June 15, 1965 J. S. HELLEN 3,189,273

HIGH SPEED COUNTER

Filed Aug. 1, 1963 2 Sheets-Sheet 1

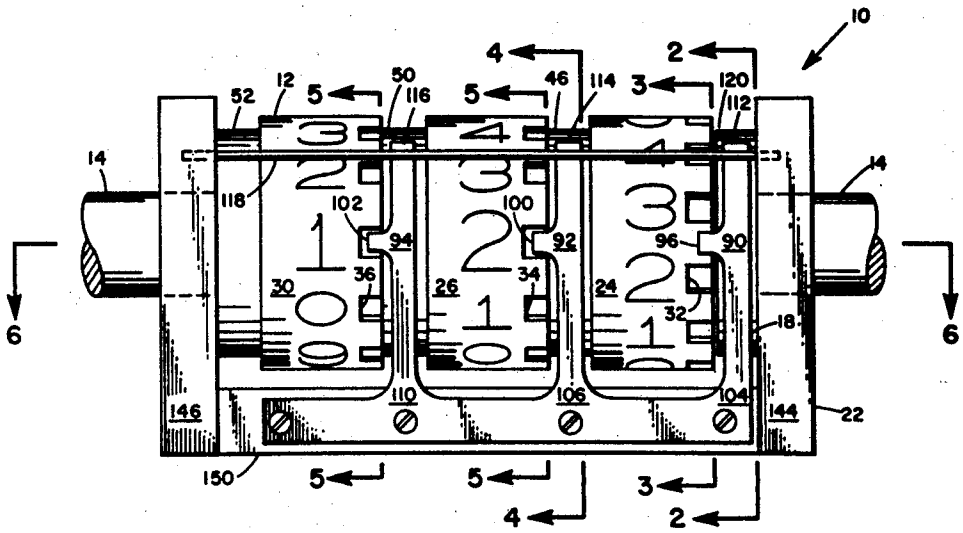


FIG. 1

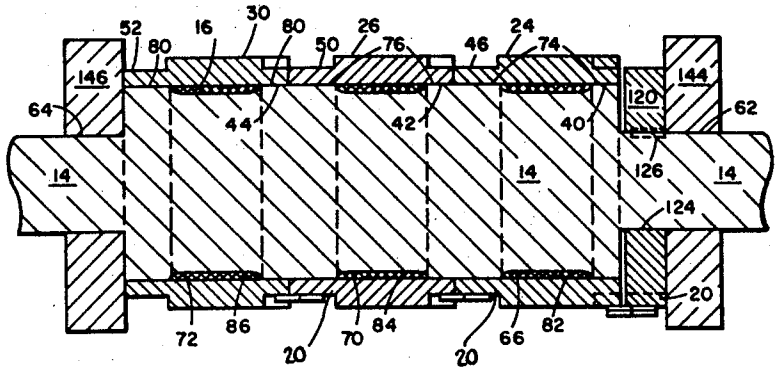


FIG. 6

JAMES S. HELLEN
INVENTOR.

BY

Thomas W. Kennedy

ATTORNEY

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HIGH SPEED COUNTER

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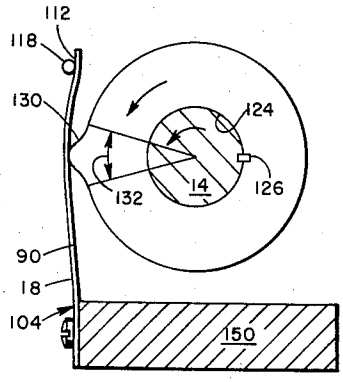


