

Feb. 28, 1956

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2,736,845

ELECTROMAGNETIC COUNTING DEVICE

Filed Nov. 17, 1951

3 Sheets-Sheet 1

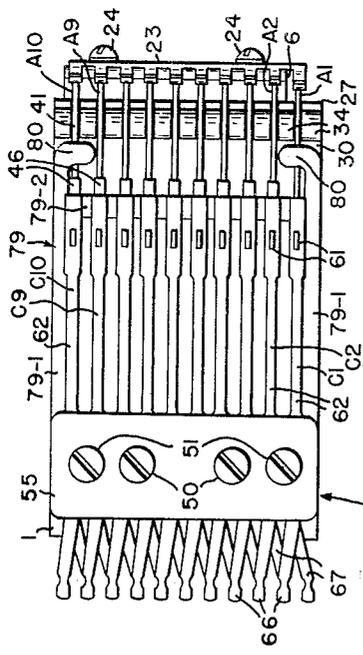


FIG. 1

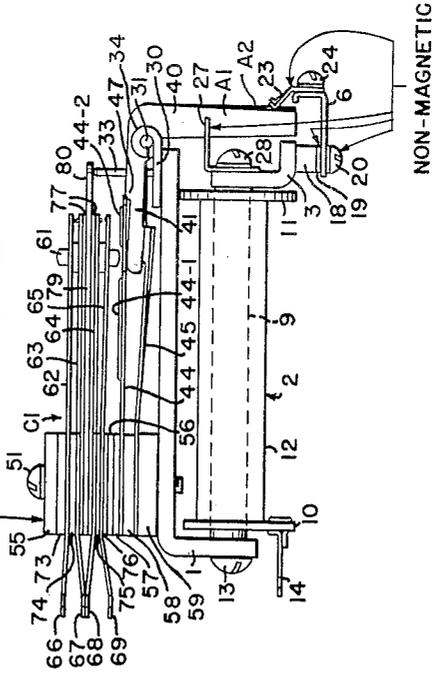
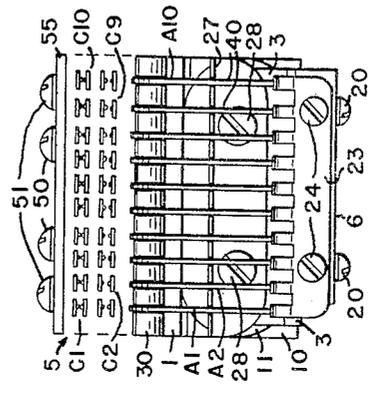


FIG. 2

FIG. 3



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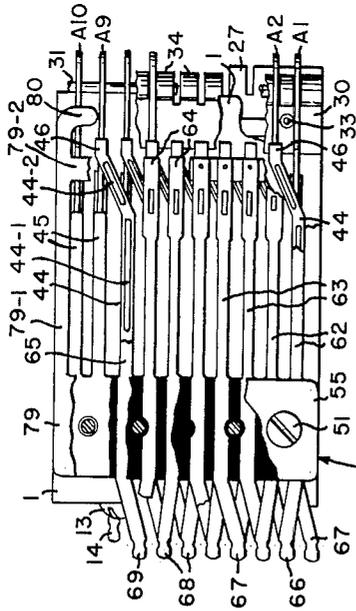


