

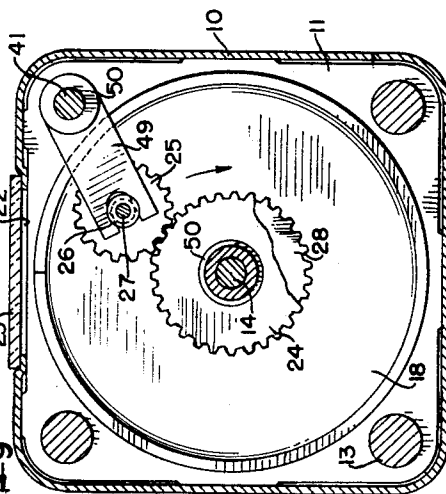
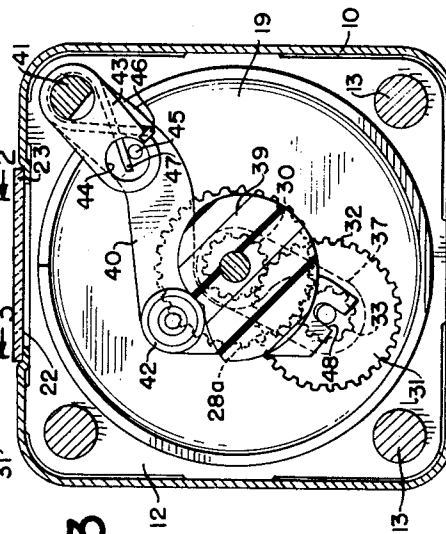
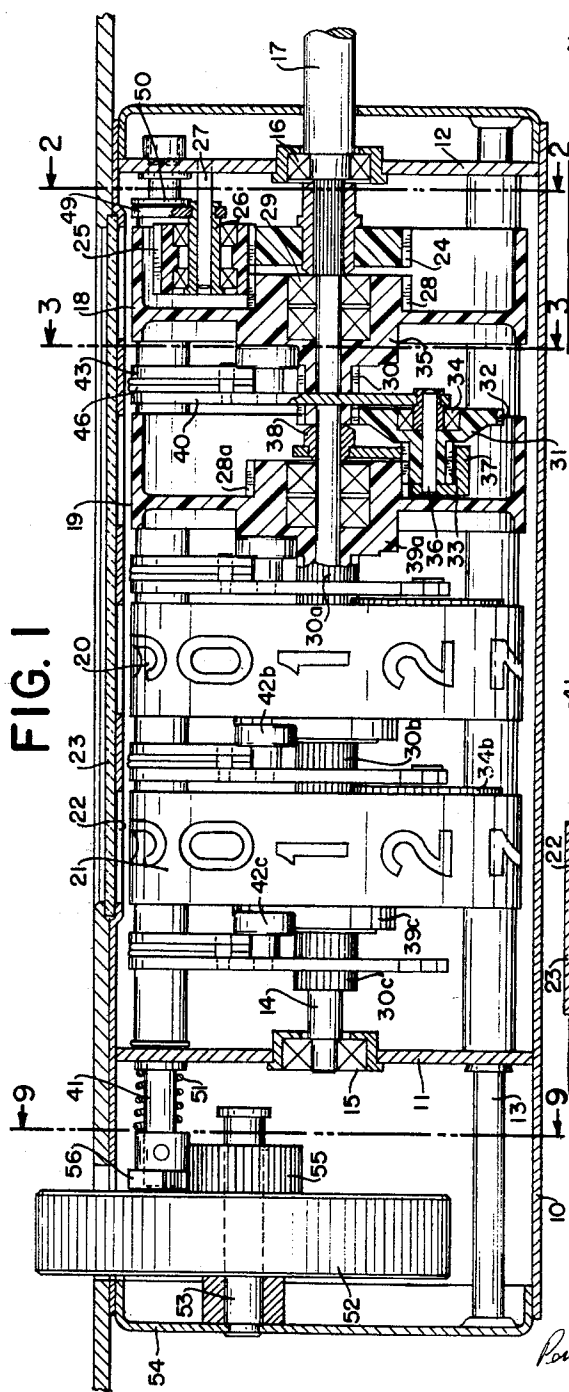
Dec. 18, 1962

