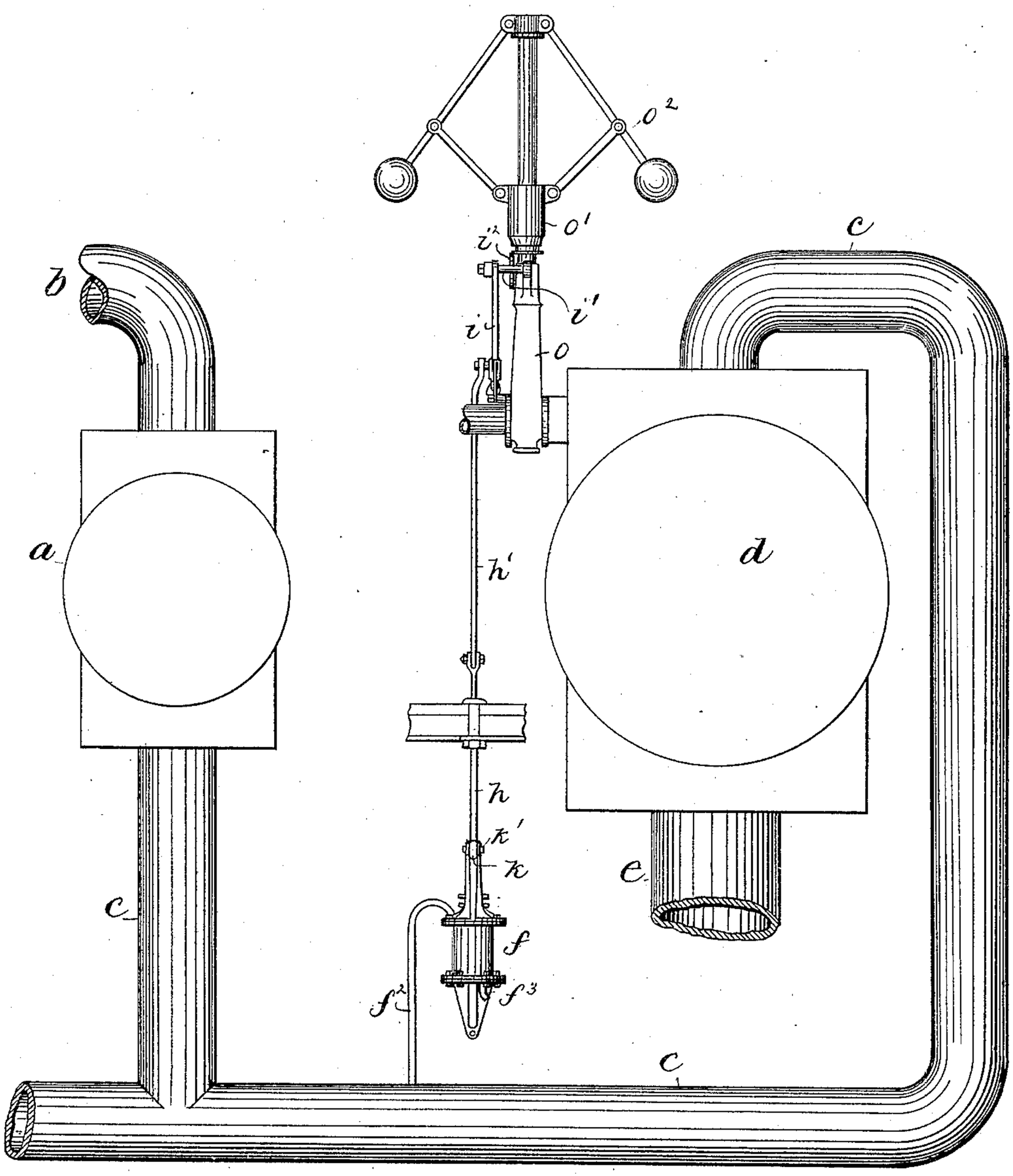
(No Model.) 2 Sheets—Sheet 1.

C. T. MAIN.

REGULATOR FOR COMPOUND ENGINES.

