Feb. 10, 1970 A. SPÄTH 3,494,549

TRANSFER MECHANISM FOR DIGITAL COUNTER

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Fig. 1a

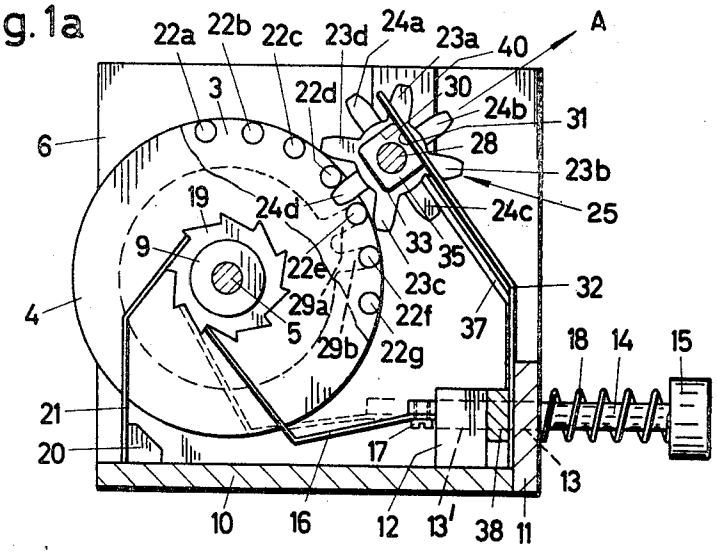
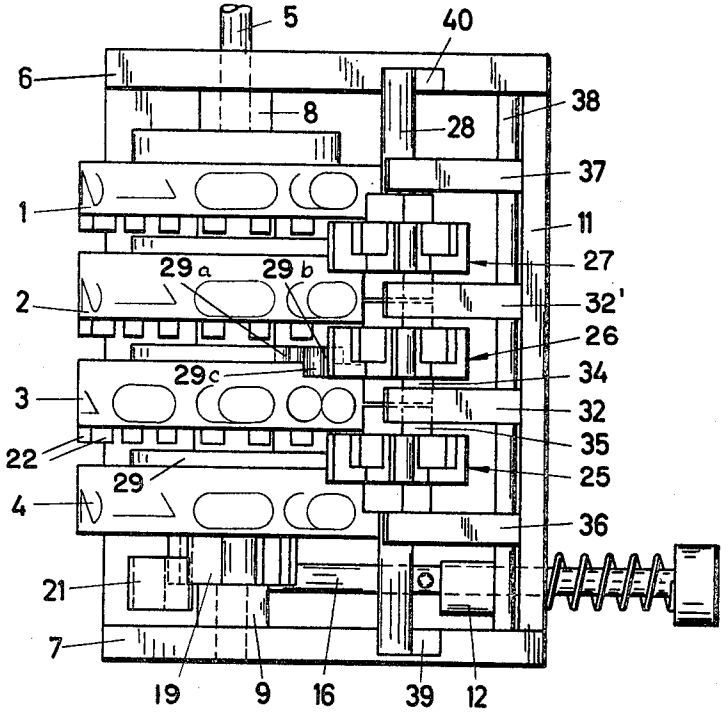



Fig. 1b

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TRANSFER MECHANISM FOR DIGITAL COUNTER

