Jan. 23, 1951 J. I. BELLAMY 2,538,819

PLURAL ARMATURE ELECTROMAGNETIC COUNTING DEVICE

Filed Sept. 7, 1948

FIG. 1

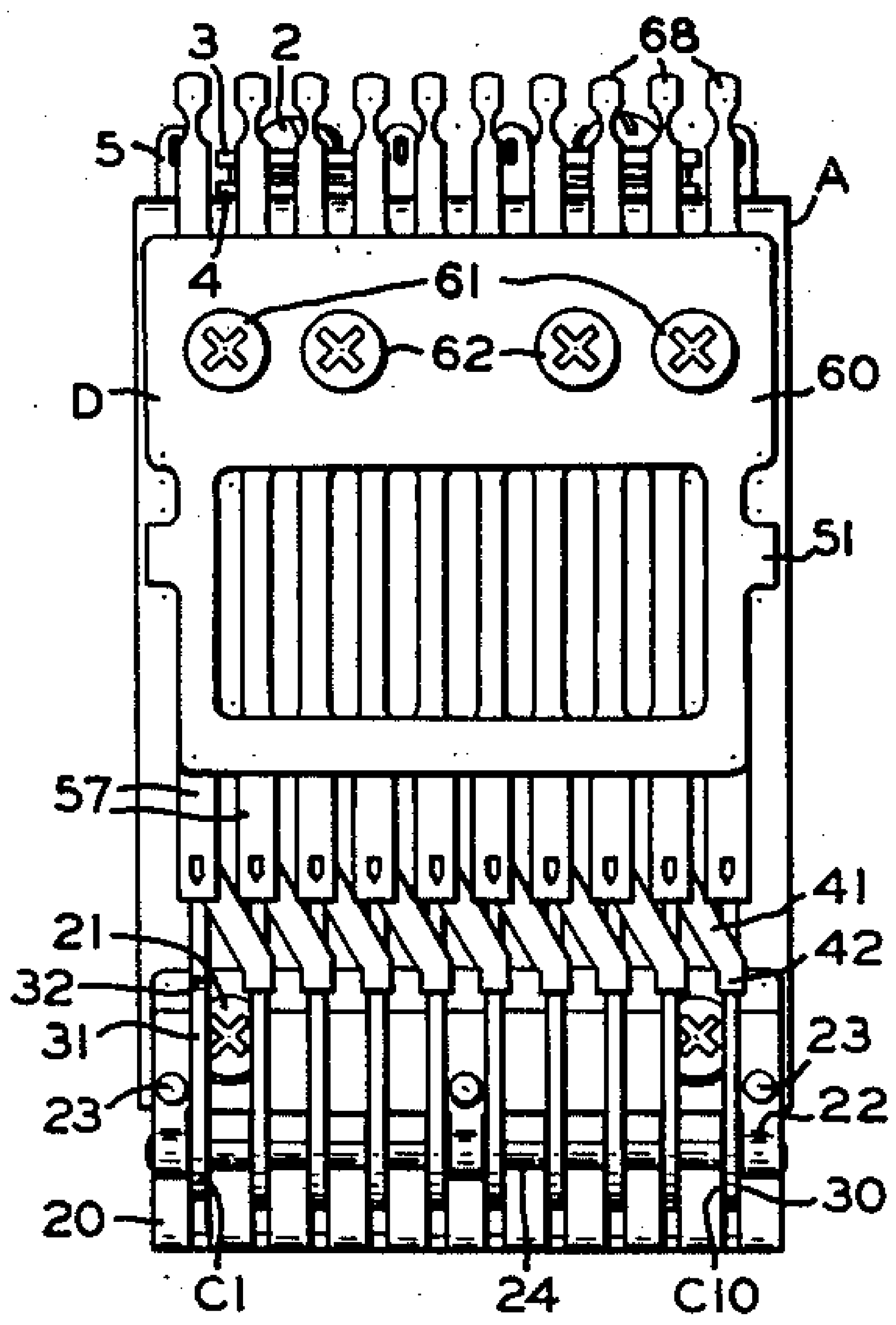


FIG. 4

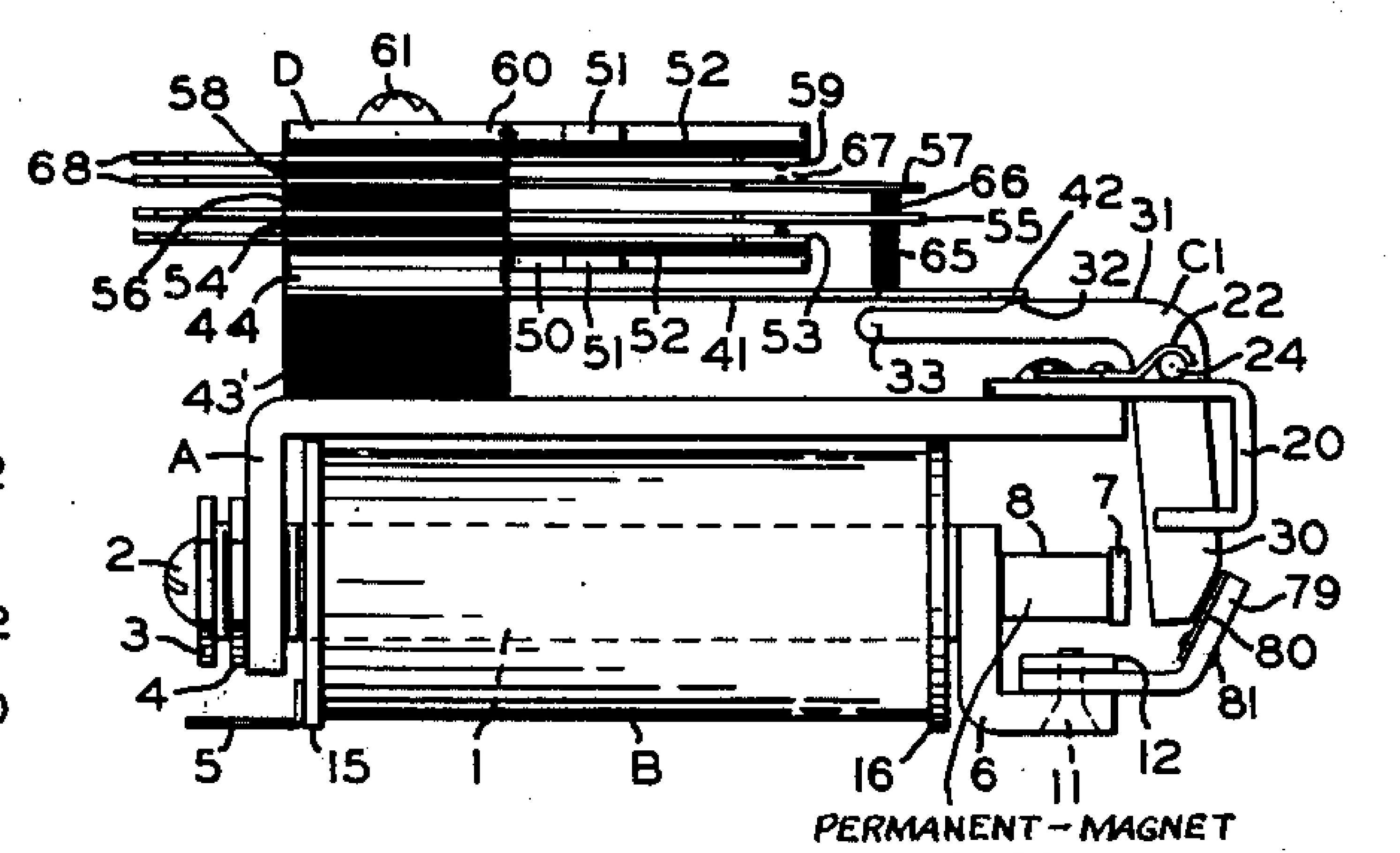


FIG. 2

