

Aug. 14, 1951

C. N. HICKMAN
IMPULSE COUNTING RELAY

2,564,432

Original Filed July 3, 1947

3 Sheets-Sheet 1

FIG. 1

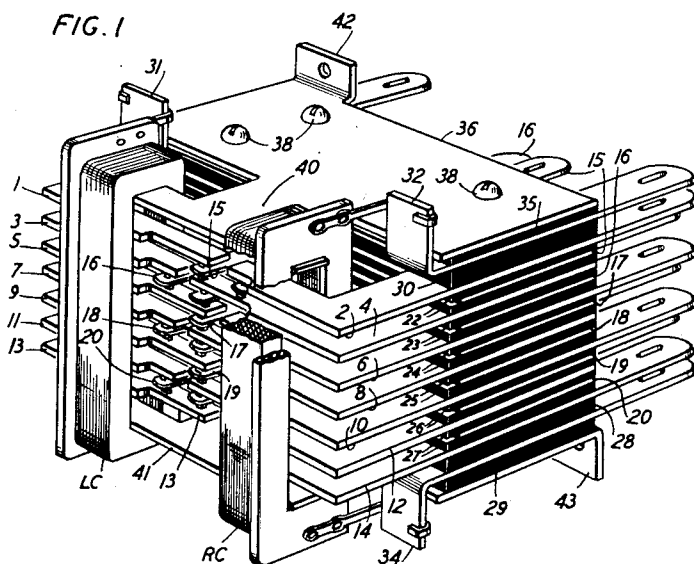
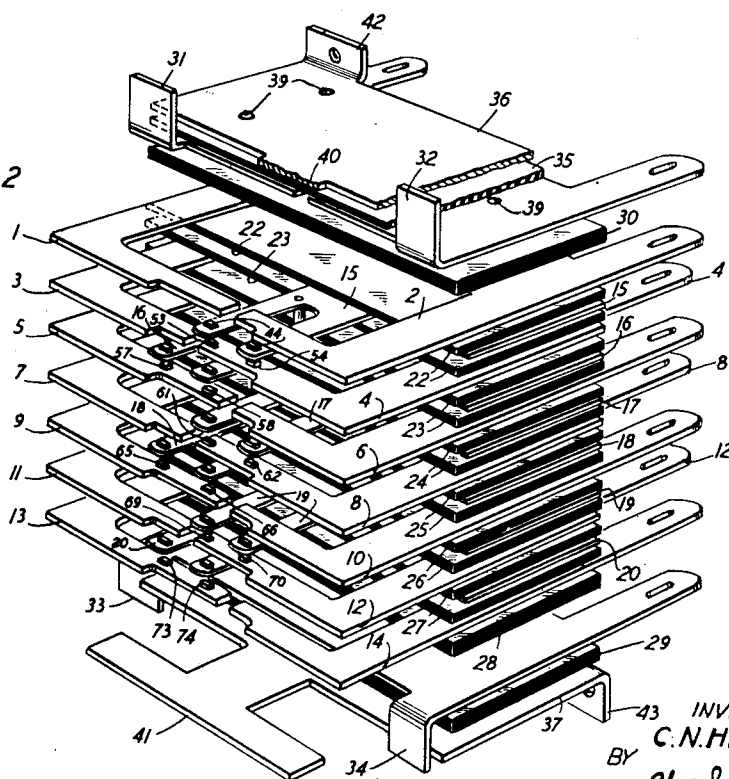