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Fig.1c

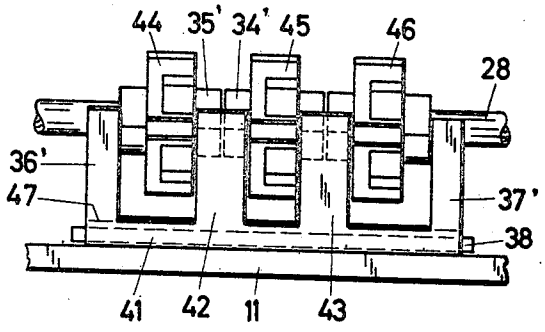


Fig. 2

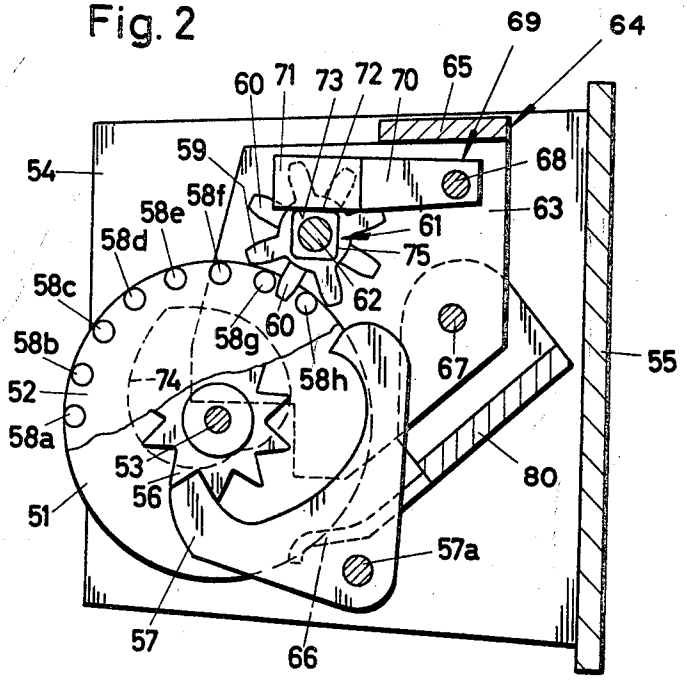


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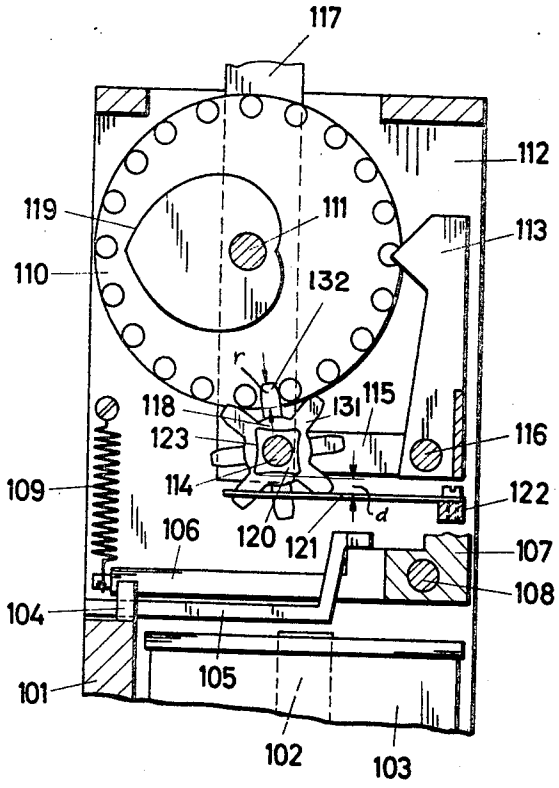
Fig. 3

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3,494,549

# TRANSFER MECHANISM FOR DIGITAL COUNTER

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U.S. Cl. 235—139
12 Claims

## ABSTRACT OF THE DISCLOSURE

Transfer pinions for the intermittent coupling of adjacent digit wheels of a digital counter, mounted on a common shaft parallel to the digit-wheel shaft and displaceable relatively thereto in a generally axial direction for disengaging the pinions from the digit wheels preparatorily to a resetting of the latter, have axially projecting polygonal hubs which during all or part of a disengagement stroke rest with one of their sides against a substantially flat surface of an indexing element extending at right angles to the direction of stroke; a single indexing element may be common to two adjoining transfer pinions by bearing simultaneously upon their aligned hubs.

The present invention relates to a digital counter wherein two or more digit wheels assigned to successive denominational orders (e.g. decades), carrying numerical designations or co-operating with respective indicator elements, are stepped by manual or automatic means acting upon the lowest-order digit wheel (e.g. units stage) which in turn, once per revolution, advances the digit wheel of the next-higher order (e.g. the tens stage), the latter in turn intermittently stepping the wheel of a further order (e.g. hundreds stage) and so on.