No. 397,507. Patented Feb. 12, 1889.

Fig. 1.



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(No Model.) 2 Sheets—Sheet 2.

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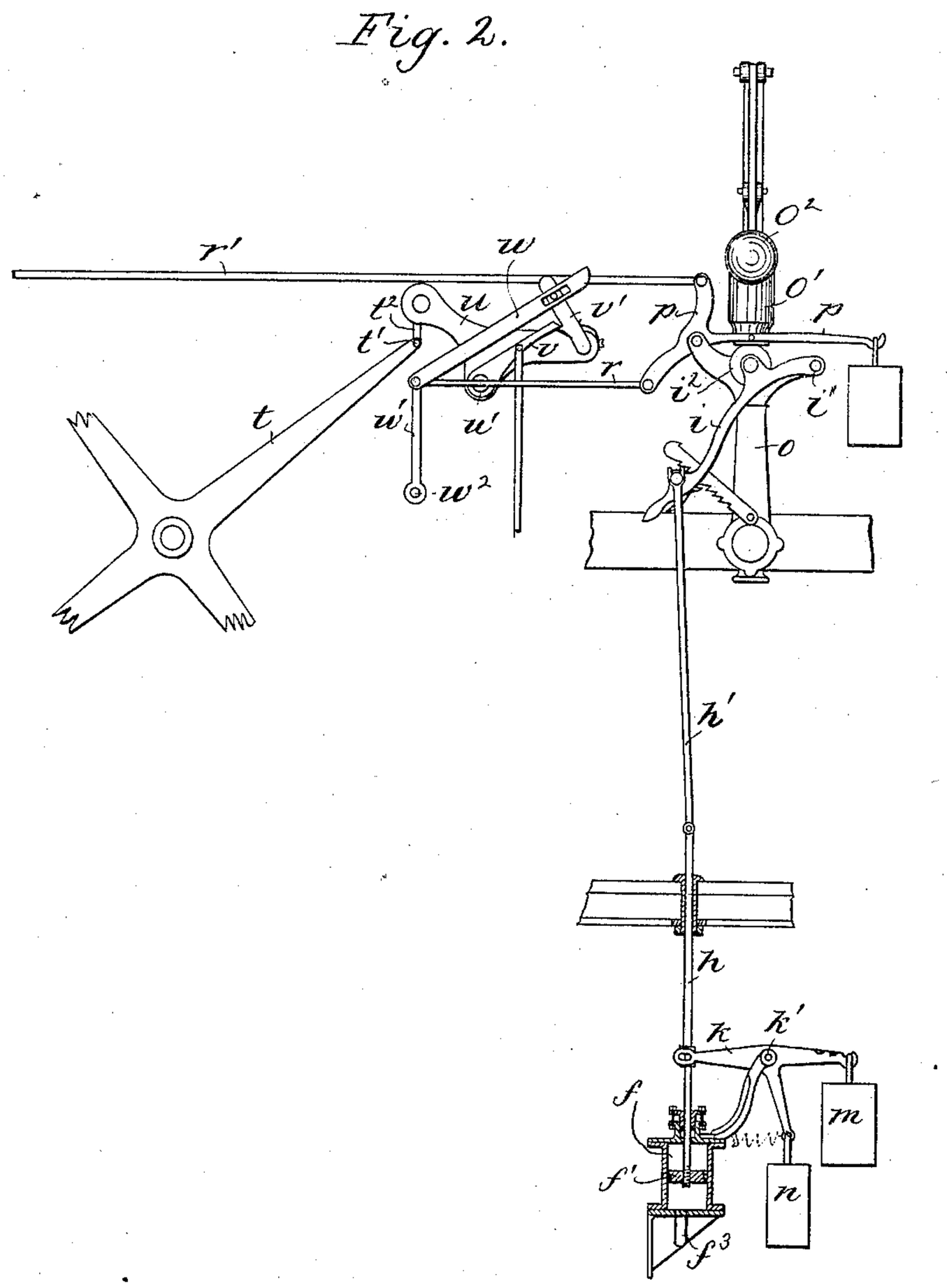
Fig. 2.



