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3,350,709 10/1967 Pursiano..... 340/319

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[54] **METER DIAL EXTENSION SYSTEM**
16 Claims, 12 Drawing Figs.

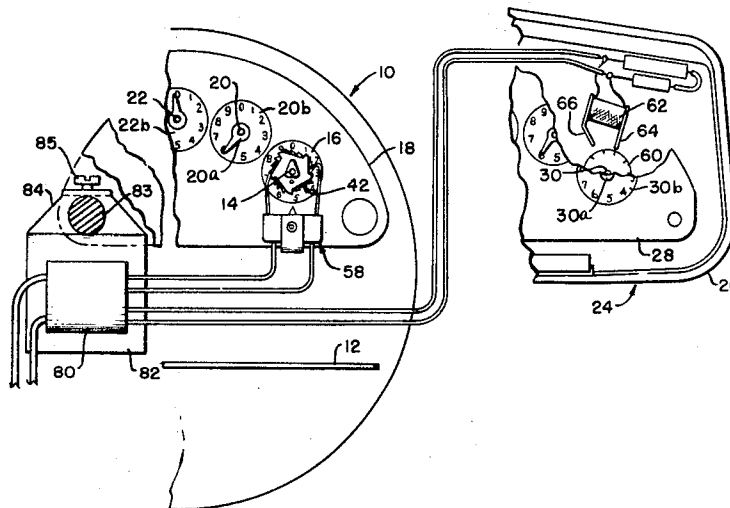
[52] U.S. Cl..... **340/203,**
340/212, 340/325

[50] Field of Search..... **340/205,**
319, 325, 193.1, 193.2; 340/203

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ABSTRACT: An arrangement in which a transmitter is mounted in a kilowatt hour or other meter so as to operate a remotely located register, the transmitter comprising a step down transformer having its secondary winding connected to the solenoid of a stepping motor comprising a disc mounted on the units shaft of the register and having a series of alternately arranged north and south poles spaced about its periphery. The transmitter also includes a switch in the solenoid circuit which is operated by a cam mounted on the units recording pintle of the meter so as to reversely connect a diode into the solenoid circuit each time the units recording pintle is turned one integer and provides a direct current signal to the solenoid which reverses, the pole pieces of which therefore reverse in polarity for each kilowatt hour recorded by the meter, the two pole pieces of the solenoid spanning one and a half or two and a half poles along the periphery of the stepping motor disc so that the disc rotates the distance between each pole thereupon in response to each reversal of the direct current signal to the solenoid.