The invention relates more particularly to a transfer pinion associated with a pair of successive digit wheels having two interleaved sets of teeth engageable with transfer teeth on a lower-order digit wheel and with stepping teeth on a higher-order digit wheel, the teeth of one set being also adapted to straddle a peripheral surface of the lower-order digit wheel for preventing rotation of the transfer pinion in an engaged position. As disclosed, for example, in U.S. Patent No. 3,244,368, the two sets of teeth of such transfer pinion may be combined into full teeth and partial teeth following one another in alternate succession along the periphery of the pinion, only the full teeth being wide enough to engage the peripheral wheel surface while the partial teeth stands proud of that surface. Thus, with $n$ full teeth and $n$ partial teeth, the total number of pinion teeth is $2n$ where $n$ is an integer preferably equal to 4.

In such a counter it is customary to make the transfer pinion or pinions displaceable, in a generally radial direction, from the axis of the digit wheels in order to facilitate a resetting of these wheels, generally to zero. Upon such decoupling of the transfer pinion or pinions from the associated digit wheels, care should be taken to prevent their spontaneous rotation which could turn some of these pinions into a blocking position in which one of their teeth could interfere with the re-engagement of the digit wheels and the pinions. For this purpose it has already been proposed (see the aforementioned U.S. Patent No. 3,244,368) to provide a flat bar extending parallel to the digit-wheel axis across the row of transfer pinions so as to be engageable by confronting sides of square-profiled hubs of these pinions at the end of a decoupling stroke, the width of the hub being so large that the circumference



of the pinion teeth falls within the area of the square. According to another solution (see U.S. Patents No. 1,744,307), a smaller pinion hub of similar square outline slides during the decoupling stroke into lateral engagement with a generally radially extending indexing spring. In either of these cases, the hub of the transfer pinion engages the restraining element (bar or spring) only in a terminal phase of the decoupling stroke so that, unless the element is strongly biased toward the pinion axis, spontaneous rotation of the pinion into a return-blocking position may occur. Such a strong bias, however, would be rather impractical in the case of a radially oriented indexing spring because of the large frictional resistance which would then have to be overcome as the hub slides along the spring. In the case of a continuous indexing bar spanning a multiplicity of transfer pinions, the normal separation of this bar from the hub faces must be sufficient to prevent the hubs from becoming jammed between the digit wheels and the bar when rotating during a transfer operation; this requirement, in turn, involves a somewhat unwieldy construction of the mechanism.

The general object of this invention is to provide a transfer mechanism of the character set forth which avoids the aforestated disadvantages while preventing untimely rotation of the transfer pinion or pinions of a multi-position digital counter.

A more particular object is to provide simple means in such transfer mechanism for normally holding each transfer pinion in close contact with its associated digit wheel so as to insure an accurate indexing of these wheels in their last-selected digital positions with avoidance of ambiguous readings.

These objects are realized, in accordance with the present invention, by the provision of a transfer mechanism of the general character described wherein each transfer pinion or pair of adjacent transfer pinions is associated with an individual indexing element having a substantially flat contact surface substantially perpendicular to the generally radial direction of decoupling displacement, the contact surface being yieldably engaged by a parallel side of a hub of polygonal cross-section, projecting axially from each associated transfer pinion, at least during a terminal phase of the decoupling displacement for resisting rotation of the pinion or pinions prior to a separation of the straddling pinion teeth from the peripheral digit-wheel surface to extent sufficient to enable such rotation.

The polygonal (preferably square) hub profile need not be sharply defined but may have rounded corners to prevent abrupt camming of the transfer pinion by the overlying indexing element from one angular position into the next, particularly if the contact surface of this element permanently engages the sub of the pinion. The sides of the polygonal hub may also be concave rather than flat, this being especially desirable where the hub is not in permanent contact with the indexing element since it enables the latter to reorient the transfer pinion in a more effective manner upon engaging its hub. It is also desirable to make the hub and the body of the pinion, especially the teeth thereof, of different materials, the material of the teeth being preferably of reduced friction compared with that of the hub. Thus, known low-friction materials (e.g. Teflon) may be used for the teeth while the hub is made, for example, of polyamide; naturally, the pinion may also be made of metal.

