(No Model.) 2 Sheets—Sheet 1.

N. MACBETH.

APPARATUS FOR RECORDING THE VARIATIONS OF SPEED IN MOTIVE POWER ENGINES.

No. 377,111. Patented Jan. 31, 1888.

FIG. 1

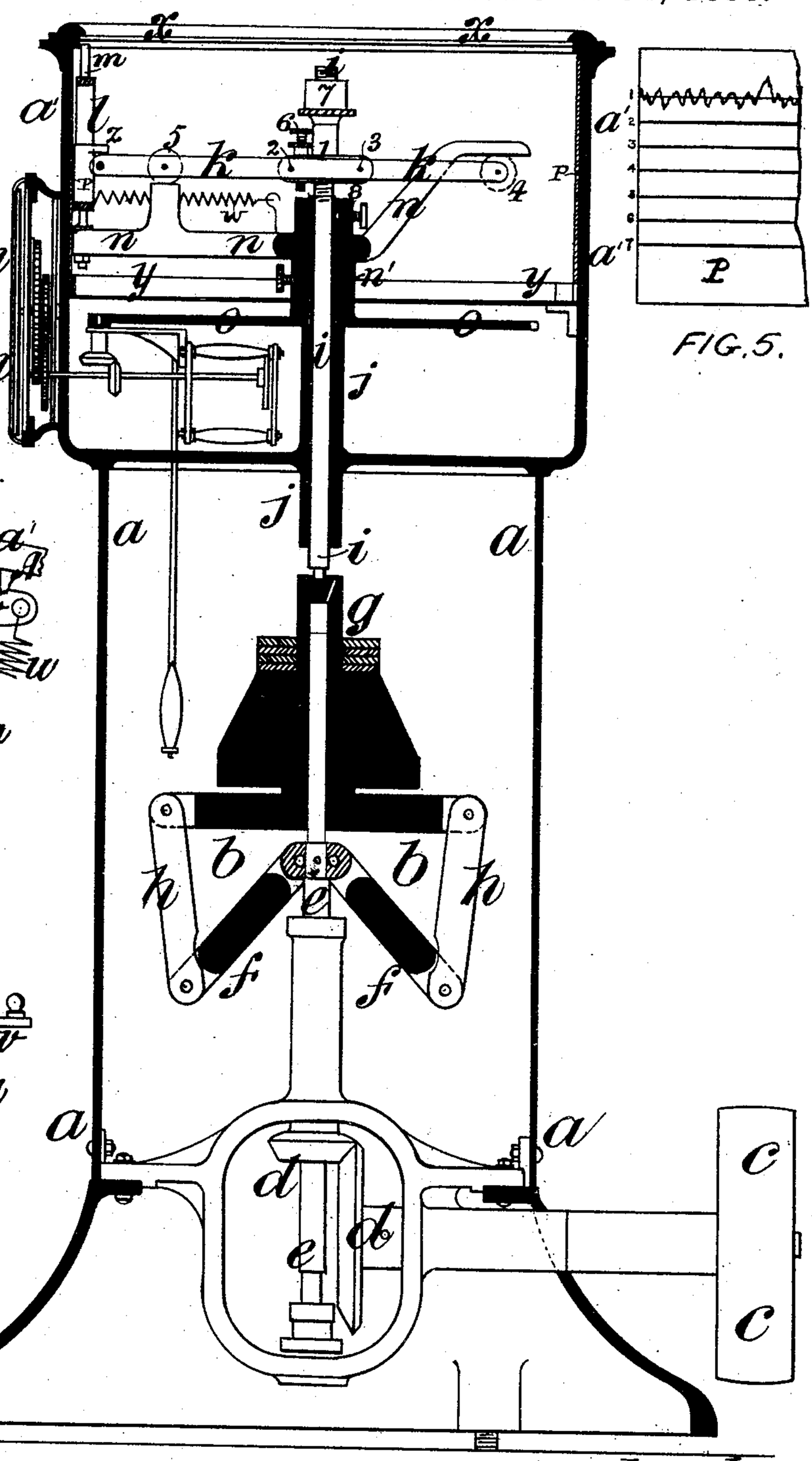


FIG. 5.

FIG. 4.