A. W. HAYDON
TRANSFER COUNTER

3,069,083

Filed Jan. 28, 1959

3 Sheets-Sheet 1



INVENTOR
ARTHUR W. HAYDON
BY
Ross, Edwards, Austin, Bonner & Taylor
ATTORNEYS

Dec. 18, 1962

A. W. HAYDON
TRANSFER COUNTER

3,069,083

Filed Jan. 28, 1959

3 Sheets-Sheet 2

FIG. 4

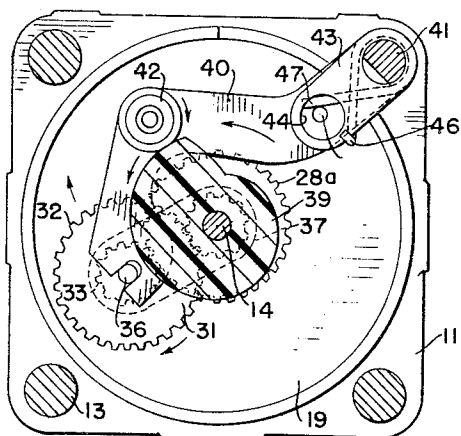


FIG. 5

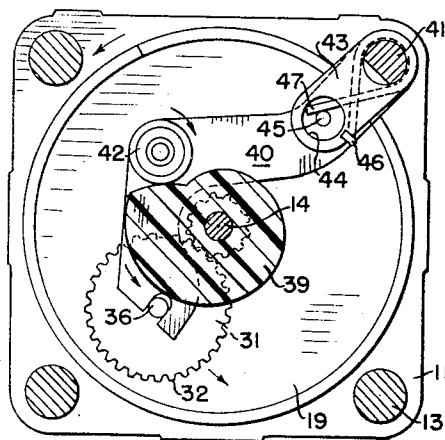


FIG. 6

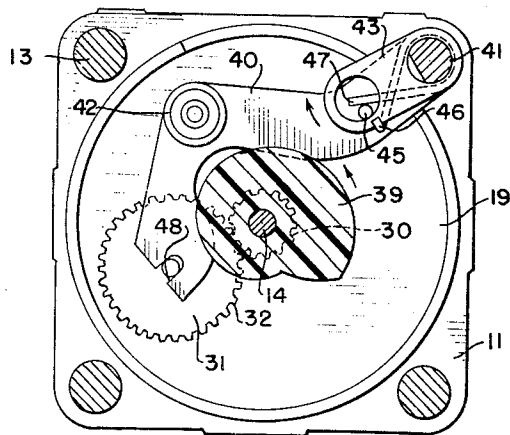
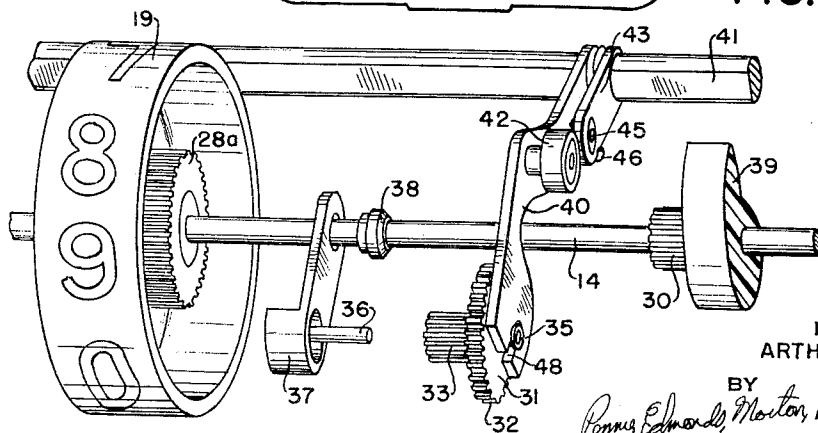


