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TELEMETERING SYSTEM

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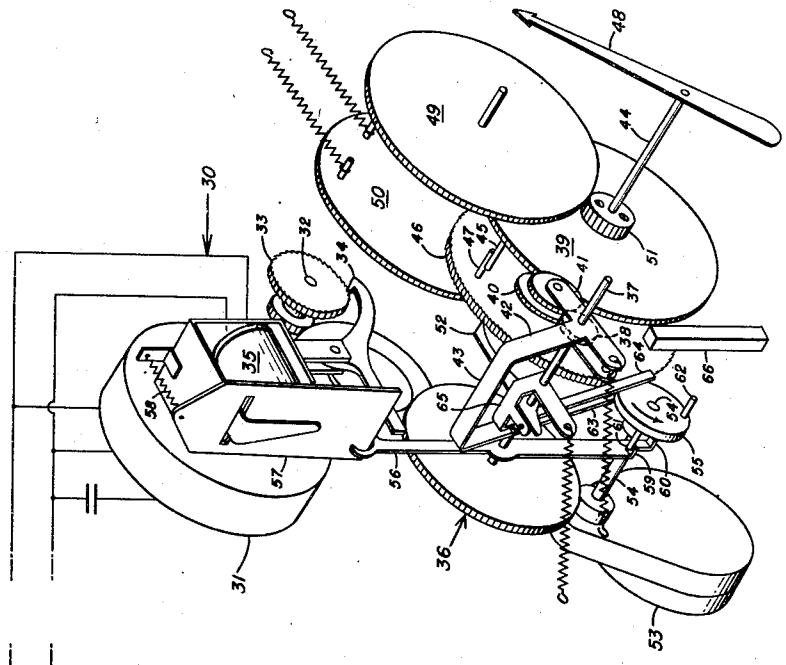

FIG. 2

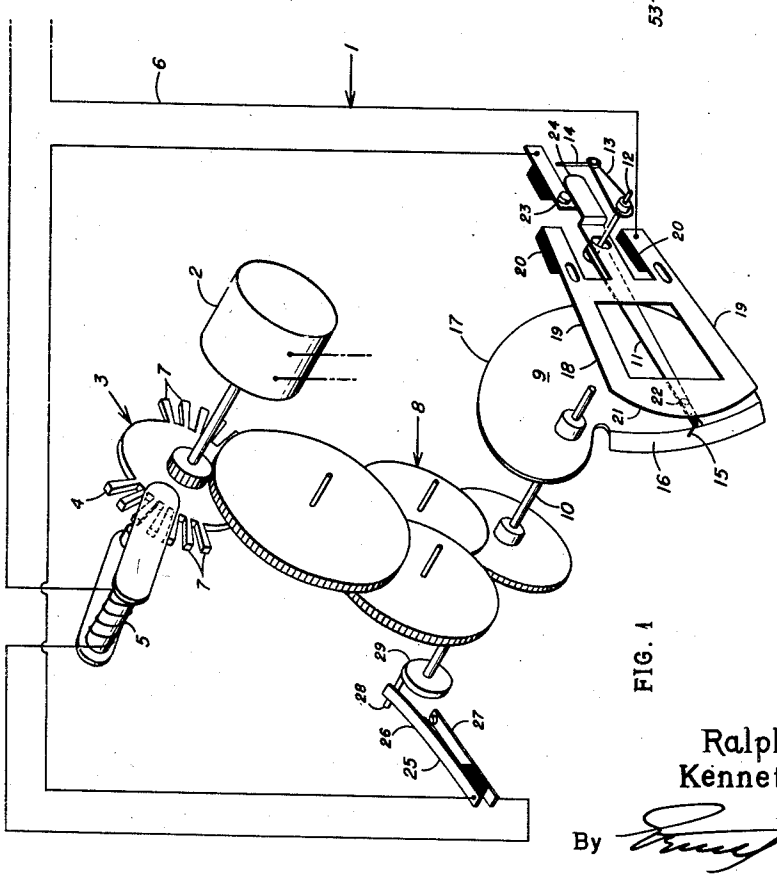

FIG. 1

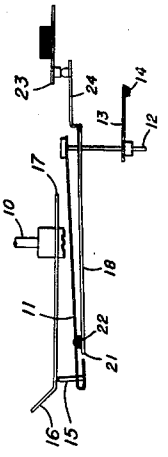

FIG. 3

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TELEMETERING SYSTEM

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11 Claims. (Cl. 340—203)