In principle, the yieldable indexing element may be biased toward the pinion hub by a variety of forces, e.g. resiliency or gravity. Thus, the indexing element may be a spring tongue or, if the direction of the decoupling stroke is generally vertical, a weighted arm. If this indexing element is in permanent contact with the hub of

a transfer pinion or—according to an advantageous modification—with a pair of such pinions extending toward each other, no separate restoring means may be needed to maintatin the pinions in their engaged position as long as resetting is not required. A particularly compact assembly is obtained if the hub diagonal is smaller than the pitch diameter of the pinion teeth, with the indexing element disposed between two adjacent transfer pinions.

The invention will be described in greater detail with reference to the accompanying drawing in which:

FIG. 1*a* is a cross-sectional view of a digital counter with a transfer mechanism representing a first embodiment;

FIG. 1*b* is a top view of the assembly of FIG. 1*a*;

FIG. 1*c* is an elevational detail view of a modification of the arrangement of FIG. 1*b*;

FIG. 2 is a view similar to FIG. 1*a*, illustrating another embodiment; and

FIG. 3 is a further cross-sectional view similar to FIG. 1*a*, showing still another modification.

FIGS. 1*a* and 1*b* show a counter with four digit wheels **1** (thousands) **2** (hundreds) **3** (tens) and **4** (units). These wheels are mounted on a common shaft **5** on which they are independently rotatable and which is held in side walls **6**, **7** of a housing having also a bottom **10** and a rear wall **13** of reduced height. The wheels **1–4** bear the usual numerical markings, i.e. numerals "0" to "9," which may be viewed through a window of a housing cover not shown; it is assumed that this window extends along the top of the housing so that the wheel position illustrated in FIG. 1*b* gives the reading "0090." Spacer disks **8** and **9** are inserted between the wheel assembly **1–4** and the side walls **6**, **7**.

A mounting block **12** rising from the housing bottom **10** has a bore **13'** aligned with a bore **13** in rear wall **11**, the two bores being traversed by the stem **14** of an actuating knob **15** which is biased outwardly by a coil spring **18**; stem **14** also passes through a mounting bar **38** serving to clamp a set of springs **32**, **32'**, **36** and **37** between itself and the wall **11** onto which the bar is held by screws not shown.

The lowest-order digit wheel **4** is integral with a ten-teeth ratchet **19** adapted to be rotated, one tooth at a time, by a stepping pawl **16** in the form of a bent leaf spring which is fastened to the inner end of stem **14** by a screw **17**. A retaining pawl **21** mounted on a block **20** prevents reverse rotation of the ratchet.

Each of the lower-order digit wheels **2**, **3**, **4** has a peripheral shoulder **29** carrying a pair of transfer teeth **29***a*, **29***b* separated by a gap **29***c* (visible for the wheel **3** in FIG. 1*b*), the gap **29***c* also extending into the adjoining peripheral wheel surface bearing the numerical markings "0" through "9." Three transfer pinions **25**, **26** and **27**, respectively assigned to the wheel pairs **3/4**, **2/3** and **1/2**, are mounted on a common shaft **28** for independent rotation, the extremities of the shaft projecting beyond the first pinion **25** and the last pinion **27** into recesses **39**, **40** of housing walls **7** and **6** in which they are guided with freedom of generally radial displacement with reference to a digit-wheel shaft **5** as indicated by an arrow A in FIG. 1*a*. Such displacement is resisted by the springs **36** and **37** bearing upon these extremities of shaft **28**.

As specifically illustrated for the pinion **25** in FIG. 1*a*, each of the three pinions **25–27** comprises two interleaved sets of teeth, i.e. a set of full teeth **23***a*, **23***b*, **23***c*, **23***d* and a set of partial teeth **24***a*, **24***b*, **24***c* and **24***d*. The teeth of both sets are arranged to mesh with the transfer teeth **29***a*, **29***b* of the associated lower-order digit wheel as well as with an array of pegs **22** on the associated higher-order digit wheel, these pegs representing a set of stepping teeth (20 in all) of which seven are shown in FIG 1*a* at **22***a*, **22***b*, **22***c*, **22***d*, **22***e*, **22***f* and **22***g*. The full teeth **23***a* etc. are wide enough to straddle the outer peripheral surface of the associated lower-order wheel, specifically the digit wheel **4** in the case of pinion **25** as illustrated for the teeth **23***c*, **23***d* thereof in FIG. 1*a*; the partial teeth **24***a* etc. are of reduced width so as to clear this peripheral surface as illustrated for the tooth **24***d*.