Witnesses,
Jas. J. Maloney.
R. E. Hill.

Inventor.
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UNITED STATES PATENT OFFICE.

CHARLES T. MAIN, OF LAWRENCE, MASSACHUSETTS.

REGULATOR FOR COMPOUND ENGINES.

SPECIFICATION forming part of Letters Patent No. 397,507, dated February 12, 1889.

Application filed July 5, 1888. Serial No. 279,056. (No model.)

To all whom it may concern:

Be it known that I, CHARLES T. MAIN, of Lawrence, county of Essex, and State of Massachusetts, have invented an Improvement in Regulators for Receiver-Pressure of Compound Engines, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

In many manufacturing establishments employing a compound engine for actuating machinery steam is taken from the receiver that conveys the exhaust from the high-pressure engine to the low-pressure engine for various purposes requiring steam at a comparatively low pressure, and the amount of steam thus drawn from the receiver at different times is variable, and thus gives rise to variations in pressure in the receiver, and consequently in the low-pressure engine when the latter runs with constant cut-off. For this reason it is customary in establishments where steam is taken from the receiver of a compound engine for other purposes than for actuating the low-pressure engine to change the cut-off of the low-pressure engine from time to time by hand, so as to keep the pressure in the receiver as nearly constant as possible; but this method of operation is not satisfactory, as it requires constant watchfulness on the part of the attendant to observe the variations in the receiver-pressure, and the proper changes in the cut-off of the low-pressure engine are not always made promptly.

The object of the present invention is to provide means for automatically varying the cut-off in the low-pressure engine as the pressure in the receiver varies owing to variations in the consumption of steam from the receiver, for other purposes than driving the engine, said regulator shortening the cut-off when the pressure falls, owing to a large external consumption, and lengthening the cut-off when the pressure rises, owing to a comparatively small external consumption, and thus tending to keep the pressure nearly uniform in the receiver, and, in fact, preventing it from varying in either direction beyond certain narrow predetermined limits.

Figure 1 is an elevation of a regulator for the receiver-pressure of a compound engine embodying this invention, showing also a sufficient portion of the engine to illustrate the relation of the regulator thereto; and Fig. 2 is a side elevation on a plane at right angles to that of Fig. 1, of the regulator, showing also a sufficient portion of the valve-gear of the low-pressure engine to illustrate the mode of operation of said regulator.

The invention is applicable to any usual type of compound engine comprising a high-pressure engine, the cylinder of which is shown at *a*, Fig. 1, and receives the steam from the steam-generator through the pipe *b*, and exhausts the steam into the pipe *c*, which conveys a greater or less portion of the steam thus exhausted from the high-pressure engine to the cylinder *d* of the low-pressure engine, from which the steam is exhausted by a pipe, *e*, into a condenser, which is not shown, as it forms no part of this invention.

The pipe *c* constitutes the receiver of the compound engine and may be extended to various points in the mill or manufactory, so as to supply the steam required for various purposes, for which steam at a comparatively low pressure can be economically used, it being understood that the amount of steam delivered into the receiver from the high-pressure engine is always somewhat in excess of the amount required for consumption outside of the engine. As the amounts drawn for such outside consumption vary widely at different times in the running of the mill, there would be corresponding variations in the pressure in the receiver if the amount taken by the low-pressure engine remained substantially constant, and such variations would be only partially compensated for, if at all, by the usual speed-regulator of the engine.

It is desirable to maintain the pressure in the receiver as nearly constant as possible, and this is effected automatically, in accordance with this invention, by means of a regulating device that varies the cut-off in the low-pressure engine in accordance with changes in pressure in the receiver, lengthening the cut-off as the pressure tends to rise, and thus consuming a larger portion of steam from the receiver in the low-pressure engine, and shortening the cut-off as the pressure falls, and thus using a smaller amount of steam in the

low-pressure engine when a large amount is withdrawn for external purposes.

