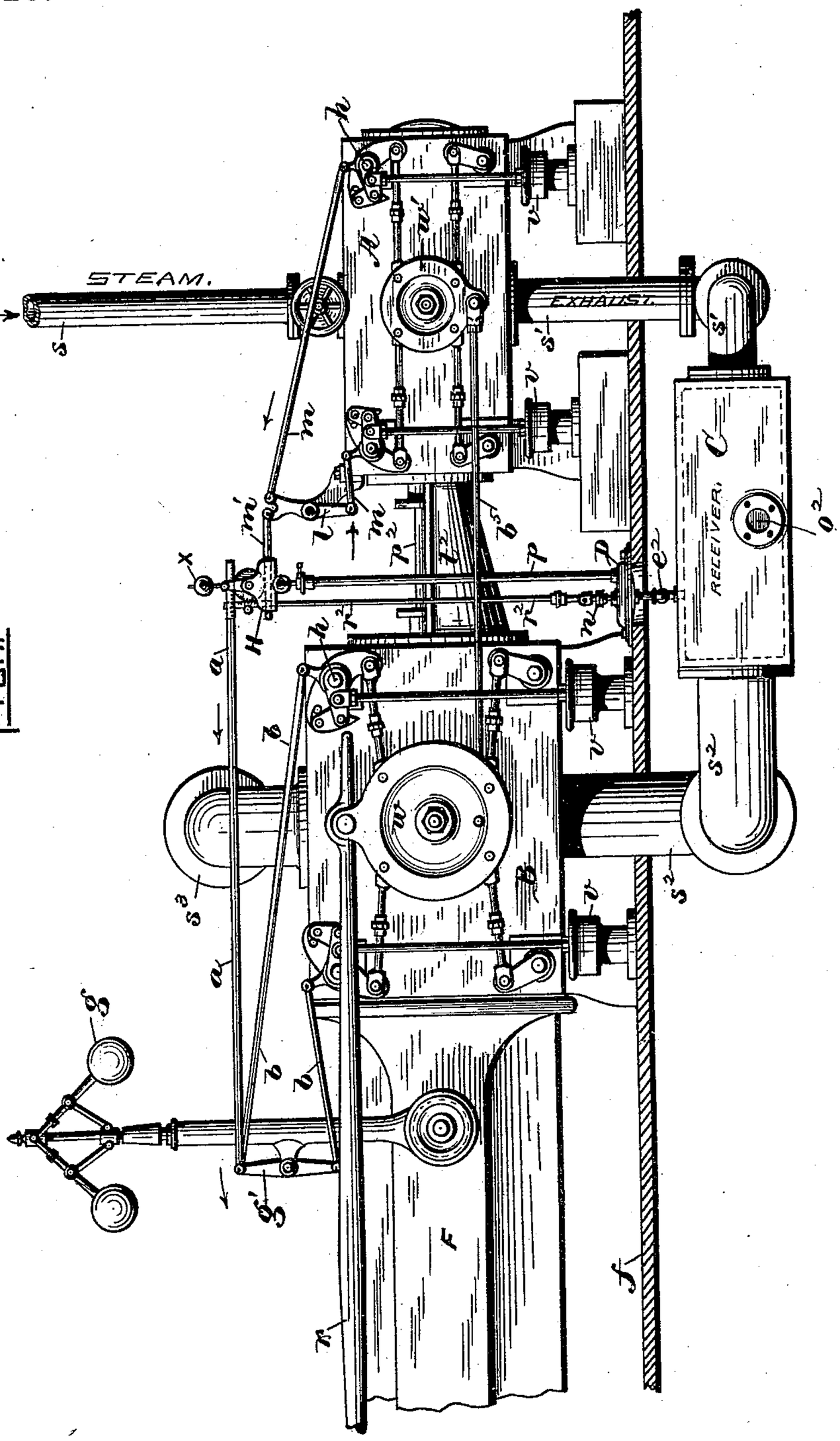
(No Model.) 2 Sheets—Sheet 1.

