Sept. 14, 1943. O. J. LEONE 2,329,400

TACHOMETER

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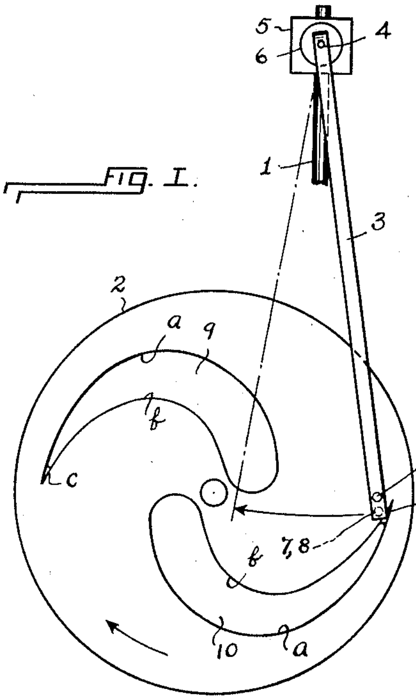

FIG. I.

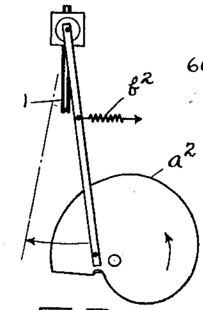

FIG. V.

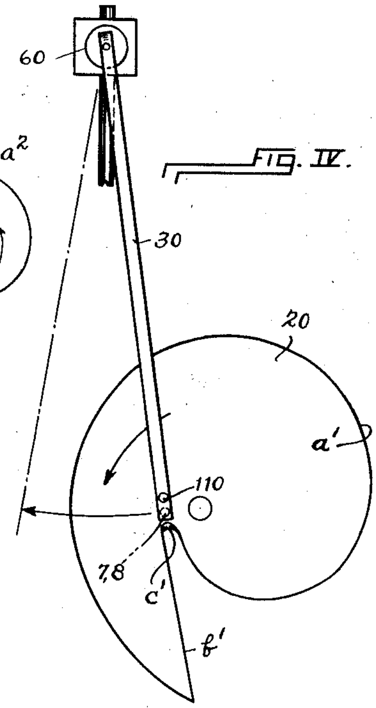

FIG. IV.

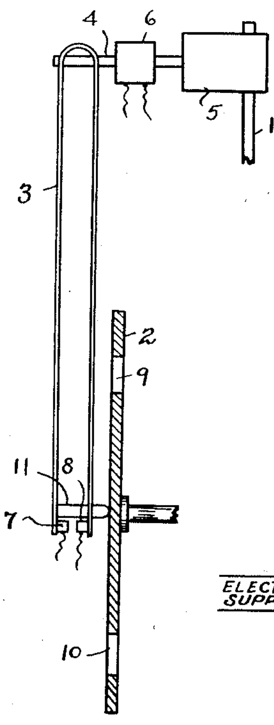

FIG. II.

