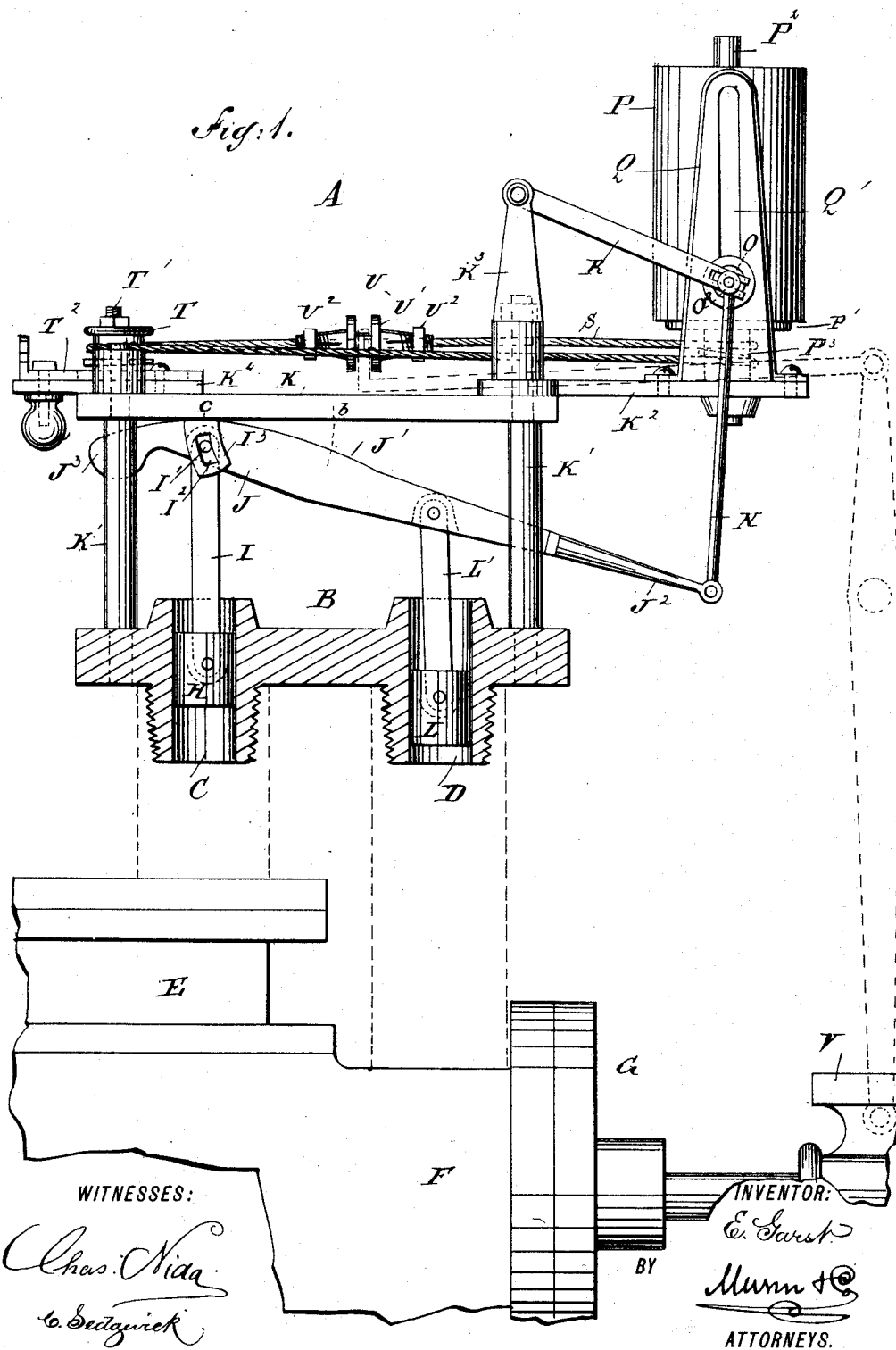


E. GARST.
STEAM ENGINE INDICATOR.

No. 419,326.

Patented Jan. 14, 1890.



UNITED STATES PATENT OFFICE.

EDWIN GARST, OF DAYTON, OHIO.

STEAM-ENGINE INDICATOR.

SPECIFICATION forming part of Letters Patent No. 419,326, dated January 14, 1890.