Pinion **25** has a hub **35** of square cross-section whose diagonal is less than the pitch diameter of the teeth **23***a*–**23***d*, **24***a*–**24***d*, being substantially equal to the root diameter of these teeth in this and subsequent embodiments. In the normal position of this pinion, in which two of its full teeth (**23***c*, **23***d*) straddle the periphery of digit wheel **4** and the intervening partial tooth (**24**[d]) projects radially past that periphery, one of the side faces **30** of hub **35** lies flat against a confronting surface **31** of spring **32**, both these surfaces lying at right angles to the decoupling direction (arrow A) represented by a line interconnecting the centers of shafts **5** and **28**. Hub **35** of pinion **25** extends axially toward the hub **34** of pinion **26**, both these hubs being bridged by that part of indexing spring **34** which extends perpendicularly to the radial direction A. In similar manner, the spring **32'** bridges the hubs of pinions **26** and **27**. End springs **36** and **37** have active portions parallel to those of indexing springs **32**, **32'** and may be somewhat stronger than the latter.

In the normal operation of the system shown in FIGS. 1*a* and 1*b*, units wheel **4** is manually stepped in a clockwise direction (as seen in FIG. 1*a*) by repeated actuation of knob **15** to increase the value of the registered count. In the illustrated zero position of this wheel, its transfer teeth **29***a*, **29***b* lie just downstream of pinion tooth **24***d* in registry with teeth **22***e* and **22***f* of tens wheel **3**, tooth **24***d* being flanked by the teeth **22***d*, **22***e* of the latter wheel. When, after nine actuations of knob **15**, tooth **29***b* comes to rest in front of tooth **24***d*, wheel **4** occupies the position illustrated for wheel **3** to register the value "9." The next actuation of knob **15** causes the teeth **29***a*, **29***b* of wheel **4** to entrain the teeth **24***d*, **23***d* of pinion **25**, the last-mentioned teeth being received in the gap **29***c* between the two transfer teeth. Pinion **25**, in rotating through an angle of 90°, imparts a rotation of 36% (in step with wheel **4**) to digit wheel **3** to advance the latter to its next angular position which happens to be "0"; thus, transfer teeth **29***a*, **29***b* of wheel **3** also entrain the pinion **26** with a resultant stepping of hundreds wheel **2** into its No. 1 position. The continuous pressure of springs **32**, **32'** upon the hubs of pinions **25**, **26** maintains these pinions in their new angular positions and contributes to the smooth operation of the mechanism.

To facilitate resetting, each of the higher-order digit wheels **1–3** may be provided with a pawl or rack (not shown) engageable with its stepping teeth **22**, whereby the wheel is rotated clockwise (FIG. 1*a*) into its zero position, the teeth **22** camming the inwardly projecting pinion tooth (e.g. **24***d*) outwardly to impart fractional counterclockwise rotation to the transfer pinion while a full tooth thereof (such as **23***d*) bears upon the periphery of the adjacent lower-order wheel; after the higher-order wheel has been reset, spring **32** or **32'** cleanly returns the pinion to its illustrated engaged position, the tooth **24***d* re-entering a gap between two teeth **22**. If the lower-order wheel is already in its zero position, its slight displacement by interaction of teeth **24***c* and **29***a* will be rectified upon such re-engagement by the tooth **23***c* co-operating with tooth **29***a*.

The corners **22** of polygonal hub **35** are shown to be slightly rounded to reduce the effort of rotataing this hub past the spring surface **31** during a transfer operation.

