C. CHRISTIANSEN.

VALVE MECHANISM.

APPLICATION FILED APR. 20, 1910.

1,010,859. Patented Dec. 5, 1911.

Fig. 1.

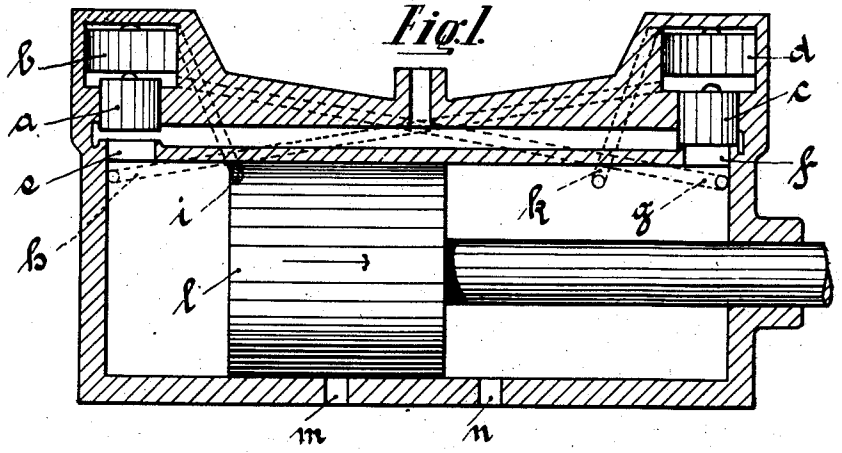
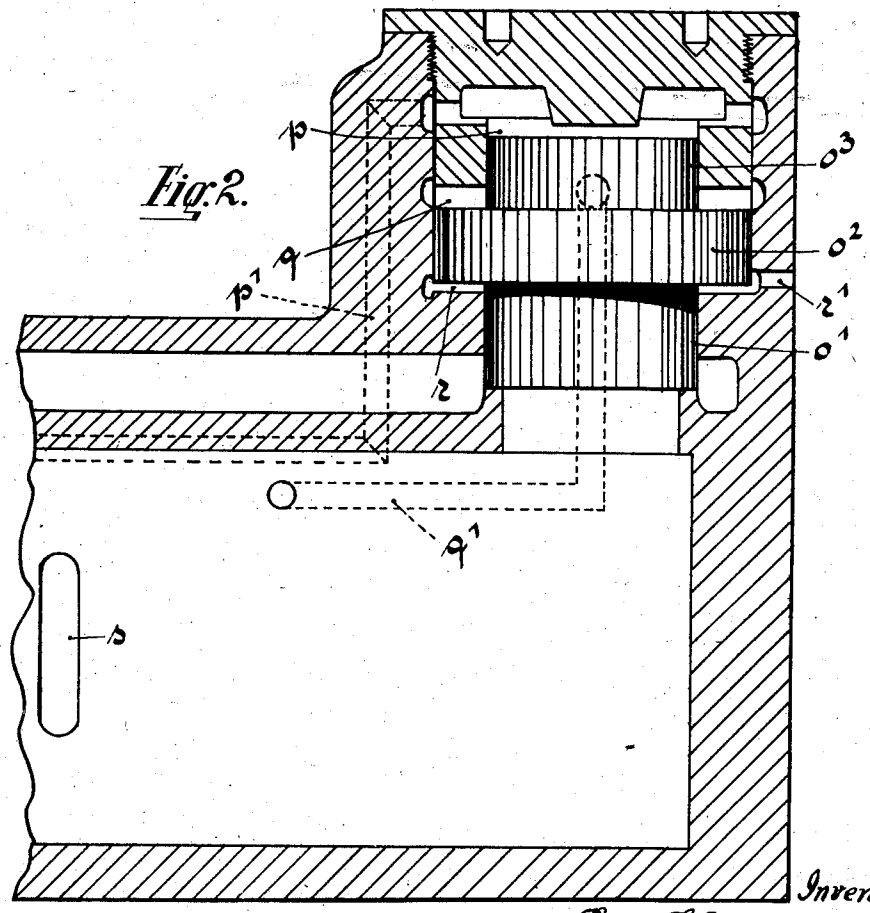


Fig. 2.



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VALVE MECHANISM.

1,010,859. Specification of Letters Patent. Patented Dec. 5, 1911.

Application filed April 20, 1910. Serial No. 556,617.