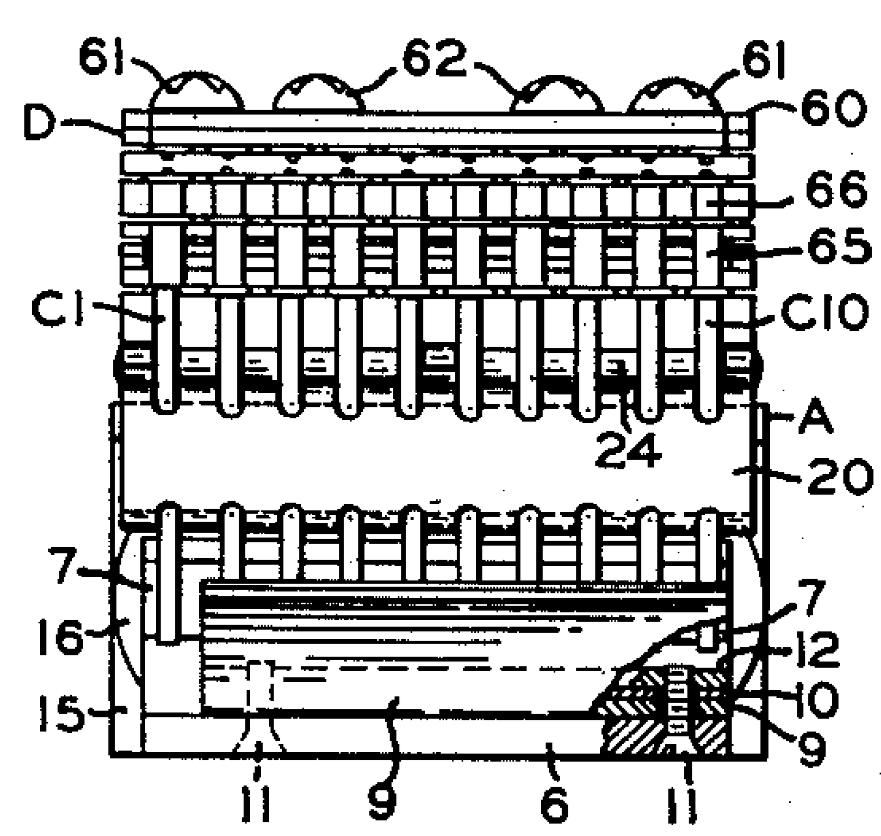


FIG. 5

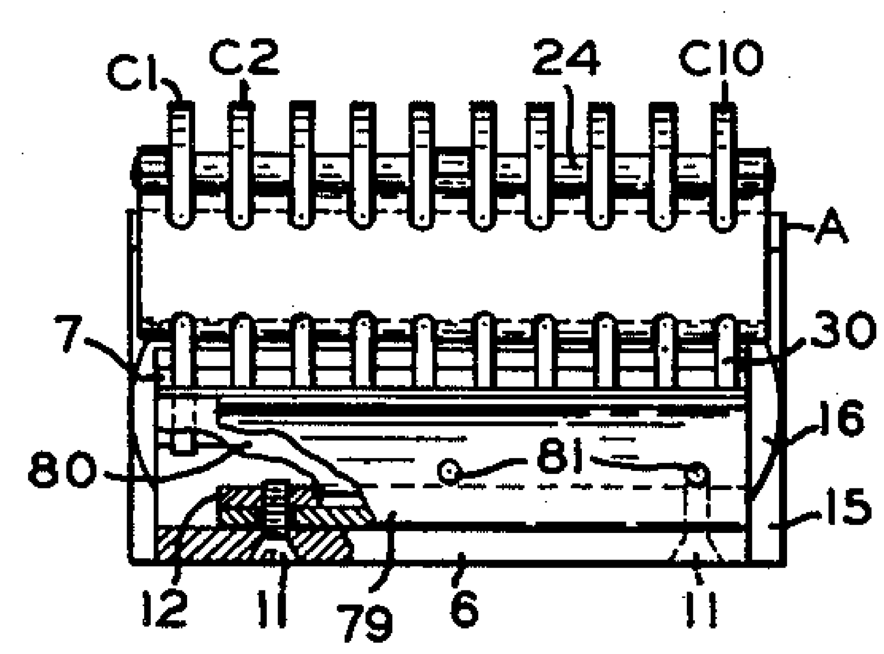
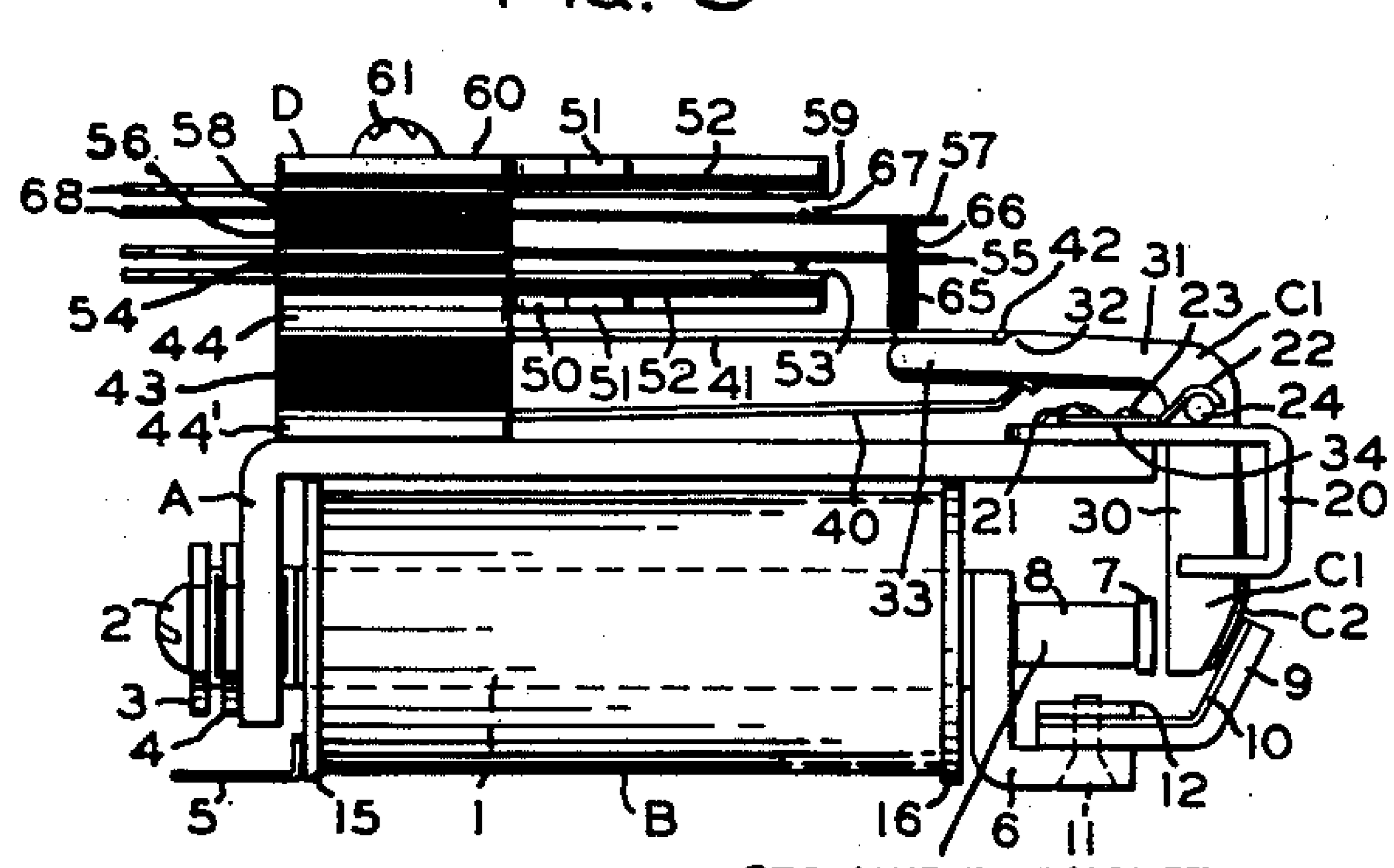