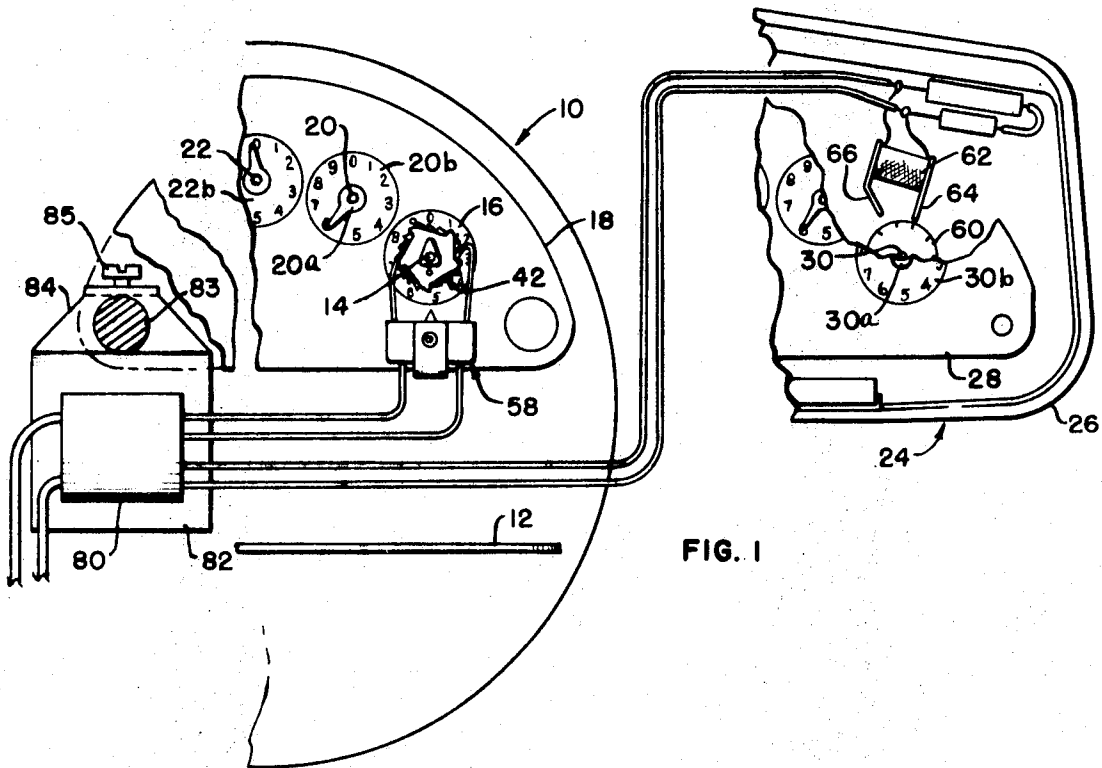


FIG. 1

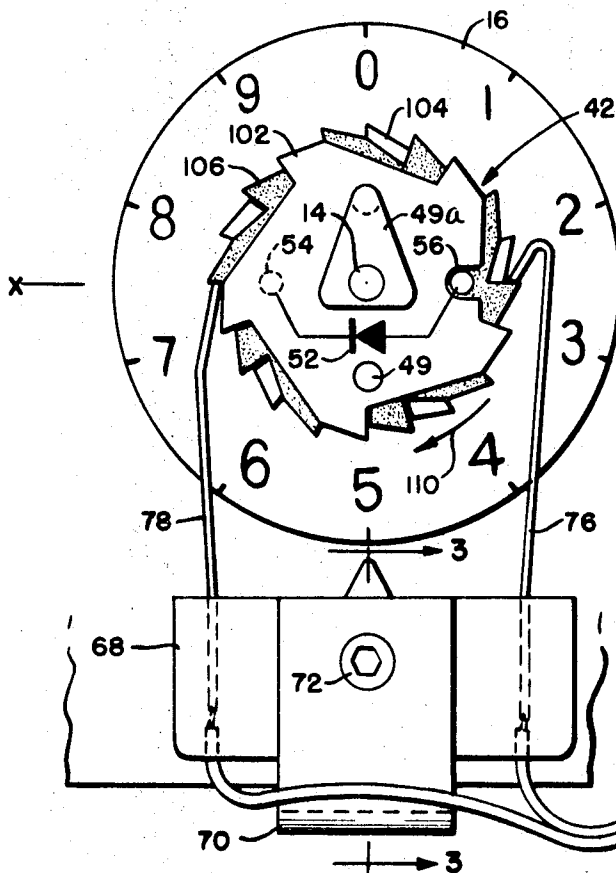
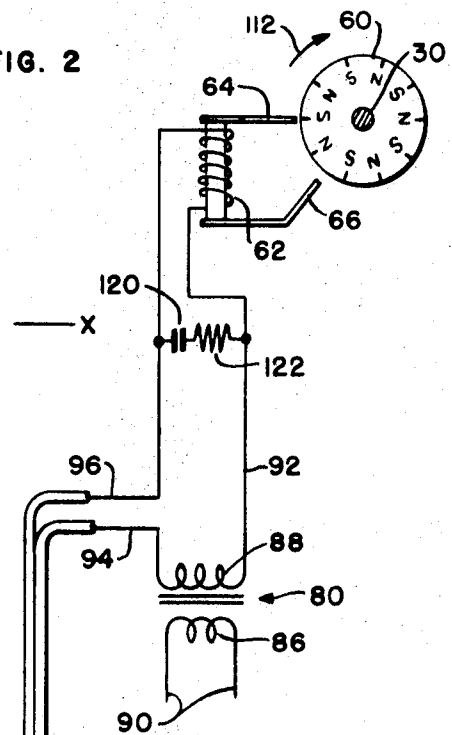


FIG. 2



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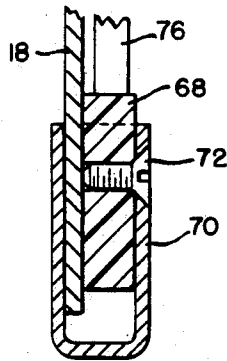


