No. 644,743. Patented Mar. 6, 1900.

J. KARLIK.

SPEED RECORDER.

(Application filed May 13, 1899.)

(No Model.) 2 Sheets—Sheet 1.

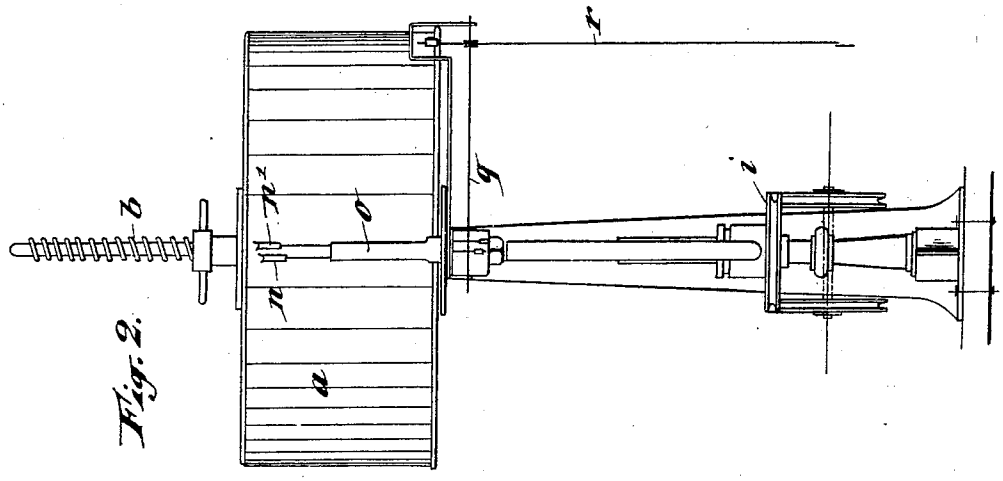


Fig. 2.

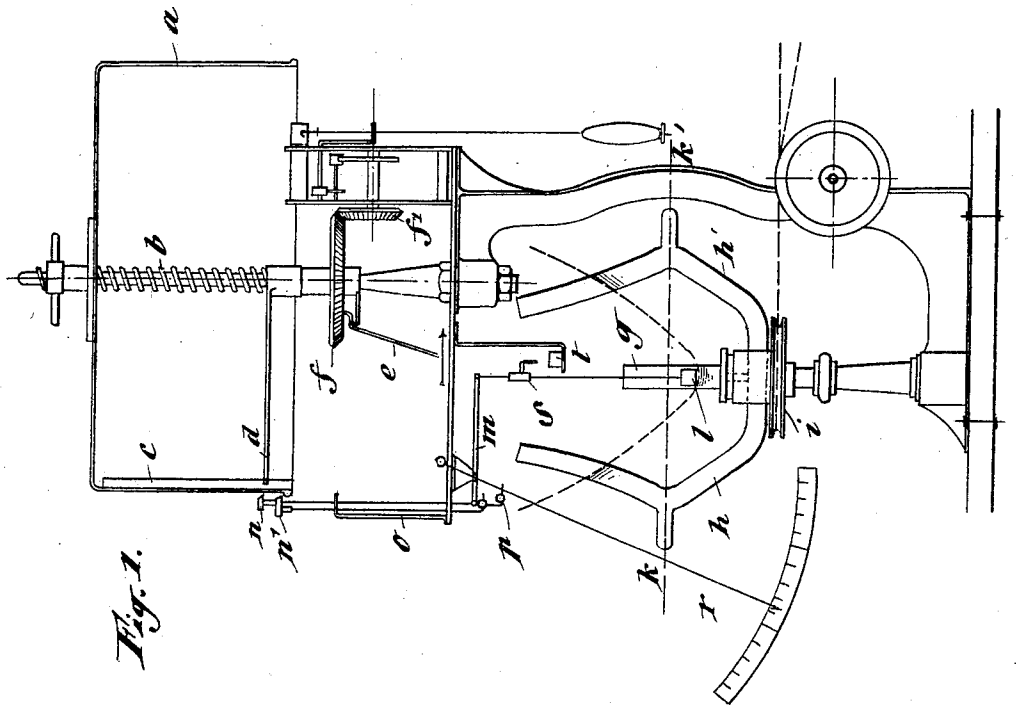


Fig. 1.

