

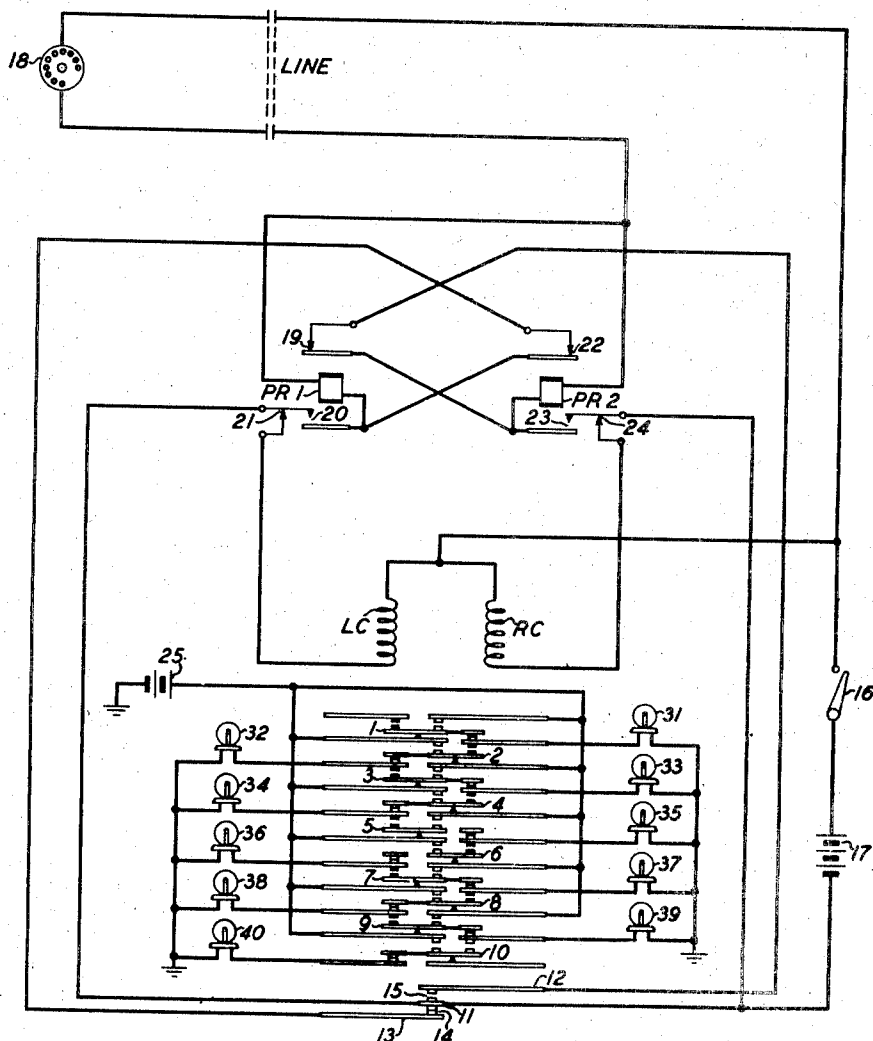
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ELECTRICAL IMPULSE COUNTING SYSTEM

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ELECTRICAL IMPULSE COUNTING SYSTEM

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1

This is a divisional application of the inventor's copending patent application Serial No. 16,091, filed March 20, 1948.

This invention relates to electrical impulse signaling systems and more particularly to improvements in magnetic counting relays and circuits for selective calling of telephone or telegraph stations of the type disclosed by C. N. Hickman in copending application Serial No. 758,904, filed July 3, 1947.

An object of this invention is to provide an electrical impulse counting system responsive to a continuous train of electrical impulses received in uninterrupted sequence.

Another object of the invention is to eliminate the requirement for a slow-release characteristic in magnetic contact counting relays heretofore employed in a telephone station calling system.

Another object of the invention is to provide an improved magnetic contact relay structure wherein the tendency of such contacts to stick is overcome and wherein a positive break of successive contacts is assured for each impulse cycle.

