Sept. 14, 1943. P. NEILL 2,329,479

ELECTRICAL CONNECTOR

Filed Oct. 31, 1940 3 Sheets-Sheet 1

FIG. 1

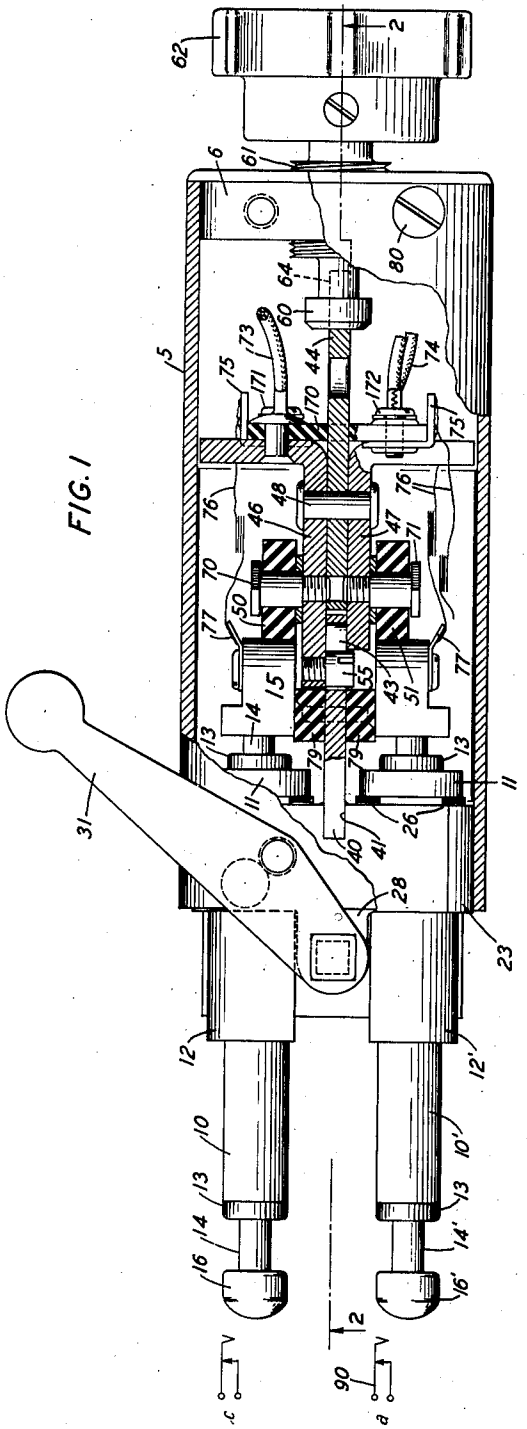
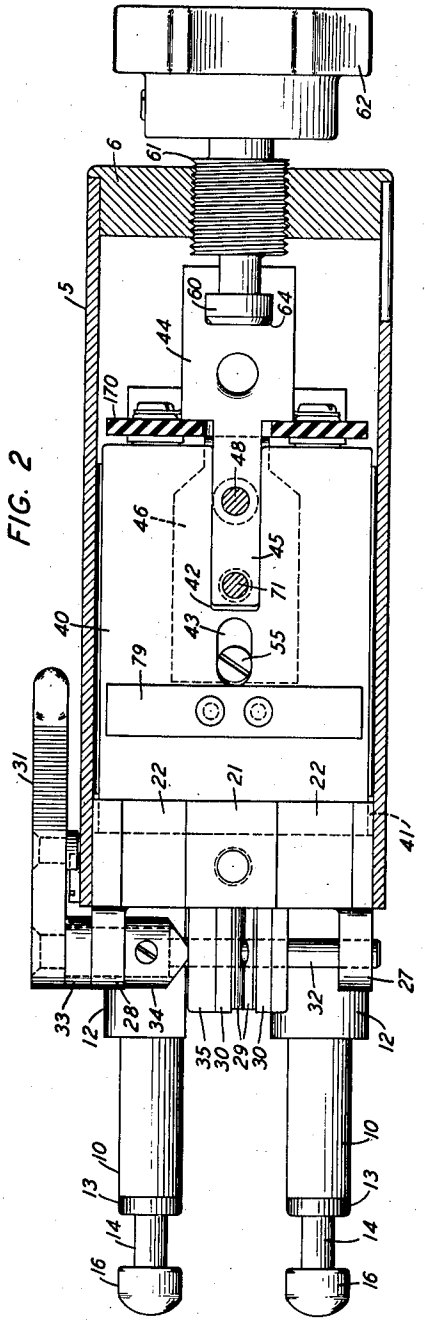


