

Nov. 1, 1955

A. KIHl ET AL

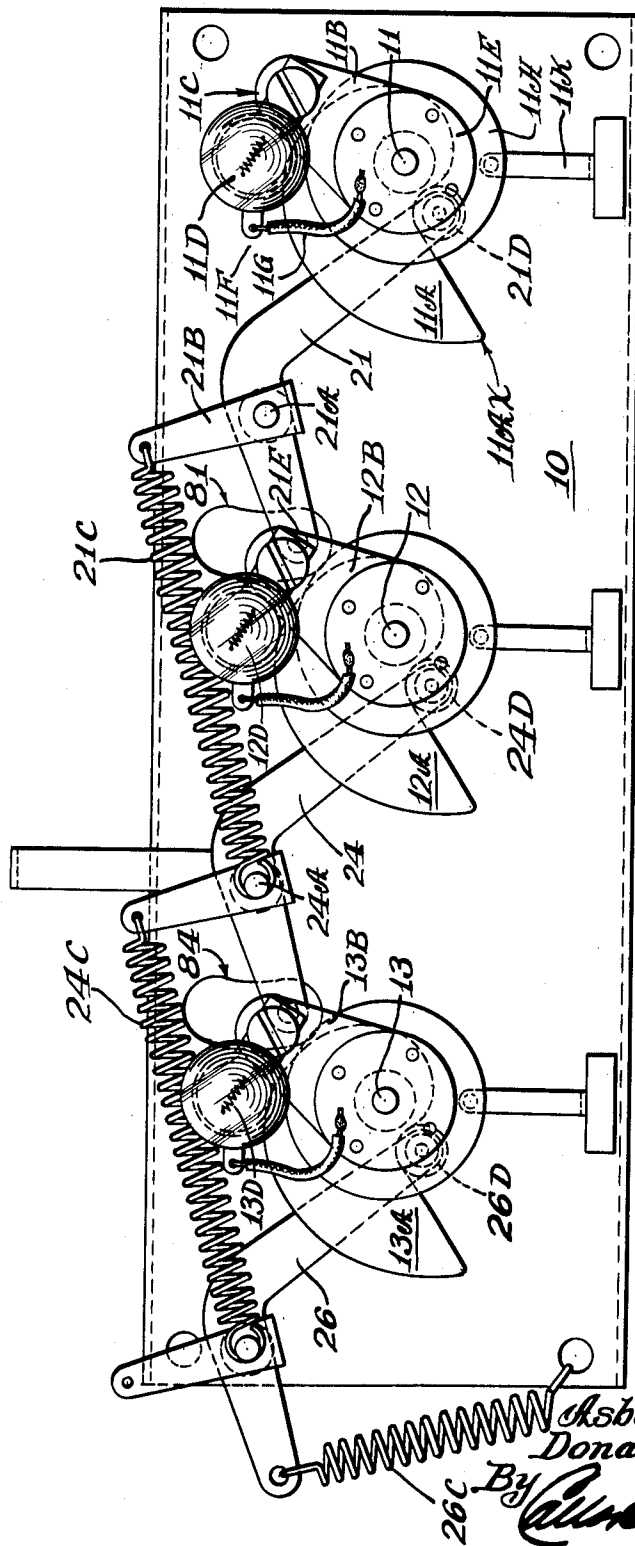
2,722,382

DECADE COUNTER AND TENS TRANSFER MECHANISM THEREFOR

Filed April 30, 1952

4 Sheets-Sheet 1

FIG. 1.



