Jan. 23, 1951 J. I. BELLAMY 2,538,816

ELECTROMAGNETIC COUNTING DEVICE

Filed Feb. 15, 1946 2 Sheets-Sheet 1

Fig. 4

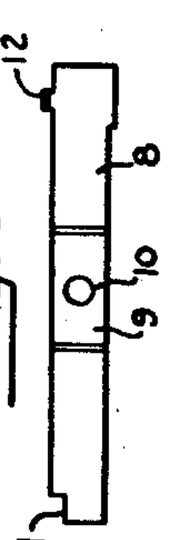


Fig. 5

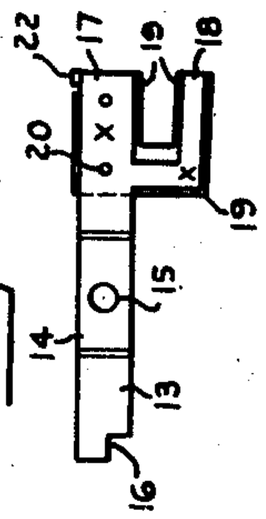


Fig. 3

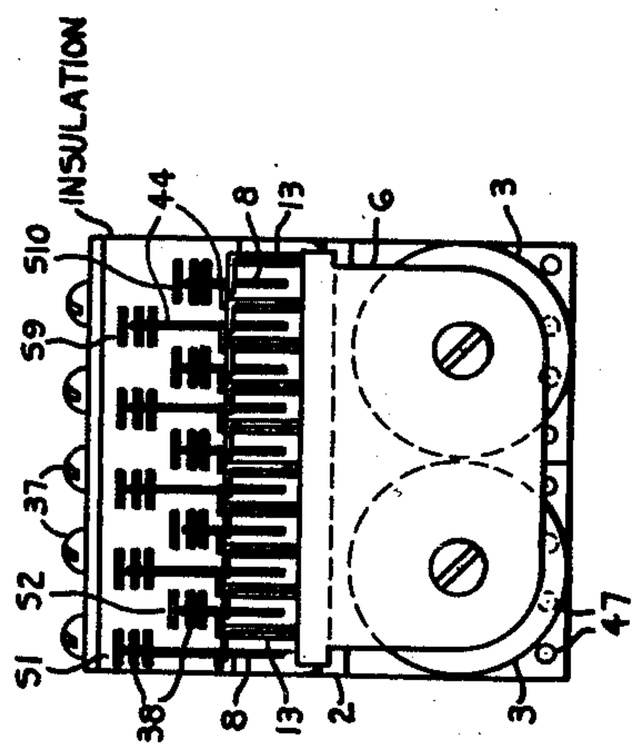


Fig. 2

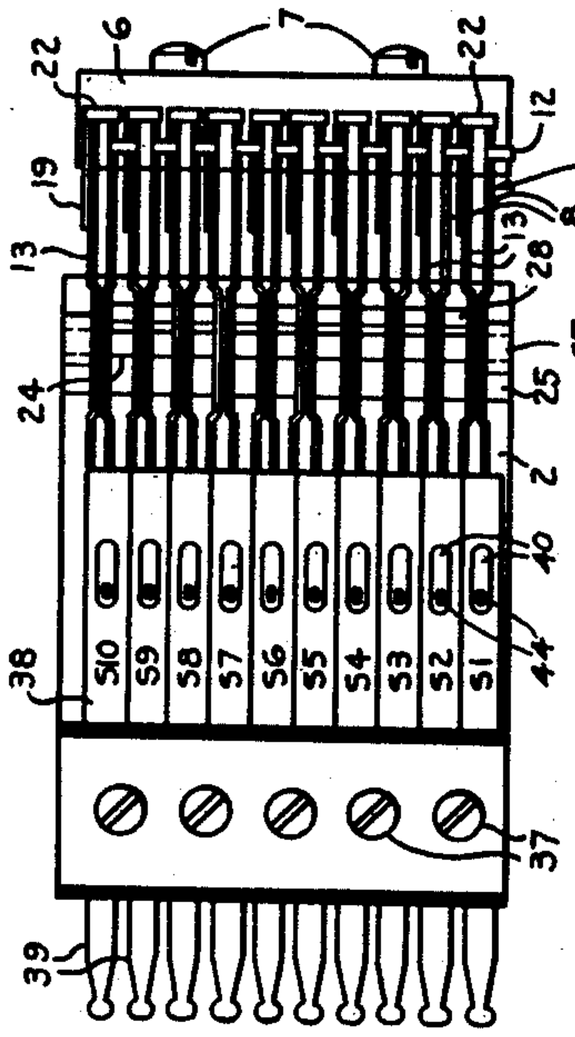
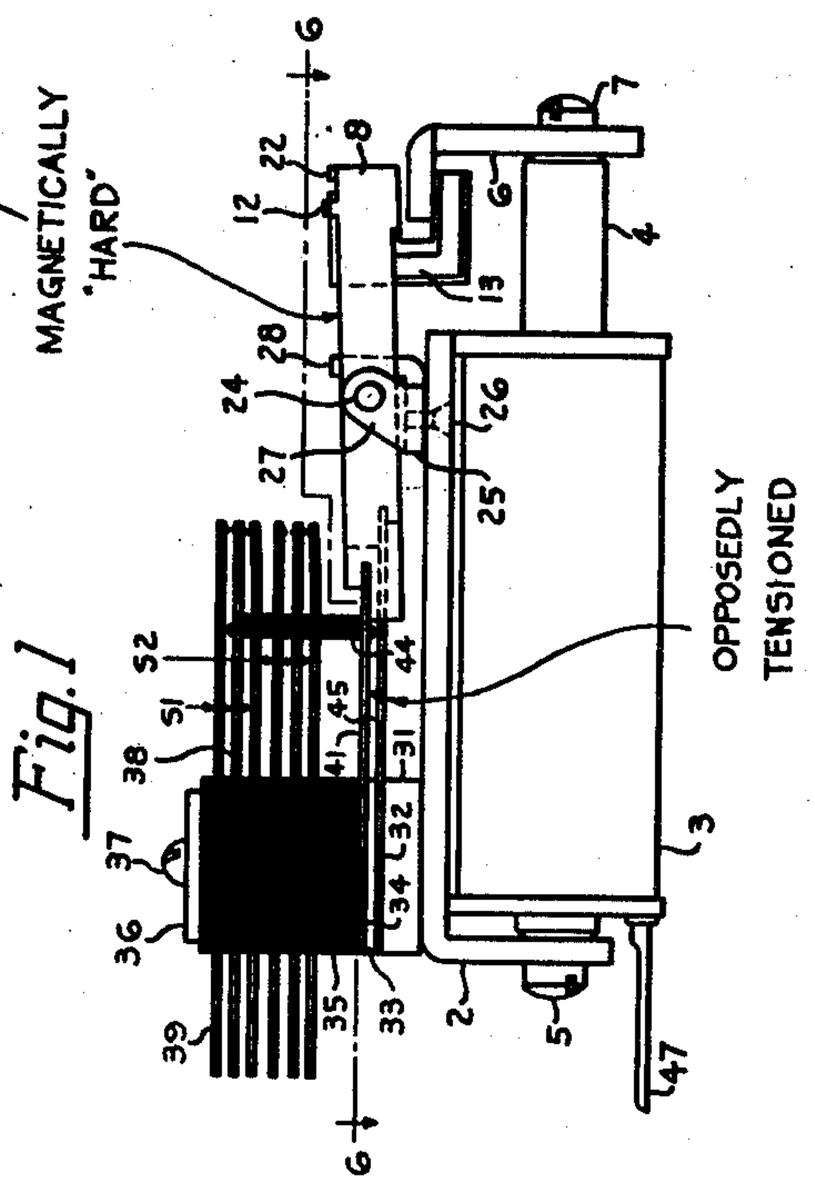


