(No Model.) 3 Sheets—Sheet 1.

B. V. NORDBERG.

AIR COMPRESSOR REGULATOR.

No. 458,975. Patented Sept. 1, 1891.

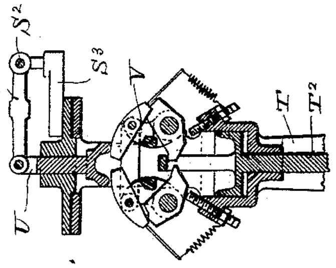


Fig. 2.

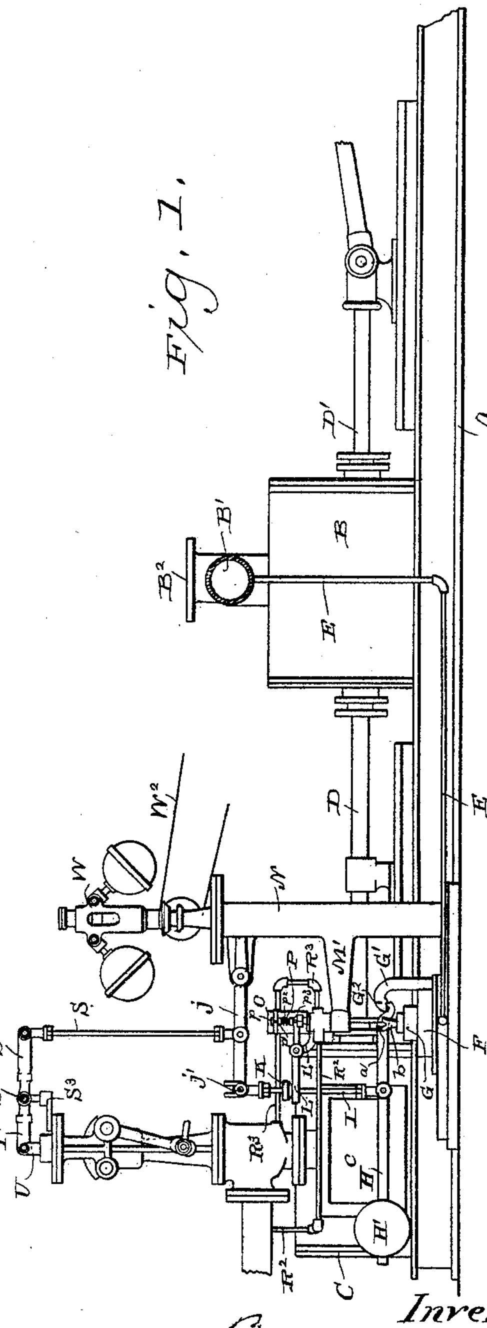


Fig. 1.

Witnesses
G. Mack Young.
Wm Klug

Inventor
Bruno V. Nordberg
by Stark & Underwood
Attorneys

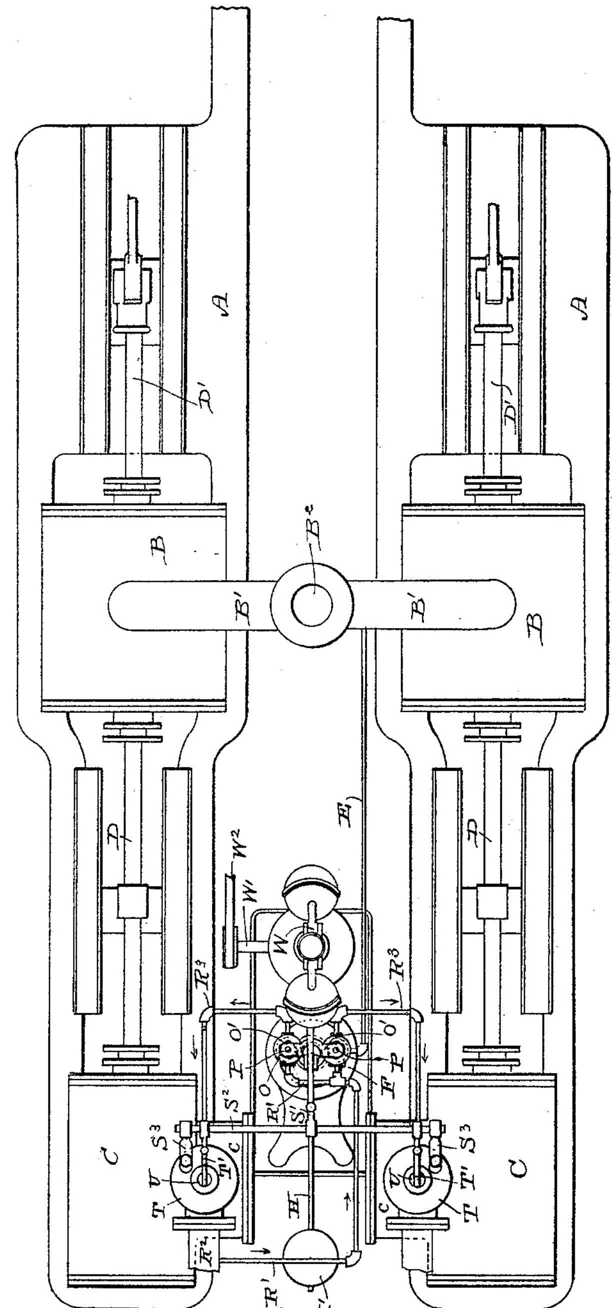
(No Model.) 3 Sheets—Sheet 2.