FIG. 2

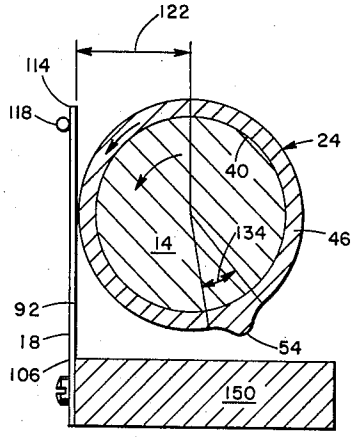


FIG. 4

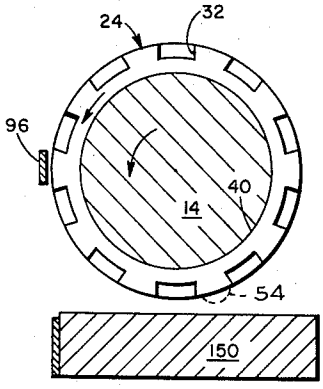


FIG 3

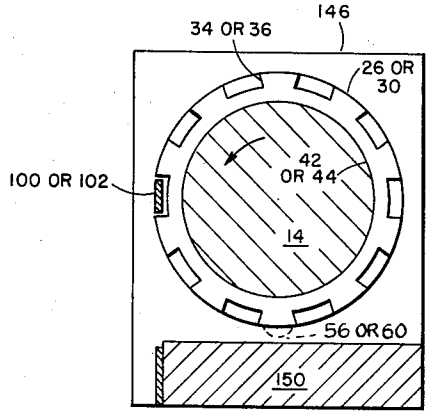


FIG. 5

JAMES S. HELLEN
INVENTOR.

BY

Thomas W. Kennedy
ATTORNEY

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HIGH SPEED COUNTER

James S. Heilen, Wayne, N.J., assignor to General Precision Inc., Little Falls, N.J., a corporation of Delaware

Filed Aug. 1, 1963, Ser. No. 300,127
6 Claims. (Cl. 235—117)

The present invention relates to counters and is concerned more particularly with the provision of a multi-dial, digital counter constructed for high speed operation in which the torque required to drive the counter decreases during the transfer of any dial.

In prior counters of this type comprising a series of dials, an input shaft, and a transfer mechanism between each pair of adjacent dials such as a Geneva drive, as each successive dial rotates and registers, more load is placed on the counter input shaft requiring the shaft to furnish more torque. Thus, in a system having a large number of these counters, the total power necessary to drive all the counters increases to peak values as additional dials of each counter operate simultaneously. Accordingly, the power level for such a system will peak excessively.

In accordance with this invention, it is a primary object to provide a counter of this type in which as each successive dial of the counter rotates and registers less load is placed on said shaft requiring the shaft to furnish less torque. Thus in a system having a large number of counters, some of which are of the prior art type and some of which are a type in accordance with this invention, as successive dials in each counter operate, the former counters will require more power and the latter counters will require less power so that the power level for such a system will not peak as excessively as in the prior art systems.

Another object is to provide a gearless type of counter with not more than a single shaft and to avoid the use of transfer pinions and gears.

A further object is to provide a counter with a shaft having viscous drag means engaging and driving each dial so as to minimize the shaft impact at stopping and starting of each dial.

A still further object is to provide a counter in which the shaft input torque is present at all times and decreases only slightly during the transfer of a single, or several dials.

To the fulfillment of these and other objects, the invention provides a high speed gearless counter comprising a series of numeral dials arranged in ordinal relation and a drive for said dials including an input shaft on which the dials are journaled. The input shaft carries coupling means which urge each said dial to rotate during rotation of said shaft. In addition, latch means are provided engaging the dials and restraining each of the dials against rotation during the time the dials are urged to rotate by the aforementioned coupling means. Further, actuating means are provided which actuate said latch means and which release each of said dials for rotation so that the first dial of the series of dials advances one step for each revolution of the input shaft and so that each succeeding dial in the series of dials advances one step for each revolution of its preceding dial.

Other objects of the invention will become apparent upon reading the annexed detailed description in connection with the drawings in which:

FIGURE 1 is a front elevation view of a counter;

FIGURE 2 is a transverse sectional view along line 2—2 of FIGURE 1;

FIGURE 3 is a transverse sectional view along line 3—3 of FIGURE 1;

FIGURE 4 is a transverse sectional view along line 4—4 of FIGURE 1;

FIGURE 5 is a transverse sectional view along line 5—5 of FIGURE 1;

FIGURE 6 is a longitudinal plan sectional view along line 6—6 of FIGURE 1.

