E. S. RENWICK.

Regulating Mechanism for Incubators, &c.

No. 210,559. Patented Dec. 3, 1878.

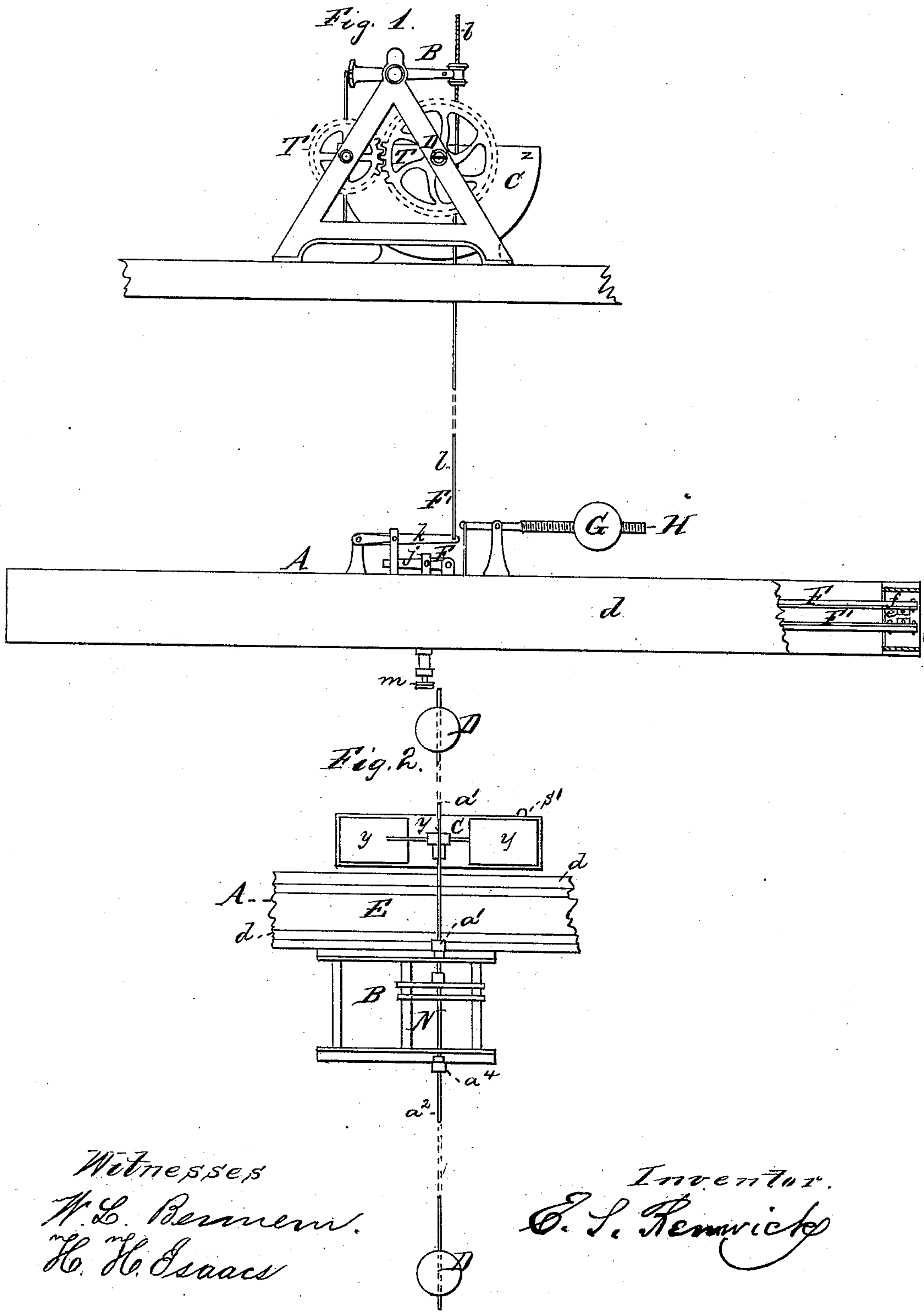

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Fig. 3.