FIG. 2



INVENTOR
C. N. HICKMAN
BY *J. W. Schmeissel*
ATTORNEY

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FIG. 3

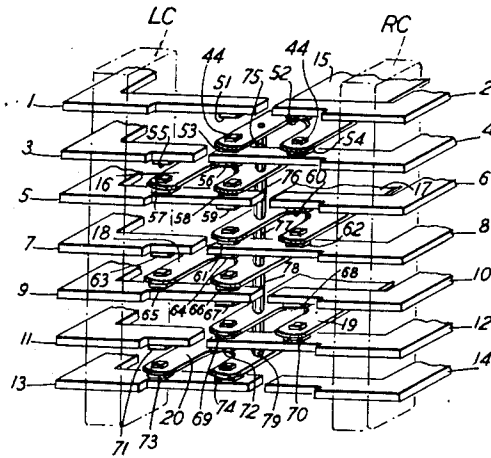


FIG. 4

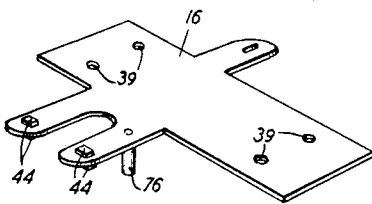
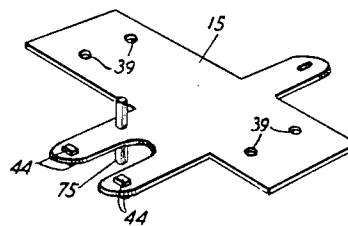


FIG. 5



INVENTOR
C. N. HICKMAN
BY
J. W. Schmitt
ATTORNEY

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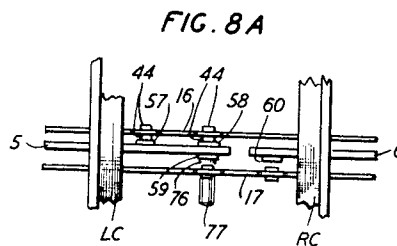
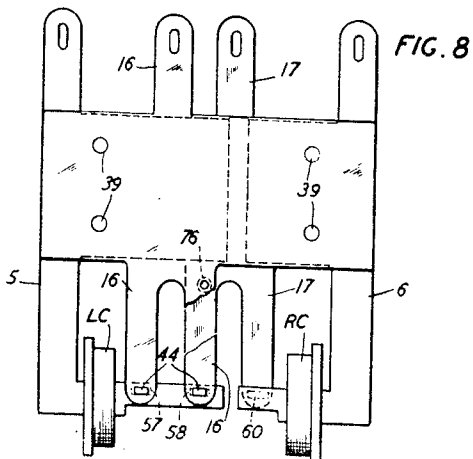
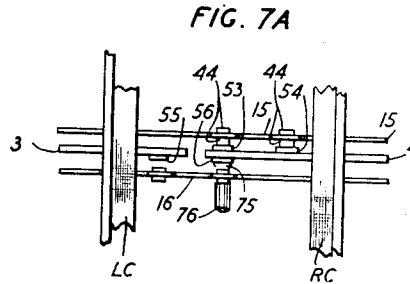
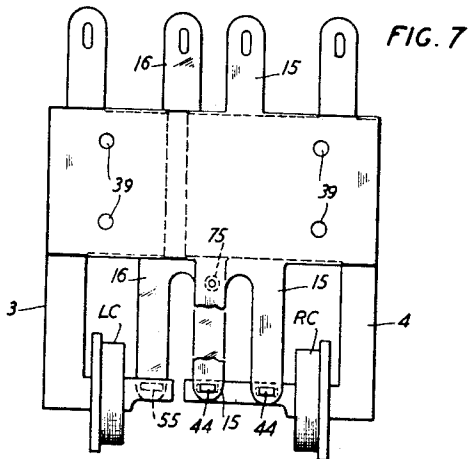
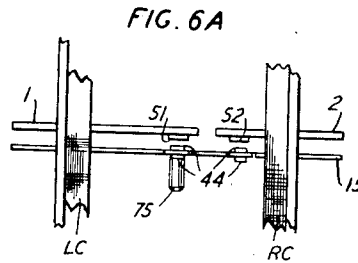
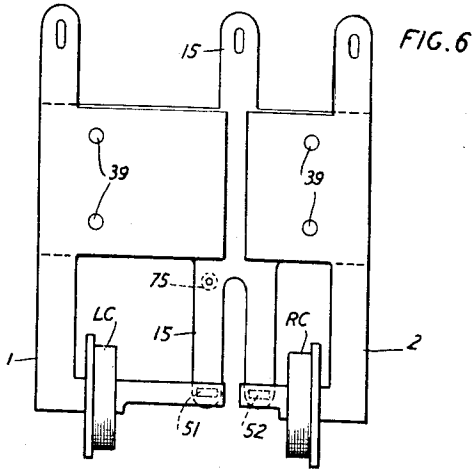
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INVENTOR
C. N. HICKMAN
BY