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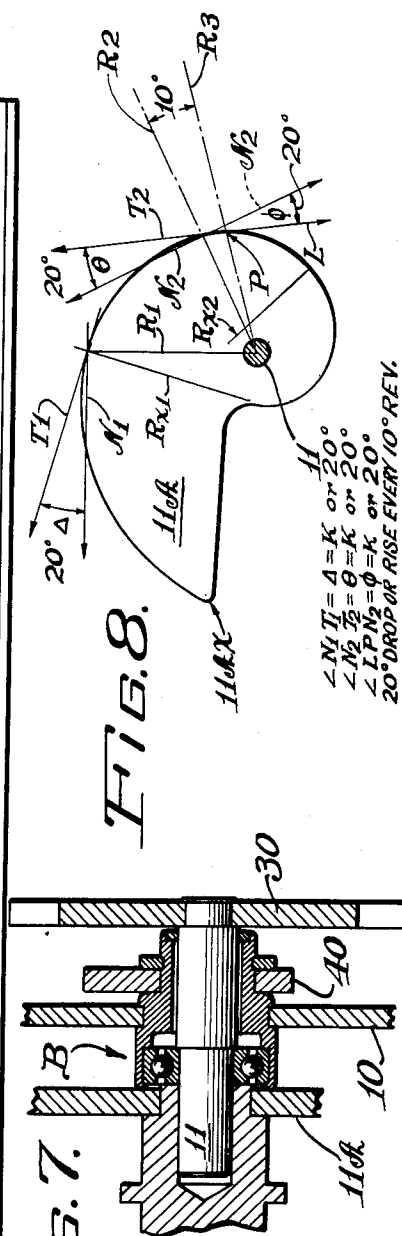
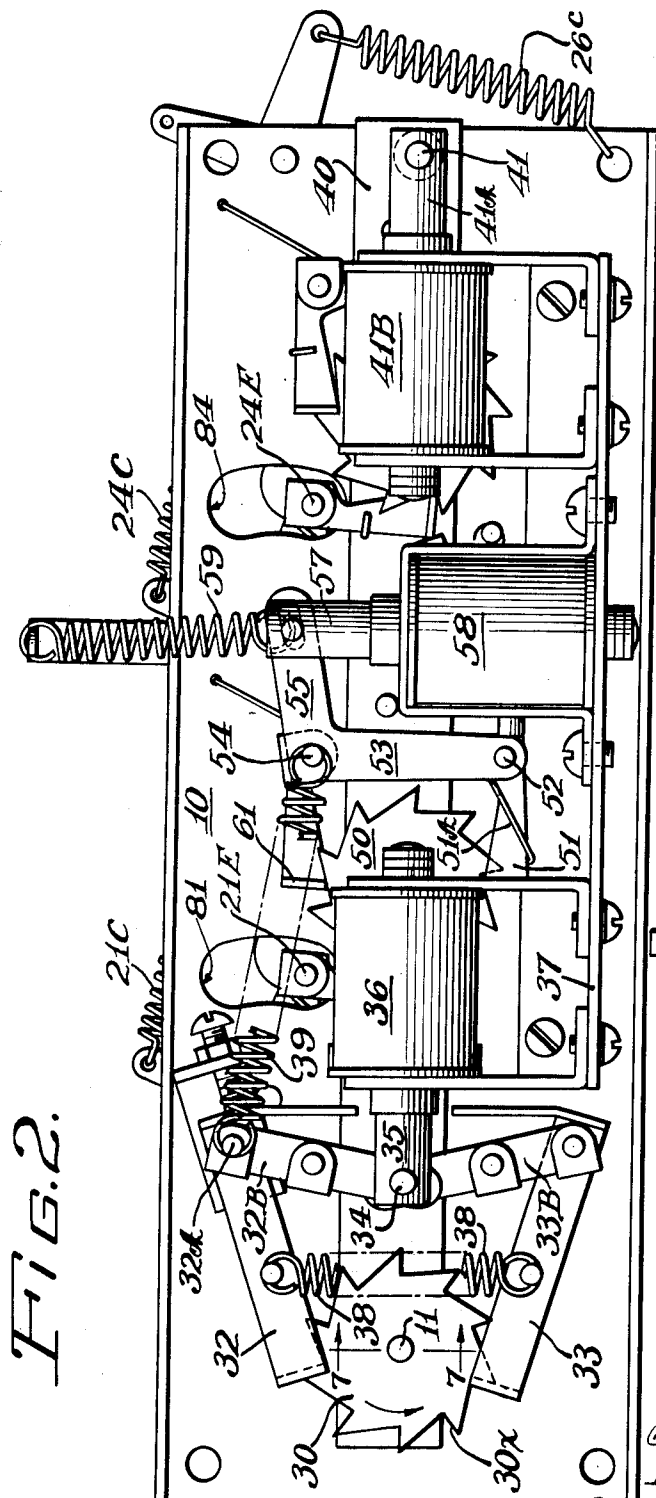
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DECADE COUNTER AND TENS TRANSFER MECHANISM THEREFOR

Filed April 30, 1952

4 Sheets-Sheet 2



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Nov. 1, 1955

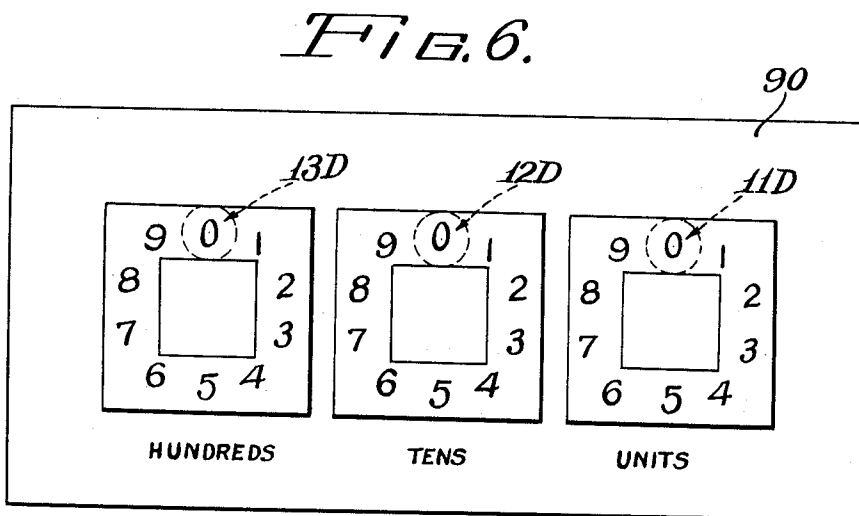
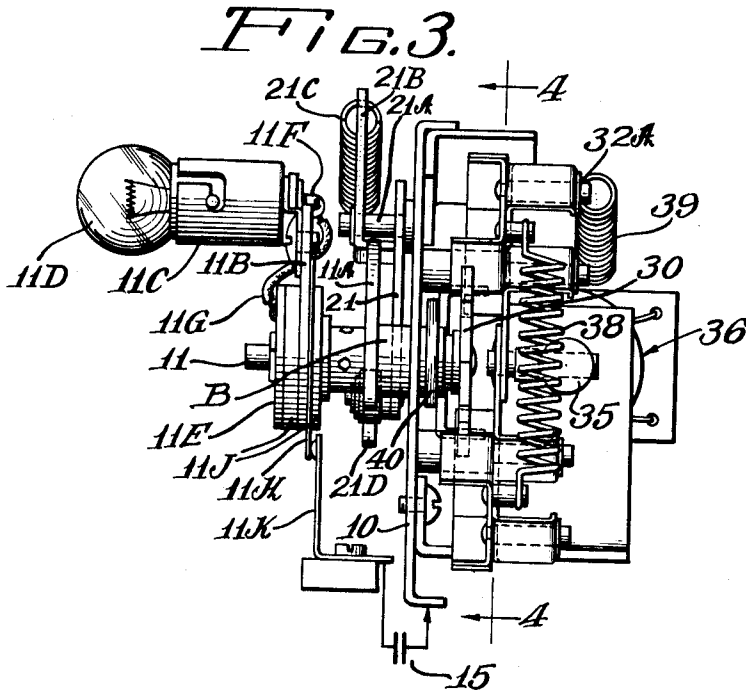
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DECADE COUNTER AND TENS TRANSFER MECHANISM THEREFOR

