Dec. 14, 1965 C. S. WRIGHT ET AL 3,223,812

SWITCH SYSTEM

Filed June 15, 1964 5 Sheets-Sheet 1

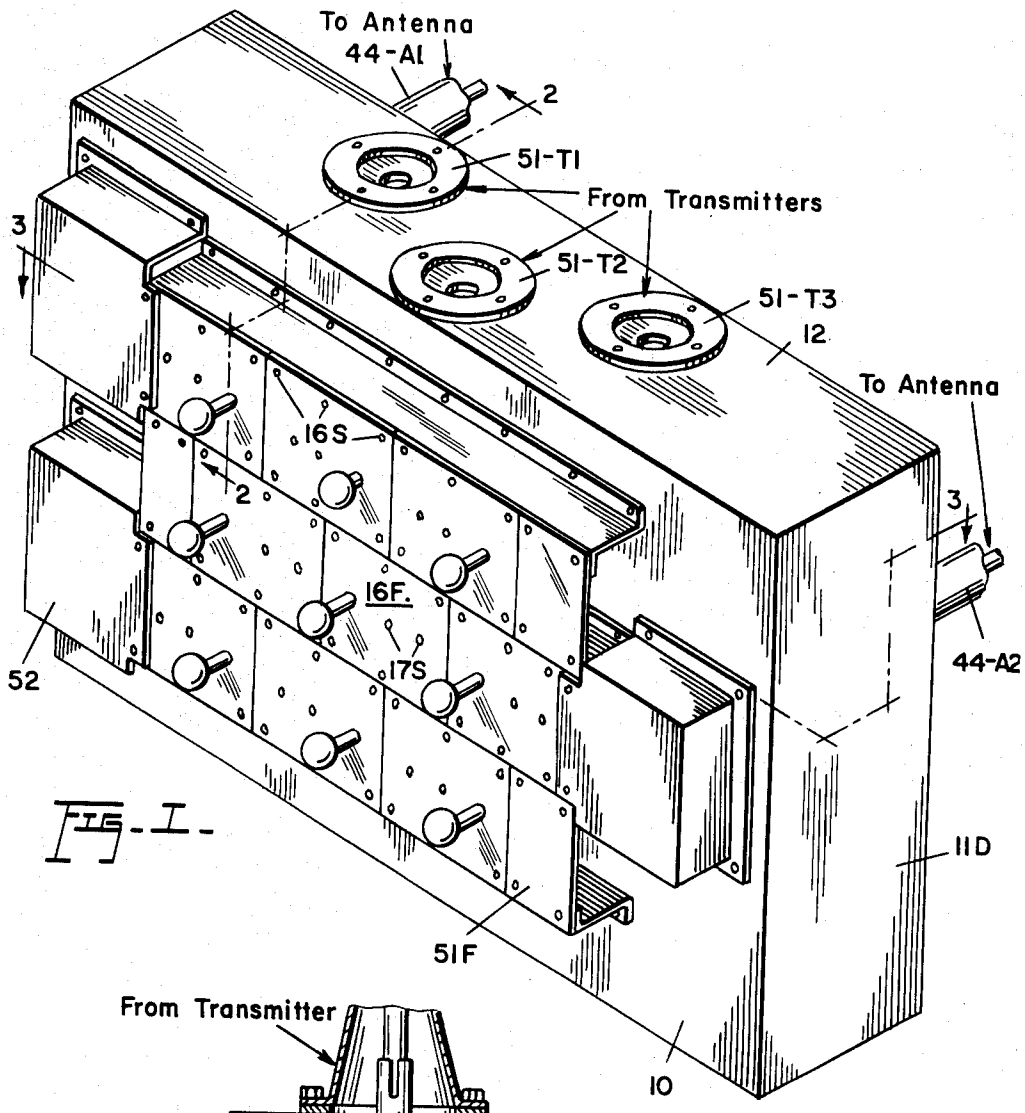


FIG. 1.

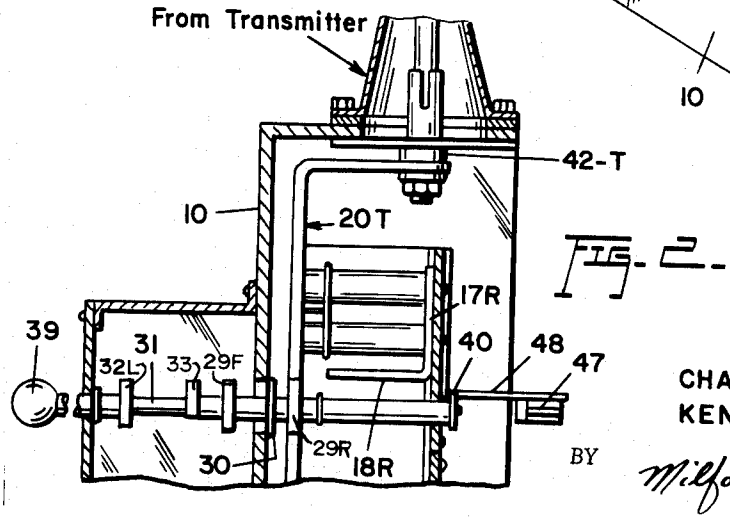


FIG. 2.