A further object of the invention is to reduce the space required for selective signaling apparatus of the magnetic contact relay type.

In the use of magnetic contact counting relays of the type disclosed by G. R. Stibitz in Patent 2,305,450, issued December 15, 1942, for selective signaling purposes, it has been found that the magnetic contacts sometimes display a tendency to stick when they should open, and this tendency has reduced the speed at which such relays could be operated and even, in some cases, has caused faulty or incorrect operation. This tendency for magnetic contacts to stick has been attributed to residual magnetism remaining in the contact members after deenergization of the operating coil, and in part to leakage flux through magnetic members of one side of the structure from the energizing coil associated with members of the opposite side of the relay structure. Heretofore, the effects of residual magnetism and leakage flux which cause this tendency for contacts to stick have been overcome solely by the application of a more powerful magnetic field to operate the relay against these restraining forces. It is apparent that this solution to the problem has required more power for the operation of the relay than would otherwise have been necessary. In the present invention an additional element has been introduced into the relay whereby the effects of

2

these undesirable forces are overcome and the relay is rendered operable by less power.

Another difficulty encountered in the use of magnetic contact counting relays for a selective signaling system is the necessity of providing a slow release characteristic for one side of such a relay when used for digit counting, as disclosed by the copending application of C. N. Hickman, Serial No. 758,904 filed July 3, 1947. Because of the inherent fast operate characteristic of these relays, and because of the relatively low current required for their operation, and the comparatively weak magnetic fields which are set up, as compared with other types of relays, it is more difficult to provide a slow release characteristic for relays of the magnetic contact counting variety than it is for other types. To overcome this difficulty the inventor has devised a new and improved electrical impulse signaling circuit in which magnetic contact counting relays without any slow release characteristic are employed.

In all similar systems for signaling or impulse counting, heretofore disclosed in the art, it has been necessary to employ two relay armatures to count each individual electrical impulse, i. e., one armature would operate at the beginning of each impulse and a second armature would operate at the end of each impulse. Although this arrangement is quite satisfactory for systems employing a short train of impulses for each digit or group, it becomes apparent that if larger groups of impulses are required, as may be the case in many signaling applications, the size of the necessary relay stack with two armatures per pulse may become unwieldy, or even so large as to be inoperable. Therefore, the inventor has devised an improved impulse counting circuit wherein only one armature of the counting relay is operated by each complete pulsing cycle. With this arrangement the over-all height of a relay stack as may be required for any particular impulse counting operation may be reduced to approximately one-half that formerly required. With this reduction in over-all size and its attendant reduction in space requirements and cost of apparatus, there is also gained a greater concentration of magnetic field which results in more efficient operation of the relay, less operating current being required than in the case of the larger structures.

The nature and operation of the present invention may be more clearly understood from a consideration of the detailed description which

3

follows when studied in connection with the related drawing wherein:

Fig. 1 is a schematic diagram showing the manner in which a magnetic contact counting relay of the type embodied in the present invention may be interconnected with two pulsing relays so that only one armature tongue of the counting relay will come up for each complete pulsing cycle. In this arrangement, as illustrated, a relay stack having only ten armature tongues may be employed to count as many as ten impulses, whereas in all arrangements previously disclosed such a relay structure would be limited to counting a maximum of only five impulses. Here, again, the insulating studs between armatures have been omitted for the sake of clarity in the circuit drawing. It will be noted that all of the armature tongues, with the exception of tongue III, have associated insulated studs as shown by Figs. 1-6 of copending application Serial No. 16,091, filed March 20, 1948.