FIG. 7



INVENTOR
ARTHUR W. HAYDON

BY
Ronny Edwards, Morton, Banerjee & Taylor
ATTORNEYS

Dec. 18, 1962

A. W. HAYDON

3,069,083

TRANSFER COUNTER

Filed Jan. 28, 1959

3 Sheets-Sheet 3

FIG. 8

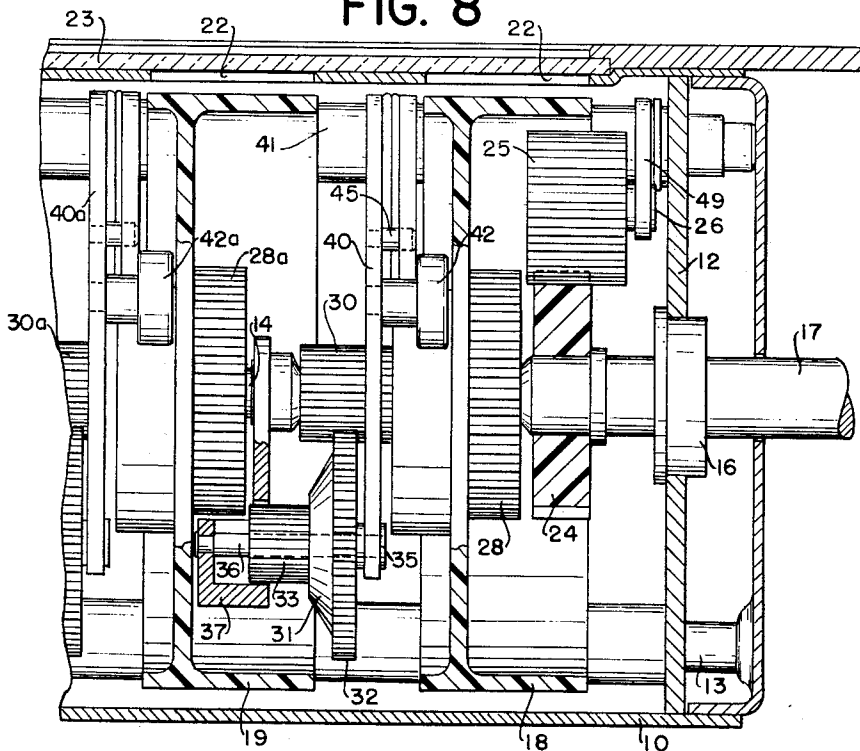
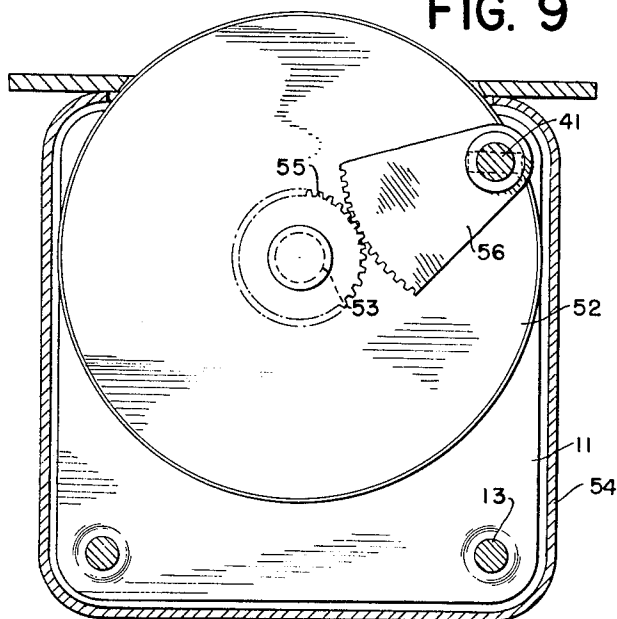


FIG. 9



INVENTOR
ARTHUR W. HAYDON

BY

Pemis, Edwards, Morton, Causey & Taylor
ATTORNEYS

1

3,069,083

TRANSFER COUNTER

Arthur W. Haydon, Milford, Conn., assignor to Haydon Switch Incorporated, a corporation of Connecticut
Filed Jan. 28, 1959, Ser. No. 789,578
9 Claims. (Cl. 235-136)

The present invention relates to counting devices, and more particularly to improvements in transfer counters, such as decade transfer counters, to the end that such counters may be economically manufactured, are of rugged, compact design, and are capable of extremely high speed operation.

In conventional transfer counters, means are provided for effecting the intermittent transfer of motion from counter drums of lower orders to counter drums of higher orders. Thus, in a decade counter, each drum is calibrated in units of ten, and a complete revolution of a lower order drum effects $\frac{1}{10}$ of a revolution of the drum of the next higher order. To facilitate reading of the device, the transfer movement of a higher order drum is effected during the last portion only of a rotational cycle of the next lower drum, as when the lower order drum moves from the "nine" to the "zero" index position.

In counting devices of conventional design, a serious limitation is placed upon the speed of operation due to high impact forces, which result from the intermittent transfer movement of the higher order drums. This is particularly true during the transfer movement of drums in the upper register of a device, since all drums of a lower order move simultaneously between the "nine" and "zero" index positions, along with the upper register drum.

Attempts have been made, heretofore, to reduce or eliminate the heavy impact forces of high speed counter operation. However, in all instances, of which the present inventor is aware, the resulting mechanisms have been of a complicated nature, costly to manufacture, of large physical size, and susceptible to damage under prolonged, severe use.