Referring to the drawings, a high speed counter **10** comprises a series of numeral dials **12** arranged in ordinal relation, and a drive for said dials including an input shaft **14** on which said dials are carried. Dials **12** are preferably annular in shape. A viscous material **16** is disposed between the inner surface of each said dial and the outer surface of said shaft. The viscous material **16** is carried on the outer surface of shaft **14** and urges each said dial to rotate during rotation of the shaft. A series of escapement latches **18** are arranged alongside said dials with one escapement latch for each dial. The escapement latches **18** normally engage the dials **12** and restrain the dials **12** against rotation, while the dials are urged to rotate by viscous coupling to shaft **14** by material **16**. A series of latch actuators **20** are arranged alongside latches **18** with one latch actuator for each escapement latch. Latch actuators **20** are operable to disengage their respective latches **18** and release the respective dials **12**. Latch actuators **20** release the first dial allowing a one step advance of said first dial during each revolution of the shaft, and release each succeeding dial allowing a one step advance of each succeeding dial during each revolution of its preceding dial. All said parts of the counter **10** are mounted in a housing **22** and are normally enclosed therein.

The dials **12** comprise a units dial **24**, a tens dial **26** and a hundreds dial **30**. Each said dial **24**, **26** and **30** has numerals 0 to 9 inclusive which are spaced circumferentially around its outer surface so that the counter **10** reads and registers from 000 to 999. Each said dial **24**, **26** and **30** is a hollow cylinder with a bore **40**, **42** and **44** having a diameter slightly larger than the diameter of the shaft. The bore diameter is as large as possible consistent with the strength of its dial. For example, each said bore is preferably not less than three-quarters of the largest outer diameter of its dial, so that the mass and inertia of the dial is as small as possible. The outer surface of each dial **24**, **26** or **30** and the inner surface of its bore **40**, **42** or **44** are coaxial. Each said dial **24**, **26** and **30** respectively has a series of grooves **32**, **34** and **36** disposed on the radially outer surface of said dial. Each series of grooves **32**, **34** or **36** comprises ten equal-size grooves, which are equally spaced around said radially outer surface along one edge of said surface of each dial. The series of grooves in each said dial have the same depth so that the radial distance from the dial axis to the bottom surface of each said series of grooves is constant.

On the outer surface of each said dial **24**, **26** and **30** along the edge opposite to said edge with the grooves is a ring portion **46**, **50** and **52** of said dial. Ring portions or rings **46**, **50** and **52** are integral with their respective dials **24**, **26** and **30**. Rings **46**, **50** are latch actuators as explained hereafter. The outer diameter of each said ring **46**, **50** and **52** is smaller than the outer diameter of the remainder of its dial **24**, **26** and **30** so that there is an annular groove in the outer surface of each said dial along one edge. The diameter of the outer surface of said ring for each dial is preferably not more than the diameter to the bottom surface of said grooves for each dial. Each said ring **46**, **50** and **52** has an apex portion **54**, **56** and **60**. The tip of the apex portion **54**, **56** and **60** on each said ring **46**, **50** and **52** protrudes radially outwardly beyond the adjacent outer surface of its ring. The aforementioned dial numbers are arranged along side said dial grooves, with one numeral adjacent to each said groove. The dials **24**, **26** and **30** are light-weight to minimize inertia and are identical pieces to facilitate manufacture.

At each end of said shaft **14** is a journal **62**, **64** for

mounting said shaft in the end walls of the housing 22. The outer surface of the shaft 14 has a larger diameter between said journals 62, 64 in order to conform to the diameter of the bores 40, 42 and 44 of said dials 24, 26 and 30. The outer surface of said shaft 14 preferably has a plurality of annular recesses 66, 70 and 72 spaced axially along said surface with one said recess opposite each said dial so that the bore 40, 42 and 44 of each dial 24, 26 and 30 faces a corresponding recess 66, 70 and 72 respectively. The bore of each said dial overlaps its adjacent shaft recess so that an annular chamber is formed by each said annular recess and its adjacent bore. Each portion of the outer surface of the shaft 14 between each pair of adjacent recesses 66, 70 and 72 in the shaft overlaps the joint between each pair of adjacent dials. The diameter of the shaft outer surface is slightly smaller than the diameters of the bores 40, 42 and 44 of the dials 12. The diameters of the outer surface portions 74, 76 and 80 are equal to each other and define said shaft outer diameter.