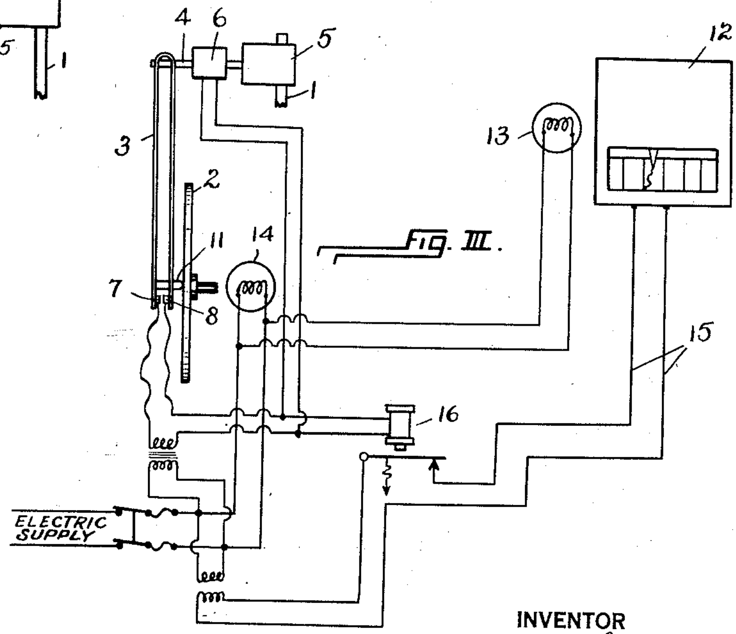

FIG. III.

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TACHOMETER

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3 Claims. (Cl. 235—61)

This invention relates to tachometers, and finds practical application in affording indication at successive regularly recurrent intervals of time of the instant angular speed of a rotating member. The successive values may, of course, be cumulated; and, in case the rotating member is (for example) the driven shaft of a displacement meter operated by a flowing stream of fluid, the cumulated value of the successive indicia will be an index of the volume of the stream flow.

In the accompanying drawing Figs. I and II are diagrammatic views in front elevation and in vertical section of the essential features of the tachometer of my invention. Fig. III is a diagram of means of affording visible indication of and, it may be, of making record of and cumulating successive instant values of the variable speed that is under mensuration. Fig. IV is a view corresponding to Fig. I, and illustrating a tachometer of the invention with some variety in form. Fig. V is a view corresponding to Figs. I and IV, but to smaller scale, and illustrating further variety in form.

Referring, first, to Figs. I and II, a shaft is indicated at **1**, and it may be understood that this shaft rotates in response to the flow of fluid in a conduit, and at a rate varying with the rate of flow. It may be the driven shaft of a displacement meter. A disk **2** is provided, and it may be understood that the disk rotates at constant speed, and in the direction indicated by an arrow. An arm **3** borne by a shaft **4** is arranged to swing in a plane adjacent to and parallel to the face of disk **2** and in its range of swing the distal end of the arm follows a path that is approximately radial with reference to the disk **2**. A suitable train of transmission gears, indicated conventionally at **5**, imparts swinging movement in clockwise direction to arm **3** in response to rotation of shaft **1**; and in this line of transmission is arranged a magnetically controlled clutch **6**.

The arm **3** is of the bifurcated, hairpin shape, best seen in Fig. II; and its two branches carry at their distal ends electrical contact pieces **7** and **8**. The bifurcated arm is a spring structure and tends to close, with the pieces **7** and **8** in contact. The arm with its contact pieces forms a make-and-break device in the circuit of the magnet that controls the clutch **6**; and the make-up-break device is operated by the turning of the disk **2**. The disk **2** is recessed, as at **9** and **10**, and one of the branches of the bifurcated arm **3** is equipped with a stud **11**.

In the course of disk rotation, this stud is alternately engaged by the face of disk **2** (and the contact pieces held apart), or is by the advance of the recesses **9** and **10** released (and, thereupon, the resilience of the bifurcated arm **3** is effective to close the contact). When the contact is closed the clutch **6** otherwise closed is opened and the arm **3** is arrested in its clockwise swing, and is free to respond to other forces tending to swing it in opposite direction.

The leading edge *a* of each recess **9** and **10** (the two recesses are alike, and are symmetrically formed with respect to the centre of rotation) extends from a point adjacent the centre of rotation in a rearwardly trailing curve toward the periphery: that is to say, each successive point in the outward extension of the curve lies in a radius that is to rearward (relative to the direction of turning) of the radii of the preceding points. The edge *a* extends in obliquity to the radii. The trailing edge *b* also extends in a rearwardly trailing (forwardly advancing) curve, and converges to the edge *a* and forms with the edge *a* toward the periphery of the disk a sharp-angled end *c* to the slot.