A principal feature of the invention resides in the provision of a novel and improved transfer counter of compact and rugged design, and of a highly practical and advantageous construction, in which compact, reliable mechanical cam means are provided in the transfer train between drums, whereby forces necessary to effect transfer or indexing movement of a higher order drum are built up gradually during the rotation of the drum of the next lower order from "zero" to "nine." The built-up forces are then released, when the lower order drum rotates from "nine" to "zero," without imposing heavy impact forces upon the drive shaft. One of the specific advantageous features of the new design is the provision of counter drums of molded plastic construction incorporating, as integral parts thereof, a gear driven by a train including the drum of the next lower order, or by an input gear, a drive pinion for driving a higher order drum, and a cam forming part of the mechanical system for storing indexing forces. The improved drums include peripheral flanges, on which the index numbers are provided, and the operating mechanism for effecting transfer movement of higher order drums is housed substantially within the outline formed by the drum flanges, whereby the complete counter mechanism is not greatly longer than the series of drums.

In accordance with another specific feature of the invention, a deluxe form of the improved transfer counter is provided, which includes selectively operable control means providing for either intermittent or continuous, proportional transfer movement between counter drums. For high speed operation, the control means is set to provide continuous, proportional driving of the drums, with

2

substantially constant forces being applied to all parts of the mechanism. At the end of a high speed counting period, the control means are advantageously returned to a position providing intermittent transfer movement, which automatically shifts the higher order drums to the next lower index position to facilitate reading of the registered count. Alternatively, for operation at low speed, the new counter may be arranged to provide for intermittent transfer movement throughout the counting period, to permit reading of the counter during operation. And, to this end, the deluxe form of the new counter includes the improved arrangements of the standard form of the counter providing for the desired, intermittent transfer movement of the counter drums without imposing on the drive mechanism the heavy intermittent torque loads characteristic of conventional devices.

Another advantageous feature of the invention, incorporated in the deluxe form of the counter, resides in the provision of improved means for effecting rapid reset of the respective counting drums to their initial or "zero" positions. To this end, the device of the invention includes means, acting individually on each drum and tending to return each drum independently to its "zero" position. In combination with the foregoing, control means are provided for selectively disengaging the respective drums, one from the other, enabling each drum to return to its "zero" position independently and within a single revolution. The resetting forces advantageously are applied to the drums by means of springs, which may be rendered ineffective by the control means during high speed operation of the counter.

As one of the more specific aspects of the invention, the advantageous "deluxe" features described in the foregoing paragraphs are interrelated and combined in a single mechanism, operable by a single control member, providing a practical transfer counter device having a minimum number of operating parts, yet incorporating the several advantageous features heretofore mentioned.

Other specific features of the invention reside in specific structural and mechanical arrangements described and illustrated in greater detail in the following specification and in the accompanying drawings, in which:

FIG. 1 is a longitudinal, cross-sectional view, with parts broken away, of a "deluxe" counter incorporating the various features of the invention;

FIGS. 2 and 3 are cross-sectional views taken along lines 2-2 and 3-3, respectively, of FIG. 1;

FIGS. 4-6 are cross-sectional views similar to FIG. 3, illustrating a sequence of positions of certain operating parts of the new device;

FIG. 7 is an expanded, perspective view of the mechanism illustrated in FIGS. 3-6;

FIG. 8 is an enlarged, fragmentary, cross-sectional view, similar to FIG. 1, illustrating the operation of the transfer mechanism; and

FIG. 9 is a cross-sectional view taken generally along line 9-9 of FIG. 1.

Referring now to the drawings, the reference numeral 10 designates a housing open at one or both ends for receiving a frame consisting of spaced deck plates 11, 12 connected by longitudinally disposed rods or posts 13. In the illustrated device, a shaft 14 is journaled in the frame, by bearings 15, 16 and has a portion 17 extending outward of one end of the housing for connection to appropriate drive means (not shown). Alternatively, the shaft 14 may be stationary, and the portion 17, hereafter referred to as a shaft, may constitute a separate shaft adapted to be rotated by external drive means. Mounted on the shaft 14 are counter drums 18-21, advantageously provided about their peripheries with the usual index numbers, 0-9, and arranged in registry with windows 22 covered by a transparent plate 23.

