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2,414,508

TELEMETERING SYSTEM

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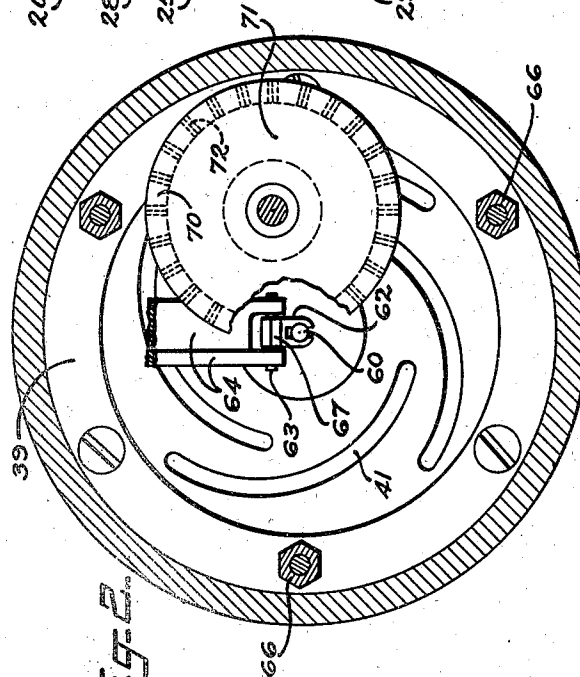
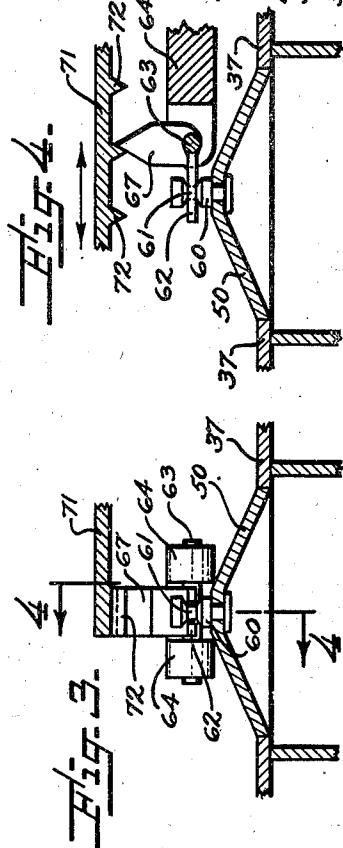
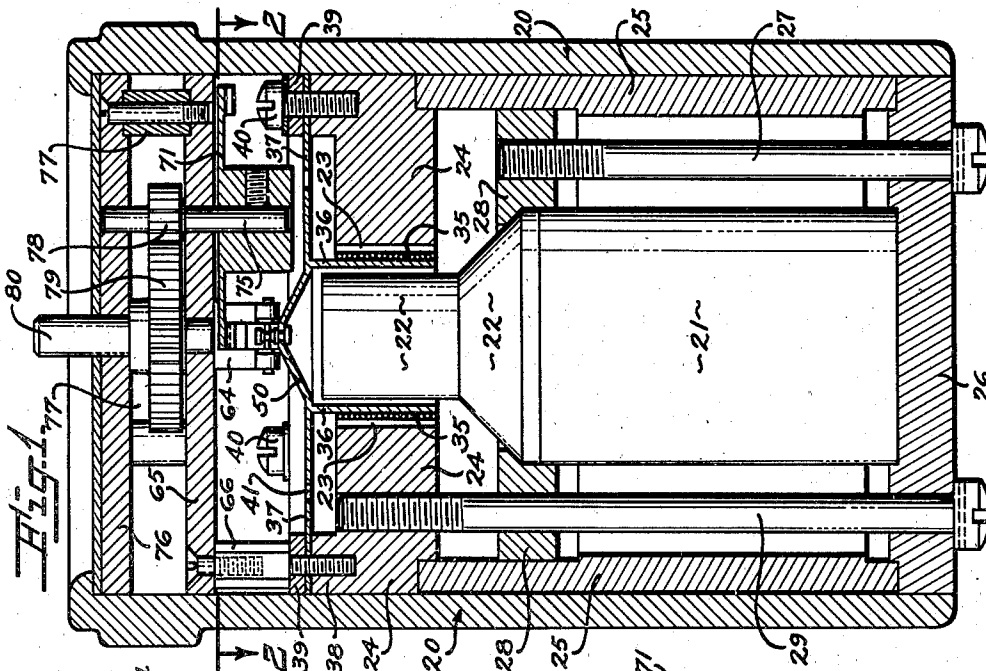