FIG. 4

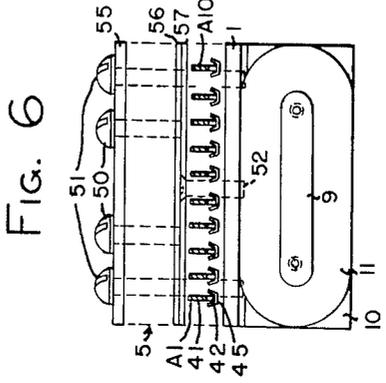


FIG. 6

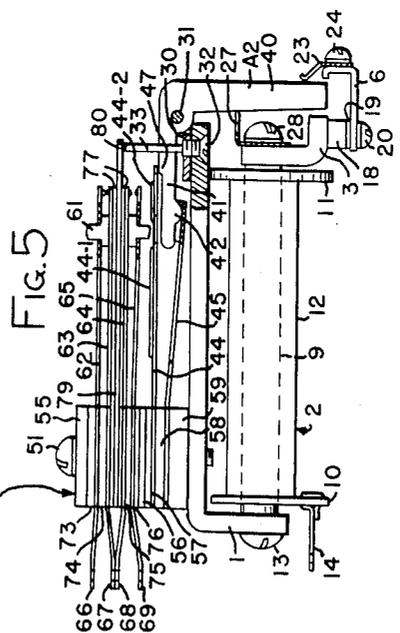


FIG. 5

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FIG. 7

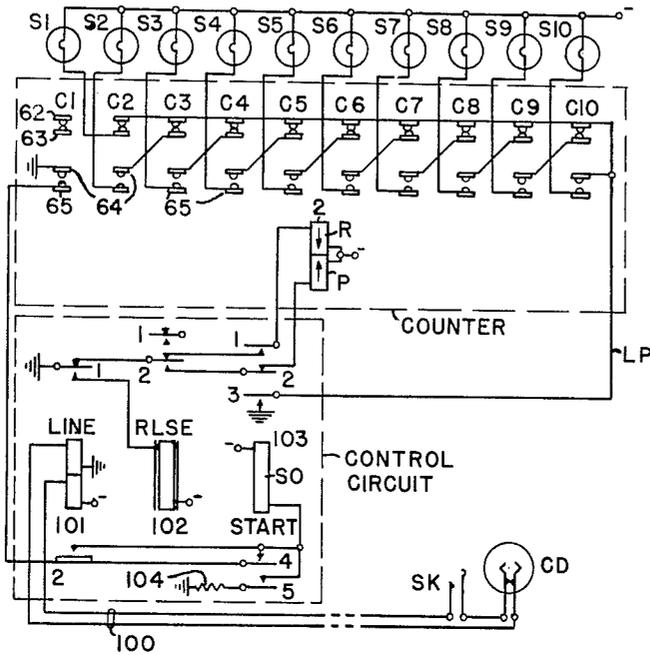
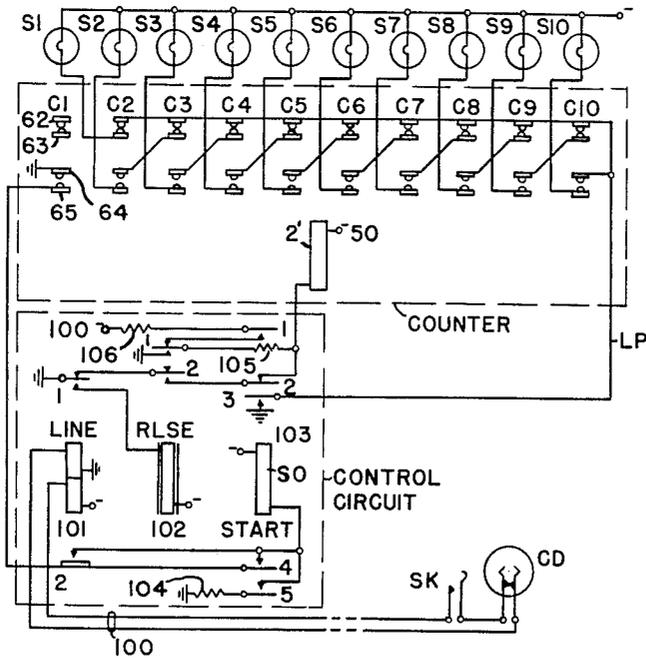


FIG. 8



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2,736,845

ELECTROMAGNETIC COUNTING DEVICE

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Application November 17, 1951, Serial No. 256,888

6 Claims. (Cl. 317—189)

This invention relates to an electromagnetic counting device. Its main object is to provide an improved form of device of this character for counting a received series of electrical impulses and for controlling contact sets in accordance with the number of impulses therein.

This invention is in the nature of a further improvement on the counting device as disclosed in the Bellamy and Arthur Patent No. 2,538,818, issued January 23, 1951, and in the Bellamy Patent No. 2,538,819, issued January 23, 1951.

A more specific object of the invention is to provide an improved form of counting device which will operate reliably under adverse conditions, such as conditions wherein it is influenced by adjacent electromagnetic devices, and magnetic protective covers or the surrounding framework.

GENERAL DESCRIPTION

In the present counting device, 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. This two-step movement comprises (1) a preparatory movement responsive to the cessation of the immediately preceding impulse, and (2) an effective counting movement responsive to the pertaining impulse.