J. T. HENTHORN.

AUTOMATIC PRESSURE REGULATOR FOR THE RECEIVERS OF COMPOUND ENGINES.

No. 395,828. Patented Jan. 8, 1889.



WITNESSES.

Charles Hannigan.

Joseph A. C. Stanford.

INVENTOR.

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(No Model.) 2 Sheets—Sheet 2.

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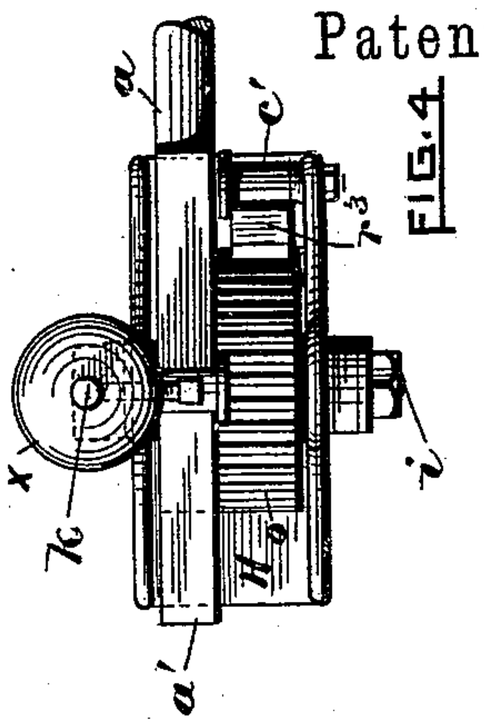

FIG. 4

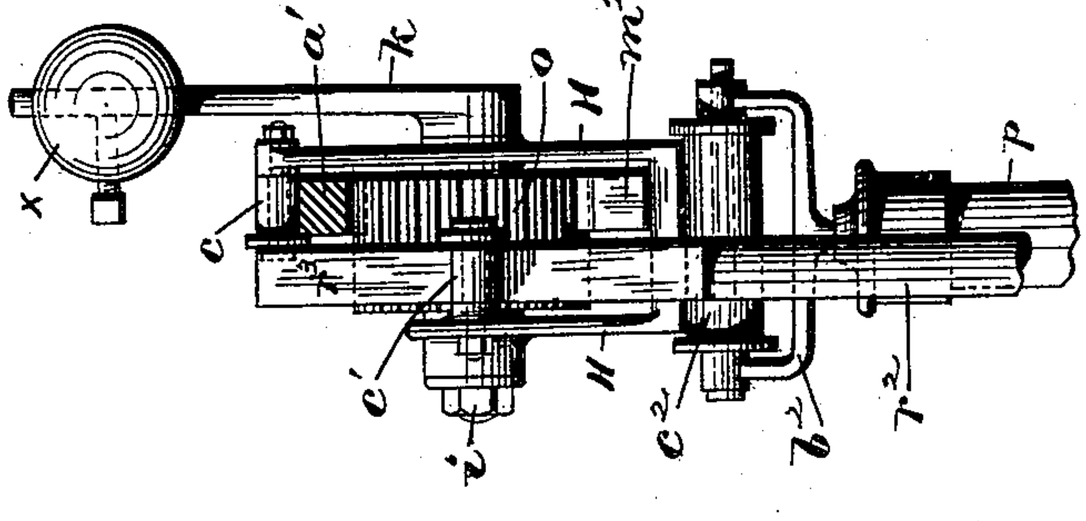

FIG. 3.