This invention relates to telemetering and has as its primary object the position of an improved telemetering system for recording variable quantities without regard to the time duration of the transmitted signal.

Another object of the invention is to provide an improved telemetering system wherein the transmitter can be actuated by any available motive power.

An additional object of the invention is to provide an improved telemetering system in which a signal generated at the transmitter is made to drive the driving means at the receiver and produce in that driving means an incremental count of the variable quantity being recorded.

A further object of the invention is to provide in the transmitter of a telemetering system a scroll cam and associated mechanism for measuring and transmitting a variable quantity with extreme accuracy.

Another object of the invention is to provide an improved telemetering system wherein a variable quantity is measured by engagement of a quantity responsive member with a scroll cam and the measurement is transmitted to a counting recorder as a count of fixed increments of movement of the cam by a pulse generator, whereby an accurate record of the quantity is obtained at a distant point without restriction in driving mechanism or the time duration of the transmission.

Other objects and advantages of the invention will appear hereafter in the detailed description, be particularly pointed out in the appended claims, and illustrated in the accompanying drawings in which:

Figure 1 is an isometric diagrammatic view of a preferred form of transmitter of the telemetering system of the present invention;

Figure 2 is an isometric diagrammatic view of the receiver of the system; and

Figure 3 is a fragmentary plan view of the cam-actuated switch of the transmitter of Figure 1.

Telemetering systems heretofore employed have been of two principal types, one having synchronized drive mechanisms at transmitter and receiver and the other depending upon the time duration of the impulses transmitted to the receiver. The critical factor in both types of systems thus being the duration of the signal, their employment has necessitated the use either of synchronous motors at both ends or of a constant speed motor at the transmitter, as well as a power source at the transmitter effective to operate its driving motor in the manner required. For permanent installations where fixed cycle alternating current is readily available this has not proved a particular handicap, but where the installation is temporary or only batteries or mobile generating units are readily available, systems of these types are effective only at inordinate expense. At an early stage in the development of telemetering, systems were devised for transmitting a pulse count of a variable quantity for actuating an indicator at the receiver through an electro-magnet or similar electrical ratchet. While such counting systems were later somewhat refined, their accuracy and speed were generally less than those of the time cycle systems

with the consequence that pulse counting systems have been little employed. The difficulties of the time cycle systems, as well as the inaccuracy and slowness of the pulse counting systems are avoided in the telemetering system of the present invention by converting the variable quantity into a signal which gives an accurate incremental or digital count of the quantity and effects corresponding movement of the driving means of the receiver. By dividing the total quantity into increments of movement, the system is rendered independent of the duration of the transmitted signal and can employ any motor as its driving mechanism without regard to its speed characteristics.

Referring now in detail to the drawings in which like reference characters indicate like parts, the improved telemetering system of the present invention has a transmitter, designated generally as **1**, comprised of a driving mechanism or motor **2** which may be operated by direct or alternating current and be of constant or variable speed.