The outer diameter of the shaft 14 is only slightly smaller than the outer diameter of the dials 12. Preferably, the outer diameter of the shaft 14 is not less than three-quarters of said outer diameter of said dials 12. In prior art counters, the outer diameter of the shaft was normally not more than one-quarter of the outer diameter of the dials, and such a smaller diameter shaft was provided in order to minimize friction between the shaft and dials, which heretofore has been a limitation. As explained hereafter, such a limitation on the relative size of the shaft due to friction is not a problem with this invention. Thus, by increasing the size of the shaft diameter and thereby increasing the ratio of the shaft diameter to dial diameter, there results an increase in the ratio of the shaft diameter to the shaft length between journals, and causes the shaft to have a relatively greater strength. Because such a shaft is also more rigid, the counter can be used in a high vibration environment without excessive vibration of the shaft and dials. Because such a shaft has a relatively greater strength without bending and the shaft can carry a greater quantity of dials, its counter can be relatively longer in shape.

The viscous material 16 is disposed between the shaft outer surface and the bores 40, 42 and 44 of the dials 12. Viscous material 16 fills the gaps or clearances between the outer surface portions 74, 76 and 80 of the shaft 14 and said bores 40, 42 and 44 of the dials. Said viscous material 16, is preferably grease-like and lubricates said outer surface portions and said bores, permitting relative rotation of said dials and said shaft. Thus, there is no metal-to-metal frictional engagement between said surfaces. The bearing pressure between said surfaces is minimized because as explained above, the dials are a lightweight, shell-type construction. In this way, said viscous material 16 is a layer between said shaft and said dials and preferably can support said dials.

In the drawings, the gaps between said outer surface portions 74, 76 and 80 and the bores 40, 42 and 44 of the dials 12 has not been shown because it is so small, that is preferably in the order of 0.002 to 0.005 inch. The viscous material 16 is disposed in said gaps and is also received in the recesses, and has separate portions 82, 84 and 86 respectively received in said recesses 66, 70 and 72. Thus, each said recess 66, 70 and 72 forms an annular chamber of viscous grease-like material 16, and assures that said gaps adjacent to the shaft portions 74, 76 and 80 are always filled with said viscous material 16. The radially inner surfaces of the viscous material 16 in said gaps adjacent to said outer surface portions 74, 76 and 80 frictionally engages and preferably adheres to said shaft surfaces 74, 76 and 80 on its inner side, and the radially outer surface of said viscous material 16 engages and preferably adheres to the inner bore surfaces of its adjacent dials 12.

Since a viscous material normally generates forces within itself to resist a flow of any portion of said viscous material, said viscous material 16, disposed in said gaps adjacent to the shaft surface portions 74, 76 and 80, and including portions 82, 84 and 86, and extending from one end of the shaft to the other, resists a relative movement between its outer surface and its inner surface. Thus, said band of viscous material 16 causes drag forces resisting relative movement between the dials 12 and the shaft 14. In this way, when the input shaft 14 rotates, said viscous material 16 transmits a turning moment on each said dial 24, 26 and 30 from said input shaft 14. Regardless of the speed of shaft rotation, the turning moment or torque provided by such viscous drag means on each said dial is always greater than the resisting moment of said dial member due to the dial's inertia, that is, the shaft 14 can always rotate the dials 12, if the dials are not restrained by other means.

Preferably, said viscous material 16 is a type which is also substantially insensitive to temperature changes such as a silicone grease. Therefore, said viscous material 16 provides a constant drag on said dials 12 under varying temperature conditions. In addition, said viscous material 16 is preferably a type which does not flow with temperature and keeps its shape, that is, it is preferably also a thixotropic material. Thus, said viscous material 16 does not flow radially outwardly through the joints between said dials 12 or between the joints adjacent to the end dials. Moreover, because such a viscous material 16 provides drag forces through a gradual shear action within the viscous material, the impact on the shaft 14 is minimized at stopping and starting of each said dial 12.