The general principles involved, and the method of operation in magnetic contact counting relays for impulse counting and signaling are described in copending application of C. N. Hickman Serial No. 758,904, and by reference thereto the disclosure and drawings of said application are hereby incorporated into the specification of the present application. In the stepping relays previously disclosed, the advantage of magnetic contacts, which provide a high contact pressure for a relatively low operating current, were offset to a large degree by the disadvantage of residual magnetism and leakage flux which tended to hold the back contacts closed at a time when they should be opening for the stepping operation. Heretofore the problem has been to provide a relay with sufficient contact pressure between the pole-pieces and back contacts of the armature to satisfy the requirement of noise-free telephone circuits, and at the same time assure positive stepping operation of the relay on each energizing cycle of the operating coil. One possible solution to the problem of residual magnetism and leakage flux is the substitution of non-magnetic discs for the magnetic back contacts as disclosed in the prior art. However, this solution limits the use of the stepping relay to those applications where back contacts are not required in the circuit.

In the present invention the problems discussed above are solved by the addition of auxiliary branch legs, the operation of which is described in detail by my copending patent application Serial No. 16,091 of which the present is a division. Each of these auxiliary branches carries a magnetic contact on the lower face of its forward extremity, which engages a corresponding magnetic contact on the upper face of the pole-piece to which the auxiliary leg is adjacent. In the entire relay structure, when completely assembled, these auxiliary branch legs may normally be biased downwardly by the spring tension of the leg itself, although such spring tension is not essential inasmuch as an ample contact pressure may be assured by the passage of magnetic flux through this auxiliary branch member and its associated magnetic contacts with the adjacent magnetic pole-piece. It will be observed that the main armature tongues in each layer of the relay stack, as represented by 1, 2, 3, 4, 5, and 6 in this view, all carry magnetic contacts on the upper faces of their forward extremities in a position to engage corre-

4

sponding magnetic contacts on the lower faces of the pole-pieces adjacent to and next above each of the main armature tongues. It will also be observed that the main armature tongues are provided with non-magnetic spacers on the underfaces of their forward extremities. These main armature tongues are normally biased in a downward direction so that even when the relay is completely deenergized, the non-magnetic spacers are held against the pole-piece below the armature tongue by means of the spring tension in the tongue. The high reluctance introduced into the magnetic circuit between each of the main armature tongues and the magnetic pole-piece immediately below by means of the non-magnetic spacers eliminates the undesirable effects of residual magnetism and leakage flux as heretofore encountered. Thus, the main armatures are freed from the retarding magnetic influences formerly exerted through magnetic back contacts and thereby are enabled to come up quickly in succession in response to pulsations of the operating coils.

As in previous magnetic stepping relays, successive operation of the armature tongues is assured by non-magnetic insulating studs, not shown, which are interposed between armatures in adjacent layers of the relay stack and by means of which all armatures except one are disabled from operating at any time, and operation of the one free armature lifts a restraining stud from the next adjacent armature thereby enabling it to operate on the next pulsing cycle.

Referring to Fig. 1 we see a circuit employing a magnetic contact stepping relay of the type disclosed by my copending application Serial No. 16,091, filed March 20, 1948. This circuit differs from all previous pulse counting circuits of the prior art employing magnetic stepping relays in that the counting relay of Fig. 1 requires only one main armature tongue for each complete pulse to be counted. That is to say, the ten armature tongues in the relay stack of Fig. 1 will count ten impulses, one tongue responding to each impulse as received, whereas in the prior art, all previous arrangements of magnetic stepping relays have required the operation of two armature tongues for each complete pulse. An obvious advantage of the arrangement of Fig. 1 is the reduction by one half of the number of armature tongues required to count any given number of impulses. A further advantage is that by operating only one tongue per impulse, the circuit of Fig. 1 may inherently require less time per pulse for counting, thus it is apparent that with the arrangement disclosed in Fig. 1 not only may the size and cost of a magnetic contact stepping relay be reduced but also the speed of operation may be increased.