Fig. 1



Inventor:
John I. Bellamy
By C. A. Soper
Attorney

Jan. 23, 1951 J. I. BELLAMY 2,538,816

ELECTROMAGNETIC COUNTING DEVICE

Filed Feb. 15, 1946 2 Sheets-Sheet 2

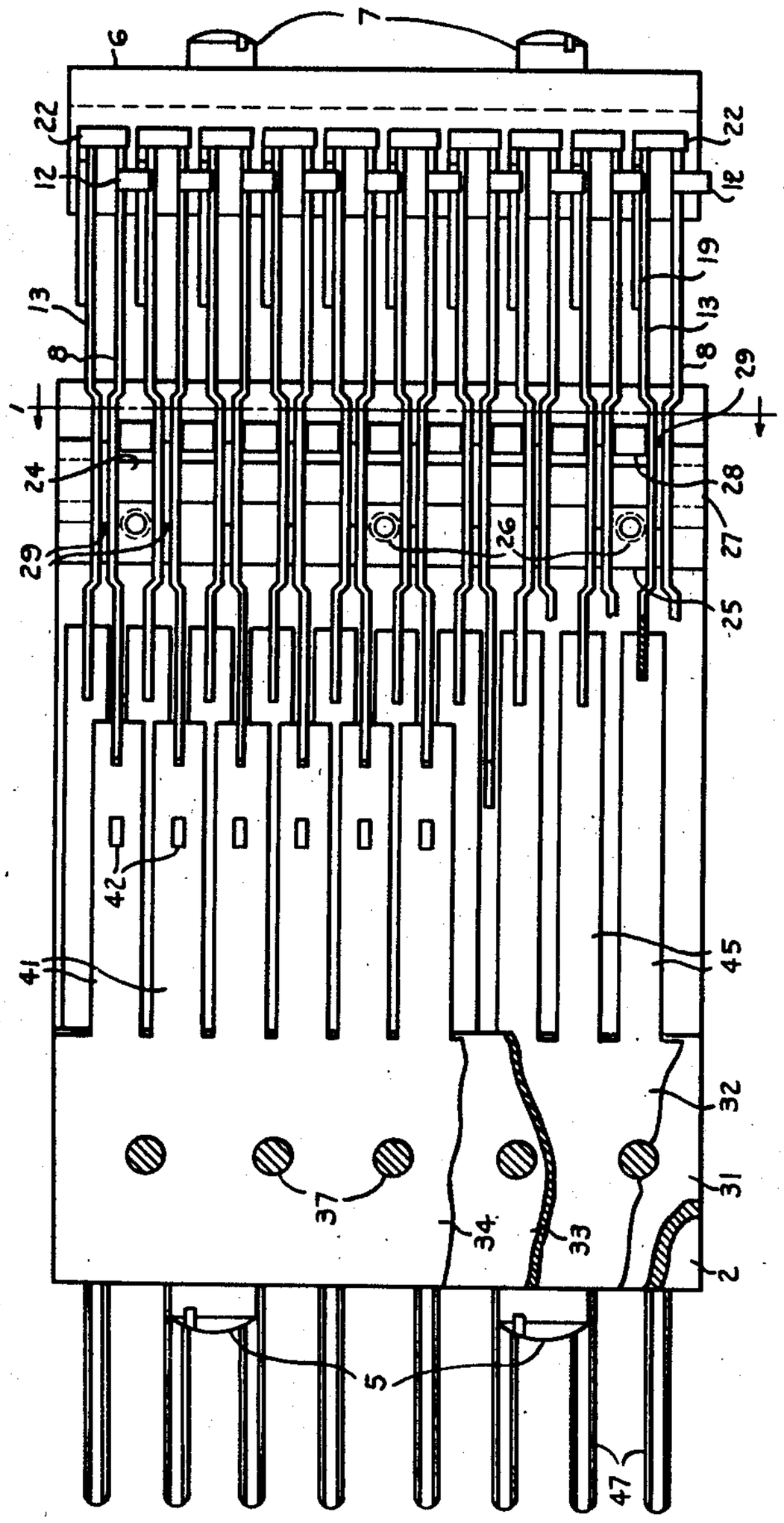


Fig. 6

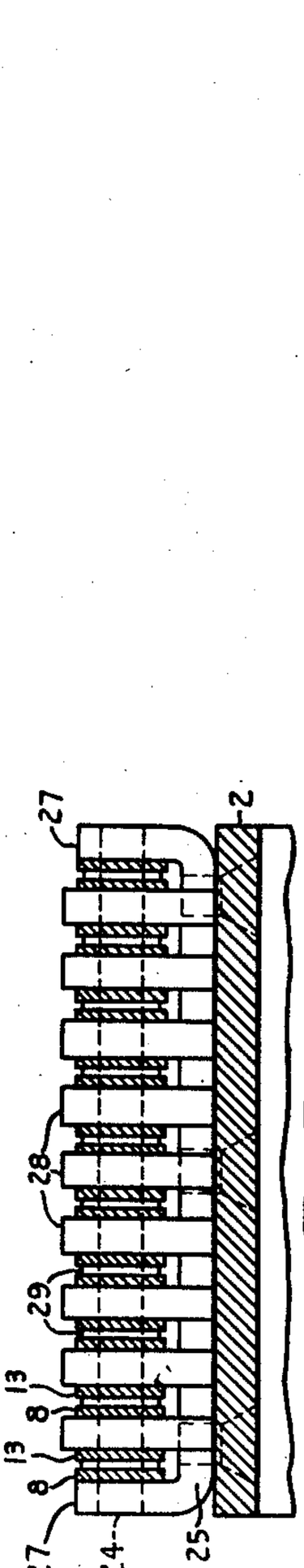


Fig. 7

Fig. 7B

Fig. 7A

Inventor:
John I. Bellamy
By C. B. Soper
Attorney

Patented Jan. 23, 1951 2,538,816

UNITED STATES PATENT OFFICE

2,538,816

ELECTROMAGNETIC COUNTING DEVICE

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

Application February 15, 1946, Serial No. 647,896

2 Claims. (Cl. 175—337)

1

This invention relates to electromagnetic counting devices. Its object is to provide an improved form of electromagnetic device 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 devices disclosed in my copending applications for Electromagnetic Counting Devices, Serial No. 493,312, filed July 2, 1943, now Patent No. 2,441,001; and Serial No. 612,689, filed August 25, 1945.

The present invention is embodied in an electromagnetic counting device of the operational type disclosed in my above-noted application Serial No. 612,689, wherein a common electromagnetic structure is provided with a series of interlinked armatures comprising pairs corresponding respectively to impulses of a received series. The first armature of any such pair operates at the beginning of its corresponding impulse, while the second armature of the pair operates at the termination of the impulse. The two armatures of any such pair are opposedly tensioned pursuant to their intended successive counting movements.

A feature of the counting device herein disclosed is that each armature thereof lies normally in the same general plane, out of which it moves edgewise to execute its counting operation, and that the armatures are so interlocked mechanically that no one of them can execute its counting movement until its immediately preceding armature has done so.

A further feature is that the first, or work, armature of any pair lies entirely on one side of the actuating pole structure so as to be influenced magnetically only in its desired operating direction, while the second, or sequence, armature of any such pair includes two portions lying on opposite sides of the common pole structure, whereby any such armature is readily urged in one direction by any impulse arriving before its counting operation occurs, and is urged in the opposite direction by any impulse arriving subsequent to its counting operation.

A further feature of the disclosed counting device is that the several stackups of contact blades carried thereby are rendered more compact laterally by arranging them in a staggered formation, whereby the width of the structure is substantially halved. Besides reducing the overall space required, the feature in question results in a more compact magnetic structure, which has the advantage that a smaller pro-

2

portion of the magnetomotive force is dissipated by leakage flux.