INVENTORS

CHARLES S. WRIGHT
KENNETH OWEN

BY Milford A. Juten

ATTORNEY

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SWITCH SYSTEM

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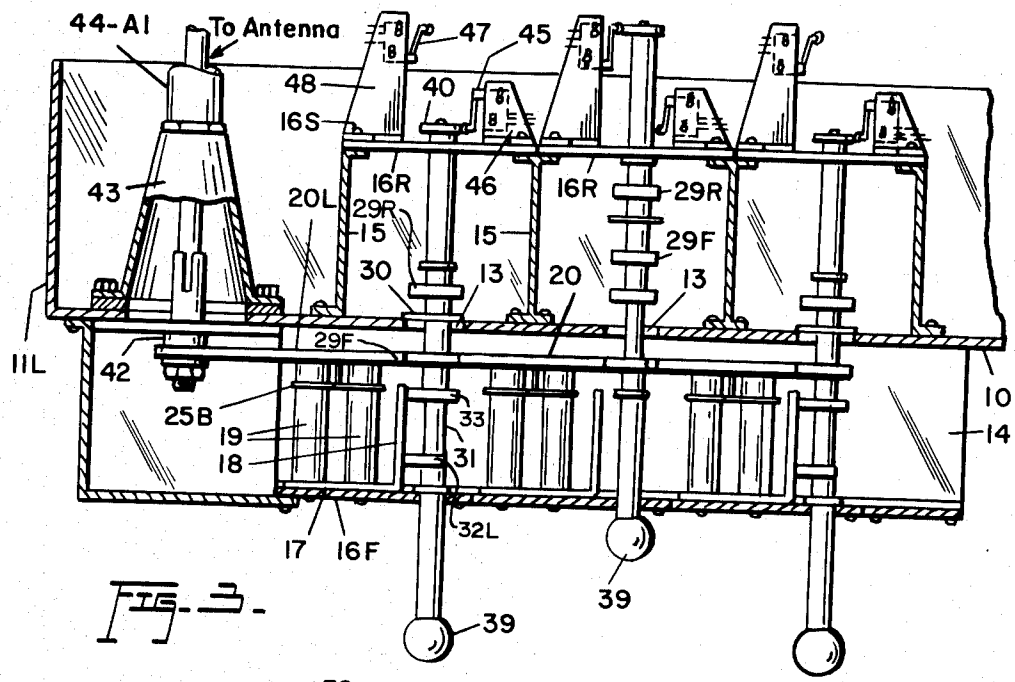


FIG. 3.

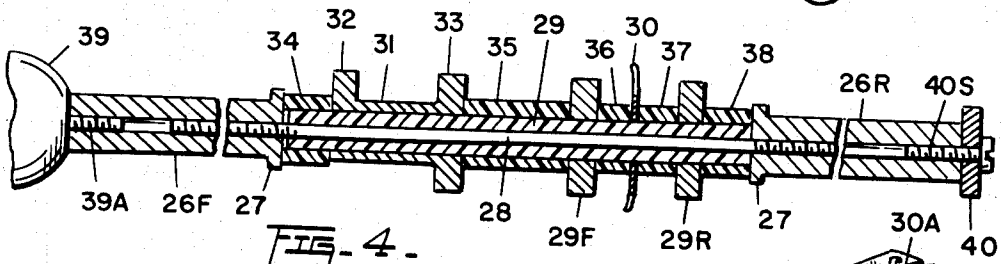


FIG. 4.

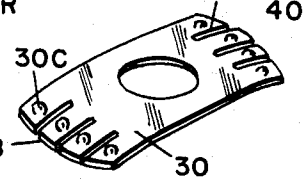


FIG. 7.

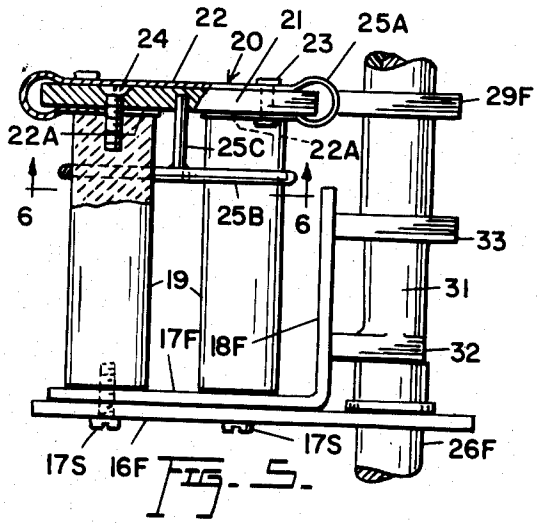


FIG. 5.

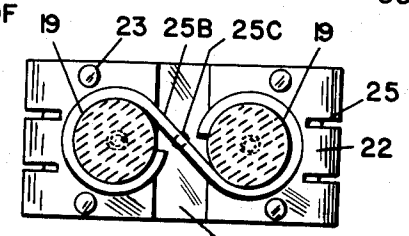


FIG. 6.