B. V. NORDBERG.

AIR COMPRESSOR REGULATOR.

No. 458,975. Patented Sept. 1, 1891.

Fig. 3.



Witnesses

Inventor
Bruno V. Nordberg
by Stout & Underwood
Attorneys

(No Model.) 3 Sheets—Sheet 3.

B. V. NORDBERG.

AIR COMPRESSOR REGULATOR.

No. 458,975. Patented Sept. 1, 1891.

Fig. 4.

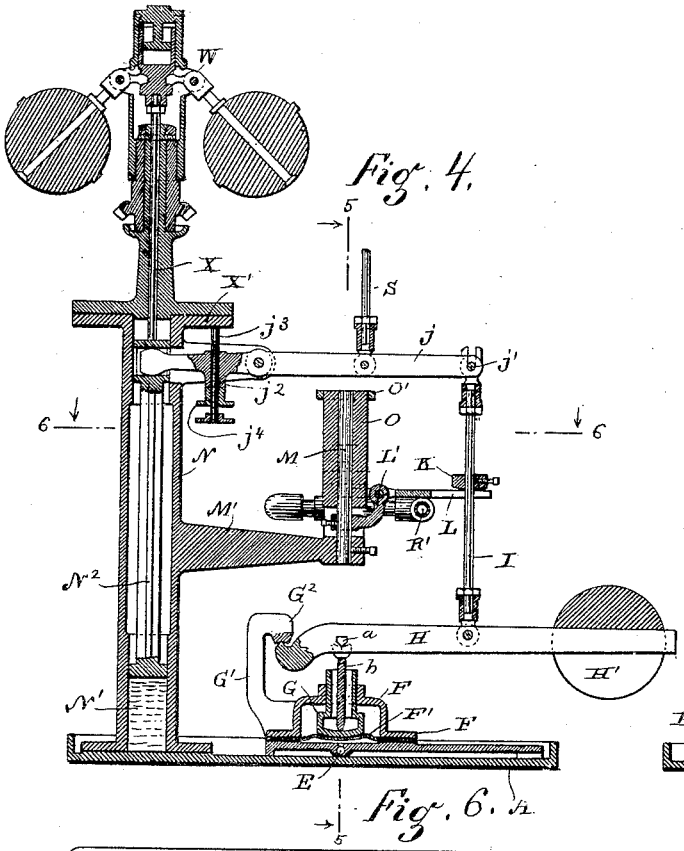


Fig. 5.

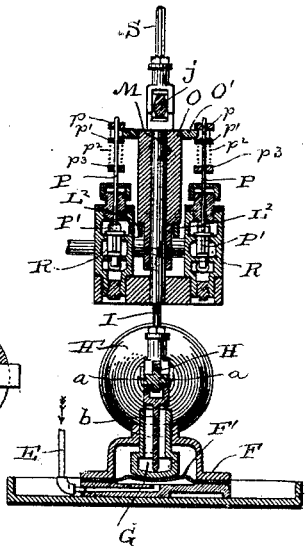
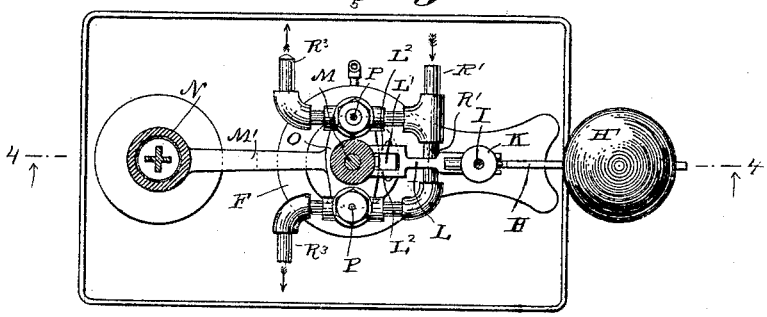


Fig. 6.