FIG. 3



INVENTOR:
JOHN I. BELLAMY

BY C. P. Sofer

ATTORNEY

Patented Jan. 23, 1951

2,538,819

UNITED STATES PATENT OFFICE

2,538,819

PLURAL ARMATURE ELECTROMAGNETIC COUNTING DEVICE

John I. Bellamy, Wheaton, Ill., assignor to Kellogg Switchboard and Supply Company, Chicago, Ill., a corporation of Illinois

Application September 7, 1948, Serial No. 48,008

4 Claims. (Cl. 175—337)

1

This invention relates to an electromagnetic counting device. Its main object is to provide an improved electromagnetic counting device which will respond reliably over a wide range of impulse conditions encountered in the signalling art. These conditions, for a given frequency, range from extremely short impulses separated by relatively long inter-impulse intervals to relatively long impulses separated by extremely short inter-impulse intervals.

It has been chosen to illustrate the invention as embodied in structure constituting a direct improvement on the structure illustrated in the application of Bellamy and Arthur, Serial No. 43,136, filed August 7, 1948. In such a structure, the armatures of a series are operated successively in a progressive impulse-counting operation which requires a two-step movement of any armature succeeding the first, comprising a preparatory movement responsive to the cessation of the immediately preceding impulse, and an effective counting movement responsive tô its pertaining impulse. Moreover, as a matter of economy, convenience, and compactness of construction, a portion of the magnetic circuit includes material of sufficient magnetic hardness that the operated armatures are held against their respective loads by residual magnetism effective during any inter-impulse interval and following the final impulse of the series to be counted. A practical difficulty encountered when an attempt is made to adjust the device of the cited application for proper operation is that the residual magnetic effect employed to hold the operated armatures acts to retard unduly the advance of unoperated armatures through their first step, thereby considerably reducing the range of impulse conditions over which the device will respond reliably.

The main object may now be restated as being to provide a satisfactory arrangement for residually holding the operated armatures which does not tend to hold an unoperated armature in initial position against first-step advance in its turn, whereby the effective range of the device is extended. The tractive pole of the electromagnet (as distinct from the return pole) is provided with two branches which extend therefrom into operative association respectively with opposite sides of the armatures. These pole branches are differentiated in essential character according to their respective functions. One pole branch provides a tractive pole for operating and holding the armatures, and accordingly is arranged to retain sufficient magnetism between and following impulses to hold the armatures which have been

2

actuated. The other pole branch provides a pole for restraining the armatures against premature out-of-turn operation. This branch is composed entirely of soft magnetic material, as are all parts in the main portion of the magnetic circuit, to the end that the residual magnetic effect is excluded entirely from the restraining branch of the magnetic circuit.

It has been chosen to illustrate the invention in the form in which the holding magnetic effect is imparted to the tractive branch of the path by permanent magnet material serially related therein, rather than by employing a holding electromagnet serially related in the tractive branch. The permanent-magnet material becomes magnetized on the receipt by the electromagnet of the first impulse of a series, and remains magnetized thereafter until a reversed, de-magnetizing impulse is delivered to the electromagnet to effect restoration of the operated armatures.

Two embodiments are disclosed which differ primarily with respect to the specific arrangement employed for advancing the armatures to intermediate position at the end of respective preceding impulses.

Of the drawings, Figs. 1 to 3 show the construction of the first embodiment, and Figs. 4 and 5 show the construction of the second embodiment.

Figs. 1 to 3 are respectively a plan view, a front view, partly in section, and a left-side view of the first embodiment.

Figs. 4 and 5 show respectively a side view and a partially sectioned front view of the second embodiment.

DETAILED DESCRIPTION

A. *General arrangement*

In the first embodiment, shown in Figs. 1 to 3, angle bar A serves as a support and as a magnetic return member for the improved electromagnetic counting device.

The counter includes two parallel electromagnets B joined at their front pole ends by an angular distributing bar 6 which is interposed between such pole ends and a rectangular magnetically hard hold bar 8 secured to its front surface, a tractive pole 7 secured to the front surface of hold bar 8, and angular restraining pole 9 forming an adjustable extension of distributing bar 6 disposed in back of the armatures succeeding the first, ten successively operable armatures C1 to C10, with each succeeding the first controllably disposed between poles 7 and 9, a switch bank D including ten similar stackups of contact members actuatable by the respective armatures, and bar A supporting these parts.

Each of the electromagnets B includes a cylindrical core 1 of magnetically soft material, a rear spoolhead 15, a front spoolhead 16, with the windings of the electromagnet disposed between the spoolheads. Each of the rear spoolheads is provided with winding terminals 5, one of which is shown in Fig. 3.

Each electromagnet B is adjustably secured at the rear to bar A by a screw 2 passing through a clearance opening in an associated adjusting collar 3 which is threaded through bar A to abut its respective core 1. Both collars 3 may be advanced or retarded to longitudinally position their respective cores 1, in cooperation with screws 2, to align the face of the tractive pole 7, effectively secured thereto as by welding, in the plane of the front face of bar A. A locknut 4 is provided for each collar 3 to retain it in an adjusted position.