In Fig. 1 the insulated studs which extend between armature tongues in adjacent layers of the relay stack have been omitted from the drawing for the sake of clarity and to avoid confusion in tracing the schematic circuit. However, it is to be understood that insulating studs of the type disclosed in Figs. 1, 2, 3, 4, 5 and 6 of my copending parent application Serial No. 16,091 are also incorporated in the magnetic stepping relay of Fig. 1. It is also to be understood that the left and right operating coils, designated schematically as LC and RC respectively in Fig. 1, are wound around the laminated pole-pieces of the left- and right-hand sides of the relay stack

5

respectively, in a manner similar to the arrangement disclosed by my copending application Serial No. 16,091. The stepping relay structure of Fig. 1 differs from those previously disclosed by the prior art in that it includes an auxiliary armature tongue 11 interposed between an auxiliary right-hand pole-piece 12 and left-hand pole-piece 13. This auxiliary armature and its associated pole-pieces may be placed either at the bottom of the stepping relay stack as illustrated in Fig. 1, or it may be placed at the top of said stack, or it may be situated anywhere else in the stepping relay structure, provided only that it must not interfere with the stepping operation of the relay. The function of this auxiliary armature tongue 11 is to indicate at all times which of the two operating coils, LC and RC, was the first to be energized whenever both are operating. By reference to Fig. 1, it will be seen that if the left coil LC is first energized, the auxiliary armature tongue 11 will be moved down into conductive engagement with left-hand pole-piece 13, thereby closing contact 14. If the right coil RC is next energized, tongue 11 will not move since the magnetic force due to the closed contact 14 is much greater than the magnetic force through the open contact 15. However, if the left coil LC is then deenergized, armature tongue 11 will come up into intimate contact with right-hand pole-piece 12 thereby closing contact 15. In this situation if the left coil LC is then reenergized, the armature tongue 11 will not again move until such time as right coil RC is deenergized. Thus it is seen that armature 11 always indicates which of the two coils LC and RC was the first to be energized. By means of the two contacts 14 and 15 associated with the auxiliary armature 11, the two pulsing relays PR1 and PR2 are alternately operated on each successive impulse. When starting from idle condition, operation of the correct pulsing relay initially is assured by providing armature 11 with a slight pretension in one direction, in the circuit illustrated by the drawing this pretension being downwardly, to insure that contact 14 is always closed when the circuit is idle.

The detailed operation of the circuit of Fig. 1 will now be traced through a step-by-step analysis. The circuit is first conditioned for operation by closing a switch 16 which completes a circuit through coils LC and RC and the battery 17. Armature tongue 11 remains in intimate contact with left-hand pole-piece 13 toward which it was initially biased by spring tension. Now if the operator's dial 18, which may be located at a remote office is operated, a circuit will be closed through the dial at the start of the first dial pulse, and pulsing relay PR1 will now be energized through contact 14. Upon operation of PR1, contact 19 first opens, then contact 20 closes to lock up PR1 to battery 17, and then contact 21 opens, thereby deenergizing coil LC, which in turn causes armature 1 to be attracted upwardly into intimate contact with the upper right-hand pole-piece. With LC now deenergized, auxiliary armature tongue 11 is attracted upwardly into intimate contact with right-hand pole-piece 12 thereby closing contact 15. However, this opening of contact 14 has no effect on pulsing relay PR1 which as we have just seen has already locked up through contact 20. At this instant, the closing of contact 15 has no effect on pulsing relay PR2 since contact 19 of PR1 is open, thereby introducing a discontinuity in the circuit through the operating coil of PR2.

6

Now, at the end of the first dial pulse, the circuit through dial 18 will open, whereupon pulsing relay PR1 is deenergized, contact 21 closes and energizes coil LC, contact 20 opens, and contact 19 closes, but pulsing relay PR2 cannot yet operate because the dial contact 18 is still open. The energizing of LC at this moment has no effect on the auxiliary armature tongue 11 since RC is still energized. However, with the start of the second dial pulse, a circuit is closed through the dial contacts at 18 whereupon pulsing relay PR2 is operated through contact 15.