J. W. Schmitt
ATTORNEY

UNITED STATES PATENT OFFICE

2,564,432

IMPULSE COUNTING RELAY

Clarence N. Hickman, Jackson Heights, N. Y., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

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7 Claims. (Cl. 177—353)

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This invention relates to stepping relays, and more particularly to improvements in magnetic contact counting relays of the type disclosed by G. R. Stibitz in Patent 2,305,450, issued December 15, 1942.

One object of the invention is to provide impulse selective signaling means which are free from rotating mechanical parts and which are more compact and more economical than the ratchet type selector switches now in use.

A further object is to provide an improved type of magnetic contact counting relay suitable for counting electrical impulses, which is more compact, more sensitive, and more reliable than the stepping relays heretofore known to the art.

Automatic telephone signaling systems now in service generally employ ratchet type selector switches which include a rotating contact arm sweeping across fixed contacts step by step as a mechanical ratchet is advanced in response to electrical impulses. Certain disadvantages of such selectors are that they are cumbersome and bulky, require careful adjustment, are slow to respond and require considerable power for their operation due to the mass of moving parts and the distance through which motion is required. Furthermore, noise may be introduced into the communication system through wear of the wiping contacts. Even the most modern of selector switches are delicate, costly pieces of apparatus, and are not well suited to such applications as mobile radio telephone installations.

To overcome these disadvantages the inventor has devised a selective signaling circuit employing magnetic contact counting relays as disclosed by his copending application Serial No. 758,904, filed July 3, 1947, of which the present is a divisional application relating to the improved relay structure employed therein.

The relay of the invention comprises a staggered arrangement of fixed pole-pieces and a bifurcated design for the magnetic armature reed, whereby the over-all height of a relay structure with a given number of contacts may be reduced by one-third, and continuous positive closure is assured at all contacts. Details of the magnetic contact counting relay which comprises the present invention will become apparent from a study of the accompanying drawings as described hereafter.

Fig. 1 is an isometric drawing of a relay of the type embodied in the present invention;

Fig. 2 is an exploded and partly cut-away view of the relay of Fig. 1 more clearly disclosing certain elements thereof;

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Fig. 3 is a front view with perspective to show the assembly of field pole-pieces with their related armatures and insulated studs. All armatures here illustrated are in their normal downward biased positions;

Fig. 4 shows a single armature lamination with insulated stud extending downwardly;

Fig. 5 shows another armature element with an alternative arrangement at the insulating stud. In this case, if the stud extends on both sides of the armature, only alternate armature laminations in a relay stack need be provided with studs. This alternative arrangement may be a more economical form of construction for the manufacture of magnetic contact counting relays of the type herein disclosed;

Fig. 6 is a plan view of one layer of laminations for the relay of Figs. 1 and 2 showing the configuration of pole-pieces 1 and 2 and armature reed 15 immediately below;

Fig. 6A is a front view of Fig. 6 showing the insulated stud 75 which is secured to and extends from armature reed 15.