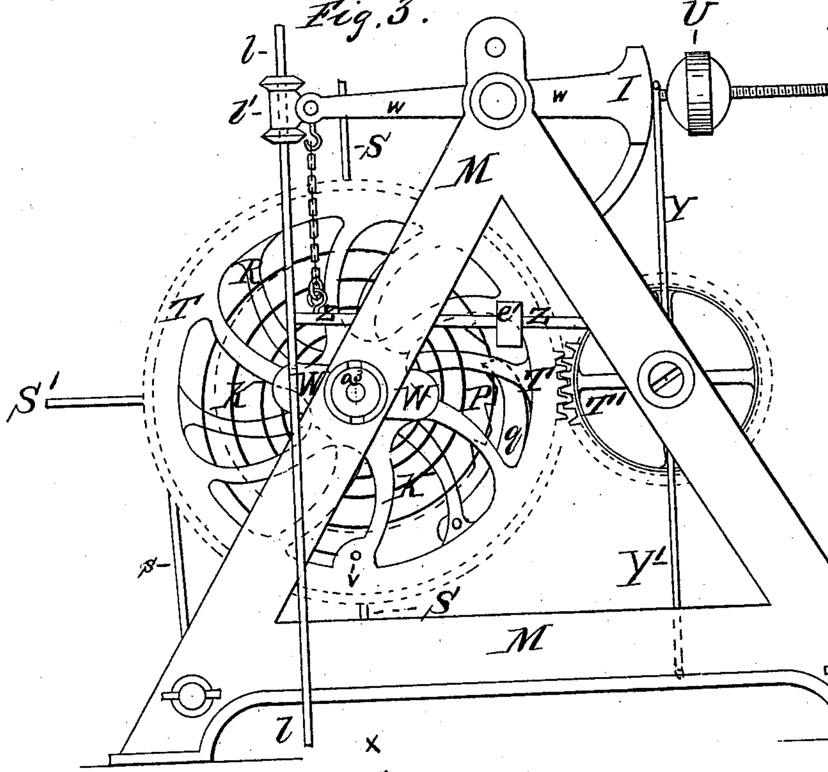

Fig 3a

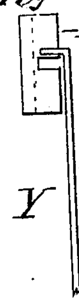

Fig. 4.

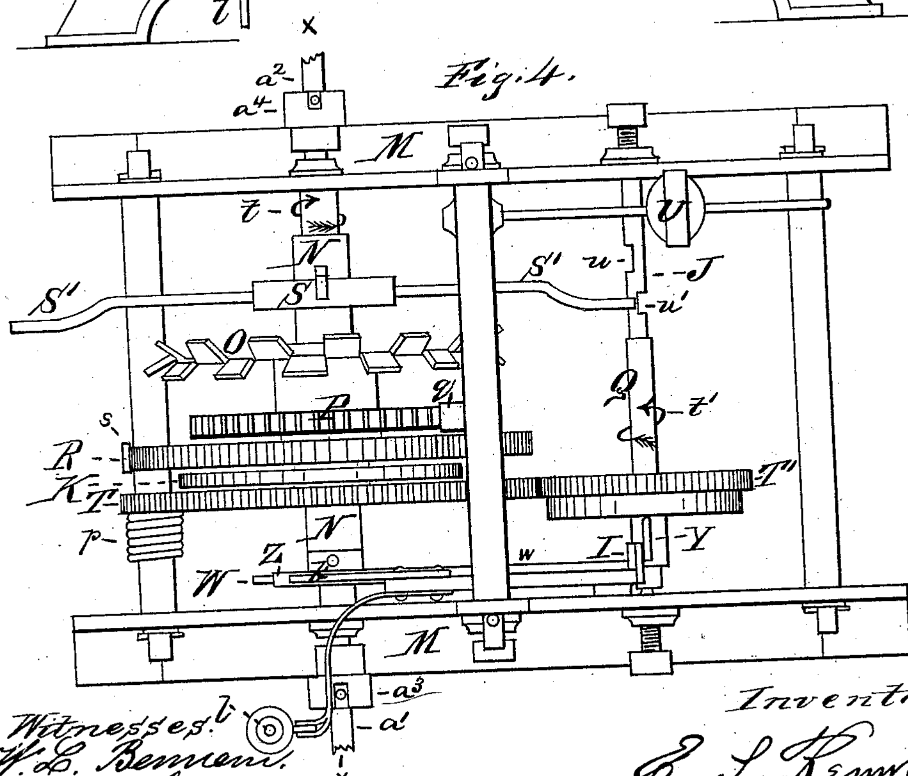

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Fig. 5.