A practical difficulty is encountered in adjusting the relationship between the operating and the restraining magneto-tractive forces, to the end that all armatures of the device will operate reliably throughout a wide range of impulse frequencies and pulse ratios and independent of whether or not there are adjacent magnetic members or electromagnetic devices.

One important feature resides in the employment of a restraining pole member which presents a relatively small surface for radiating flux to adjacent members or devices, or for receiving flux therefrom.

A related feature concerns the provision of structure providing an air gap between the main pole member of the device and the noted restraining pole member, which feature renders the length of the air gap between the armatures and the restraining pole member less critical.

A further feature of the invention resides in structure rendering the armatures individually adjustable. This structure includes a non-magnetic backstop comb having a separate tooth for each armature.

Other features relate to improved structure for guiding the pivoted armatures, which are of the bell-crank shape. The tractive portion of the armatures is guided by the teeth of a comb-like non-magnetic member, while the switch-actuating portion is guided by the same spring blades of the switch bank that are necessary for the two-step control of the armatures. To this end, the forward portion of each such spring blade has a longitudinal trough-like end portion within which the rear end of the associated armature rests.

Still further features reside in improvements in the bank of contact blades and include simple and effective structure for adjustably supporting the free end of the

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fixed contact blades with respect to the normal position of the members through which they are actuated by armature movement.

Other objects and features will appear upon further perusal of the specification.

The drawings

In the accompanying drawings, which show a counting device constructed according to the principles of the invention, Figs. 1 to 6 show the construction of the improved counting device, while Figs. 7 and 8 are alternative circuit drawings of a simple signalling system employing the counting device of Figs. 1 to 6.

More in particular, Figs. 1 to 3 are respectively a top view, a side view, and a front view of the improved counting device;

Figs. 4, 5, and 6 are respectively similar views with certain parts removed;

Fig. 7 shows a signal system wherein the counting device of Figs. 1 to 6 has two windings and employs residual magnetism for holding the operated armatures; and

Fig. 8 shows a similar system wherein the counting device has but one winding, and further employs an auxiliary electrical circuit for holding the operated armatures.

DETAILED DESCRIPTION

1. General arrangement

Referring first to Figs. 1 to 3, the improved counting device includes a generally rectangular magnetic structure of which magnetic return plate 1 comprises the rear limb and the upper limb; ten armatures A1 to A10 comprise the front limb; and electromagnet 2 and actuating pole member 3 comprise the lower limb.

As best seen in Figs. 2 and 6, the single electromagnet 2 includes the relatively wide, flat core 9, a rectangular rear spool head 10, an oval front spool head 11, and a winding 12 wound between the spool heads. The rear spool head 10 is provided with winding terminals 14. Electromagnet 2 is secured to return plate 1 by a pair of screws 13.

L-shaped actuating pole member 3 is secured to the front pole face of core 9 by screws 28 (Figs. 2 and 3), which also retain the L-shaped non-magnetic armature-guide comb 27. Parts 18, 19, and 6 which form the restraining-pole branch are secured to the horizontal lower limb of pole member 3 by screws 20. Screws 24 secure the non-magnetic backstop comb 23 to the outside vertical face of member 6.

Each armature has an opening for receiving pivot rod 31, as seen best in Fig. 5 pivot rod 31 is held by each of the eleven curled-over teeth-like projections on the magnetic pivot bracket 30, between which the ten armatures rest. Bracket 30 is held in place by counter-sunk screws 32 (Fig. 5) which pass through tapped openings in the bracket.

Contact-bank assembly 5, attached to return plate 1, supports ten similar contact sets C1 to C10, one for each of the ten armatures A1 to A10. This assembly includes parts clamped between plates 55 and 56 by short screws 50 (see Fig. 6). Bank assembly 5 is underlaid by the control-spring assembly comprising layers of springs 44, 45 and spacers 58, 59 clamped between plate 57 and return plate 1 by a single counter-sunk screw 52. The latter assembly is applied first and secured by screw 52, following which the contact-bank assembly 5 is placed in position over it and is secured by the two long screws 51 which threadedly engage return plate 1. This construction permits the device to be adjusted for its desired sequential counting operation before the contact bank 5 is applied, and therefore while the control blades 44 and 45 are more accessible for individual corrective adjustment.

