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54 **Counter.**

57 A counter comprises a series of hollow digit-displaying drums (13-17), with mechanical driving connections (18 - 21) driving succeeding drums so that a decimal total number is set up. The higher significance digit drums (14 - 17) each carry an optical encoder comprising a cylindrical surface with slots forming a binary code which is related to the displayed digit. U-section reading devices (30 - 33) straddle the encoder to read the code and produce an electrical coded output.

To avoid problems caused by readings at changeover points, the lowest significance digit-displaying drum (13) is associated with an impulse drive which is triggered at each changeover point to drive the drum forward so that it does not come to rest at the changeover point. The impulse drive comprises an off-centre weight which rotates with the drum.

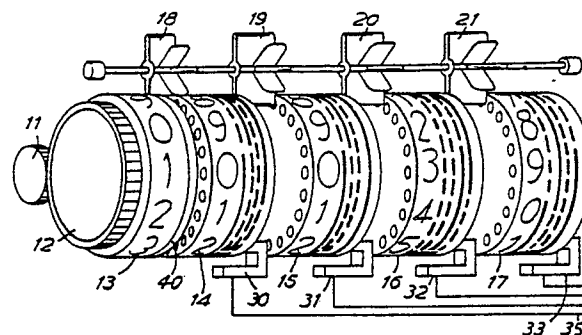


Fig.1

COUNTER

This invention relates to counters of the kind comprising a series of rotating digit-displaying indicators mechanically connected together so that a rotating input drive causes an increasing number to be set up which is a measure of the angular rotation of the input drive. Such counters have had to be read by inspection of the indicators, but efforts have been made to enable the readings to be made electronically from remote location by, for instance, causing each indicator to operate electrical means setting up a coded electrical representation of the reading.

These previous methods include, as described in our Patent Application No. 2 168 862, electrical encoders associated with each digit-displaying indicator in which an electrical slider moves over a pattern of concentric strips having contact areas arranged in a code, so that an energization pattern unique to each digit is set up, as each indicator rotates. Such systems, and similar ones, suffer the problem of uncertainties as the slider leaves or enters a contact area. Codes such as the Gray Code have been devised with the intention of reducing the uncertainty, but there still remain problems as each changeover occurs, since the apparent reading may change back-and-forth a number of times, particularly if the indicator has come to rest at a changeover point. Moreover, the coded patterns have to be manufactured with great accuracy to avoid errors, and are thus expensive.

The invention provides a counter comprising a series of rotating decimal digit-displaying indicators, mechanically interconnected to be driven from a single rotary input drive, said mechanical interconnection including means for producing a drive impulse, associated with a lower significance digit-displaying indicator and triggered as said indicator approaches a changeover point for its displayed digit, the drive impulse being directed to drive that indicator over the changeover point and, once triggered, being independent of the motion of the input drive, some or all of the said indicators carrying or driving coded patterns rotating with the indicators or set up readable representations of the displayed digits and means for enabling transmission of the codes to a remote location.

It will be appreciated that because the said lower significance digit-displaying indicator will always change its displayed digit at the same time as any of the higher significance digit-displaying indicators, the drive impulse will be transmitted to drive all of the higher significance indicators over their changeover points as they approach them. Said coded patterns may be comprised by optical encoders having optical means for reading light

patterns which change as the indicators rotate. The light patterns may be by light source means shining through slots forming the codes. The coded patterns may comprise a binary code, in which four binary numbers are set up to represent the decimal digit being displayed.

The binary numbers may be read or translated into electronic form for transmission over electrical wires to the remote location. Alternatively, when light patterns are used optical fibres may transmit the light to the remote location.

Since the drive impulse is triggered before the changeover point and drives the indicator over and past the changeover point, it will be understood that the indicators cannot come to rest over a changeover area which extends each side of the changeover point. Readings are not therefore taken in this area and it may be found desirable for these sections of the coded patterns to be omitted. In any case, because no readings are taken here there is no need for any great degree of accuracy in forming the changeover points in the coded patterns. The impulse drives the indicators ahead of the rotary input drive, so that there is a higher reading than is warranted, but this is cancelled out by the indicators remaining stationary until the rotary input drive catches up.