FIG. 2



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ELECTRICAL CONNECTOR

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FIG. 3

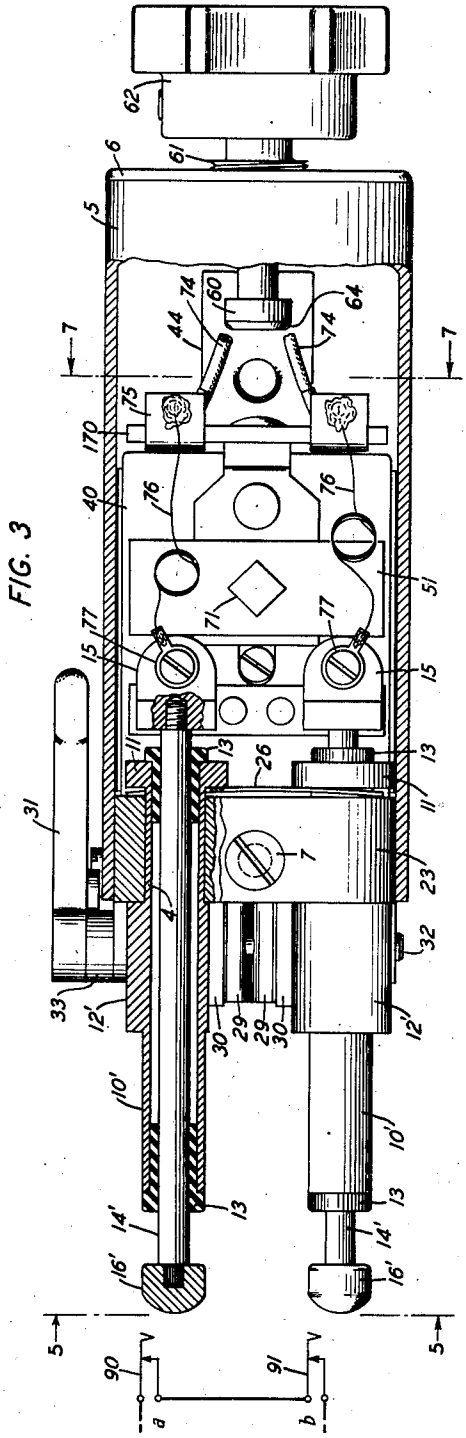
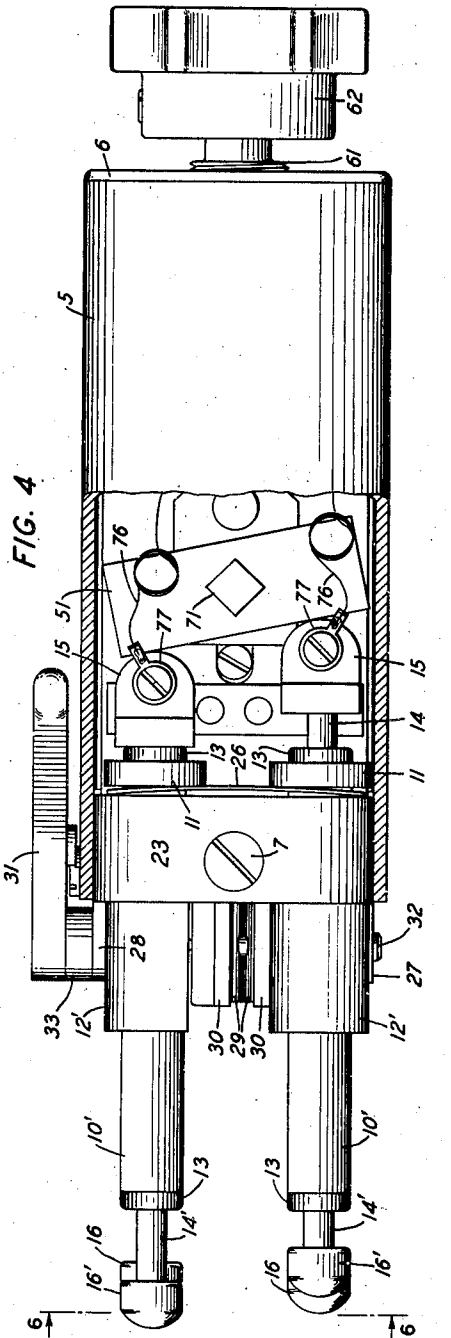