Witnesses
George D. Richards
C. D. Davis

Inventor
John Karlik
by Wm. H. Babcock & Co.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 644,743. Patented Mar. 6, 1900.

J. KARLIK.

SPEED RECORDER.

(Application filed May 13, 1899.)

(No Model.) 2 Sheets—Sheet 2.

Fig. 3.

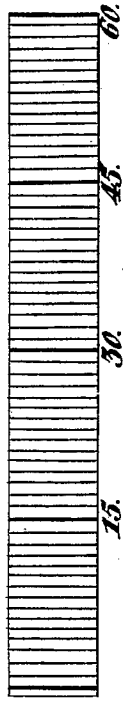
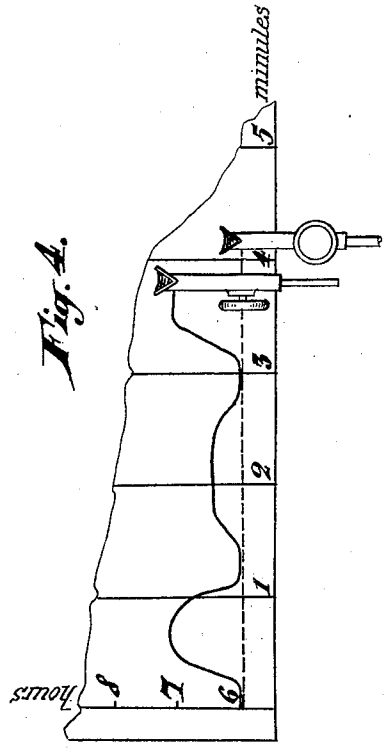


Fig. 4.



Witnesses,
George N. Richards
C. D. Davis

Inventor,
John Karlik
by W. H. Babcock
Atty

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

JOHN KARLIK, OF KLADNO, AUSTRIA-HUNGARY.

SPEED-RECORDER.

SPECIFICATION forming part of Letters Patent No. 644,743, dated March 6, 1900.

Application filed May 13, 1899. Serial No. 716,636. (No model.)

To all whom it may concern:

Be it known that I, JOHN KARLIK, a citizen of the Empire of Austria-Hungary, residing at Kladno, Austria-Hungary, have invented certain new and useful Improvements in Speed-Recorders or Tachographs for Main and Transmission Shafts, of which the following is a specification.

The present invention relates to a speed-recorder for driving-shafts and line-shafting in which the drum that receives the diagram-paper is mounted on a screw having a pitch such that the drum descends automatically by its own weight and uniformly by reason of the action of a brake. A liquid (preferably mercury) inclosed in a system of communicating tubes caused to rotate by the shaft the speed of which it is desired to measure moves a scribing-stylus that draws the diagram of the speed, while a fixed stylus draws the base-line of the diagram.

The accompanying drawings illustrate, by way of example, a form of construction of the new speed-recorder.

Figure 1 is a front elevation, partly in section, of the apparatus. Fig. 2 is a side elevation. Fig. 3 is a developed view of the diagram-paper. Fig. 4 shows a portion of a diagram, as well as the base-drawing stylus and the recording-stylus.

a is the drum, on which lies the strip of paper on which the diagram is to be drawn. The drum is free at the top and on the sides in order to facilitate the placing of the strip of paper. The drum, mounted on the fixed screw *b*, acquires, by reason of its own weight, a rotary motion about said screw, which causes it to move in a determined period (several hours or several days) from the position shown in Fig. 1 into the position shown in Fig. 2 in such a manner that every point of the drum will describe a helix corresponding to the pitch of the screw.