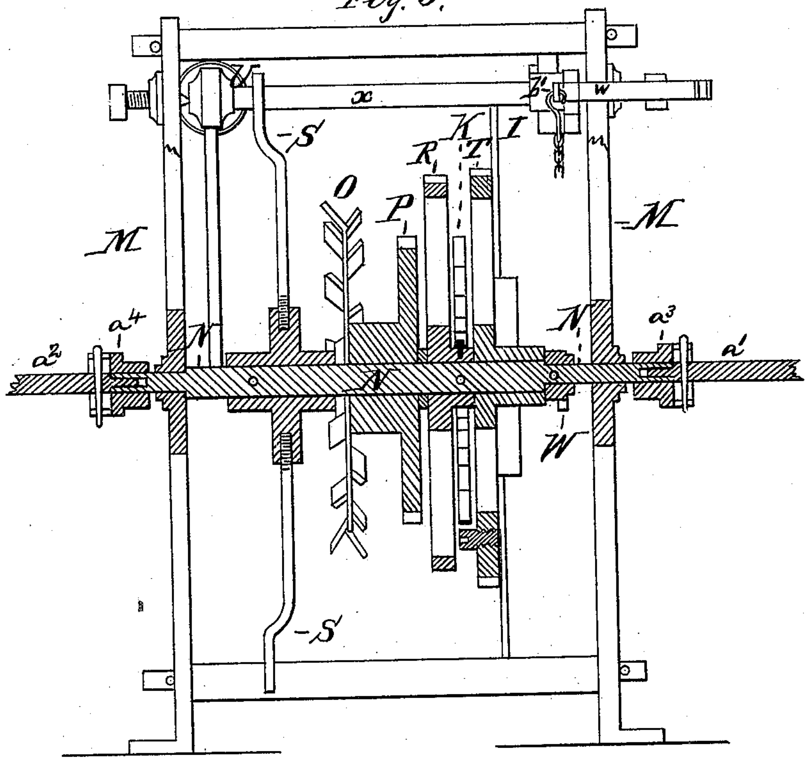
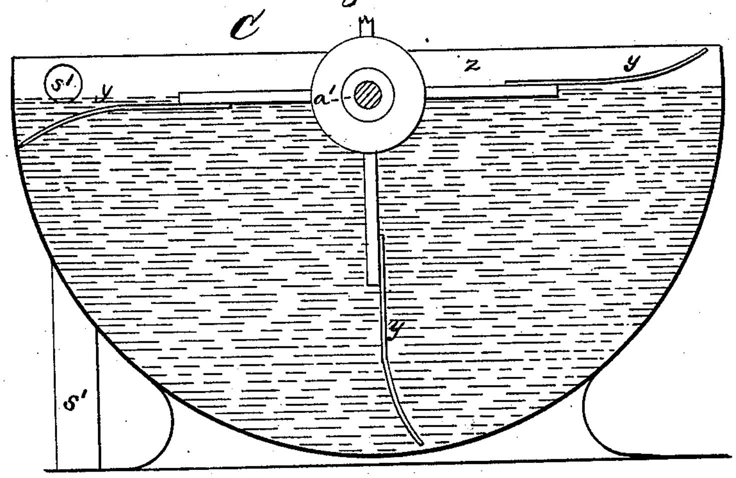


Fig. 6.



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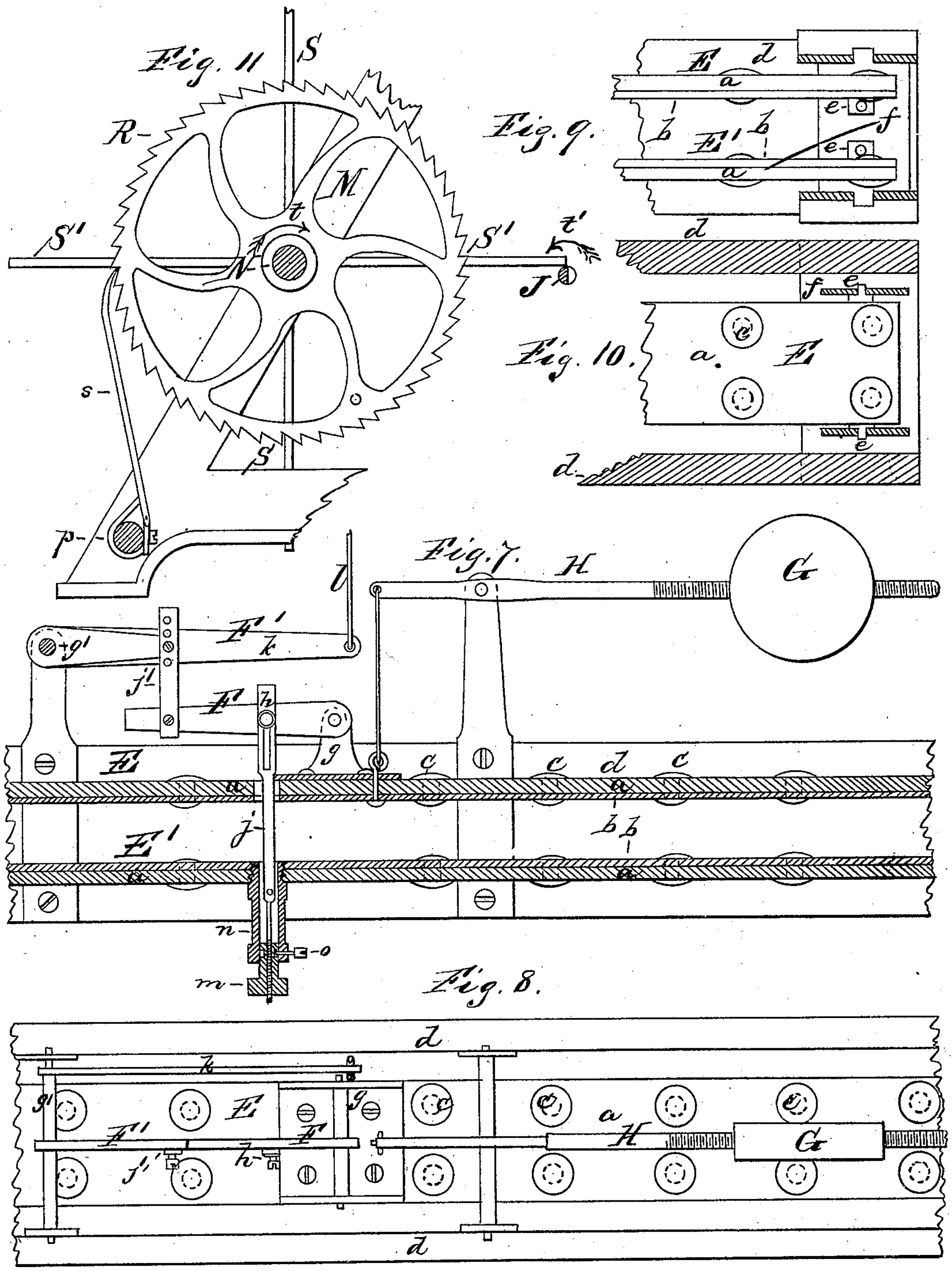