Fig. 2

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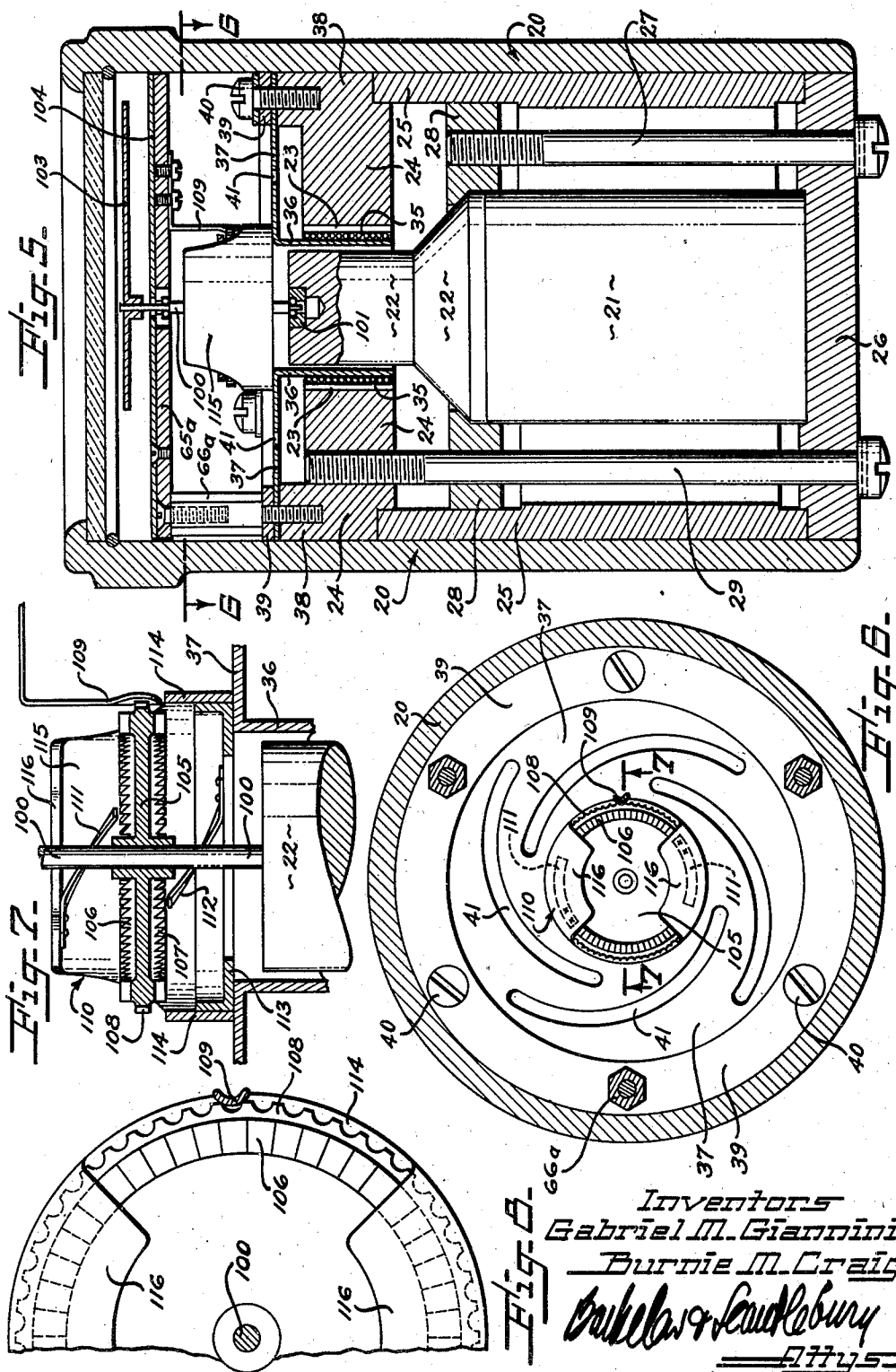
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TELEMETERING SYSTEM