To all whom it may concern:

Be it known that I, CHARLES CHRISTIANSEN, a citizen of the German Empire, residing at Gelsenkirchen, in the Kingdom of Prussia, German Empire, have invented new and useful Improvements in Valve Mechanisms, of which the following is a specification.

My invention relates to improvements in valve mechanisms especially adapted for compressed air tools, rock drills, and the like, which permit expansion of the compressed air during a definite period of the stroke of the working piston, and therefore a definite degree of expansion of the compressed air.

The object of the invention is to provide regulating mechanism in which the admission valves are surely opened and securely held in open position during the admission period and surely closed and securely held in closed position during the remainder of the stroke of the piston. This construction also permits the tool to be surely started, and the valves are simple in construction, and can be easily manufactured, and mounted or dismounted.

With these objects in view, my invention consists in improved mechanism comprising valves at both ends of the cylinder independent of each other and opened in the usual way by the pressure of the air during the compression period, and which valves are also subjected to a differential action between the pressure of the opposite end of the cylinder which constantly acts on the valve, and the pressure of the adjacent end of the cylinder which is active after a port has been opened by the working piston.

Two examples embodying the invention have been illustrated in Figures 1 and 2, in which longitudinal sections of the cylinders are shown.

In the example shown in Fig. 1, there is a valve plunger at each end of the cylinder, each consisting of two sections, the sections at one end of the cylinder being marked *a* and *b*, and at the other end, *c* and *d*, the sections *a* and *c* being of less diameter than the sections *b* and *d*. These valve plungers are located in bores at the ends of the cylinder communicating therewith and extending laterally therefrom, each bore having sections of smaller diameter to receive sections *a* and *c* of the plungers and sections of larger diameter to receive the sections *b* and *d*. The valve plungers are longitudinally shiftable in bores of the cylinder wall and by this means the admission port *e* to the left hand end of the cylinder and the admission port *f* to the right hand end of the cylinder can be opened or closed. In this example there is a space provided between the plunger sections *a* and *b* which communicates with the right hand end of the cylinder through a canal *g* and a space between the plunger sections *c* and *d* which communicates with the left hand end of the cylinder through a canal *h*. The space at the rear of the plunger section *b* communicates with the cylinder through a canal *i*, and the space at the rear of the plunger section *d* communicates with the cylinder through a canal *k*. The position of the discharge end of the canal *i* determines the end of the admission period, or the beginning of the expansion period, at the left hand end of the cylinder, and the position of the discharge end of the canal *k* determines the end of the admission period, at the right hand end of the cylinder. In the position shown the valve plunger sections *a* and *b* are in their elevated positions, and they are held in their elevated positions by the pressure of the air which is being admitted to the cylinder, which pressure acts on the lower side of the plunger section *a*. Therefore the working piston *l* is forced toward the right. In the position of the piston shown the discharge end of the canal *i* is still covered by the piston *l*. At the next moment, however, the said discharge end will be freed from the piston *l*. Now high pressure air is admitted through the canal *i* to the space at the rear of the plunger section *b*. As the cross-sectional area of the plunger section *b* is larger than that of the plunger section *a*, the plunger *b* is forced downward so as to move the valve plunger section *a* on its seat. During the further movement of the piston the compressed air is expanded. Therefore the canal *i* which determines the beginning of the expansion may be termed the "expansion canal". The pressure at the rear of the plunger section *b* is the same as that which acts on the working piston. Therefore the plunger section *b* holds the valve plunger in its closed position. Before, upon the further movement of the piston *l*, the exhaust port *m* of the left hand end of the cylinder is freed from the piston *l*, the exhaust port *n*

of the right hand end of the cylinder has already been closed by the piston. Therefore compression at the right hand end of the cylinder has begun prior to the exhaust at the left hand end of the cylinder. As long as the pressure at the left hand end of the cylinder is greater than the pressure at the right hand end of the cylinder, the pressure in the rear of the plunger section b is greater than that in front of the same. On the other hand, the pressure in the rear of the plunger section a is less than that in front of it. As the diameter of the plunger section b is larger than that of the plunger section a, the plunger section b, and consequently the plunger section a in advance of it, are forced forward and the plunger section a is held in its closed position. As soon as, by reason of compression at the right hand end of the cylinder, and exhaust at the left hand end thereof, the pressure at the right hand end has become greater than that at the left hand end, the plunger section b is elevated and separated from the plunger section a, but the plunger section a is still forced on its seat as before. Upon the further movement of the piston l toward the right, the canal k is covered by the piston, and finally by the compression of the air the plunger sections c and d are elevated, so that admission of the pressure fluid begins. The plunger sections c and d remain in their elevated positions, until, after the return of the piston, the canal k is opened. At this moment the valve is closed by the plunger section d. The operations of the regulating mechanism are the same at the right hand end of the cylinder as at the left hand end thereof.