In the illustrated embodiment the motor **2** is connected directly to a signal generating device or generator **3** capable of generating discrete pulses and transmitting such pulses either alone or as modulations of a carrier wave. A suitable generator for this purpose is a notched "tone wheel" **4** operating between the legs of a permanent magnet **5**, about which are wound coils of a transmitting line or circuit **6**. This wheel functions as an inductor-alternator to produce in the line **5** an alternating carrier wave of a frequency determined by the number of the arms or inductors **7** and the speed of the wheel. By then interrupting the wheel by providing gaps between the inductors at spaced points about its periphery, there are imposed on the carrier wave generated by the inductors, modulations or modulating pulses corresponding to the interruptions, the basic and modulating frequencies being fixed or variable, depending upon the power supply at the transmitter, and their ratio being determined by the characteristics of the transmitting medium and the driving mechanism of the receiver, respectively. For example, for transmitting over leased telephone wires, usually an available medium, and actuating a receiver driving mechanism, such as hereinafter to be described, there may be employed a basic or carrier frequency of 1,000 cycles per second, modulated at 60 cycles per second. In such application a substantially constant speed motor is preferred as the transmitter driving mechanism **2** to avoid interference with other signals being transmitted over the line.

For converting the quantity or value at the time of transmission of temperature, pressure, liquid level, or other variable quantity to be recorded into a count of the modulations of the signal generator **3**, the tone wheel **4** is intergeared or drivably connected by a gear train **8**, with a scroll cam **9** through the drive shaft **10** of the latter. So connected, each modulation or pulse of the generator represents an increment or unit of movement of the cam, fixed relative to its full cycle of movement by the ratio of the gear train **8**. To enable the quantity to be measured in terms of movement of the cam **9**, there is provided a measuring arm **11**, adapted to ride over a face or surface of the cam and pivotably mounted on the shaft **12**. This arm is pivoted or rotated by a lever **13** connected to a hygrometric or other quantity sensing unit, such as the illustrated hair **14**. The lever **13** and the pivot of the measuring arm are so arranged relative to the cam that the arm moves toward the center or pivot of the cam as the variable quantity increases in value. At its outer or free end, the measuring arm **11** carries a finger or pointer **15** which normally projects beyond the plane of the confronting face of the cam and is adapted to engage or ride on that surface of the cam, reaching it over the bevelled or inclined leading edge **16** of the cam. With its position relative to the cam determined by the value at that moment of the variable quantity, the finger rides

over the surface of the cam as the latter moves under it, in process causing the measuring arm 11 to bend or flex outwardly until the finger drops off the trailing edge 17 of the cam, restoring the measuring arm to its initial unflexed position. Overlying the measuring arm 11 is a spring contact member 18 of somewhat U-shape, the legs of 19 of which are fixed adjacent their outer ends as by insulating blocks 20, and the head of 21 of which is adapted to be contacted by the measuring arm 11 through an insulating button 22, outward flexing of the measuring arm 11 thus causing a corresponding flexing of the contact member 18 about a point adjacent the insulating blocks 20. This flexing is in turn used in the transmission line to close a switch 23 through a contact carrying tongue 24 integral with the member and to hold it closed until the finger 15 drops off the trailing edge 17 of the cam.

Were the switch 23 the only switch in the transmission line, accurate recording of the value would require both leading and trailing edges of the cam to be cut precisely. To avoid this necessity the transmission line 6 is also interruptable by a second switch 25, wired in series with the first switch 23. In its illustrated form the second switch has an upper leaf 26 which is movable out of contact with its lower leaf 27 by a pin 28. Keyed to the cam shaft 10, the pin 28 bears a definite space relation to the cam and is positioned relative thereto to open the switch 25 as the cam approaches the finger 15 of the measuring arm 11 and to hold it open until the finger crosses a definite line on the flat face of the cam. The position of the switch 25 thus provides a fixed radial position in the rotative cycle or path of travel of the cam at which measurement starts, regardless of the pivotal position of the measuring arm 11, thereby requiring precise cutting only of the trailing edge 17 to obtain an accurate measure of the instant value of the variable quantity. Once started, measurement of the value, as determined by the position of the measuring arm 11, continues in terms of rotative movement of the cam 9 until the finger 15 drops off its trailing edge 17. The circuit of the transmitter being closed during this engagement, the signal generator 3 simultaneously induces in the transmission line its generated pulses or modulations and transmits them as a signal, which, by virtue of the inter-gearing of the cam and the tone wheel 4, constitutes an exact incremental, digital or unit count of the measurement. The same intergearing also makes it unnecessary to machine the cam face to absolute flatness since it is the movement of the cam and not the finger that is being measured and any imperfections or waves in that face thus can have no effect upon the transmission.

