of liquid, the volume of the piston-rod entering the brake-cylinder b^2 being equal to that of those coming out of the equalizing-cylinders s^2. The entrance and exit of water upon running in and running out of the piece of ordnance takes place in this arrangement by means of the fixed piston-rods t^2 of the equalizing-cylinders, while in the reversed arrangement with movable piston-rod the liquid passes through the connections *o* and *p* of the cylinder. In both cases the fixed conically-shaped regulating-rod enters the brake-cylinder on the recoil taking place and the area of the passage for the water in the piston is contracted in proportion to the increasing thickness of the regulating-rod. From the drawings it will be seen that the volume of liquid before the equalizing-pistons is also applicable to working and increasing the effectiveness of the brake.

Instead of two equalizing-cylinders with one brake-cylinder, there may be one equalizing-cylinder with two brake-cylinders in connection, as the brake in Fig. 1 may be applied with one or two cylinders; or, instead of two equalizing-cylinders, one of such may be employed in connection with a brake-cylinder of which the diameter of the piston-rod is the same as that of the brake-piston rod. This arrangement is shown at Fig. 3, in which the cylinders lie by the side of each other, while those in the representation given in Fig. 4 lie in the same axis.

In the arrangement shown at Figs. 3 and 4 the piston moves with the carriage, the cylinder being fixed. The movement during the recoil on firing is in the direction from left to right, as indicated by the arrow. As upon the employment of these equalizing-cylinders the front and rear working surfaces are equal, the area of the piston-rod cannot be used as a working surface, as in the first arrangement. It is therefore necessary to prevent the brake-

piston valve from opening by the pressure upon the forward movement of the piston. This may be effected by loading the valve correspondingly to the working pressure or by a special counter-pressure cylinder, which loads the valve during the forward movement of the piston. In Fig. 5 an arrangement of this counter-pressure cylinder is shown. The hollow piston-rod a^5 is provided with a tubular valve c^5 and carries on its shaft i^5 a piston k^5, which is in a cylinder r^5, situated at the piston-rod head. This piston is movable with the valve, and at the end u^5, projecting out of this cylinder, is a spring d^5. At v^5 is a pipe connection for the pressure-liquid behind the piston k^5, which enters immediately if the slide-valve for the forward movement of the gun is opened. In this arrangement the valve c^5 would be pressed on its seat at the entrance of pressure-liquid behind the piston in the pressure-cylinder at an insufficient load of the spring. To prevent this, the said valve is provided, as already has been mentioned, with a piston k^5, which is arranged in the cylindrical part r^5 of the piston-rod a^5 and may be put in communication by v^5 with the pressure-pipe. The piston k^5 being of larger area than the valve c^5 in the brake-piston, an additional pressure is given to the same by the pressure-liquid, whereby it is firmly pressed on its seat. When the pressure-liquid is caused to escape through v^5, only the tension of spring d^5 acts on the valve. This latter action is intended during the recoil, the greater load of the valve, on the contrary, when the ordinance is moved by the pressure-liquid. The same effect is obtained by the arrangement shown in Fig. 6 on the delivery-valve, which has for its purpose to evacuate the liquid from the cylinder during the recoil. The valve m^6 is also provided with a piston k^6, which is of a greater area and may receive pressure-liquid in its cylinder r^6 through m^6. By the additional pressure the valve is kept firmly on its seat. As soon as the pressure-liquid in r^6 acts no longer on piston k^6, the valve is only under the load of spring n^6. The supply of the pressure-liquid to the counter-pressure cylinders r^5 and r^6 is effected through the slide-valve regulating the entrance of the liquid to the brake-cylinder. The said slide-valve is arranged in such manner that in its rest position or in firing position the pipes applied at v^5 and v^6 to the counter-pressure cylinders allow the liquid to escape, but that in opening the slide the pressure-liquid enters the brake-cylinders for moving the piston, and at the same time the counter-pressure cylinder r^5 or r^6 for shutting off the valve c^5 and m^6.

Instead of the tubular valve shown at Fig. 1, valves as shown in the arrangement Figs. 7 and 8 may also be employed, these latter being circular valves c^7 c^8, the springs being outside the piston, or instead of one circular valve several single valves arranged around the piston-rod may be employed, or a circular valve having several rings arranged concentrically may also be employed. In like manner the tube-valve according to Fig. 1 may, instead of a spring lying in the piston-rod, be combined with a spring outside the piston-rod, according to the arrangement shown at Fig. 5.

If the purpose should be to use the brake piston rod for strain instead of for pressure, a modification of the brake-valve in accordance with Fig. 9 is introduced. The piston-rod a^9 receives into its bore the regulating-rod e^9, which at the thin end is fastened into the cylinder-cover, and the piston g^9 is provided with a valve c^9, the spring of which d^9 is held by a cover w^9. A brake-cylinder provided with a valve constructed in the latter manner may in the described mode be also combined with one or more equalizing-cylinders, or may be employed in connection with a second brake-cylinder, as shown at Fig. 10. In the arrangement shown at Fig. 10 the piston-rods are movable with the carriage in the direction of the arrow from right to left. In this arrangement the piston-valve of the cylinder b^{10} is opened from the piston side of the cylinder, and the piston-valve of the cylinder b'^{10} is opened from the piston-rod side of its cylinder b'^{10}. The regulating-rod e^{10} is fastened at the larger end and the regulating-rod e'^{10} at the smaller end, and the valve-springs are sufficiently strong to prevent the opening of the valves by the liquid upon the operation of moving the gun forward and backward. The entrance or exit of water takes place by means of tubular connections to the fixed cylinders while the same effect would follow to movable cylinders and fixed piston-rods through the latter.

The specified invention can be applied to ordnance of various calibers and systems.

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

1. In hydraulic brakes for ordnance, the combination, with a cylinder, of a tubular piston-rod and its tubular piston, said piston having ports, a tubular valve within the tubular piston-rod and a seat for the same at the piston, and a spring acting upon the tubular valve to press the same to its seat, substantially as set forth.

2. In hydraulic brakes for ordnance, the combination, with a cylinder, of a tubular piston-rod and its tubular piston, said piston having ports, a tubular valve within the tubular piston-rod and a seat for the same at the piston, and a helical spring within the tubular piston-rod and acting upon the tubular valve to press the same to its seat, substantially as set forth.

3. In hydraulic brakes for ordnance, the combination, with a cylinder, of a tubular piston-rod and its tubular piston, said piston

having ports, a tubular valve within the tubular piston-rod, and a seat for the same at the piston, and a spring acting upon the tubular valve to press the same to its seat, and a tapering regulating-rod connected at its larger end with one cylinder-head, substantially as set forth.

4. In hydraulic brakes for ordnance, the combination, with a cylinder, of a tubular piston-rod and its tubular piston, said piston having ports, a tubular valve and a seat for the same at the piston, and a spring acting upon the tubular valve to press the same to its seat, a tapering regulating-rod connected with one cylinder-head, a valve *m* and its case connected at one end of the cylinder, and a spring *n* for pressing the valve *m* to its seat, substantially as set forth.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

JOHANNES KRONE.

Witnesses:
FRITZ MOELLENHOFF,
HUGO RIETZ.