Upon operation of PR2 contact 22 opens, contact 23 closes thereby locking up PR2, and contact 24 opens to deenergize coil RC. Upon deenergization of coil RC the auxiliary armature tongue 11 comes down into engagement with the left-hand pole-piece 13 to close contact 14 and the armature 2 is attracted upwardly into intimate contact with the left-hand pole-piece. Contact 15 is thereby opened but this has no effect on pulsing relay PR2 since, as we have seen above, this relay has already locked up through its contact 23. The closing of contact 14 at this moment has no effect on the operation of pulsing relay PR1, since contact 22 of PR2 is now open thus introducing a discontinuity in the circuit of the operating coil of PR1. As we have seen above, at the end of this dial pulse the circuit through dial 18 is momentarily opened whereupon pulsing relay PR2 is deenergized, contact 24 closes and energizes coil RC, contact 23 opens, and contact 22 closes but cannot operate pulsing relay PR1 because at this moment the dial contact 18 is open. Similarly, at this instant the energizing of coil RC has no effect on the auxiliary armature 11 since coil LC is still energized and armature 11 is thereby held in intimate magnetic contact with left-hand pole-piece 13. We have now completed one cycle of two dial pulses, and at this time the first two armature tongues 1 and 2 are up and a circuit is completed from battery 25 through armature tongue 2 and lamp 32 to ground, thereby indicating that two pulses have been received and counted. On reception of successive impulses the same sequence of operation will follow. This sequence may be tabulated as follows:

Step	Left Coil (LC)	Right Coil (RC)	Pulse
1	energized	energized	start (SW 16 closed).
2	deenergized	do	1st pulse-dial contact closed.
3	energized	do	1st pulse-dial contact opened.
4	do	deenergized	2nd pulse-dial contact closed.
5	do	energized	2nd pulse-dial contact opened.

This sequence results in only one armature tongue of the counting relay coming up for each complete pulse, thereby reducing the number of tongues necessary to count a given number of pulses, and at the same time increasing the speed at which such pulses may be counted. This arrangement may be of considerable advantage in applications where large numbers of pulses must be counted or where the saving in space and cost of the smaller sized counting relay may more than offset the addition of a second pulsing relay. Referring to the drawing, the dark magnetic contacts represent magnetic contacts covered by a thin insulating material for the purpose of circuit isolation.

It is to be understood that the scope of the present invention is not limited to the particular arrangement illustrated by the accompanying

7

drawing, but that numerous modifications may be made, both in the design of the relay structure and in the arrangement of the operating circuit, without departing from the spirit of the present invention as defined by the specification and the appended claims.

What is claimed is:

1. In an impulse switching system, a magnetic contact counting relay having an auxiliary armature capable of attraction into conductive engagement with either of two adjacent pole-pieces, a first pulsing relay connected through one of said pole-pieces and auxiliary armature to one operating coil of said counting relay, and a second pulsing relay connected through the other of said pole-pieces and said auxiliary armature to another operating coil of said counting relay whereby alternate deenergization of said coils may be effected to operate a different armature of said counting relay in response to each impulse.

2. In an impulse switching system, a magnetic contact counting relay having an auxiliary armature capable of attraction into conductive engagement with either of two adjacent pole-pieces under the magnetic influence of either of two operating coils, two transfer relays connected with said operating coils, said auxiliary armature and a source of sequential electrical impulses, whereby said transfer relays alternately respond to alternate impulses of a sequence and thereby al-

8

ternately deenergize operating coils of said counting relay to count the number of impulses in said sequence.

3. In an electrical impulse switching system, means for counting the number of successive impulses in a sequence, comprising two rows of rigid magnetic members, a plurality of magnetic armatures interposed between said rows and said members, said armatures insulated from said members and from each other but attractable into conductive engagement with adjacent magnetic members of either row, an energizing coil surrounding one row of said magnetic members, a second energizing coil surrounding said armatures, and mechanical coupling means interposed between adjacent armatures whereby upon successive energization and deenergization of said second coil, a number of said armatures are successively attracted into conductive engagement with adjacent members corresponding to the number of impulses in said sequence.

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REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
2,305,450	Stibitz	Dec. 15, 1942