FIG. 4



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ELECTRICAL CONNECTOR

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FIG. 5

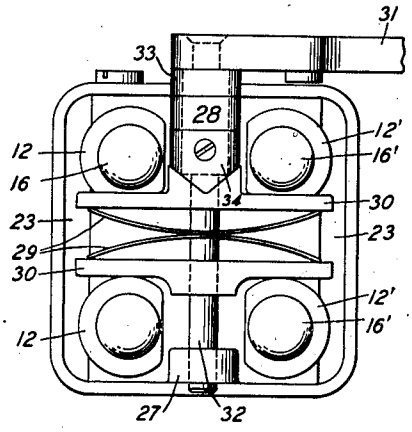


FIG. 6

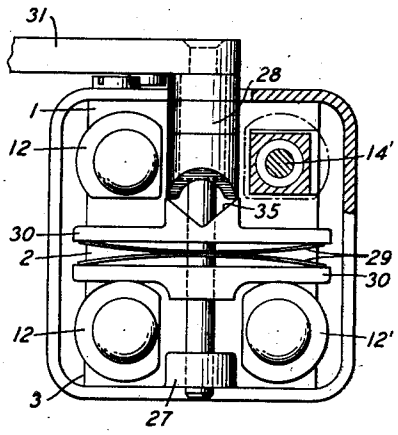


FIG. 7

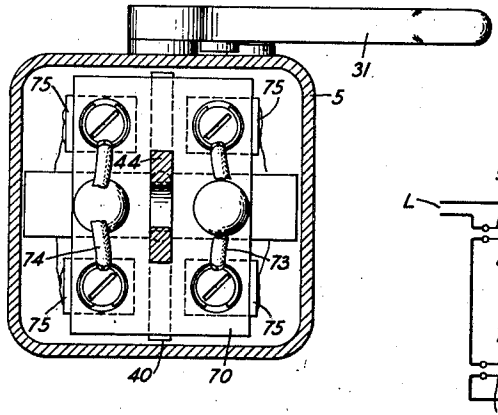
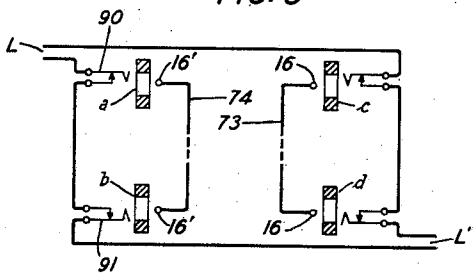


FIG. 8



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Patented Sept. 14, 1943 2,329,479

UNITED STATES PATENT OFFICE

2,329,479

ELECTRICAL CONNECTOR

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Application October 31, 1940, Serial No. 363,727

12 Claims. (Cl. 173—361)

This invention relates to electrical connectors of the plug-in type and particularly to multifinger plugs of the type commonly employed in the telephone plant.

In telephone practice, telephone toll stations are interconnected by means of toll lines which usually pass through several intermediate offices located at intervals between the toll stations and are accessible at these several offices for testing purposes. At such intermediate offices, the toll lines and associated equipment are interconnected by jacks, by means of which a test operator or attendant may gain access to the lines, or equipment, by plugging into the jacks for the purpose of interchanging or connecting he necessary test apparatus to the line. A twin jack designed for this purpose is disclosed in U. S. Patent 2,032,191, issued February 25, 1936, to G. P. Tromp et al. As such toll lines are usually composite in nature, that is, designed to carry both telegraph and speech currents, it is essential that no interruptions of the line occur when the equipment is changed or the test apparatus is connected to the line, lest the printing telegraph equipment associated with the line respond to such interruptions and cause serious mutilation of the telegraph messages being transmitted. Such breaks, in the telephone and telegraph arts are known as "hits."