FIG. 3

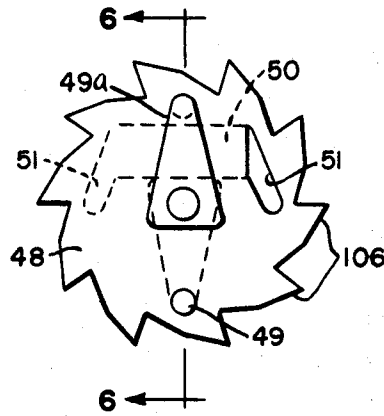


FIG. 5

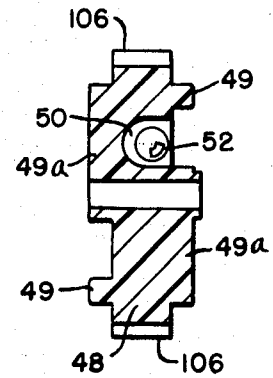


FIG. 6

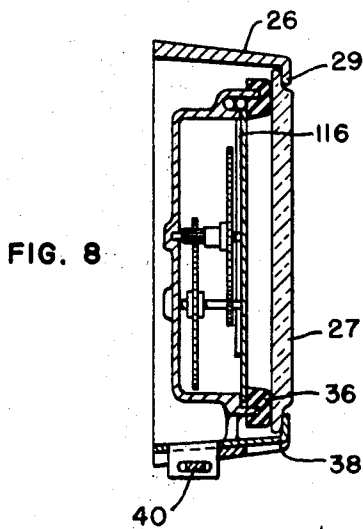


FIG. 8

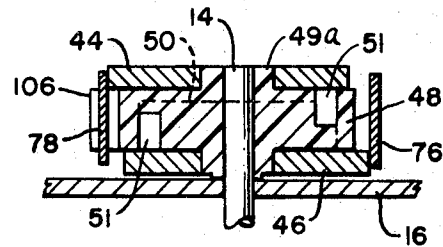


FIG. 4

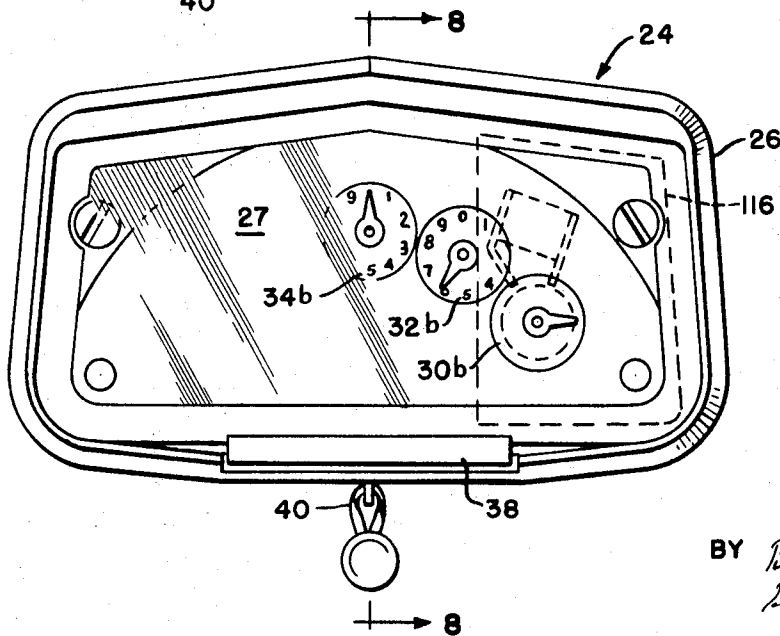


FIG. 7

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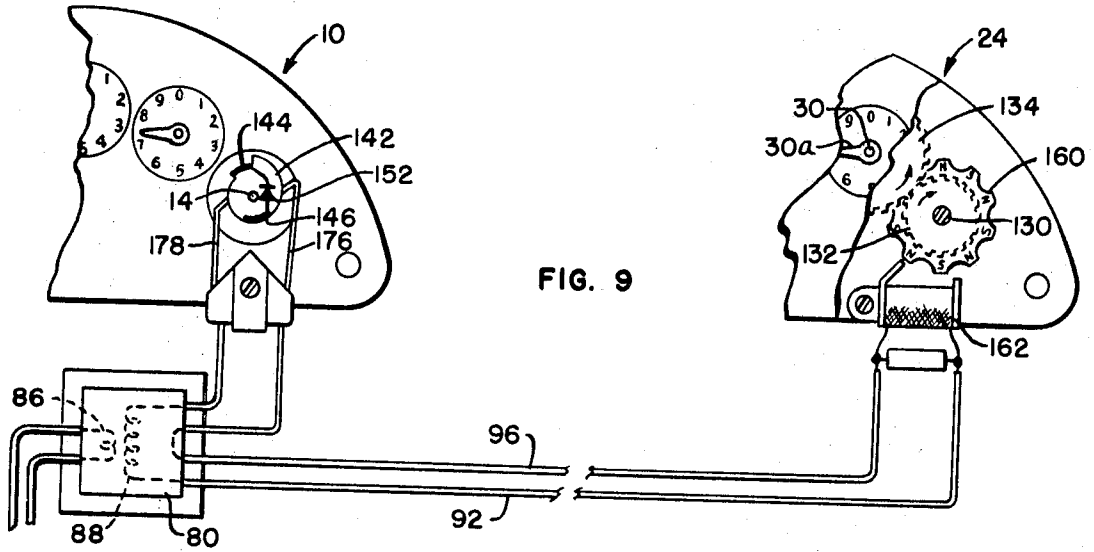


FIG. 9

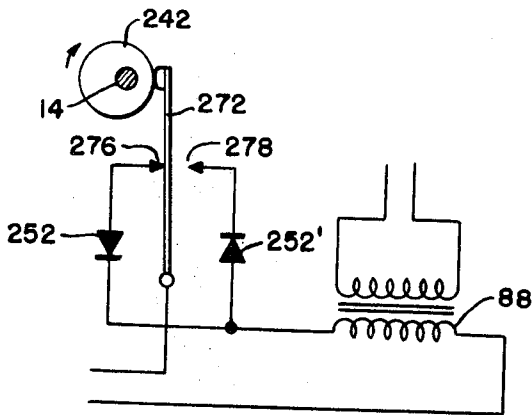


FIG. 10

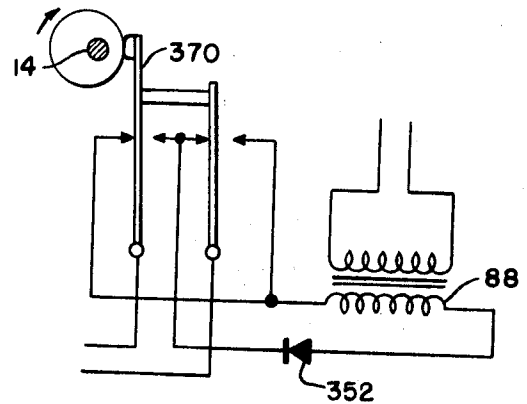


FIG. 11

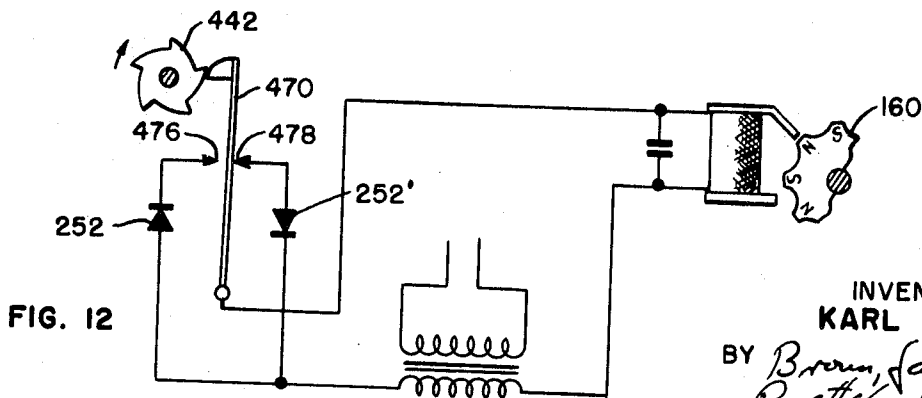


FIG. 12

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METER DIAL EXTENSION SYSTEM

This invention relates to metering apparatus and particularly to novel structure for operating an integrating form of meter register located at a position which is remote from the integrating meter to which the register relates. A particular application of the invention is to the provision of a readily accessible meter register, for example on the outside wall of a building where it is convenient for displaying the reading of a commodity supply meter which is located within the building itself. Although particularly adapted for displaying the reading of a watt hour meter or other electricity supply meter, the invention is utilizable with meters generally, such as are used to read or integrate the flow consumption of various commodities and particularly gas, water and the like. Accordingly, for ease of illustration, the invention is hereinafter described in connection with a watt hour meter such as is conventionally supplied the customers of an electrical power company; nevertheless, it is to be understood that the utility of the invention is not to be construed thereby as so limited in its application.

Although almost all watt hour meters for residential loads are now installed outdoors to facilitate reading, many older indoor installations in the United States and particularly installations within plural dwelling or apartment buildings present a problem of "skip readings" and "repeat calls" by the meter reader. Previous to the present invention, conversion of these older installations to outdoor metering involved extensive revamping and the cost factor was high.

A principal object of the present invention is to provide an inexpensive system which may be readily and conveniently added to an already installed electric meter which will permit a readout at any accessible point to the meter reader.

In accordance therewith, the invention comprises a transmitting unit which may be readily back fitted to the units' recording pintle of an existing already installed meter register (it may also be a factory installation) and a remotely located receiving register which repeats the reading of the watt hour meter dials.