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2 Sheets-Sheet 2



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TELEMETERING SYSTEM

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8 Claims. (Cl. 177-351)

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This invention relates to telemetering systems of the general type and kind in which a transmitting instrument generates a succession of spaced electrical impulses of sign depending on direction of transmitter movement; and a receiver is actuated by those impulses to remotely operate mechanisms, controls, counters or indicators, etc., in consonance with the operation of the transmitter. In such systems the transmitter may be manually operated, or may be actuated by any mechanism whose movement or whose condition may be desired to be reproduced or indicated at a distance. The operation is characterized by step-by-step energization and actuation of the receiver, and is further characterized by movement or actuation of the receiver in opposite directions according as the receiver receives positive or negative impulses.

A system of that general type and kind has been previously disclosed in the application of Gabriel M. Giannini, Ser. No. 597,459, filed June 4, 1945, and entitled Telemetric system. The present invention has the general objective and purpose of producing an instrumentation for the described type of telemetering systems, particularly adaptable to various industrial uses. The general nature of the invention will be best understood from the following description of preferred and illustrative forms of instruments which are shown in the accompanying drawings, in which

Fig. 1 is a vertical central section, with parts in elevation, showing a preferred and illustrative form of transmitter element;

Fig. 2 is a section taken as indicated by line 2-2 on Fig. 1;

Fig. 3 is an enlargement of certain portions of Fig. 1;

Fig. 4 is a section taken as indicated by line 4-4 on Fig. 3;

Fig. 5 is a central vertical section, with parts in elevation, of a preferred and illustrative form of a receiver element;

Fig. 6 is a section on line 6-6 in Fig. 5;

Fig. 7 is an enlarged detail cross section on line 7-7 of Fig. 6; and

Fig. 8 is a fragmentary enlargement in certain parts of Fig. 6.

Referring first to Figs. 1 to 4 of the drawings, a suitable and preferably cylindric case is shown at 20, containing a magnet system which is made up in cylindric assembly. The magnet system as shown comprises an axially located permanent magnet 21 with a pole-piece 22 at its upper end. The upper reduced cylindric portion of pole piece

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22 extends spacedly through a circular axial opening 23 in an annular pole piece 24 which is mounted at its outer periphery on a cylindric circuit element 25. The lower end of magnetic circuit element 25 rests upon a lower circular yoke piece 26 upon which the lower end of permanent magnet 21 also rests. The parts so far described are all composed of magnetically permeable material, preferably of low reluctance. A series of bolts or cap screws 27 (only one of which is shown in Fig. 1) pass through the lower yoke 26 and are threaded into an upper annular clamping member 28, of non-magnetic material, acting to hold pole piece 22 in close contact with the upper end of permanent magnet 21 and to hold the lower end of the magnet in close contact with yoke 26. And a series of screws 29 (only one of which is shown in Fig. 1) pass through lower yoke 26 and clamp 28 and are screw-threaded into upper annular pole piece member 24 to forcibly hold member 24, member 25 and yoke 26 in close contact. The assembled magnetic circuit thus has an annular air gap in the bore 23 of pole piece 24.

In the annular air gap at 23 a moving coil 35, wound as a helix on an axis which coincides with the central vertical axis of the magnetic system, is carried by a sleeve 36 which depends from an elastically flexible diaphragm 37, the sleeve and diaphragm being of non-magnetic material. The diaphragm is mounted at its outer periphery upon an upstanding flange 38 which is conveniently formed as an integral part of annular pole piece 24; an annular hold down ring 39 and screws 40 serving to rigidly secure the outer edge of the diaphragm. The diaphragm is preferably perforated with a pattern of spiral slots 41. By such perforations the flexibility of the diaphragm may be controllably increased without making the diaphragm too thin. Although other suitable spring means may be employed to maintain the coil in a normal medial position, and to return it to that position upon release from a displaced position at either side of the medial position; preferably that spring means is embodied in the described elastic diaphragm constructed of suitable spring metal or other material, such for instance as phosphor-bronze, fibre or plastic. Diaphragm 37 may be, and is preferably shown as flat in its annular portion between its outside edge and the depending sleeve 36. It is that portion of the diaphragm structure which is elastically flexible.