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UNITED STATES PATENT OFFICE.

EDWARD S. RENWICK, OF MILLBURN, NEW JERSEY.

IMPROVEMENT IN REGULATING MECHANISM FOR INCUBATORS, &c.

Specification forming part of Letters Patent No. **210,559**, dated December 3, 1878; application filed November 11, 1878.

To all whom it may concern:

Be it known that I, EDWARD SABINE RENWICK, of Millburn, in the county of Essex and State of New Jersey, have made an invention of certain new and useful Improvements in Regulating Mechanism for Incubators and other purposes; and that the following, taken in connection with the accompanying drawings, is a full, clear, and exact description and specification of the same.

The object of this invention is more particularly to control the heat of incubators and other apparatuses in which a regular heat is to be maintained.

To this end my invention consists of certain new combinations of devices, of which the following are the principal: A thermostatic bar, consisting of connected strips of substances having different capacities of expansion by heat; a lever or levers combining two thermostatic bars, as hereinafter described; a regulator-detent, which, when the entire invention is used, is operated by one or more thermostatic bars; a dynamic engine, operated preferably by a weight or spring, and capable of exerting force and producing movement; an engine-detent, for releasing the dynamic engine at the times it is to be permitted to move, and for holding it at rest at other times; a detent-motor, for operating the engine-detent—this motor is preferably a spring or a weight; a liquid speed-controller, for controlling the rapidity of movement of the dynamic engine; detent-arms, or their equivalents or substitutes, for operating in connection with the detents; one or more valves, or their substitutes, by which the application of heat is regulated; a shifting weight, or its equivalent, by means of which the movement of the regulator-detent is assisted in alternately-opposite directions.

The various combinations of which the invention consists are specified in detail at the close of this specification. In order that they may be fully understood, I have represented in the accompanying drawings, and will proceed to describe, the best mode which I have thus far devised of embodying my entire invention in a practical form, it being understood that some parts of my invention may be used without others, and that the modes in which the several parts of the invention can be embodied may be greatly varied.

Figure 1 of the accompanying drawings represents a side elevation of the apparatus, (certain parts being omitted for perspicuity.) Fig. 2 represents a plan of parts of the same. Fig. 3 represents a side view of the engine and detent mechanism, suitable for operating in connection with an incubator. Fig. 4 represents a plan of the same. Fig. 5 represents a vertical transverse section of the same at the line *x x* of Fig. 4. Fig. 6 represents a transverse section of the liquid speed-controller. Fig. 7 represents a vertical longitudinal section of the central portion of the compound thermostat, with its members, in the positions they should occupy when the heat to which they are subjected is at its mean. Fig. 8 represents a top view of the central portion of the compound thermostat. Figs. 9, 10, and 11 represent detail views of the apparatus, designated by the same letters as the same parts in the other figures.

The principal members of the apparatus represented in the accompanying drawings are the thermostat A, the detent and engine mechanism B, the liquid speed-controller C, and the valves D, which control the heat by opening or closing flues or pipes, through which passes the hot air from lamps or gas-lights, or the steam from a steam-boiler.