A feature of the system conceived by the invention is that the receiver which is operated by the transmitter employs a stepping motor which is mounted in the register so as to drive the units recording shaft of the register only upon reversal of a direct current signal supplied thereto from the transmitter. In accordance with the invention, the transmitter therefore includes a switch connected into the stepping motor circuit by a two-conductor cable which switch is operated by rotation of the units' recording pintle of the meter so as to provide a DC signal to the stepping motor which reverses in polarity for each kilowatt hour or other designated increment of electrical power consumption, wherefore the dials of the register can be caused to duplicate and/or to give the same information as would appear on the dials of the meter itself.

A further feature of the invention is that the stepping motor can be constructed as a rotatable disc having alternate north and south poles spaced about its periphery and so as to be influenced by the adjacently located pole pieces of a solenoid to which the direct current signal is directed.

Thus a further feature of the invention is that the remote register and its operating mechanism can be operated at very low voltage which can be supplied through a stepdown isolating transformer mountable within the meter itself and connected to the switch mechanism of the transmitter and the solenoid of the stepping motor in the receiver by a low voltage two-conductor cable of relatively light gauge. For example the system can be operated at 12 volts and low primary current with a receiver as far as 3,000 feet away from the meter itself.

An important feature of the invention is that power interruptions or failures do not produce a false or spurious reading in the register as characterizes certain prior art systems which depend on a making and a breaking of the current supplied to the receiver.

A further feature is that if the receiver is damaged or the interconnecting control cable broken or short circuited, or

otherwise interfered with, the parent meter is not affected and continues to provide accurate readings. Thus in the case of unauthorized tampering with the wiring or with the remote register itself, the original meter reading is preserved at the meter.

Among other features of the invention are that both the receiver and the modification of the meter to incorporate the transmitter comprise components of simple construction, that are easy to manufacture due to lack of critical tolerances, and in the case of the transmitter can be easily and conveniently installed in an existing meter without the necessity to drill or tap holes and at a considerably less cost than would be required to move the parent register, for example to a more accessible location.

A feature companion to the above is that the components of both the transmitter and the receiver can by reason of their simplicity be made durable so as to assure long, maintenance-free life.

A further feature of the invention is that the two pole pieces of the solenoid are spaced from the periphery of the rotatable disc of magnetizable material comprising the stepping motor by air gaps of unequal dimension so that one pole will predominate over the other. In the demagnetized condition of the solenoid the magnetism of the disc will cause it to index with the nearer of the two pole pieces and each time the solenoid is magnetized the reversing of the polarity of the closer pole piece of the solenoid will repel the adjacent pole of the disc so that the closer pole piece will act to index and determine the position of the disc, both when the coil is energized and when it is not energized. To further facilitate this indexing, the invention further provides that the pole pieces will be so spaced about the periphery of the disc to span an angular distance equal to one or more full pole spacings on the disc periphery plus a half pole spacing.

Then too, the pole piece of the solenoid spaced by the greater air gap from the periphery of the disc tends to repulse any movement of the disc in its direction with the result that the disc continues to rotate always in the same direction. Of consequence, the register dials are properly registered with the dials of the meter.

In practice it has been found that the operation of this stepping motor has less than 0.1 percent effect on the light load meter accuracy and wherefore there are no recalibration problems.

A further feature of the invention is that by reason of the described construction an interruption of current flow after the disc has been advanced by the direct current signal from the transmitter and indexed cannot be further advanced except by reversal of the polarity of the direct current signal which would ordinarily only be obtainable from the transmitter. An interruption of the current flow after the disc had been advanced and a reestablishment of the current in the same direction would produce no further rotation. Of consequence, the registers and their readings are less susceptible to tampering by vandals and/or others.

It will be appreciated that a further feature of the invention is that in those areas where meters are attractive items to vandals, the registers can be placed outside a building for the convenience of the reader and the parent watt hour meter located inside the building utilizing the safety thereof. The registers can be made of relatively small size in comparison to the meter itself, so that they are more likely to go unnoticed. Furthermore, in the event the register is damaged, the reading on the meter itself is preserved.

A companion feature of the invention is that in new construction, as for example a high rise multiapartment building with the only place left for meter installation is a small hard-to-reach corner, the registers for each of the several apartments can be conveniently clustered together in a convenient central location for efficient meter reading. For example, all the meters of an apartment building can be ganged on one central reading panel which could be located and locked for access only by the meter reader.

Many other objects, advantages and features of the invention will be at once apparent or will become so from the more detailed description of selected embodiments of the invention which will now be described in connection with the drawings which accompany the application.

Referring therefore now to said drawings:

FIG. 1 is a schematic view of one form of the invention showing the transformer, switch and cam comprising the transmitter installed in the meter and hooked to the solenoid which operates the magnetized disc of the stepping motor also shown mounted on the units recording shaft of the remote register;

FIG. 2 shows on a larger scale the switch and operating cam of the meter and illustrates the electrical circuit into which the switch operated by the cam is utilized;

FIG. 3 is a sectional view taken along lines 3-3 of FIG. 2 and shows the manner of mounting the switch to the meter dial panel;

FIGS. 4, 5 and 6 are plan and sectional views respectively, showing details in the construction of the cam which is mounted on the units recording pintle of the register; FIG. 4 being a section taken through the cam along center line X-X of FIG. 2; FIG. 5 a plan view of the insulator assembled between the two contact plates and FIG. 6 a sectional view taken along lines 6-6 of FIG. 5;

FIG. 7 is a plan view of the remote register and illustrates details in the construction thereof;

FIG. 8 is a sectional view taken along lines 8-8 of FIG. 7 to show further details in the construction thereof; and

FIGS. 9, 10, 11 and 12 illustrate additional embodiments of the invention.

Referring therefore now more particularly to the several views wherein like parts are identified by like reference numerals, the preferred embodiment of the invention will now be described in connection with FIGS. 1 through 8.