Transmitted by wire or other suitable medium, the signal from the transmitter 1, if in the form of a modulated carrier wave, is first passed through a suitable demodulating and amplifying unit (not shown) on reaching the receiver 30, where the modulating pulses working from the signal generator are separated from the carrier wave and amplified. The output of this circuit is then fed to the driving mechanism 31 of the receiver. Using the example given in describing the transmitter, of a 60 cycle modulating frequency, the output of the unit will be substantially 115 volt 60 cycle alternating current, each cycle of which represents one increment of movement of the cam 9. The driving mechanism 31 by which this current is translated or converted into a record of the instantaneous value of the variable quantity being recorded, is essentially an electrical ratchet whose armature moves a given distance for each cycle, mechanism such as the SMY type motor made by the General Electric Company, which incorporates a rotating permanent magnet structure and moves the distance of one pole for each cycle, being suitable for this purpose. Energized by the out-put of the demodulator-amplifier unit and moving so long as a signal is transmitted by the transmitter, the motor may have its armature stop at the end of the signal

in such a position relative to its field that the first pulse or cycle of the next signal would turn it backwards. This is avoided by mounting on the drive or armature shaft 32 of the ratchet motor 31 a ratchet gear 33 held by a pawl 34 against rearward movement, a magnet 35, connected in parallel with the motor 31 and energized by the same signal, pulling the pawl out of engagement with the ratchet as the motor starts, to eliminate drag during the balance of the signal.

Other than its ratchet type driving mechanism 31 the elements of the receiver may take a variety of forms depending upon the type of record desired. As will be seen, the illustrated form of the receiver employs the simplest form of recorder, a pointer, and exemplifies an arrangement of elements by which the incremental count of the transmitter can be made to record the value of a variable quantity at a given transmission, as well as its variations over any desired period of time. In the exemplary form of recorder, the drive shaft 32 of the motor 31, through suitable reduction gearing 36 drives a drive shaft 37 to which is keyed or fixed a driving gear 38. This driving gear 38 normally drivably engages a fine-toothed wheel 39 through a fine-toothed pinion 40, the latter being carried by an extension 41 projecting from one arm 42 of a yoke or rocker 43, which in turn is pivotally mounted on the drive shaft 37. The toothed, setting or count wheel 39 rides loosely on a shaft 44 and, by a pin 45 projecting axially of the wheel adjacent its periphery, has a one-way drive connection with a ratchet wheel 46 through a like pin 47 carried on the confronting face of the ratchet wheel. Keyed or fixed to the shaft 44, the ratchet wheel 46 drives through this shaft the recorder by which a record of the variable quantity is made, the recorder here being shown simply as a pointer or needle 48, without dial or other usual adjuncts. Drivably connected only when their pins 45 and 47 are in contact, the count and ratchet wheels 39 and 46 are normally urged toward initial, starting or zero position by resilient or yieldable means, such as the illustrated spring urged wheels 49 and 50, respectively, each coupled with the associated wheels 39 and 46 through the geared hubs of the latter, only the hub 51 of the count wheel being shown.

Between recordings it is usually desirable that the pointer or other recording member 48 remain fixed to indicate the value last transmitted by the transmitter 1, particularly where a continuous record of the variations in the variable quantity is wanted. For this purpose the ratchet wheel or pointer lock ratchet 46 controlling the position of the pointer 48, is normally held against movement under impetus of its spring wheel 50 by a pawl 52 which may conveniently be mounted on the drive shaft 37 of the driving gear 38. Since the count wheel 39 is adapted to drive the ratchet wheel 46 only in one direction and the variable quantity may well shift in the opposite direction, provision is made both for compensating for such shift and for resetting the count wheel 39 at starting position at the end of each transmission. For this purpose there is provided a small torque motor 53 which is constantly energized and adapted to drive a shaft 54 carrying at its outer or free end a setting or tripping disc 55. This disc is normally restrainted from movement and through it the torque motor is normally stalled by an escapement mechanism comprised of an escapement lever 56 pivoted on the drive shaft 37 and having its upper end connected to an armature 57 of the magnet 35, which, as previously mentioned, is wired in parallel with the driving motor 31 of the receiver and energized by the same signal. Normally held away from the magnet, as by a spring 58 the armature 57 is drawn in on energization of the magnet at the start of the signal from the transmitter, thus rocking the escapement lever back and forth as the magnet is energized and deenergized. This rocking of the lever 56 is utilized to control movement of the setting disc 55 by forming on the escapement lever, adjacent its lower end, a pair of later-