It is the object of this invention to provide an improved multifinger plug which minimizes the possibility of circuit interruptions, or "hits" when used to associate test apparatus or similar instrumentalities with a transmission line.

This object is attained, in accordance with a feature of the invention, by the provision of a multifinger plug which functions to insure circuit continuity through the instrumentality which terminates in the plug, before the plug opens the line with which the instrumentality is to be associated. More specifically, the plug of this invention is provided with pairs of tip connector elements which are free to move longitudinally with respect to their respective plug sleeves, and with means for preventing any one tip connector from operating its corresponding jack spring until the other tip connector of a pair has engaged its corresponding jack spring. Thus, any instrumentality, such as a test circuit, a patching cord, a spare repeater or the like, is electrically included in the transmission line without the line being opened or otherwise disturbed due to the temporary change in conditions. This structural feature of the plug serves to compensate for any mechanical variations in the jack which might otherwise cause the line contacts to open sequentially rather than simultaneously when a multifinger plug is inserted in the jack.

Another feature of the invention resides in the use of means for mechanically locking the plug in the jack with which the plug functions.

A further feature of the invention contemplates the use of means which functions to permit the tip connectors to be moved into and out of engagement with their corresponding jack contacts while the plug is effectively locked in position, thus further insuring against the possibility of "hits," particularly when the plug is being removed from the jack.

These and other features of the invention will be readily understood from the following detailed description made with reference to the accompanying drawings in which:

Fig. 1 is a top elevation or plan view of the plug structure of this invention with a portion of the plug shell broken away to reveal the interior construction. In this figure the upper plug finger illustrated, is one of a pair of plug fingers, whereas the lower plug finger is one of another pair, it being understood that a finger, similar to each of the plug fingers shown, is located in the back of those illustrated;

Fig. 2 is a partial sectional view taken along the line 2—2 of Fig. 1 and looking in the direction of the arrows. In this view, the upper plug finger corresponds to the upper finger of Fig. 1, and the lower finger is the plug finger paired with the upper finger. In other words, the two plug fingers shown in Fig. 2 constitute a pair;

Fig. 3 is a side view of the plug with a portion of the plug shell and of other details broken away to show the interior construction of the plug as well as the general plugfinger construction. In this view the locking mechanism is unoperated;

Fig. 4 is a view generally similar to that of Fig 3, and in which the locking mechanism is in its operated position and the tip connectors are shown relatively displaced;

Fig. 5 is a front view taken along the line 5—5 of Fig. 3, looking in the direction of the arrows;

Fig. 6 is a front view taken along the line 6—6 of Fig. 4, looking in the direction of the arrows;

Fig. 7 is a section taken along the line 7—7 of Fig. 3, looking in the direction of the arrows; and

Fig. 8 is a circuit diagram illustrating the line wires of a transmission line passing through the contacts of a pair of twin jacks of the type with which the plug of this invention functions. In

this figure, the jack contacts of the left-hand pair of jacks *a*, *b* would be engaged by the tip connectors of one pair of plug fingers, whereas the contacts of the right-hand pair of jacks *c*, *d* would be operated by the tip connectors of another pair of plug fingers.

In the drawings, wherever possible, the elements comprising the plug fingers of one pair of fingers are identified by unprimed numerals, whereas the corresponding elements of the other pair of plug fingers are identified by the same numerals primed. For example, the elements of the pair of plug fingers shown in Figs. 2 and 3 bear the identifying numerals **10**, **12**, **13**, **14** and **16**, whereas the corresponding elements of the other pair of plug fingers, only one of which appears in Fig. 1, bear the identifying characters **10'**, **12'**, **13'**, **14'** and **16'**. It is to be understood that the plug pictured in the several figures, in reality, comprises two twin plugs combined in a unitary structure, and each pair of tip connectors **14**, **14** and **14'**, **14'** have their own individual operating rocker arm **50** and **51**, respectively, as will be more fully described hereinafter.