As best seen in Fig. 2, each contact stackup C1 to C10 comprises four contact blades 62 to 65, a lower normally open pair (a make combination) 64 and 65, and an upper, normally closed pair (a break combination) 62 and 63. External connections to the contact blades may be made through their rear terminal portions 66 to 69. Each contact stackup has a cross-shaped actuating member 61 of insulating material secured between its contact blades 62 and 65.

The front face of lower limb of tractive pole member 3 is in operative relationship with the lower tractive portion 40 of each armature A1 to A10. The rear face of the short upper limb of the restraining pole member 6 is in restraining relationship to armatures A2 to A10, but member 6 does not overlap the first armature A1, as seen best in Figs. 1 and 3.

2. Detailed arrangement

In the restraining pole branch, magnetic spacer 18 and restraining pole member 6 are preferably composed of magnetically soft material. Gap member 19 is non-magnetic, as are screws 20 to provide a small non-magnetic gap to separate the restraining pole branch from the tractive pole branch. This provision renders the length of air gap between the armatures A2 to A10 and the restraining face of pole member 6 less critical. The last-named gap may be separately adjusted for each armature A2 to A10 by using a suitable tool to bend the individual teeth of backstop comb 23, whereby manufacturing irregularities of contour and composition of the armatures may be compensated for.

The armature-control spring assembly (clamped to the structure by screw 52 and plate 57 of Fig. 6, as noted) has an upper row of nine flat downwardly tensioned laterally offset armature-restoring springs 44 separated by spacing member 58 from a lower row of ten armature-advance springs 45 which have a light upward tension. As shown fragmentarily in Fig. 4, the springs 45 may comprise teeth of a comb-like structure whose back portion is clamped. The springs 44 may similarly be joined together within the clamped assembly.

The nine restoring springs 44, while acting as restoring springs for armatures A2 to A10, respectively, are located respectively over the armatures A1 to A9 which control these springs. The forward end portion of each spring 44 is diagonally offset to provide a restoring tip portion 46 which overlies the armature to which the restoring spring pertains. Such tip portion rests on, and applies restoring force to the high portion 47 of its armature. A tenth spring (not shown) similar to springs 44, but without the offset end portion may overlie armature A10 to keep the operational level of the tenth armature on the same plane as that of the other armatures.

Each spring 44 preferably is stiffened throughout a large portion of its length as by the raised or embossed portions 44-1 and 44-2 to confine the bending to the short "hinge" portion adjacent to the clamping structure. As will appear from the description hereinafter of the operation of the device, each of the nine restoring springs 44 must be sufficiently tensioned downwardly to at least overcome the lifting action of two underlying armature-advance springs 45, that of its own armature and that of the succeeding armature.

The forward end portion of each upwardly tensioned spring 45 is trough shaped (see Figs. 4 to 6) to receive and laterally guide the bearing portion 42 of the operating tail 41 of its armature. This arrangement provides the third lateral guide point for each armature, the other two being the two parts 34 between which it lies at its pivot location, and the two teeth of comb 27 between which the tractive portion of the armature lies.

Contact bank 5 includes the upper and lower clamp plates 55 and 56, the two upper layers of normally closed contact blades 62 and 63 with their associated insulators 73 and 74, the metal adjusting plate 79 (with adjustment

ears 80) and its overlying and underlying insulating plates 77, the two lower layers of normally open contact blades 64 and 65 with their associated insulators 75 and 76.

As seen best in Figs. 1 and 4 adjusting plate 79 has a generally oblong outline form. Its rear portion is secured within the clamping zone, and its forwardly extending portion has a large window for the underlying contact sets and the actuating members 61, leaving the front cross portion 79-2 connected to the clamped portion by a pair of side arms 79-1. The insulators 77 are of a similar windowed form. The laterally extending front portion 79-2 serves as a backstop to locate the free end of the fixed blades 63 and 64.

The side arms 79-1 extend forwardly to terminate in the adjustment tabs 80 which rest on the ends of posts 33, which comprise reduced-diameter upward extensions of screws 32. Accordingly, the level of crossbar 79-2 and consequently of the free end of fixed springs 63 and 64, may be adjusted to the desired working height by suitably bending adjustment tabs 80. The side arms 79-1 are preformed with a normal downward slope to provide enough tension against posts 33 that crossbar 79-2 does not rise materially incidental to the upward shift in spring load incident to the successive operation of the armatures.

