Jan. 16, 1940. W. B. ELLWOOD ET AL 2,187,115

SWITCHING DEVICE

Filed March 2, 1939 2 Sheets-Sheet 1

FIG. 1

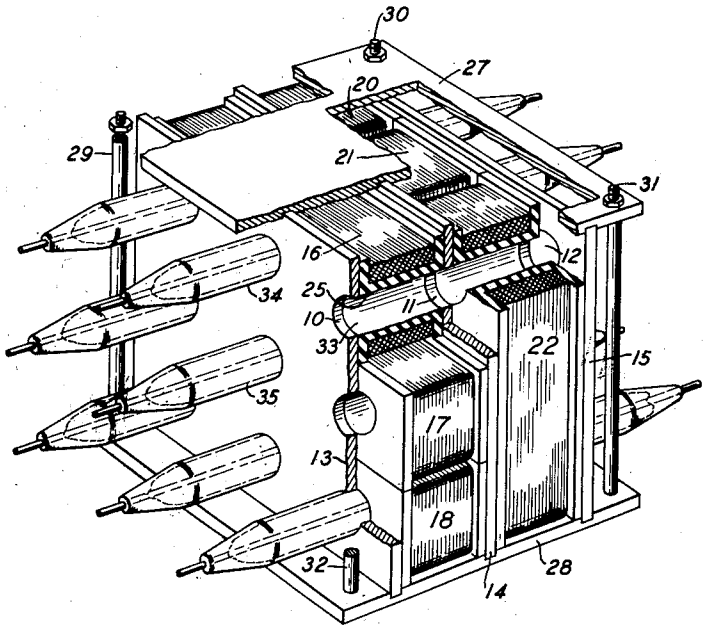
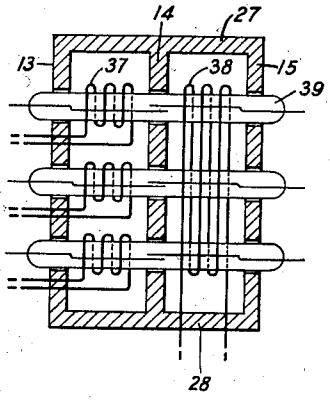


FIG. 2



INVENTORS: W. B. ELLWOOD
W. H. T. HOLDEN

BY

W. T. McKenney

ATTORNEY

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FIG. 3

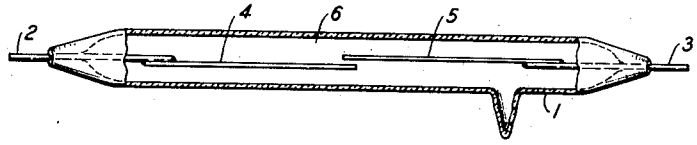
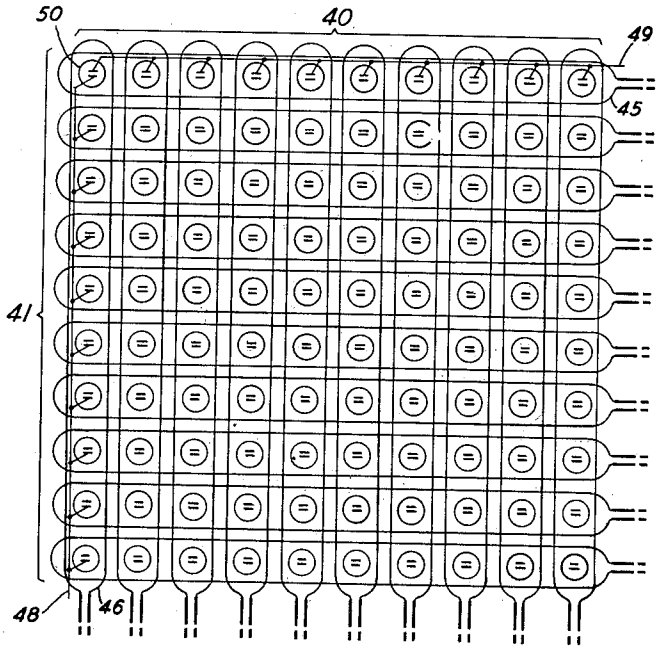