In operation (the parts being in the position shown in Fig. I, and the clutch **6** being closed), the disk **2** turns clockwise and at constant and predetermined speed, and the arm **3** swings clockwise, and at a speed that accords with the speed of turning of shaft **1** (a variable rate). The stud **11** bearing endwise upon the face of disk **2** holds the contact pieces spaced apart, as seen in Fig. II. As disk and arm continue to move, the stud **11** borne by the arm **3** will pass beyond the leading edge *a* of the recess **9**. Thereupon the make-and-break device, relieved of restraint, will under its inherent spring tension close; the contact pieces **7** and **8** will come together, the clutch **6** will open, and the arm **3**, no longer driven, will stop. Thereafter, as the disk **2** continues to rotate, the trailing edge *b* of the recess **9** will engage the side of the stud **11**, and, by virtue of the shape of that edge, will swing the arm **3** back again in counter-clockwise turning to its initial position. The recess **9** at its outer end *c* and the tip of stud **11** will be so minutely shaped as to spread the make-and-break device and bring the stud **11** again to endwise bearing upon the face of the disk. In the spreading of the make-and-break device the controlling electric circuit will be broken; the clutch **6** will close; and, with the return of the stud **11** to endwise abutment upon the face of the disk, the cycle of operation will be repeated.

It will be apparent that, as the rate of turning of shaft 1 is slow or fast (within the range to which the instrument is adapted), the point at which the stud 11 crosses the leading edge a of recess 9 (the point that defines the limit of the range of swing of the arm 3) will be near to or remote from the circumference of the disk; the period of time during which the stud 11 bears upon the face of the disk will be long or short; and in the amplitude of such swing and in the duration of this interval are found the measure of the rate of turning of the shaft 1.

The leading edge a of the slot is so particularly shaped that the interval of contact of the stud 11 with the face of disk 2 (the interval in which the contact pieces 7 and 8 are held apart, with the clutch 6 closed) varies directly as the rate of flow that impells rotation of shaft 1 and swing of arm 3; that is to say, when (for instance) the rate of flow is doubled, the stud 11 will cross the edge a when the arm 3 has swung through an angular range exactly twice that of the lower rate of flow; and so with other rates of flow. Thus the successive values of the rate of flow plotted against the successive intervals of contact of the stud 11 with the face of disk 2 yield a straight line.

The curvature of edge a may be calculated, and in a given instrument may after cutting be rendered accurate by minute shaping when brought into comparison with a standard instrument.

The drawing shows two recesses in disk 2; the number is not important. The important fact is that with each rotation of disk 2 (the rotation is at constant speed), the arm 3 swings one or more times (in this case, twice), and through a range of space and an interval of time that measure the instant value of the variable rate of rotation of shaft 1.

Referring to Fig. III the reference numeral 12 is applied to an instrument in which, through the agency of suitable electromagnetically controlled clutch elements, a constantly driven mechanism is caused to bring an index to position, in accordance with the relative durations of recurring impulses in an electric circuit. Such an instrument is fully described in United States Letters Patent No. 2,040,918, granted May 19, 1936, to C. W. Bristol, and it suffices here to note that the instrument may be either of the indicating or of the cumulative recording type or both; that the constantly driven mechanism of the instrument is operated by a telechron drive 13, and the disk 2 is operated by a telechron drive 14, and the two drives operate in synchcronism; and that the recurring electric impulses are transmitted through a circuit 15 to the instrument 12. The circuit 15 includes a relay 16 which closes the circuit when in rotation of the disk 2 the contact pieces 7 and 8 separate, and the circuit remains closed so long as the contact pieces are, by the engagement of stud 11 with the face of disk 2, held apart. Such closing of the relay produces an electrical impulse in the circuit and the duration of the impulse is determined by the time interval in which the stud 11 bears upon the face of the disk 2. It will be understood, therefore, that the continuous and constant rotation of the disk 2, effecting the recurrent opening and closing of the contact pieces, produces recurrent electrical impulses in the circuit 15; and from the foregoing description it will be understood that the duration of each impulse is proportional to the instant value of the speed of rotation of the meter shaft 1. Thus the instrument 12, whose index shifts in accordance with the durations of the recurrent impulses transmitted to it, affords an indication of the instant value of the rotary speed of the meter shaft 1, or the rate of flow of fluid through the meter that rotates the shaft. And as already mentioned, the instrument 12 may be of the recording type, in which case it will make cumulative record of the value of the duration of the successive impulses; and, the parts being properly standardized, may afford indication of volume of fluid that passes through the meter.

