No. 696,504. Patented Apr. 1, 1902.

H. C. SERGEANT & W. PRELLWITZ.

REGULATING DEVICE FOR AIR COMPRESSORS.

(Application filed Feb. 28, 1901.)

(No Model.) 3 Sheets—Sheet 1.

Fig. I.

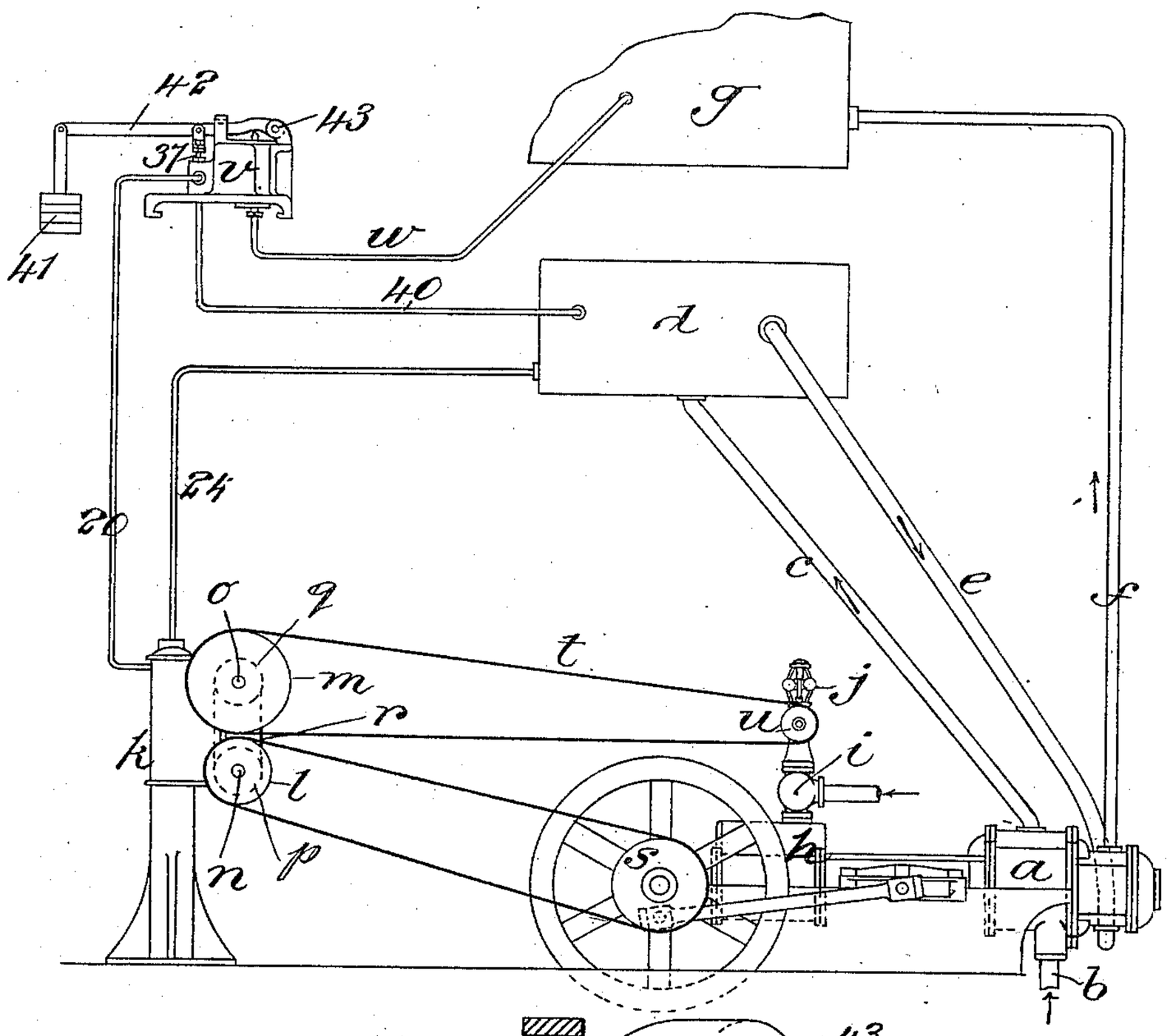
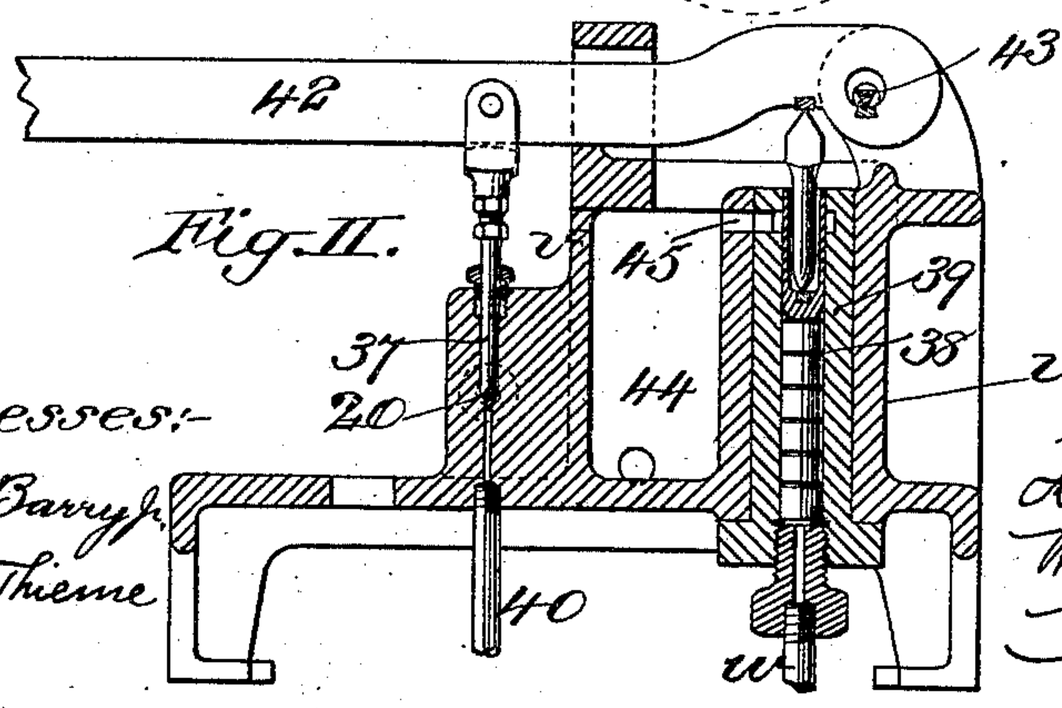