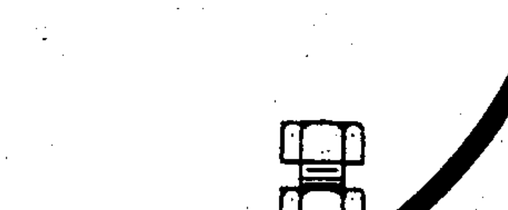
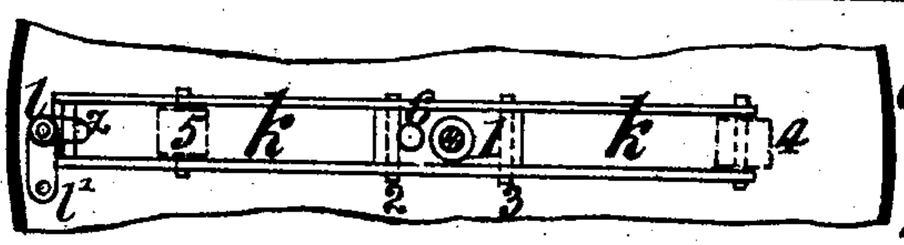


FIG. 3.

FIG. 2.



Witnesses—
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Inventor,
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Howson & Sons

(No Model.) 2 Sheets—Sheet 2.

N. MACBETH.

APPARATUS FOR RECORDING THE VARIATIONS OF SPEED IN MOTIVE POWER ENGINES.

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FIG. 6.