Filed April 30, 1952

4 Sheets-Sheet 3



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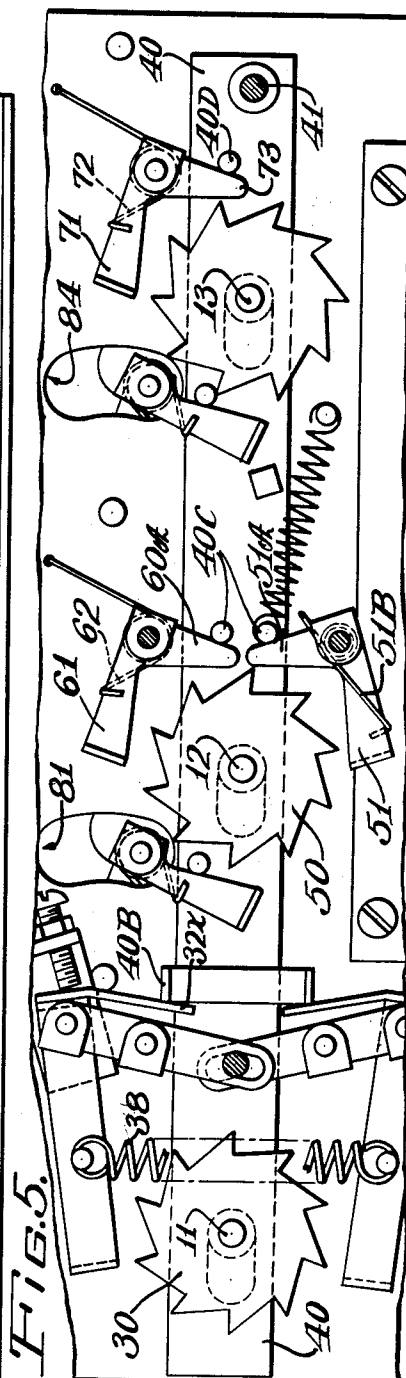
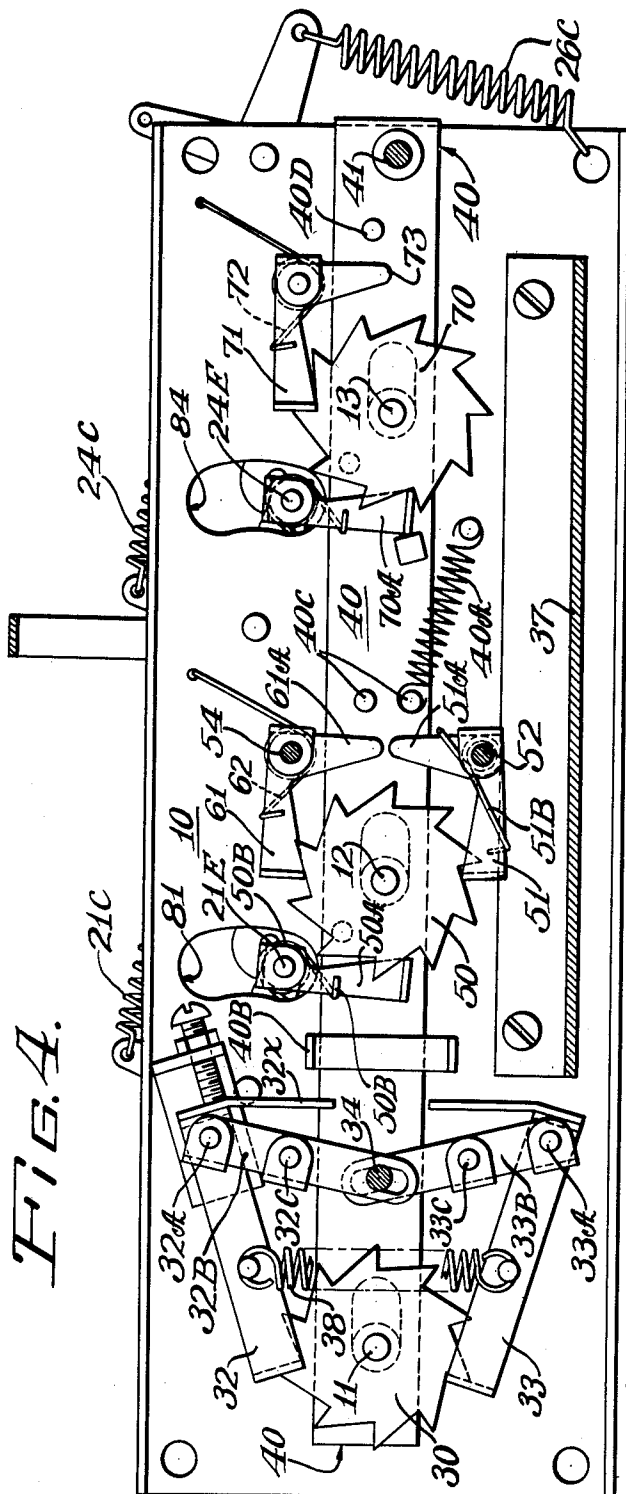
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DECADE COUNTER AND TENS TRANSFER MECHANISM THEREFOR

Filed April 30, 1952

4 Sheets-Sheet 4



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2,722,382

DECADE COUNTER AND TENS TRANSFER MECHANISM THEREFOR

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Application April 30, 1952, Serial No. 285,268

10 Claims. (Cl. 235—134)

This invention relates to display registers and counting mechanisms and has as its principal object the provision of a totalizing type of score register or display device of general utility and application, but especially suited for use in game apparatus for indicating score totals and the like.