Fig. II.



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Henry Thieme

Inventors:-
Henry C. Sergeant
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Fig. V.*

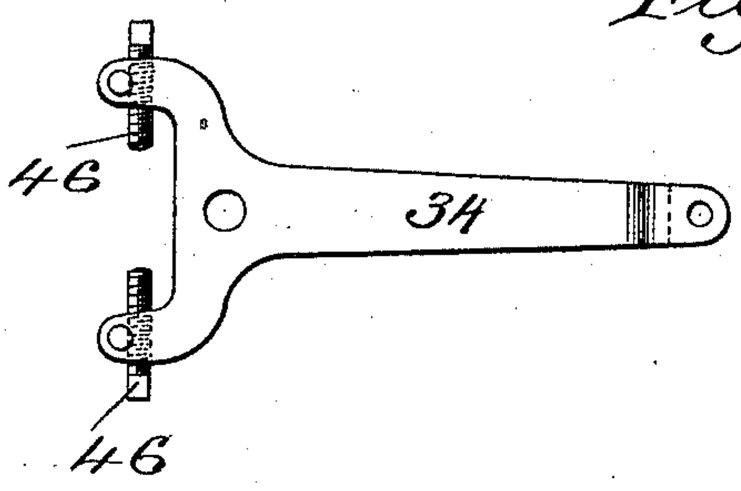


Fig. V.

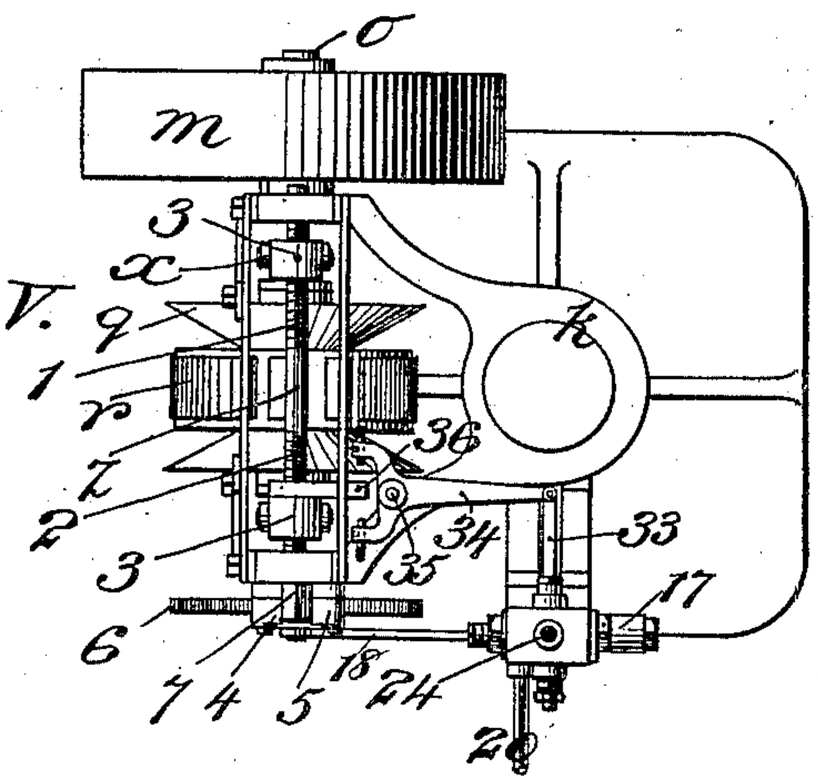


Fig. III.