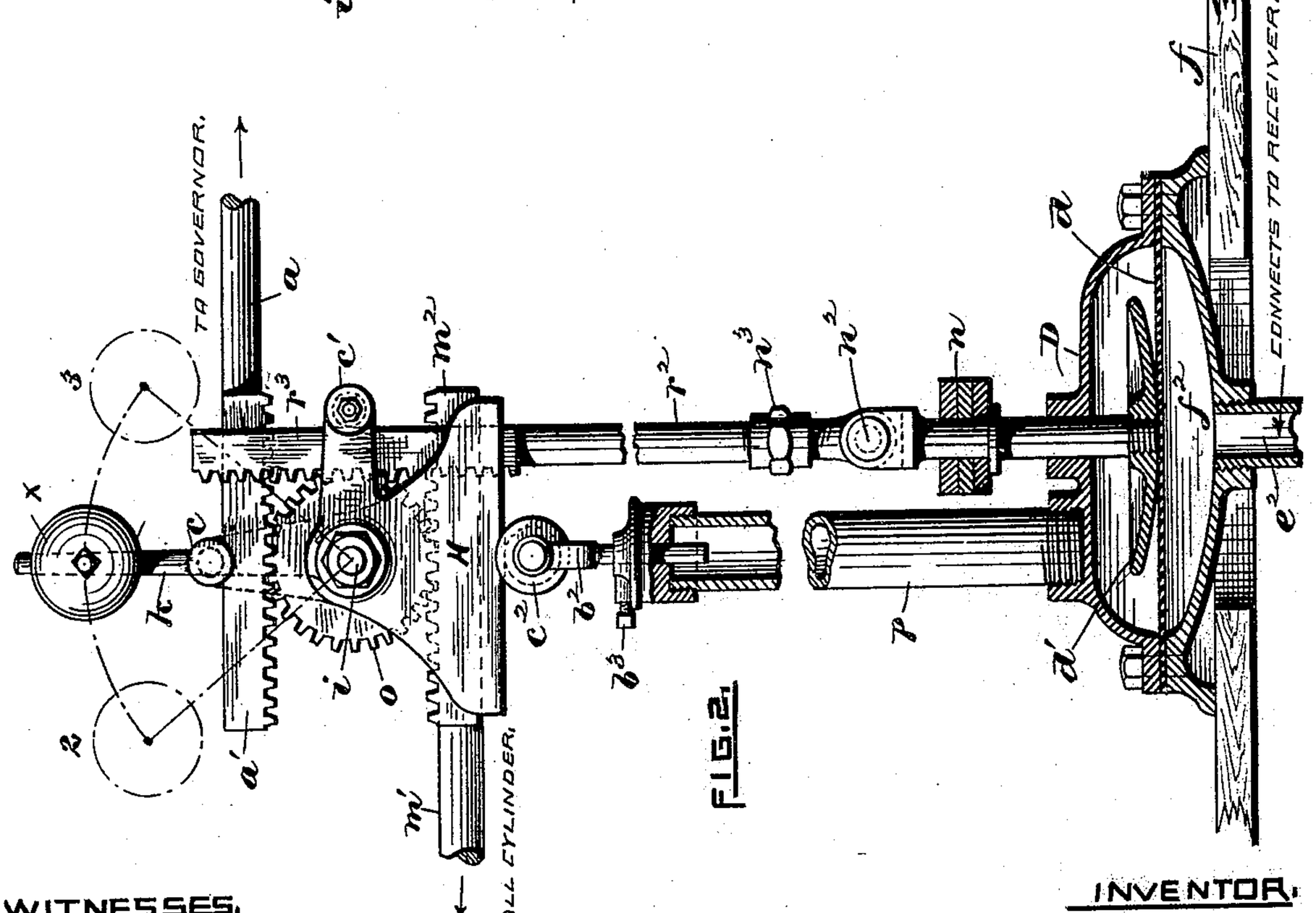

FIG. 2.

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JOHN T. HENTHORN, OF PROVIDENCE, RHODE ISLAND.

AUTOMATIC PRESSURE-REGULATOR FOR THE RECEIVERS OF COMPOUND ENGINES.

SPECIFICATION forming part of Letters Patent No. 395,828, dated January 8, 1889.

Application filed January 31, 1888. Serial No. 262,524. (No model.)