Application filed March 20, 1889. Serial No. 303,964. (No model.)

To all whom it may concern:

Be it known that I, EDWIN GARST, of Dayton, in the county of Montgomery and State of Ohio, have invented a new and Improved Indicator, of which the following is a full, clear, and exact description.

The invention relates to steam-engine indicators for showing the working of the steam in the cylinder.

The object of the invention is to provide a new and improved indicator which is simple and durable in construction, very effective in operation, self-adjusting to any pressure of steam, and actuated entirely by steam, thus avoiding all springs.

The invention consists of certain parts and details and combinations of the same, as will be fully described hereinafter, and then pointed out in the claims.

Reference is to be had to the accompanying drawings, forming a part of this specification, in which similar letters of reference indicate corresponding parts in all the figures.

Figure 1 is a side elevation of the improvement as applied, parts being in section. Fig. 2 is a plan view of the improvement. Fig. 3 is an end elevation of the same. Fig. 4 is a transverse section of part of the improvement on the line *xx* of Fig. 2. Fig. 5 is an enlarged sectional side elevation of one of the cord-clamps on the line *yy* of Fig. 6. Fig. 6 is a sectional end elevation of the same on the line *zz* of Fig. 5, and Fig. 7 is an enlarged sectional elevation of the pencil-holder.

The improved engine-indicator A is provided with a base-plate B, containing the cylinders C and D, placed parallel with each other and open at their upper ends. The lower end of the cylinder C is connected by suitable means with the interior of the steam-chest E, and the lower end of the cylinder D is connected by like means with the interior of the cylinder F of the steam-engine G of any approved construction.

In the cylinder C is held to slide a piston H, pivotally connected with the pitman I, pivotally connected at its upper end, by the pin I', with a balancing-beam J, provided with a curved top edge J', adapted to roll on the under side of a plate K, extending parallel with the base-plate B, and supported from the

same by suitable standards K'. The pivot-pin I projects into a segmental slot I², formed in a lug I³, secured to the under side of the plate K. (See Figs. 1 and 4.) The pin I' thus forms the pivot for the pitman I, and also for the balancing-beam J to roll on the under side of the plate K. Instead of the curved top edge J', which is formed in the arc of a circle, I may form the under side of the plate K in the shape of an arc of a circle and leave the top edges of the beam J straight.

In the cylinder D, connected with the steam-cylinder F of the engine G, is mounted to operate a piston L, pivotally connected by the pitman L' with the balancing-beam J. On the latter is formed an extension J², pivotally connected by a link N with the pencil-holder O, containing the pencil O', adapted to mark on the paper cylinder P, secured on the solid cylinder P', mounted to turn on a spindle P², secured in the brackets K², fastened to one end of the plate K.

The pencil-holder O is formed of a tube, through which passes the pencil O', and the tube O passes through a vertical slot Q', formed in a standard Q, secured to the bracket K², and locked in place on the cylinder P.

In order to guide the pencil-holder O up and down in the standard Q, I provide the tube with two washers or nuts O², fitting against the front and rear of the standard Q. (See Fig. 7.)

On the outer end of the pencil-holder O' is secured a collar O³, provided with an annular recess engaged by the forked end of an arm R, secured to a collar R', fastened on a transversely-extending shaft R², mounted to slide in the standards K³, secured to the plate K. A spring R³ is coiled on the said shaft R² and presses at one end against one of the standards and at its other end against the said collar R', so as to press the latter against the other standard. The shaft R² passes through the front standard K³, and is provided with a collar R⁴, located a short distance from the said standard, so that the inward motion of the shaft R² is limited. When the operator presses against the outer end of the shaft R², the latter slides rearward and causes a like motion of the arm R, so that the pencil O' is pressed against the paper roll

P. When the operator releases the pressure on the shaft R^2 , the spring R^3 again forces the shaft R^2 to its former position, so that the arm R moves the pencil O' away from the paper cylinder P .