The plug structure is housed in a tubular rectangular metal shell **5**, one end of which is provided with a cap or cover **6** of similar material and the other end of which is open. Each of the four sides of the shell **5**, near its open end, is provided with a small centrally located aperture, each of which accommodates a screw **7**, by virtue of which the shell is held in position on the finger mounting member **21**.

The finger mounting member **21** is an integral unit, and as viewed in Figs. 5 and 6 consists of three horizontal legs **1**, **2** and **3** jointed by a centrally located vertical leg so as to provide four slots, two of which are indicated by the numeral **22** in Fig. 2. Each of these slots provides a housing or bearing for a plug finger.

Since each of the plug fingers are identical in construction, except in one detail, which will be referred to presently, the structure thereof will be described with particular reference to Fig. 3. Each plug finger comprises a tubular sleeve whose intermediate section **12'** is larger in diameter than either of its two end sections **10'** and **4**. The section of each of the upper fingers (as seen in Figs. 5 and 6) have two flat sides interconnected by a semicircular portion, whereas this section of the lower fingers, Figs. 5 and 6, has but one flat side. The end portions **10'** and **4** are circular in section. Each of the end portions **4** of the several fingers terminates in a circular flange **11**. An insulating bushing **13** is tightly fitted into the outer ends of each of the sleeve portions **10'** and **4**. These bushings serve as bearings for the tip connectors **14'**, which are arranged to freely move longitudinally therein. Each tip connector **14** or **14'** is provided with a contact **16** or **16'** at its outer end, and with a terminal bearing element **15** at its inner end. The outer end of each tip connector is knurled longitudinally or otherwise fitted to accommodate its respective contact **16** or **16'**, whereas the rear end of each connector is threaded to receive its respective terminal piece **15**. Interposed between the flanges **11** of each plug sleeve and the rear face of the mounting member or plate **21** is an H-shaped spring **26**, which serves to permit a limited amount of play between the plug sleeves and their mounting apertures **22**. On either side of the mounting plate **21** there is provided a metal strip **23** which serves to enclose the open ends of the apertures **22** of the mounting plate **21** after their respective plug sleeves have been inserted therein. The screws **7**, one on each side of the forward end of the shell **5**, serve to secure the mounting **21** and its side plates **23** in position within the forward end of the shell.

The rear face of the mounting plate **21** is provided with a slot or groove, indicated at **41** in Fig. 2, which accommodates a substantially rectangular plate **40**. The slot **41** is centrally located, and, viewing Fig. 2, extends vertically, whereas in Fig. 1 the position of the slot is horizontal. The plate **40** is permanently fitted in the slot **41**.

The plate **40** is provided with a centrally located slot **42** which extends half-way from one end toward the end which is fixed in slot **41**, and with a smaller slot **43**. Two oppositely disposed brackets **46** and **47** are mounted on an element arranged to slidably move in the slot **42**. This element consists of two integral portions, a substantially rectangular portion **44** and a smaller rectangular portion **45**, the latter being just wide enough to be freely accommodated by the slot **42**. The brackets **46** and **47**, which are in effect right-angle brackets, are secured to the smaller portion **45** of the slidable member by means of a rivet **48**. The flat, or horizontal, portion of each bracket (viewing Fig. 1) carries an insulating rocker arm such as **50** or **51**, which arms are pivotally mounted at their centers on the screws **70** or **71**, respectively. The upper bracket **46** is provided with a screw **55** whose head extends into the slot **43** in element **40** and serves to limit the extent to which the slidable element **44—45** may be moved. This screw serves to prevent breakage of the connecting wires **76** by preventing the slidable element **44—45** from being withdrawn when the cap **6** and knob **62** are removed.

The outer extremity of portion **44** is provided with a T-shaped slot **64** into which the correspondingly shaped end **60** of a turn screw **61** is adapted to be fitted and to be capable of substantially universal movement therein. The turn screw **61** is provided at its outer end with a finger grip or handle **62**.