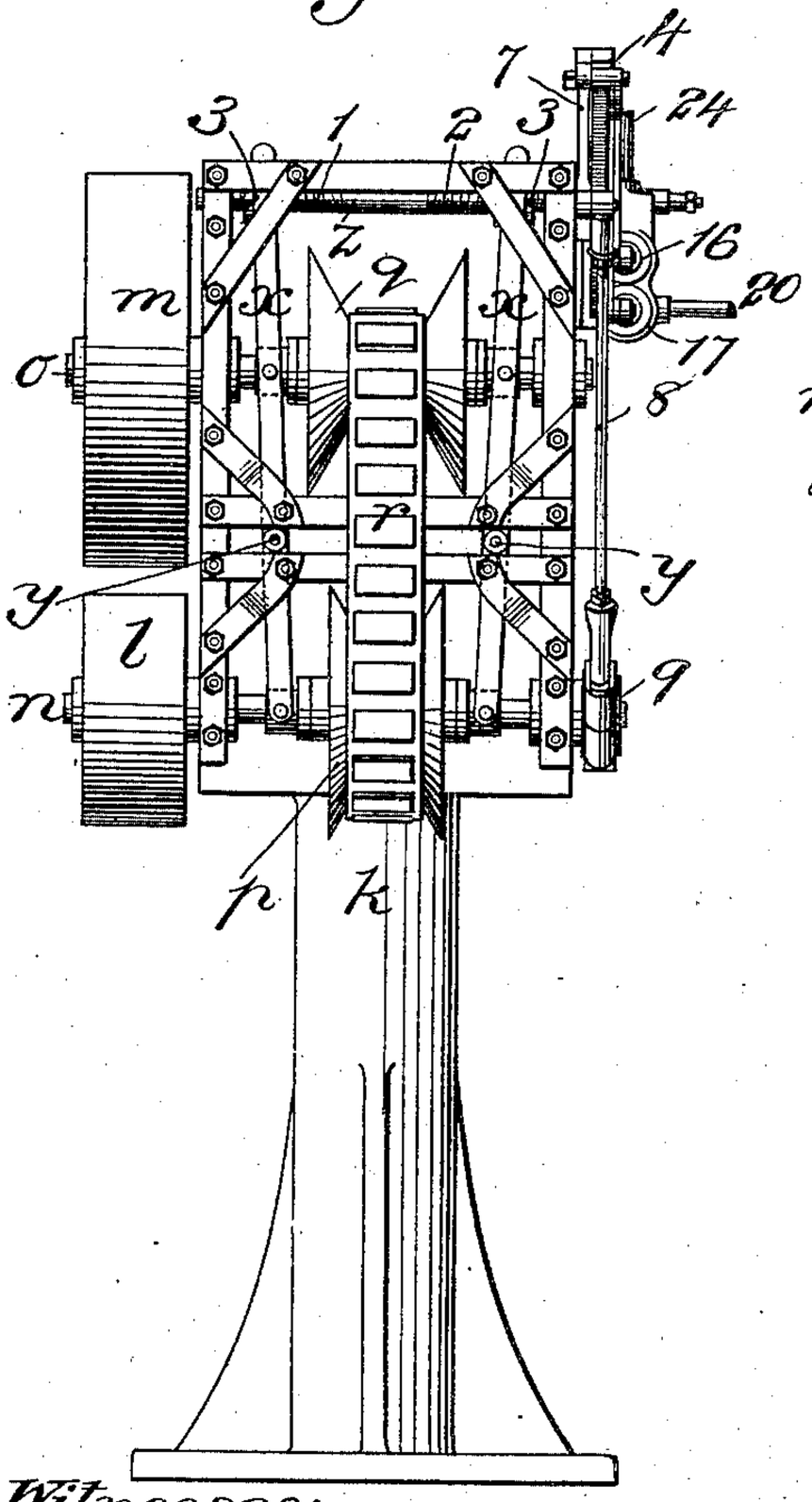
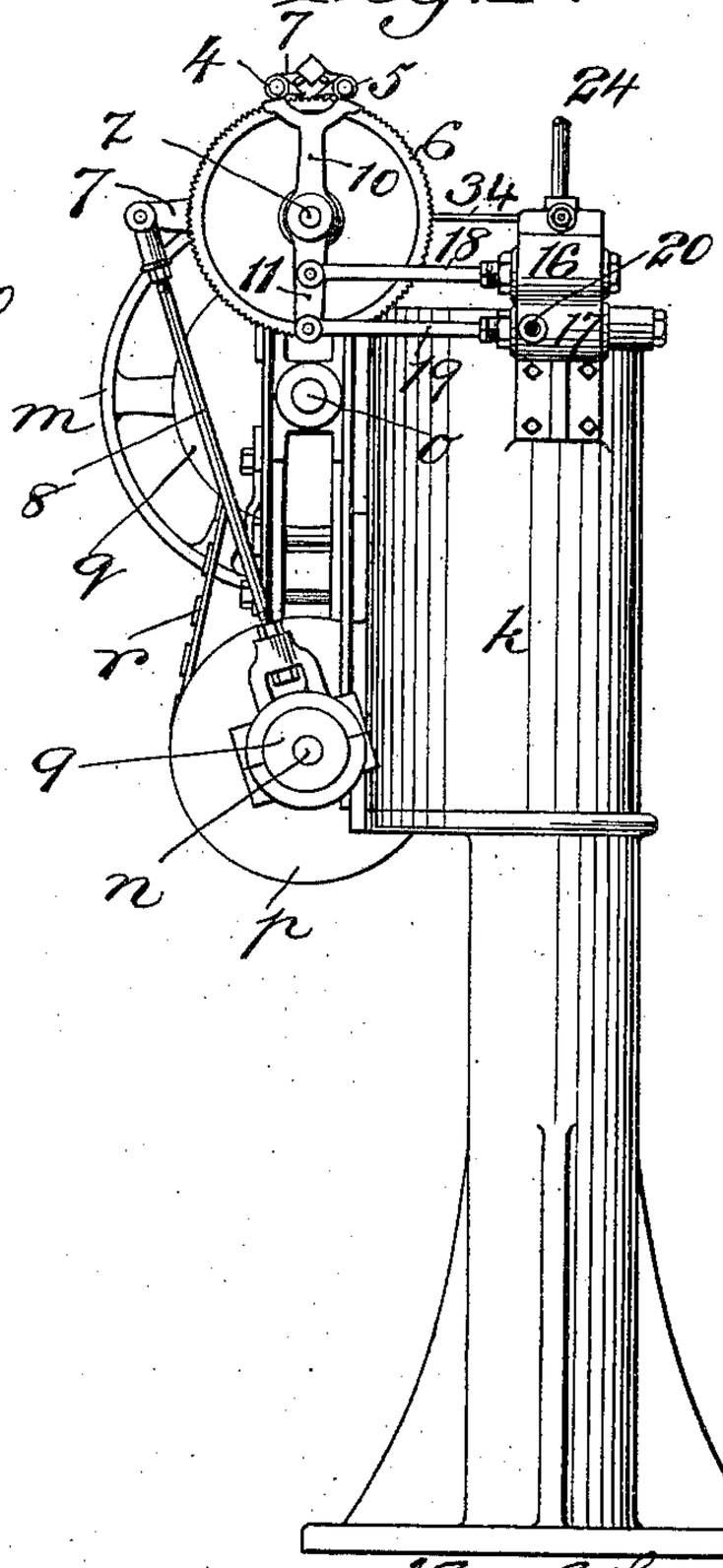


Fig. IV.