The impulse drive may comprise an off-centre rotating weight which is driven to a top position by the rotary input drive and then drops under the force of gravity, driving the indicator in advance of the rotary input drive.

A specific embodiment of the invention is shown in the accompanying drawings, in which:-

Figure 1 is a perspective view from the rear of a counter,

Figure 2 is a plane projection of the surface pattern of an indicator drum of the counter of Figure 1,

Figure 3 is a detail of a preliminary indicator drum of the counter of Figure 1, and

Figure 4 is a view in the direction of arrows IV - IV of Figure 3, with some items in a different position.

The counter shown is intended for use in a gas meter of the kind in which back-and-forth movement of flexible diaphragms caused by flowing gas is translated into rotational drive movement of gear (11). This rotation is transmitted by gear (12) to a series of five hollow indicator drums (13, 14, 15, 16, 17), each bearing a circle of decimal digits 0 - 9. A row of viewing windows on the far side of the drums define the digits to be read. Mechanical drive gears (18, 19, 20, 21) are arranged in known

manner to drive succeeding drums through an angle subtending one of the digits, each time the previous drum changes over from 9 to 0. Thus, the succeeding drums show successively higher significance digits in a total decimal number which is related to the angle through which gear (11) has rotated, and is a measure of the volume of gas which has passed through the meter.

The lowest digit in the decimal number carried on drum (13) is not normally read and has no viewing window, or may be coloured differently to show that it does not form part of the reading. This drum has no encoder associated with it. Each of the other drums (14 - 17) is extended to provide a cylindrical encoding surface, shown in plan at (22) in Figure 2. The encoding surface provides four cylindrical tracks (23, 24, 25, 26), each having a different pattern of slots (27) cut through the thickness of the drum to the hollow interior.

Stationary photo-electric reading devices (30, 31, 32, 33) are of U-section, with one limb of the U-shape extending across the four tracks inside the drum and the other limb extending across the four tracks outside the drum. Each device comprises a light source in one limb and four sensors in the other limb, aligned with the four tracks. The digit being read is set up by the slots in binary form, the open portions appearing as binary 1, the closed portions as binary 0. Thus the four tracks provide four binary numbers, and the patterns of slots are devised as described in more detail hereinafter, so that each decimal number is represented by a specific pattern of four binary numbers. Electrical signals from each photo-sensor comprise a binary electrical code for the decimal number, these signals being taken on electrical wires (35) to a reading or transmitting station (not shown).

The drum (13) bearing the lowest value decimal number has no encoder, but in its place operates an impulse drive, shown best in Figures 3 and 4. An impulse disc (40) is mounted to rotate about the same axis as drum (13), but does not have a rigid drive connection to it. Instead, a drive peg (41) secured to or integral with drum (13) extends into the path of a weight (42) which is secured near to or at a point on the periphery of the impulse disc. When drum (13) is rotated in its normal direction, the peg (41) contacts the weight (42) and drives the disc in the same direction.

The mechanical drive gear (18) operating to transmit drive to the next drum (14) has no permanent connection to drum (13). While not operating, it rests as shown in Figure 4, with two teeth sliding on the outer periphery of the impulse disc.

When drum (13) reaches the position at which a changeover from 9 - 0 is to be made, the impulse disc has reached the position shown in Figure 4. Here, the force of gravity on weight (42) takes over,

and rotates the disc until the weight is at the bottom-most point, leaving the drum and peg (41) behind. A slot (44) in the periphery of disc (40) is located so that as the weight starts its downward movement, the tooth (45) on the drive gear (18) drops into the slot, the downward movement then driving the gear (18) round until the position is reached at which tooth (45) leaves the slot and the next tooth (46) comes into contact with the periphery of the disc. The rotation of the gear (18) is transmitted by meshing gears to the next drum (14), which thus turns to present the next decimal number to the viewing window.