Fig. IV illustrates an alternate form for the rotating disk of the tachometer. In this case the arm 30 swings once with each rotation of the disk, and the peripheral edge portions a' and b' function, respectively, as the edge portions a and b of each of the slots 9 and 10 of the disk 2, first described. Whereas in the first-described structure the point of origin of swing of the arm (one or the other of the points c at which the converging edge portions a and b of the slots 9 and 10 meet) is near the periphery of the disk, in the alternate structure the point of origin of swing of the arm is near the centre of the disk—at the point c' where the edge portions a' and b' meet.

The operation is essentially that already described: In the course of disk rotation at constant velocity and in the direction indicated by an arrow (in this case counter-clockwise), the stud 110 is engaged by the face of the disk (and the arm-borne contact pieces 7 and 8 held apart); the clutch 60 is closed, and the arm 30 is caused to swing, until in such movement the stud 110 passes beyond the edge a' of the disk. Thereupon the contact pieces come together; the clutch opens, and the arm stops. The arm remains at rest until the edge portion b' of the rotating disk laterally engages the stud 110 (as manifestly it will) and returns the arm to its initial position, whereupon the cycle of operation will be repeated.

As in the case of the edge a of the disk 2, Fig. I, the edge a' of the disk 20, Fig. IV, is so particularly shaped that the interval of contact of the arm-borne stud with the face of the disk varies directly as the rate of flow of the fluid that is under mensuration.

In each of the structures of Figs. I and IV an edge portion (b or b') of the rotating disk is by lateral engagement with the arm-borne stud effective to return the arm from the end of its swing to the point of origin. Fig. V illustrates that a spring b^2 may be effective to such end. The spring is of less potency than the arm-swinging torque transmitted from shaft 1 through the magnetic clutch, but the potency of the spring is effective, as the arm swings clockwise and the arm-borne stud moves beyond, and into lateral engagement with, the edge a^2 of the disk, yieldingly to hold the stud against such edge of the disk. Thus in the uninterrupted rotation of the disk (in the counter-clockwise direction indicated), the arm is under spring tension returned to its initial position.

While I have indicated a practical application of my invention in association with a displacement meter for a fluid, it is manifest that the invention is applicable in the measurement of the rate of turning of any rotating machine part.

I claim as my invention:

1. In a tachometer, and in combination with a rotating machine part whose rate of rotation

is to be determined, an arm adapted to be brought intermittently into operative connection with the rotating part and adapted, when connection is established, to swing in response to such rotation and at a speed in accord with the speed of such rotation, a clutch through which operative connection is established between machine part and arm, clutch-opening means including a rotatable disk, means for rotating the disk continuously and at constant speed, and a spring-impelled control member borne by said arm and adapted to be alternately engaged by the rotating disk and released from such engagement, with consequent shifting between ineffective and effective positions, the said parts being so shaped and arranged that within a unit range of disk rotation the control member is shifted to ineffective position, released, and returned again to ineffective position, the engagement of the disk with the control member continuing throughout a fraction of such unit range that is great or less, according to the rate of swing of said arm.

2. The structure of claim 1, the effective shape of the disk in the cooperation with the control member being defined by an edge that extends obliquely to the radii.

3. The structure of claim 1, the control member being arranged in its engagement with the disk to bear upon the face of the disk, and the face of the disk being cut away along an edge that extends obliquely to the radii.

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