In FIG. 1, 10 represents a commodity supply meter of conventional construction, for example, a single phase kilowatt hour meter used for measuring the consumption of electrical power which a load draws from a power source. As is well known in the art, such meters are commonly provided with a meter disc 12 which is caused to rotate by reason of the interacting magnetic fields from coils provided in the load line and from the current they induce in the disc. Meter disc 12 is mechanically coupled to a pintle 14 shown associated with units dial 16 on the face plate 18 of the meter. Shaft 14 commonly carries a pointer (not shown) so that as it rotates with the meter disc 12 relative to disc 16, it indicates the kilowatt hours of electrical energy or power which the meter disc is measuring as drawn by the load from the power source. Commonly shaft 14 will rotate 36° or one-tenth of a turn for each kilowatt hour measured by disc 12 and shaft 14 is intercoupled by a gear train in a 1 to 10 ratio with an adjacent shaft 20 such that each time shaft 14 is rotated by meter disc 12 through a full turn it will have rotated shaft 20 one-tenth of a turn. Pointer 20a on shaft 20 therefore indicates by means of dial 20b with which it is related the number of tens of kilowatt hours measured by the meter disc 12. Shaft 22 of the hundreds dial 22b is similarly driven by the tens shaft 20, therefore the numerals on the several dials with which the pointers on the respective shafts 16, 20 and 22 of the meter 10 relate, indicate the electrical power measured by disc 12. A meter such as described is of conventional construction and is well known to the art. If the meter were used to measure consumption of other commodities such as gas, or water, the operation of the meter would be substantially the same except that meter disc 12 would be replaced by a suitable mechanism responsive to the flow of the commodity being measured.

In accordance with the invention, means are provided whereby the position of the mentioned shafts and their pointers relative to the meter dials can be exactly reproduced on corresponding dials of a register remotely located from the meter. For example, as previously described, meter 10 may be located within the basement of a house or other building, for

example close to the circuit breaker box, while the receiver indicated generally at 24 in FIG. 1 will be located on the outside wall of the building or in some location to which a meter reader has convenient access.

As shown by FIG. 1, when considered with FIGS. 7 and 8, register 24 comprises a housing 26 which may be affixed to the outside wall of the house or other building by screws or other suitable means not shown. The register housing 26 is provided with a removable transparent window 27 in its front wall through which dials corresponding to the meter dials may be visible. In FIG. 1, 30b represents a units dial corresponding to units dial 16 of the meter; 32b represents the tens dial and 34b the hundreds dial corresponding to dials 20b and 22b respectively of the meter, the pointer and operating shafts associated with said dials of the register being in the same relation as in the meter. Window 27 is preferably held with its peripheral edge beneath lip 29 of housing 26 and in sealed relation against weatherstripping 36, as by a clamp 38 which is shown locked to the register housing 24 by a Brooks seal or other connector 40.

In accordance with the invention, remote register 24 is provided with a stepping motor consisting of a disc magnet 60 shown in FIG. 1 as inconspicuously fixed to the units recording shaft 30 below the dial supporting panel 28, so that pointer 30a mounted thereon rotates with said shaft relative to the numerals of the units recording dial 30b. Disc magnet 60 is provided with ten poles equidistantly spaced about its periphery which are alternately north and south, the ten poles corresponding in number and location to the numerals on the units recording dial 30b. Disc magnet 60 may be of the type having salient poles as in the embodiments illustrated by FIGS. 9-12; however in the preferred embodiment of FIG. 1, a solid disc of magnetic material such as Indox I is used which has a sufficiently high resistance to demagnetization that its poles may be confined within the disc periphery. Indox I is a nonoriented barium ferrite permanent magnet having a peak energy product of 1.0 million B_H, a typical coercive force of 1,825 oersteds and a typical residual induction of 2,200 gauss. The field structure of the stepping motor comprises a solenoid 62 having pole pieces 64, 66 at its two ends disposed adjacent the periphery of the disc magnet 60, each with an air gap therebetween and the periphery of the disc, the pole pieces being separated a distance apart so as to span 1½ times the pole span of the disc.

The span between pole pieces 64, 66 may be increased to 2½ times the pole span of the disc to compensate for leakage fields if that is a problem. In any event, as will later be made clear, the separation of pole pieces 64, 66 should equal some whole number of pole spans of disc 60, plus one-half a pole span. Solenoid coil 62 is alternately energized by pulses of direct current from the transmitter which is mounted within the meter 10 as afterwards described, and the polarity or flow of said pulses of direct current is reversed each time the meter disc 12 measures a kilowatt hour of power drawn across the load line wherefore the solenoid pole pieces under the influence of the transmitter cause the disc to move an angular distance equal to the spacing between its poles each time the pole pieces 64, 66 of the solenoid reverse their polarity. As noted above, this angular distance corresponds to the angular spacing of the numerals on dial 30b wherefore the pointers on the dials of the register index and/or correspond to the position of the pointer on the meter dials.

The transmitter which feeds said pulses of direct current to the solenoid is shown in FIG. 1 as comprising a cam indicated generally at 42, which is affixed to the units recording pintle 14 of the meter 10 so as to turn therewith. Cam 42 comprises an inner contact plate 44 and an outer contact plate 46 of phosphor bronze separated by an insulator thickness of nylon 48. Conveniently as shown by FIG. 4, insulator 48 has locating projections 49 on its two surfaces which mate with provided openings in the two contact plates 44, 46 such that the three elements of the cam may be assembled in a predetermined relation and cemented together in said relation. One of said

projections 49a may be shaped to replace the pointer which the cam 42 replaces. As shown in FIG. 4, insulator 48 further includes a cavity 50 in which a diode 52 is located, one side of the diode being connected by conductive pin 54 to the inner contact plate 44 and the other side of the diode to the outer contact plate 46 by conductive pin 56. For this purpose insulator is provided with suitably directed channels 51 which communicate with the two surfaces of the insulator and its diode-containing cavity 50.