It will be understood that once weight (42) starts to fall, it will continue its movement without hesitation, whatever the drum (13) is doing. Thus, if the drum (13) is rotating only slowly, or halts at a position on a changeover, the gear (18) will complete its rotation to present the next number centrally to the viewing window. In this movement, the optical encoder is also rotated, so that the photo-sensor normally reads at a central position in each section of the slot. There is a short but finite time during which the weight is falling and it is possible that an electronic reading could be taken during this period. Each reading is therefore repeated after the finite time (e.g. 10 milliseconds) to check the validity. There is no requirement for complex coding arrangements to resolve uncertainties. Nor is there any requirement for minute accuracy in the cutting of the slots. It will be appreciated that the location of the centre position of each number is tied to the centre position of each section of the binary tracks. Similarly, the location of the peg (41) and slot (44) are located so that the movement of gear (18) takes place at the changeover point and through an angle such that the next decimal number takes up a central position in the viewing window.

When gear (18) reaches its next stationary position, the disc (40) remains stationary until rotation of drum (13) brings the peg (41) into contact with weight (42) and the drive is taken up again. It will thus be seen that drum (14) always takes up stable positions in which a decimal number and the related optical code are at central positions, not left at changeover points. This has a knock-on effect on the remainder of the drums (15, (16) and (17) which similarly always take up the stable, central positions.

As is well known, four binary-coded signals as provided by the four tracks can provide up to 16 different codes, and so represent up to 16 decimal numbers. Since only 10 are required, and there is no need to provide for reduction of coinciding changeover points, there is some latitude for selection of which coded arrangements to use. In the arrangement shown in Figure 2, the codes have

been selected to simplify the cutting pattern so that no slot extends over only one sector, i.e., all the slots are at least two sectors long, and there is thus a reduced number of different slots. The codes have also been selected so that a simple logic arrangement will disclose if the counter has been reverse driven (for instance, by fraudulent means to reduce the apparent gas usage). In the arrangement shown, track (24) changes from binary 1 to binary 0 only once in every revolution. This change occurs when track (25) is indicating binary 0. If the drum is reverse driven through a revolution, then a change from binary 1 to binary 0 will occur when track (25) is indicating binary 1. Thus an electronic checking device (not shown) checks in each revolution that a change on track (24) from binary 1 to 0 only occurs when track (25) is at binary 0 and operates a reverse operation alarm should track (25) be at binary 1.

Although a cylindrical drum shape has been used to provide the optical encoder slots, it is within the invention to provide different arrangements. For instance, the circular end surface of each drum could bear the slots in concentric circles. Alternatively, a separate encoder drum or disc can be driven from each indicator drum, either directly or through gears. The counter could be used with other kinds of gas meter, or indeed with any form of meter in which it is desired to read a mechanical counter electrically.

Claims

1. A counter of the kind comprising a series of rotating decimal digit-displaying indicators (13, 14, 15, 16, 17) mechanically connected together to be driven from a rotary input drive (11), characterized by the combination of a) an impulse drive associated with a lower significance digit-displaying indicator (14) which is triggered as said indicator (14) approaches a changeover point to release a drive impulse to drive that indicator over the changeover point, the drive impulse, once triggered, being independent of the motion of the input drive (11), and b), some or all of said indicators (14, 15, 16, 17) driving coded patterns (22) rotating with the respective indicators to set up a readable representation of the digit being displayed and means (30, 31, 32, 33) for enabling transmission of the code to a remote location.

2. A counter as claimed in claim 1, further characterized by said coded patterns (22) comprising optical encoders secured to their respective indicators (14, 15, 16, 17) and having optical means (30, 31, 32, 33) for reading light patterns as the indicators rotate.

3. A counter as claimed in claim 2, further characterized by said light patterns being formed by light shining through perforations (27).

4. A counter as claimed in any of claims 1 to 3, further characterized by the coded patterns (22) each comprising four circular strips (23, 24, 25, 26) together forming a binary coded representation of the decimal digit being displayed by the respective indicator, each strip being divided into binary 0 and binary 1 sections.