Witnesses
G. Wash. Young.
Wm. Kelly

Inventor
Bruno V. Nordberg
by Munn & Underwood
Attorneys

UNITED STATES PATENT OFFICE.

BRUNO V. NORDBERG, OF MILWAUKEE, WISCONSIN, ASSIGNOR TO THE BRUNO NORDBERG COMPANY, OF SAME PLACE.

AIR-COMPRESSOR REGULATOR.

SPECIFICATION forming part of Letters Patent No. 458,975, dated September 1, 1891.

Application filed July 29, 1889. Serial No. 319,000. (No model.)

To all whom it may concern:

Be it known that I, BRUNO V. NORDBERG, of Milwaukee, in the county of Milwaukee, and in the State of Wisconsin, have invented certain new and useful Improvements in Regulating Apparatus for Air-Compressors, &c.; and I do hereby declare that the following is a full, clear, and exact description thereof.

My invention relates to air-compressing engines and pumps; and the invention consists in certain peculiar and novel features of construction and arrangement, as hereinafter described and claimed.

In order that my invention may be fully understood, I will proceed to describe it with reference to the accompanying drawings, in which—

Figure 1 is a side elevation of an air-compressing engine with my improvements applied thereto. Fig. 2 is a detached view, in transverse vertical section, of a portion of the cut-off mechanism. Fig. 3 is a plan view of the mechanism shown in Fig. 1. Fig. 4 is a transverse vertical section on the line 4 4 of Fig. 6. Fig. 5 is a transverse vertical section on the line 5 5 of Fig. 4. Fig. 6 is a horizontal cross-section on the line 6 6 of Fig. 4.

The objects of my invention are to produce means whereby air-compressing and liquid-pumping engines having trip cut-offs shall be automatically started after they have been stopped by the air or liquid pressure in the compression-cylinders reaching the required maximum limit; also to provide for automatically stopping the action or working of such engines by the arrival of the air or liquid pressure in the compression-cylinders at the maximum limit. These results I attain by virtue of the construction which I will now proceed to describe.

In the said drawings, A A designate the bed-plates, B B the compression-cylinders, and C C the steam-cylinders, of a double air-compression engine, the steam-piston of each engine being connected by its piston-rod D to the compressor piston or head of the engine and the said compressor-heads being connected by rods D′ to a suitable fly-wheel or balanced shaft. (Not shown.) The compression-cylinders B B are connected together by cross-pipes B′ B′, which communicate with a common outlet B^2.

Into one of the pipes B′ is tapped a pipe E, preferably of less diameter than the pipes B′, and this pipe E is connected at its opposite end with the bottom of a pressure-chamber F, the arrangement thus being such that fluid-pressure within the cross-pipes B′ is communicated to the interior of the said pressure-chamber F.

Within the lower portion of the chamber F is placed a flexible or elastic diaphragm F′, upon which rests the lower end or head of a hollow piston or plunger G, the upper portion or stem of which works vertically through an opening in the top of the pressure-chamber. Within this piston or plunger G is placed a vertical standard *b*, the lower end of which rests upon the upper side of said plunger, and the upper end of which is bifurcated to embrace a lever H and to partially support the same through the medium of two knife-edged studs *a*, projecting oppositely from said lever. A standard G′ extends vertically upward from one side of the chamber F and carries at its upper end a lateral extension G^2, the under side or end of which is recessed to receive the inner end of the lever H, the said lever carrying upon its outer end a weight H′, as shown. Thus the lever H is supported by the standards *b* and G′, the extensions G^2 constituting a fixed support or fulcrum for the lever, while the standard *b* constitutes a movable support for the same.

To the lever H, about midway of its length, is pivotally connected the lower end of a rod I, the upper end of which is bifurcated in one direction to embrace the outer end of a lever *j*, to be presently more fully described, and also bifurcated oppositely to receive a cross stud or pin *j′* at the said outer end of the lever *j*. This lever *j* is pivoted upon a lateral arm near the upper end of the governor-standard *n*, and its inner extremity lies across the path of movement of the governor-rod X.