ally and longitudinally spaced pallets **59** and **60**, on the upper **59** of which a pin **61**, fixed to a confronting face of the disc, normally rests. At the start of the signal the outward rocking of the lower end of the escapement lever by the magnet **35** moves the upper pallet **59** out of the path of the pin **61** causing the pin under drive of the torque motor **53** to drop or shift to the lower pallet **60**, where it remains during the balance of that transmission.

It will be noted that the disc **55** carries on its outer face a second pin **62**, positioned in advance of its first pin **61** in the direction of rotation of the disc and that there is interposed in the path of movement of each of the pins a member adapted to be tripped thereby, that of the first pin **61** being a rocker arm **63** of the rocker **43** carrying the pinion **40** and the member of the second pin being a rocker arm **64** of a rocker **65** straddling and adjustably engageable with the pawl **52** of the ratchet wheel **46**. With this arrangement, the end of the signal and consequent rocking of the escapement lever **56** to its normal position by release of the armature **57** by the magnet **35**, frees the pin **61** of the lower pallet **60**, permitting the disc **55** to be rotated by the constantly energized torque motor **53**. As the disc rotates its second pin **62** trips the rocker **65**, thereby releasing the pawl **52** and freeing the ratchet wheel **46**. If the value just transmitted is less than the preceding value, the ratchet wheel **46** is then moved backwards by its spring wheel **50** to the position indicative of the new value as determined by engagement of its pin **47** with the pin **45** of the count wheel **39**. Further rotation of the disc **55** releases the rocker **64** causing the pawl **52** to reengage the ratchet wheel **46** and hold or lock it at that position. As the disc **55** continues to rotate its first pin **61** then engages and trips the rocker arm **63** of the rocker **43** moving the pinion **40** out of engagement with the count wheel **39** and enabling that wheel to be moved by its spring wheel **49** to starting position where it is stopped or held by engagement of its pin **45** with a stop **66**. The disc **55** rotating during this interval, later releases the rocker **43**, enabling the pinion **40** and count wheel **39** to reengage, and continues to rotate until its first pin **61** comes to rest on the upper pallet **59** of the escapement lever which is then interposed in its path.

It will thus be seen that at the start of a signal the driving motor **31**, through the connecting gear train **36**, drive shaft **37**, driving gear **38** and pinion **40**, progressively drives the count wheel **39** until at the end of the signal the pin **45** of the count wheel has reached a position representing the value of the variable quantity at the time of the transmission. If this value is greater than that previously transmitted the count wheel, as its pin **45** passes the previous value, will pick up the ratchet wheel **46** and the two wheels will rotate together until the end of the signal. If on the other hand the previous value was greater, there will be no contact between the two wheels until the signal has terminated, whereupon, through the torque motor **53** and the associated escapement mechanism, the ratchet wheel **46** will be turned back by its spring wheel **50** until it reaches the new value. The same escapement mechanism then sequentially releasing the count wheel **39** at the end of each transmission, enables that wheel to be brought back to starting position by its spring wheel **49**, from thence to move in exact correspondence with the value next transmitted, the extent of movement in each instance being on the same incremental basis as the transmission. It will be obvious that the zero position of the pointer **48**, as determined by the starting position of the count wheel **39**, cannot represent the absence of a signal since the torque motor **53** would then not release to move the pointer to that position. Consequently the zero position is made to represent the minimum number of transmitted pulses which will safely energize the magnet **35**.

