3 Sheets—Sheet 1.

A. J. VANDEGRIFT.

VALVE-GEAR FOR STEAM-ENGINES.

No. 195,466. Patented Sept. 25, 1877.

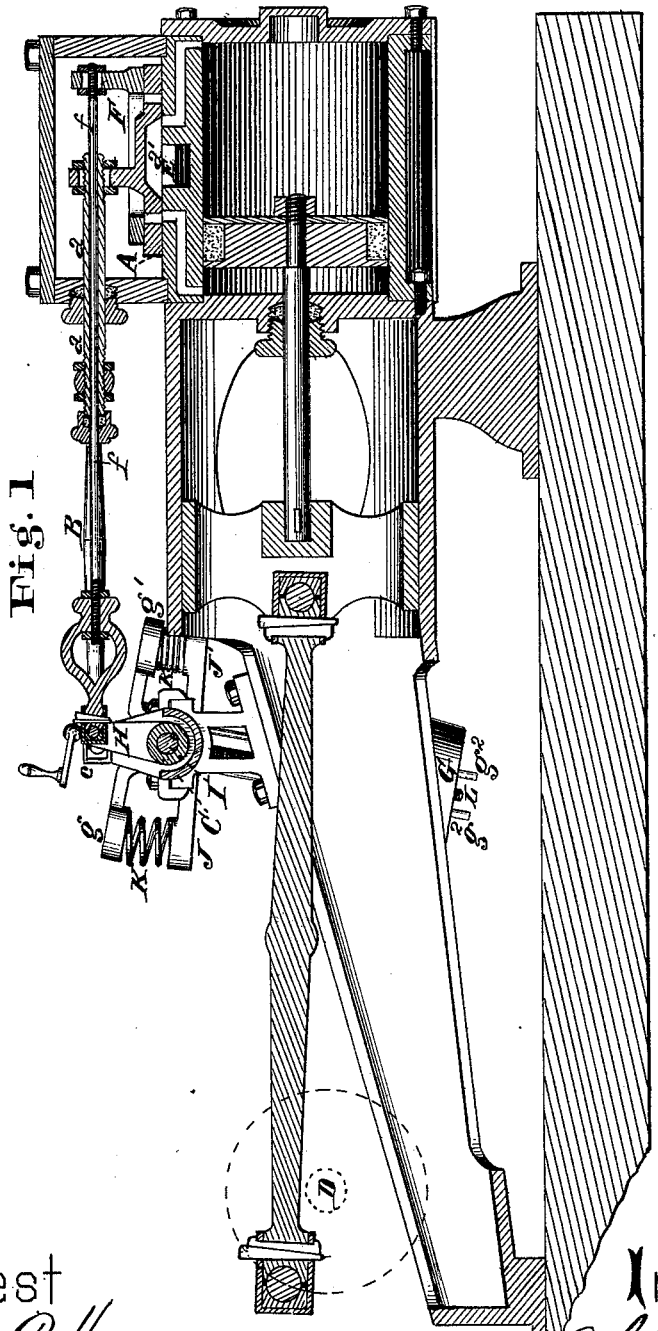

Fig. 1

Attest

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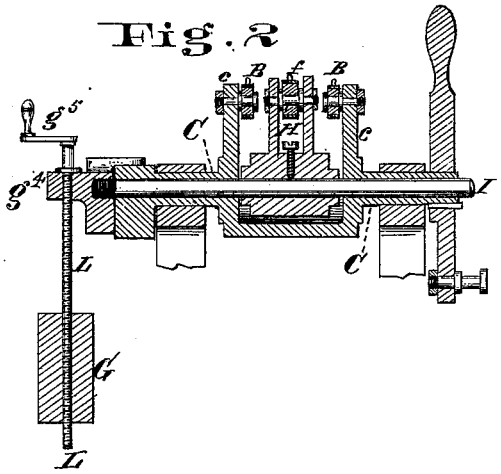
Fig. 2



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A. J. VANDEGRIFT.

VALVE-GEAR FOR STEAM-ENGINES.