The vertical portions of the brackets **46** and **47** (viewing Fig. 1) serve to support a common insulating terminal strip **170** which carries four terminals, such as **171** and **172**, to which the leads **73** and **74** may be connected in any suitable manner. Each of these terminals is provided with a lug **75** to which may be soldered one end of the lead wires **76**, the other ends thereof being soldered to terminals **77** carried by the terminal bearing elements **15**.

On either side of the plate **40**, there is mounted an insulating block **79**, each of which is so positioned with respect to a different pair of terminal bearing elements **15** as to prevent the latter and their associated tip connectors **14**, **14'** from rotating through any appreciable arc.

The turn screw **61** is adapted to be rotated in a threaded hole in the cover **6**, which, through the medium of screws, such as **80**, is securely fitted to the shell **5**.

Extending forwardly from the upper and lower edges (Figs. 2, 3, 4, 5 and 6) of the finger support **21**, and centrally located thereon, are two integral lugs **27** and **28**. These lugs extend slightly into the area between the finger sleeves and serve to support the plug finger locking mechanism, which consists, essentially, of a pair of bowed springs **29**, a pair of clamping jaws **30** and an operating handle **31**. The bowed springs

29 are interposed between the clamping members 30 and have their apices contacting, so that the bows of the two springs are reversed relative to one another. The clamps 30 and springs 29 are each provided with a centrally located hole through which a pin 32 extends in passing through aligned holes in the lugs 27 and 28. The operating handle is secured in any suitable manner to one end of the pin 32. A spacing washer 33 is interposed between the handle 31 and the upper face of lug 28. Immediately below the lug 28 there is pinned or otherwise fixed to the pin shaft 32 a sleeve 34, whose lower end is cut from the center line at diverging angles to effect a cam. This cam end of sleeve 34 normally rests in a triangular trough 35 effected by integral projections on the upper face of the upper clamp 30.

In Fig. 5 the clamp members 30 are shown separated to a maximum extent. In this position the bowed springs exert substantially no pressure on the clamps other than that required to hold them in the position shown. When the handle 31 is moved through an arc of substantially 90 degrees, a similar movement is imparted to the pin shaft 32 and its associated cam sleeve 34. During this movement, the cam end of sleeve 34 acts upon the inclined faces of the trough 35 causing the upper clamp to move downwardly and compress the springs 29 as shown in Figs. 2 and 6. When the sleeve 34 is rotated through an arc slightly greater than 90 degrees, the high points of its cam end rest upon the top of the sides of trough 35 so that the clamps 30 are locked in the position shown in Fig. 6. The lower clamp 30, accordingly, exerts a downward pressure on the plug-finger sleeve sections 12 and 12' to frictionally lock the plug in a jack into which it may have been inserted. To free the plug it is only necessary to move the handle 31 out of the position illustrated in Fig. 6 whereupon the springs 29 assume their normal condition and the pressure is removed from the sleeve sections 12 and 12'.

In this position of the plug in the jack, and with the slidable element 44—45 withdrawn to its outer extremity, the tip contacts 16 and 16' may or may not contact their respective jack tip springs and preferably would not, though no jack-spring operating function is performed until after the plug is locked in position. The handle 62 is then turned to advance the screw 61 inwardly through the cover 6. This movement forces the slidable element 44—45 to move inwardly, carrying with it the rocker arms 50 and 51. As the rocker arms 50 and 51 advance with their support 44—45, they engage the rear edges of the terminal members 15 and force the tip connectors 14 and 14' outwardly. As the tip connectors move outwardly from the plug they engage corresponding jack springs such as 90 and 91 (Fig. 3) and cause them to be moved out of engagement with their associated springs and to thus open the line circuit. Should the jack springs 90 and 91, for example, vary in position with respect to the jack center line or in distance from the jack face either one or the other contacts 16' (Fig. 3) would engage its jack spring before the other engaged its corresponding jack spring. In such a case, the tip connector 14' whose contact 16' first engaged its jack spring (91, for example) would be held against further longitudinal movement by the jack spring pressure, and continued rotation of the handle 62 would result in a rotational movement of the rocker arm 51 about its pivot support 71 to cause the other tip connector 14' to be advanced until its contact 16' came in contact with its corresponding jack spring 90. This condition is illustrated in Fig. 4. When both contacts 16' are in engagement with their respective jack springs, continued rotation of the handle 62 further advances both tip connectors 14' simultaneously with the result that both jack springs 90 and 91 are actuated simultaneously. The operation of the jack springs in the line circuit caused by the two tip connectors, occurs simultaneously and only after both tip contacts 16' have engaged their respective jack springs 90 and 91. Obviously, therefore, the line circuit conductor is not opened until the test instrument or other instrumentality connected to the leads 73 or 74 has been effectively included in the line. The possibility of a "hit" is thus eliminated. It will be understood that, though the immediately preceding description has been directed to the operation of rocker arm 51 and its associated tip connectors 14', the same applies equally well to the operation of rocker arm 50 and its associated tip connectors 14.