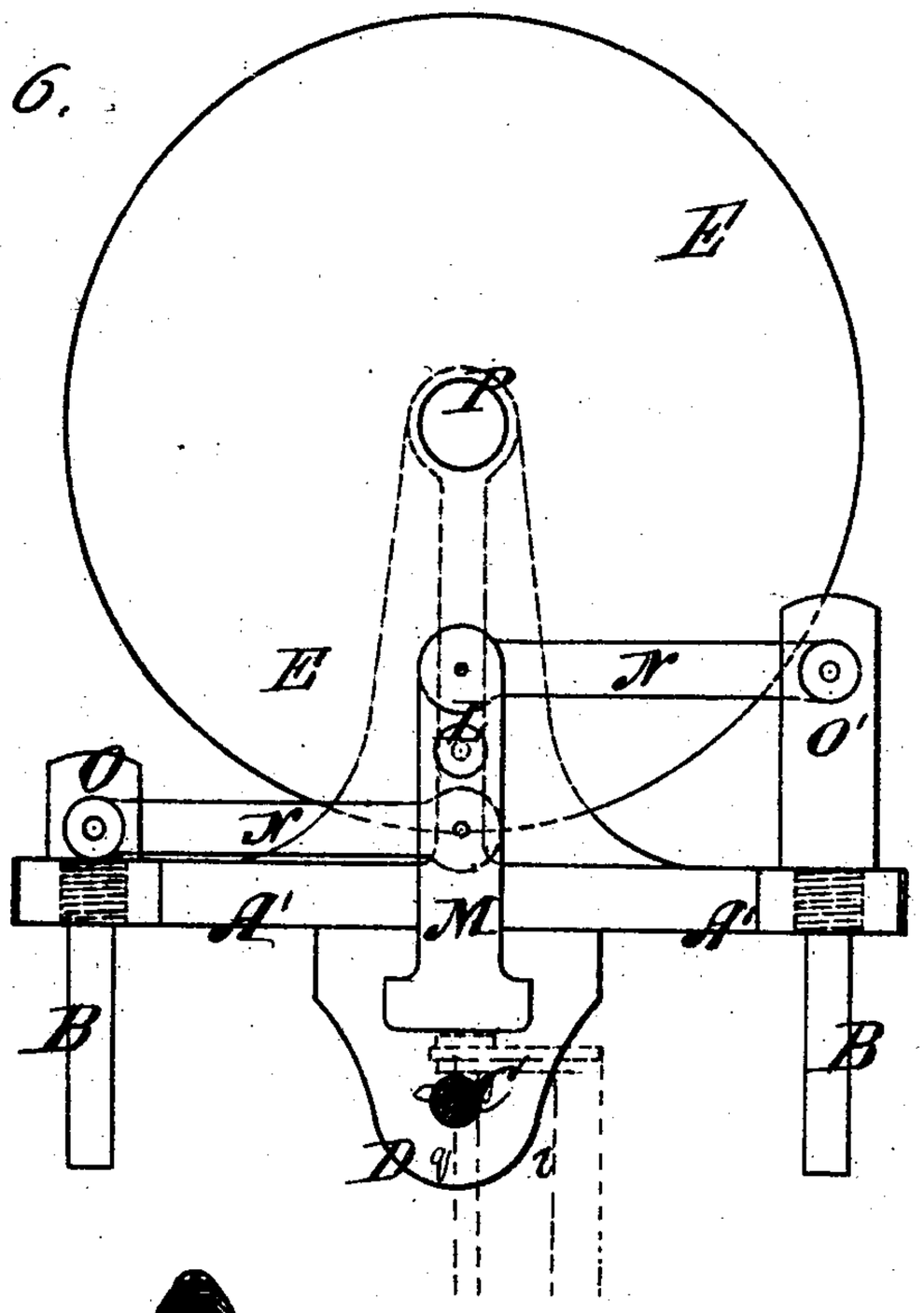
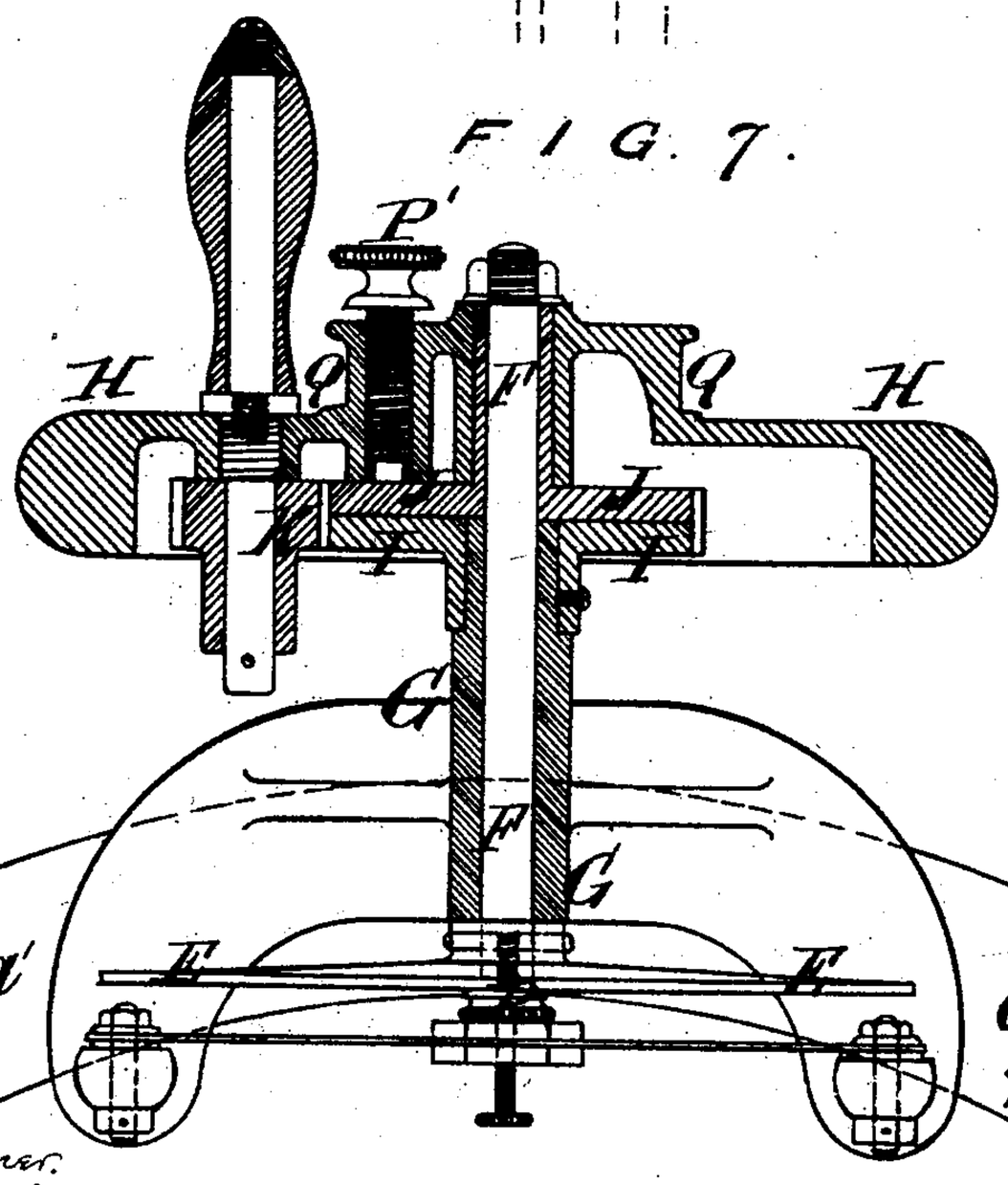