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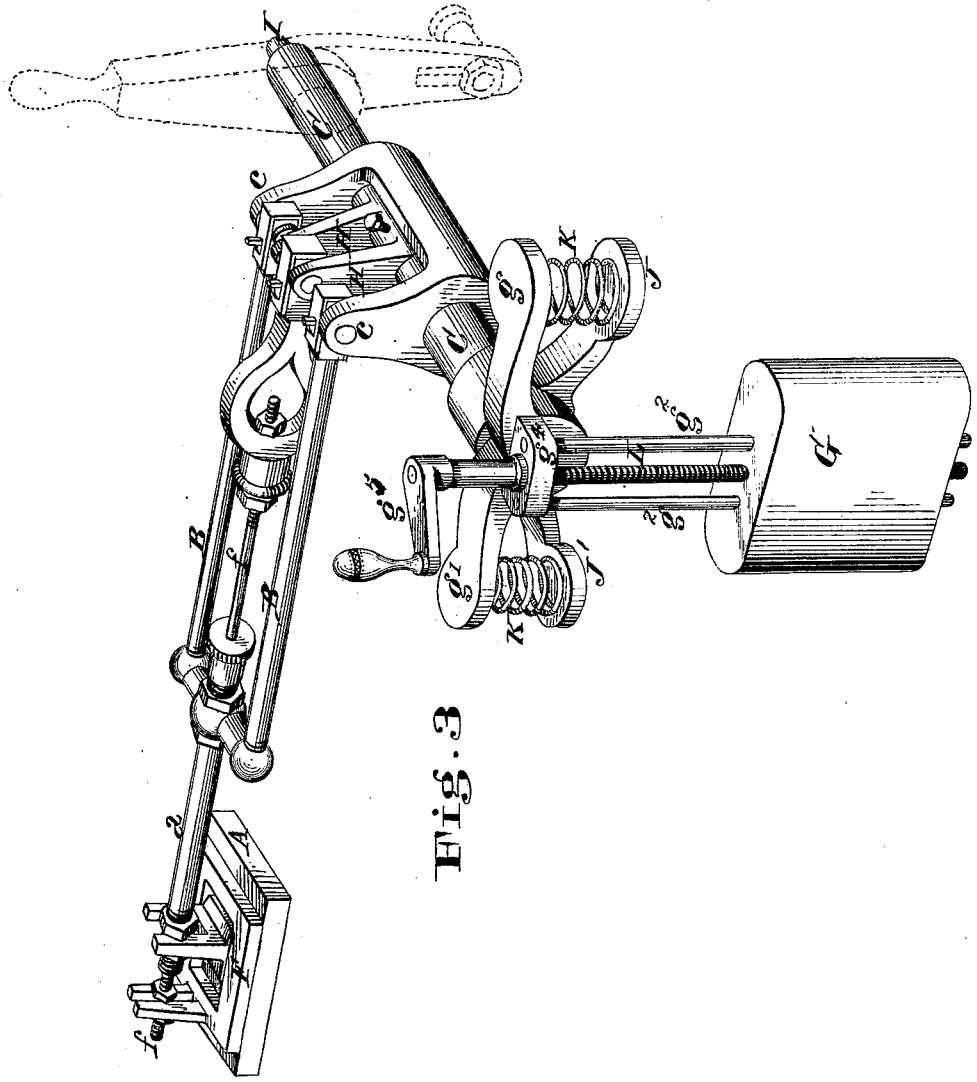

Fig. 3

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Inventon

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UNITED STATES PATENT OFFICE.

ANDREW J. VANDEGRIFT, OF COVINGTON, KENTUCKY.

IMPROVEMENT IN VALVE-GEAR FOR STEAM-ENGINES.

Specification forming part of Letters Patent No. **195,466**, dated September 25, 1877; application filed June 8, 1876.

To all whom it may concern:

Be it known that I, ANDREW J. VANDEGRIFT, of Covington, Kenton county, State of Kentucky, have invented a certain new and useful Improvement in Cut-off Gear for Steam-Engines, of which the following is a specification:

My invention relates to that class of engines known as cut-off engines, in which the steam is admitted to the cylinder at the boiler-pressure during only a part of the stroke, the object being to utilize the expansive force of the steam after being so cut off during the remainder of the stroke.