To provide a more complete understanding of the plug structure and its operation, particular reference will now be made to Fig. 8 in conjunction with the other figures of the drawings. In Fig. 8 there is shown a toll line L, L' which passes through an intermediate office at which the jacks *a*, *b*, *c* and *d* are located. Normally, the conductors of the line L, L' are rendered continuous by means of the springs of jacks *a*, *b*, *c* and *d* in their normal condition. If it is desirable for an attendant at the intermediate office to gain access to the line L, L', this would be accomplished by utilizing a plug such as is shown in Figs. 1 to 7, inclusive. The plug would be so associated with the jacks that the plug fingers whose tip connectors terminate in contacts 16' would be inserted in jacks *a* and *b*, while the plug fingers whose tip connectors terminate in contacts 16 would be inserted in jacks *c* and *d*. An examination of Fig. 8 renders it obvious that unless the test equipment associated with lead 74, for example, is connected to both jack springs 90 and 91 before either of these springs is moved out of engagement with its mating spring, the line conductor which passes through jacks *a* and *b* would experience an open, or "hit."

The possibility of either spring 90 or 91 being moved out of engagement with its mating spring before both tip connector contacts 16' come into contact with their corresponding jack springs 90 or 91 and, therefore, before the line conductor is rendered continuous through the lead 74 and its associated test equipment, is eliminated by the plug structure of this invention, as described hereinbefore.

When the plug is inserted in the jacks in the manner described above, the locking lever 31 is actuated to cause the upper clamp 30 to compress bow springs 29 and thus force the lower clamp 30 tightly against the portions 12 and 12' of the two lower plug fingers. In this manner the plug is effectively locked in the jacks. The knob 62 is then rotated in such a manner as to cause the screw 61 to advance through the cover 6 into the interior of the shell 5. The longitudinal movement of screw 61 is imparted to the sliding member 44—45 which causes the rocker arms 50 and 51 to function in the manner fully described hereinbefore.

Since it is equally important that no circuit interruptions or "hits" occur when the plug is withdrawn from the jacks, the knob 62 is rotated in a reverse direction to withdraw the rocker arms and thus free the tip connectors which, due to the action of the jack springs on the contacts 16 and 16', are forced longitudinally in a backward direction. The mating springs of the jack then contact the tip springs, such as 90 and 91, before the connector contacts 16, 16' are disengaged from the tip springs. In this manner the continuity of each line conductor is effected through the jack springs before the test apparatus has been disconnected from the conductors.

What is claimed is:

1. In a plug, a pair of plug fingers each having a stationary sleeve, a tip connector slidably housed in the sleeve of each of said plug fingers and each connector movable in its respective sleeve independently of the other connector, and manually operable means independent of said tip connectors for sliding said tip connectors in their respective sleeves.

2. In a plug, a pair of plug fingers each having a stationary sleeve, a tip connector in each of said stationary sleeves and movable therein independently of one another, a longitudinally movable support, means common to said tip connectors carried by said support, and means for moving said support longitudinally to cause said common means to move said tip connectors longitudinally in their respective plug sleeves.

3. In a plug, a pair of plug fingers each having a cylindrical sleeve, a tip connector arranged to slide longitudinally in the sleeve of each of said plug fingers, a longitudinaly movable support, an insulating member pivotally mounted on said support and arranged to engage a tip connector on either side of its pivot support when said support is moved longitudinally, whereby said tip connectors are moved longitudinally in the sleeves of their respective plug fingers, and manually operable means for moving said support longitudinally.