Suitable damping means may be used for damping free oscillations of the coil, but in the

structure as described no special damping means has been found necessary. The diaphragm is to some extent air damped, and may be made of a material which is not perfectly elastic. Also the sleeve 36 may be of a conductive material, to be damped by eddy currents. But in any case, whether or not any such damping is applied to the coil movements, current generation in the coil by reason of its movement tends to retard that movement and thus to damp oscillation.

Within the diameter of depending sleeve 36 the diaphragm is either formed into a conical formation 50, preferably projecting upwardly, or that conical formation is rigidly secured to the diaphragm as by brazing, welding or cementing as shown in Figs. 3 and 4. The purpose of providing this formation is to provide a rigid and inflexible motion transmitting member carried by the elastically flexible diaphragm and joining the diaphragm at the circle which is defined by the coil carrying sleeve; so that movements imparted to the apex of the conical formation, or to a member carried by it, will be wholly transmitted to coil 35 carried on depending sleeve 36. The mechanism which is now about to be described is mechanism for imparting to the rigid cone 50 a movement or force which will flex the diaphragm selectively in either direction and will release the diaphragm for free snap action back to its normal position.

For that purpose the simple form of mechanism shown in the drawings, and particularly in Figs. 3 and 4, is preferred. As there shown a button or stud 60 with an annular groove 61 is rigidly mounted on the apex of cone 50. A forked arm 62 straddles the grooved portion of the stud and is pivoted at 63 on a pivot supporting bracket 64 which (see Fig. 1) depends from a mounting plate 65 which is spacedly supported above ring 39 and diaphragm 37 by the studs 66. Pivot 63 also carries an upstanding finger 67, preferably pointed at its upper end. In the normal medial position of diaphragm 37, arm 62 stands in a horizontal position and finger 67, which is rigidly connected to the arm, stands in a vertical position. The finger formation at its upper end, preferably pointed, is also preferably symmetric about a vertical line through axis 63.

The toothed periphery 70 of a disk or wheel 71, which is mounted on a vertical axis, is positioned just above the upper end of finger 67. This peripheral portion has a series of teeth 72 which depend far enough to engage the upper end of finger 67 as the toothed wheel rotates in either one direction or the other. The relative opposite movements of the peripheral portion of wheel 71 which overlies finger 67 are indicated by the double headed arrow in Fig. 4. Wheel 71 is here shown as mounted on the vertical axis shaft 75 which is journaled immediately above the wheel in mounting plate 65 and at its upper end in another mounting plate 76 which is spacedly supported above mounting plate 65 by supports such as shown at 77. A pinion 78 on axis shaft 75 meshes with a gear 79 on the actuating or driving shaft 80 which is also conveniently journaled in mounting plate 65 and 76. While it will be understood that toothed wheel 71 may be driven either directly from an initial driving shaft, or through any suitable gearing train, the arrangement shown here is a typical one for driving the toothed wheel at an angular velocity somewhat greater than that at which the initial driving shaft is driven.