Indicated generally at 58 in FIG. 1 is a switch member comprising a mounting block shown of suitable nonconductive insulating material supported on the upper surface of the dial panel 18 adjacent the edge thereof, by a U-clamp 70 (FIG. 3) and secured in place by a setscrew 72 which extends through a provided opening in the insulator member 68 and is tightened against the upper surface of the panel. Within mount 68 are cantilever-supported a pair of spring arms 76 and 78 of electrically conductive material. These spring arms are arranged on opposite sides of cam 42 so that their outer free ends engage with diametrically opposite portions of the cam 42, as shown by FIG. 2. In said FIG. 2 it will be seen that the free end of spring arm 78 is inwardly deflected so that it has constant bearing contact with the outer surface of the cam immediately below a centerline designated X-X and spring arm 76 has its outer free end bent inwardly so that it constantly bears against the opposite side of the cam immediately above said centerline. The transmitter mounted within the meter further includes a voltage reducing transformer indicated generally at 80. As shown in FIG. 1, the transformer may be supported in a clamp 82 having an apertured end 84 which fits over one of the two dial panel supporting posts 83 (usually of tapered shape) and secured thereon as by setscrew 85.

Considering now the electric circuit schematically shown in FIG. 2, it will be seen that the transformer 80 comprises a primary coil 86 and a secondary coil 88. In said FIG. 2, 90 represents a pair of conductors by which the primary coil 86 of the transformer is connected to a continuously available alternating current supply. In the illustrated application of the invention to an electric watt hour meter, terminals connected to the main line will be available within the meter housing itself. Thus it will be convenient to supply conductors 90 with spade clips by which the conductors may be conveniently connected to the terminals. One side of the secondary coil 88 of the transformer is connected by line 92 to one side of the solenoid 62, the other side of the secondary coil 88 being connected by line 94 to spring arm 78 of the switch mechanism 68; and the other side of the solenoid 62 being connected by line 96 to spring arm 76. As previously described, spring arms 76, 78 engage against opposite sides of cam 42 so that with spring arms 76, 78 each engaging a respective one of contact plates 44 and 46 a circuit is completed in which diode 52 functions to convert the alternating current induced into the transformer secondary from the primary to direct current voltage. Conveniently a capacitor 120 and if necessary a resistance 122 may be connected across lines 92 and 96 in order to smooth out the direct current pulses.

Considering FIG. 5 with FIG. 2, it will be noted that the outer contact plate 46 of the cam 42 has its periphery divided into five projections 102 and the inner contact plate 44 has its periphery divided into five similar projections 104 which are equidistantly spaced about the periphery of the respective plates. Additionally the two plates are so assembled relative to each other that the projections of one plate are alternately centered between pairs of projections of the other plate. It will be further seen that the intermediately disposed insulating member 48 has ten peripherally located projections 106 which are also equidistantly spaced about its periphery. Referring next to FIG. 2, it will be seen that projections 102 of plate 44 and also projections 104 of the inner contact plate 46 are separated by radially receding surfaces 108, each of which is of sufficient extent and radial depth that the projections of the plates protrude radially beyond said surfaces when intermediately located between pairs of projections of the other

contact plate. Surfaces 108 are also located that the projections 106 of the insulator member 48 also protrude radially therebeyond wherefore the periphery of the cam 42 effectively comprises a series of projections which in sequence comprise a conductive projection 104, a nonconductive projection 106, followed by a conductive projection 102, then a nonconductive projection 106, then a conductive portion 104 and so on. Also from FIG. 4 it will be seen that each of spring arms 76 and 78 have a width such that each wipes substantially across the full thickness of the cam 42 and of consequence each spring arm is alternately stepped into engagement with the projections of one of the two contact plates by the projections 106 of the insulator member 48 as the cam 42 is rotated, but is isolated from the other plate as the second arm engages the other of the contact plates so as to successively locate the plus side of the diode with first one spring arm and then with the other as the cam 42 is rotated under the drive of meter disc 12.

Thus as shown by FIG. 2, spring arm 78 will in one position of rotation of cam 42 have electrical contact only with a projection 102 of the outer contact plate 46 while spring arm 76 will have electrical contact only with a projection 104 of the inner contact plate 44. In this condition diode 52 is coupled to the solenoid 62 via outer contact plate 46, spring arm 78, line 94, secondary coil 88, line 92, the winding of the solenoid, line 96, spring arm 76 and inner contact plate 44 such that pole piece 64 of the solenoid is a north pole and pole piece 66 a south pole. As the cam continues to rotate with shaft 14 of the direction indicated by the arrow 110 responding to the metering function of disc 12, it will be evident that the free ends of the two spring arms will be caused to move off the projections 102 and 104 of the respective contact plates and onto projections 106 of insulator 48 so as to interrupt the circuit. With the circuit interrupted, the south pole of the disc magnet 60 will remain attracted to pole 64 due to its proximity and so hold the magnetic disc in this position wherefore pointer 30a will not move. Any forces tending to align pole piece 66 with a pole on the magnetic disc 60 will be less due to the greater air gap which spaces it from the nearest pole of the disc 60. As the cam rotates further in response to meter disc 12, spring arm 78 will be caused to engage the next projection 104 of the inner contact plate 46 and simultaneously the outer end of spring arm 76 will be brought into engagement with the projection 102 of the outer contact plate wherefore the diode will now be connected in reverse to its original connection with the solenoid 62. Consequently pole piece 64 will now become a south pole and pole piece 66 a north pole. When this occurs, by reason of the phenomena that like magnetic poles tend to repulse each other and opposite poles to attract, solenoid 62 will cause the disc to turn on shaft 30. The disc 60 might be driven in either direction, depending on the equilibrium of its mounting. However, pole 66 now being a north pole will tend to attract the closest south pole on the magnetic disc 60 and repel the nearest north pole so that the disc will continue to turn in a clockwise direction as indicated by arrow 112. The pole with the larger gap therefore determines the direction of rotation of the disc 60 and the pole piece with the narrower air gap determines the alignment of the disc and therefor the indexing of pointer 30a with the numerals of dial 30b. As the cam continues to rotate, the circuit will be again interrupted by reason of the spring arms 76, 78 reengaging succeeding projections 106 of the insulator. Of consequence, as the cam 42 rotates with shaft 14 under the direction of meter disc 12 as it measures power consumption, diode 52 is caused to alternately make pole piece 64 a north pole and then a south pole so as to enforce rotation of the disc 60 in steps, each step corresponding to the angular displacement of the numerals on the units dial 30b of the register 24.