INVENTORS
CHARLES S. WRIGHT
KENNETH OWEN
BY Milford A. Juten
ATTORNEY

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SWITCH SYSTEM

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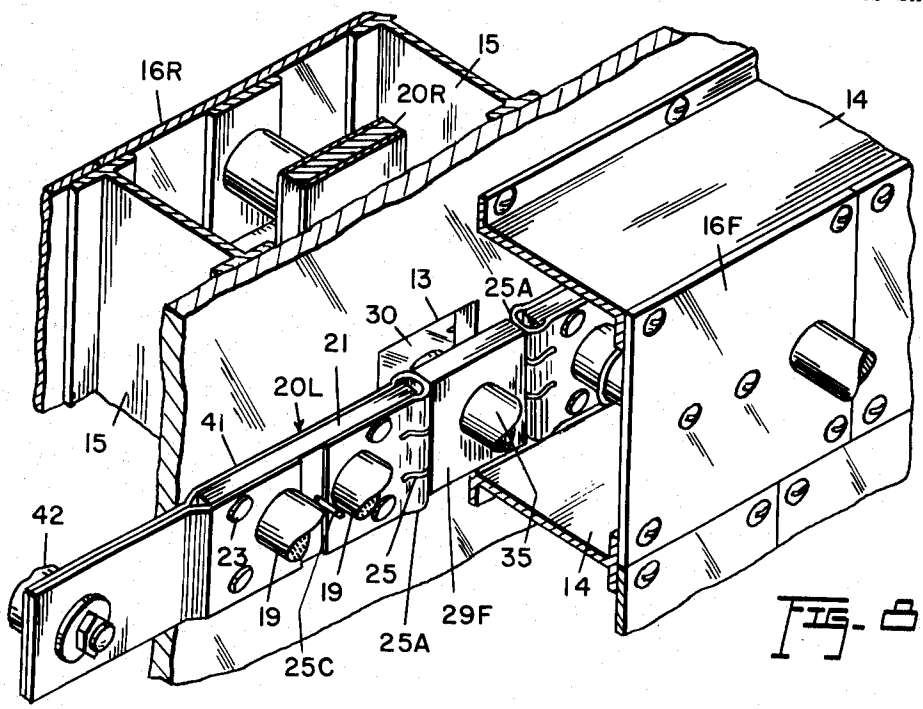


FIG. 8.

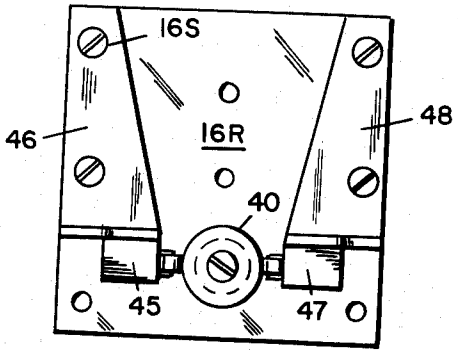


FIG. 13.

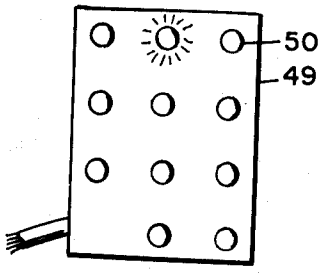


FIG. 14.

INVENTORS

CHARLES S. WRIGHT
KENNETH OWEN

BY Milford A. Juten
ATTORNEY

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SWITCH SYSTEM

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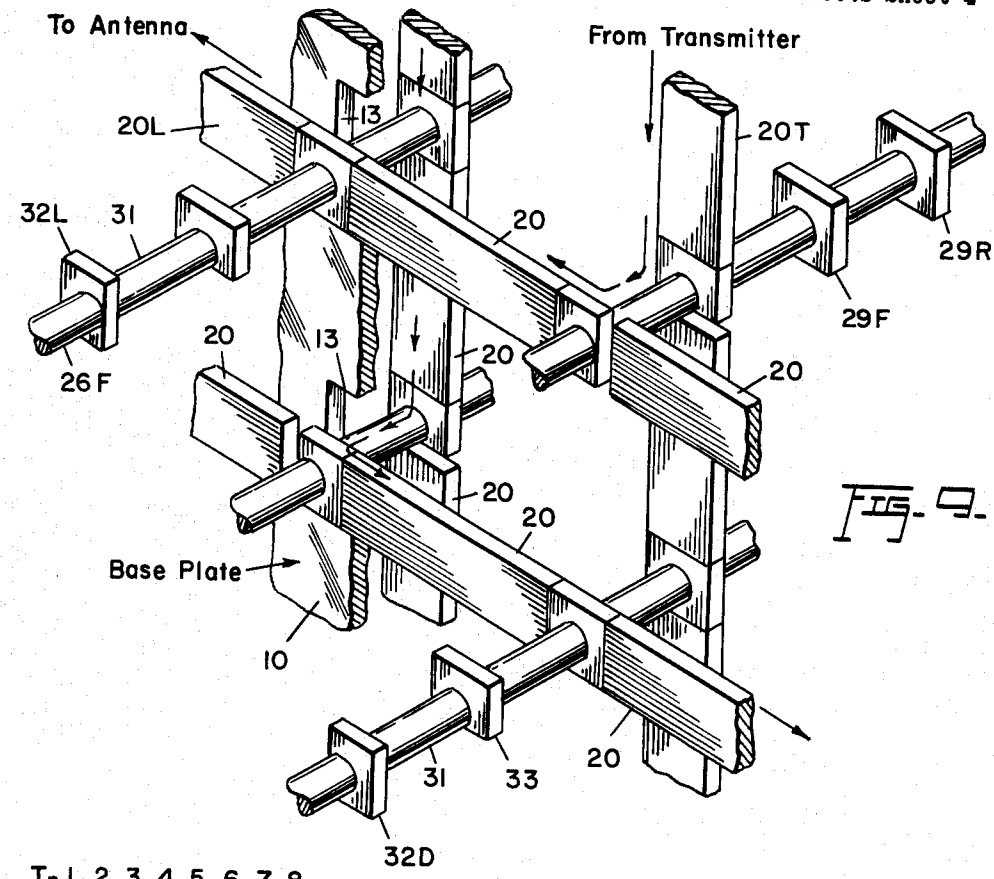


FIG. 9.