To all whom it may concern:

Be it known that I, JOHN T. HENTHORN, a citizen of the United States, residing at Providence, in the county of Providence and State of Rhode Island, have invented certain new and useful Improvements in Automatic Pressure-Regulators for the Receivers of Compound Engines; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to letters or figures of reference marked thereon, which form a part of this specification.

In the construction of compound engines, more especially stationary engines of the compound type, it is very desirable at times that a portion of the exhaust-steam from the small or high-pressure cylinder be employed for heating purposes, such exhaust-steam being directly taken from the connection or receiver uniting the high and low pressure cylinders. The quantity of steam thus taken for heating and drying purposes—as, for example, in print-works, paper-mills, &c.—varies greatly, not only during each day, but also is affected by atmospheric changes—as from the extremes of summer and winter.

In order to maintain even an approximately uniform steam-pressure within the receiver, it has been necessary, so far as I am aware, to meet the varying demands upon the receiver for such exhaust-steam for heating, &c., to adjust the point of cut off of the small steam-cylinder by hand. Such manner of adjustment necessarily requires the constant attendance and watchfulness of the engineer in charge. Sometimes in manufactories where a series of drying-cylinders are used they are successively stopped, thereby causing the receiver-pressure to increase rapidly. In such case the engineer cannot make the necessary counteracting adjustment of the cut-off with sufficient quickness to prevent the increased pressure from seriously affecting the efficiency of the engine, aside from the attending danger to it. On the other hand, the requirements of the connected heating system may call for an increased quantity of steam from the receiver, when at once a contrary result will be realized from that just described, thereby leaving an insufficient amount of steam of the required pressure for the engine to properly do the work demanded by the connected machinery until the receiver-pressure is again restored to its normal limit by a readjustment of the cut-off.

The object of my present invention is to overcome the disadvantages before referred to, and to provide an engine with an automatically-operating device which maintains a substantially-uniform pressure within the receiver irrespective of the demands upon the reservoir from a heating system connected therewith. To this end I employ a diaphragm mounted in a casing communicating with the receiver. To the diaphragm is connected a suitably-guided rod arranged to independently operate the cut-off rod or connection which unites the latter with the governor of the engine and the valve-releasing mechanism of the high-pressure cylinder, or, in other words, the device is adapted to automatically change the point of cut off of the high-pressure cylinder, whereby a uniform pressure is maintained in the receiver. As before intimated, the device in no wise prevents a full and free action of the governor upon the cut-off mechanism, as common in engines of this class.

My improvement immediately becomes automatically operative in the event of a portion of the steam being taken from the receiver and used independently of the large or low-pressure cylinder of the engine.

In the accompanying two sheets of drawings, Figure 1, Sheet 1, represents a front side view of the cylinders and valve-gear connections of a compound engine, the cylinders as drawn being of the "Corliss" type and arranged "tandem." Said figure also shows the receiver communicating with the two cylinders and my automatically-acting device connected with the receiver, and also connected at its upper end with the cut-off rod, the latter uniting the releasing mechanism of the high-pressure cylinder and governor. Fig. 2, Sheet 2, is an enlarged side elevation, in partial section, of my automatic pressure-controlling device viewed from the opposite side of the engine. Fig. 3 is a partial side view, and Fig. 4 is a plan view thereof.

The following is a more detailed description of my invention, including the manner of its general operation:

A in the drawings designates the smaller or high-pressure cylinder, and B the large or low-pressure cylinder, each being provided with valve-gear of the Corliss type, as before stated. The inlet or steam valves are mounted on stems *h*, which are actuated to produce a cut-off, as usual, vacuum-pots *r*, connected with the valve-arm, &c., serving to close the valves after being tripped by the governor.