We may now suppose initial driving shaft 80 to be rotated by any means, either manually or from some connected mechanism. If the system is used for remote manual control, shaft 80 may merely have a handle or dial connected with it. On the other hand if the system is used for the remote actuation of some mechanism or indicator in consonance with an initial actuating mechanism, then shaft 80 will be rotated by that initial actuating mechanism. We may assume, for instance, that the system is being used for the purpose of remotely indicating the positional condition of some member or mechanism, and that that member or mechanism is connected, either directly or indirectly, to actuating shaft 80 to rotate it in consonance with change of position of the member or mechanism. As the actuating shaft is rotated, toothed wheel 71 rotates in a direction consonant with the direction of movement applied to actuating shaft 80, and moves the teeth 72 successively in one direction or the other into contact with upstanding finger 67. If we suppose that the teeth are moving toward the right in Fig. 4, then a tooth is moved toward the right against the finger to such a position as shown. Further movement will then throw finger 67 over toward the right, and throw arm 62 upwardly, about pivot 63. The upward movement of finger 62 will be transmitted to diaphragm 37 through stud 60 and the rigid cone 50, flexing the diaphragm upwardly and moving sleeve 36 and coil 35 upwardly. As the lower edge of a tooth wipes over the upper edge of the deflected finger, the finger and arm 62 and diaphragm 37 are suddenly released. The diaphragm then snaps back to its normal medial position under its own spring action. That return movement is relatively fast. The total mass of the diaphragm and the parts directly supported thereby is made to bear such a relation to the elastic characteristics of the diaphragm that the whole system will have a natural frequency in the lower audible frequencies. Due to the rapid return movement of the diaphragm, an electrical pulse of comparatively high voltage is generated in coil 35, to be transmitted to the receiver by any suitable circuiting. (Preferably one side of coil 35 is grounded so that a single wire circuit to the receiver may be used.) The damping reduces its oscillation about the normal position to a small or negligible amplitude, so that the pulses of alternating sign generated in the coil immediately following the generation of the first pulse are of small or negligible amplitude and duration.

The instrument is so designed, including its gearing ratio of connection with the initial actuating mechanism, that the velocity of diaphragm displacement by the initial forced movement of finger 67 is much slower than the snap action return of the diaphragm when released. The current pulse which is generated by the initial forced displacement of the diaphragm is therefore of very low or negligible voltage.

Consequently, upon movement of toothed wheel 71 in one direction, say toward the right in Fig. 4, the instrument will generate a spaced series of electrical pulses, all flowing in the same direction. On the other hand, when toothed wheel 71 is rotated in the opposite direction, so that the relative movement in Fig. 4 is toward the left, the finger 67 is periodically forced over toward the left, depressing arm 62 and diaphragm 37, and periodically releasing to allow the diaphragm to spring upwardly to its normal position. And, on

each such actuation of the diaphragm, the fast upward movement of coil 35 generates a pulse flowing in the opposite direction. The instrument thus generates a spaced series of electrical pulses, whose sign is dependent upon the direction of movement which is applied to the instrument. The total number of those successive impulses, added algebraically, then becomes an indication of the instant position of the instrument and of the member or mechanism which operates it.

In the receiver shown in Figs. 5 to 8, the magnet system, the elastically flexible diaphragm and the coil carried thereby are all preferably the same as the corresponding parts in the transmitter. Mounting plate 65a and its supports 66a are also substantially the same as the corresponding parts in the transmitter. That duplication is not necessary, but preferable for standardization of manufacture. The duplicate parts in Figs. 5, 6 and 7 are marked with the same numerals as in Figs. 1 to 4. The only differences in structure and function between the transmitter and receiver are in those parts which, in these preferred designs, are located above the diaphragm and are operatively associated with the diaphragm to cause diaphragm and coil movements in the transmitter, and to be actuated by the coil and diaphragm in the receiver—that is, to cooperate diaphragm and coil movements with movements of a shaft.

In the receiver a simple two-way ratchet mechanism is provided, to be actuated by diaphragm movements in one direction or the other, depending upon the direction of diaphragm displacement, depending in turn upon the sign of the pulse flowing through the coil.

As shown in preferred form in the drawings, a central vertical indicator shaft 100 is mounted at its lower end in a bearing 101 set in the upper end of pole piece 22. The shaft, and all the parts carried by it, are preferably of non-magnetic material. (In fact, in both instruments it is preferred that all parts except those forming the magnetic circuit be of non-magnetic material.) The upper end of shaft 100 passes through the upper mounting plate 65a, and is journaled therein, and as here shown carries an indicator pointer 103 at its upper end. A dial 104 may be mounted on the upper face of mounting plate 65a. As here illustrated, the receiver is thus an indicating instrument; but it will be understood that shaft 100 may actuate any desired device or mechanism.

A double-faced ratchet wheel 105 is fixedly mounted on shaft 100 a short distance above diaphragm 37. Ratchet wheel 105 has ratchet teeth 106 on its upper side facing in one direction and ratchet teeth 107 on its under side facing in the opposite direction. The wheel is also notched or toothed at 108 on its periphery to be engaged by a spring detent 109 which may be conveniently secured on the under face of mounting plate 65a as illustrated in Fig. 5.