In Fig. 2, the rear end of a pressure cylinder is shown on a larger scale, which cylinder is provided with a regulating mechanism of a modified construction. The regulating member consists of a plunger comprising a plurality of sections o^1, o^2, o^3. The middle section o^2 has a larger diameter than the end sections o^1 and o^3. The sections are guided in an air tight manner in bores of the cylinder wall. The chamber p provided above the section o^3 communicates with the opposite end of the cylinder through a canal p^1; the annular chamber q provided above the section o^2 communicates with the adjacent end of the cylinder through an "expansion canal" q^1; and the annular chamber r provided below the section o^2 communicates with the atmosphere through a canal r^1. When the piston in the cylinder is in its extreme right hand position, the sections o^1, o^2, o^3 will have been raised and the valve opened by the pressure of the air in the cylinder compressed by the piston. The sections o^1, o^2, o^3 remain in the raised position during the first part of the return stroke of the piston to the left, because the pressure of the compressed air admitted direct thereto, acts on the lower face of the section o^1 and the rear of the valve is connected to the exhaust through the canal p^1. When, however, the canal q^1 is freed from the piston, the directly admitted pressure is transmitted through the said canal to the annular chamber q, and the plunger sections are moved to the closing position. The diameter of the plunger sections o^1 and o^3 is the same, and the cross-sectional areas of the annular chambers above and below the plunger section o^2 are somewhat larger than the faces of the plunger sections o^1 and o^3. As the annular chamber r below the plunger section o^2 is under atmospheric pressure, and the annular face above the plunger section o^2 is larger than the faces of the plunger sections o^1 and o^3, the plunger sections o^1, o^2, o^3, are held in the closing position, as long as the pressure at the right hand end of the cylinder is greater than that at the left hand end. When the pressure at the right hand end of the cylinder has decreased to atmospheric pressure by opening the exhaust port s, compression has already begun at the left hand end of the cylinder. Therefore the sections o^1, o^2, o^3, are not held any longer on their seats by the pressure within the chamber q, but by the pressure within the chamber p.

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

1. Valve mechanism comprising a cylinder, having an admission port near each end, an exhaust port between each admission port and the midlength of the cylinder, a valve for each admission port, a canal leading from each end of the cylinder to admit pressure therefrom to the rear of the valve at the opposite end, and a canal leading from the cylinder between each admission and exhaust port to admit pressure therefrom to the rear of the valve at the same end of the cylinder.

2. Valve mechanism comprising a cylinder, a lateral valve chamber at each end communicating directly with the cylinder, and divided into sections, valve plungers each comprising sections fitting the valve chamber sections, each forward section of each plunger forming an admission valve to the cylinder, a canal leading from each valve chamber at the rear of one section of the plunger to the opposite end of the cylinder, and a canal leading from each valve chamber in the rear of another section of each plunger leading to the end of the cylinder with which said valve chamber communicates.

3. Valve mechanism comprising a cylinder, and a piston reciprocating therein, plunger sections of different diameters for each end of the cylinder reciprocating in corresponding lateral chambers communi-

cating with the ends of said cylinder, a section of each plunger of a smaller diameter serving as an admission valve to the cylinder, said cylinder having an exhaust port in its wall at a distance from the cylinder head, a canal connecting the chamber at the rear of the larger section of each plunger with the adjacent end of the cylinder at a point intermediate the cylinder head and the exhaust port, and a canal connecting a chamber at the rear of a smaller section of each plunger with the opposite end of the cylinder.

4. Valve mechanism comprising a cylinder, and a piston reciprocating therein, a plunger for each end of the cylinder, consisting of independently movable sections of different diameters and reciprocating in chambers communicating with the ends of said cylinders, a section of said plunger of smaller diameter serving as an admission valve to the cylinder, said cylinder having an exhaust port in its wall at a distance from the cylinder head, a canal connecting the chamber at the rear of the larger section of each plunger device with the adjacent end of the cylinder at a point intermediate the cylinder head and the exhaust port, and a canal connecting a chamber at the rear of a smaller section of each plunger with the opposite end of the cylinder.

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

CHARLES CHRISTIANSEN.

Witnesses:

JEAN GRUND,

CARL GRUND.