At a point about midway of its height the governor-standard *n* carries a bracket-arm M′, to the outer end of which is rigidly connected the lower end of a rod M, which is loosely surrounded by a counter-weight O.

To the rod M, just above the outer end of the bracket-arm M′, is secured a bracket-arm L′, and to the outer end of said bracket-arm L′ is pivotally connected a lever L, said lever being bifurcated or forked, as at L^2, to embrace the bracket-arm L′ and also the lower part of the counter-weight O. The outer end of the lever L is also bifurcated to embrace the rod I, before referred to, and to be engaged by the under side of a stop K, adjustably secured to said rod I, while the inner bifurcated ends L^2 of the lever lie beneath shoulders formed on the lower part of the counter-weight O.

The outer end of the bracket-arm M′ carries two valve-chambers R, which extend upward at opposite sides of the counter-weight O, and within each of which works vertically a plug-valve P′. The upwardly-extending stems P of these valves carry each two stops p p', which embrace a shoulder O′ on the upper part of the counter-weight O, and the upper part of each valve-stem P is also surrounded by an equalizing-spring p^2, which is confined between the lower stop p' and a similar stop p^3, placed still lower down upon said valve-stem.

To the lever j, about midway of the length of the same, is pivotally connected the lower end of a rod S, the upper end of which is pivotally connected to the outer end of a rock-arm S′, which is attached to a rock-shaft S^2, midway of the length of the latter. This rock-shaft S^2 has bearings at its ends in brackets S^3 upon the upper ends of the two trip-standards T, and near each end said rock-shaft carries a rock-arm T′, which is pivotally connected to the upper end of the trip-head U of the corresponding trip mechanism, (indicated at V in Fig. 2.)

The particular trip mechanism shown is of the type embraced in Letters Patent No. 369,612, granted to me September 6, 1887; but any other suitable or preferred type of trip mechanism may be used, as desired—a valve-stem T^2 leading from the trip mechanism to a suitable cut-off valve for regulating the admission of steam.

The valve-chambers R are connected by a pipe R^2 to one of the main steam-supply pipes, and said valve-chambers are also connected by pipes R^3 to the spaces between the cut-off valves and the main distribution-valves of the engines.

The governor W is driven by a belt W^2, leading from the balanced or fly-wheel shaft or other suitable part of the engine, and running over a pulley upon the usual governor-actuating shaft W′.

The governor-standard N is made hollow to contain a plunger N^2 and also a body of oil N′, in which the lower end of said plunger is submerged, thereby serving to neutralize the jerk or jar caused by the action of the trip mechanism, as well as to prevent a too rapid action of the governor.

The operation of the above-described mechanism is as follows: Assuming the engine to be running with an average pressure in the pressure-cylinders B B, as the engines continue to work any increase in pressure in the cylinders B B will be communicated through pipe E to the pressure-chamber F, raising the flexible or elastic diaphragm F′ and with it the standard b. This action raises the outer end of lever H against the resistance of its weight H′ and through the rod I the outer end of lever j is likewise raised, this upward movement of lever j being communicated by rod S to rock-arm S′, and causing the latter to partially rotate the rock-shaft S^2. The rock-arms T′ and trip-heads U are thus depressed, causing the trip mechanism to produce a quicker action of the cut-off valves, thereby lessening the periods of admission of and consequent power of steam within the steam-cylinders and tending to reduce the speed of the engines. In this condition the engine continues to operate until by an excess of pressure in the compression-cylinders the regulating devices are actuated so as to further depress the trip mechanism and give a still quicker action of the cut-off valve, or by a decrease of pressure within the compression-cylinders the reverse movement of the regulating mechanism is effected so as to produce a slower operation of the trip mechanism, thereby lengthening the periods of steam admission and the consequent power of steam within the steam-cylinders. In this manner the operation of the engines is entirely governed by the pressure within the compression-cylinders, and the speed of the engine is regulated in accordance with the amount of work to be done by the engines. The governor mechanism W is preferably adjusted so as to limit the maximum speed of the engines, so that in case of an unusual decrease of pressure within the compression-cylinders the movement of the engines will be regulated by the governor in the usual manner so as to prevent a too rapid operation of the same. Now, supposing that the engines have been stopped and that it is desired to again start said engines, it will be observed that in this position the weight H′ and arm H, together with the standard I, will occupy their lowest positions, thereby operating the rock-shafts, so as to elevate the trip mechanism to its highest position, and the cut-off valve being closed. In this position of the parts the collar K upon the standard I is in engagement with the free end of the bifurcated lever L, thereby depressing said free end and elevating the weight O upon the standard M, which weight, by its engagement with the stems P P of the valves P′ P′, operates to raise said valves from their seats. Now when steam is admitted through the main steam-supply pipe it is prevented from entering the steam-chest in the usual manner by reason of the cut-off valve being closed, but is free to pass through the pipe R^2 to the valve-chambers R, and thence through valves P′ and the pipe R^3 to