In order to render uniform and to regulate the motion of the paper-drum, a crank-arm *d*, ending in a groove *c* in the drum, transmits the force of rotation to gearing *f f'*, which transmits it to a governor of the fixed or of the pendulum type. By varying the ratio of the gearing and the phases of the braking action any desired duration of rotation can be obtained. On pushing back the lever *e* in the direction of the arrow the bevel-wheels *f f'* become disengaged and the drum can be rotated in any direction in order to set it to the time, or it can be wound up completely for the purpose of placing a fresh strip of paper on it.

The diagram-paper is divided into minutes, as indicated in Fig. 3, when it is required to record speeds that vary quickly, while a division into hours is sufficient for recording speeds that vary slowly. The helicoidal base-line corresponding to the pitch of the screw is drawn by a fixed stylus at the same time that the diagram is being drawn. This base-line, which is drawn automatically and perfectly straight, when developed constitutes the axis of the abscissæ for the diagram to be drawn, while the ordinates that are drawn to said axis of abscissæ give the measure of the speeds in a given time.

The speed-recorder proper which serves for producing the diagrams is of the most simple kind and consists of the central vertical tube *g* and of the lateral tubes that communicate with the central tube and are of a peculiar shape based on calculation of the centrifugal force. The annexed drawings show two lateral tubes *h h'*. These three tubes are hermetically inserted in the head of a shaft provided with a grooved pulley *i* and they are filled up to the level *k k'* with a suitable liquid, preferably mercury, on account of its greater ascending force and its less tendency to evaporation. The pulley is connected by means of a belt to the driving-shaft or line of shafting which it is required to control and which actuates the entire arrangement of tubes and thus subjects the liquid to a rotary motion. The centrifugal action resulting from this rotation causes the mercury to descend in the central tube *g*, while it rises in the lateral tubes *h h'* in proportion to the speed of the driving-shaft or line-shafting which it is required to control.

In order to regulate the descent of the mercury in a simple ratio to the number of revolutions of the shaft, it is necessary to make the lateral tubes *h h'* of a shape which is based on the calculation of the centrifugal action and which has the result of converting the increase in the centrifugal action that is proportional to the square of the number of revolutions into a simple progression of the descent of the mercury in the tube *g*.

The shape of the lateral tubes *h h'* is based

upon the following principles: When a receptacle containing any desired liquid is rotated, the surface of said liquid will assume a parabolic form, as is well known. Therefore such a receptacle could already serve as a speed-indicator if it is provided with a float, provided that the liquid follows immediately the movement of the receptacle; but such a speed-indicator would not indicate for like differences in the number of revolutions like differences of the float, but it would act only very weakly for a low speed and too strong for a high speed. On the other hand, when the liquid contained in a series of tubes connected to each other is adapted to be lowered at the center as much as has been adopted for a given difference of speed and when the parabolas corresponding to greater differences of speed have been drawn the shape of the lateral tubes may be exactly determined after selecting or adopting a given system of tubes. The shape of the tubes may be determined graphically or analytically.

Analytic determination.—Assuming the centrifugal force = C, the weight of a small mass $d\,m$ of liquid = G = $d\,m \times g$, the angular speed = $w = e \times$ const., then we have

$$C = x \times w^2 \times d\,m$$

and

$$\text{Tan. } \alpha = \frac{C}{G} = \frac{x \times w^2 \times d\,m}{d\,m \times g} = \frac{x \times w^2}{g};$$

but the resultant force of C and G is at right angles with the surface of the liquid. Therefore

$$\text{Tan. } \alpha = \frac{d\,y}{d\,x}.$$

$$\text{Tan. } \alpha = \frac{d\,y}{d\,x} = \frac{x\,w^2}{g}$$

$$\int d\,y = \frac{w^2}{g}\int x.\ d\,x.$$

$$y = \frac{w^2}{g} \times \frac{x^2}{2} + \text{const.}$$

If $x = o$, then $y = o$, and therefore const. $= o$. So I find

$$y = \frac{w^2}{g} \times \frac{x^2}{2} = \frac{x^2\,w^2}{2\,g}$$

and

$$w = e.\ \text{const.}$$

Therefore

$$\frac{y = x^2 \times e^2.\ \text{const.}}{y_o = x_o^2 \times e_o^2.\ \text{const.}}$$

and

$$y_n = x_n^2 \times e_n^2.\ \text{const.}$$

$$\frac{y_o}{y_n} = \frac{x_o^2 \times e_o^2}{x_n^2 \times e_n^2}.$$

It follows, therefore, that

$$x_n = x_o \frac{e_o}{e_n} \sqrt{\frac{y_n}{y_o}}.$$

In this formula x_o and y_o are assumed to be known, $\frac{e_o}{e_n}$ will be selected as desired, and y_n will be approximately known by the equation of the volumes. Thus it is evident that the center line of the lateral tubes may be readily drawn by means of the above formula.