As is conventional in all transfer counters, the drum of the lowest order—here drum 18—is driven by the shaft 17, while each of the higher order drums is driven by the drum of the next lower order. To this end, a pinion 24 is mounted on the shaft 17, adjacent the lowest order drum 18, and is arranged to drive an idler gear 25. The gear 25 is mounted, advantageously by anti-friction bearings, on a bushing 26 movable axially on a pin 27 anchored in the deck plate 12. The drum 18 is advantageously of molded, plastic construction and has formed integrally thereon a gear 28, which is substantially identical to the gear 24. The idler gear 25 is of such axial length as to be able, in one axial position, to engage the gears 24, 28 simultaneously, whereby rotations of the shaft 14 are imparted to the lowest drum 18. As will be described in greater detail, the idler gear 25 may be shifted axially at desired times, along the pin 27, and thereby taken out of engagement with the gear 28, while retaining its engagement with the gear 24. Alternatively, releasable driving engagement between the shaft 17 and drum 18 may be provided by means of a suitable clutch mechanism, for example.

As illustrated best in FIG. 1, for example, the drums 18–21, of molded construction, comprise disc-like web sections, with axially extending flanges forming the outer peripheries of the drums. The flange and web sections form, in effect, recesses in the drums, in which a substantial portion of the operating mechanism of the counter is received, in the interests of compactness.

Advantageously, each of the drums 18–21 is mounted for free rotation with respect to the drive shaft 14, by means such as anti-friction bearings 29, means being provided to interconnect lower order drums each with a drum of the next higher order, whereby rotational movement of the lower order drums is transferred in a desired manner to the higher order drums. In accordance with the invention, each drum has fixed thereto a pinion 30, which is advantageously an integral part of the drum molding. In the illustration of FIG. 1, details of the transfer gear means are shown for the drums 18, 19, it being understood that similar transfer means is provided connecting each lower order drum with a higher order drum. Thus, a compound gear 31, consisting of a large diameter gear 32 and a small diameter gear 33, meshes with the pinion 30 of the drum 18 and with the gear 28 of the drum 19, the relation between the respective sets of gears being such as to provide a 10:1 reduction ratio between the drums 18, 19, as is typical in decade transfer counters.

The compound gear 31 is advantageously supported for anti-frictional rotation by a bearing 34 and bushing 35, the latter being mounted slidably on a pin 36. The pin 36 is, in turn, anchored at one end in a radius arm 37 mounted rotatably on the shaft 14 by a bushing 38. The radius arm 37 permits movement of the gear 31 about the axis of the shaft 14 while retaining the gear in proper position to mesh with the pinion 30 and gear 28. Similar transfer gear mechanisms are provided to interconnect the other lower order drums with drums of the next higher order, and these mechanisms will not be described separately. However, where reference is made to corresponding elements of other mechanisms, appropriate prime reference numerals will be employed to indicate similarity of parts.

In conjunction with the transfer gear means connecting the respective counter drums, it is necessary to provide motion modifying means operative to limit the effectiveness of the transfer gear means to selected portions of the rotational cycle of the lower order drums. Thus, it is undesirable to provide a straight reduction gear drive between drums since, during fractional revolutions of lower order drums, the higher order drums will rotate fractionally from one index position toward the next index position. At intermediate positions, therefore, it would be difficult to read the drums. Accordingly, it is

conventional, in the broad sense, to provide motion modifying means whereby the action of the transfer mechanism is without effect as the lower order drum moves from its "zero" position to its "nine" position, and whereby the entire transfer movement of the higher order drum takes place during the movement of the lower order drum from its "nine" position to its "zero" position.

In the apparatus of the invention, the action of the transfer gear means is modified by cams 39, advantageously formed integrally with each drum, which act upon motion compensating arms 40 to shift the transfer gear 31 circumferentially about the shaft 14 in predetermined relation to rotations of the drum 18. As shown best in FIGS. 3–6, the compensating arm 40 is pivoted on a rod 41, which may be referred to as a control rod, and has a cam follower 42 intermediate its ends arranged to rest upon the surface of the cam 39. Adjacent each compensating arm 40 is a control arm 43, which is fixed to the control rod 41. The outer end of the control arm has an enlarged opening 44 wherein, in which is received a pin 45 extending laterally from the compensating arm. The control arm 43 also serves to anchor a spring 46, the free end 47 of which rests on the pin 45, urging the compensating arm 40 to pivot counterclockwise, as viewed in FIGS. 3–6.

An open slot 48 is provided at the end of the arm 40 to receive a recessed end portion of the bushing 35 which mounts the transfer gear 31. The slot 48 provides for relative movement of the bushing 35 toward and away from the axis of the control rod 41, but prevents relative axial movement of the bushing with respect to the compensating arm.