FIG. 7.



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by his Attys
Howson & Sons

UNITED STATES PATENT OFFICE.

NORMAN MACBETH, OF BOLTON, COUNTY OF LANCASTER, ENGLAND.

APPARATUS FOR RECORDING THE VARIATIONS OF SPEED IN MOTIVE-POWER ENGINES.

SPECIFICATION forming part of Letters Patent No. 377,111, dated January 31, 1888.

Application filed July 15, 1886. Serial No. 208,153. (No model.)

To all whom it may concern:

Be it known that I, NORMAN MACBETH, a subject of the Queen of Great Britain and Ireland, residing at Bolton, in the county of Lancaster, England, have invented certain Improvements in Apparatus for Recording the Variations of Speed in Motive-Power Engines, of which the following is a specification.

My invention relates to speed-recorders in which the tracer is raised and lowered by the action of a governor operated from the engine or other revolving part, so as to mark the indications upon a strip of paper or material which is bent around the inside of a circular case. The present invention relates more particularly to a novel arrangement of the tracer-carrier, whereby at the end of each day's work a fresh tracer is presented to the paper in a different plane, so that the record of, say, a week's work can be taken automatically. My improved recorder is made either with or without an adjunct for analyzing or enlarging a portion of the record when such analysis or enlargement is thought to be necessay.

Sheet 1 of the annexed drawings illustrates the improvements applied to the recorder, and Sheet 2 shows the analyzing or enlarging apparatus.

Figure 1 is a vertical section of a complete recording apparatus. Fig. 2 is a plan of the double lever-arm which moves the tracer-carrier. Fig. 3 is an enlarged view of the tracer-carrier. Fig. 4 is a plan of the device shown in Fig. 3, with the addition of a portion of the casing. Fig. 5 is a diagram of a piece of the record sheet. Fig. 6 is an elevation of the analyzer drawn to a larger scale, and Fig. 7 is a sectional plan view of the same.

The recorder-casing *a* is cylindrical in form, and contains a governor, *b*, which is driven from the engine by a band passing round the pulley *c*. The shaft which carries the pulley *c* is connected by bevel-gearing *d* to the upright shaft *e*, which supports the governor. As the governor revolves, the arms *f* rise or fall, and correspondingly raise or lower the weighted sleeve *g*, which is connected by links *h* to the arms *f*. On the top of the sleeve *g* is supported the lower end of a spindle, *i*, which revolves and slides in a sleeve-bearing, *j*, and carries at its upper end the double lever-arm *k*, which communicates the rising-and-falling motion to the tracer-carrier *l*. The tracer-carrier *l* (which is not fully shown in Fig. 1, but is more clearly illustrated in Figs. 3 and 4) is mounted to turn and slide on a stud, *m*, on the outer end of the revolving arm *n*, the said arm *n* revolving on a reduced extension of the sleeve-bearing *j*. A toothed spur-wheel, *o*, is fixed by a set-screw to the boss *n'* of the arm *n*, so that as the spur-wheel *o* is revolved by the clock-work arrangement *p* and connecting-gearing shown the arm *n* is correspondingly revolved to the extent of, say, one revolution per twenty-four hours. The tracer-carrier *l* is thus taken once round the interior of the cylindrical case in each twenty-four hours. As more clearly shown in the enlarged view, Figs. 3 and 4, the tracer-carrier consists of a sleeve, *l*, having projections *l'* at the top and the bottom, which carry a tracer-bar, *q*, the said bar *q* being provided with a number of tracers, r' r^2 r^3 r^4 r^5 r^6 r^7, corresponding in the present instance to the number of days in the week.