Diaphragm 37 carries a centrally arranged mounting member 110 adapted to carry the oppositely facing pawls 111 and 112. As here shown, this mounting member comprises a ring 113 of angular cross section, secured directly to diaphragm 37 around its central opening, and carrying the lower pawl or pawls 112. Secured to ring 113 there is another member which, as here shown, consists of a ring 114 with two upward extensions 115 which carry at their upper ends the horizontal inward projecting extensions 116. An upper pawl 111 is mounted upon the under

side of an extension 116. While it is sufficient to have only one upper pawl and one lower pawl, another oppositely facing pair may be mounted on ring 113 and on the other upper extension 116. Fig. 6 indicates two upper pawls 111. The composite mounting member 110 which carries the pawls is, like the conical formation 50 of Fig. 1, a relatively rigid movement transmitting member which joins the flexible diaphragm at the circle defined by the coil carrying sleeve.

For purposes of simplicity in structure the pawls are preferably spring pawls. In effect, they are swinging pawls having effective swinging centers but stopped in their swinging movement toward the ratchet wheel at their normal unstressed positions. In their normal positions, and with diaphragm 37 in its normal medial position, both the upper and lower pawls preferably clear their respective ratchet teeth by a short distance, as shown in Fig. 7. When the coil receives a pulse of one sign, say positive, it moves the diaphragm and the parts mounted thereon in one direction, say downwardly. Upon such downward movement, the upper pawl or pawls immediately move downward into engagement with the upper ratchet teeth and then the free end of the pawl is swung relatively upwardly, and in Fig. 7 toward the right, to move the ratchet wheel in a corresponding direction through a distance corresponding to one tooth spacing. The register teeth 108 are preferably spaced the same as the ratchet teeth, so that upon each actuation the ratchet wheel moves one register tooth under detent 109 and at the end of the operation detent 109 is resting in the next notch between teeth to hold the ratchet wheel in the position to which it has been moved by the pawl action.

Upon cessation of the received electrical pulse, the elastic diaphragm immediately moves back to its medial position. It may pass through and somewhat beyond its medial position, but being damped it does not pass far enough beyond that medial position to carry the lower pawl or pawls 112 upwardly far enough to displace ratchet wheel 105 through a distance more than a small fraction of a complete step. Thus, although the ratchet wheel may be momentarily reversely displaced through a short distance, it is not displaced far enough to displace detent 109 from the notch in which it is at the time engaged. In this connection it may be noted that detent 109, in the form of a flat spring, has a slight elasticity in a direction peripherally of the ratchet wheel.

Upon receiving an electrical pulse of the opposite sign, say negative, the coil moves the diaphragm and its carried parts in the opposite direction, say upwardly. Upon such movement, the lower pawl or pawls 112 are engaged with the lower ratchet teeth 107, and move the ratchet wheel in a direction opposite to that previously described, through a distance equal to one tooth spacing.

From what has been said, it will now be understood that the total displacement in one direction of the ratchet wheel, and of any parts, devices or mechanisms actuated thereby, will depend upon the number of received pulses of one sign; while the total displacement of the parts in the opposite direction will depend upon the number of received pulses of the opposite sign. The instant position of the actuated parts, with relation to any selected zero position, will always correspond to the algebraic sum of the positive and negative pulses which have been received.

No claim is made in this application to the

feature of the moving coil, in and of itself in a telemetering system; that being the subject matter of a co-pending application filed by Gabriel M. Giannini and Joseph F. Manildi, Ser. No. 625,364, filed October 29, 1945.

We claim:

1. A telemetering instrument comprising a magnet system whose circuit includes an air gap, a movable coil in the air gap, a damped elastic member supporting the coil normally in a medial position and for displacement in either of two opposite directions and acting to return the coil from either displacement to its medial position, a toothed wheel rotatively mounted on an axis parallel with the line of displacement movement of the coil, and means whereby movements of the toothed wheel in its two opposite directions of rotation through a distance of one tooth spacing are selectively cooperated respectively with the opposite displacements of the coil from its medial position.