This regulator, as shown in this instance, consists of a cylinder, *f*, containing a piston, *f'*, and communicating above the said piston with the receiver *e*, as by the pipe f^2, so that the upper side of the piston is exposed to the pressure in the receiver while the under side is exposed only to an atmospheric pressure, the lower part of the cylinder being open to the atmosphere through the pipe or outlet f^3. The piston *f'* is connected by a rod, *h*, and pitman *h'* with a cut-off-controlling lever, *i*, (best shown in Fig. 2,) that controls the cut-off valves of the low-pressure engine, which valves may be of any usual kind, being shown in this instance as of the well-known Corliss type, which will be briefly described hereinafter, it being sufficient for the present to understand that raising the rod *h* and lever *i* shortens the cut-off of the low-pressure engine. The rod *h* is connected at h^2 with one arm of a three-armed lever, *k*, pivoted at *k'* on a suitable bracket or support, two arms of which lever in the operation of the lever rise and fall a short distance above and below the horizontal position, while the third inclines more or less from the vertical position. The horizontal arm of the lever *k* is provided with a weight, *m*, and the vertical arm with a weight, *n*, which operates as follows: When the pressure is at the lowest admissible point in the receiver, the cut-off in the low-pressure cylinder must be the shortest, and the piston *f'* is at its highest position. The weight *n* is then vertically below the point *k'* of the lever *k*, and has no leverage and consequently no effect on the piston, and the weight *m*, which is then slightly below the horizontal position, is adjusted to just balance the minimum pressure on the piston and other parts connected therewith and the frictional resistance to their movement. The said cylinder *f* constitutes a pressure-chamber, and the piston is a part moved by variations in the pressure in said chamber, being arranged to respond to slight changes in said pressure, and constituting, as it were, a pressure-gage that responds to variations in pressure in the engine-receiver, and it is obvious that any of the well-known pressure gages or contrivances having a part corresponding to the piston *f'* that moves in one or the other direction, according as the pressure rises or falls, might be substituted as a mechanical equivalent for the piston and cylinder, which latter constitute, however, a very efficient and convenient gage for the regulator forming the subject of this invention. Then as the pressure in the receiver increases it tends to force the piston *f'* downward and to move the weight *n* from the position vertically below the point *k'*, so that the said weight acts with gradually-increasing leverage until, when the piston *f'* arrives at the lowest point, the said weight *n* exerts sufficient force to balance the increase in pressure in the receiver, which is then at the highest point allowable, the amount of variation between the maximum and minimum pressure of the steam in the receiver being determined by the amount of the weight *n*, which can be chosen to keep the variation within any required limits.

It is obvious that a spring might be employed instead of the weight *n*—as indicated, for example, in dotted lines at *n'*—in order to produce a variable resistance to the movement of the piston *f'*.

When used in connection with the Corliss cut-off, as shown in this instance, the lever *i* is pivoted at *i'* upon an arm of the governor-pedestal *o*, and is provided with a roller, i^2, that bears against the lower edge of the governor-sleeve *o'*, which is provided with a groove engaging a projection or roller on one arm of a three-armed lever, *p*, the other two arms of which are connected by links *r* and *r'* with the tripping device for the valves at each end of the cylinder, one only of said valves being shown, as it is substantially the same in construction as the other.

The valves are actuated by the usual wrist-plate or rocker, *t*, which is oscillated at each revolution of the engine and is provided with wrist-pins *t'*, connected by links t^2 with rocking levers *u*, pivoted at *u'* concentrically with the spindle of the valve that admits steam to the engine. The said valve-spindle has connected with it an arm, *v*, which is engaged by a catch, *v'*, pivoted on the rocking lever *u*, which causes the arm *v* and valve to accompany the said rocking lever *u* in a greater or less portion of its movement, as determined by the tripping device *w*, which co-operates with a projection on the catch *v'*, and is connected at one end with the link *r*, and also with a radius-bar, *w'*, pivoted at w^2 upon the frame-work. When the lever *i* is raised, the tripping device disengages the catch from the lever-arm *v* earlier in the movement of the rocking-lever *u*, and thus cuts off the admission of steam to the cylinder earlier than when the said lever *i* is in the lower position.