It will be observed that each tracer-point is set at a different angle to the others, so that when one of the tracer-points is resting on the paper the other tracer-points will be clear of the paper. The top of the bar *q* carries a ratchet-wheel, *s*, the teeth of which correspond to the number of tracer-points. A spring-detent, *t*, prevents the ratchet-wheel from revolving more than one tooth at a time. A projection, *z*, on the sleeve *l* serves as a shoulder, whereby the double lever *k* raises the tracer-carrier, and at the lower end of the sleeve *l* is a projection, *v*, to which a spring, *w*, is attached, as shown in Fig. 1, so as to hold the tracer-point against the paper. The strip of paper, P, is placed within the interior of the upper part, *a'*, of the casing *a*, and is held securely between the cover *x* and the spring-clip *y*, which is sprung into the case after the paper has been inserted. The paper, P, is ruled with, say, seven lines for the seven days, as shown at Fig. 5, each line being opposite to the center of its corresponding tracer-point when the engine is at its normal speed. Thus at the commencement of a week's work line 1 will be opposite to tracer-point r'. At the end of the first day's work, starting from the point A, Fig. 4, the tracer-carrier will have com-

pleted the circuit in the direction of the arrow, and the projection A will come into contact with the tooth of the ratchet-wheel which corresponds to the tracer-point r', and will cause the tracer-bar q to make one-seventh of a revolution, presenting the tracer-point r^2 to the line 2 on the paper and recommencing a fresh record for the current day. The ratchet-wheel might be dispensed with and the bar q be turned by acting directly upon the tracers, as if they were teeth upon the bar; but I prefer to use a ratchet-wheel for the purpose. The bar q is thus revolved and a fresh tracer-point presented daily until the week's work is completed, after which the paper is removed and a fresh slip inserted.

If desired, the paper could be made to contain more than one week's work, in which case the number of tracers would be correspondingly increased.

In addition to the day-lines the paper may also be marked with indications of time, such as hours, half-hours, &c. The rise and fall of the tracer-points may correspond exactly with the rise and fall of the governor; or, if desired, the rise and fall of the tracers as compared with the movements of the governor may be multiplied or diminished. When it is desired that the rise and fall of the tracer shall correspond exactly to the movement of the governor, the double lever k is fixed to the block 1 by both of the pins 2 and 3, in which case the lever k rises and falls in a horizontal plane and moves the tracer-carrier exactly as the governor rises and falls. Should it be desired, however, to exaggerate the movements of the tracer-point as compared with the movements of the governor—as, for example, in the case of an engine in which the variations of speed are not great—it is only necessary to remove one of the two pins 2 and 3 and insert a stop or roller, 4, (indicated in dotted lines,) between the prolonged ends of the double lever k. The bent tail of the revolving arm n prevents this end of the double lever from rising, and acts as a fixed fulcrum, the motion of the free end of the double lever being thus correspondingly increased. The tracer-carrier is thus raised and lowered to a greater degree, as compared with the movements of the governor, than in the former case. When it is required to diminish the movements of the tracer, as compared with those of the governor, which might be desirable in the case of an engine running at greatly-varying speeds, the required diminution may be effected by removing the roller 4 from the outer end of the double lever and placing it in the position marked 5, a projection being formed on the arm n to act as an abutment to the roller in this position.

A set-screw, 6, and jam-nut are or may be applied to the block 1, to prevent the lever k and tracer-carrier from falling below a certain point. The block 1 is screwed upon the upper end of the spindle i, and is jammed in position by a nut, 7. The arm n and spur-wheel o are kept in their position on the checked sleeve-bearing j by a collar, 8, retained by a set-screw.

Owing to the slow speed of the clock-work the indications of the tracers on the paper are usually so close together that it is almost impossible to distinguish the separate up-and-down strokes of the tracer.

In order to analyze or spread out these markings, so as to render them separately more apparent as regards fluctuations within a very short space of time—say, for example, during one or more revolutions of the engine—I use the part of the apparatus shown on Sheet 2 of the annexed drawings.

The frame A′ of the apparatus is made capable of being readily secured to and removed from the rim of the upper part, a', Fig. 7, of the cylindrical casing a, within which the paper is applied.