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(No Model.) 3 Sheets—Sheet 3.

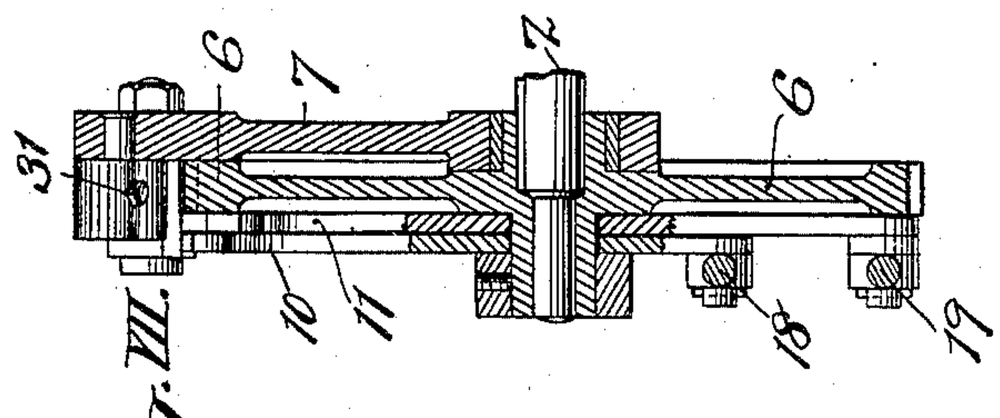

Fig. V.

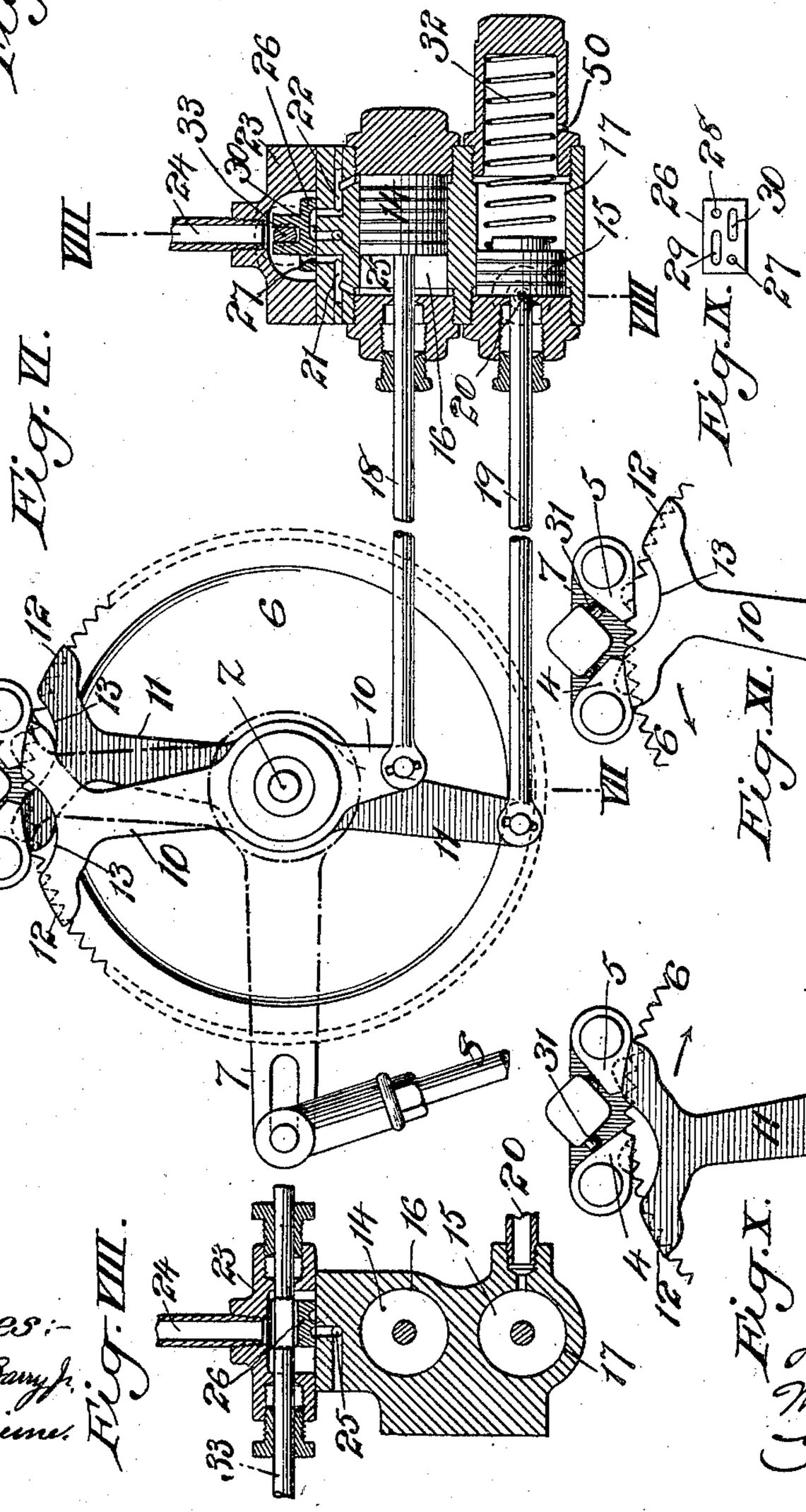

Fig. VI.