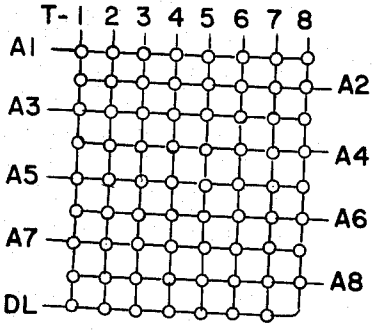


FIG. 11.

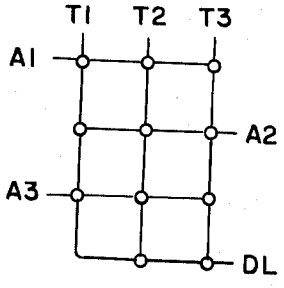


FIG. 10.

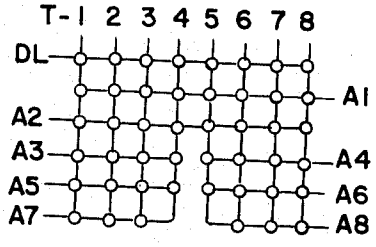


FIG. 12.

INVENTORS

CHARLES S. WRIGHT

KENNETH OWEN

BY

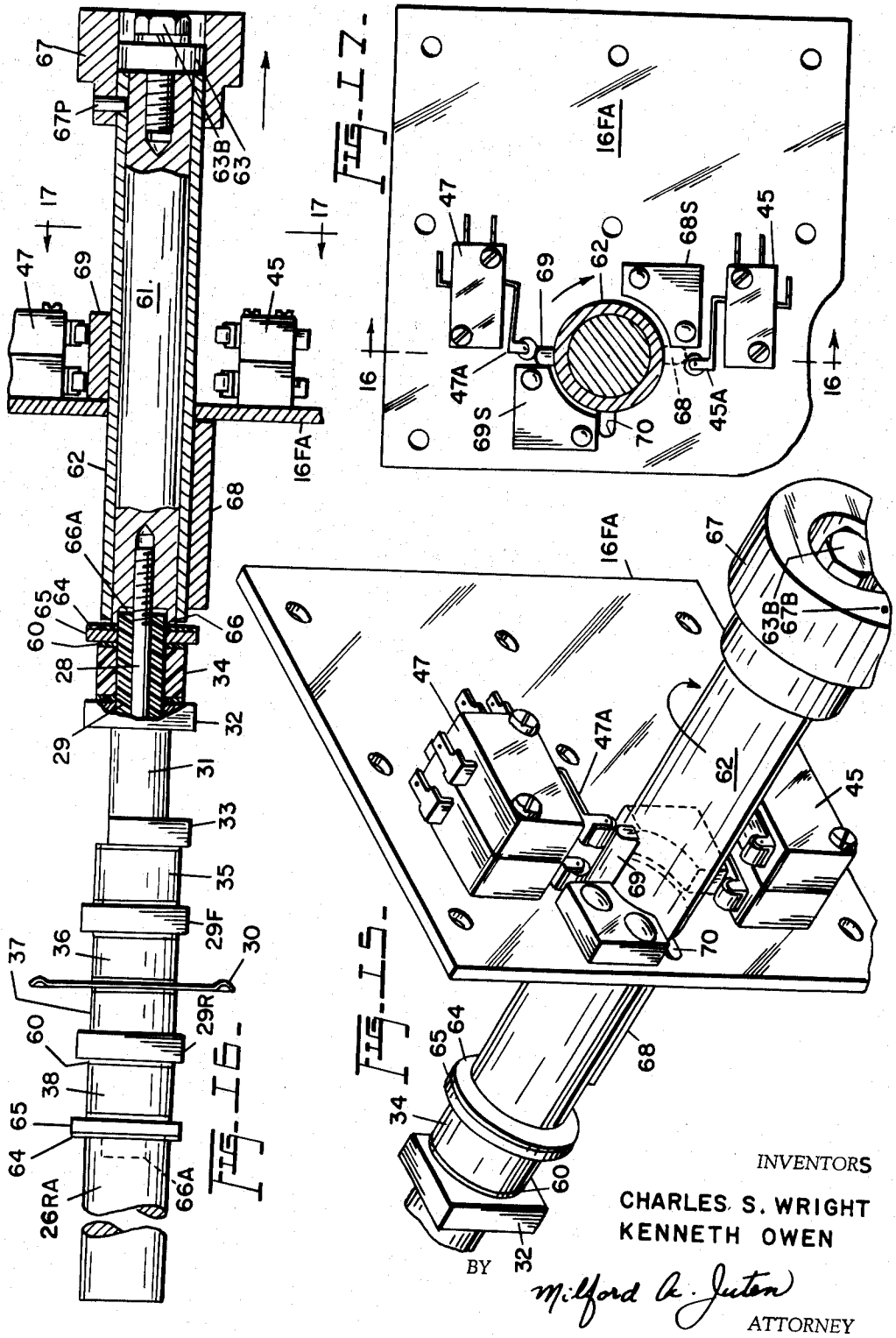
Milford A. Juten

ATTORNEY

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SWITCH SYSTEM

Filed June 15, 1964 5 Sheets-Sheet 5



INVENTORS

CHARLES S. WRIGHT

KENNETH OWEN

BY Milford A. Juston

ATTORNEY

United States Patent Office 3,223,812 Patented Dec. 14, 1965

3,223,812

SWITCH SYSTEM

Charles S. Wright, 6700 Jansen Court, and Kenneth Owen, 6481 Hibbling Ave., both of Springfield, Va.