Another object is the provision of a decade counting mechanism of simple and relatively inexpensive and fool-proof construction which achieves a tens-transfer action by use of an especially contrived cam-and-trip-off drive means for additive transfer of the tens multiples from column to column in the units, tens, hundreds, etc. groups.

Another object is the provision of a simple reset mechanism for zeroizing the counter in conjunction with a particular type of high-speed impulsing ratchet mechanisms.

Another and more specific object is the provision of a tens-transfer mechanism utilizing a cam of peculiar development and a transfer lever progressively conditioned thereby to store spring energy for delivering a transfer impulse to the next higher counting means upon each tenth step of the cam, such that each tens transfer means may be said to consist simply of an especially developed cam, an impulse lever, and a simple and relatively light spring progressively tensioned as a function of each cycle of ten counting steps to impart a ratchet-driving force sufficient to advance the next higher counter at each tenth step without significantly loading the driving means of the lower counter.

Another object is the provision of a reversible cam and lever drive mechanism including a cam and a spring-loaded lever having parameters of angular character to provide a substantially constant starting load on the cam, and such an angular drive and minimized load for the lever that the latter can be spring-urged to impart torque to the cam and drive the latter reversely to the driving effort of the cam on the lever.

Additional objects and aspects of novelty and utility relate to details of the embodiment described hereafter and illustrated in the annexed drawings, in which:

Fig. 1 is a front elevation of a decade-counting unit employing the new tens-transfer means and showing the special transfer cam and lever means, and display lamp means;

Fig. 2 is a rear elevation of the counter showing the electromagnetic stepping-ratchet mechanism;

Fig. 3 is a side elevation of the decade-counting unit;

Fig. 4 is a rear elevational view, similar to that of Fig. 2, but with parts shown in section and the driving electromagnets removed;

Fig. 5 is a view similar to that of Fig. 4, but showing the ratchet mechanism in resetting condition;

Fig. 6 is a front elevation of a score-display or register panel to be illuminated by the lamp-index means of Fig. 1 or 3;

Fig. 7 is a sectional detail to enlarged scale, taken along lines 7—7 of Fig. 2 of the bearing support for the cam and ratchet spindles;

Fig. 8 is a plan view of one of the decade cams.

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The counting unit shown in Fig. 1 comprises a mounting plate 10 carrying three counter spindles 11, 12, 13, each journaled in a special bearing unit B, such as shown sectionally in Fig. 7, later referred to.

Carried upon each spindle is a cam 11A, 12A, 13A, respectively representing, in the order named, the units, tens, and hundreds counting groups.

Also carried by each of said spindles to rotate therewith is a radial index arm 11B, or 12B, or 13B, at the free end of each of which is secured a lamp socket, such as the socket 11C (Fig. 3), for a corresponding display lamp 11D, or 12D, or 13D, the several counting mechanisms being identical in these and other respects, so that only the units section will be described until necessary to point out any significant differences for any of the other components.

Considering now the units counting means of Fig. 3, as also representative of the tens and hundreds counters, it will be understood that the base plate 10, spindle 11, and bearing means B, are all of metal and sufficiently interconnected electrically to afford one conduction path, grounded or common to plate 10.

At the front end of the spindle 11 (Figs. 1 and 3) is a metal washer 11E contacting the spindle, and to which one lamp terminal lug 11F is connected by a short jumper wire 11G soldered thereto.

The shell of the lamp socket 11C, as the remaining lamp terminal, is electrically connected through the index radius arm 11B by contact with a large bronze washer 11H pressed between flanking non-conductive washers 11J (Fig. 3), so as to be insulated from spindle 11. A spring wiper 11K pressing against the bronze commutating or wiper disc 11H affords a connection to power source or battery 15 grounded to base plate 10 for illuminating the index or display lamp 11D.

The electrical energizing connections for all of the indicating lamps are identical to that just described for the lamp 11D.

As viewed in Fig. 1, the transfer cam 11A has a transfer lever 21 pivoted on the base plate at 21A and provided with an offset 21B to which is attached one end of a tractile spring 21C, the opposite end of which is anchored on the pivot pin means 24A for the adjacent tens unit.

The spring 21C urges the tens transfer lever 21 counterclockwise to thrust a roller 21D against the face of the corresponding cam 11A, and is shown in the drop-off or zero position relative to the latter in Fig. 1. Similarly, the tens group counter has a transfer arm 24 urged by its spring 24C to thrust roller 24D against its cam 12A; and the hundreds lever 26 has a spring 26C (anchored on the base plate, however) to thrust its roller 26D against its cam 13A, so that all of the tens-transfer cams and levers will be seen to be substantially identical up to this point.

Referring now to Fig. 4, which shows the reverse side of the base plate from Fig. 1, and regarding mainly the units counter at the left-hand end thereof, it will be observed that this end of the spindle 11 is provided with a ratchet wheel 30 engaged on diametrically opposite sides by the respective noses of a pair of alternately acting driving pawls 32, 33, respectively pivotally connected at 32A, 33A, with corresponding links 32B and 33B, which are in turn respectively pivoted on the base plate at 32C, 33C.

The two links 32B and 33B are also interconnected at their juxtaposed free ends by a coupling pin 34, working in elongated slots in said free ends, and projecting from an attachment to the plunger 35 (Fig. 2) of an electromagnetic solenoid 36, mounted on a bracket 37 which is removably bolted to the base plate.

As seen in Fig. 2 (or 4) the two drive pawls 32, 33 are urged toward each other by a common spring 38.

acting to lodge their respective nose portions in the teeth of ratchet 30 on cam spindle 11.