Fig. IX.

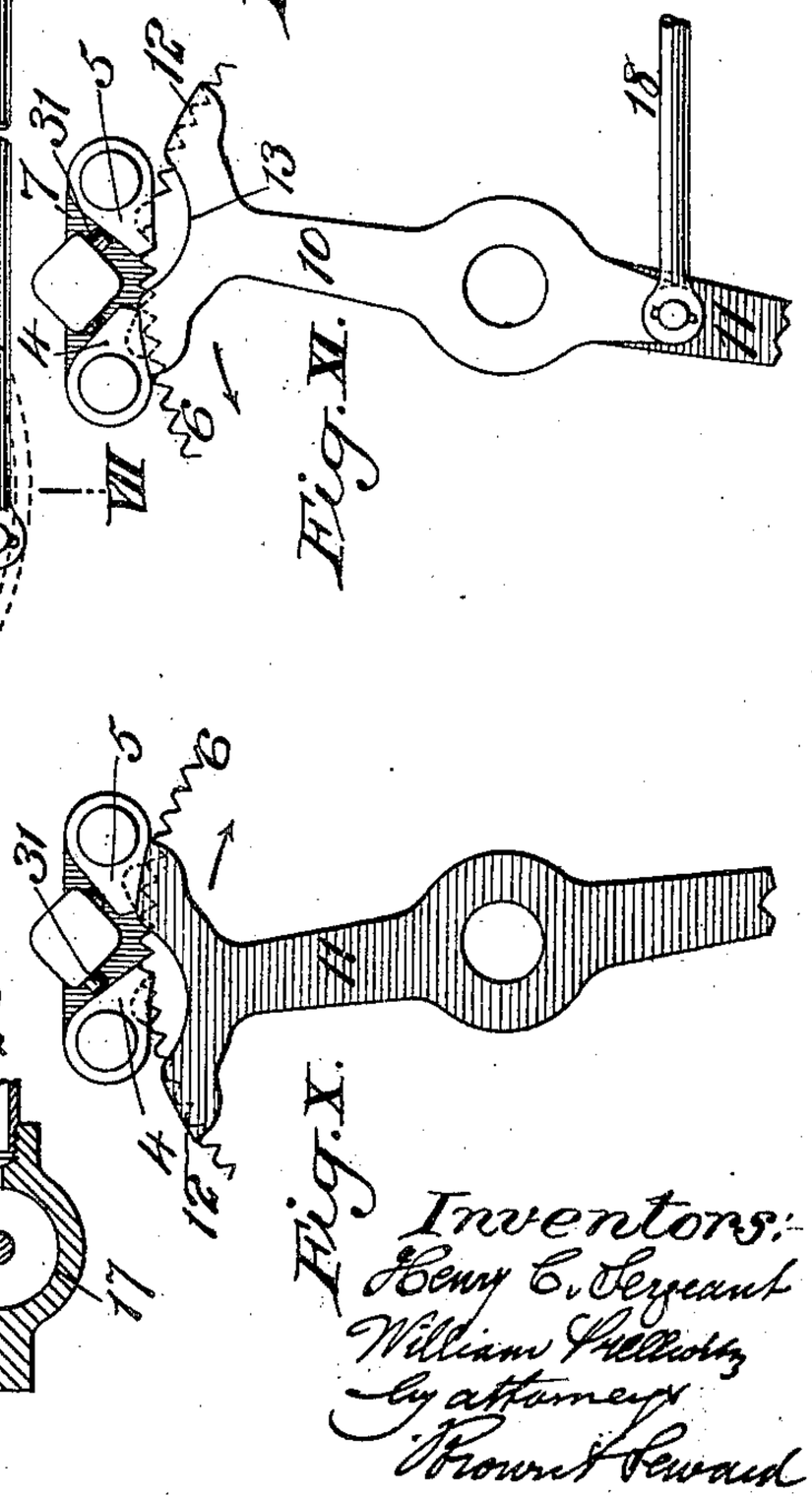

Fig. XI.

Fig. X.

Fig. VIII.

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UNITED STATES PATENT OFFICE.

HENRY C. SERGEANT, OF WESTFIELD, NEW JERSEY, AND WILLIAM PRELLWITZ, OF EASTON, PENNSYLVANIA, ASSIGNORS TO THE INGERSOLL-SERGEANT DRILL COMPANY, OF NEW YORK, N. Y., A CORPORATION OF WEST VIRGINIA.

REGULATING DEVICE FOR AIR-COMPRESSORS.

SPECIFICATION forming part of Letters Patent No. 696,504, dated April 1, 1902.

Application filed February 28, 1901. Serial No. 49,211. (No model.)

To all whom it may concern:

Be it known that we, HENRY C. SERGEANT, a resident of Westfield, in the county of Union and State of New Jersey, and WILLIAM PRELLWITZ, a resident of Easton, in the county of Northampton and State of Pennsylvania, citizens of the United States, have invented a new and useful Improvement in Regulating Devices for Air-Compressors, of which the following is a specification.

This invention relates to regulating devices for an air-compressor which operates by reducing the normal speed of its driving-engine to any slower speed that may be necessary when the desired maximum pressure in the receiver or system supplied by the compressor has been exceeded and by maintaining such reduced speed until the pressure in the receiver has been sufficiently reduced. When regulating devices of this character are applied to multiple-stage or other compressors by which compression is effected to a very high degree, it is extremely desirable that this reduction of speed shall be very gradual and that it should be effected much more slowly than it can be effected by an ordinary governor driven directly by a belt or gearing from the engine-shaft. Otherwise the whole machine, including the compressor and the engine, is liable to serious shock or vibration.