In illustrating the invention there have been employed

driving mechanisms capable of recording a variable quantity at any conceivable distance from its source by virtue of the amplification of the modulating pulses from the transmitter by which the driving mechanism of the receiver is driven. However, if the same source of alternating current is available at both transmitter and receiver, a synchronous motor can be employed in the transmitter in place of both its driving motor and its signal generator and a corresponding synchronous motor can be substituted for the driving mechanism of the receiver. With this arrangement the synchronous motor of the transmitter will drive the cam **9**, as does the illustrated driving motor **2**, and the synchronous motor of the receiver will be driven during the interval in which the two switches of the transmitter are closed, the extent of its movement being determined by the number of cycles of line current received during that interval and these cycles thus functioning in the same manner as the modulating pulses of the illustrated embodiment. This alternative construction would find particular use where the telemetering is to be employed over short distances, as within one building or between buildings of a group.

From the above detailed description it will be apparent that there has been provided an improved telemetering system wherein by measuring a quantity in terms of movement of a cam, converting this movement into an incremental pulse count of the value of the variable quantity at the time of transmission and utilizing this count correspondingly to drive the driving mechanism of the receiver, an accurate record of the quantity is obtained, regardless of conditions at the transmitter and the distance between transmitter and receiver. It will be understood that the described and disclosed embodiment is merely exemplary of the invention and that all modifications are intended to be included which do not depart either from the spirit of the invention or the scope of the claims.

Having described our invention, we claim:

1. A telemetering system comprising a rotatable spiral cam, a generator drivably connected to said cam and generating pulses digitally counting the movement of said cam, a member engageable with a face of said cam during rotation thereof and shiftable substantially radially of said cam in response to a variable quantity, a switch connected to said member and closed on engagement thereof with said cam face, a second switch connected to said cam and closed at a predetermined position during engagement of said cam and member, said switches being connected in series in a transmission line and when closed transmitting pulses from said generator thereover, driving mechanism actuated by and driven in correspondence with the number of said transmitted pulses, and an indicator driven by said driving mechanism for indicating said quantity.

2. In a telemetering system, a transmitter comprising a rotatable spiral cam, a generator drivably connected to said cam and generating pulses digitally counting the movement of said cam, a member engageable with a face of said cam during rotation thereof and shiftable substantially radially of said cam in response to a variable quantity, a switch connected to said member and closed on engagement thereof with said cam face, and a second switch connected to said cam and closed at a predetermined position during engagement of said cam and member, said switches being connected in series in a transmission line and when closed transmitting pulses from said generator thereover.

3. A telemetering system comprising a rotary cam, a generator drivably connected to said cam for inducing in a transmitting circuit a carrier wave modulated in correspondence with the incremental rotation of said cam, means for driving said cam and generator, a quantity responsive member engageable with said cam for measuring a variable quantity, switch means associated

with said cam and member for closing said transmitting circuit and transmitting said modulated wave during said measurement, driving mechanism actuated by the modulations of said wave and driven in correspondence with the number thereof, and an indicator driven by said driving mechanism for indicating said quantity.

4. A telemetering system comprising a rotary cam, a generator drivably connected to said cam for inducing in a transmitting circuit a carrier wave modulated in correspondence with the incremental rotation of said cam, means for driving said cam and generator, a quantity responsive member engageable with said cam for measuring a variable quantity, switch means associated with said cam and member for closing said transmitting circuit and transmitting said modulated wave during said measurement, and means removed from said transmitting circuit for counting the modulations of said wave and indicating said quantity.