Filed June 15, 1964, Ser. No. 375,153
22 Claims. (Cl. 200—153)

The present invention relates to electrical switching and more particularly to switching apparatus for use in the radio frequency range whereby any one of a plurality of transmitters or receivers can be connected to any one of a plurality of antennas with freedom from objectionable cross-talk.

Heretofore transmitters have been connected to certain antennas to obtain the desired directional effect and this connection has been obtained by coaxial cables with suitable connectors such as coaxial patch cords so any one of a plurality of transmitters could be connected to any one of a plurality of antennas but the use of coaxial cables with their connectors has been awkward to use and has required excessive time for each change, and there was uncertainty as to the power from the transmitter being turned off during the change.

One object of the present invention is to provide a switching arrangement which overcomes the above difficulties.

An object of the present invention is to provide a switching arrangement particularly useful for connecting any one of a plurality of transmitters, power means or receivers to any one of a plurality of antennas or loads in a minimum of time and with visible indication of which antenna or load is connected to which transmitter, power means or receiver,

Another object of the present invention is to provide a shielded switching arrangement which avoids objectionable cross-talk between conductors.

A further object is to provide positive locking means to prevent an antenna switch change until after the power is turned off.

Other and further objects will be apparent as the description proceeds and upon reference to the accompanying drawings, wherein:

FIGURE 1 is an isometric view of one form of the antenna switching arrangement for connecting any one of a plurality of transmitters by a strip-line system to any one of a plurality of antennas.

FIGURE 2 is an enlarged, fragmentary, vertical section taken substantially on line **2—2** in FIGURE 1, showing a single plunger in normal position providing a continuous strip-line conductor from a first transmitter which is insulated and shielded from a similar continuous strip-line conductor from the first antenna.

FIGURE 3 is an enlarged fragmentary, horizontal section taken substantially on broken line **3—3** of FIGURE 1 showing the end plunger assemblies in normal or strip-line continuing position and showing the center plunger assembly in cross-switching position and also illustrating the microswitches for causing disconnection of the transmitter during the switching operation and for indicating the position of the plunger in cross-switching position.

FIGURE 4 is an axial section of one form of plunger assembly showing the end shafts mechanically connected by a threaded rod with a tubular insulator, strip-line continuing contacts, cross-switch contact, electrical shielding sheet element, insulating spacer collars, operating knob and microswitch actuating disk.

FIGURE 5 is a plan view of a fragment of a plunger assembly supported in a front plate showing one square contact element on the plunger in contact with a strip-line section supported on insulators mounted on the plate

and forming a continuous strip-line and showing the cross-switching contact being guided by a dihedral angle bracket supported on the same plate.

FIGURE 6 is a section taken on line **6—6** of FIGURE 5 showing how insulator capacitance effects are minimized by a conductive figure **8** shaped yoke.

FIGURE 7 is a perspective view of an electrical shielding sheet element for closing a plunger receiving aperture in the base.

FIGURE 8 is a fragmentary isometric view showing how a continuous strip-line is formed by a square strip-line continuing contact between strip-line sections with the plunger in normal position for carrying the signals through the continuous strip-line and with the electrical shielding element closing the associated plunger receiving aperture of the base and showing a terminal strip-line section connected to a center terminal of a coaxial cable.

FIGURE 9 is a fragmentary isometric schematic view showing one plunger assembly with a right-hand cross switch in normal or carry through condition and one plunger assembly with a right-hand cross-switch contact in antenna and transmitter cross connecting position and showing plunger assemblies with left-hand cross-switch contacts in corresponding conditions, with details omitted for clarity.

FIGURE 10 is a diagrammatic illustration of a switching apparatus for selectively connecting three transmitters to three antennas similar to FIGURE 1 and also showing plungers for connecting each transmitter to a dummy load.

FIGURE 11 is a diagrammatic illustration of apparatus for selectively connecting any one of eight transmitters, for example, to any one of eight antennas.

FIGURE 12 is a diagrammatic illustration of a modification of the arrangement of FIGURE 11 where eight transmitters can be connected to a dummy load and to any one of two antennas and can be connected to certain ones only of six other antennas.

FIGURE 13 is an enlarged rear elevation of one of the rear plates with the microswitches in position.

FIGURE 14 is a schematic diagram of a signal or annunciator board used with the switching arrangement of FIGURE 1 with the addition of the dummy load.

FIGURE 15 is a front perspective on a further enlarged scale of a modification of plunger and front bearing plate assembly with the contacts in strip-line continuing position and showing a manually rotatable control locking sleeve on a shaft core with cam means on the locking sleeve cooperating with a slot in the front plate communicating with the bearing aperture and with the cam means cooperating with microswitches mounted on the front plate for controlling the transmitter and for additionally retaining the locking sleeve and the plunger in either the strip-line continuing position or the cross switching position.

FIGURE 16 is a fragmentary vertical section through the assembly of FIGURE 15 showing detent action of the outer cam means and showing the contact elements with yieldable insulating washers at each end of the contact spacer insulators.

FIGURE 17 is a section taken on line **17—17** of FIGURE 16 showing the detent action of microswitch operating arms and the relative angular positions of the cams, the cam receiving slots, and the stops limiting angular movement of the locking sleeve.