The general operation of the apparatus is that the thermostatic bars of the thermostat change their curvature when exposed to variations of heat; that this change enables them to move a detent, (denominated the "regulator-detent,") which controls the action of a light spring or weight, (denominated the "detent-motor;) that this light spring or weight, when permitted to act, operates a second detent, (denominated the "engine-detent,") which determines the action of the dynamic engine for moving the valves; that the liquid speed-controller controls the speed with which the dynamic engine shall move, and prevents jar when its movement is arrested by the engine-detent, and that the valves or their substitutes are moved by the engine, and regulate or control the expenditure of heat by lamps or other devices.

The thermostat A in the present example is a compound one, having two thermostatic bars, E E', (see more particularly Figs. 7, 8, 9, and 10,) each composed of a strip of hard vulcanized india-rubber, *a*, about one-eighth of an inch thick, and a thin strip of brass, *b*, about one-twenty-fifth of an inch thick, connected by rivets *c*. These two bars are arranged back to back, or with the strips of the same material (brass in this example) opposite each other, so that variations in heat cause the thermostatic bars to curve in opposite directions.

The two thermostatic bars are supported in a frame, *d*, made preferably of wood, with brass mountings, (see Figs. 1, 2, 7, 8, 9, and 10,) each thermostatic bar being fitted at its end with a cross-bar, *e*, whose ends are round and project laterally beyond the edges of the bar into holes in the mountings *f* of the frame.

The holes in the mountings for the cross-bars at one end of the frame are round, those at the other are oval, or slots, to permit the ends of the cross-bars to move in them longitudinally of the frame as the thermostatic bars change their curvature.

The two thermostatic bars are connected by a lever, F, the bearing *g* of the fulcrum-shaft of which is carried by the upper bar, E, while the arm of the lever is connected, by a pivot, *h*, and rod *j*, with the lower thermostatic bar, E'. Hence, when the thermostatic bars, which, as before stated, are back to back, change their curvature, the fulcrum of the lever F and the connecting-pivot *h* are caused to move in opposite directions, the result of which is an angular movement of the lever F about double that which would be obtained if the fulcrum of the lever were a fixture, and both thermostatic bars were connected with the arm or arms of the lever F at a distance from the fulcrum thereof.

The connecting-lever F is in this instance long enough to multiply the movement of the thermostatic bars, and this movement is still further multiplied by means of a second lever, F', whose fulcrum-shaft *g'* is supported by the frame *d*, and whose longer arm, *k*, is connected by a rod, *l*, with the regulator-detent. It is preferred to arrange the thermostatic bars over each other and horizontally flatwise, and in this case it is also preferred to counterpoise a portion of the weight of one or both bars by means of a counterpoise, G, which may be adjusted by screwing it along the arm of the counterpoise-lever H, that connects the counterpoise with the upper thermostatic bar. The practical effect of this counterpoise is to prevent the weight of the bars themselves from materially affecting their curvature, and to render their curvature, by variations of temperature, more free. In practice it is found expedient to counterpoise half the weight of the upper thermostatic bar directly, and half of that of the lower thermostatic bar indirectly, through the connecting-rod *j* and connecting-lever F. If, therefore, the arms of that lever are as two to one, the strain of the counterpoise upon the upper thermostatic bar may be equal to three-quarters of the weight of one of the bars. For convenience of adjustment the lower end of the connecting-rod *j* is screw-threaded, and is fitted with a milled nut, *m*, which is held free to turn in the lower end of a tube attachment, *n*, by the point of a screw, *o*. Hence by turning the milled nut the connecting-lever F may be set so as to stand about level at the mean temperature under which the apparatus is to work. For greater freedom of movement the screw-threaded end of the connecting-rod *j* is made separately, and is connected with the main portion by a pivot; and for further convenience of adjustment it is preferred to construct the connecting-link *j'*, between the connecting-lever F and the multiplying-lever F', with a series of pivot-holes, so that the effective length of the link may be varied as found expedient.

The detent and engine mechanism B, Figs. 1 and 2, (represented more fully at Figs. 3, 4, 5, and 11,) comprises the regulator-detent I, the engine-detent J, the detent-motor, which in this example is a watch-spring, K, the dynamic engine, and the various appurtenances hereinafter described. All of these devices are mounted in a frame, M.

The dynamic engine in the present example consists of a main or engine shaft, N, constructed to revolve in bearings in the frame, and fitted with a cord-pulley, O, to which is applied the cord or chain of the weight that is employed to drive the engine. The pulley O is constructed to turn upon the engine-shaft N, and is connected with that shaft through the intervention of a ratchet-wheel, P, a pawl, *q*, and the connecting-wheel R, secured to the engine-shaft. This connection permits the pulley O to be turned backward for the purpose of winding up the motor, but compels the engine-shaft to turn forward with the pulley O, when the motor weight or spring is permitted to operate. In order to prevent the accidental back motion of the engine-shaft during the winding up of the motor, the connecting-wheel R has its rim formed into ratchet-teeth, which engage with a pawl, *s*, pivoted to the engine-frame M and pressed upon by a spring, *p*.