Further advantageous features include the intermediate pivoting of the armatures to enable a desired ratio of armature travel to contact-spring travel to be selected, and include the provision of an economical arrangement for maintaining the armatures in position along a common pivot rod and for providing them with a magnetic return path of relatively low reluctance.

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

The accompanying drawings show a preferred simple embodiment of a counting device constructed according to the principles of the invention, together with a desirable modification of a portion thereof.

Figures 1 to 3 show respectively a left-side view, a top view, and a front view of the preferred simple embodiment of the device.

Figure 4 is a left-side view of one of the work armatures 8 of the device of Figs. 1 to 3.

Figure 5 is a similar view of one of the sequence armatures 13.

Figure 6 is an enlarged sectional view, taken generally along the line 6—6 of Fig. 1.

Figure 7 is an enlarged fragmentary sectional view of the device taken generally along the line 7—7 of Fig. 6.

Figures 7A and 7B are an edge view and a full view respectively of a modified form for the inter-armature spacing washers 29 of Figs. 1 to 7.

Construction

The construction of the preferred simple embodiment will now be described with reference to the principal views of Figs. 1 to 3, and the auxiliary views of Figs. 4 to 7.

The device includes an L-shaped heel plate 2 and a pair of electromagnets 3, attached thereto by rear screws 5, and having terminal members 47. L-shaped pole piece 6 is attached to the forward extension of cores 4 by front screws 7.

Contact blades 38, with their respective terminal portions 39, are supported in insulation block 35 mounted at the rear of the device. Contact blades 38 comprise ten groups, or stackups S1 to S10. In the operation of the device, these stackups are actuated successively, one for each received impulse of a series. As seen best in Fig. 1, each such stackup includes three contact blades, comprising what is known as a break-make combination. It is the function of the work armatures of the device to actuate the

stackups S1 to S18 successively as the impulses of a series are received and counted.

The armatures of the device comprise ten pairs, each pair comprising a work armature 8 and a sequence armature 13. The armatures are pivoted about a common pivot rod 24.

Pivot bracket 25, secured to heel plate 2 as by screws 26 (Figs. 1 and 6), has a pair of upturned end portions 27 for supporting pivot rod 24. Additionally, it has a series of uniformly spaced upturned guide portions 28. Portions 27 and 28 of bracket 25 serve to position the armatures in pairs uniformly along pivot rod 24, and to provide low-reluctance return paths to heel plate 2, the pivot bracket being constructed of magnetic material.

As seen best in Fig. 7, the armatures 8 and 13 of any pair are maintained slightly separated by an intervening spacing washer 29, any such washer serving to maintain each of its associated armatures in fairly close relationship to its associated return member, 27 or 28.

As an alternative arrangement, the rigid washers 29 can be replaced by spring washers 29' of Figs. 7A and 7B. Washers 29' are preferably of comparatively thin spring material, and are formed as shown in profile view in Fig. 7A so as to urge each armature lightly in a lateral direction into intimate engagement with its associated magnetic return member.

It will be observed that the several armatures 8 and 13 are generally uniformly spaced at the front and at the rear, but that the two armatures of any pair are laterally offset toward each other in the intermediate zone including pivot bracket 25. This offset arrangement permits pivot bracket 25 to be formed of comparatively sturdy stock and still have upstanding parts 28 formed integrally therewith as by a simple punching and forming operation.

The several sequence armatures 13 are further maintained in their illustrated aligned position by their respective spring blades 45, as may be seen best in Figs. 1 and 6. Each spring blade 45 is bifurcate at the front end to receive the rear end of the concerned sequence armature 13. By this expedient, the armatures are not required to fit snugly around pivot rod 24. Similarly, impulse armatures 8 are maintained in aligned position by their respective bifurcate spring blades 41.