As mentioned, the two air gaps are not equal and in practice it has been found advantageous to make one twice as large as the other to assure the closer pole will predominate over the other pole to obtain the proper indexing of the disc 60 and pointer 30a which it operates, both when the coil is energized and when it is not energized. In addition, the pole pieces 64,

66 of the solenoid are spaced so as to span one or more full poles on the periphery of the magnetic disc 60, plus one-half a pole span, again to assure that the disc rotates always in the same direction. It will also be appreciated that by reason of the described construction of the stepping motor any interruption of the current flow after the disc 60 has been advanced to an angular displacement equal to one pole span, reestablishment of the current in the same direction as from an external source would produce no further rotation. Only a reversal of the direction of the current flow as would be obtained by a further rotation of cam 42 will produce the next step of rotation of disc 60.

It will be appreciated also that the described system requires only a minimal amount of line voltage to operate the stepping motor represented by the magnetic disc 60 and its controlling solenoid 62. Preferably, therefore, the windings of the primary coil 86 and secondary 88 of the transformer are so related that the line voltage which is conventionally as high as 120 or 240 volts AC may be stepped down to 12 volts. This lower voltage has been found sufficient to successfully operate the stepping motor when the register is as far as 3,000 ft. away from the meter register.

Although not necessary to the operation thereof, advantageously a shield 116 may be located over the magnetic disc 60 and its control solenoid 62 in the register but concealed beneath panel 28 so as to provide against possible external magnetic interference from vandals and/or others seeking to tamper with the register.

In the embodiment thus far described, pointer 30a of the units recording dial of the register moves one full numeral each time a direct current pulse or reverse polarity is received from the transmitter under the direction of cam 42 and its diode 52.

Referring however to FIG. 9, a second embodiment of the invention is shown wherein the units recording shaft 14 of the supply meter 10 has a cam 142 secured thereto which is provided with two diametrically opposed contacts 144 and 146 which in turn engage with opposing spring arms 178 and 176 as pintle 14 turns under the influence of meter disc 12. The two contacts 144 and 146 are interconnected through a small rectifier diode 152 also carried on the cam. As in the first described embodiment, spring arms 176, 178 form part of a series circuit comprising the secondary winding 88 of a step-down transformer 80, a two-wire connecting link 92, 96 and solenoid 62 of the described stepping motor. In this embodiment of the invention, however, magnetic disc 160 comprises ten salient poles alternately north and south and is coupled to an auxiliary shaft 130 of the remote register 24. Auxiliary shaft 130 is provided with a tooth wheel 132 which drivingly meshes with a proportionately larger toothed wheel 134 on the tens recording shaft 30 so that pointer 30a duplicates the position of the pointer of the tens meter dial 20b.

The primary winding 86 of the transformer 80 is connected as in the first embodiment to a suitable continuously available alternating current supply, such as the public supply mains. In the case of application of the invention to an electricity supply meter, such means will be available within the meter mechanism itself.

In operation, as the pintle 14 rotates, the direct current pulses delivered to the solenoid 62 of the stepping motor by the diode are alternately reversed by the cam 142, alternate pulses being made with the diode 52 connected with one polarity sense and the intervening pulses made with the diode connections reversed. In consequence the stepping motor is supplied with a series of alternate positive and negative going pulses necessary to operate the stepping motor correctly.

Such a system like that of FIG. 1 is also immune from the ill effects of any spuriously induced pulses, since these will not, in the normal course of events be of alternately opposite polarity. At the most, any induced pulse of one polarity will serve to advance disc 160 of the stepping motor by one step only and only prematurely to the arrival of the next pulse of the same polarity from the cam disc 142 which will not then operate the motor.

The arrangement is similarly adaptable as in the case of the first described embodiment to use with a 2 conductor link 92, 96 of considerable length by appropriate choice of the output voltage of the transformer while the additional mechanism necessary on the register of the metering instrument is obviously simple and inexpensive.

As an alternative to the use of the rotating cam-plus-diode structure of FIG. 9, a form of register switch mechanism as shown in FIG. 10 may be employed. In this further embodiment an eccentric cam disc 242 is coupled to the pintle 14 of the meter units recording dial 16 so as to operate a changeover contact bearing arm 272 between opposed fixed contacts 276, 278. Such contacts 276, 278 are arranged to provide alternate circuit paths through oppositely poled diode rectifiers 252, 252' which are in series with the secondary winding 88 of the transformer and the solenoid 162 of the remote register motor as in FIG. 9.

The arrangement of FIG. 10 requires the use of two diode rectifiers. This can be avoided by employing a double-pole changeover switch bearing arm 370 controlled by the eccentric cam mechanism as shown in FIG. 10, where the single rectifier 352 in series with the transformer secondary winding 88 provides a DC output whose polarity of application to the solenoid of the stepping motor is reversed twice during each revolution cycle of the pintle 14 as driven by the meter disc.

FIG. 12 shows a still further embodiment which is generally similar to the FIG. 10 embodiment, except that the eccentric cam 242 has now been replaced by a five pointed cam 442. As shown in FIG. 12, cam 442 rotates with pintle 14 of the meter 10 on which it is mounted to move switch bearing arm 470 corresponding to arm 370 of FIG. 11 to first engage contact 478 by the high point of the projection and then to engage contact 276 as it follows the projection inwardly to its low point. Thus as shown in FIG. 12, this type of cam permits the magnetic disc of the stepping motor to be directly coupled to shaft 30 of the units recorder of the remote register without the necessity of employing gears or toothed wheels as is required by the embodiments of FIGS. 9-11. It will also be understood that the five pointed cam 442 of the FIG. 12 embodiment could also be utilized in each of the FIGS. 9, 10 and 11 embodiments to obtain the same advantages.

From the aforesaid description, it will be apparent that all of the recited objects, advantages and features of the invention have been demonstrated as obtainable in a highly practical and efficient, yet inexpensive to manufacture and use apparatus.