Moreover, a spring 39 (Fig. 2) attached at one end to the pivot 32A, and at its opposite end to the pivot 54 of the adjacent ratchet drive pawl means, normally pulls the link 32B to withdraw the solenoid plunger 35, and also to retract the alternate drive pawl 33 through the common pin connection 34.

The foregoing ratchet drive constitutes a high-speed stepping means which forms the claimed subject matter of a copending application, Serial No. 252,858, now Patent No. 2,627,755; and the operation is such that for each energizing and de-energizing pulse to the solenoid 36, the ratchet wheel 30 will take not one, but two steps, driving spindle 11 counterclockwise as seen in Fig. 2, and consequently stepping the corresponding transfer cam 11A clockwise as seen in Fig. 1.

The two-step action of the aforesaid high-speed ratchet means is achieved by reason of the fact that on the attracted or inward (right) stroke of plunger 35 both pawls 32 and 33 shift toward the left, the pawl 32 (being already engaged with a ratchet tooth) therefore stepping the ratchet wheel a distance of one tooth, while the companion pawl 33 merely slides forward (to the left) and drops around the apex of a tooth, as at 30X, without causing any movement of the wheel; but on the return stroke of plunger 35, and hence the two pawls, pawl 32 slips idly but pawl 33, now hooked around tooth 30X, imparts the second step to the ratchet wheel.

The aforesaid dual stepping can be effected at a remarkably high rate, but it will shortly be observed that only the ratchet wheel 30 for the units counter has been equipped with such a high-speed stepping means, since the counting action in this group of numbers is fastest, and the tens and hundreds counters will be required to step only at long intervals while the antecedent counters build up the requisite tens-multiples to advance the higher units as the tens and hundreds factors are accumulated.

It may be remarked at this juncture that a common reset means for all counting mechanisms is shown to advantage in Fig. 4, and includes a long bar 40 normally urged to the right (Fig. 4) by a spring 40A, and having three elongated slots each spaced respectively to ride upon one of the spindles 11, 12, 13.

At its right-hand end, the reset bar is provided with pin means 41 (Fig. 2) projecting into engagement with the plunger 41A of a reset solenoid 41B, which when energized, shifts the reset bar toward the left, as in Fig. 5, thereby causing an offset lug 40B to bear against an offset arm 32X on the drive pawl 32, thereby urging the latter, and hence the companion pawl 33, into a position of complete disengagement with the teeth of ratchet wheel 30, as depicted in Fig. 5.

The ratchet means for driving the tens counter shaft 12 is much like that for the units counter, just described, except that it does not have the high-speed dual-stepping action for the reasons explained.

The tens ratchet wheel 50 on spindle 12 is stepped by only one pawl 51 (Fig. 4) pivoted as at 52 on the lower leg of a bell crank lever 53 (Fig. 2) which in turn is pivoted as at 54 on the base plate.

The offset upper leg 55 of the crank lever has pivotal connection at 56 with the plunger 57 of a solenoid 58.

The driving pawl 51 is urged by a wire spring 51B, on pivot 52, into the teeth of the tens ratchet wheel 50, so that upon attraction of the plunger 57, crank lever 53 rocks clockwise thrusting pawl 51 toward the left (Figs. 2 and 4) idly over one ratchet tooth; but upon the return stroke of the solenoid plunger, by its spring 59, the pawl 51 will pull the ratchet wheel 50 through the arc of one tooth, and hence step the spindle 12 and its transfer cam 12A correspondingly.

A holding pawl 61, also turning on pivot 54 for the solenoid bell crank, is spring-urged by wire spring 62 into

normal engagement with the teeth of the tens ratchet wheel 50 to prevent retrograde motion of the latter.

When the common reset bar 40 is shifted toward the left in resetting operation by energization of solenoid 41B, a pair of studs 40C on the bar (Fig. 5) bear against the respectively offset legs 51A and 61A of the driving and holding pawls and turn the latter out of engagement with the teeth of ratchet wheel 50 into the reset position illustrated in Fig. 5.

The hundreds counter spindle 13 (Fig. 4) is likewise provided with a ratchet wheel 70, but since the hundreds values are merely to be accumulated from multiples transferred thereto by the tens counter, there is no independent electromagnetic drive provided for the hundreds ratchet wheel 70. A holding pawl 71, however, prevents retrograde movement and serves as a detent in stopping the ratchet and its cam in proper position.

Holding pawl 71 is urged into engagement with the ratchet teeth by a wire spring 72, and has an offset or tail 73 positioned to be engaged (Fig. 5) by a stud 40D on the reset bar when the latter shifts as aforesaid.

In order to understand how the several counters are reset to zero, it is first necessary to consider the operation of the tens-transfer means and certain peculiarities of the action of the tens transfer levers.

Reverting to Fig. 1, it will be seen that there are two spaced arcuate slots 81, 84, near the top edge of the base plate, one opposite each offset end of each of the transfer levers 21 or 24.

Except for the fact that the hundreds transfer lever 26 has no transferring function in the illustrated counter (because its capacity is only 999, and there is no thousands counter) the transfer lever means for each group is substantially identical.

Considering the lever 21, for example, it will be observed to have pin means 21E at its offset end projecting through the corresponding arcuate slot 81 to the rear of the base plate for engagement (Fig. 4) with a stepping pawl 50A drivingly engageable with the teeth of the tens ratchet wheel 50.

A small wire coil spring 50B carried on pin means 21E urges the stepping pawl always into a position to enter the teeth of the ratchet wheel.

It may here be noted that the hundreds ratchet wheel 70 is similarly provided with a stepping pawl 70A carried on pin means 24E, which projects through the second arcuate slot 84 from transfer lever 24.