The relatively fixed blades 63 and 64 are downwardly and upwardly tensioned against insulating members 77, supported in turn by crossbar 79-2. Blades 63 and 64 are slotted to permit the wide portion of insulating actuators 61 to pass freely therethrough.

The flexible traveling blades 62 and 65 are tensioned downwardly and upwardly respectively (as by a preforming operation) against the shoulders of insulating actuators 61, being provided with suitable apertures to receive the reduced end portions of parts 61. Each lower traveling blade 65 is so tensioned upwardly (as by preforming) that, when the actuator 61 is lifted clear by an armature operation, it engages its overlying contact member 64 with the desired contact force. Each blade 62 is so tensioned downwardly that in the normal position of the device, it holds the associated traveling blade 65 away from blade 64, while the blade 62 engages its own fixed blade 63 with the desired contact force, the height, or level, of the forward end of the fixed contact blades 63 and 64 is preferably so adjusted (by bending the adjustment tabs 80 as previously referred to) that a small discernible clearance exists between the lower end of each insulating actuator 61 and the upper face of the underlying blade 44, through which actuation of the contact members is effected. This clearance insures that the net downward tension force of the concerned blade 62 is exerted on the illustrated contact points affixed to blades 62 and 63, as well as assuring that the normal position of the concerned blade 44 is not disturbed.

The terminal members 66 to 69 of blades 62 to 65 are offset right and left to facilitate the chain-wiring of the contact sets C2 to C10 as shown in Figs. 7 and 8. For this purpose, concerned ones of the terminal members 67 and 68 are bent down and up, respectively, as seen in Figs. 2 and 5.

3. Counting operation

The counting operation of the device of Figs. 1 to 6 from its illustrated normal position responsive to the impulses of a series will now be described. Each effective impulse delivered to the winding 12 magnetizes the core 9 of electromagnet 2 to cause each armature to be attracted by flux emanating from tractive pole member 3, and returning through common magnetic return plate 1.

Each armature A2 to A10, however, is subjected to an effective restraining force exerted by restraining pole member 6 because of the normal closeness thereto of these armatures. Consequently only the first armature A1 responds to the first impulse. It is able to do so because it is nearer to the tractive face of member 3 than the other armatures (see Fig. 2), and because the member 6 does

not overlap it as previously noted (see Figs. 1 and 3). It may be pointed out here that armature A1, having no restoring spring 44 (the first such spring is for restoring armature A2 as previously noted), is held normally in its intermediate, or advanced, position by its advance spring 45, with the upper surface of its tail portion 41 in contact with the overlying blade 44.

When armature A1 operates in response to the first impulse of the series, its arm 41 raises its overlying armature-control spring 44 into engagement with the associated actuating member 61, and moves parts 44 and 61 to their fully operated position. Downwardly tensioned traveling blade 62 is thereby moved upwardly out of engagement with its underlying fixed blade 63, and permitting the upwardly tensioned traveling blade 65 to engage its overlying fixed blade 64. To insure the desired upward pressure of traveling blade 65 against its associated overlying fixed blade 64, the actuator 61 is moved sufficiently upward that a slight clearance exists between its lower wide shoulder portion and the upper face of the underlying flexible traveling blade 65. The said movement of armature-control spring 44 by armature A1 raises the offset tip 46 thereof away from the next succeeding armature A2 leaving that armature free to be advanced to its intermediate position by advance spring 45 on the termination of the impulse.

When the first impulse of current through the winding of electromagnet 2 ends, the magnetomotive force (and consequently the flux) drops sharply but remains at a holding value by residual action alone, or by residual action aided by a holding current, as will be explained for Figs. 7 and 8. Consequently armature A1 is held in its fully-operated position (against its spring load) by the residual (or holding) flux, which is relatively great because, with the armature operated, the air gaps between the parts are substantially zero in length.

When the magnetomotive force subsides as noted at the end of the first impulse, armatures A2 to A10 are thereby released from the effective restraining force because the air-gap separation between these armatures and the adjacent face of pole member 6 is great enough that the interimpulse flux is too small to hold a mechanically released armature against the force of its advance spring 45.

Upon being released from its effective magnetic restraining force, as noted, armature A2 is moved forward by its blade 45 in execution of its first step, and comes to rest in its intermediate position in engagement with the overlying armature-restoring spring 44 for the third armature A3.