FIG. 4



INVENTORS: W. B. ELLWOOD
W. H. T. HOLDEN
BY
M. T. McKenney
ATTORNEY

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UNITED STATES PATENT OFFICE

2,187,115

SWITCHING DEVICE

Walter B. Ellwood, New York, and William H. T. Holden, Long Island City, N. Y., assignors to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application March 2, 1939, Serial No. 259,314

8 Claims. (Cl. 179—27.54)

This invention relates to improvements in switching devices and in particular to switches in which the coordinate principle is used for establishing electrical connections.

It is an object of this invention to improve switches of this kind to function with greater accuracy and reliability and with a minimum number of movable parts.

Heretofore coordinate switching arrangements have been used in which no moving parts except the contacts at cross-points are employed. Means have been provided for establishing circuit connections at intersecting points in which a set of relays, each having two windings, are arranged in horizontal and vertical rows. Two groups of circuits for these relays may be provided. Each circuit in one group includes one of the windings on a row of relays arranged in a horizontal direction and each circuit in the other group includes the other windings of a row of relays arranged in a vertical direction. In the telegraph art, for example, such circuits have been used for selecting and operating a relay at an intersecting point over horizontally and vertically connected windings to actuate keys for selecting characters for printing. Similar systems have also been used in so-called all-relay automatic art for establishing telephone connections.

This invention relates to switching devices of the type employing the coordinate principle in which no moving parts except the contacts at cross-points are employed to establish connections and a feature of the invention is to arrange two groups of long coils to cross each other to form parallelepipedal apertures at each point where a coil of one group crosses a coil of the other group and an air-tight vessel in each aperture containing electromagnetically responsive circuit closing contacts, the contacts in a particular vessel being operated to close a circuit connection when a corresponding coil of one group and a corresponding coil of the other group are energized. The contact devices and coils may be so constructed and the energizing current may be so adjusted that a connection will be maintained between the contacts in a vessel after one of these coils is deenergized and the energization of the other coil is reduced to as low as fifty per cent of its original energizing value. These elements and energizing currents may be further adapted so that when a coil is energized to this lower percentage of its full energizing value, any of the contact elements subjected to the effect of this lower energization when subjected to the full energization of another coil surrounding any of said contact elements, connections will not be effected at the cross-points of said coils. Coordinate switch contact operations may therefore be performed by this arrangement in the same manner as in standard mechanically operated cross-bar switches.

Another feature of the invention is the provision of a shield structure for the coils to prevent the flux from affecting contact elements in the neighborhood of the contact elements actuated by two coils crossing each other.

This invention has been illustrated in the accompanying drawings in which

Fig. 1 shows in perspective and partly in cross-section, a mechanical structure embodying the applicants' invention.

Fig. 2 is a diagrammatic representation of this invention as illustrated in Fig. 1 showing the arrangement of the shield in relation to the coils.

Fig. 3 discloses one of the air-tight vessels containing contact elements for insertion at the cross-points of the switch structure shown in Fig. 1, and,

Fig. 4 shows in diagrammatic form the arrangement of the coils with the contact elements at the cross-point indicated.

Referring now to the drawings and particularly to Fig. 1 and Fig. 3, a series of air-tight vessels are arranged to be surrounded by coils. These air-tight vessels may be of the type disclosed in the copending application of W. B. Ellwood, Serial No. 198,629, filed March 29, 1938, and may consist of terminals 2 and 3 to which are respectively connected contact springs 4 and 5 of magnetic material preferably pure iron as employed in the above-mentioned copending application. When vessels of this kind are surrounded by windings and said windings are energized, connection between the contacts 4 and 5 may be made as at the point 6 by magnetic flux acting on these pure iron contacts. These air-tight vessels may be inserted through apertures such as 10, 11 and 12 in parallel plates 13, 14 and 15 of magnetic material in the structure shown in Fig. 1. Between the plates 13 and 14 are inserted windings such as 16, 17 and 18. The winding 16 surrounds the upper horizontal row of three such vessels, the winding 17 surrounds a second horizontal row of three vessels and the winding 18 surrounds a third or lower horizontal row of three vessels. Between the plates 14 and 15, these vessels are surrounded by coils 20, 21 and 22, coil 20 surrounding the left-hand vertical row of three vessels, the coil 21 surrounds the middle vertical row of three vessels and coil 22 surrounds the right-hand vertical