The object of this improvement is to effect such a gradual or slow reduction of the speed, and for this purpose we interpose between the engine and the governor, a speed-varying mechanism which is driven by the engine and through which we drive the governor and the varying operation of which is effected and controlled by the pressure of the air in the final receiver; and the said improvement consists in the several combinations hereinafter described and claimed embodying a so applied and controlled speed-varying mechanism and other devices in connection with such mechanism.

In the accompanying drawings, Figure I is a diagrammatic view of a compound compressor and its driving-engine having our invention applied; Fig. II, a vertical section of the regulator through which control of the speed-varying device is effected by the pressure in the final receiver. Figs. III and IV represent elevations taken at right angles to each other of the speed-varying mechanism and its operating devices; Fig. V, a plan corresponding with Figs. III and IV; Fig. V*, a plan, on a larger scale, of a lever shown in Fig. V; Fig. VI, a side view, partly in section, of parts of the speed-varying mechanism and its controlling devices; Fig. VII, a transverse vertical section taken approximately in the line VII VII of Fig. VI; Fig. VIII, a transverse vertical section in the line VIII VIII of Fig. VI; Fig. IX, a face view of a valve which appears in section in Figs. VII and VIII. Figs. X and XI represent in different positions some of the details shown in Fig. VI.

Referring first to Fig. I, *a* is the low-pressure cylinder of the compressor, which receives the air through the inlet-pipe *b* and delivers it compressed through a pipe *c* to an intercooler or intermediate receiver *d*, whence it passes by a pipe *e* to the high-pressure compression-cylinder, to be thence delivered further compressed through a pipe *f* to the final receiver *g*. *h* is the steam-engine which drives the compressor; *i*, the throttle-valve of the engine; *j*, a centrifugal governor for operating said valve. *k* is a stand which contains the speed-varying mechanism, to be hereinafter more fully described with reference to Figs. III, IV, V, which comprises two pulleys *l m* on the shafts *n o*, on which are pulleys *p q* of variable diameter, belted together by a belt *r*. The pulley *l* receives motion from a pulley *s* on the engine-shaft and drives the pulley *m* through the variable pulleys *p q* and their belt *r*, and the pulley *m* drives the governor by means of a belt *t*, running from said pulley to a pulley *u*, which is geared with and drives the governor. *v* is the regulator through which the pressure of air in the final receiver, acting through a pipe *w*, controls the operation of the speed-varying mechanism.

Referring now to Figs. III, IV, V, the pulleys *p* and *q* of the speed-varying mechanism consist each of two conical disks so fitted to their respective shaft *n* or *o* as to turn therewith, but to be capable of being moved toward or from each other by two levers *x*, which work on fulcrums *y*, supported in the stand *k*. The movements of these levers are produced by a spindle *z*, turning in bearings in the upper part of the stand *k* and having upon it right and left hand screw-threads 1 2, which work in nuts 3 3, carried by the upper ends of the said levers. By turning this spindle *z* in one direction or the other the nuts 3 are drawn toward each other or forced apart and the upper ends of the levers *x x* are moved correspondingly, and so caused to draw together or spread apart the conical members of the upper pulley *q* and at the same time to spread apart or draw together the corresponding members of the lower pulley *p*, thus contracting the driving diameter of one pulley and expanding the driving diameter of the other one, and so varying the speed transmitted by the pulley *p* to the pulley *q* by the belt *r*. As thus far described, this speed-varying mechanism is well known, being the subject of United States Patent No. 583,402, and it has only been here described to illustrate its adaptation to our invention.

The turning of the screw-spindle *z* for the purpose above described is effected by the operation of one or other of two pawls 4 5 on a toothed wheel 6, (represented in Fig. IV, but better on a larger scale in Figs. VI and VII,) which is fast on the said spindle. These pawls are carried by a lever 7, which rocks upon the hub of the wheel 6. The said pawls are capable of engaging, one at a time only, with the teeth of the wheel 6, one of them for the purpose of turning the said wheel and the screw-spindle in one direction and the other for the purpose of turning them in the other direction; but both are held out of engagement so long as the pressure in the receiver does not exceed the desired maximum and the engine runs at normal speed. The lever 7 receives continually the necessary motion for producing the operation of the pawls 4 5 through a rod 8 from an eccentric 9 (see Figs. III and IV) on the shaft *n* of the speed-varying mechanism. For the purpose of holding one or both of the pawls 4 5 out of engagement with the wheel there are two disengaging-levers 10 11, fitted to rock on the hub of the wheel 6. The upper ends of the levers 10 11 are represented as leaved or forked, the leaves or prongs 12 of their forks having arc-formed ends or faces which conform to the circumscribing circle of the points of the teeth of the wheel 6, so that either pawl may be raised out of engagement of the wheel by one of the levers 10 or 11, while the other remains in engagement, or both may be raised out of engagement. Fig. VI represents both pawls disengaged, the pawl 4 being held up by the left-hand leaf of the lever 11 and the pawl 5 by the right-hand leaf of the lever 10. The crotch 13 between the two leaves 12 of each of the levers 10 11 is deep enough to let its respective pawl into engagement and wide enough to permit to the pawl a sufficient movement to produce the requisite turning of the wheel *e*. Spring-actuated pressers 31 are applied to the lever 7 at the backs of the pawls to keep them in engagement with the teeth of the wheel 6 or to hold them down to the disengaging-leaves 12 of the levers 10 11.