Armatures C3 to C10 do not advance at this time since they are still held in normal position by their unlifted restoring springs 44.

At the beginning of the second impulse the previously operated armature A1 is attracted still more firmly against pole 3, and the armatures A3 to A10 are held from operating by the noted restraining magnetic force. Armature A2 promptly advances to its operated position, raising its overlying spring 44 to permit the next succeeding armature C3 to operate in its turn, and actuating its associated overlying stackup C2.

When the second impulse of the instant series ends, both operated armatures A1 and A2 are held as described above for armature A1, and armatures A4 to A10 are magnetically released. Armatures A4 to A10 are prevented from advancing by their unlifted restoring springs 44. Armature A3, however, having been mechanically released by the described lifting of its restoring spring 44, is now advanced to its intermediate position by its underlying advance spring 45.

As the succeeding impulses of a series arrive, the armatures corresponding respectively thereto operate as described for armatures A1 and A2. Having the illustrated ten armatures A1 to A10, the device is capable of counting the impulses of any series up to ten.

As previously stated as a feature of the invention, the structure is provided with an air-gap between the main pole member and the restraining pole member thereby rendering the air-gap between the armatures and the restraining pole member less critical. With but one armature operated and with nine armatures drawing flux through member 6 the drop in magnetomotive force across the gap introduced by non-magnetic member 19, approximates the increase drop in magnetomotive force in core 9 and main pole member 3 with nine armatures operated. At that time, only one armature, the tenth, is drawing substantial flux through gap 19 and member 6 with the result that there is a negligible drop therein of magnetomotive force. Consequently, about the same gap separation between an armature and the tractive end face of member 6 serves for all armatures, to hold any mechanically released armature reliably against the advancing force of its spring 45 until the instant impulse ends, and then to release it with reasonable uniform promptness.

When the operated device is to be cleared out, the electromagnet 2 is given a mild reversed magnetization (such as by a reversed current flow through the winding) to neutralize the residual magnetism of the structure. The operated armatures A thereupon restore by virtue of stored downward tension of the operated ones of the contact sets C1 to C10 aided by the tension of restoring springs 44 which complete the restoring movement after the studs 61 reach normal position.

The system of Fig. 7

Fig. 7 illustrates the use of the device of Figs. 1 to 6, in a simple signalling system wherein residual magnetism is employed exclusively to hold the operated armatures. For this purpose, core 9 may be composed of magnetically hard material, while the remaining parts of the magnetic structure may be of magnetically soft material. Some commercial grades of fully annealed tool steel are satisfactory for the core 9 for the system of Fig. 7.

In the system of Fig. 7, the counting device is illustrated in circuit diagram within the rectangle labelled "Counter" and a relay group for controlling the operation of the system is shown within a further rectangle labelled "Control circuit." The impulse counter is controlled over line 100, through the illustrated control circuit, to light signal lamps S1 to S10 selectively. The control is exercised from the illustrated remote control station, including switch key SK and a calling device CD, of the usual dial telephone type, which can transmit a series containing from one to ten break impulses.

In the control circuit relay 101 corresponds to the line relay generally employed in automatic telephone systems; relay 102 corresponding to the slow-restoring release relay; and relay 103 is the slow-operating start relay which refrains from operating until the transmitted series of impulses has terminated.

The electromagnet 2 has two differentially connected windings, the lower winding P receives impulses to be counted, while the upper winding R is a relatively low-powered demagnetizing winding used in clearing out the device.

Assume now that a desired one of the signal lamps S1 to S10 is to be lighted to display a corresponding signal. This operation is effected from the control station by first closing key SK and the manipulating calling device CD to transmit the desired number of impulses over line 100. Line relay 101 responds to the closure of key SK by operating release relay 102 to prepare an impulse circuit for the counter. Being slow restoring, release relay remains operated throughout the restorations of line relay 101 incident to the assumed operation of calling device CD.

Line relay 101 restores momentarily each time calling device CD interrupts line 100. Each time it does so it

closes a circuit for the lower pulse winding P of electromagnet 2 by the way of the front contact of contacts 2 of the operated release relay 102. Impulses thus delivered to the electromagnet 2 causes a counting operation to occur actuating the concerned contact sets C1 to C10 successively, beginning with contact set C1.