The assembly illustrated by Figs. 6 and 6A may be the first, or top, layer of a relay stack such as shown by Figs. 1 and 2;

Fig. 7 is a plan view of the next layer of field laminations adjacent to the layer of Fig. 6, showing the armature reed 15 of Fig. 6 in position immediately above the right field lamination 4 and another reed armature 16 offset to the left and immediately below in juxtaposition to the underside of both the left and right field laminations 3 and 4, respectively;

Fig. 7A is a front view of Fig. 7, showing insulating stud 75 extending from armature 15 and bearing upon armature 16, and stud 76 extending from armature 16;

Fig. 8 is a plan view of a third layer of field laminations next adjacent to the layer of Fig. 7, showing the lower armature reed 16 of Fig. 7 adjacent to and above the left field lamination 5 of this third layer, and a fifth armature reed 17 offset to the right and below in juxtaposition to the underside of both field laminations 5 and 6 of this layer;

Fig. 8A is a front view of Fig. 8 showing insulated stud 76 extending from armature 16 and bearing upon armature 17, with stud 77 extending from armature 17.

The fourth layer of the laminated stack is not shown in separate drawings but would appear the same as the first layer illustrated by Figs. 6 and 6A. Similarly, the fifth layer corresponds

to the second layer as illustrated by Figs. 7 and 7A, etc.

The structure and operation of the magnetic contact counting relay, which comprises the present invention will now be described. Referring to Figs. 1 to 8, it will be seen that the relay structure includes an upper left field lamination 1, and an upper right field lamination 2, positioned in the same plane but not in conductive engagement with each other, spaced below these laminations, in a plane parallel to the first layer, another pair of left and right field laminations 3 and 4, respectively, but not in conductive engagement with each other, and interposed between the two layers an armature lamination 15, the shape of which is clearly disclosed by the perspective drawings Figs. 4 and 5, and by the plan view of Fig. 6. The armature lamination 15 is insulated from the adjacent field laminations by interposed laminations 22 of insulating material. Armature reed 16 similar to 15 but offset to the left is interposed between the second and third layers of field laminations 3, 4 and 5, 6. Similarly, armature reeds 18 and 20, which are identical with 16, are offset to the left and interposed between the fourth and fifth layers and sixth and seventh layers of field laminations, respectively. In like manner, armature reeds 17 and 19, which are identical with reed 15, are respectively interposed between the third and fourth, and fifth and sixth, layers of field laminations. The armature reeds in each layer are insulated from their adjacent field laminations by interposed laminations of insulating material 22 through 27. The top and bottom of the stack are bounded by clamping plates 36 and 37, respectively, formed of non-magnetic material, and held in a rigid assembly by screws 38. Clamping plates 36 and 37 are insulated from the remaining structure by insulating laminations 25 and 29. Interposed between the top clamping plates and the top layer of field laminations are left and right coil terminal supports 31 and 32, respectively, insulated from each other and from the remaining structure by insulating laminations 35 and 30. At the opposite end of the stack, between the bottom clamping plate and the bottom layer of field laminations, are placed bottom coil terminal supports 33 and 34, insulated from each other and from the remaining structure by laminations of insulating material 28 and 29.

Surrounding the pole-pieces of the left field laminations is energizing coil LC, as shown in Fig. 1, supported by forward extending T portions of top and bottom clamping plates 40 and 41, and by terminals secured to brackets 31 and 33. Surrounding the pole-pieces of the right field laminations is energizing coil RC shown partially cut away in Fig. 1, supported by the same forward-extending T portions 40 and 41, and by terminals secured to brackets 32 and 34. Coils LC and RC may, if desired, be wound upon copper sleeves to provide slow-release characteristics for either side of the relay device. As will be seen in the detailed description of the preferred arrangement of my selective signaling system which follows, coil LC of one such relay is provided with such a slow-releasing copper sleeve.