My invention further relates to devices arranged to work automatically, so that the steam shall be cut off at variable points in the stroke, in such a manner that by said automatic action the speed of the engine under varying loads shall be regulated in the most perfect manner, the time of the continuance of the steam-supply being accurately adequate to the performance of the duty at a specific speed, thus obtaining uniform speed and saving of fuel by the use of the steam expansively; and my invention consists of the combination of main valve or valves and cut-off valve or valves, the first being connected directly in the ordinary way to the eccentric of the engine, and the cut-off operated by the same or separate connection from the engine-shaft, through the medium of an oscillating weight or pendulum, which, by reason of a flexible connection, operates so far independently of its driving force as to move in accordance with its own natural laws, and thus govern the movements of the cut-off valve or valves in such a way as to control the speed of the engine by the regulation of the duration of the reception or supply of steam, without increase or diminution of the initial pressure. By my invention, therefore, an oscillating weight or pendulum is used, so arranged and attached to the cut-off valve or valves, and through an elastic or yielding intermediate attachment with the positive moving parts of the engine that, notwithstanding the weight or pendulum receives its impulse from the positive moving parts of the engine, it is nevertheless, by reason of its yielding or elastic connection with the same, in a great measure independent in its motion, as before stated, and as by natural laws it inclines to make its vibrations uniformly in a given time, and by its connection imparts its own motion to the cut-off valve.

It will be understood that as the engine runs faster or slower than the natural motion of the pendulum, the relative position of the two valves (that is, the main valve and the cut-off valve) is changed each vibration in proportion to the difference existing between the two motions, the main valve moving in unison with the engine, by its positive attachment thereto, while the cut-off valve, being attached to the flexibly-connected pendulum, is under the influence of conflicting governing forces, acting to close the steam-ports whenever the speed of the engine is in excess of the speed of the pendulum, and retain them open for an increased length of time, when the speed of the engine falls below the natural speed of the pendulum, so that the speed of the engine is accurately governed thereby, the steam in the cylinder being used expansively after having been cut off.

My invention further consists in the provision for a change at will in the working-speed of the engine by the adjustment of length of the pendulum or equivalent adjustment of the tension of its springs, and also of devices by which this speed may be changed while the engine is in motion.

In the accompanying drawings, Figure 1 is a vertical section of a steam-engine embodying my improvement. Fig. 2 is a cross-section, through the shafts, for operating the valves and pendulum. Fig. 3 is a perspective skeleton view of the valves, valve-rods, rock-shaft, and pendulum.

The cylinder, crank-shaft, pitman, and connections for operating the main valve, may be of any preferred construction.

A is the main valve of the engine, which may be termed a gridiron-valve, the steam being admitted through ports in the valve, in contradistinction to valves in which the steam is admitted past the ends of the same. The main valve is operated by a hollow stem, *a*, which is connected by a cross-head to side rods B B, which, in turn, are attached to cranks *c c* on rock-shaft C, which is con-

nected to an eccentric on the engine-shaft D in the ordinary way. The exhaust-cavity *a'* in the main valve communicates alternately with side passages of the cylinder, and is in constant communication with the exhaust discharge-pipe E. The upper side of main valve A is faced off to form a valve-seat for cut-off valve F, the latter being rectangular, forming what may be called a skeleton-valve, having a large central opening, sufficiently large when standing square over the main valve A, and moving in unison with the same, to admit steam at both ports, so that when the engine in operation is moving exactly in unison with the natural speed of the pendulum G, to which the cut-off valve is connected, this would be the condition of the cut-off valve, relatively with the main valve, and the steam would be admitted to the engine during the entire stroke of the same; but as soon as the engine begins to run faster than the natural speed of the pendulum G, and has gained a fractional part of a vibration, the cut-off valve operates, relatively with the main valve, in such a way as to cut off the steam at a corresponding point in the stroke, while the operation of exhausting freely (through the exhaust-cavity *a'* of the main valve A) remains undisturbed.

The cut-off valve F is operated by a central rod, *f*, which passes through the hollow stem *a*, and is attached to crank H upon a shaft, I, which passes through the rock-shaft C, and has secured upon its end a pendulum, G. Upon the under side of the rock-shaft C projecting arms J J', on each side, are provided, which are located immediately under similar projecting arms *g g*^{1} on the pendulum G, and between these projecting arms coil-springs K are introduced, which form a flexible medium between the driving-force of the pendulum and the pendulum itself, for the purpose of leaving the pendulum in a measure free to operate independently, according to its own natural laws of vibration. It will be seen that the pendulum governs the operation of the cut-off valve, and that the engine is governed solely by the limitation or duration of time during which the steam at boiler-pressure is admitted to the cylinder, and that therefore the steam is not wire-drawn to govern the speed, as in the use of the ordinary centrifugal governor, but that, as the engine increases its speed above that of the natural vibrating speed of the pendulum, the pendulum refusing (owing to the natural laws which govern it) to increase its motion in accordance with the increased speed of the engine, hangs back, as it were, and cuts off the steam at the end of each vibration still earlier in the stroke, as the engine increases its speed above that of the natural vibrating speed of the pendulum.