The means for producing the movements of the disengaging-leaves under the control of the pressure of the air in the receivers are partly shown in Figs. III, IV, V, but better shown in section in Figs. VI and VIII, with reference to which they will be described in detail. These means consist principally of two pistons 14 and 15, working in cylinders 16 and 17, (represented in Figs. III, IV, and V,) attached to the stand *k*. The piston 14 of the upper cylinder 16 is connected by a rod 18 with the lower end of the lever 10, and the piston 15 of the lower cylinder 17 is connected by a rod 19 with the lower end of the lever 11. The lower cylinder 17 has communication provided for on the left-hand side of the piston with the intercooler *d* through pipes 20 40 and the regulator *v*, which latter has been hereinbefore mentioned with reference to Fig. I, but will be hereinafter described in detail. On the right side of the piston the said cylinder 17 contains a spring 32, (see Fig. VI,) which tends to press the piston to the left, and on the same side of the piston the said cylinder is provided with a vent 50, communicating with the atmosphere. The upper cylinder 16 has communication provided through ports 21 22 at both ends with a valve-chest 23, which is always in communication through a pipe 24 (see Figs. I, IV, V, VI, and VIII) with the intercooler *d*. In this valve-chest 23 there are, besides the two ports 21 22, a central exhaust-port 25, leading to the atmosphere, the said ports being controlled by a slide-valve 26, in which there are two ports 27 28, as shown in Fig. IX, running through it, and two coves 29 30 in its face. This valve is operated by a rod 33, which works through stuffing-boxes in the valve-chest and is connected, as shown in Fig. V, with a forked longitudinally-operating lever 34, having a fixed fulcrum 35 on the top of the stand *k* of the speed-varying mechanism. The fork of this lever receives between its prongs a tappet 36, which projects from one of the nuts 3 on the screw-spindle *z*, and by the action of which on one or the other prong of the fork at the proper time moves the valve to either one of two positions, one of which is shown in Fig. VI. In this position air from the valve-chest is admitted through the ports 27 21 to the outer or left-hand end of the cylinder 16, while the inner or right-hand end of said cylinder is open through the port 22 and cove 30 to the exhaust-port 25 and the atmosphere. In the

other position of the valve the ports and coves are reversed and air enters the cylinder 16 at the right-hand end and exhausts from the other end through its port 28 and cove 29. The valve is, however, stationary in the condition represented in Fig. VI so long as the compressor runs at the normal speed and until the regulator *v*, which will now be described, comes into operation. This regulator, which is shown in section in Fig. II, consists of a box or body *v*, in which there is a valve 37, controlled by a piston 38, which works in an upright cylinder 39, at the bottom of which there is constant communication through the pipe *w*, before mentioned, with the final receiver. The valve 37 (represented as a needle-valve) opens and closes communication between the pipe 40, which is always in communication with the intercooler *d*, and the pipe 20, before mentioned, which leads to the lower one, 17, of the cylinders 16 17, before described, whose pistons are connected with the pawl-disengaging levers 10 11, before described. The piston 38 is loaded to the maximum pressure which is desired in the final receiver by a weight 41 (see Fig. I) applied to a lever 42, which works on a fixed fulcrum 43, and the valve 37 is connected with this lever, so that when the pressure in the final receiver exceeds the desired maximum, and the piston 38 is thereby caused to rise, the said valve is raised and communication is opened through the pipes 40 and 20 between the intercooler *d* and the inner or left-hand end (see Fig. VI) of the cylinder 17. The box *v* contains an oil-reservoir 44 for the lubrication of the cylinder and piston 39 38 through an orifice 45 in the side of the cylinder.

Having now described in detail the several devices which constitute our invention, we will proceed to describe their relative operations in controlling the compressor-driving engine. First, suppose the pressure in the final receiver to be at or not above the maximum desired. The pistons 14 15, which operate the disengaging-levers 10 11, will then be in the respective positions shown in Fig. VI. The communication between the cylinder 17 and the intercooler through pipe 20 is closed by the valve 37 of the regulator and the piston is held at the left-hand end of its cylinder 17 by the spring 32. The valve 26 is in position to admit the air from the intercooler, with which the chest 23 is always supplied, to the left-hand end of the cylinder 16 and to exhaust from the other end thereof, and the piston 14 is at the right-hand end of said cylinder. In this position the pistons 14 15, by their connections 18 19 with the disengaging-levers 10 11, hold both of the pawls 4 5, as shown in Fig. VI, out of engagement from the wheel 6, which, with the screw-spindle *z*, remains stationary, and the relative operative diameters of the speed-varying pulleys *p q* remain constant. Now suppose the pressure in the final receiver to increase. The piston 38 is raised and the valve 37 thereby opened to admit air from the intercooler *d* through the pipe 20 to the cylinder 17. The piston 15 then moves inward or to the right of Fig. VI, and, taking with it the disengaging-lever 11, causes the said lever to let the pawl 4 fall into engagement with the wheel 6, as shown in Fig. X, and at the same time bring its right-hand leaf 12 under the pawl 5, which is thus for a time held out of engagement by both levers 10 and 11. The movement of the lever 7, which is kept continually in operation by the eccentric 9, then turns the said wheel 6 step by step to the left, and so causes the turning of the screw-spindle 7 in a direction to move the nuts 3 3 away from each other, so as to move the levers *x x* in such directions as to spread apart the disks of the driven pulley *q*, and so reduce its effective diameter and at the same time draw together the disks of the driving-pulley *p*, and so increase its effective diameter, thereby so gradually changing the ratio of the speeds of the engine and governor as to cause the engine to gradually slow down until the tappet 36, carried by one of the nuts 3 3, by coming against one of the prongs of the fork of the valve-operating lever 34 moves the said lever in a direction and to a sufficient distance to reverse the position of the valve 26, and so produce the movement of the piston 14 to the left, by which means the disengaging-lever 10 is caused to disengage the pawl 4, as shown in Fig. XI, and so leave the wheel 6 free, the pawl 5 still remaining disengaged by the lever 11, as shown in Fig. X. The machine, engine, and compressor will continue to run at its slow speed until the pressure in the receiver has been sufficiently reduced to allow the piston 38 to descend and close the valve 37, thus cutting off the air from the cylinder 17 and allowing the spring to return the piston 15 to the position first described with reference to Fig. VI, which brings the lever 11 to the position to allow the pawl 5 to come into engagement with the wheel and turn it to the left, the pawl 4 being still held out of engagement with the lever 10. The wheel 6 and screw-spindle *z* are then turned in a direction to bring the nuts 3 toward each other. This movement continues until the variable-speed pulleys have been brought back to their respective normal relative diameters and the requisite speed of the engine and compressor has been again arrived at. By that time the nut-tappet 36 will have moved the valve-operating lever 34 to the position to bring back the valve 26 to the position first described. (Represented in Fig. VIII.) The above-described operation repeats itself whenever pressure in the final receiver brings the regulator-valve 37 into operation.