The completed assembly is clamped together by means of bolts 39 which extend through aligned holes 39 in the assembled members and which may be threaded into tapped holes in the lower clamping plate 37 or into locking nuts at their lower ends. These bolts are insulated from the assembled members through which they pass by

means of insulating sleeves. The upper and lower clamping plates 36 and 37 are provided with out-turned ears 42 and 43 which serve as mounting brackets by means of which the complete relay structure may be secured to a suitable relay rack. The end clamping plates are formed of non-magnetic material, whereas the armature reeds and field piece laminations are formed of magnetic material having a high degree of permeability.

The armature reeds extend forwardly in a position to move freely between the faces of the left and right energizing coils LC and RC, and between the pole-pieces of the associated field laminations. Secured to both the top and bottom surfaces of the forward-extending end of each armature reed are contacts 44 of magnetic material, shown clearly in Figs. 3 and 4. Secured to corresponding surfaces of adjacent pole-pieces, as seen in Figs. 2, 3 and 7A, are similar contacts of magnetic material 53 and 54 so placed as to engage conductively with corresponding armature reed contacts 44.

This structure differs from the relay disclosed by Stibitz in Patent 2,305,450 in that my armature reeds and associated pole-pieces are grouped in a staggered arrangement which permits a reduction of one-third in the over-all height of a relay for any given purpose. This makes for a more compact structure which is more economical of manufacture and more reliable in operation. The manner in which these advantages are brought about will be more clearly understood from a detailed analysis of the relay operation which follows.

In idle condition, with neither left nor right operating coils energized, the armature reeds may extend freely between alternate layers of pole-pieces without conductive engagement between contacts. However, to make the relay less sensitive to vibration or mechanical shock these armature reeds are normally biased into conductive engagement with the lower pole-piece in each layer as illustrated by Fig. 3.

Reference is now made to Fig. 3 which is a perspective drawing illustrative of the essential operating elements embodied in a three-digit counting relay such as Fig. 1, viewed from the front. It will be observed from Figs. 3, 4, 6A, 7A and 8A that an insulated stud is secured to the underside of each armature reed in such manner that its free end extends downwardly between layers and rests upon the next armature immediately below. These studs are hidden from view in drawings Fig. 1 and Fig. 2 but are clearly represented in Fig. 3 by element 75 secured to armature 15, 76 secured to armature 16, 77 secured to armature 17, 78 secured to armature 18 and 79 secured to armature 19.

By the alternative form of construction illustrated in Fig. 5, the insulating stud may be made to extend through the armature reed so as to protrude an equal distance both above and below the armature lamination, with which arrangement studs need be provided only for every alternate armature lamination in a given stack. This construction may be more economical of manufacture, but in either arrangement, whether each armature be provided with an insulating stud extending in one direction only or whether alternate armatures be provided with through-extending studs protruding in both directions, the operation of the relay device will be the same.

Now, to analyze the operation of this relay we start from idle condition with all armatures

biased downwardly into conductive engagement with the adjacent pole-piece immediately beneath each armature. It will be seen that if the right-hand energizing coil RC is first energized, no action will take place because the top armature 15 will be held against its lower right-hand pole-piece 4 in conductive engagement with magnetic contacts 53 and 54 through the magnetic attraction of this pole. Although this pole-piece 4 is also exerting an upward attraction for armature 16, it will be seen that this armature is prevented from moving upwardly through the downward force exerted by insulated stud 75. Similarly, armature 18 which is now attracted by right-hand pole-piece 8 is prevented from rising through the intervention of insulated stud 77 which is secured to armature 17 now held in conductive engagement with pole-piece 8 through magnetic contacts 61 and 62 and also held down by stud 76 depending from armature 16. In like manner, each successive armature is disabled by the downward force from each insulating stud secured to the armature immediately above. Now if the left-hand energizing coil is next energized, it will be seen that no action takes place because top armature 15, although subjected to an upward force from the magnetic pull of left-hand pole-piece 1, is still held in conductive engagement with right-hand pole-piece 4 so long as right-hand energizing coil RC is energized. However, if coil RC is next deenergized, armature 15 will then be attracted upwardly into conductive engagement with left-hand pole-piece 1 through magnetic contact 51. This lifts insulating stud 75 from the top of armature 16 but no motion of armature 16 occurs because this armature is now held in conductive engagement with left-hand pole-piece 5, through magnetic contacts 57 and 58. Now if coil RC is energized, no further action will take place until coil LC is deenergized at which time armature 16 will be attracted upwardly into conductive engagement with right-hand pole-piece 4 through magnetic contact 56. When armature 16 comes up, its insulated stud 76 is lifted from armature 17 thus enabling armature 17 to operate upon the next sequential energization of coil LC followed by deenergization of coil RC. In this manner subsequent armatures may be successively enabled and operated through sequential energization and deenergization alternately of coils LC and RC. Thus if the two energizing coils are properly connected with a continuity changeover pulsing relay, a means is provided for counting electrical impulses as received. In such an arrangement one relay armature comes up when an electrical impulse starts and the next armature immediately below comes up when the impulse ends, thus two armatures are employed for counting each impulse. The structure of Fig. 3 which we have just examined, contains only six armatures which would enable this device to count only three pulses.