As heretofore described, the tractive poles of the electromagnets B (as distinguished from the return poles secured to bar A) are provided with an operating and holding pole branch and a restraining pole branch extending therefrom into respective operative association with opposite sides of the tractive arms 30 of the armatures. All parts of each branch are composed of magnetically soft material, with the exception of the non-magnetic inner sheathing portion 10 of the restraining pole 9, and the hold bar 8 included in the operating and holding branch which is composed of magnetically hard material to provide a desired residual magnetic effect for such branch to retain operated armatures in such position between magnetizing impulse intervals. The structure of each of such branches will now be described.

B. *The tractive pole branch*

The tractive pole branch includes a tractive pole 7, a magnetically hard rectangular hold bar 8 and the portion of the distributing bar 6 intervening between bar 8 and the front cores of electromagnets B, all suitably secured together.

The tractive pole 7 is secured to the front surface of hold bar 8 and, as shown in Fig. 2, extends across the structure in operative relationship with a lower portion of the inner surface of the tractive arms 30 of armatures C1 to C10. The vertical dimension of the tractive pole 7 is such as to provide a normal operating air gap therebetween and any armature of a cross sectional area substantially equal to the cross sectional area of any such armature. The tractive pole 7 provides an operating and holding pole face for the armatures C1 to C10 and, by virtue of the magnetically soft material of which it is composed, causes the flux distributed by the distributing bar 6 to the magnetically hard hold bar 8 to traverse the whole of such bar 8 rather than missing the parts between the armatures.

The rectangular magnetically hard hold bar 8 is secured to the front surface of distributing bar 6 which, as stated, is secured to the front pole ends of electromagnets B. Bar 8 extends across the structure for a similar distance to that of tractive pole 7 and is of a vertical dimension which for the material employed provides flux density of an operating and magnetizing value sufficient to operate and subsequently hold the armatures. The hold bar 8 becomes substantially evenly magnetized through distributing bar 6 upon receipt of the first impulse of a series, which operates the first armature, and by virtue of the permanent magnetic material of which it is composed retains sufficient residual magnetism thereafter to promptly advance each armature in turn in cooperation with its lifting spring 40, subject to the release of its mechanical restraining force, upon the termination of the instant impulse and the consequent ending of the magnetic restraining force, to its intermediate first-step position and to hold the armatures which have been operated until a reversed demagnetizing impulse is delivered to the electromagnets to effect restoration of the operated armatures.

The distributing bar 6 being of magnetically soft material serves to effectively distribute the magnetic flux of the tractive poles of the electromagnets B to all portions of the hold bar 8.

C. *The restraining pole branch*

The restraining pole branch represents an important feature of the invention for it effectively provides the reliable response of the device over a wide range of impulse conditions previously noted as the main object of the invention. Such response is attained by including only magnetically soft material in the restraining pole branch of the device, whereby the restraining force thereof ends entirely upon the termination of any impulse operating its corresponding armature to thereby permit the next succeeding armature to be promptly advanced to its intermediate first-step position by the previously described residual magnetism retained in the magnetically hard hold bar 8 of the tractive branch acting in cooperation with the associated lifting spring 40.

The restraining pole branch has no influence on the first armature which insures its reliable operation in response to the first impulse even in view of the slight time lag experienced before the first impulse can build up the magnetic field to operate value, starting from zero as it does because of the preceding demagnetizing action to clear out the armatures previously operated.

The angular restraining pole 9 is an adjustable extension of the distributing bar 6 and is of a length and disposition as to lie in back of armatures C2 to C10 only. Restraining pole 9 is adjustably secured to the lower flange of bar 6 by means of two screws 11 countersunk in bar 6 and passing through slotted portions in the lower flange of restraining pole 9 and threaded into non-magnetic retaining member 12. The restraining pole 9 provides an adjustable back-stop determining the normal position of armatures C2 to C10 and serves to magnetically retain any such normally positioned armatures during the interval of a received impulse. Restraining pole 9 is provided with a thin inner sheathing portion 10 of suitable non-magnetic material to avoid direct magnetic contact with any associated normally positioned armature.

The cross sectional area of the portion of the restraining pole 9 overlapping the biased outer edge portions of armatures C2 to C10 is less than the cross sectional area presented to the inner edge portions of the armatures by the tractive pole 7, which is desirable in view of the lower reluctance of the restraining pole branch.

D. *The armatures*

The ten armatures are referred to individually as armatures C1 to C10. They are punched-pressed from sheet material of the desired thickness and are of the illustrated bell-crank form.

The armatures are edge-operated and, with the exception of the single-step first armature, require two operational steps for movement to operated position from normal position.

Each armature C1 to C10 contains a pivot-pin opening through which common pivot pin 24 passes to pivotally support each armature in its respective slotted guide portion in the armature-support member 20. Member 20 is stamped and pre-formed of suitable non-magnetic material to the illustrated form and is secured to the forward upper surface of bar A by means of two screws 21 passing through enlarged openings therein and threaded into bar A. The enlarged openings in member 20 through which retaining screws 21 pass, permit a horizontal positioning of the member to provide that the operated armatures assembled therewith simultaneously strike the front face of bar A and tractive pole 7. Member 20 is provided with a pivot-pin-retention plate 34 which is secured to the upper surface of member 20 by means of three rivets 23. The retention plate 34 includes three semi-circular pivot-pin-retention arms 22 which retain the common pivot pin 24 in its vertical position with the intermediate retention arm 22 engaging a depressed portion in pin 24 to prevent its horizontal movement.