Upon the actuation of contact set C1 (separation of its contact blades 62 and 63, and closure of its contact blades 64 and 65) incident to the receipt of the first impulse of a series, a circuit is prepared for slow-operating start relay 103. This circuit is momentarily opened upon each operation of line relay 101 during the transmission of the impulse series. Being slow-operating, start relay 103 does not respond to these momentary closures of its circuit, but delays until its circuit is closed relatively permanent, when line relay 101 comes to rest in an operated condition at the end of the impulse series.

Upon operating, at the end of the transmitted impulse series, start relay 103 closes a self-locking circuit at its contacts 4, independent of the lower contacts 2 of line relay 101; prepares a clearout circuit for the counter at its contacts 1; at its contacts 3 it applies ground potential to the signal conductor LP extending to the counter, thereby completing a lighting circuit for one of the signal lamps S1 to S10 which corresponds to the last-operated one of contact sets C1 to C10; and at its contacts 5 applies a ground potential through resistor 104 to its windings to render it slow-releasing during the clearout of the device.

If, for example, the received impulse of a series contained only a single impulse, only contact set C1 has been operated. In this event, lamp S1 is lighted in a circuit through the contact blades 63 and 62 (contact blades 62 of contact sets C2 to C10 are strap-wired together), signal conductor LP to ground through contacts 3 of start relay 103. On the other hand, if two impulses have been received, contact set C2 is operated along with contact set C1. Then lamp S1 is disconnected (by the separation of contact blades 62 and 63 of contact set C2), and lamp S2 is substituted being connected to signal conductor LP by the noted strap wiring, contact blade 63 of contact set C3, and contact blades 64 and 65 of contact set C2.

Operation of any succeeding contact set C3 to C10 results in the disconnection of the signal lamp associated with the preceding contact set and the substitution of the locally associated signal lamp.

When the system of Fig. 7 is to be cleared out switch key SK is reopened, permitting line and release relays 101 and 102 to restore successively. Incidentally, a further delivery of an actuating impulse to the impulse counter during the interval of time required for relay 102 to restore following the restoration of relay 101 is avoided by providing relay 103 with a pair of normally closed contacts 2 in series with the pulse winding P of electromagnet 2.

Start relay 103 remains operated through the lower contacts of C1 and through its contacts 4. With relays 101 and 102 both restored, a clearout circuit exists through contacts 1 of relay 101, contacts 2 of relay 102, contacts 1 of relay 103 to the low-power demagnetizing winding R of electromagnet 2. Responsive to the flow of current through the winding R, the counting device clears out and all operated ones of the contact sets C1 to C10 return to their normal illustrated position. When this occurs, the opening of the lower contact pair of contact set C1 causes relay 103 to restore slowly under control of its delay-circuit to open the clearout circuit, returning the system to its normal illustrated position. The delay circuit for relay 103 consists of having a ground potential through delaying resistor 104, contacts 5 of relay 103, through the winding of relay 103 to battery. The flow of current through the delaying circuit is not sufficient to keep relay 103 operated by merely to retard the restora-

tion of the relay for a sufficient length of time to make certain all the operated armatures, of the counting device, have returned to their normal illustrated position.

The system of Fig. 8

Fig. 8 illustrates use of the improved counting device in a simple signalling system, similar to Fig. 7, employing a leak-holding system for the counter instead of the permanent magnet system as employed in Fig. 7. The counting device used in this system is similar to the device employed in the system of Fig. 7 with the exception that all magnetic parts may be of magnetically soft material and the electromagnet 2' has only one winding instead of the two windings employed for electromagnet 2 in Fig. 7. The device of Fig. 8, as that of Fig. 7, is controlled over line 100 from a remote control station including switch key SK and a calling device CD.

In the control circuit, line relay 101, release relay 102 and start relay 103 are operated in a manner as described for the circuit of Fig. 7.

Line relay 101 restores momentarily as the calling device CD interrupts line 100 (after the closure of switch key SK) and through its contacts 2 prepares an operating circuit for start relay 103 upon the termination of a series of impulses.

Release relay 102 operates in the manner as described for Fig. 7 and at its contacts 1 applies a holding ground potential to electromagnet 2' of the counting device through resistor 105.

The resistor 105 is of a predetermined value permitting electromagnet 2' to be energized a sufficient amount to hold the operated armatures in their fully operated position. At its contacts 2 release relay 102 prepares an impulse circuit for the device.