The forked valve-operating lever 34 (see Figs. V and V*) is represented as having in each of its two prongs a screw 46, upon the inner end of which the tappet 36 operates to

shift the valve 26 in one direction or the other. By the adjustment of these screws nearer together or farther apart the number of turns made by the screw-spindle for expanding and contracting the variable-speed pulleys is controlled for the purpose when desired of varying the maximum and minimum speeds of the machine.

In the example of the invention represented we use air from the intercooler to produce the operation of the pistons 14 15, but it is obvious that by connecting the pipes 24 and 40 with the final receiver instead of with the intercooler the higher pressure may be used for the same purpose, and of course in the application of the invention to single-stage compressors the pipes 24 and 40 would have to be supplied with air from any receiver or pipe system to which the compressor delivers. It will also be easily understood that any fluid under pressure may be supplied for the same purpose from any source through the pipes 24 and 20 and the same regulator *v*.

By the terms "air" and "air-compressor" in this specification we intend to include all aeriform and gaseous bodies and all compressors used for such bodies.

What we claim as our invention is—

1. The combination with an air-compressor and a motor therefor and a governor for the latter, of speed-varying mechanism between the motor and the governor and means for controlling said mechanism by the pressure of the air delivered by the compressor, substantially as herein described.

2. The combination with an air-compressor and a motor therefor, of a motor-controlling governor, means for driving said governor by said motor consisting in part of speed-varying mechanism interposed between said motor and the governor, and means under the control of the air delivered by the compressor for operating said speed-varying mechanism, substantially as herein described.

3. The combination with an air-compressor and a steam-engine for driving the same, of a throttle-valve and rotary governor for said engine, means for driving said governor by said engine composed in part of speed-varying mechanism interposed between said engine and the governor, and means under the control of the air delivered by the compressor for operating said speed-varying mechanism, substantially as herein described.

4. The combination with an air-compressor and a motor therefor, of a motor-controlling governor, a speed-varying mechanism consisting of two expanding and contracting pulleys and a belt between them, means for driving one of said pulleys from the motor-shaft, means for driving the governor from the other of said pulleys and means for simultaneously expanding one and contracting the other of said pulleys under the control of the pressure of the air delivered by the compressor, substantially as herein described.

5. The combination with an air-compressor and a motor therefor, of a motor-controlling governor, a speed-varying mechanism consisting of two expanding and contracting pulleys and a belt between them, means for driving one of said pulleys from the motor-shaft, means for driving the governor from the other of said pulleys, levers for expanding and contracting said pulleys, a screw-spindle having right and left hand threads and nuts thereon for actuating said levers, and means for turning said spindle in one direction or the other under the control of the air delivered by the compressor, substantially as herein described.

6. The combination with an air-compressor and a motor therefor and a governor for the latter, of speed-varying mechanism consisting of two expanding and contracting pulleys and a belt between them, means for driving one of said pulleys from the motor-shaft, means for driving the governor from the other of said pulleys, levers for expanding and contracting said pulleys, a screw-spindle having right and left hand threads and nuts thereon for operating said levers, a toothed wheel on said spindle, a lever fulcrumed on said spindle and two pawls carried by said lever for turning said wheel and spindle in opposite directions, means for operating said lever by the rotation of one of said pulleys, two pawl-disengaging levers fulcrumed on said spindle for disengaging said pawls, and means under the control of the pressure of the air delivered by the compressor for separately operating said disengaging-levers, substantially as herein described.

7. The combination with an air-compressor and a motor therefor and a governor for the latter, of speed-varying mechanism consisting of two expanding and contracting pulleys and a belt between them, means for driving one of said pulleys from the motor-shaft, means for driving the governor from the other of said pulleys, levers for expanding and contracting said pulleys, a screw-spindle having right and left hand threads and nuts thereon for operating said levers, a toothed wheel on said spindle, a lever fulcrumed on said spindle and two pawls carried by said lever for turning said wheel and spindle in opposite directions, means for operating said lever by the rotation of one of said pulleys, two pawl-disengaging levers fulcrumed on said spindle for disengaging said pawls, cylinders one for each of said disengaging-levers and pistons in said cylinders actuated by fluid-pressure from any source for operating said levers, pipes leading from said source to each of said cylinders, and a valve for opening and closing one of said pipes under the control of the final pressure of the air delivered by the compressor, substantially as herein described.

8. The combination with a compound or multiple-stage compressor and a motor therefor and a governor for the latter, of speed-varying mechanism between the motor and the governor, means for operating the speed-varying mechanism by fluid-pressure from an

intermediate receiver, and a valve under the control of the final-receiver pressure for admitting and shutting off the intermediate-receiver pressure from said means for operating the speed-varying mechanism, substantially as herein described.

In testimony that we claim the foregoing as our invention we have signed our names, in presence of two witnesses, this 21st day of February, A. D. 1901.

HENRY C. SERGEANT.
WILLIAM PRELLWITZ.

Witnesses:
H. D. MAXWELL,
EDWARD A. SMITHSON.