Each armature C1 to C10 includes a tractive arm 31 disposed in operative relationship with tractive pole 7, with a biased back portion of each armature C2 to C10 in a restraining tractive relationship with restraining pole 9. Each armature C1 to C10 further includes an actuating arm 31 for lifting its respective related actuating studs 65 and 66 to operate its associated upper and lower contact sets upon the operative engagement of its tractive arm 30 with tractive pole 7 upon the pertaining impulse energizing electromagnets B.

Each actuating arm 31 includes a portion 32 adjacent to the fulcrum of the armature which is raised with respect to the remaining portion 33. The raised portion 32 of each armature C2 to C10 is normally engaged by the offset tip 42 of the flat restoring spring 41 whose straight portion partially overlies the depressed portion 33 of the preceding armature with a gap therebetween. The height differential between actuating arm portions 32 and 33 permits a flat restoring spring 41 to determine the intermediate first-step position of advance of one armature (closing of gap between portion 33 and straight portion of the spring) while holding the next succeeding armature (by the engagement of the offset tip 42 and raised actuating arm portion 32) in a normally retracted position determined by the adjusted position of restraining pole 9 effecting the tractive arm 30.

The first armature C1, not being influenced by the offset tip 42 of a preceding restoring spring 41, is normally positioned as shown in Fig. 3 by the lifting action of its underlying lifting spring 40. Each of the armatures C2 to C10 is normally retracted by the associated offset restoring spring tip 42 to the position shown for armature C2 in Fig. 3.

E. *The armature-control spring assembly*

The armature-control spring assembly includes an upper row of nine flat downwardly tensioned laterally offset restoring springs 41 separated by spacing member 43 from a lower row of ten upwardly tensioned lifting springs 40 clamped between a pair of similar upper and lower clamp plates 44 and 44', with the assembly and the overlying contact bank assembly D being secured to bar A by two screws 61 passing through the assembly and threaded into the bar.

Each of the nine flat restoring springs 41 is similar and has a straight intermediate portion and a laterally offset tip portion 42. The straight portions of the springs overlie the depressed portions 33 of the actuating arms 31 of the respective armatures C1 to C9 to determine the forward limit of their intermediate first step position, such limit being determined for the tenth armature by its associated contact spring load. The offset tip portions 42 of springs 41 normally engage the raised portions 32 of the actuating arms 31 of their respective armatures C2 to C10 to retain such armatures in their normally retracted position, the backward limits of which are adjustably determined by restraining pole 9, during inter-impulse intervals when the magnetic restraining force of the restraining pole 9 ends and to restore the operated ones of such armatures to their normal position upon the subsequent demagnetization of the device at the conclusion of its operation. The first armature C1 has no tip portion 42 restraining its action and consequently it is normally advanced by its underlying lifting spring 40 to the position shown in Fig. 3 for operation in response to the first impulse. The disposition of springs 41 is such that the completed operation of any armature C1 to C9 raises the overlying straight portion of spring 41 sufficiently to entirely remove the offset tip 42 thereof from the operating path of the next succeeding armature.

The ten lifting springs 40 respectively engage the lower edge of the actuating arms 31 of the armatures C1 to C10 and each is effective to promptly advance its associated armature in turn to its intermediate first-step position subject to the removal therefrom of the mechanical restoring force of respective restoring spring tip 42 (with the exception of the first armature C1 normally so advanced) upon the termination of the instant impulse effectively ending the restraining force of the restraining pole 9. The lifting action of springs 40 associated with armatures C2 to C10 is aided by the noted "residual" magnetic force of the operating and holding branch of the magnetic circuit.

F. *The contact bank*

The contact bank D includes a row of ten similar normally open front contact sets overlying a corresponding row of ten similar normally closed back contact sets with suitable insulating members between the parts, all clamped together between similar upper and lower plates 60 and 50 by two screws 62 passing through the upper plate, the intervening parts and threaded into the lower plate. Two screws 61 pass through the assembly and the underlying armature-control assembly and are threaded into bar A to secure both assemblies in position.

Each front contact set includes a fixed upper contact blade 59 tensioned against and adjustably fixed in position by the front bar of back-stop plate 60 and insulated therefrom by insulating member 52, and a lower relatively long and flexible downwardly tensioned traveling contact blade 57 insulated from its fixed blade 59 by insulating member 58. Each back contact set is insulated and properly separated from the overlying front contact set by insulating member 56 and includes an upper relatively long and flexible downwardly tensioned traveling contact blade 55 and a lower fixed contact blade 53 insulated therefrom by insulating member 54 and downwardly tensioned against and adjustably fixed in position by the front bar of the lower back-stop plate 50 with an insulating member 52 therebetween. Contact members 67 are affixed to each of the traveling blades 55 and 57 for cooperating with corresponding contact members affixed to their respective fixed blades 53 and 59 of the contact sets.

The overlying traveling blades 57 and 55 extend forwardly from the contact bank proper to overly their respective armature actuating arms 31. Blades 57 and 55 are provided respectively with downwardly extending actuating studs 66 and 65 located at a similar point adjacent to their forward ends and so related that the raising of a lower stud 65 by the underlying restoring spring 41 incident to the operation of the associated armature raises the corresponding overlying stud 66 whereby the positions of the normally-closed contact set associated with stud 65 and the normally-open contact set associated with stud 66 are alternated.