The escapement latchs 18 normally restrain the dials 12 from rotation. The dial grooves 32, 34 and 36 are respectively engaged by the escapement latches 90, 92 and 94. Each escapement latch 90, 92 and 94 is an elongated resilient member which is supported at each of its ends. Each escapement latch 90, 92 and 94 has a prong 96, 100 and 102 near the center of its span, with each said prong engaging respectively a groove 32, 34 and 36 in its adjacent dial 24, 26 and 30. Said prongs 96, 100 and 102 are disposed along a reference line parallel to the shaft axis but displaced therefrom. In this way, said escapement latches 90, 92 and 94 engage their respective dial grooves and align the counter numerals. In FIGURE 1, the tens dial 26 and hundreds dial 30 are shown at rest and are restrained by adjacent escapement latches 92, 94. However, the units dial 24 and its groove 32 is clearly out of engagement with its adjacent escapement latch 90 and is illustrated in a rotating condition.

Each escapement latch 90, 92 and 94 has a fixed end 104, 106 or 110 and has a guided end 112, 114 or 116. A guide bar 118 extends from one end wall of the housing 22 to the other end wall and is supported at each said end wall. The guided ends 112, 114 and 116 of the escapement latches bear against said guide bar 118. The escapement latches 90, 92 and 94 are similarly offset from the shaft axis, that is, the distances from the shaft axis to the inner face of each latch strip 90, 92 and 94 are substantially equal. This uniform offset distance is substantially equal to the radius from the shaft axis to the bottom surface of each said dial groove 32, 34 and 36.

Actuating means 20 includes actuators 120, 46, 50 having respective apex portions 130, 54, 56, which respectively engage latches 90, 92, 94. Actuator 120 is a disc member, as shown in FIGURE 2. The said first latch actuator 120 has a bore portion 124 which is journaled on said shaft 14 between the units dial 24 and the adjacent end wall of the housing 22. Said first latch actuator 120 is fixedly connected to the shaft 14 by a key 126. The outside diameter of said disc member 120 is substantially equal to the outside diameter of the rings 46, 50 and 52 on the units dial 24, tens dial 26 and hundreds dial 30. The disc member 120 also has an apex portion 130 on its radially outer surface, having substantially the same shape as the apex portions 54, 56 and 60 which

are disposed on the said rings **46**, **50** and **52** respectively. Said apex portion **130** on the disc member **120** actuates the escapement latch **90** once in each revolution of said disc member **120**. Once in each revolution of the units dial **24**, the apex portion **54** on the units dial **24** actuates the escapement latch **92** which engages and normally restrains the tens dial **26**. Once in each revolution of the tens dial **26**, the apex portion on the tens dial **26** actuates the escapement latch **94** which engages and normally restrains the hundreds dial **30**. Thus, the first dial **24** of the series of dials advances one step for each revolution of the input shaft **14** and each succeeding dial **26**, **30**, in the series of dials advances one step for each revolution of its preceding dial.

It is noted that the apex portions **130**, **54** and **56** are similar to cams and the disc member **120** and the rings **46** and **50** are similar to cam wheels. Each said apex portion **130**, **54** and **56** lies within the arc of a circle having its center on the shaft axis, said arc being preferably not more than 36°. The radial angle **132** or **134** measuring said arc of each of said apex portions is indicated in FIGURES 2 and 4. The radial distances from the shaft axis to the tips of said apex portions **130**, **54**, **56** and **60** are preferably equal, and this uniform distance is slightly greater than the uniform radial distance to the outer surface of said dials **24**, **26** and **30**.

Each of said apex portions **54**, **56** and **60** are disposed in the region of their respective rings **46**, **50** and **52** which is adjacent to the numeral 9 on their respective dials **24**, **26** and **30**. In this way, as the preceding, rotating dial of any pair of adjacent dials leaves the numeral 9 and proceeds to the numeral 0, its successive dial will also leave a numeral and advance through the same arc at substantially the same speed to its next higher numeral. It is noted that the apex portion **60** of the last dial **30** is not essential to the operation of the counter **10** and has been included only to make all of the dials **12** alike.

The profile and shape of each apex portion **130**, **54** and **56** is preferably designed so that the escapement latches **90**, **92** and **94** are deflected very briefly and just enough to disengage their prongs **96**, **100** and **102**. In this way, the inner surface of each said prong can bear against the outer surface of its dial in the region between the grooves, while the dial is rotating. This provides the escapement latches **90**, **92** and **94** with a snap-action when their dials **24**, **26** and **30** are registering.