The frame is made with two steadying pins or studs, B, which lie against the inner circumference of the casing a', while a pinching-screw, C, passing through a projection, D, on the frame, serves to bind the frame to the casing. A disk, E, is carried by a shaft, F, mounted in a sleeve-bearing, G, carried by a bracket projecting from the frame A′, and the said shaft can be rotated from a hand-wheel, H, on the end of the shaft. I prefer to apply differential gearing between the hand-wheel and the shaft, so as to rotate the shaft and disk E slowly in comparison with the speed of the hand-wheel. This object is effected in the present instance by fixing a spur-wheel, I, by means of a pinching-pin, on the end of the sleeve-bearing G.

Another spur-wheel, J, is placed alongside of and in contact with the spur-wheel I, both wheels gearing with a pinion, K, running loosely on a stud on the hand-wheel H. A difference of, say, one tooth exists between the wheel I and the wheel J, the wheel I having, say, one hundred teeth and the wheel J ninety-nine teeth. As the hand-wheel H is rotated, the pinion K, deriving motion from the fixed wheel I, causes the wheel J to advance by one tooth to each revolution of the hand-wheel, the shaft F and disk E being therefore rotated to that extent. A tracer, L, projects from the link M against the face of the disk E, the link M being connected by links N with fixed points O O′ on the frame A in such a manner as to insure the perpendicular rise and fall of the tracer L. A paper disk is applied to the face of the disk E and is secured thereto by the screw P′.

When it is desired to use the analyzer, it is fixed to the top of the casing a' and opposite to wherever the tracer-carrier shown in Sheet 1 of the drawings happens to be. The foot of the link M is placed upon the top of the tracer-carrier, as indicated by dotted lines in Fig. 6, so as to partake of its up-and-down movements. When all is prepared, the tracer L on the link M is set up against the paper on the disk E and the hand-wheel H is turned in unison with

the crank of the engine. As the disk rotates much more quickly than the traverse of the clock-work in the casing *a*, the markings of the tracer L are correspondingly wider apart than the markings of the tracers r' r^2, &c., on the tracer-carrier beneath, and can be easily read.

The differential gearing between the hand-wheel H and the shaft and disk E might, if desired, be dispensed with, or where the apparatus is made with differential gearing, as shown on the drawings, the analyzer may be used without the gearing by removing the pinion K and binding the hand-wheel to the spur-wheel J by means of the pinching-screw P'. When this is done, the shaft and disk can be rotated directly by turning the hand-wheel. Where it is desired to secure exact unison between the motions of the engine and the analyzer, I may pass a band or cord from a reciprocating or revolving part of the engine around the pulley Q on the hand-wheel, in which case the handle would be unscrewed from the hand-wheel. When the said cord is attached to a reciprocating part of the engine it will act in the same manner as the cord which actuates the ordinary Richard's indicator, the recoil being effected by a weight or spring; or the free end of another band could be held in the hand and pulled against the pull of the working-band. By the latter means a diagram would be taken in the form of a loop, showing the fluctuations during one revolution of the engine.

The invention is applicable in recording speeds other than the speed of prime motors.

I claim as my invention—

1. In a speed-recorder, the tracer-bar *q*, carrying a number of tracers, r' r^2, a traversing arm carrying the bar, and a case carrying a slip of paper to receive the record, in combination with means, substantially as described, for turning the said tracer-bar at intervals, whereby the tracers are presented in successive order for marking the slip.

2. The combination of the cylindrical case containing the record-paper of a speed-recorder with a traversing arm carrying a tracer-bar, *q*, with a number of tracers, a ratchet-wheel on the tracer-bar, and a fixed stop on the case to turn the tracer-bar as the traversing arm moves in the case, substantially as set forth.

3. The combination of the traversing arm and tracer-bar of a speed-recorder and the casing carrying the paper with the analyzing apparatus consisting of a frame adapted to the arm of the recorder-casing, a moving disk, E, a tracer, L, and a link, M, carrying the tracer and adapted to rest on and be operated by the tracer-bar of the recorder, all substantially as set forth.

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

NORMAN MACBETH.

Witnesses:
DAVID FULTON,
ARTHUR LEOSER.