I claim:

1. A meter extension system comprising a receiver embodying a rotor having alternately spaced north and south poles about its periphery, and a solenoid having opposite pole pieces adjacent the periphery of said rotor for rotating the rotor, and transmitter means for operative connection to the metering means of the meter, the transmitter means providing pulses of direct current for the solenoid which reverse the magnetic polarity of the solenoid pole pieces for each successive quantum of the commodity which the metering means measures, the rotor being thereby caused to turn in steps corresponding to the quanta of the commodity measured by the metering means, the receiver further including indicating means operated by the stepped rotation of the rotor which indicates the quanta of the commodity measured.

2. A meter extension system as claimed in claim 1 wherein the pole pieces of the solenoid are spaced from the periphery of the rotor by air gaps of unequal width.

3. A meter extension system as claimed in claim 1 wherein the pole pieces of the solenoid are spaced apart a distance equal to the span between at least two poles on the rotor periphery plus an additional one-half a pole span.

4. A meter extension system as claimed in claim 1 wherein the transmitter means comprises a cam mounted for rotation by the meter means, a circuit for providing the pulses to the solenoid including a pair of contact arms series-connected in said circuit, two sets of contacts carried by said cam, and a current rectifier having one side connected to one set and its

opposite side connected to the second set of contacts, said two sets of contacts being staggered about the periphery of the cam and located for wiping by said contact arms so that as the cam rotates one contact arm successively wipes a contact of one set and then a contact of the other set, the two contact arms being further so spaced that one contact arm engages the contact of one set simultaneously as the other contact arm engages a contact of the other set whereby to reversely connect the current rectifier into the circuit as the cam is rotated by the metering means.

5. A meter extension system as claimed in claim 4 wherein said contacts comprise a pair of spaced contact plates having said current rectifier connected therebetween, each said contact plate having projections spaced about the periphery thereof for wiping by the two contact arms, the projections of one contact plate being staggered between the projections of the other contact plate such that each contact arm successively wipes a projection of one plate as the other arm wipes a projection of the other plate.

6. A meter extension system as claimed in claim 5 wherein said cam comprises insulating material separating the two contact plates and supporting the current rectifier.

7. A meter extension system as claimed in claim 4 in which said circuit further includes a pair of conductor means for connecting said contact arms to opposite sides of the solenoid, one of said conductors including the secondary of an AC transformer.

8. A meter extension system as claimed in claim 1 wherein said transmitter means comprises a circuit for connection to the solenoid and a source of alternating current, current rectifying means and contact means, and cam means mounted for rotation by the metering means and operable with said contact means for reversely connecting said current rectifier means into said circuit each time the metering means measures a quantum of the commodity so as to reverse the polarity of the solenoid in order to drive the rotor in timed response to the metering of the commodity by the meter.

9. A meter extension system as claimed in claim 8 wherein said contact means comprises a pair of spaced contacts carried by said cam means and a pair of contact bearing members connected in said circuit, said contacts being alternately wiped by said contact bearing members as said cam means are rotated.

10. A meter extension system as claimed in claim 8 wherein the cam means comprise a multipointed cam, the high and low points of which are successively wiped by a contact bearing member of said contact means.

11. In apparatus for measuring a consumer's use of a commodity such as gas, water, electricity and the like, the combination of means for measuring a commodity being used, a first shaft which is rotated by said means in measuring the commodity, a second rotatable shaft, a rotor fixed on said second shaft having north and south poles alternately spaced about its periphery, a solenoid having pole pieces of opposite polarity disposed adjacent the periphery of said rotor, a circuit including means for connecting said circuit to a source of alternating current, rectifier means, and contact means operated by rotation of said first shaft to reversely connect said rectifier means into said circuit for sequentially converting alternating current to direct current pulses of reversed flow for application to said solenoid so as to reverse the magnetic polarity of the pole pieces of the solenoid and thereby ef-

fect rotation of the rotor and the second shaft fixed thereto in accordance with rotation of the first shaft by the commodity measuring means, said second shaft having indicating means associated therewith which indicate the quantity of the commodity measured.

12. An extension system for a meter having measuring means for measuring quanta of a commodity comprising transmitter means operatively connected to said measuring means including first means for providing a circuit path for connecting unidirectional current from a source of potential to associated equipment, and cam means operable with said first means for reversing the direction of flow of the current over said circuit path for each successive quantum of the commodity measured by said meter measuring means to thereby provide pulses of different polarities for successive quanta, and register means connected to said circuit path and responsive to said pulses for registering the number of reversals in the polarity of said pulses to thereby register the quanta of the commodity measured by the meter measuring means.

13. An extension system as set forth in claim 12 in which said source of potential is a source of AC current, and said first means include contact means, and current rectifier means, and in which said cam means are operable with said contact means to reversely connect said current rectifier means into said circuit path each time a quantum of the commodity is measured by said meter measuring means to rectify AC current from said source to provide said pulses, and to reverse the polarity of the pulses for each quantum of the commodity measured.

14. An extension system as set forth in claim 13 in which said register means include a stepping motor having a rotor and a solenoid connected to said circuit path, said solenoid being operatively energized responsive to the reversals of the polarity of the pulses provided over said circuit path to cause said rotor to rotate in steps which correspond to the quanta of the commodity measured by said meter measuring means.

15. An extension system as set forth in claim 13 in which said contact means include a pair of spring arms connected in said circuit path, and a pair of spaced contacts connected to said rectifier means and located for wiping by said spring arms, and in which said cam means are mounted for rotation by said measuring means and operable to step the spring arms into and out of engagement with said contacts as said cam means are rotated, said cam means being operative to step each spring arm into engagement with a different one of the contacts and to alternate the contact engaged by the spring arms in successive steps thereby reversely connecting said rectifier means into said circuit path.

16. A pulse transmitter for providing pulse signals for a functional device which represent quanta of a commodity measured by a meter, said pulse transmitter comprising a pulse generating circuit including input means for connection to a source of AC current, current rectifier means, and contact means for connecting said current rectifier means into said pulse generating circuit to rectify AC current from said source to said functional device thereby providing direct current pulse signals for the functional device, and cam means driven by said meter and operable with said contact means to reverse the connection of said rectifier means in said circuit each time a quantum of the commodity is measured by said meter whereby the polarity of said pulse signals is reversed for each quantum of the commodity measured.