The motor weight or spring tends to turn the engine-shaft N forward or in the direction of the arrows *t*; but its actions or times of movement are determined by the engine-detent J. This engine-detent, in the present example, consist of a portion of a rotary shaft, Q, having parts of its substance cut away to form two slots, *u u'*. The engine-shaft N is provided with a set of detent-arms, S S', which project from it sufficiently to strike the solid surface of the engine-detent J, and the ends of one pair, S S, of these detent-arms are arranged to revolve opposite one detent-slot, *u*, while the ends of the other pair of detent-arms, S' S', are arranged to revolve opposite the other detent-slot, *u'*, so that when, from the turning of the detent-shaft Q in the direction indicated by the arrow *t'*, either slot

(u', for example) faces the engine-shaft N, the detent-arm (S′, for example) opposite that slot can pass and permit the engine-shaft to turn until the next succeeding detent-arm, S, moves to and strikes the solid substance of the engine-detent behind the other detent-slot, u. The movement of the engine-shaft is thereby arrested, and it then remains at rest, with the detent-arm resting on the detent-shaft, until the next movement of the latter, whereupon the detent-arm so resting is allowed to pass through its slot, and the engine-shaft turns until again arrested by the action of the engine-detent upon the next succeeding detent-arm.

In the present example four detent-arms are used; but this number may be increased or decreased, as found expedient, according to the angular movement to be permitted in the engine-shaft N at each action of the engine-detent J.

In order that the engine-detent J may be moved, a light motor is provided; and in the present example this detent-motor consists of the watch-spring K, which is coiled around the engine-shaft N, and operates the engine-detent through the intervention of the cog-wheels T T′, the first of which is fitted to revolve freely upon the engine-shaft N, while the second, T′, is secured to the engine-detent shaft Q.

In the present example the engine-detent J is arranged to turn half a revolution at each operation, and the proportions of the wheels are as two to one.

The detent-motor may be arranged to be wound up by hand, in which case it need not be coiled on the engine shaft; but in the present case a provision is made for winding up the detent-motor by the engine, so that the engine-motor is the only motor that requires attention. To this end the inner end of the coil of watch-spring K is connected with the engine-shaft N, through the intervention of the hub of the wheel R, while the outer end of the coil is connected with the cog-wheel T by its lateral stud v, and the spring is coiled in the direction proper to be wound up by the forward turning of the engine-shaft.

As the wheels T T′ are in the proportion of 2 to 1, the turning of the engine detent-shaft Q half a revolution to release the engine-shaft runs down the detent-spring K a quarter of a turn; but as the engine-shaft has four detent-arms, S S′, and turns a quarter of a revolution immediately after it is released, it then winds up the detent-spring a quarter of a turn, so as to restore its tension.

The movement of the engine-detent by the detent-motor is determined by the regulator-detent I, which, when the detent mechanism is used in combination with a thermostat, is operated by the latter. This regulator-detent I consists, in this example, of a slotted curved plate connected with one arm of a lever, w, with whose other arm the rod l from the thermostat is connected for the purpose of moving the detent. The detent-lever is secured to a shaft, x, capable of rocking upon pivot-bearings in the frame M, and a counterpoise, U, is connected with this detent rock-shaft to exercise a constant tensile strain upon the connecting-rod l, which, therefore, may be of small dimensions. In order that this regulator-detent may determine the action of the engine-detent J, the engine-detent shaft Q is fitted with two detent-arms, Y Y′, the end of each of which is bent so as to pass through the slot of the regulator-detent when it is within the circle of revolution of such end. One of these detent-arms is longer than the other, so that their bent ends do not revolve in the same circle; consequently, when the regulator-detent I is moved to the position required to let one arm, Y, pass through the detent-slot, and thus permit that arm and the engine-detent to be moved by the detent-motor K, the plate of the detent crosses the circle of revolution of the other arm, Y′, which is stopped thereby until the succeeding movement of the regulator-detent releases it in turn. For convenience of adjustment, the upper end of the rod l is screw-threaded, and is connected with the detent-lever w by means of a tubular connection, l', and two milled nuts.