Considering Fig. 1 again, it will be apparent that as the units counter cam 11A steps clockwise in additive movements the transfer lever 21 will be pivoted also in a clockwise sense, tensioning the driving spring means 21C, as cam roller 21D rides outwardly to its maximum radial displacement in approaching the tip 11AX of the cam.

In the latter movement of the transfer lever 21, the pin means 21E will rise toward the top of the arcuate slot 81, carrying the corresponding stepping pawl 50A (Fig. 4) with it.

Whenever the cam 11A takes a tenth step, the spring 21C will be under maximum tension, and the cam roller 21D will drop sharply off of the cam point 11AX and permit the transfer lever 21 to be reversely moved abruptly by spring 21C in a counterclockwise sense a distance equal to the radius from tip 11AX to the zero position of cam roller 21D shown in Fig. 1.

This abrupt and reverse movement of the transfer lever 21 in the dropping of roller 21D from cam tip 11AX will abruptly thrust the stepping pawl 50A back into the teeth of ratchet 50 of the next higher (or tens) counter, thus transferring the count of one tens value to the counter spindle 12 on which ratchet 50 is fixed, the units counter now being at zero (as in Fig. 1) preparatory to further counting of unit values.

A feature of the invention now important to understand is the especial angular development of the cam faces of the several transfer cams, described with reference to

Fig. 8, depicting the cam 11A, it being understood, however, that the transfer cams (as well as the transfer levers) are substantially all alike.

The angular development of the cams (meaning the working faces thereof) is such as to present a minimized loading thereof throughout the entire cycle of travel, the loading being that of the effort of spring 21C imparted through lever 21 and roller 21D to the cam face as the latter advances in its additive stepping to progressively tension spring 21C for the drop-off.

This cam development is such that the angle Δ (or θ) measured between the tangent at any point and the normal to the corresponding radius of angular travel is a constant, K.

Thus, in Fig. 8, the angle Δ formed by the normal N_1 to the angular radius R_1 and the tangent T_1 to the radius of curvature RX_1 is a constant K preferably equal to about 20° .

Likewise, any other such angle θ measured between the normal N_2 of any angular radius R_2 to the tangent T_2 of the radius of curvature RX_2 gives the same constant angular value $K=20^\circ$.

Stated otherwise, the angle included between any radius vector and its tangent is a constant; and the curve is always equal to the product of the logarithm of the radius vector and the tangent of the constant angle, by reason of which the cam may also be characterized as a "logarithmic" cam.

Thus, in Fig. 8, either angular radius R_1 or R_2 is also a radius vector with corresponding tangents T_1 , T_2 , for which the respectively included angles will be found to be about 108° , so that the constant angle may be described as being preferably about 20° as defined by the tangent and normal parameters explained above, or equivalently as being about 108° when defined in terms of the angle included between the tangent and radius vector.

As a result of such angular characteristics, the transfer cams may be said to have an arcuate or eccentric cam face, periphery, or track in the nature of an involute curve, the angular parameters of which afford an approximated "20°-in-10°" drop or rise in curvature so as to effect a retrograde torque-producing couple with their respective transfer levers with a minimized loading of the cam by the levers. The utilitarian advantages of these characteristics make possible the manufacture of an inexpensive counting mechanism operated by a relatively simple and rugged type of ratchet stepping mechanism with a simple cam-actuated resetting action.

Applicant's cam development is not predicated primarily upon change in axial radius, but upon a constant change in angular drop, which, in the commercial embodiment (depicted with practical accuracy herein) the change is about 20° of drop for every 10 degrees of angular or rotary displacement.

It should be observed that the radii of curvature, such as RX_1 , RX_2 , are the critical radii of evolution for the curvature of the cam face; whereas the angular radii, R_1 , R_2 , are the radii of rotary motion or angular travel for the cam about the axis of its spindle 11.

This distinction is necessary since by definition the tangent to a curve must be normal to a radial intercept at the point of tangency. But, because of the constant change in curvature, it is necessary to refer to the "virtual tangent" which can be referred only to the radii of curvature. One radius of curvature is RX_1 and the corresponding tangent is T_1 ; and it may be observed here that the angular radius R_1 also intersects the point of tangency for T_1 , yet the normal N_1 at this point intercepts the curve and cannot be made a tangent. Hence the virtual tangent T_1 must be referred to the radius RX_1 and not R_1 .

Another way of characterizing the rate of change in the cam drop (or rise) is to say that the virtual tangent T_1 (referred to any radius of curvature RX_1) would be about 20° off from the normal to the angular radius to the point of virtual tangency.

Yet another way of defining the cam development is to state that there is a drop (or rise) of 20° for every 10° of revolution. Thus, if angular radii (extended from the axis of spindle 11) are projected every 10° , then the normal to any radius at the intercept with the arc will make an angle of 20° with the normal of the next adjacent angular radius 10° away.

If angular or axial radii are projected from the center of the cam spindle 11, say, every ten degrees and normals thereto are struck therefrom at the points of intersection with the cam curve, and if lines are then projected from such points at 20° up or down (depending on whether the curve is rising or falling), it will be found that the curve rises or falls by amounts of about 20° . This is another way of stating what is depicted in Fig. 8, excepting that there, instead of using a plurality of axial radii 10° apart to illustrate the development, one radius of curvature RX_1 and several angular radii R_1 , R_2 , R_3 were selected to illustrate both the tangency method and 10° -interval method of defining the curve.

To illustrate this 20° -in- 10° drop, consider the angular or axial radius R_3 (extended), which is 10° (clockwise) from radius R_2 . If the line L is taken at the angle ϕ 20° down from the normal to R_2 , extended (which is the same as normal N_2), then the line L will intersect the curve and radius R_3 at the point P, which is 20° down from the normal. Going in the opposite or counterclockwise direction, it will be found that the same constant angular rise of 20° will appear at 10° intervals.