Referring more particularly to the drawing, a strip-line switch system includes a vertically positioned flat base **10** to which side walls **11D** and **11L** and a top wall **12** are secured with the base being provided with a plurality of plunger receiving square apertures **13** therethrough with the apertures arranged in vertical and horizontal rows which rows will be identified numerically

from the top down and from left to right as shown in FIGURES 10 and 11 and the plungers carrying the switch contacts will be similarly identified where necessary.

Horizontally extending partition members **14** of Z-shape or I-shape section extend between the horizontal rows of apertures **13** on the front of base **10** and vertically extending partition members **15** are located between the vertical rows of apertures **13** on the rear of base **10**. A plurality of front plates **16F** extend between the adjacent front partition members **14** while identical plates **16R** extend between the rear partition members **15** but the rear plates are rotated through 90° about the axis of the shaft receiving aperture to the position shown in FIGURE **13**. Each plate **16F** and **16R** has a shaft receiving aperture serving as a bearing.

Each set of cooperating plates has its shaft receiving apertures in axial alignment with each other and in axial alignment with the cooperating square aperture **13** in the base **10** as clearly shown in FIGURE 3. The plates **16** are held in position by screws **16S** threaded into tapped holes in the partition members **14** and **15** and the partition members are secured to the base **10** by screws threaded into tapped holes in the base.

Where parts are similar the part in front of base **10** is identified by the reference numeral with the suffix F and a part rear of base **10** is identified by the reference numeral with the suffix R.

A dihedral angle guide bracket has one leg **17** supported on the inner surface of each plate **16F** or **16R** and the other leg **18** extends transversely to its plate and to the base **10** and parallel to the axis of the cooperating shaft-receiving apertures. Insulators **19, 19** having threaded bores at each end, are secured by one end to the one leg **17** of the angle bracket and to the cooperating plate **16** by screws **17S, 17S**. The insulators **19** carry a strip-line section **20** which comprises a bar **21** of silver-plated copper covered by a resilient strip of silver-plated beryllium copper **22** loosely wrapped over each end of the bar **20** forming a loop at each end and terminating short of the mid-length of bar **21** on the surface away from base **10** and secured by rivets **23** to bar **21**. The ends of the strip **22** are provided with inwardly extending slots **22A** which permit wrapping the strip **22** around the bar **21** after headed attaching studs **24** are pressed into position in small apertures in the bar **21** so that the insulators **19, 19** can be screwed on the studs **24** and the strip-line section **20** can be securely maintained in accurate parallel relation to the base **10** by being supported from plate **16** by screws **17S, 17S** extending through leg **17**, of guide bracket **17, 18** and into insulators **19, 19**. The loops formed at each end by the strip **22** are provided with cuts **25** providing three independently yieldable contacts **25A**.

To minimize inductance heating, a conductive rod **25B** is bent into a yoke of figure-8 conformation and at the center thereof a stud **25C** extends laterally and is press-fitted into an aperture in the cooperating strip-line bar section **21** so the figure-8 shaped yoke is kept at the same potential as the bar section **21** and screw **24**, thereby minimizing any heating effect.

Slidably supported in shaft-receiving apertures in the plates **16F** and **16R** cooperating with one of the square apertures **13** in the base plate **10** is a plunger assembly shown in section in FIGURE 4 which plunger assembly includes a front shaft section **26F** and a rear shaft section **26R** of identical construction each provided with a threaded bore at each end and provided with a flange **27** on the inner end serving as a stop by engagement with the cooperating plate. A rod **28** threaded at both ends extends through a tubular insulator **29** on which a front square contact **29F** and a rear square contact **29R** are mounted with an electrical shielding resilient sheet element **30** located therebetween for closing the cooperating square aperture **13** when the square contacts **29F** and **29R** engage cooperating strip-line sections **20** at the front and rear respectively of the base plate **10**, as shown in FIGURES 2, 3, and 8.

A cross-switch contact including a conductive tubular body **31** having a front rectangular contact element **32** and a rear rectangular contact element **33** is also supported on the insulating tube **29**.

The various contacts and electrical shielding sheet element are maintained in proper spaced relation by insulator collars **34, 35, 36, 37**, and **38** between the flange ends **27** of the shafts **26F** and **26R**, thereby maintaining the contacts in accurately spaced relation. A handle or operating knob **39** is mounted on the front shaft by means of a screw **39A** threaded into the front shaft **26F**, while a microswitch operating disk **40** is mounted on the other shaft section **26R** by a screw **40S**, thereby completing the plunger assembly.

The electrical shielding sheet element **30** shown in FIGURE 7 is of a width substantially the same as one side dimension of the square contacts **29F** and **29R** while the length is substantially greater to effectively close the cooperating aperture **13**. The ends of the electrical shielding sheet element **30** are provided with slots **30A** to provide spring fingers **30B** for electrically conductive engagement with the conductive base plate **10**. A dimple **30C** is formed on each spring finger to form a projection that engages the plate **10** with adequate contact pressure.

The terminal end strip-line section **20L, 20D** or **20T** is modified from the strip-line sections **20** between apertures **13** by having the resilient beryllium copper strip **41** thereof (FIGURE 8) formed into a loop at the inner end of the bar **21** in the manner previously described but the strip **41** projects beyond the outer end of the bar **21** a length sufficient to reach the center contact **42** of one of the conventional coaxial cable connection adapters. Each adapter includes a conical housing **43** bolted to the base plate **10** and connected to a conventional coaxial cable **44** which extends to the corresponding antenna.

Similarly the connections to the transmitter or the receiver are made from the strip-line sections **20** with the top most strip-line section being similar to the strip-line section **20L** which includes the resilient yieldable bendable strip material **41** for connection by a 90° dihedral angle bend to the center contact of a coaxial cable connection **42T** to a transmitter or receiver.