With the four-stage counter shown in FIG. 1*b*, two indexing springs **32** and **32'** are needed for the three transfer pinions **25–27**, pinion **26** being controlled by both indexing springs. If the number of transfer pinions is even (and, therefore, the number of digit wheels is odd), only one indexing spring will be needed for every two transfer pinions.

In FIG. 1*c* there has been shown a modified spring assembly wherein elements **42**, **43**, **36'** and **37'**, corresponding to springs **32**, **32'**, **36** and **37** of the preceding embodiment, are integrally interconnected, resilient tongues forming part of a yoke **41** clamped between bar **38** and wall **11**. Tongues **42** and **43**, bridging again respective hub pairs such as hubs **34'** and **35'**, are of sufficient width to maintain the necessary spacing between the associated transfer pinions **44**, **45**, **46** on shaft **28** without the need for additional spacing means. The outer tongues **36'** and **37'** are bent toward the axis of shaft **28**, as indicated at **47**, at a sharper angle than the tongues **42**, **43** so as to bear upon this shaft for the purpose and in the manner described with reference to FIGS. 1*a* and 1*b*.

FIG. 2 shows a generally similar digital counter wherein, however, the manual actuator **14–19** of the preceding embodiment has been replaced by an automatic drive for the units wheel **51** of a set of such wheels of which only the tens wheel **52** is visible; this automatic drive includes a ratchet **56** rigid with the wheel **51** and a double pawl, comparable to the escapement of a timepiece, which may be intermittently or continuously operated (e.g. by an electromagnetic control as illustrated in FIG. 3) to bring about a step-by-step advance of wheel **51** in response to a clockwise driving torque applied, for example, through a wound spring or a slipping clutch to the wheel shaft **53**. The housing of the counter, of which only a side wall **54** and a back wall **55** are visible, supports a yoke **64** with lateral arms **63** (only one shown) and a bridge **65**, this yoke being swingably mounted on a fixed rod **37** which also serves as a fulcrum for a similar yoke **80** carrying a set of resetting prongs **66**. Yoke **64** supports a shaft **62** on which a set of transfer pinions **61** (only one shown) with full and partial teeth **59** and **60** are independently rotatable; these teeth coact with peripheral teeth **58***a*–**58***h* of wheel **52** and with transfer teeth (not shown) of wheel **51**.

The hub **75** of pinion **61** has its upper horizontal side **73** overlain by a substantially flat surface **72** of an indexing element **69** which comprises an arm **70** with a weighted extremity **71** forming the surface **72**; the arm is swingably mounted, along with other such arms associated with further transfer pinions, on a rod **68** spanning the yoke **64**.

For zero-setting purposes, each of the digit wheels **51**, **52** etc. is reset by means of a respective heart cam **74** coacting with one of the prongs **66** when the yoke **64** is swung clockwise about its pivot **67** to decouple each of the pinions **61** from the teeth of the associated digit wheels; yoke **80** may then be swung in the same sense, manually or by other means, to arrest the liberated digit wheels in their starting positions in which the bent extremities of prongs **66** fall into the recesses of the corresponding heart cams **64** as is well known per se (see, for example, U.S. Patent No. 3,248,051).

In this embodiment, as in the preceding ones, the indexing element again is in permanent contact with the hub of the associated transfer pinion.

FIG. 3 shows part of a modified counter with digit wheels **110** (only one shown) on a shaft **111**, a housing **112** supporting this shaft, and a resetting lever **113** cooperating with a heart cam **119** substantially in the manner described with reference to elements **66** and **74** of FIG. 2, lever **113** being swingable about a rod **116** parallel to shaft **111**. An extension **115** of lever **113** supports a shaft **114** carrying a set of transfer pinions **118** (only one shown) with hubs **120** which, while also being of basically square cross-section, differ from the hubs of the previous embodiments by having slightly concave sides **123**. An indexing element individual to each hub, or to a pair of confronting hubs as previously described, is shown as a flat leaf spring **121** supported on a fixed bar **122**.