Thus, the cam curvature may also be characterized as rising or falling about 20° in every ten degrees of angular rotation.

The cams 11A, 12A, 13A, etc. may be counterbalanced, if desired, to increase the sensitivity for reverse or resetting response, and make it possible to further reduce the magnitude of the spring loading, so that even less electromagnetic driving power is required for the advancing movements.

Viewed from another aspect, the angular development of the transfer cams according to the foregoing constant drop of curvature (or rise, going in the opposite sense) is such as to provide a substantially constant or uniform starting load for the driving agency.

This means that relatively light springs (such as 21C) and relatively low-powered solenoids (such as 36, 58) may be employed while assuring positive response and reliable operation. This advantage alone is of great practical value.

But of equal advantage is the fact that the transfer levers, such as 21, 24, 26, and their respective springs 21C, 24C, 26C, can be reliably employed to drive their respective cams in the resetting or zeroizing operation, the direction of rotation of the cams in such resetting movement being the reverse of their additive travel.

The illustrative embodiment set forth herein is provided with electromagnetic stepping or advancing or driving means, such as solenoids 36 and 58 for only the units and tens factors, and either of these solenoids may be directly energized to enter the corresponding units or tens values selectively.

It will be apparent, however, that the capacity of the entire counter mechanism may be expanded as desired by adding units, and that any intermediate unit (such as the tens counter herein) may be supplied with its own stepping solenoid means for direct entry of the value which it represents. For instance, if so desired, the hundreds counting unit could be equipped with a stepping means like the solenoid 58 and its pawl means 61, where there is a need for making direct entries, as distinguished from cumulative entries effected by the tens transfers cam and lever means.

The display feature of the illustrative embodiment includes the several indicating lamps 11D, 12D, 13D (Figs. 1, 3) which can be positioned and utilized to illuminate some form of indicia scale, such as shown in Fig. 6, which

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consists of a translucent panel 90 of glass or the like, having three scales of indicia thereon, with the plate positioned in front of the decade counting unit so that each of the lamps 11D, 12D, and 13D, will be in register with the indicia of the appertaining scale for illumination of the numbers thereon as the lamps rotate in their indicating travel.

We claim:

1. In a tens transfer mechanism, including at least two rotatable counting members and means for advancing same from a starting position to advanced counting positions together with releasable holding means normally restraining said rotatable members against retrograde movement, improvements comprising, to wit: a constant-rise cam rotatable with at least a first one of said rotatable members, said cam having a low radial starting point and a higher radial drop-off point, with a curved working face in between said points and so pitched that the angle included between any tangent thereto and the appertaining radius vector to the point of tangency is a constant; a transfer and return lever having a riding part and means yieldingly urging same against said cam face to drop off said drop-off point responsive to predetermined advance of the cam in counting action of said first rotatable member; transfer mechanism actuated by drop-off movement of said lever to effect counting advance of the second said rotatable counting member; said urging means and lever acting upon said cam to effect retrograde movement thereof from any advanced condition of the cam short of said drop-off point responsive to release of said holding means, said cam acting both in resetting said rotatable member and cam, and in transferring counting motions to said second rotatable member.

2. In a cam-type tens transfer mechanism, a spring-loaded cam-follower lever; a rotatable cam for said lever having an involute cam periphery; a cam-riding part on said lever engageable with said periphery; spring means pivoting said lever to urge the cam riding part thereof against said cam periphery; a starting point of predetermined minimum eccentricity on said cam periphery; a drop-off point at a position of maximum eccentricity on said periphery and angularly remote from said starting point in a direction of advancing movement of the cam; said periphery being evolved to provide a cam rise of about 20° at intervals of 10° of rotation of the cam from said starting point toward said drop-off point, whereby to provide a uniform and minimized loading of the cam by said lever, and to provide a retrograde torque couple with the lever for rotation of the cam by said lever reversely to said advancing movement at all points along said cam face between said starting and drop-off point; means cooperable with said lever for transferring a component of driving effort of the drop-off movement of the lever to a desired instrumentality; and releasable means normally preventing retrograde movement of said cam.

3. In a counting mechanism, at least two adjacent counting shafts adapted for rotative step-by-step counting advance; electromagnetic stepping mechanism for stepping a first one of said shafts, a cam rotatable with said first shaft, a spring-loaded transfer lever pivoted adjacent said first cam and having an eccentric end region adapted to ride the cam face of said cam to be pivoted from a starting position to an advanced position by advancing rotative displacement of the cam; a second stepping mechanism for stepping the second shaft, a stepping pawl actuated by said first lever in retrograde movement thereof to actuate said second stepping mechanism; said cam having a cam curvature pattern evolved to rise about 20° for every advance of approximately 10° of rotation thereof, whereby to pivot said lever from starting position toward an advanced position, and further to provide a minimum loading by said lever, and further to effect a retrograde driving of said cam by spring-driven retrograde action of said lever, said cam having

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a drop-off formation located at a certain position of maximum advance thereof at a certain position of maximum advance thereof to free said lever from a predetermined condition of advance thereby to effect retrograde spring-return of the lever to said starting position, whereby said second shaft will be stepped once for each cycle of travel of said cam from said starting position to said condition of maximum advance.

4. In a cam and lever type of tens transfer mechanism for registers and counting mechanisms, a cam having a working face with a curvature such that the angle included between any tangent thereto and the radius vector to the point of tangency is a constant; and a lever riding said face and yieldingly loaded to exert a force thereon, said lever adapted to actuate a transfer mechanism in response to predetermined angular advance of the cam, and to turn the cam in retrograde motion for resetting thereof from advanced position whenever said cam is free to turn retrogressively from an advanced position.