Whenever the engine-shaft N is released by the action of the detents, it is turned by the engine-motor, and the speed and force with which it tends to turn if not controlled would depend upon the excess of the motor force over the resistances. It is always desirable that there should be considerable excess of motor force, so as to insure the movement of the engine under all circumstances that may occur in practice. Such an excess of force, if not controlled, would cause the engine-detent arms to strike with a jar against the engine-detent, and might also so increase the frictional pressure upon the latter as to require more force in the detent-motor K than is desirable. In order to prevent such jar or the frictional pressure incident to it, the liquid speed-controller C is provided. This device consists of a set of paddles, y, connected with the engine-shaft N, and fitted to revolve in a trough, z, containing a liquid, such, for example, as water, oil, or glycerine. The edges of the paddles revolve close to the sides and bottom of the trough, so that the liquid will be moved by the turning of the engine-shaft; consequently the latter can turn no faster than the liquid will permit the paddles to move, while, on the other hand, as there are no solid parts in contact, the friction is practically nothing when the speed is slow, and consequently the loss of force is practically inappreciable. The comparatively slow movement of the engine-shaft, compelled by the liquid speed-controller, effectually prevents the jar of the engine-detent arms against the surface of the engine-detent.

In the present example it has been found convenient to connect the liquid speed-controller with the engine-shaft by means of the valve-shaft *a'*; but any other suitable connection may, of course, be employed, if preferred.

It has also been found expedient to provide the regulator-trough with an overflow-pipe, *s'*.

The contact of the surfaces of the regulator-detent and detent-arms and of the pivots of the regulator-detent shaft produces a slight friction, which impedes to some extent the movement of the thermostat. In order to neutralize the effect of this friction a shifting weight is provided, to assist the movement of the detent by the thermostat. In the present example this weight has the form of a lever, Z, which is pivoted at one end to the frame of the engine, and is connected at the other end with the shank *b'* of the regulator-detent lever *w*. Beneath this lever-weight there is a cam, W, secured to the engine-shaft N in a position to raise the lever-weight at the times the thermostat is so moving as to let the connecting-rod *l* rise, and to free the lever-weight and permit it to hang upon the detent-lever at the times the thermostat is moving to pull the connecting-rod *l* downward. When the weight Z is thus raised by the cam W the strain of whatever weight it exerts is taken off from the thermostat, which can thus exert an equal force in raising the connecting-rod, and when the weight is allowed to hang upon the shank of the detent-lever the thermostat is assisted by the force of the weight in moving the connecting-rod downward. The cam thus shifts the action of the weight, and the latter assists the thermostat to move the regulator-detent in alternately-opposite directions—in one direction by relieving a part of the strain, and in the other direction directly by an assisting force.

In order that the acting weight of the lever Z may be adjusted, a slide, *e'*, is applied to it, and held in position by frictional contact.

In the present example the engine is employed to operate two valves, D D, whose shafts a^1 a^2 are connected with the engine-shaft by clutches a^3 a^4, the outer end of each valve-shaft being supported in practice by a bearing, which is not shown in the drawings. In the present example the valves are of the damper class, and are moved directly by the turning of the engine-shaft, a quarter of a revolution of the latter opening the valves, and a succeeding quarter turning them crosswise of the flue and closing them. If preferred, however, the valves may be operated indirectly through the intervention of cranks or eccentrics and connecting-rods, or by gearing. The valves also may be of different forms, and, if preferred, other controlling devices may be substituted for a valve or valves. Thus, if the thing to be controlled be the flame of a lamp, the engine-shaft may be connected with a sliding wick-tube, so as to move it, or with the wick-raising device, so as to move it. If, again, the thing to be controlled is the flame of gas, the valve or cock controlling the supply of gas may be suitably connected with the engine-shaft, so as to constitute a substitute for the damper-valve represented in the drawings.

It is sometimes expedient to inclose the engine and detent mechanism in a glass shade. In such case the engine-shaft may be connected with the valve-shaft or other shaft beneath by means of an endless chain and chain-wheels, or by other power-transmitting devices.

From the foregoing description it appears that the dynamic engine cannot move until released by the action of two detents, I J, one of which is operated by a special motor, K. This duplex detent mechanism is of great value whenever the force available to determine the times of movement of the dynamic engine is small, while the engine force is comparatively large. If, for example, the engine-detent should be operated directly by the available controlling or determining instrumentalities, the latter would have to overcome the whole of the frictional resistances due to the pressure exerted by the engine-motor upon the engine-detent. By interposing the regulator-detent and the detent-motor between the determining instrumentality and the engine-detent, such a state of facts is at once changed, because the detent-motor so interposed overcomes the frictional resistances due to the pressure exerted by the engine-motor upon the engine-detent, and the available force of the determining instrumentality is burdened only with the slight work of operating or controlling the operation of the light detent-motor. The resistances to the action of the available force of the determining instrumentality are thus reduced about in the proportion of the extent of movements of the engine-detent to the extent of movements of the ends of the engine-detent arms; and this ratio may be increased by increasing the length of the detent-arms, or by interposing gearing between the engine-detent and a shaft carrying such detent-arms. In fact, the sensitiveness of the duplex detent mechanism, even when constructed as represented in the drawings, is very great, so that the movements of the engine may be determined by a thermostat or a thermometer capable of exerting a slight force.