It will be apparent that modifications and variations of the arrangements herein disclosed may be made by those skilled in the art without departing from the scope of the invention.

What is claimed is:

1. An impulse counting relay comprising two groups of magnetic members, means insulating said members and groups from each other, members of each group comprising alternate layers of long and short pole-pieces arranged with the long pole-pieces of each group adjacent to short pole-pieces of the other group, armatures of magnetic material interposed in staggered relation-

ship between layers of said members with each armature underlying adjacent pole-pieces of both groups on one side and overlying a single pole-piece of one group on the other side, said armatures normally insulated from said members and pole-pieces but attractable into conductive engagement therewith, separate energizing coils surrounding each group of said members, mechanical coupling means extending between adjacent armatures whereby upon the alternate energization and deenergization of said coils said armatures are sequentially attracted into conductive engagement with adjacent pole-pieces of both groups of members.

2. A counting relay comprising in two piles magnetic laminations of alternate long and short pole-pieces stacked adjacent to but insulated from each other, with the long pole-pieces of each pile adjacent respectively to the short pole-pieces of the opposite pile, armature springs of magnetic material interposed in staggered arrangement between layers of said laminations with each armature spring underlying adjacent pole-pieces of both piles in one layer and overlying a pole-piece of but one pile in the adjoining layer, said armature springs insulated from each other and from said laminations but attractable into conductive engagement therewith, an insulated coupling stud secured to each of said armature springs, each of said studs bearing upon an adjacent armature spring whereby said springs are normally held in engagement with their respective underlying pole-pieces, and separate energizing coils surrounding each pile of magnetic laminations whereby upon alternate energization and deenergization of said coils said springs are sequentially attracted into conductive engagement with adjacent pairs of pole-pieces in both piles.

3. A relay comprising two adjacent stacks of field laminations of magnetic material having alternate layers of long and short pole-pieces of one stack opposite respectively to alternate short and long pole-pieces of the opposite stack, armature tongues of magnetic material interposed between layers of said field laminations in a manner such that each armature underlies both long and short pole-pieces of a layer in both stacks and overlies only a long pole-piece of one stack in the adjoining layer, means separating said pole-pieces and armatures from each other respectively, further means for sequentially attracting said armature tongues into conductive engagement with adjacent pole-pieces of both stacks, said further means comprising insulated mechanical studs extending between adjacent armature tongues whereby said tongues are normally held disengaged from adjacent pairs of pole-pieces, and separate energizing coils surrounding each stack of field laminations whereby upon alternate energization and deenergization of said coils said tongues are successively attracted into conductive engagement with adjacent pairs of pole-pieces in both stacks.