In Fig. 6, it will be observed that spring blades 45 are in the nature of comb teeth formed integrally with their common back portion 32, and that springs 41 are similarly formed as the teeth of a comb having back portion 34.

It will be observed that screws 37 retain an assembly at the rear of the device which includes base plate 31, comb strip 32, inter-comb strip 33, and comb strip 34, followed by insulation block 35 and cap plate 36.

Referring now to Fig. 4, it will be observed that each work armature 8 is provided with a pivot opening 10 through which pivot rod 24 passes in the assembled position of the device, such opening being through the intermediate offset portion 9. Each such armature is provided with a rear notch 11 within which the bifurcate portion of its associated, downwardly tensioned, restoring spring 45 terminates, permitting such spring to press downwardly on the rear end of the armature with a restoring spring tension.

The front portion of each work armature 8 is provided with a side tab 12, extending to the left. In the assembled position of the device,

the side tab 12 of any armature 8, except the first, overhangs the immediately preceding sequence armature 13, whereby any work armature 8, except the first, cannot move downwardly from normal position into operated position until its immediately preceding sequence armature 13 has done so.

Referring now particularly to Fig. 5, each sequence armature 13 has a pivot opening 15 through its intermediate offset portion 14, and is provided at the rear with a notch 16 within which the bifurcate portion of its associated actuating spring 45 terminates. Springs 45 are tensioned upwardly comparatively lightly, but with sufficient force that any one of them suffices to bring its associated sequence armature into operated position as soon as it is permitted to do so.

The principal forward portion of any sequence armature 13 overhangs the horizontal portion of pole piece 6 in the assembled position of the device. As illustrated, each sequence armature 13 has a lower portion 18 which underlies the horizontal portion of pole piece 6.

A so-called residual plate 19, composed of nonmagnetic material is fixed to the right side of the front portion of each sequence armature 13, as by spot welding at points X. Holes 20 in parts 13 and 19 may be used to align the parts for accurate assembly.

Plate 19 is of bifurcate construction conforming generally to the shape of the front portion of the armature 13 to which it is attached, but the opening between the arms of part 19 is less than the opening between the arms of armature 13, whereby armature 13 is maintained out of contact with pole piece 6 by a predetermined distance in its normal position, and by a predetermined distance in the operated position thereof, whereby the flux drain is considerably reduced.

Residual plate 19 extends somewhat above the top line of the sequence armature 13 to which it is attached. During the counting operation, this arrangement keeps the overhanging tab 12 of the next succeeding work armature 8 out of intimate magnetic contact therewith to avoid inter-armature "sticking." The upper front portion of each part 19 has a side tab 22 extending to the left therefrom. In the assembled position of the device, each such side tab 22 overhangs, and rests upon, the front portion of the immediately preceding work armature 8 of the same armature pair, thereby defining the normal position of the work armature 8, and preventing premature operation of the sequence armature 13.

Preferably, the parts are so dimensioned that the overhanging side tab 12 of any work armature 8 succeeding the first is normally slightly out of contact with the residual plate 19 of its immediately preceding sequence armature, whereby the normal position assumed by any work armatures does not prevent the immediately preceding sequence armature from assuming its intended normal position.

In the preferred embodiment of the device now being described, each of the work armatures 8 is composed of material that is magnetically "hard" whereby any such armature, upon having once been attracted downwardly into engagement with pole piece 6, remains so attracted by residual magnetism against the normally exerted restoring force of its associated spring 41.

Referring again to the contact blades 38 com-

prising the ten separately actuatable stackups S1 to S10, it will be observed that each such stackup comprises three contact springs. The intermediate contact spring of any such stackup is preferably formed of comparatively thin, flexible stock, and is so tensioned as to normally rest in electrical engagement with its underlying back-contact blade, from which position it can be moved upwardly out of contact therewith, and into contact with its immediately overlying front-contact blade. The front-contact and back-contact blades are preferably of relatively rigid construction.