Start relay 103 operates at the termination of an impulse series and at its contacts 1 prepares a clearout circuit for the device upon the restoration of release relay 102. Relay 103 also at its contacts 2 prevents any further impulses to be delivered to the counter, at its contacts 3 applies ground potential to conductor LP to light the proper signal lamp, at its contacts 4 provides its own holding circuit, and at its contacts 5 prepares its delay circuit to render the relay slow-releasing, as previously described for Fig. 7.

When the system of Fig. 8 is to be cleared out switch key SK is reopened permitting line and release relays 101 and 102 to restore successively.

Start relay 103 remains operated through the lower contacts of contact set C1 and through its own contacts 4. With relays 101 and 102 restored, a clearout circuit exists from the winding of electromagnet 2', through resistor 105, the contacts 1 of relay 102, contacts 1 of relay 103, resistor 106 to battery. The battery potential of electromagnet 2' (for operation purposes) may be 50 volts while the battery potential through resistor 106 may be of any appreciable higher value, say 100 volts. Applying the higher battery potential, to the clearout circuit, causes the current flow through electromagnet 2' to reverse its direction thereby demagnetizing the counting device to return it to its normal illustrated position. Relay 103 remains operated for a sufficient period of time permitting the counting device to clear out, as described in connection with Fig. 7.

Subject matter disclosed in this application is claimed in my divisional application for an Electromagnetic Counting Device and Contact Bank, Serial No. 519,791, filed July 5, 1955.

I claim:

1. In an electromagnetic counting device including an electromagnet and a series of armatures arranged side by side, the electromagnet including a main pole structure providing a tractive pole face extending along one side of the armatures, control means including (1) means normally urging each armature toward a normal position and (2) means causing said armatures to move away from

normal position toward the said tractive pole face in a counting sequence responsive respectively to the impulses of a series delivered to the electromagnet, said control means including auxiliary structure providing a path for delivering restraining flux through magnetic material from the main pole structure to the other side of each of said armatures for restraining any armature from moving away from normal position during an impulse, and non-magnetic members included in said auxiliary structure to provide two serially related non-magnetic gaps in said path which act together to secure a uniform restraining and releasing action as the armatures move successively away from normal position during the counting operation.

2. In an electromagnetic counting device as set forth in claim 1, means for adjusting the length of one of said non-magnetic gaps individually for any armature.

3. In an electromagnetic counting device including an electromagnet and a series of armatures arranged side by side, control means including (1) means normally urging each armature toward a normal position and (2) means causing said armatures to move away from normal position in a counting sequence responsive respectively to the impulses of a series delivered to the electromagnet, said control means including structure providing a path for delivering restraining flux through magnetic material from one pole of said electromagnet to each of said armatures for restraining any armature from moving away from normal position during an impulse, said structure providing a restraining pole face adjacent to said armatures, and non-magnetic backstop members separately adjustable to fix the normal position separately for any armature according to the desired normal separation thereof from the said pole face.

4. In an electromagnetic device, an electromagnet including structure providing a pair of opposed pole faces, a series of armatures disposed side by side between said pole faces and means supporting them for movement away from one pole face and toward the other, a non-magnetic comb-like member and means securing it to the structure with its teeth overlapping the armatures respec-

tively and serving as stops to prevent them from contacting one pole member, said teeth being bendable individually to vary the gap distance from said one pole face at which the respective armatures are stopped.

5. In an electromagnetic device, an electromagnet, a pole member associated with one pole of the electromagnet, a series of armatures disposed along said pole member and means pivotally mounting them for movement toward and away from the pole member incidental to energizations and deenergizations of the electromagnet, a guide comb associated with the pole member having teeth extending between and alongside the armatures in the direction of their said movement to guide such movement by limiting lateral displacement of the armatures, and clamp members extending through said guide comb and said pole member and fixed with the electromagnet to hold the concerned parts firmly in assembled relationship.

6. In combination, a series of armatures disposed side by side in a row, means loosely pivoting said armatures for movement transversely of the row, an electromagnet operatively associated with the armatures to induce the said movement thereof, blade-like control springs underlying the respective armatures at the end thereof and acting with the electromagnet to control their movement, and outwardly flared upwardly extending longitudinal side members fixed with each control spring and serving to limit lateral displacement of the end of the associated armature.

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