A control lever **117**, linked with extension **115**, can be moved downwardly to swing the assembly **113**, **114**, **115** counterclockwise about its pivot **116**, thereby decoupling the transfer pinion **118** from the associated digit wheel **110** and bringing the point of lever **113** into co-operating relationship with heart cam **119**. During this decoupling movement the hub **120** approaches the spring **121** so that one of its sides **123** comes to rest against this spring before the full teeth **131** of pinion **118** have cleared the periphery of the associated lower-order digit wheel to an extent sufficient to let this pinion rotate freely, i.e. after the pinion has swung downwardly by a distance *d* less than the extent of radial overlap *r* between the partial tooth **132** and the digit wheel.



FIG. 3 also shows an electromagnet **103** with a pole shoe **101**, a core **102**, and an armature **105** supported by a lug **104**, the armature **105** engaging a lever **106** integral with a member **107** which may be linked with the escapement **57** of FIG. 2 or otherwise form part of a stepping drive for the counter. Lever **106** is swingable about a pivot pin **108** and is normally held withdrawn by a tension spring **109**.

The invention is applicable to all kinds of digital counters, including those specifically illustrated and others with manual or automatic drive, designed to measure a succession of operated cycles of reciprocating or rotating elements.

I claim:

**1.** In a digital counter having a plurality of coaxially juxtaposed digit wheels of progressively higher denominational orders, including at least one lower-order wheel provided with transfer teeth adjoining a peripheral surface and at least one higher-order wheel provided with a peripheral array of stepping teeth, said counter further having at least one transfer pinion associated with said lower-order and higher-order wheels and provided with two interleaved sets of teeth engageable with said stepping teeth and with said transfer teeth, the teeth of one set being arranged to straddle said peripheral surface for preventing rotation of said transfer pinion in an engaged position, the combination therewith of mechanism for decoupling said transfer pinion from said digit wheels by displacement in a generally radial direction from the axis of the latter, and at least one yieldable indexing element biased toward said axis and provided with a substantially flat contact surface substantially perpendicular to said direction of displacement, each transfer pinion being provided with an axially projecting hub of polygonal cross-section having a side parallel to said contact surface of an associated indexing element in engagement therewith at least during a terminal phase of said displacement for resisting rotation of said transfer pinion prior to a separation of said one set of teeth thereof from said peripheral surface to an extent enabling such rotation.

**2.** The combination defined in claim **1** wherein the corners of said polygonal cross-section are rounded.

**3.** The combination defined in claim **1** wherein the sides of said polygonal cross-section are concave.

**4.** The combination defined in claim **1** wherein the number of said digit wheels is greater than two and the number of transfer pinions is greater than one, the diagonal of said polygonal cross-section being smaller than the pitch diameter of the teeth of said transfer pinions, said indexing element being disposed between two adjacent transfer pinions.

**5.** The combination defined in claim **4** wherein said indexing element is wide enough to keep said adjacent transfer pinions axially spaced apart.

**6.** The combination defined in claim **4** wherein the hubs of said adjacent transfer pinions are extended toward each other, said indexing element bridging coplanar sides of both said hubs.

**7.** The combination defined in claim **4** wherein the number of indexing elements is greater than one, said indexing elements being integrally interconnected resilient tongues.

**8.** The combination defined in claim **4** wherein said transfer pinions are provided with a common shaft hav-

ing extremities guided for lateral displacement in said generally radial direction and projecting beyond the first and last transfer pinions, further comprising a spring yoke with a pair of arms bearing upon said extremities for resisting said lateral displacement, said indexing element being a resilient tongue integral with said yoke.

**9.** The combination defined in claim **1** wherein said indexing element is in permanent contact with said hub.

**10.** The combination defined in claim **1** wherein said generally radial direction is substantially vertical, said indexing element comprising a swingable arm with a weighted end bearing upon said hub.

**11.** The combination defined in claim **1**, further comprising a frame swingable about a line parallel to said axis and normally inoperative zero-setting means on said frame, said transfer pinion being mounted on said frame for displacement away from said axis in said generally radial direction and against the force of said indexing



element upon movement of said zero-setting means into an operative position.

**12.** The combination defined in claim **1** wherein said sets of teeth of said transfer pinion consist of a material of reduced friction with reference to the material of said hub.

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U.S. Cl. X.R.

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