The speed of the engine may be changed, as required or desired, with as much accuracy as that of a clock, by adjusting the length of the pendulum to suit the required speed, as the vibrating time of a pendulum when left free to oscillate without interference is well known to be in proportion to the distance of the weight from the point of suspension; but as the impulse is given through the medium of a spring or springs, the regulation may be effected by the increase or diminution of the tension or strength of the spring or springs, as is done where the balance-wheel is used as the equivalent of the pendulum in the construction of watches. I prefer, however, to regulate the speed of the engine by adjusting the length of the pendulum in a way similar to that in which the speed of a clock is regulated, and to this end I fix the weight G to its guide-rods g^2, so that it may slide thereon, being suspended by a screw, L, which passes through it, whereby it may be raised or lowered.

It will be seen that there are various modes of operating the cut-off valve from the engine besides the one shown. There may be a separate rock-shaft used, operated by a separate eccentric, in which case the cut-off valve may be set by the eccentric so as to cut off at a given point in the stroke independent of the interfering action of the pendulum, and the pendulum be made to regulate the engine through the balance of the stroke. In fact, this mode will in all probability be found preferable in practice, where it is found essential to govern the engine in a very sensitive manner.

There are also many ways of attaching the springs between the moving force of the cut-off valve and its pendulum other than that shown, without departing from the characteristic features of my invention.

It is obvious also that, in place of the lever-pendulum shown and described, a balance-wheel, such as is used in construction of watches, or oscillating weights in other forms, may be used in connection with springs, any of which may be properly regarded, when so used, as pendulums. The balance-wheel form may be preferable in some cases, particularly in the application of my improvement to locomotives or marine engines.

My invention can be very readily and cheaply applied to all slide-valve engines now in use without material change, whether the engine be upright or horizontal. It can also be applied to any form of engine with either slide, piston, or puppet valves. The modes of application to the different forms of engine, of course, will vary with the forms; but with a proper knowledge of the working parts of my improvement any novice will be able readily to make the application.

In the operation of my engine, as before described, under a variable load there is a constant tendency on the part of the crank-shaft to increase or diminish in speed, and on the part of the pendulum to maintain a uniform speed. There exists, therefore, under a variable load, an antagonism between the motion of the engine and the motion of the pendulum,

and the position of valves A F, relatively to each other, is so changed or varied thereby to suit the exigencies of the case as to proportion the amount of steam served out by them to the continually-varying quantity of work the engine has to do. The steam is therefore in my engine not only used expansively to the saving of fuel, but is used as sparingly as possible, and the speed of the engine is rendered more uniform than in the most expensive engines with independent cut-off valves governed by a centrifugal governor.

The weight G is not rigidly secured to its rods g^2, but so that it may slide thereon; and, owing to the provision of two rods, it cannot rotate so as to become misplaced. The screw L is provided with a collar resting on the lug g^4, and with a crank, g^5, by which it may be operated.

By this construction it will be observed that the weight can be raised or lowered while the engine is in motion, so that it can be adjusted to run at any given speed.

I claim—

1. In combination with the main valve and cut-off valve, the intermediately-placed pendulum, said pendulum being moved by the positive action of the engine, and free to move in advance in such manner that it will accelerate the movement of the cut-off valve by its greater swing when the engine is inclined to run faster, thereby cutting off the steam earlier in the strokes by moving a greater distance in a given time than the main valve, and vice versa, substantially as described.

2. The combination of the main valve, cut-off valve, intermediate pendulum actuated by the positive action of the engine, whereby the movement of the cut-off is accelerated, and the interposed springs *k k*, substantially as described.

3. The combination of the rocker C, actuated by the engine, the arms J and J′, (with or without the springs *k k*,) arms $g\ g^1$, pendulum G, shaft I, and the connections with the cut-off, substantially as described.

4. The combination of pendulum-weight G, suspension-rods g^2, hand-screw L, and crank g^5, to provide for an adjustment in regular running speed of the engine at will while in motion.

In testimony of which invention I hereunto set my hand.

ANDREW J. VANDEGRIFT.

Witnesses:

FRANK MILLWARD,

GEO. H. THAYER.