5. A telemetering system comprising a rotatable cam, a generator inter-geared with said cam for generating pulses each representing a fixed increment of rotation of said cam, a quantity responsive member engageable with said cam for measuring a variable quantity, means associated with said member for transmitting the pulses generated during said measurement, driving mechanism actuated by and driven in correspondence with said transmitted pulses, setting means drivable by said driving mechanism from a starting position through a distance representing said quantity, indicating means positionable by said setting means on shift of said quantity in one direction to indicate said quantity, a constantly energized motor, means associated with said motor for sequentially engaging said indicating means with said setting means on shift of said quantity in another direction and restoring said setting means to starting position, escapement means normally stalling said motor, and means operable at the end of each transmission for momentarily releasing said motor for actuation of said associated means.

6. A telemetering system comprising a rotatable cam, a generator inter-geared with said cam for generating pulses each representing a fixed increment of rotation of said cam, a quantity responsive member engageable with said cam for measuring a variable quantity, means associated with said member for transmitting the pulses generated during said measurement, driving mechanism actuated by and driven in correspondence with said transmitted pulses, setting means drivable by said driving mechanism from a starting position through a distance representing said quantity, indicating means positionable by said setting means on shift of said quantity in one direction to indicate said quantity, a constantly energized motor, means associated with said motor for sequentially engaging said indicating means with said setting means on shift of said quantity in another direction and restoring said setting means to starting position, escapement means normally stalling said motor, and means operable at the end of each transmission for momentarily releasing said motor for actuation of said associated means.

7. A telemetering system comprising a rotatable cam, a generator inter-geared with said cam for generating pulses each representing an equal increment of rotation of said cam, a quantity responsive member engageable with said cam for measuring a variable quantity, means associated with said member for transmitting the pulses generated during said measurement, driving mechanism actuated by and driven in correspondence with said transmitted pulses, indicator means, means driven by said driving mechanism and engageable with said indicator means for positioning said indicator means to indicate said quantity, yieldable means for normally locking said indicator means against movement, and means operative on termination of said pulses for releasing said indicator means for movement by said yieldable means.

8. A telemetering system comprising a rotatable cam, a generator inter-geared with said cam for generating pulses each representing a fixed increment of rotation of said cam, a quantity responsive member engageable with said cam for measuring a variable quantity, means associated with said member for transmitting the pulses generated during said measurement, driving mechanism actuated by and driven in correspondence with said transmitted pulses, indicator means, means driven by said driving mechanism and engageable with said indicator means for positioning said indicator means to indicate said quantity, yieldable means for normally locking said indicator means against movement, and means operative on termination of said pulses for sequentially releasing said indicator means for movement by said yieldable means and restoring said positioning means to starting position.

9. In a telemetering system, a transmitter comprising a rotary scroll cam, means associated with said cam for generating pulses each representing an increment of rotation of said cam, a transmitting circuit, a member engageable with a face of said cam and shiftable radially thereof in response to a variable quantity, a switch in said circuit, said switch being closed by said member during engagement thereof with said cam face, a second switch in said circuit, and means connected to said cam for closing said second switch during engagement of said member with said cam face and in definite space relation to the trailing edge of said cam, said generator on closing of said switches inducing said pulses in said transmitting circuit.

10. A telemetering system comprising a transmitting circuit, a rotary scroll cam, a generator inter-geared with said cam for inducing alternating current in said transmitting circuit modulated in correspondence with movement of said cam, a member engageable with a face of said cam and shiftable radially thereof in response to a variable quantity, a switch in said circuit closed on engagement of said member with said cam face, a second switch, means connected to said cam for closing said second switch after closing of said first switch and in definite space relation to a trailing edge of said cam to start transmission of said modulated current, and a receiver circuit including driving mechanism driven by said modulations in correspondence with the number thereof, and an indicator positionable by said driving mechanism to indicate said quantity.

11. In a telemetering system a transmitter comprising a rotary scroll cam, a member engageable with a face of said cam and shiftable radially thereof in response to a variable quantity, a transmitting circuit, switch means in said circuit, and means associated with said cam for closing said switch means subsequent to engagement of said member with said face of said cam and in definite space relation to the trailing edge thereof, said circuit on closing of said switch means transmitting a signal for the duration of engagement of said member with said cam face.

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