Actuation of any of the stackups of contacts is effected by its associated control stud 44. Any such stud is provided with a body portion of suitable length to extend from restoring spring 41 to the flexible travelling contact blade thereof. Any control stud 41 is held in position by a pair of end extensions thereof, one of which is received within locating hole 42 (Fig. 6) of its associated restoring spring 41, while the upper end thereof is similarly received within a hole in the travelling blade of the associated stackup. The front-contact and back-contact blades of the stackups may be all formed alike, each provided with a hole 40 (Fig. 2) large enough to freely receive control studs 44.

The counting operation

The counting operation of the device of Figs. 1 to 7, responsive to impulses received by electromagnets 3, will now be described. It will be noted that these electromagnets are connected magnetically in parallel between heel plate 2 and pole piece 6. The arrival of an impulse to be counted results in the energization of both electromagnets 3 in the same sense, whereby they both present the same polarity of magnetomotive force to pole piece 6.

Responsive to each impulse energization of electromagnets 3, each unoperated sequence armature 13 is attracted upwardly since its lower arm is closer to the horizontal portion of pole piece 6 than is the upper arm thereof whereby it remains in normal position. Each work armature 8, however, is attracted downwardly toward operated position. The action of these armatures in counting a series of received impulses will now be described.

First impulse begins

At the beginning of the first received impulse of a series, work armature 8 of the first pair moves downwardly (rotates in a clockwise direction, as seen in Fig. 1, about pivot rod 24) into operated position, coming into intimate contact with the upper surface of the horizontal portion of pole piece 6. This movement occurs against the restraining influence of the associated restoring spring 41. The consequent elevation of spring 41, through the medium of the first control stud 44, raises the intermediate contact blade of stackup S1 from engagement with its underlying back-contact blade into engagement with its overlying front-contact blade.

As previously noted, none of the sequence armatures 13 responds at this time, for each unoperated one of them (and all are unoperated initially) is urged upwardly during a received impulse.

None of the work armatures 8 succeeding the first can respond to the first impulse, as each such succeeding work armature 8 is restrained by its attached side tab 12 from moving downwardly

into operated position prior to the operation of the sequence armature 13 of the immediately preceding armature pair. As previously noted, any side tab 12 is preferably slightly out of contact with the highest portion of the sequence armature over which it extends, wherefore a slight, and ineffectual, downward movement of the succeeding work armatures 8 occurs before such motion is arrested when the side tab 12 of any such armature makes restraining contact. Ideally, the parts should be so dimensioned that no such idle movement occurs, but practically, such movement should be provided for as a matter of manufacturing tolerance, as will be readily appreciated.

First impulse ends

Upon the termination of the first impulse of a received series, the consequent demagnetization of pole piece 6 permits the slightly moved impulse armatures 8 succeeding the first to restore completely. The fully operated first armature 8 however is maintained in its fully operated position by residual magnetism, all such armatures being composed of magnetically "hard" material as previously noted.

With impulse armature 8 of the first pair thus held in operated position, the cessation of the first impulse permits sequence armature 13 of the first pair to obey its associated operating spring 45 by moving clockwise (as seen in Fig. 1) from normal position into operated position. This movement unblocks impulse armature 8 of the second pair to leave it free to respond to the second impulse. Additionally, this movement brings the upper arm (see Fig. 5) of the front portion of the operated first sequence armature 13 closer to the horizontal portion of pole piece 6 than the lower arm thereof then is, whereby the sequence armature is not retracted by succeeding impulses.

Second impulse begins

At the beginning of the second impulse of the received series, the work armature 8 of the second pair, being no longer restrained, executes its counting movement as described for the work armature of the first pair. Such movement causes actuation of the second stackup S2, at the same time unblocking the associated sequence armature 13 of the second pair to permit it to operate upon the termination of the second impulse.