The drum 18 is illustrated in its "zero" position in FIG. 3, and it will be observed therein that the relationship between the cam 39 and cam follower 42 is such that the follower rests in the low area of the cam, being urged to such position by the action of the spring 46 on the pin 45. If the drum 18 is rotated, as by counterclockwise rotation of the drive shaft 17, the drum 18 rotates counterclockwise, effecting clockwise rotation of the transfer gear 31 and thereby tending to effect counterclockwise rotation of the drum 19. However, as the drum 18 rotates throughout the initial 90% of a full revolution (324°) the cam follower 42 is forced away from the axis of the drive shaft 14 by the cam 39. This causes clockwise pivotal movement of the compensating arm 40, to the ultimate position shown in FIG. 4. In this respect, the cam 39 is of single lobe form and is contoured such that the clockwise displacement of the transfer gear 31 substantially exactly compensates for its tendency to effect counterclockwise rotation of the drum 19, so that, in fact, no rotation of the drum 19 takes place. The transfer gear 31 remains meshed with the pinion 30 and gear 28 of the drum 19, by reason of the radius arm 37, which maintains a fixed distance between the axes of the drive shaft and gear shaft 36.

During the last portion of a revolution of the drum 18, the lobe of the cam 39 passes under the cam follower 42, in the manner shown in FIG. 5, causing the compensating arm 40 to be pivoted counterclockwise under the influence of the spring 46. This occurs as the drum 18 rotates from its "nine" to its "zero" index position, and the bodily movement, in a counterclockwise direction, of the transfer gear 31 during this period effects the desired counterclockwise transfer movement of the next drum 19 through $\frac{1}{10}$ revolution, or one index position.

As will be understood, the transfer of motion to the upper registers of drums occurs exactly as heretofore described for all sets of drums, regardless of the number thereof.

During a counting period, it may be desirable to render ineffective the compensating means, to avoid intermittent, accelerated movement of parts of the mechanism. Accordingly, the illustrated device includes means for

5

rotating the control rod 41 in a clockwise direction, to an extent such that the pin 43 extending laterally from each compensating arm is engaged by the lower edge of the opening 44 of each control arm, causing the compensating arms to be pivoted clockwise to a position, shown in FIG. 6, wherein the cam follower 42 lies wholly outside the path of the cam 39. The respective transfer gears are thus effectively locked in position, and a direct gear drive is established between the sets of drums. This enables the counting device to be driven at extremely high speeds, since rotation of all the drums is uniformly related to the rotation of the drive shaft 14, except for the fact that the drums rotate progressively slower in the upper registers.

In order to read the count, following a high speed counting period, the control shaft 41 is rotated counterclockwise to its initial position, permitting counterclockwise movement of the compensating arms 40 to the extent permitted by the respective cams 39. The drums then shift to the proper index positions, so that the final reading is the same as if the control rod 41 had been retained in its initial position throughout the counting period.

In accordance with one of the specific features of the invention, resetting of the respective drums to "zero" or starting positions may be effected rapidly and in a substantially automatic manner by temporarily disengaging the input drive connection to each drum. Advantageously, this is accomplished by shifting the control rod 41 axially to the right, as viewed in FIG. 1, moving the respective compensating and control arms to the right to withdraw the pinions 33 of the transfer gears 31 axially out of engagement with the gears 28 of the respective drums. At the same time, the idler gear 25 (or clutch, as the case may be), driving the first drum 18, is withdrawn axially by an arm 49, which is rotatable but axially immovable on the control rod 41 and engages the bushing 26 mounting the idler gear 25.

It will be observed in FIG. 1 that the axial length of the cams 39 and the pinions 30 is such as to accommodate the required axial movement of the cam followers 42 and transfer gears 31, while retaining the gears 30-32 in mesh and maintaining contact between the cams and cam followers. Accordingly, when the control rod 41 is shifted axially, to a limit position determined by a shoulder 50 at the left end of the rod, each of the drums 18-21 is freely rotatable on the drive shaft 14, each independently of the others. When the drums are thus released, the action of the spring urged cam followers 42 on the cams 39 rotates the cams and drums, until the cam follower reaches the lowest point on the cam, illustrated in FIG. 3, at which time the drum is in its starting or "zero" position. The maximum rotation of any drum, during resetting, is $\frac{1}{10}$ of a revolution. It should be noted that the follower 42c, cooperating with the highest order drum, functions only to return the drum to its "zero" position and does not act as a motion modifier, as do the other followers.

When all the drums are aligned in their "zero" positions, the control rod 41 may be released and allowed to shift to the left, under the action of a spring 51, re-establishing the driving engagement of the idler gear 25 and the transfer gears 31. In this respect, the transfer gears are advantageously retained in mesh with at least one gear of the train at all times, so that the teeth of these gears are properly aligned for re-engagement, when the drums are returned to "zero" positions.