4. An impulse counting relay comprising two groups of field laminations of magnetic material, stacked in adjacent piles having alternate layers of long and short lamination pole-pieces in each group, with alternate short and long pole-pieces of one group opposite alternate short and long pole-pieces of the other group respectively, laminations of insulating material interposed between said field laminations, reeds of magnetic material interleaved between layers of said field laminations in both groups and normally sep-

arated therefrom but attractable into conductive engagement therewith, each of said reeds underlying pole-pieces of both groups in one layer and overlying a pole-piece of but one group, an electrical terminal extending from each of said laminations, insulated mechanical coupling means extending between adjacent reeds whereby said reeds are normally restrained from conductive engagement with overlying pole-pieces of both groups, and separate energizing coils surrounding each of said groups of field laminations respectively whereby upon energization and deenergization of said coils alternately said reeds are successively attracted into conductive engagement with their respective overlying pairs of pole-pieces to sequentially establish electrical continuity between pairs of terminals in each layer of laminations.

5. An impulse receiving means comprising a plurality of field laminations of magnetic material stacked in two adjacent groups of alternate long and short pole-pieces with the long pole-pieces of one stack aligned opposite short pole-pieces of the other stack, laminations of insulating material interposed between adjacent layers of said magnetic laminations, magnetic armatures interposed between adjacent layers of said field laminations and insulated therefrom but attractable into conductive engagement therewith, said armatures each underlying both long and short pole-pieces of a layer in both groups of laminations and overlying a long pole-piece of but one group of laminations, electrical terminals extending externally from each of said laminations and armatures, mechanical coupling means extending between adjacent armatures whereby said armatures are normally restrained from conductive engagement with adjacent pairs of overlying pole-pieces, and energizing coils surrounding each group of field laminations whereby upon alternate energization and deenergization of said coils said armatures are successively attracted into conductive engagement with their respective pairs of overlying pole-pieces to sequentially establish electrical continuity between each of said armatures and a pair of terminals in each layer of field laminations.

6. An impulse counting device comprising magnetic field laminations of alternate long and short pole-pieces stacked in two piles adjacent to but insulated from each other, with the long pole-pieces of each pile adjacent respectively to the short pole-pieces of the opposite pile, armature springs of magnetic material interposed in staggered arrangement between layers of said field

laminations and insulated therefrom but attractable into conductive engagement therewith, each of said armature springs underlying pole-pieces of both piles and overlying a pole-piece of but one pile, insulated coupling studs secured to said armature springs and bearing upon the adjacent armature springs in a manner to maintain each spring's engagement with its underlying pole-piece, a plurality of external terminals connected with each of said laminations, and a pair of energizing coils surrounding laminations of each pile whereby upon alternate energization and deenergization of said coils said armatures are sequentially attracted into conductive engagement with adjacent pairs of overlying pole-pieces to successively establish electrical continuity between corresponding pairs of said external terminals.

7. Impulse responsive means comprising in stacked relationship a plurality of magnetic laminations in two adjoining groups, said laminations in each group comprising alternate layers of long and short pole-pieces with the long pole-pieces of each group adjacent respectively to the short pole-pieces of the adjoining group, means insulating said laminations from each other, bifurcated armature tongues of magnetic material interposed between layers of said laminations and insulated therefrom but attractable into conductive engagement therewith, each of said armature tongues underlying pole-pieces of both groups and overlying a pole-piece of one group, insulated mechanical studs extending between adjacent armature tongues in a manner to restrain each tongue from engagement with its overlying pair of pole-pieces and to normally maintain each tongue's engagement with its underlying pole-piece, a plurality of incomplete electrical paths between adjacent pairs of said laminations, and a pair of energizing coils, one coil surrounding laminations of each group, whereby upon alternate energization and deenergization of said coils said armatures are sequentially attracted into conductive engagement with adjacent pairs of overlying pole-pieces to complete said electrical paths between successive pairs of said magnetic laminations.

CLARENCE N. HICKMAN.

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

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