w' indicates the "wrist-plate" of the small cylinder, the same being mounted to vibrate on a central stud and having four links or connections, which are jointed to the four valve-arms. A vibratory motion is imparted to the wrist-plate through the medium of a connection, b^5, jointed thereto and to a similar wrist-plate, *w*, of the large cylinder, this last-named wrist-plate in turn being vibrated by a rod, *r*, which is reciprocated by an eccentric or other suitable mechanism operated by the main shaft, as commonly practiced. The rear or small cylinder is firmly tied to the front cylinder by a connection, t^2, the piston-rod p^2 passing from one cylinder to the other. The bed or frame F is secured to the front end of the large cylinder, also as common. Intermediate of and beneath the two cylinders is located the closed receiver C, into which the exhaust-steam from the high-pressure cylinder is conducted by a pipe, *s'*. A pipe, s^2, conducts the steam from the receiver to the large cylinder B, where it is employed in useful work, and is finally exhausted therefrom into a pipe, s^3, connected with a suitable condensing apparatus, also as usual.

o^2 indicates an outlet formed in the receiver's shell for the purpose of taking out steam to be used for heating and drying, as may be desired.

g designates a fly-ball governor mounted and adapted to operate as usual in mechanism of its class. A lever, *g'*, of the governor is made to vibrate in unison with the fluctuations of the governor-balls. Links or cut-off connections *b b* are jointed to said lever and to the respective "knock-off" levers or cams of the steam-valves of the low-pressure cylinder. A connection, *a*, is also jointed to the lever *g'*, and in conjunction with my device, about to be described, together with a pivoted two-arm lever, *l*, and connected links *m m*, performs a like office to the steam-valves of the high-pressure cylinder.

My automatically-operating mechanism, which fluctuates in its action relatively to the receiver-pressure, is connected directly with the said rod *a*, and is supported by a stationary standard, *p*, the same carrying at its upper end a flanged truck-roll, c^2, mounted in a yoke, b^2, adjustably secured in position by a set-screw, b^3.

H indicates a combined rod and gear carrying frame resting upon the truck-roll c^2. A wide-faced pinion, *o*, is secured to a shaft, *i*, which is mounted to turn freely in bearings formed in the frame H. The end of the rod *a* is made rectangular in section, and is practically a narrow rack, *a'*, resting upon and meshing into the gear wheel or pinion *o*. A shorter rod, *m'*, having a rack portion, m^2, is reversely arranged at the under side of the pinion and rests upon the frame H, and is jointed to the upper arm of the lever *l*, carried by the small cylinder, (see Fig. 1,) the two racks being in the same vertical plane. A jointed diaphragm-rod, r^2, provided with a rack portion, r^3, also engaging said pinion, is vertically arranged to travel up and down in front of the two racks first named, a guide-roll, *c'*, mounted in the frame H, serving to maintain the rack portion of the rod in contact with the pinion, a similar roll, *c*, at the top of said frame acting in a like manner for the rack *a'*. An arm, *k*, is secured to the pinion-shaft *i* exterior of the frame. Said arm, which is vertical in its normal position, is provided with an adjustably-secured counter-weight, *x*, at its upper end, as clearly shown.

D designates a hollow casing, in which is mounted and secured a spring-diaphragm, *d*, and forming an enlarged chamber, f^2, immediately beneath the diaphragm. A pipe, e^2, leads from the receiver C and communicates with said chamber, the pressure in the diaphragm-chamber and receiver obviously being the same. The lower portion of the rod r^2, before referred to, passes through and is guided by the top of the hollow casing, and is provided with an enlarged disk-shaped slightly-spherical head, against which the diaphragm is always in contact. The diaphragm-rod is made, preferably, in two or three sections, the same being connected by an adjusting device, as n^3, and further provided with a joint, as n^2. By means of this construction it is apparent that the pinion-carrying frame H and its attached parts may move horizontally in unison with the governor, the weight being borne by the lower guide-roll, c^2, the vertical rod r^2 at the same time vibrating from the point n^2. The diaphragm-rod is further adapted to carry a series of removable weights, *n*, the same being mounted thereon below said joint.

In the arrangement of the diaphragm-case, &c., I prefer to locate it so that the toothed rod *a* will lead fair to the governor, as usual. I then secure the casing to the floor *f*, and finally connect the chamber f^2 and receiver together by a steam-pipe, e^2.