The housing **22** normally contains two end walls, a top wall, a bottom wall, a front wall and a rear wall. In FIGURE 1, only the end walls **144** and **146**, and the bottom wall **150** are illustrated. Windows (not shown) are normally provided in the front wall (not shown) for viewing the numerals. However, such windows can instead be located in either the top wall, or the bottom wall, or the front wall, or the rear wall. Thus, this type of counter can have its windows in any one of its four sidewalls and is more adaptable to diverse mounting arrangements than are the prior art counters wherein the windows can normally be placed in only one of its sidewalls because their transfer mechanisms are disposed usually between the dials and the other three sidewalls.

In order to drive the input shaft **14** and its three dials **24**, **26** and **30** at a constant shaft design speed, a maximum level of torque is necessary which is substantially constant from the start of rotation of the shaft until the units dial **24** is released. As the units dial **24** is released and rotates there is a reduction in the required level of torque for driving the counter **10**. After numeral 9 is recorded on the units dial **24**, the tens dial **26** is released and rotates together with the units dial **24** until the following numeral on the tens dial **26** is recorded. As both the units dial **24** and the tens dial **26** are released and are rotating, there is a further reduction in the required level of torque for driving the counter **10**. In this way, the total reduction in the required level of torque is proportional to the quantity of dials which are simultaneously released and rotating. Thus, in a system having a large number of counters, some of which are the prior art type and some of which are a type in accordance with this invention, as successive dials in each counter operate, the former counters will require more power and the latter counters will require less power so that the power level for such a system will not peak as excessively as in the prior art systems.

Alternate types of drag means may be provided in place of the viscous material **16**, such as a frictional type of drag means, or such as a magnetic type of drag means. Such alternate types of drag means may also be used in combination with said viscous material form of drag means.

If desired, the disc member **120** may also be used as a tenths dial. By the addition of numerals to the outer peripheral surface of the disc member **120** in a manner similar to the numerals on the units dial **24**, tens dial **26**, and hundreds dial **30**, the disc member **120** can then measure portions of a revolution of the input shaft **14**, so that the counter can record to the nearest tenth of a shaft revolution.

In an alternate embodiment of the invention, the viscous material **16** can be deleted, and the counter dials **24**, **26** and **30** can be made from a self-lubricating, resilient material, such as Teflon, or the like. In addition, in this embodiment, each dial **24**, **26** and **30** would be preferably a one-piece, discontinuous ring. Such an embodiment would also be illustrated by FIGURES 1–6 inclusive, with some minor changes to the drawings. That is, in FIGURE 6, the viscous material **16** would be omitted. In FIGURES 3 and 5, a radial line would be added on each dial cross-section extending between the inner diameter and the outer diameter of each dial at one region of the perimeter of the dial so that each dial would be shown as cut transversely through its thickness at one line of its peripheral surface, forming a diametrically expansible, discontinuous ring. With such an expansible dial, before being expanded and assembled on the input shaft **14**, the inner diameter of each dial **24**, **26** or **30** would be slightly smaller than the outer diameter of the shaft **14**. When such dials **24**, **26** and **30** are expanded diametrically and assembled on the input shaft **14**, the inner surface of each dial would provide a radially inward pressure on the outer surface of the input shaft **14**. Thus, a frictional drag would be assured between each dial **24**, **26** and **30** and its adjacent portion of the input shaft **14**. With this construction using self-lubricating, resilient dials, a radially inward pressure is maintained on the input shaft **14** even after wearing of the adjacent frictional surfaces of the shaft and dials. Further, the recesses **66**, **70** and **72** normally provided in the shaft for receiving a viscous material can be deleted whereby a straight shaft can be used. Dials of such type, particularly if composed of "Teflon," or the like, are easily made by molding. A counter, in accordance with this alternate embodiment of the invention, further facilitates ease and economy of manufacture.

While the present invention has been described in detail in its present preferred embodiment it will be obvious to those skilled in the art after understanding this invention that various changes and modifications may be made therein without departing from the spirit or scope thereof. It is intended by the appended claims to cover all such modifications.