5. In a counting mechanism, at least two adjacent counting shafts adapted for rotative step-by-step counting advance; electromagnetic stepping mechanism for stepping a first one of said shafts, releasable holding means for preventing retrograde motion of said first shaft, at least, a cam rotatable with said first shaft, a spring-loaded transfer lever pivoted adjacent said first cam and having an eccentric end region adapted to ride the eccentric cam face on said cam to be pivoted from a starting position to an advanced position by advancing rotative displacement of the cam; a second stepping mechanism for stepping the second shaft and releasable holding means therefor; a stepping pawl actuated by said first lever in retrograde movement thereof to actuate said second stepping mechanism; said cam face having a cam curvature pattern evolved to rise about 20° for every advance of approximately 10° of rotation thereof, whereby to pivot said lever from a starting position toward an advanced position, and further to provide a minimum loading by said lever, and further to effect a retrograde driving of said cam by spring-driven retrograde effort of said lever responsive to release of the appertaining holding means; said cam having a drop-off formation located at a certain position of maximum advance thereof to free said lever from a predetermined condition of advance in engagement with said cam face and thereby effect abrupt retrograde spring-return of the lever to said starting position, whereby said second shaft will be stepped once for each cycle of travel of said cam from said starting position to said condition of maximum advance.

6. For use in register, counting, and indicating devices, decade type counting and resetting mechanism comprising: a plurality of counting shafts each having a cam rotatable in step therewith; electromagnetic mechanism for stepping said shafts selectively; releasable holding means for each shaft to hold the stepping gain thereof; said cams being of involute curvature and each having a cam track with a low starting point of least eccentricity curving into a rising eccentricity terminating at a drop-off point radially aligned with said starting point; a pivoted transfer lever for each said cam; spring means urging an eccentric portion of each lever into riding engagement with the cam track of a corresponding one of said cams whereby the respective levers are pivoted from a starting condition in engagement with the starting point on the corresponding cam, toward and past the corresponding cam drop-off point, responsive to stepping advance of the corresponding cam; said levers being pivoted in retrograde movement by their respective spring means in moving as aforesaid from the drop-off point to the starting point on their respective cams; mechanism actuated by each lever in retrograde movement as aforesaid for actuating the stepping mechanism for an adjacent counting shaft; said cams having param-

eters of curvature affording a minimized starting loading thereof by their respective transfer levers and further effecting a torque-producing couple with their respective transfer levers such that said levers are capable of positively driving their respective cams in retrograde movement responsive to release of the corresponding holding means under the conditions where said levers are engaged with the cam track at any point between the starting and drop-off points thereon at the time of such release, whereby said counting shafts may be reset by their transfer levers under the prescribed conditions.

7. In a mechanism of the class described, first and second shafts adapted to be rotatively advanced from a starting position to a predetermined advanced position; means for advancing the first shaft; a cam rotatively advanced by said first shaft; a pivoted transfer lever including means riding the cam face of said cam and pivoted by the latter from a starting position to a predetermined advanced position; spring means urging said lever to said starting position thereof and into driving engagement with said cam as a load on the latter; advancing motion of the cam increasing the spring tension as said cam advances and pivots said lever; a drop-off on said cam releasing said lever for retrograde spring-restoration to said starting position in a certain angular advance of the cam; mechanism actuated by said transfer lever in a retrograde movement thereof for advancing said second shaft; and releasable holding means for holding the gain of said first shaft, at least, said cam having a cam pattern with parameters presenting a minimized loading couple with reversible driving effects between the same and said lever such that upon release of the holding means in advanced conditions of the lever and cam, the lever will produce retrograde torque in the cam to restore the same to a predetermined starting position.

8. In a stepping mechanism, a plurality of rotatable shafts, mechanism for selectively stepping said shafts in a predetermined advancing direction; cam means on certain adjacent ones of said shafts, a transfer lever associated with each cam and including a riding part riding the cam pattern of the appertaining cam; spring means urging each lever into riding engagement with its cam; each cam having a lever drop-off point remote from a starting point thereon and from which the associated lever moves under urgency of said spring means to a starting position in engagement with said starting point on said cam; said levers being respectively moved by their corresponding cams from said starting positions to certain advanced positions approaching and at said drop-off points; and means actuated by each lever in movement from the corresponding drop-off point to said starting point, and cooperating with said stepping mechanism for the next adjoining shaft to actuate said stepping mechanism and step said adjoining shaft at least once, whereby a predetermined rotative movement of a selected cam in advancing direction will step the adjoining

shaft as aforesaid by drop-off movement of the lever associated with said selected cam; releasable holding means cooperable with said stepping mechanism for releasably holding the advance gain of any shaft; said cam patterns having parameters of curvature minimizing the loading effect of said levers on the associated cams and shafts, and further effective to produce retrograde torque thereon to restore the associated cams to said starting positions responsive to release of the holding means for any shaft.

9. Stepping mechanism according to claim 8 in which said parameters of curvature are such that the curvature rises in one direction of cam movement, from said starting position toward said drop-off point, about 20° for each 10° of angular travel, and the curvature falls at the same rate in the reverse direction of travel.

10. In a cam type tens transfer mechanism for counting registers and indicators of the class in which a spring-loaded lever riding a cam is cocked by advancing rotation of said cam until the lever drops from a rise of the cam in advance of the latter for the purpose of actuating a stepping means to transfer a counting value to the next higher counting unit, improvements in the cam and resetting means therefor comprising, to wit: a tens transfer cam having a cam face characterized by a curvature such that the angle included between any tangent thereto and the radius vector to the point of tangency is a constant; said transfer means being further characterized in that a transfer lever rides said cam face and is spring loaded and cocked by advance of the cam, and acts to turn said cam in a retrograde direction opposite from the advance movement thereof in the absence of any restraining agency preventing such retrograde motion.

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