the space between the main distribution-valve and the cut-off valve of each engine. It will be understood that the two engines are so adjusted with reference to the crank-shaft that when one of said engines is on a dead-center the other engine will be at about the middle of its stroke, so that the slide-valve of one or the other of said engines will always be in a position to take steam. If now steam be admitted through the steam-supply pipe, as before described, it will pass through the pipe R^2, valves P′ P′, pipes R^3 R^3, and through one of the said slide-valves, so as to fill the steam-cylinder of one of the engines and thus start the engine. As soon as the engines are started the governor mechanism will be operated to depress the short arm of the lever *j* so as to raise the longer arm of said lever, thus elevating the rod S and operating the rock-shaft to depress the trip-heads, and causing the cut-off valves to operate. The speed of the engine will now be regulated by the governor until the air-pressure in the compression-cylinders, acting through the diaphragm F′, becomes sufficient to lift the plunger G, together with the weighted arm of lever H, when said lever H, acting through lever *j* and its connections, will operate to depress the trip-heads U, thus shortening the periods during which steam is admitted to the cylinders, and consequently lessening the speed of the engines. This upward movement of the parts will obviously carry the stop or collar K on the rod I out of engagement with the lever L, so as to permit the weight O to descend to close the valves P′. In this condition steam will be cut off from the space between the cut-off valve and the main distribution-valve of the engine, except through the cut-off valve. It will therefore be understood that the valves P′ P′ are employed solely for the purpose of starting the engines. In order to permit of the adjustment of the regulating mechanism by hand, so as to regulate the motion of the cut-off valves and the consequent speed of the engines, as may be desired, a screw-threaded aperture j^2 is provided in the short arm of the lever *j*, through which is passed an adjusting-screw j^3, carrying a lock-nut j^4. The upper end of the bolt j^3 impinges against the under side of a flange X′ on the stand N and serves to limit the movement of the lever *j*. By this means, if the engines are going slower than is desired, the bolt j^3 may be screwed down so as to permit the outer or long arm of the lever *j* to descend and throw the inner or short end of said lever up hard against the bottom of the plunger-stem X, and by this movement of lever *j* the rod S, rock-shaft S^2, and arms T′ T′ will be operated to lift the trip-heads U U so as to increase the periods during which the cut-off valves are held open, thereby increasing the power of the engines. The reverse adjustment of the screw will obviously operate to depress the inner end of the lever *j*, and through the medium of the rod S, rock-shaft S^2, and arms T′ T′ will serve to depress the trip-heads U U so as to shorten the periods during which the cut-off valves are held open, and thus lessening the speed of the engine.

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

1. In an air-compressing engine, the combination, with the compression-cylinders and connected chamber having a movable diaphragm, of a plunger supported by said diaphragm, a weighted lever supported by said plunger, valves connected with the steam-supply pipe and with the space between the cut-off valve and the main distribution-valve, and connections between said weighted lever and said valves for opening said valves upon the descent of said lever, substantially as set forth.

2. In an air-compressing engine, the combination, with the compression-cylinders and a connected chamber having a movable diaphragm adapted to be raised or lowered by an increase or decrease in the pressure within the compression-chambers, of a plunger supported by said diaphragm, a weighted lever operatively connected with said plunger, pipes leading from the main steam-supply pipe back of the cut-off valves and communicating with the spaces between said cut-off valves and the main distribution-valves, and valves in said pipes governed by said weighted lever and adapted to be opened and closed by movements of said lever, substantially as set forth.

3. The combination, with the compressing-cylinders and connected chamber having movable diaphragm and the trip mechanism and governor-stem, of the plunger and weighted lever supported thereby and a lever pivoted to the governor-stand, with its one arm projecting beneath the governor-stem and the other arm connected with the weighted lever and with the trip mechanism, whereby the speed of the engine is regulated both by the governor and the pressure of air in the cylinders, as set forth.

4. The combination, with the cut-off valve and trip mechanism controlling the same, of a lever connected with said trip mechanism, said lever being pivoted upon the governor-standard and engaged at one end with the governor-rod, and an adjusting-screw passed through said lever and adapted to engage with a flange or stop upon the governor-standard to limit the movement of said lever, substantially as described.