4. In a plug a plurality of plug fingers having substantially stationary sleeves, an independently movable tip connector slidably housed in the sleeve of each of said plug fingers, and manually operable means, independent of said tip connectors for slidably moving said tip connectors in their respective sleeves.

5. In a plug, a housing therefor, a pair of plug fingers extending from one end of said housing and having stationary sleeves, a tip connector slidably housed in the sleeve of each of said plug fingers and having a contact end protruding from the extended end thereof and a terminal end extending within said housing, a support within said housing arranged to be moved longitudinally in a direction parallel to the longitudinal axes of said tip connectors, a rocker arm pivoted at its center on said support and having a portion on either side of its pivot support in substantial alignment with the terminal end of a tip connector, and means for moving said support in a direction parallel to the axes of said tip connectors whereby the terminal end of each of said tip connectors is engaged by the portion of the rocker arm aligned therewith, and the contact ends of said tip connectors are caused to protrude further from the extended ends of said plug fingers.

6. In combination, a multiple jack having a pair of separately operable contact springs, and a plug for association with said jack comprising a pair of plug fingers, each of said plug fingers having a longitudinally movable tip connector, and means effective after said plug has been associated with said jack for simultaneously advancing the tip connectors of said plug fingers to cause them to simultaneously actuate the contact springs of said jack.

7. In combination, a multiple jack having a pair of separately operable contact springs, and a plug for association with said jack having a pair of hollow plug fingers, each of said plug fingers having a tip connector movable longitudinally within said plug fingers, and means effective after said plug has been associated with said jack for causing said tip connectors to simultaneously approach corresponding contact springs of said jack, said means adapted to advance either of said tip connectors individually after the other of said tip connectors has engaged its corresponding jack spring.

8. In combination, a multiple jack having a pair of separately operable contact springs, and a plug for association with said jack having a pair of plug fingers, each of said plug fingers having a tip connector movable longitudinally independently of said plug fingers, and means for propelling said tip connectors longitudinally to cause them to approach and engage corresponding contact springs of said jacks, said means functioning to insure the simultaneous operation of said jack springs by said tip connectors though engagement between said tip connectors and their corresponding jack springs occurs sequentially.

9. In combination, contact springs, a pair of plug fingers, a tip connector slidably housed in each of said plug fingers and having a contact at one end thereof for engagement with one of said contact springs, means for advancing said tip connectors into engagement with their respective contact springs, and means for delaying the actuation of either of said contact springs by its respective tip connector until both of said tip connectors have been advanced into engagement with their respective contact springs.

10. In combination, contact springs, a pair of plug fingers having stationary sleeves, a tip connector slidably housed in the sleeve of each of said plug fingers and having a contact at one end thereof for engagement with and for actuating one of said contact springs, and means for insuring contact between both of said tip connector contacts with their respective contact springs before either of said tip connectors functions to actuate its respective contact spring, said means comprising a pivoted member cooperating with one end of each of said tip connectors to simultaneously advance said tip connectors in their respective sleeves, when moved in a direction parallel to the longitudinal axes of said tip connectors until either thereof engages its respective contact spring, and thereafter to advance the other of said tip connectors into engagement with its respective contact spring, and means for moving said pivoted member in a direction parallel to the longitudinal axes of said tip connectors.

11. In combination, a multiple jack having sleeve elements, a multifinger plug having a plurality of flexibly mounted plug fingers each of which includes a sleeve and a contact element slidably housed therein, said plug sleeves adapted to fit into corresponding sleeve elements of said jack, and means for locking said plug in said jack

comprising manually operable means for spreading the sleeves of certain of said plug fingers to cause them to frictionally lock in their corresponding jack sleeves.

12. In a plug-type electrical connector, a plurality of plug fingers each having a sleeve and a tip connector longitudinally displaceable relative to the sleeve, and means effective upon the longitudinal displacement of one of said tip connectors in one direction relative to its corresponding sleeve for longitudinally displacing another of said tip connectors in the opposite direction relative to its corresponding sleeve.

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