Each back-stop plate 60 and 50 is provided with two laterally extending side portions 51, one on either side of each plate, which may be manipulated by means of a suitable forked tool to raise or lower the front bar of the plate to provide a readily accessible adjustment means for vertically positioning the fixed contact blades 59 and 53 respectively tensioned thereagainst to provide sufficient contact pressure between the operated blades 57 and 59 and between the normally closed blades 53 and 55 of the respective contact sets.

G. *The counting operation*

It will be noted that electromagnets B are connected magnetically in parallel between return bar A and distributing bar 6. The windings of these two magnets are intended to be so interconnected (in series for example) that the arrival of an impulse to be counted results in the energization of both electromagnets B in the same sense whereby they both present the same polarity of magnetomotive force to the front magnetic structure.

G1. *First impulse begins*

On the receipt by the windings of electromagnets B of the first magnetizing impulse of a series, each armature C1 to C10 is subjected to an operating force and each armature C2 to C10 to a restraining force. The operating force is the combined attraction exerted by pole 7 and the front face of bar A on the tractive arm 30 of any armatures C1 to C10 across the operating gap and the return gap between such parts. The restraining force is the backward force exerted between armature portions 30 of armatures C2 to C10 and restraining pole 9.

With armatures C2 to C10 in normal fully retracted position, the restraining force for each exceeds the operating force, wherefore each such armature C2 to C10 remains in normal position during the first impulse. Armature C1, however, being normally nearer to tractive pole 7 than to restraining pole 9, receives a stronger operating force. Additionally, it receives a weaker restraining force due to its normally advanced position, because (1) the normal return gap (between its part 30 and the front edge of part A) is less and (2) it is further from restraining pole 9. Accordingly, armature C1 operates promptly in response to the first impulse, engaging pole 7 and the front face of bar A.

When armature C1 has completed only a portion of its stroke, its actuating arm 31 raises its overlying upper restoring spring 41 into engagement with the associated lower stud 65. Upon completing a further portion of its stroke, it lifts studs 65 and 66. This lifts traveling blade 55 from engagement with its underlying fixed blade 53, thereby opening the back contact represented by those two blades.

Just before armature C1 completes its stroke, the movement of stud 66 forces the overlying traveling blade 57 upwardly into engagement with its overlying fixed contact blade 59, thereby closing the front contacts represented by blades 57 and 59. Further movement results in flexing of blade 57 incident to the building up of contact pressure between the contacts of blades 57 and 59.

Upon the completion of its stroke, armature C1 has raised the overlying upper restoring spring 41 sufficiently to remove the offset tip 42 thereof out of the operating path of the next succeeding armature C2, to thereby permit such armature to be promptly advanced to its first-step position by its associated lower motor-control spring 40 and by the "residual" magnetism retained in the operating branch of the magnetic circuit on the termination of the impulse.

G1a. *First impulse ends*

When the first impulse through the windings of electromagnets B ends, the magnetomotive force drops to zero except for residual force and flux, arising largely from the noted magnetic hardness of hold bar 8 in the operating end holding branch. Armature C1 is held in its fully operated position (against the combined restoring force of its upper motor-control spring 41 and its associated traveling contact blades 55 and 57) by the noted residual flux, which is relatively great because the magnetic path through an operated armature is of low-reluctance since the air gaps between the parts comprising its holding path are substantially zero in length.

When the magnetomotive force subsides at the end of the first impulse, armatures C2 to C10 are thereby released from the restraining force of the restraining pole branch which ends entirely, except for the comparatively negligible residual force of the magnetically soft material, on the termination of such impulse. Upon being released from the magnetic restraining force as noted, armature C2 moves forwardly in execution of its first step, and comes to rest in its intermediate position upon engaging the overlying portion of the upper restoring spring 41 of the succeeding armature C3. This first-step movement of armature C2 is induced by the light lifting force of its underlying lower motor-control spring 41 aided by the "residual" magnetic effect retained in the operating and holding branch of the magnetic circuit.

Armatures C3 to C10, while magnetically released during the interval between pulses, are each prevented from advancing from its normal position by the associated offset tip 42 of their restoring springs 41.

G2. *Second impulse begins*

At the beginning of the second impulse of the series, the previously operated armature C1 is attracted still more firmly into engagement with tractive pole 7, and armatures C3 to C10 are held from operating in response to the second received impulse by the previously noted restraining magnetic force for each.

Armature C2, having been advanced to its first-step position during the interval between the first and second impulses, promptly operates fully as previously described for armatures C1. It shifts its overlying contact parts to alternate position, and raises the overlying restoring spring 41 to permit the next succeeding armature C3 to operate in its turn.

G2a. *Second impulse ends*

When the second impulse of the instant series ends, armatures C1 and C2 are held in fully-operated position by the residual magnetism retained in hold bar 8, and armatures C3 to C10 are released from the restraining force of the magnetic structure. Armatures C4 to C10 are prevented from advancing from their normal position by the tips 42 of the restoring springs 41 overlying armatures C3 to C9.

Armature C3, having been released from the retarding force of its restoring spring tip 42 by the operation of armature C2, is now advanced by its underlying lower motor-control spring 40 and the residual magnetism retained in the operating and holding branch of the magnetic circuit to its first-step position preparatory to operation in response to its pertaining impulse.

G3. *Succeeding impulses*

As the succeeding impulses of the series arrive, the armatures corresponding to any such impulse operates as previously described to shift its contact parts to alternate position and to raise the overlying restoring spring 41 preparatory to the advance of the next succeeding armature to its first-step position when such impulse ends. The counting operation is thereby continued as described. The device is capable of counting the impulses of a series equal in number to the number of armatures, ten being provided in the illustrated example.