The shape of the lateral tubes being thus determined, the volumes v, displaced in the central tube by the action of the centrifugal force, will balance two volumes v in said lateral tubes, and the descent of the liquid will be regulated in a simple ratio to the number of revolutions of these tubes.

Upon the mercury in the central tube there floats a light float of cork or similar material which moves with the level of the mercury and transmits its motion to the stylus n either directly or through the medium of the lever m, as indicated in the drawings. By varying the ratio of the arms of the levers the amplitude of the diagram can be varied. Also by varying the ratio of the gearing of the drum the development of the diagram can be varied. A fork o insures the guidance and a weight p insures the light contact of the stylus n. The fixed adjacent stylus n', which draws the base-line, is provided with the same arrangements. The prolonged axle q of the lever m carries a hand or pointer r, which can be seen from the engineer's box and which indicates on a scale the speed (number of revolutions) of the shaft.

In order to notify the engineer by an audible signal that the maximum speed is reached, the lever m is provided with a vertical rod s, which when the float is in its extreme lower position, corresponding to the said maximum speed, plunges in a cup t, filled with mercury, and thus closes the circuit of an electric bell.

The apparatus is inclosed in a cupboard fitted with glass panels in order to protect it from the attempts of persons of bad intent. It may be illumined at night-time, so as to render the pointer visible from the engineer's box.

In order to enable the invention to be more clearly understood, I shall now proceed to describe the application of an apparatus to a pit-hoisting engine.

In order to enable the diagram to indicate exactly the time in seconds of each ascent and of each stoppage for changing the cage, the drum must move through a sufficiently great distance per unit of time. For example, it must make one revolution every two hours, so as to move in twelve revolutions (twenty-four hours) the drum down the screw b from the starting position, Fig. 1, into the end position, Fig. 2. During this rotation the fixed stylus has only drawn the base-line of helicoidal form, (visible in part in Fig 4,) and the stylus n, actuated by the float of the tachometer, has drawn the diagrams of the different ascents.

Fig. 4 shows after six hours' time a diagram of the speeds and of the time consumed in the ascent of a coal-skip, a diagram of the ascent of a cage containing workmen, and an unfinished diagram of a fresh ascent of a coal-skip.

For driving-shafts or line-shafting whose speed does not undergo such great fluctuations in short periods of time—such as exhausting-machines, blowing-engines, rolling-mills, &c.—it will be sufficient to arrange the drum to make one revolution per day, so that a single strip of paper will be capable of recording the diagrams of twelve working days, or of a fortnight.

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

1. A registering tachometer or tachograph for main and transmission shafts, comprising: a drum receiving the diagram-paper, and axially mounted on a screw, along which it is moved by its own weight; a braking device for regulating the rotation of said drum; the tachometer proper actuating the registering stylet or point, and a second stationary stylet for drawing the base-line on the diagram, substantially as and for the purpose set forth.

2. A registering tachometer or tachograph for main and transmission shafts, comprising a movable drum receiving the paper for diagrams, a series of interconnected tubes rotated by the shaft acted on and containing liquid, a float on the liquid in the central tube, a movable stylet actuated by the float and registering on the paper of the drum, the variations of the liquid-line corresponding to the variations of speed of the shaft, and a stationary stylet drawing the base-line on the diagram drawn by said movable stylet, substantially as and for the purpose set forth.

In testimony whereof I affix my signature in presence of two witnesses.

JOHN KARLIK.

Witnesses:
L. A. STURM,
GREGORY PHELAN.