What is claimed is:

1. A high speed counter comprising:

a plurality of juxtaposed rotatable members each member having a bore portion and each member bearing a series of discrete alpha-numeric indicia thereon spaced about the respective centers of rotation of the members, individual indicia on respective members being adapted for display in groups to convey intelligence;

a rotative input drive shaft member extending through

said bores forming annular gaps separating said rotatable members from said shaft;

a yieldable-solid substance disposed in said annular gaps and carried by said shaft for supporting said rotatable members and for providing a slipable coupling between said rotatable members individually and said drive member; and

latch means normally maintaining said rotatable members against rotation and sequentially operative to release respective rotatable members momentarily for incremental rotational displacement.

2. A high speed counter comprising:

a plurality of juxtaposed rotatable members each bearing a series of discrete alpha-numeric indicia thereon spaced about the respective centers of rotation of the members, individual indicia on respective members being adapted for display in groups to convey intelligence;

a drive shaft coated with a yieldable-solid substance and journaled in said rotatable members and rotatable selectively in a clockwise direction and also in a counter-clockwise direction for imparting rotary motion in each said direction individually to said rotatable members;

latch members with each latch member normally maintaining one of said rotatable members against rotation in both said directions of rotary motion; and

actuating members with each actuating member adapted to sequentially actuate one of said latch members individually and to release one of said respective rotatable members momentarily for incremental rotational displacement in one of said directions of rotary motion for continuously totaling successive clockwise and counter-clockwise inputs.

3. A high speed counter as claimed in claim 2 and in which said yieldable-solid substance is a viscous thixotropic adhesive material that is solid enough to support said dials without flowing and yieldable enough to shear under slight distortion by said shaft rotation and that is disposed between the peripheral surface of said shaft and the inner surface of each of said dials whereby each said dial is urged in rotation by a turning moment from said viscous material during rotation of said input shaft.

4. A high speed counter as claimed in claim 2 and in which the outer peripheral surface of said input shaft has a plurality of recesses spaced along said shaft surface adjacent to and with substantially the same spacing as said dials and having an outer surface portion between each pair of adjacent recesses, with the inner surface of each said dial overlapping and facing its adjacent recess to assure that said gaps are always filled.

5. A high speed counter as claimed in claim 2 and in which said rotatable members are dials and said actuating members include a first actuating member carried on said shaft and engaging said first latch mechanism which engages said first dial, to actuate said first latch mechanism and to release said first dial allowing a one step advance of said first dial during each revolution of said shaft; and a series of actuating members carried by said dials with each said dial carrying one of said series of actuating members, each said actuating member engaging said latch mechanism which engages its succeeding dial, to actuate said succeeding latch mechanism and to release said succeeding dial allowing a one step advance of said succeeding dial during each revolution of said dial.

6. A high speed counter comprising:

a series of annular numeral dials of similar size including a units dial, tens dial and hundreds dial, arranged side-by-side, having a common axis, each dial having a bore coaxial with said dial axis, each dial having a peripheral surface with ten equally-spaced grooves thereon about said axis and with ten numerals from 0 to 9, inclusive, one numeral adjacent to each groove, for display of said numerals in one group at a time having a numeral from each dial;

an input drive shaft coaxial with said dials extending through said bores of said dials, the shaft having a peripheral surface having annular recesses spaced equally apart along said shaft with one recess opposite each dial, the bore of each dial overlapping its recess forming an annular substantially sealed chamber within each dial;

a viscous yieldable-solid material disposed in each said recess engaging said shaft peripheral surface and said dial bore surface;

a series of latches, one opposite each dial, each latch having a prong engaging one of said grooves in its respective dial to maintain said dials against rotation and align said dial numerals in a group; and

a series of latch actuating members, one actuating member opposite each latch including a first actuating member coaxially fixed to said shaft having an apex portion which contacts said units dial latch once in each revolution of said shaft, and a second actuating member disposed between said units dial and tens dial, and a third actuating member between said tens dial and said hundreds dial, both said second and third actuating members being fixedly joined with its preceding dial and coaxial therewith, each of said second and third actuating members having an apex portion which contacts said latch of its succeeding dial once in each revolution of said preceding dial,

so that in each revolution of said shaft the units dial is released once to advance one groove and one numeral and one-tenth of a revolution, and in each revolution of said units dial the tens dial is released once to advance one groove and one numeral and one-tenth of a revolution, and in each revolution of said tens dial the hundreds dial is released once to advance one groove and one numeral and one-tenth of a revolution.

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LEO SMILOW, *Primary Examiner.*