On the solid cylinder P' , carrying the paper cylinder P , is formed a pulley P^3 , around which is wound twice an endless cord S , also passing once around a pulley T , mounted to turn loosely on a stud T' , secured on a plate T^2 , held longitudinally adjustable on a bracket K^4 , secured to a plate K . The plate T^2 is made longitudinally adjustable, so as to take up any slack in the cord or rope S . On the said cord S is fastened a cross-head U , connected by suitable means with the cross-head V of the steam-engine, so that the said steam-engine cross-head imparts a forward sliding motion to the cross-head U , thereby imparting a traveling motion to the cord or rope S . The cross-head U is preferably made of the two sections U' , (see Figs. 5 and 6,) through which the rope passes, and each of which is provided on its outer end with a conical slotted end, threaded and adapted to receive a nut U^2 , which, when screwed up, forces the arms formed by the slots toward each other, and thereby securely clamps the part U' to the rope. Other suitable means may be employed instead of the cross-head U . The left-hand end of the balancing-beam J is provided with a weight J^3 , for counterbalancing the said beam and its connection with the pencil O' .

The operation is as follows: When the indicator is attached to the engine G , as above described, the pressure in the steam-chest E is exerted against the piston H in the cylinder C , so that the said piston H , by its pitman I , moves the balancing-beam J into the position shown in Fig. 1—that is, the curved top J' of the balancing-beam J rests against the under side of the fixed plate K , directly above the pivot-pin I' . The interior of the engine-cylinder F is connected with the cylinder D , and now as soon as the cylinder takes steam through one of its ports the piston L in the steam-cylinder D is caused to move upward, so that its pitman L' presses against the beam J , which latter thus swings upward and its curved top edge J' rolls on the under side of the fixed plate K until the point of fulcrum of the balancing-beam is changed from the point c to the point b on the fixed plate K . This point b is half-way between the fulcrum-points of the pitmen I and L' , and when the balancing-beam J has assumed this position the pressures in the engine-cylinder and the steam-chest are completely balanced. Thus it will be seen that by the upward motion of the piston L and the upward swinging motion of the balancing-beam J the pencil O' is raised to a certain height in front of the paper cylinder P . The pencil O' now cannot rise any higher upon the paper cylinder until the compression in the engine-cylinder is greater than that in the steam-chest, so that the pressure on the pis-

ton L overcomes the pressure on the piston H , whereby the balancing-beam J is swung farther upward, thereby causing the pencil O' to move a short distance higher. When the port of the engine-cylinder is closed, the expansion takes place, and then the pressure in the steam-chest is greater than the pressure in the cylinder, and consequently the piston H overbalances the piston L and is moved upward as fast as the expansion takes place in the engine-cylinder F . The left-hand end of the balancing-beam J is thus caused to swing upward and the right-hand end of the beam to swing downward, whereby the pencil draws an expansion-line on the paper cylinder P . When the exhaust takes place, the point of fulcrum of the beam J is changed to the point c , and the pencil then rests in its lowermost position—that is, on the atmosphere-line on the paper-cylinder P —unless a condenser is used by the engine. In that case the vacuum acts on the piston L , which causes the pencil to pass below the atmosphere-line to the extent of the vacuum. The above-described operation is then repeated by the next stroke of the piston in the engine-cylinder F .

It will be seen that when the engine is in operation the cross-head V imparts a rotary motion to the cylinder carrying the paper cylinder P , so that the pencil O' operates in unison with the movement of the engine. It is to be understood that the pencil O' is disconnected from the paper cylinder P until the operator presses on the outer end of the shaft R^2 , so that the point of the pencil is moved inward against the paper cylinder. It is to be further understood that the pivot-pin I' travels in the segmental slot I^2 when the curved top J' of the balancing-beam J rolls on the under side of the fixed plate K , as before described.

By employing the two pistons operated from the steam chest and cylinder, respectively, I dispense entirely with the spring usually employed to counteract the cylinder-pressure and force the pencil back to the atmospheric-pressure line. These springs must be graduated for or adjusted to different boiler-pressures, but by using cylinders C D and the balance-beam operated therefrom I can take a correct diagram from any steam-engine at any variation of the boiler-pressure without readjusting a single part.

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

1. In a steam-engine indicator, the combination, with the steam chest and cylinder, of a balancing-beam, separate and independent operating connections between the said beam and the chest and cylinder, and a marker operated by the beam, substantially as set forth.

2. The combination, with the steam cylinder and chest and two rods or pitmen actuated, respectively, therefrom, of a balance-beam pivotally connected to said rods or pit-

men, a bearing-surface, on which the beam rolls or rocks between the rods or pitmen, and a marker operated from the beam, substantially as set forth.