The connection of the strip-line section **20L** to the antenna coaxial cable is shielded by a box **52** having an open back and one open side which has an extension overlying the plate **16F** adjacent the antenna connection and is secured to the base **10** and the plate **16F** by attaching screws to permit removal for servicing.

The plates **16F** on the front are arranged in staggered relation depending upon whether the antenna connection is at the left or at the right, and small end plates **51F** are provided to complete the shielding and also to provide a neat appearance.

It will also be noted that the rows of plates **16R** on the rear are arranged at 90° rotation about the associated shaft receiving apertures to the position shown in FIGURE 13 thereby making the staggered arrangement of the rear plates **16R** such that the end plates **51R** are located at the top and bottom.

The leg **18F** of each dihedral angle guide bracket **17F, 18F** at the front is adapted to guide an edge of each contact element **32, 33** of each switch contact **31, 32, 33** and prevent rotation thereof when the cross switch contact is in the line continuing position of FIGURES 2 and 5 while the guide dihedral angle bracket **17R, 18R** at the rear is adapted to guide the square contacts **29F, 29R** as well as the long side of the rectangular electrical shielding element **30** to thereby assure that the contacts remain in operative registration assuring that the contacts will pass into operative engaging positions with the resilient end portions **25A** of the resilient strips **22** or **41** of the strip-line sections. Thus there is no danger of the contacts becoming excessively angularly displaced

about the insulator **29**, thereby assuring that the contacts will slide into operative contacting positions with the strip-line sections. It will also be noted that the rounded portions of the loop **25B** formed by portions **25A** act as cam means to direct the contacts into operative engaging position.

The switching arrangement of the present invention provides for continuous strip-lines in a horizontal direction on the front of the flat base and continuous vertical strip-lines on the rear of the flat base. When a plunger is in its forward position as shown in FIGURES 2 and 8, for example, the strip-lines are continuous through that plunger but when the plunger is in the position shown at the center of FIGURE 3 the cross-switch contact connects the strip-line extending from the center transmitter **A2** to the antenna strip-line which is connected to the top antenna **A1** at the left of the equipment shown in FIGURE 1. It will be apparent that any transmitter **T1**, **T2**, or **T3** can be connected to any antenna **A1**, **A2**, or **A3** by the selection of the proper plunger and moving such plunnger to the rear to the position shown by the top center plunger **T2–A1** in FIGURES 1 and 3.

It is important that the power be turned off during the switching operation and that the power be not turned on again until the switching operation is completed to avoid objectionable interference, arcing, and the like and for this purpose a first microswitch **45** having auxiliary contacts is mounted on a first dihedral angle supporting bracket **46** and a second microswitch **47** is mounted on a second dihedral angle supporting bracket **48**, each bracket with its microswitch being mounted on its cooperating plate **16R** by screws **16S** and such microswitches are actuated by engagement of their arms with operating disk **40** carried by the cooperating shaft **26R** shown in FIGURE 3.

These microswitches are arranged to control the transmitter to prevent transmitter power being on during the switching operation. Also the switch **47** having additional auxiliary contacts is provided with an indicator operating contact which is connected in circuit to an annunciator board **49** (FIG. 14) to turn on an indicator such as a light corresponding to the plunger which is in cross-switching position and such annunciator board **49** is adapted to be positioned at a remote location with the lights **50** in the same relative positions as the plungers viewed from the front. The center light **50** in the top row is lighted to show that the center transmitter **T2** is connected to the top antenna **A1**. The center top plunger would be identified as **T2–A1** to indicate the second transmitter and the first antenna and to shorten the expression it would be referred to as 2–1 with similar expressions used for identifying the various locations giving the transmitter location first and the antenna or dummy load the second identification after the hyphen.

In FIGURE 10 a diagrammatic showing corresponding to FIGURE 1 includes a dummy load with the dummy load being indicated by **DL** at the bottom showing two plungers therefor. FIGURE 11 shows an arrangement in which eight transmitters and eight antennas are used with a dummy load at the bottom.

It should be noted that the switch arrangement has its antenna **1** connection **44A1** at the left and antenna **2** connection **44A2** at the right so the parts may be closely assembled and still have room for large diameter coaxial cable connections or adapters. The transmitter connection flanges **51** are all arranged at the top of the equipment in staggered relation providing sufficient space for the conventional large diameter coaxial cable connections, the details of such coaxial cable connection being omitted for simplicity.

In the diagram of FIGURE 11 the plunger which would normally be at location **8–DL** is omitted since it would perform no useful function since a plunger at that location would still connect transmitter **8** to the dummy load in either position.

Another example of 100% flexibility is the use of 10 transmitters, 10 antennas and 10 dummy loads with 109 switches so that each antenna can be connected to each transmitter.

However, a reduced flexibility between 10 transmitters and 10 antennas is obtained when 10 transmitters are connected to a dummy load and to antennas **1** and **2** similar to FIGURE 12 with antennas **7**, **8**, **9**, and **10** being connectable to transmitters **1** to **5** only and with antennas **3**, **4**, **5**, and **6** being connectable to transmitters **6** to **10** only. This reduced flexibility requires only 68 plungers and has a flexibility of 63%.