The various parts of the apparatus thus described may be greatly varied if deemed expedient. Thus a single thermostatic bar or a thermometer may be employed in place of the two combined bars if the combination of thermostatic bars and connecting-lever, hereinafter claimed as the first part of my invention, be not used. It is also not essential that the thermostatic bar should consist of two materials, riveted or otherwise secured together throughout their length, because a thermostat may be made by connecting a bar of one material, in the form of a bow, with a straight bar of another material of a lower thermo-expansive capacity, the latter holding the ends of the bow-bar from spreading apart. The form of the detent mechanism also may be greatly changed. Thus a disk or plate with projecting pins may be substituted for the detent-arms; or, the engine-detent and engine-detent arms may consist of a detent plate and arms like those of the regulator-detent and its arms. In this case the engine-detent would be arranged to vibrate, and, instead of being formed in one piece with the detent-shaft, would be constructed separately, and be connected with the detent-shaft Q by means of an eccentric or by a crank and rod, so as to be vibrated to and fro by the turning of the detent-shaft. I have also used with success a single revolving detent-arm, operating in connection with two vibrating detent-plates, in cases in which the shaft carrying the detent-arm was required to make a complete revolution at each operation. In this case the detent-arm was constructed to vibrate crosswise of its plane of revolution, so that at one revolution it operated in connection with one detent-plate, and at the succeeding revolution in connection with the other detent-plate.

The duplex detent mechanism above described is applicable to other purposes than controlling heat. Thus, for example, it may be employed to determine the times of movement of the motor of a heavy turret-clock or of the calendar mechanism of a clock. In such case the time-movement would operate the regulator-detent, and the detent-motor would operate the detent which releases the heavy weight that moves the hands of the dials or the striking mechanism.

The combination of the detent-motor with the engine-shaft, whereby the said motor is wound up by the engine, is important, because it avoids the necessity of winding the detent-motor by hand; but this combination, as set forth in the third claim, is not essential to other parts of my invention and may be omitted, in which case the detent-motor may be a weight or spring arranged to be wound up by hand.

The liquid speed-controller is an important accessory to the engine, because it controls the speed of the latter without the intervention of the multiplying-gearing, which is necessary when a fly revolving in air is used; and, if deemed expedient, a similar liquid speed-controller of small size may be applied to the engine detent-shaft Q, so as to prevent the arms thereof from striking the regulator-detent with a jar.

The shifting weight Z is an effective auxiliary of the detent mechanism. It may be replaced by a spring operating in substantially the same manner, and it may be employed with advantage in cases of a single detent mechanism, in which the detent-arms, operated by the engine or motor, are arranged to operate directly upon the regulator-detent.

Instead of combining the shifting weight directly with the detent-lever, it may be combined therewith indirectly—as, for example, by connecting the weight or spring with the connecting-rod *l*, or with one of the levers of the thermostat.

The effective force which the shifting weight exerts may be adapted to the exigencies of the case in which it is employed. In the present example it is preferred to have this effective force slightly greater than is sufficient to overcome the friction of the movements of the parts which are moved simultaneously with the thermostat.

The cam for relieving the weight is a convenient device for that purpose; but it may be replaced by any substitute that will do the work at the proper times.

I claim as my invention—

1. The combination, substantially as before set forth, of two thermostatic bars by means of a connecting-lever, which has its fulcrum carried by one of said bars and its arm connected with the other of said bars.

2. The combination, substantially as before set forth, of a thermostatic bar, arranged horizontally with a counterpoise-weight.

3. The combination, substantially as before set forth, of the engine-shaft, detent-motor, and engine-detent, whereby the detent-motor is wound up by the engine.

4. The combination, substantially as before set forth, of the engine, engine-detent, detent-motor, and regulator-detent.

5. The combination, substantially as before set forth, of the engine, liquid speed-controller, and engine-detent.

6. The combination, substantially as before set forth, of a thermostatic bar, regulator-detent, detent-motor, engine-detent, and engine.

7. The combination, substantially as before set forth, of the engine, liquid speed-controller, engine-detent, detent-motor, and regulator-detent.

8. The combination, substantially as before set forth, of the regulator-detent, detent-motor, engine-detent, engine, and valve.

9. The combination, substantially as before set forth, of a thermostatic bar, regulator-detent, detent-motor, engine-detent, engine, and valve.

10. The combination, substantially as before set forth, of the detent and the shifting weight.

11. The combination, substantially as before set forth, of the thermostat and the shifting weight.

Witness my hand this 21st day of October, A. D. 1878.

EDWARD SABINE RENWICK.

Witnesses:
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