G4. *Clearing cut*

When the operated device is to be cleared out, the electromagnets B are given a mild reversed magnetization to neutralize the residual magnetism of the magnetically hard hold bar 8 of the operating and holding branch of the structure. The operated armatures C1 to C10 thereupon restore by virtue of the stored downwardly exerted tension in the operated ones of the contact sets, assisted by the comparatively light restoring tension of upper restoring springs 41.

The second embodiment

Referring now to Figs. 4 and 5, the second embodiment of the improved magnetic counting device will be described.

In general operating principle and structure, the second embodiment is similar to the first.

The principal structural difference is that the lifting springs 40 respectively employed in the first embodiment to assist in advancing armatures C1 to C10 through their intermediate first step position are eliminated in the device illustrated in the second embodiment. In the operation of the device of the second embodiment sufficient "residual" magnetic force and flux is retained after the termination of the first impulse in the operating and holding branch of the magnetic circuit by virtue of the permanent-magnet material composing the hold bar 8 included therein to attract and to thereby advance each armature C2 to C10 to its intermediate first step position in its turn between impulses subject to the removal therefrom of the downward force of the associated restoring spring tip 42 incident to the operation of the preceding armature and to the ending of the restraining magnetic force of restraining pole 79 on the termination of the instant impulse.

The noted magnetic force retained after the termination of the first impulse received by the electromagnets B in the operating and holding branch of the magnetic circuit is effective to promptly advance each armature C2 to C10 in turn to its effective intermediate position for operation in response to its pertaining influence because of the absence of any spring load on any armature until it reaches the limiting stop of the overlying portion of the restoring spring 41 of the succeeding armature determining its intermediate position and because of the substantially complete cessation of the restraining force of restraining pole 79 upon the termination of the instant impulse.

The normal position of the first armature C1 is not critical as it will respond reliably to the operating force of the operating and holding branch of the magnetic circuit on the receipt of the first impulse by the electromagnets B inasmuch as it is not influenced by the restraining force of the restraining pole 79 which extends in back of armatures C2 to C10 only.

A minor structural difference is that the inner non-magnetic sheathing portion 10 of the restraining pole 9 of the first embodiment is replaced in the structure of the second by an applied non-magnetic plate 80 secured to the inner offset portion of the restraining pole 79 by means of three rivets 81. The non-magnetic plate 80 differs from the sheathing portion 10 of pole 9 in that it extends laterally to lie in back of armature C1 to provide a back-stop position therefor beyond which it cannot be returned by the restoring force of its associated portion of the first restoring spring 41 and by the stored tension in its associated traveling contact blades 55 and 57.

I claim:

1. In a magnetic counting device including a pole structure and magnetizing means serially joined thereto for operatively magnetizing it, armatures associated with said pole structure, control means rendering said armatures attractable to said pole structure, in succession only, responsive respectively to successive magnetizations thereof by said magnetizing means, means local to said pole structure and external to said magnetizing means for maintaining said pole structure magnetized relatively weakly between said magnetizations but sufficiently to hold the armatures which have been attracted thereto, said control means including a restraining pole member extending from the junction of said magnetizing means with said pole structure to a location behind the armatures and terminating in effective restraining relationship to each said armature succeeding the first.

2. In a magnetic counting device including a pole structure and magnetizing means serially joined thereto for operatively magnetizing it, armatures associated with said pole structure, control means rendering said armatures attractable to said pole structure, in succession only, responsive respectively to successive magnetizations thereof by said magnetizing means, means local to said pole structure and external to said

magnetizing means for maintaining said pole structure magnetized relatively weakly between said magnetizations but sufficiently to hold the armatures which have been attracted thereto, said control means including a restraining pole member extending from the junction of said magnetizing means with said pole structure to provide a pole face located in effective restraining relationship to each said armature succeeding the first.

3. In a magnetic counting device including a pole structure and an electromagnet serially joined thereto for operatively magnetizing it, armatures associated with said pole structure, control means rendering said armatures attractable to said pole structure, in succession only, responsive respectively to successive magnetizations thereof by said electromagnet, means local to said pole structure and external to said electromagnet for maintaining said pole structure magnetized relatively weakly between said magnetizations but sufficiently to hold the armatures which have been attracted thereto, said control means including a restraining pole member extending from the junction of said electromagnet with said pole structure to provide a pole face located in effective restraining relationship to each said armature succeeding the first.

4. In combination, an electromagnet, pole structure comprising a fixed extension of one pole of the said electromagnet, said pole structure including a distributing bar adjacent to the electromagnet and a pair of pole branches extending therefrom, the first pole branch being in general alignment with the said electromagnet and containing a section of normally unmagnetized permanent-magnet material, the second pole branch being laterally offset therefrom and being composed exclusively of magnetically soft material, the said pole branches terminating respectively in opposed pole faces, a series of armatures and means fixed with the electromagnet for turnably supporting them, said armatures extending from the support means into the space between the said pole faces.

JOHN I. BELLAMY.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,252,312	Warren	Jan. 1, 1918
2,170,694	Perry	Aug. 22, 1939
2,352,948	Edgar	July 4, 1944
2,441,001	Bellamy	May 4, 1948
2,454,713	O'Meara	Nov. 23, 1948
2,456,169	Bellamy	Dec. 14, 1948