The governor o^2 of the low-pressure cylinder should be set to have no effect upon the cut-off, due to slight changes in speed from the normal speed of the engine, although it will act after a slight percentage of increase in speed to diminish the cut-off, and thus prevent great acceleration of the engine in case its load should be suddenly reduced.

The governor on the high-pressure engine operates with variations in speed and thus regulates the engine in the usual manner.

The operation of the entire apparatus is substantially as follows: When a very large amount of steam is used from the receiver for external purposes, the piston *f'* rises and shortens the cut-off of the low-pressure engine, so that the latter takes but comparatively little steam from the receiver, and the pressure therein is not diminished below the predetermined minimum amount. The low-pressure engine then does a smaller portion

of the work, and if the speed of the engine tends to fall off in consequence the regulator of the high-pressure engine will admit more steam thereto, thus tending to exhaust more steam into the receiver and prevent the pressure from falling below such predetermined minimum limit. If, on the other hand, the amount of steam consumed for external purposes is diminished, the pressure in the receiver rises and forces down the piston *f* and lengthens the cut-off of the low-pressure engine, so that a larger amount of steam is used from the receiver for power, and if the greater power developed by the low-pressure engine tends to increase the speed the regulator of the high-pressure engine will diminish the amount of steam supplied thereto, and consequently the engine will be kept running with nearly uniform pressure in the receiver, thus giving practically uniform pressure of the steam admitted to the low-pressure engine and insuring uniformity of back-pressure in the high-pressure cylinder—conditions which are most favorable for the economical working of the engine. There is no waste of steam from the receiver through a relief or safety valve, as is the case when the low-pressure engine runs with constant cut-off, when it may happen that a considerable diminution in the quantity of steam drawn from the receiver for external uses increases the pressure in the receiver, for while such increase in pressure might tend to make the low-pressure engine do more work, the increase in back-pressure would make the high-pressure engine do less work, so that the speed of the engine might not increase, and consequently the amount of steam admitted to the high-pressure engine would not be diminished by the speed-governor, and consequently the receiver has to be provided with an escape-valve to prevent overpressure if the attendant should fail to change the cut-off of the low-pressure engine.

With engines as commonly used, when a large amount of steam is taken at times from the receiver, it is a common practice to introduce steam into the receiver directly from the boiler through a pressure-reducing valve, in order to provide sufficient steam for properly operating the low-pressure cylinder and for external purposes when the exhaust for the high-pressure engine is not sufficient.

The herein-described regulating device prevents the operation of said valve until the cut-off in the low-pressure cylinder reaches the shortest admissible point and the cut-off of the high-pressure cylinder reaches its maximum length, owing to the diminution in work done by the low-pressure engine, so that the largest possible amount of steam passes through the high-pressure cylinder and performs its work therein; and no steam is allowed to pass through the reducing-valve and expand without doing work until the draft of steam for external purposes is greater than the engine can possibly supply.

I claim—

1. A regulator for compound engines, comprising a pressure-gage or pressure-chamber connected with the receiver and having a part movable by changes in the pressure in said receiver, the said moving part of the pressure-gage being connected with the cut-off controller for the valves of the low-pressure engine, and by its movement changing the cut-off for said valves, as set forth, whereby the quantity of steam admitted to the low-pressure engine from the receiver is increased as the pressure in the receiver rises and is diminished as the pressure in the receiver falls, substantially as and for the purpose described.

2. A regulator for compound engines, comprising a cylinder and piston therein, said cylinder communicating with the receiver of the engine, and said piston being connected with the cut-off controller of the low-pressure engine combined with a weighted lever connected with said piston, having one weighted arm which moves a short distance above and below the horizontal position, and a second weighted arm that moves toward and from the vertical position in the stroke of said piston, substantially as and for the purpose described.

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

CHAS. T. MAIN.

Witnesses:
FRANZ H. SCHWARZ,
W. W. LATHROP.