5 3. The combination, with the steam cylinder and chest and two parallel rods or pitmen actuated, respectively, therefrom, of a balance-beam pivotally connected to the outer ends of said rods or pitmen, a plate on which
10 the beam rocks, provided with slotted lugs through which the pivot connecting the beam and one of said rods or pitmen passes, and a marker actuated by said beam, substantially as set forth.

15 4. In a steam-engine indicator, the combination, with two parallel rods actuated from the steam cylinder and chest, respectively, of a balance-beam pivotally connected to the upper ends of said rods or pitmen and
20 having one end weighted, a plate on which the beam rocks, provided with slotted lugs through which the pivot connecting one rod or pitman with the beam passes, and a marker operated from that end of the beam opposite
25 to the weight, substantially as set forth.

5 5. In a steam-engine indicator, the combination, with a fixed plate, of a balancing-beam adapted to roll on the said fixed plate and controlled by the steam in the steam-chest
30 and engine-cylinder, a pencil operated by the said balancing-beam, and a paper cylinder turned by the cross-head of the engine, and on which operates the said pencil, substantially as shown and described.

35 6. In a steam-engine indicator, the combination, with the engine, of a balancing-beam controlled by the steam in the steam chest and cylinder of the said engine, a fixed plate
40 on which the said balancing-beam is adapted to roll, a pencil operated by the said balancing-beam, and a paper cylinder turned by the said engine, and on which operates the said pencil, substantially as shown and described.

45 7. In a steam-engine indicator, the combination, with two cylinders, of which one is connected with the interior of the steam-chest and the other with the engine-cylinder, of
50 pistons operating in the said cylinders, and a balancing-beam connected with the said pistons and adapted to operate a pencil, substantially as shown and described.

8. In a steam-engine indicator, the combination, with two cylinders, of which one is
55 connected with the interior of the steam-chest and the other with the engine-cylinder, of pistons operating in the said cylinders, a balancing-beam connected with the said pistons and adapted to operate a pencil, and a fixed
60 plate on which rolls the said balancing-beam, substantially as shown and described.

9. In a steam-engine indicator, the combination, with two cylinders, of which one is

connected with the interior of the steam-chest and the other with the engine-cylinder, of
65 pistons operating in the said cylinders, a balancing-beam connected with the said pistons and adapted to operate a pencil, a fixed plate on which rolls the said balancing-beam, and a paper cylinder turned by the engine and on
70 which operates the said pencil, substantially as shown and described.

10. In a steam-engine indicator, the combination, with two cylinders, of which one is connected with the interior of the steam-chest
75 and the other with the engine-cylinder, of pistons operating in the said cylinders, a balancing-beam connected with the said pistons and adapted to operate a pencil, a fixed plate on which rolls the said balancing-beam, a paper
80 cylinder turned by the engine and on which operates the said pencil, and means, substantially as described, for connecting and disconnecting the said pencil and the paper cylinder, as set forth. 85

11. In a steam-engine indicator, the combination, with two cylinders, of which one is connected with the steam-chest and the other
with the engine-cylinder, of pistons operating in the said cylinders, a balancing-beam pivotally connected with the said pistons, a fixed
90 plate on which the said balancing-beam is pivoted and adapted to roll, and a pencil adapted to be operated by the said balancing-beam, substantially as shown and described. 95

12. In a steam-engine indicator, the combination, with two cylinders, of which one is connected with the steam-chest and the other
with the engine-cylinder, of pistons operating in the said cylinders, a balancing-beam pivotally connected with the said pistons, a fixed
100 plate on which the said balancing-beam is pivoted and adapted to roll, a pencil adapted to be operated by the said balancing-beam, and a paper cylinder controlled by the engine
105 and on which operates the said pencil, substantially as shown and described.

13. In a steam-engine indicator, the combination, with two cylinders, of which one is connected with the steam-chest and the other
110 with the engine-cylinder, of pistons operating in the said cylinders, a balancing-beam pivotally connected with the said pistons, a fixed plate on which the said balancing-beam is pivoted and adapted to roll, a pencil adapted
115 to be operated by the said balancing-beam, a paper cylinder controlled by the engine and on which operates the said pencil, and means, substantially as described, for connecting and disconnecting the said pencil and the said
120 paper cylinder, substantially as set forth.

EDWIN GARST.

Witnesses:

MARCUS SHOOP,
MILES S. PARSONS.