Second impulse ends

When the second impulse ends, the sequence armature 13 of the second pair, having been unblocked by the counting movement of the impulse armature 8 of the same pair, executes its counting movement obedient to the force of its operating spring 45, with results similar to those explained in connection with the operation of the sequence armature 13 of the first pair.

Succeeding impulses

As the succeeding impulses of the series are received, the work armatures 8 and sequence armatures 13 operate successively, as described, each operating at the beginning, or at the end, as the case may be, of its corresponding impulse of the series.

It may be noted at this point, that the only function of the sequence armature 13 of the final pair is to serve as a backstop (by its attached side tab 22) for its associated work armature 8. It may be additionally noted that all parts included in the magnetic circuit, with the exception of

the magnetically "hard" impulse armatures 8, are preferably composed of magnetically soft material.

Clearing out

When the operated device is to be cleared out, the electromagnets 3 are given a mild reversed magnetization, as by providing each with a low-powered winding reversely found. Obedient to this mild magnetization in the opposite direction, the residual magnetism of the operated impulse armatures 8 is at least neutralized, permitting all operated armatures to restore. Such restoration occurs by virtue of the stored downward tension in restoring springs 41, acting in opposition to the comparatively mild upward tension in springs 45.

I claim:

1. In a magnetic counting device, a pole piece and means for imparting impulses of magnetic force thereto, a series of armatures comprising work armatures and sequence armatures appearing alternately and overlapping the pole piece, the armatures lying generally side by side in a row laterally displaced from the pole piece and generally parallel to the near edge thereof, means supporting the armatures for individual movement transversely of the row and of the said edge, each work armature lying entirely on one side of the pole piece and being attractable thereby, each sequence armature having a part lying on one side of the pole piece and a further part lying on the other side, whereby it is attracted in one direction or the other by the pole piece depending upon its position when the pole piece is magnetized, and means including inter-armature linking means, cooperating with biasing means for the sequence armatures and opposed biasing means for the work armatures, for causing said armatures to be moved successively responsive to said impulses to count them, a separate work armature moving responsive to the beginning of each impulse, and a separate sequence armature moving responsive to the termination thereof.

2. In a magnetic counting device, a pole piece and means for imparting impulses of magnetic force thereto, a series of armatures comprising

work armatures and sequence armatures appearing alternately and overlapping the pole piece, the armatures lying generally side by side in a row laterally displaced from the pole piece and generally parallel to the near edge thereof, means supporting the armatures for individual movement transversely of the row and of the said edge, each work armature lying entirely on one side of the pole piece and being attractable thereby in a given direction, each sequence armature having a part lying on the other side of the pole piece, whereby it is attractable in an opposed direction, and means including inter-armature linking means, cooperating with biasing means for the sequence armatures and opposed biasing means for the work armatures, for causing said armatures to be moved successively responsive to said impulses to count them, a separate work armature moving responsive to the beginning of each impulse, and a separate sequence armature moving responsive to the termination thereof.

JOHN I. BELLAMY.

REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
733,563	Sundh	July 14, 1903
978,161	Carichoff	Aug. 29, 1905
936,724	Ihlder	Oct. 12, 1909
1,226,617	Parker	May 15, 1917
1,252,312	Warren	Jan. 1, 1918
1,743,196	Duggan	Jan. 14, 1930
2,067,151	Dicke	Jan. 5, 1937
2,145,950	Persons	Feb. 7, 1939
2,180,288	Beach	Nov. 14, 1939
2,211,701	McGrath	Aug. 13, 1940
2,296,123	Stimson	Sept. 15, 1942
2,305,450	Stibitz	Dec. 15, 1942
2,313,597	Stimson	Mar. 9, 1943
2,360,664	Field	Oct. 17, 1944
2,410,136	Vincent	Oct. 29, 1946
2,435,425	Cunningham	Feb. 3, 1948
2,441,001	Bellamy	May 4, 1948
2,456,169	Bellamy	Dec. 14, 1948
2,487,015	Bellamy	Nov. 1, 1949