Any suitable arrangement may be employed for actuating the control rod 41, including automatic, remotely actuated mechanisms. For purposes of illustration only, a manual actuating means is shown, comprising a manipulating wheel 52 mounted rotatably and slidably on a rod 53 anchored at one end in the end wall 54 of the housing. A pinion 55 is fixed to the wheel 52 and meshes with a gear segment 56 fixed on the control shaft 41.

6

Suitable stop means and/or detent means (not shown) may be provided to lock the wheel releasably in a preset position. With reference to FIG. 9, the device is set for slow speed operation or for reading by moving the wheel 52 to one limit position, in which the rotary position of the control rod 41 and control arms 43 is as indicated in FIGS. 3-5. To condition the device for high speed operation, the control wheel 52 is rotated counterclockwise, as viewed in FIG. 9, to a second limit position. Such rotation of the control wheel causes the control rod 41 to be rotated clockwise, to the position shown in FIG. 6, wherein the cam followers 42 are raised out of the paths of the cams 39.

At the end of a high speed counting operation, the control wheel 52 is first rotated to its first limit position, returning the cam followers to the cams to allow reading of the device. The control wheel 52 is then shifted axially thereby engaging the end of the control rod 41 and causing it to shift axially to the right as illustrated in FIG. 1. The gears 25 and 31 are thereby shifted axially, to reset positions, as shown in FIG. 8.

One of the advantageous features of the deluxe form of the device resides in the provision of means providing a direct gear drive for high speed operation, which is selectively operable to adjust the respective positions of the drums at the end of a counting period to index positions, in which the drums may be easily read. Another valuable feature resides in the novel arrangement for returning the respective drums to "zero" or starting positions at the end of counting operations. Each drum is acted upon by a spring urged cam follower, which tends to roll "down-hill" on a cam to return the drum to "zero" position, whenever the drum is permitted to rotate freely. Thus, by providing a simplified control mechanism, capable of disengaging each drum from the drive system and permitting free and independent rotation thereof, all of the drums may be quickly reset to "zero," with no re-winding or other application of external motion. A further significant feature of the illustrated device resides in the advantageous combination of the features above mentioned, whereby the cam and cam follower means employed during slow speed counting, and during reading, for modifying or compensating the transfer means, is utilized following a counting period for resetting the counting drums to "zero." The overall arrangement provides a highly versatile and substantially improved counter device of relatively simplified design.

Although only the deluxe form of the device has been illustrated, it will be understood certain basic features of the invention are retained in the "standard" form of the device, in which the shifting and resetting means may be omitted. The standard form of device retains the many advantages resulting from the use of compact, one-piece molded drums including a gear, a pinion and a cam, and also incorporates the improved structural arrangement of the motion modifying means, including a planetary gear movable about the axis of the drum shaft and a cam-actuated arm for moving the planetary gear through its limited orbital path.

It should be understood, therefore, that the form of the invention herein specifically illustrated and described is intended to be representative only, as certain changes may be made therein without departing from the clear teachings of the disclosure. Accordingly, reference should be made to the following appended claims in determining the full scope of the invention.

I claim:

1. A transfer counter comprising a plurality of register drums, lightweight resiliently biased floating transfer means interconnecting lower order drums with higher order drums and operative normally to effect rotation of a higher order drum in predetermined relation to rotations of the drum of the next lower order, cam means operated by lower order drums for shifting the floating transfer means during portions of the rotational cycles of the lower order drums whereby rotation of a higher order

drum is caused only during selected portions of rotational cycles of a drum of the next lower order, said transfer means comprising reduction gears interconnecting adjacent drums, lightweight resiliently biased movable means mounting the reduction gears, said cam means acting on the movable means to shift the position of a set of reduction gears in accordance with rotations of a lower order drum and in a direction and at a speed to offset relative movement between the reduction gears and the higher order drum driven thereby, during a portion of the rotational cycle of the drum of the next lower order, and in an opposite direction during the remaining portion of the rotational cycle to return the gears to an initial position, and a control means comprising means selectively to positively disengage said cam means from said movable means to permit high speed operation of the counter and to engage said cam means to facilitate reading of the counter.

2. The transfer counter of claim 1, in which the cam means includes cams carried by lower order drums, said movable means including cam followers adapted to engage the respective cams, and control means for rendering the cam means ineffective to shift the floating transfer means, said control means including means operative selectively to hold the cam followers out of contact with the cams and to urge the followers resiliently against the cams.