The general operation of my device, when connected with the governor and receiver of a compound engine, is as follows: We will first assume, however, that the diaphragm-rod is weighted and otherwise adjusted so as to maintain the weighted arm *k* in a substantially vertical position, of course taking into account the area of the diaphragm and the amount of the receiver-pressure when the engine is doing its regular work under ordinary conditions—that is to say, prac-

tically, when all the steam exhausted from the high-pressure cylinder is used in the low-pressure cylinder. While the engine is thus doing its regular work, should the load vary from its normal amount, the action of the governor will instantly produce a corresponding change in the point of cut off for both cylinders, substantially as usual in any first-class automatic engine, my improvement thus far not being brought into action; neither does it prevent a free action of the governor. Now we will assume, further, that a quantity of steam of a comparatively low pressure is required for heating or drying purposes. Instead of taking this amount of steam from the main supply by "throttling" or "wire-drawing" it down, I first connect a pipe with the receiver—say at o^2—and lead it to the place where the steam is to be used for said heating or drying purposes. By so doing I get the benefit of the expansion in the small cylinder of the steam thus used. Obviously, a later cut off will be necessitated by admitting this additional amount of steam into the small cylinder. Therefore this increased terminal pressure calls for an unequal division of the work done in the two cylinders to the extent of that due to the utilization of the expansive force of the steam diverted for heating purposes, and following which, for a uniform load upon the engine, is a corresponding change in the point of cut off in the large cylinder to thus neutralize this excess of power developed in the small cylinder. As the demand for steam required for heating is variable during different portions of the day, it therefore follows as these changes occur that a corresponding change in the cut off of the small cylinder becomes necessary, even though the engine may be developing a uniform load to supply an adequate amount of steam necessary for heating in addition to that required to overcome the load upon the engine. The effect of a temporary discontinuance in the use of a portion of the steam for heating taken from the receiver is to momentarily increase the pressure in the receiver, which, acting upon the diaphragm d of my improved regulating device, elevates the rod r^2, and, by means of the rack r^3 at its upper end, imparts an angular motion to the pinion o. As the pinion is also in engagement with the racks a' m^2 of the cut-off rods a and m', leading, respectively, to the governor of the engine and the small cylinder, movement is thereby imparted to the rod m', leading to the small cylinder, and thus the point of cut off is shortened by the teeth of the pinion reacting upon the normally-stationary rod a, leading to the governor, which is thus held stationary by the centrifugal force of the governor-balls.

The action of these several parts more in detail is as follows: The upward movement of the vertical rod r^2, by means of the toothed connection, rotates the pinion o, and, as the rod a is, as before stated, normally stationary by its being under the influence of the centrifugal force of the governor-balls, it follows that the axis of the pinion, together with the frame II, which is supported by the guide-roll c^2, will travel in a direction parallel with that rod and carry with it, through the medium of the rack m^2, the rod m', and thus change the point of cut off of the small cylinder independently of that of the large cylinder. The lateral motion of the jointed portion of the rod r^2, resulting from changes in the receiver-pressure, is twice that of the movement of the axis of the pinion and its frame.

To the pinion-shaft i is secured the weighted arm k. Now, as the pinion is rotated by changes in the receiver-pressure, the arm and its weight x are deflected from the vertical or normal position, thus materially assisting to produce a much more rapid change in the relative position of the parts and consequent effect upon the cut off of the small cylinder.

It is obvious that the more extreme the variations are in the receiver-pressure, due to sudden and extreme demands for steam for heating, the greater the angle the weighted arm k will assume, and consequently the latter will exert a greater influence upon the mechanism to automatically produce the proper adjustment of the receiver-pressure.