2. A telemetering instrument comprising a magnet system whose circuit includes an annular air gap, an annular coil located in the air gap, a damped elastic diaphragm supported concentrically with, and in a plane normal to, the axis of the coil and air gap and supporting the coil in a medial position in which the diaphragm is unstressed, the coil being displaceable in either of two opposite directions along said axis in accompaniment with stressed displacement of the diaphragm in corresponding directions, a rotatable shaft mounted on an axis parallel to the axis of diaphragm displacement, and means whereby rotational movements of the shaft through a definite angle in each of its two opposite directions of rotation are selectively cooperated respectively with the opposite displacements of the diaphragm from its medial position.

3. An instrument as defined in claim 1 and in which the last mentioned means comprises a pivoted finger adapted to be wiped over by the teeth as the toothed wheel moves in either of its two opposite directions of movement, an arm rigidly connected with the finger to swing therewith, and connection between the arm and the coil.

4. An instrument as defined in claim 1, in which the toothed wheel has oppositely facing ratchet teeth on its opposite side faces, and in which the last mentioned means comprises a pair of ratchet engaging pawls each swingingly connected with the coil to move therewith, the two pawls being positioned at opposite sides of the wheel, facing in opposite directions peripherally of the wheel and normally lying at equal and opposite angles to the plane of the wheel.

5. An instrument as defined in claim 2, and in which the last mentioned means comprises a pivoted arm whose length normally lies parallel to the plane of the diaphragm and having its swinging end connected with the center of the diaphragm, a pivoted finger rigidly connected with the arm, the length of the finger normally extending in a direction parallel to the axis of the coil and of diaphragm displacement, a wheel mounted to rotate on an axis parallel to the axis of diaphragm displacement, and peripherally spaced teeth extending from the wheel and

adapted to wipe over the free end of the finger upon wheel rotation in either direction.

6. An instrument as defined in claim 2, and in which the last mentioned means comprises a shaft journaled on an axis coincident with the axis of diaphragm displacement, a ratchet wheel mounted on said shaft in a plane spaced from the diaphragm, said wheel having a series of ratchet teeth on each of its opposite side faces with the two series of teeth facing in opposite peripheral directions, and a pair of swinging pawls carried by the diaphragm one opposed to each face of the ratchet wheel, the two pawls facing in opposite directions peripherally of the wheel and normally standing at equal and opposite angles to the plane of the wheel.

7. A telemetering instrument, comprising a magnet system arranged symmetrically about a central longitudinal axis and having an annular air gap concentric with said axis, a circular elastic damped diaphragm stationarily peripherally mounted concentrically with respect to, and in a plane normal to, said axis, an annular coil carried by the diaphragm concentrically with the axis and projecting from the plane of the diaphragm to lie in the annular air gap, a rigid structure associated with the central part of the diaphragm within the circle defined by the annular coil, an arm pivotally mounted on a stationary pivot and normally positioned with its length parallel to the plane of the diaphragm, means connecting the free end of the arm to the center of the rigid diaphragm structure, a finger rigidly associated with the arm and projecting from the pivot in a direction parallel to said axis, a finger actuating wheel mounted to rotate on an axis parallel to the diaphragm axis in a position where its periphery rotates over the free end of the finger, and spaced teeth projecting from the periphery of the wheel and adapted to wipe over the end of the finger.

8. A telemetering instrument, comprising a magnet system arranged symmetrically about a central longitudinal axis and having an annular air gap concentric with said axis, a circular elastic damped diaphragm stationarily peripherally mounted concentrically with respect to, and in a plane normal to, said axis, an annular coil carried by the diaphragm concentrically with the axis and projecting from the plane of the diaphragm to lie in the annular air gap, a rigid structure associated with the central part of the diaphragm within the circle defined by the annular coil, a shaft journaled on an axis coincident with the axis of the coil and diaphragm, a ratchet wheel mounted on the shaft in a plane spaced from the diaphragm, two oppositely facing series of peripherally spaced ratchet teeth on the opposite side faces of the wheel, a rigid annular pawl supporting structure secured to the diaphragm at the circle defined by the annular coil, and a pair of oppositely facing swinging pawls carried by said rigid structure, said pawls being respectively engageable with the opposite series of ratchet teeth upon displacement of the diaphragm in opposite directions from its normal plane.

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