5. A counter as claimed in any of claims 1 to 4, wherein said impulse drive comprises an off-centre weight (42) mounted to rotate, which is repeatedly driven to a top position by the input drive (11) from which position it drops under the force of gravity, driving the said lower significance digit-displaying indicator (13) forward, the relative locations of the changeover point of the said indicator and the weight (42) being such that the indicator (13) is driven over and passes the changeover point in advance of the input drive.

6. A counter as claimed in claim 5, wherein said weight is mounted on a preliminary rotating digit-displaying indicator (13) which does not have an associated coded pattern, and which drives said lower significance digit-displaying indicator (14).

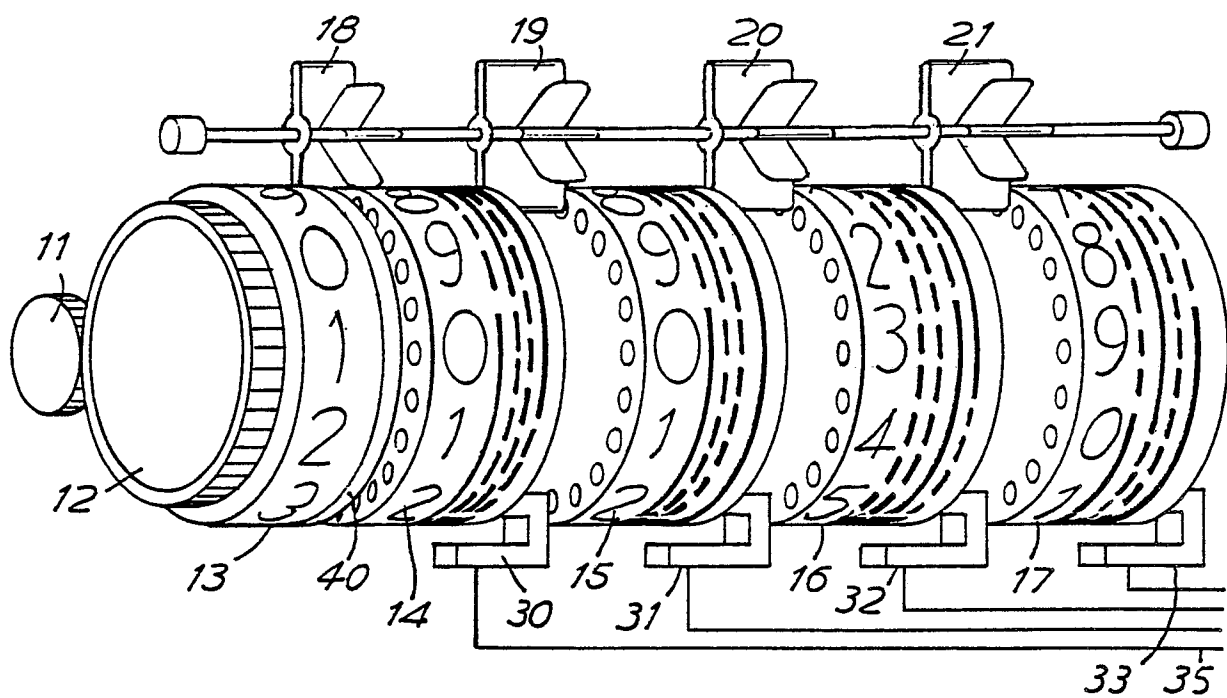


FIG. 1

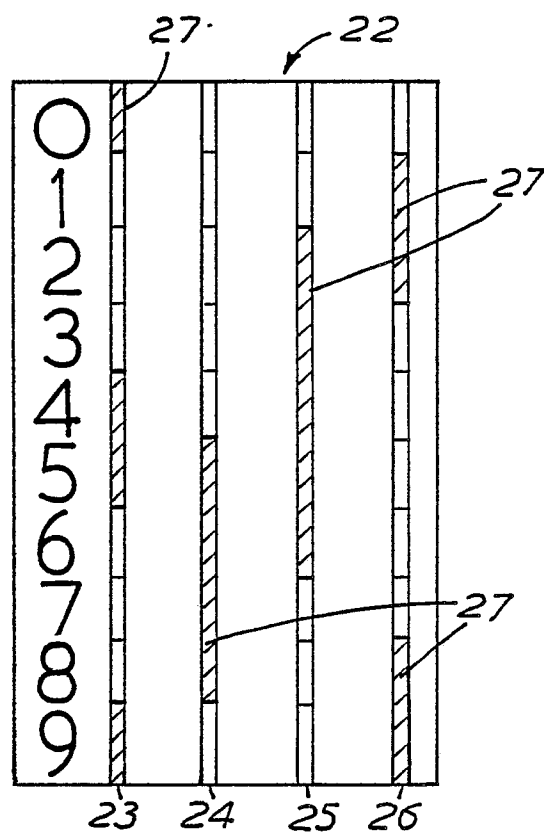


FIG. 2

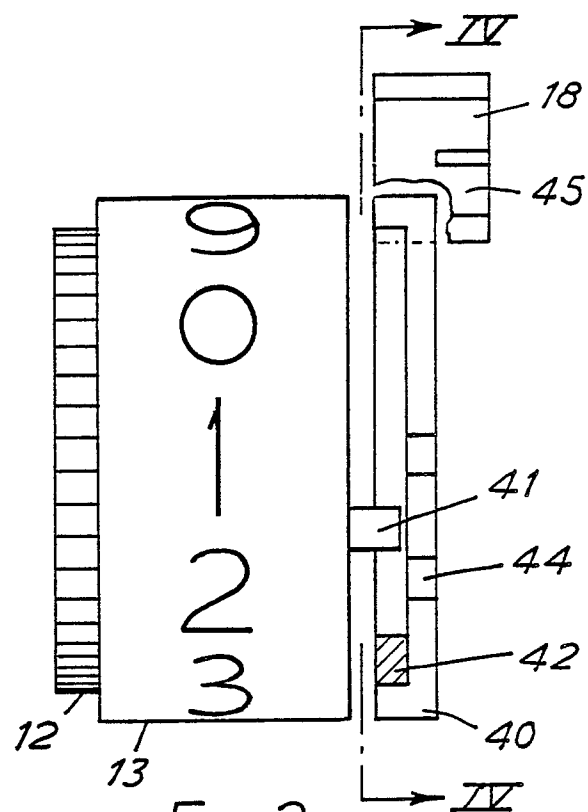


FIG. 3

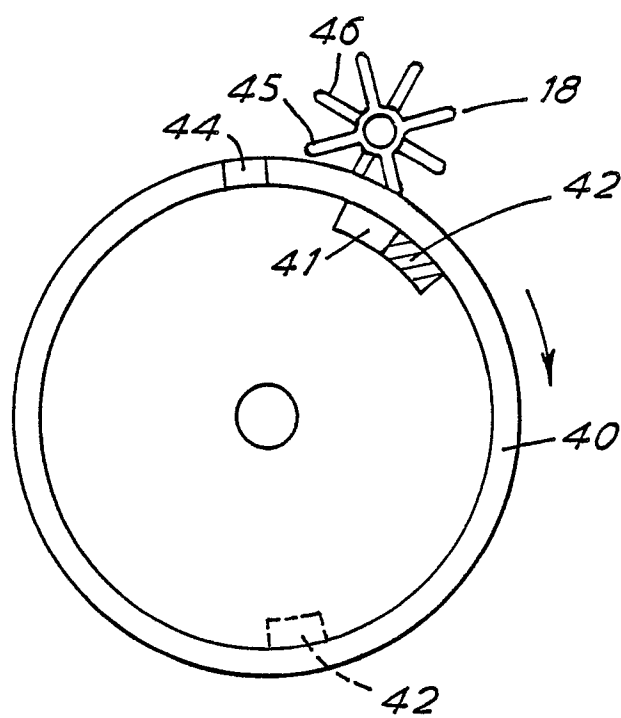


FIG. 4