row of three vessels. These coils may be wound on specially formed spools of insulation material such as the type illustrated at 25 in cross-section of Fig. 1. The three plates 13, 14 and 15 form part of a shield structure including also an upper plate 27 and a lower plate 28 of magnetic material. The whole shield structure is held together by bolts such as 29, 30, 31 and 32. Thus the three horizontal coils 16, 17 and 18 and the three vertical coils 20, 21 and 22 form parallelepipedal openings at their cross-points, each of which contains one or more vessels having electromagnetic contact elements.

When one of the horizontal windings and one of the vertical windings are energized, magnetic flux will be produced at the point where they cross to operate the contacts of the corresponding vessel inserted at this cross-point to establish an electrical circuit through the contacts. The electrical characteristics of the windings and the amount of the magnetic flux passing through these contacts may be so adjusted that the contacts will operate when currents of certain fixed values are passed through these coils and be maintained operated after the current through one of the windings is discontinued and the current through the other winding is reduced to 50 per cent or any other suitable value. The shield structure comprising the plates 13, 14, 15, 27 and 28 prevents the flux from effecting the contacts in any other vessel surrounding the one in which the contacts have been operated. The effects of these current values and magnetic flux may also be such that if, for example, a connection has been made through the vessel at the cross-point 33 of windings 16 and 22 and the value of the original current in winding 16 remains at 50 per cent and then coil 21 is energized to its full energization, the contacts in the vessel 34 will not be operated as the energization for this vessel only amounts to 75 per cent of the full value. On the other hand if in addition to the energization of coil 21, coil 17 is also energized, then the contacts of the vessel 35 will be operated. The energization of coil 21 may then be discontinued and the value of the energization of the coil 17 may be reduced to 50 per cent to maintain the contacts in vessel 35 energized.

Fig. 2 illustrates in diagrammatic form how the shielding effect may be produced. The electromagnetic flux produced, for example, by the windings 37 and 38 causes the operation of the contacts in vessel 39, but the magnetic lines of force that may extend outside of the area in which this vessel 39 is located will be shunted through the shield structure. This magnetic flux may extend through the side members 13, 14 and 15 and the upper member 27 and lower members 28. In this particular case this flux will naturally be concentrated in the plates 13, 14, 15 and 27 as the plate 27 is nearer the tube 39 than the plate 28. Hence contacts in the vessels in the neighborhood of vessel 39 will not be disturbed by this flux.

Fig. 4 shows a diagrammatic representation of an arrangement of ten vertical windings 40 and ten horizontal windings 41 with contact elements at each cross-point. This is to indicate that any number of horizontally and vertically arranged windings may be employed in telephone systems, for example, for establishing connections. It is assumed that, for example, the upper contacts in each horizontal row are connected together to one telephone line and the lower contacts in each vertical row of contacts are connected together to another telephone line. By energizing for example the horizontal winding 45 and the vertical winding 46, a connection may be established for the first left-hand vertical line 48 and the upper horizontal line 49 over the contacts at the cross-point 50. In this arrangement, therefore, connections may be established from any one of ten subscribers' lines in one group to any one of ten subscribers' lines in any other group. It is evident that while only a single line connection has been shown for each cross-point, it should be understood that any other circuit arrangements may be employed for establishing any other type of connections at these various cross-points and that any desirable number of horizontal and vertical windings or any number of vessels enclosing contacts may be provided for establishing such connections.

What is claimed is:

1. A switching device comprising two groups of long narrow coils arranged to cross each other to form a parallelepipedal aperture at each point where a coil of one group crosses a coil of the other group, a set of contacts of magnetic material in each of said apertures, each set operative in response to electromagnetic flux produced by the energization of the two coils surrounding said set of contacts, and magnetic shields surrounding said two groups of coils for limiting the electromagnetic flux produced by the energization of the two coils surrounding said set of contacts to affect only said set of contacts.