3. The transfer counter of claim 2, in which the drums are mounted for rotation about a common axis, a control rod mounted parallel to said axis and extending along said drums, motion compensating arms extending between sets of drums and each engaging a cam follower and a set of reduction gears, spring means normally urging said arms in a direction to press the followers against the cams, said control rod operatively engaging the arms to move said arms to a position preventing contact between the followers and cams.

4. The transfer counter of claim 3, in which the compensating arms are pivoted on said control rod, the control rod being mounted for limited rotation and carrying control arms engageable with the compensating arms to raise the compensating arms out of contact with the cams.

5. The transfer counter of claim 2, in which the control means is operable selectively to disengage the transfer means to permit independent rotation of the drums, whereby the drums are returned to zero positions by the action of the cam followers on the cams.

6. The transfer counter of claim 5, in which the control means comprises a rod mounted for axial and rotational movement, said rod being movable rotationally to move the cam followers into and out of contact with the cams and movable axially to effect disengagement of the transfer means.

7. The transfer counter of claim 5, in which the transfer means comprises gears on adjacent lower and higher order drums, and gear means interconnecting said gears, said control means comprising means for effecting relative axial movement between said gears and gear means, whereby the gear means is disengaged from one of the gears.

8. A transfer counter comprising a drum shaft, a plurality of drums mounted on said shaft for rotation about its axis, means for rotating a lower order drum, a transfer pinion carried by said lower order drum, a differential planetary transfer gear meshing with said transfer pinion, a radius arm mounted for pivotal movement on said drum shaft and positioned between said lower order drum and the drum of the next higher order, said planetary transfer gear being mounted on said radius arm for rotation about an axis laterally offset from the axis of said drum shaft and for limited orbital movement about the axes of said shaft, said radius arm and said planetary transfer gear being positioned substantially within the peripheral outline

of said drums and said laterally offset axis lying within the peripheral outline of said drums, a transfer gear carried by the drum of the next higher order and meshing with said planetary transfer gear, a compensating cam carried by said lower order drum within the peripheral outline of said drums, a compensating arm mounted for pivotal movement about a predetermined fixed axis and extending between said lower and higher order drums, said compensating arm being connected to said radius arm and said planetary transfer gear, said predetermined fixed axis lying generally on the opposite side of said drum shaft from the point of connection between said compensating arm and said radius arm, cam follower means on said compensating arm positioned between said predetermined fixed axis and said planetary transfer gear and engaging the surface of said compensating cam, and resilient means urging said cam follower means into engagement with said compensating cam, said compensating cam being contoured to move said compensating arm, and hence said radius arm and planetary transfer gear in a manner to retain said higher order drum substantially motionless during a predetermined portion of a revolution of said lower order drum and to effect transfer movement of said higher order drum through a predetermined indexing increment during the remaining portion of a revolution of said lower order drum.

9. A transfer counter comprising a drum shaft, a plurality of drums mounted on said shaft for rotation about its axis, means for rotating a lower order drum, a transfer pinion carried by said lower order drum, a differential planetary transfer gear meshing with said transfer pinion, a radius arm mounted for pivotal movement on said drum shaft and positioned between said lower order drum and the drum of the next higher order, said planetary transfer gear being mounted on said radius arm for rotation about an axis laterally offset from the axis of said drum shaft and for limited orbital movement about the axis of said shaft, a transfer gear carried by the drum of the next higher order and meshing with said planetary transfer gear, a compensating cam carried by said lower order drum, a compensating arm mounted for pivotal movement about a predetermined fixed axis and extending between said lower and higher order drums, said compensating arm having an offset portion passing around said shaft and having a free end located generally on the opposite side of said shaft from said predetermined fixed axis, said radius arm having a portion extending generally directly away from said predetermined fixed axis, said portion being connected to the free end of said compensating arm, and cam follower means on the offset portion of said compensating arm engaging the surface of said compensating cam, said compensating cam being contoured to move said compensating arm, and hence said radius arm and planetary transfer gear in a manner to retain said higher order drum substantially motionless during a predetermined portion of a revolution of said lower order drum and to effect transfer movement of said higher order drum through a predetermined indexing increment during the remaining portion of a revolution of said lower order drum.

References Cited in the file of this patent

UNITED STATES PATENTS

1,148,516	Irion	Aug. 3, 1915
1,913,983	Gardner	June 13, 1933
2,344,627	Mixer	Mar. 21, 1944
2,405,626	Williams	Aug. 13, 1946
2,456,101	Yeastling	Dec. 14, 1948
2,613,033	Pfleger	Oct. 7, 1952
2,622,805	Avery	Dec. 23, 1952
2,680,562	Dalzell	June 8, 1954
2,920,816	Greenhow	Jan. 12, 1960