5. The combination, with the governor, trip mechanism, and connecting lever, of a plunger for supporting the inner end of the lever and the governor-stand and fluid-cushion, substantially as described.

6. The combination, with the compression-cylinders and the cut-off valve of an air-compressing engine, of a chamber connected with said compression-cylinders and provided with a movable diaphragm, a piston or plunger

resting upon said diaphragm, a weighted arm fulcrumed upon the engine-frame and resting upon said plunger, pipes leading from the steam-supply pipe back of the cut-off valves and communicating with the spaces between said cut-off valves and the main distribution-valves, valves in said pipes, a weight for normally holding said valves closed, a lever operatively connected with said weight, and a connection between the weighted arm and said lever, whereby a cessation of pressure in the compression-cylinders and a consequent depression of said weighted arm will open said valves, substantially as described.

7. The combination, with the compression-cylinders, the cut-off valves, and the governor of an air-compressing engine, of a lever fulcrumed upon the governor-standard and operatively connected at one end with the governor-rod and at the other end with said trip mechanism, a chamber connected with the compression-cylinders and provided with a movable diaphragm, a plunger resting on said diaphragm, a weighted arm engaged with said plunger, and a rod connected with said weighted arm and movably engaged at its upper end with said lever, substantially as described.

8. The combination, with the compression-cylinders, the cut-off valves, and the governor mechanism of an air-compressing engine, of trip mechanism controlling said cut-off valves, a lever operatively connected with said trip mechanism and with the governor-rod, a chamber connected with the compression-cylinders and provided with a movable diaphragm, a plunger resting on said diaphragm, a weighted arm supported by said plunger, pipes leading from the steam-supply pipe and communicating with the spaces between the cut-off valves and the main distribution-valves of the engine, valves in said pipes, an arm for opening said valves, and a rod connected with said weighted arm and operatively connected with said pivoted lever and said valve-operating arm, substantially as described.

9. The combination, with the compression-cylinders, the cut-off valves, and the governor mechanism of an air-compressing engine, of trip mechanism controlling said cut-off valves, a lever operatively connected with said trip mechanism and with the governor-rod, a chamber connected with the compression-cylinders and provided with a movable diaphragm, a plunger resting on said diaphragm, a weighted arm supported by said plunger, pipes leading from the steam-supply pipe and communicating with the spaces between the cut-off valves and the main distribution-valves of the engine, valves in said pipes, an arm for opening said valves, and a rod connected with said weighted arm and operatively connected with said pivoted lever, and an adjustable stop on said rod adapted for engagement with said valve-operating-arm, substantially as described.

10. The combination, with the compression-cylinders, the cut-off valves, and the governor mechanism of an air-compressing engine, of trip mechanism controlling said cut-off valves, a lever operatively connected with said trip mechanism and with the governor-rod, an adjustable screw-bolt passed through said lever and adapted to engage with a stop on the governor-standard to limit the movement of said lever, a chamber connected with the compression-cylinders and provided with a movable diaphragm, a plunger resting on said diaphragm, a weighted arm supported by said plunger, pipes leading from the steam-supply pipe and communicating with the spaces between the cut-off valves and the main distribution-valves of the engine, valves in said pipes, an arm for opening said valves, and a rod connected with said weighted arm and operatively connected with said pivoted lever and said valve-operating arm, substantially as described.

11. The combination, with the compression-cylinders, the cut-off valves, and the governor mechanism of an air-compressing engine, of a chamber connected with the compression-cylinders and provided with a movable diaphragm, a plunger resting on said diaphragm, an arm fulcrumed on the engine-frame and supported by said plunger, an adjustable weight on said arm, pipes leading from the main steam-supply pipe and communicating with the spaces between the cut-off valves and the main distribution-valves of the engine, valves in said pipes, a weight for normally closing said valves, a lever for opening said valves, trip mechanism governing the cut-off valves, a lever operatively connected with said trip mechanism and with the governor-rod and provided with an adjustable screw-bolt for limiting its movement, and a rod connected with the weighted arm and having a movable engagement with said lever, said rod being further provided with an adjustable collar adapted to engage with the free end of the said valve-operating rod, substantially as described.

In testimony that I claim the foregoing I have hereunto set my hand, at Milwaukee, in the county of Milwaukee and State of Wisconsin, in the presence of two witnesses.

BRUNO V. NORDBERG.

Witnesses:
S. S. STOUT,
H. G. UNDERWOOD.