2. A switching device comprising two groups of elongated coils arranged to cross each other to form an aperture at each point where a coil of one group croses the coil of the other group, an air-tight vessel in each of said apertures containing circuit closing contacts operative in response to electromagnetic flux produced by the energization of the two coils surrounding a vessel, and means for confining the electromagnetic flux produced by the two coils surrounding a vessel to operate only the circuit closing contacts in said vessel.

3. A switching device comprising two groups of long narrow coils arranged to cross each other to form a parallelepipedal aperture at each point where a coil of one group crosses a coil of another group, an air-tight vessel at each of said apertures containing electromagnetically responsive circuit closing contacts operative when the coils surrounding the associated vessel are energized, and a common magnetic shield for all of said coils for limiting the operative action to the electromagnetically responsive circuit closing contacts in the air-tight vessel associated with the energized coils.

4. A switching device comprising two groups of long narrow coils arranged to cross each other to form parallelepipedal apertures at each point where a coil of one group crosses a coil of the other group, an air-tight vessel in each of said apertures containing electromagnetically responsive circuit closing contacts operative when both coils surrounding the associated vessel are energized and maintained operative after one of the coils is deenergized, and a common magnetic shield for all of said coils for limiting the operative action to the electromagnetically responsive circuit closing contacts in the air-tight vessel associated with the energized coils.

5. A switching device comprising two groups of elongated coils arranged to cross each other to form an aperture at each point where a coil for one group crosses a coil of the other group, an

air-tight vessel in each of said apertures containing electromagnetically responsive circuit closing contacts operative when both coils surrounding the associated vessel are energized and maintained operative after one of said coils is deenergized and the energization of the other coil is reduced within certain limits, and a common magnetic shield for all of said coils.

6. A switching device comprising two groups of elongated coils arranged to cross each other to form an aperture at each point where a coil of one group crosses a coil of the other group, means for energizing said coils, an air-tight vessel in each of said apertures containing electromagnetically responsive circuit closing contacts operative when both coils surrounding the associated vessel are energized and maintained operative after one of said coils is deenergized and the current through the other coil is reduced within 50 per cent of its full energizing value, and a common magnetic shield for all of said coils.

7. A switching device comprising one group of horizontally located long narrow coils, and another group of vertically located long narrow coils arranged so that the coils of one group cross the coils of the other group to form an aperture at each point where a horizontal coil crosses a vertical coil, an air-tight vessel in each aperture containing electromagnetically responsive circuit closing contacts operative when the horizontal and vertical coils surrounding the associated vessel are fully energized and maintained operative if the horizontal coil is deenerergized and the vertical coil is partly deenergized, the remaining partial energization of said vertical coil being insufficient to cause the contacts from being operated in other vessels surrounded by said vertical coil when any other horizontal coil surrounding any one of said other vessels is fully energized, and a magnetic shield surrounding said horizontal and vertical coils for limiting the operation of circuit closing contacts to the contacts in the vessel surrounded by a fully energized horizontal coil and a fully energized vertical coil.

8. A switching device comprising one group of horizontally located coils, and another group of vertically located coils arranged so that the coils of one group cross the coils of the other group to form a parallelepipedal aperture at each point where a horizontal coil crosses a vertical coil, an air-tight vessel in each aperture containing electromagnetically responsive circuit closing contacts operative when both of the coils surrounding the associated vessel are fully energized and maintained operative if one coil is energized below 50 per cent of its full energization and the other coil is fully energized, a partition of magnetic material between the horizontal coils and the vertical coils, and a housing of magnetic material surrounding two horizontal and two vertical outer sides of said two groups of coils, said partition and housing being electromagnetically connected to limit the operative action to the electromagnetically responsive circuit closing contacts in an air-tight vessel when the horizontal coil and vertical coil surrounding said vessel are fully energized.

WALTER B. ELLWOOD.
WILLIAM H. T. HOLDEN.