By means of removable weights n, mounted upon the vertical rod r^2, the apparatus may be adjusted to any pressure desired necessary to be carried in the receiver and the heating system. If we now assume for a moment that the pressure in the receiver is uniform, the rod r^2 will therefore be vertically stationary. Consequently any variations in the resistance of the engine will induce the governor-balls to assume a different elevation, and thus shorten or lengthen the point of cut off, as the case may be, in the large and small cylinders. This change in the elevation of the governor will therefore produce a corresponding endwise movement of the cut-off rods, and, as the pinion o is prevented from rotating by its connection to the rack of the now stationary vertical rod r^2, the pinion and its connected frame H and connections a and m' will therefore move horizontally back and forth upon the guide-spool c^2, which latter serves also to sustain the weight of the whole, the rod r^2 meanwhile vibrating in unison from its joint n^2.

The shortening of the point of cut off in the small cylinder by the excess of the receiver steam-pressure, which elevates the diaphragm d, produces the effect of allowing the receiver-pressure to again assume its normal condition at which it may be set, while at the same time it has the effect of slightly changing the relative proportion of the power which each cylinder may be developing. This change is instantly felt by the governor and results in the governor-balls assuming a slightly lower elevation, and thus lengthening the cut-off of the large and small cylinders sufficiently to overcome the resistance

of the engine. This lengthening of the cut-off in the small as well as the large cylinder of course disturbs the pressure in the receiver and again brings my regulating device into action, thereby shortening the cut-off of the small cylinder, and thus, by the combined movements of the engine-governor and said device, the speed of the engine and the pressure within the receiver are uniformly maintained.

I claim as my invention—

1. In an engine of the class specified, the combination, with steam-cylinders provided with cut-off-valve gear, a receiver connecting the cylinders, and an auxiliary cut-off-controlling mechanism, substantially as hereinbefore described, actuated by the receiver-pressure, of a speed-controlling governor connected with said auxiliary cut-off-controlling mechanism and the said cut-off-valve gear, substantially as described, and for the purpose specified.

2. In a compound engine, the combination, with the steam-cylinders, a receiver uniting the cylinders, a speed-controlling governor, and cut-off-valve gear, substantially as described, of an automatically-operating pressure-controlling apparatus, substantially as described, communicating with the receiver and connected with the said governor and cut-off-valve gear by means of suitably mounted and supported toothed rods intergearing with a loosely-mounted gear-wheel, all combined, arranged, and operating, whereby any variation in the receiver-pressure from its normal pressure automatically produces a change in the point of cut off of said high-pressure cylinder independently of the governor's action, substantially as hereinbefore described and set forth.

3. In a compound engine, the high and low pressure cylinders provided with suitable valve-gear and mechanism for operating the same, a governor and cut-off rods leading therefrom and connecting with the releasing mechanism of the steam-valves, and an exhaust-receiver, as C, the combination therewith of a mounted diaphragm communicating directly with and adapted to be automatically actuated by the receiver-pressure, a vertically-mounted jointed rod having said diaphragm secured thereto, a frame mounted to travel back and forth, a pinion mounted therein having the upper portion of the diaphragm-carrying rod meshing into the pinion, oppositely-mounted and reversely-arranged toothed rods $a m'$, intergearing with the pinion and adapted to be reciprocated by said governor, and a weighted arm, as k, mounted to vibrate by the action of the pinion, substantially as shown and hereinbefore described, and for the purpose specified.

4. In a compound engine, the combination, with a diaphragm mounted in a chamber communicating with the receiver and a jointed and counterweighted vertically-mounted rod having a toothed upper portion, of two reversely-arranged toothed rods adapted to be reciprocated in unison by the governor, an adjustably mounted and guided frame in which the said three toothed rods are mounted, a pinion mounted in the frame and having the rods intergearing therewith, and a counterweighted arm secured to the pinion-shaft, the whole arranged and operating substantially as shown and hereinbefore described, and for the purpose specified.

In testimony whereof I have affixed my signature in presence of two witnesses.

JOHN T. HENTHORN.

Witnesses:
CHARLES HANNIGAN,
GEO. H. REMINGTON.