Where less flexibility is required the arrangement of antenna and transmitters may be that shown in FIGURE 12 where the center strip-line sections between the three bottom antenna strip-lines are omitted between transmitters **4** and **5** so antennas **A–3**, **A–5** and **A–7** can be connected only to transmitters **T–1**, **T–2**, **T–3** and **T–4**; while antennas **A–4**, **A–6** and **A–8** can be connected only to transmitters **T–5**, **T–6**, **T–7** and **T–8**. The dummy load **DL** is located on the top in this arrangement and a plunger with its contact is provided for each crossing of the dummy load strip-line and the transmitter strip-lines **1** to **8**.

Any number of transmitters and any number of antennas can be arranged for cooperation while avoiding objectionable cross-talk since the strip-line is completely shielded by the conductive base plate **10**, partitions **14** and **15**, plates **16F** and **16R** and shields **30** closing the square apertures so the equipment of the present invention gives the effect of complete coaxial shielding without the disadvantages of prior structures.

Referring more particularly to FIGURES 15 to 17, inclusive, a modified form of plunger is shown mounted in a modifield form of front plate **16FA** with the microswitches **47** and **45** being mounted on the same front plate **16FA**. The plunger includes the rear shaft **26RA**, the various contacts and the spacers which spacers are shown in this modification as being of ceramic material with Teflon washers **60** shown at each end of each spacer where the spacer contacts a metallic element such as a contact or the stop flange **27**, for example, thereby making it possible to use less expensive spacers of ceramic material telescoped on the Teflon tubular insulator **29**. The forward shaft in the modification of FIGS. 15 to 17 is shown to include a shaft core **61** having an axial threaded bore at each end. A hollow cylindrical shaft locking sleeve **62** is freely rotatable on the core **61** and is prevented from longitudinal movement relative to the core **61** by a washer **63** secured to the outer end of the shaft core **61** by a bolt **63B** with the washer **63** being of less diameter than the sleeve but of greater diameter than the core. The other end of the sleeve **62** is prevented from longitudinal movement by a nylon washer **64** which abuts against a metal washer **65** which metal washer **65** abuts against a Teflon washer **60** of the type used at each end of each ceramic spacing insulator. The nylon washer **64** also serves as the stop providing a cushioning action between the plate **16FA** and the plunger assembly. The assembly of contacts with the rear shaft **26RA** and the shaft core **61** is accomplished by the screw-threaded rod **28** which has its forward end threaded into the rear end of the shaft core **61** while the Teflon tubular insulator **29** is of less length than the total axial length of the contacts, and the depth of the cylindrical recesses **66A**, the washers and the ceramic insulators so that compression occurs on the insulators and the contacts between the projecting rim **66** of the core **61** formed by the cylindrical recess **66A** in the rear end of the core **61** receiving the Teflon tubular insulator **29** and the corresponding rim **66** in the shaft **26RA** so that a strong clamping action is obtained by the screw-threaded rod **28** to retain the contacts and insulators in proper angular relation by the frictional engagement between the clamped parts.

The showing in FIG. 4 being on a small scale shows the flanges 27 as being part of the shaft 26 to avoid confusion but the structure is preferably that shown in FIG. 16 where the flange 27 of FIG. 4 is shown as being a washer 65 with a nylon washer 64 abutting the shaft core 61 or shaft 26RA with the shaft core 61 and shaft 26RA each having a cylindrical recess 66A formed by the projecting rim 66 so that the tubular insulator 29 may be telescopingly received into such cylindrical recess. The nylon washer 64 also serves as a cushioning stop for the plunger assembly against the inner surface of the cooperating bearing plate.

The dihedral angle guides 17, 18 previously described engage the adjacent edges of the contacts 29, 29, 33, 32 to prevent relative rotation thereof, while the strip-line sections 20, 20L and 20T retain the contacts in correct registration with the strip-line in the operative position of the strip-line continuing contacts so that the contacts are retained in angular relation by friction for a minimum of movement in the axial direction of the plunger.

An operating knob 67 having a cylindrical bore receiving the outer end of sleeve 62 extends beyond and is fixed to the sleeve 62 by a pin 67P so that a portion of the knob 67 extends forwardly beyond the washer 63 and the retaining screw 63B so there is no danger of an operator having his hand engage the shaft core 61 or any parts fixedly attached thereto.

The locking sleeve 62 is provided with a first elongated cam 68 adjacent the inner end and a second elongated cam 69 spaced from said first cam by the thickness of the plate 16FA and such cam 68 is adapted to pass through a slot 70 communicating with the sleeve receiving aperture in the plate whereby the locking sleeve may be rotated to a position where the cam 68 is in registry with the slot 70 to permit axial movement of the plunger assembly including the locking sleeve 62. The slot 70 is shown extending horizontally while the first cam 68 extends downwardly and the second cam 69 extends upwardly.

Mounted on the outer surface of the plate 16FA are arcuate stops 69S and 68S which limit the movement of the sleeve 62 to 90 degrees and this limited movement permits registration of the cam 68 with the slot 70 and while permitting limited rotation of the locking sleeve 62. The cams 69 and 68 are adapted to operate the microswitches 47 and 45, respectively, and these switches are operated by their spring biased actuating arms 47A and 45A, respectively. The position of the rollers on the ends of such arms is such that the rollers engage the cams 69 or 68 to actuate the switches and the rollers then also serve as detents yieldingly retaining the cams in abutting contact with the stops 69S or 68S as clearly shown in FIGURES 15 to 17, inclusive. This modification of the present invention assures that power from the transmitter is positively disconnected before the plunger is moved in an axial direction to change the connection of the antenna to the transmitter and similarly, the indicator operated by the switch 47 is operative to indicate on the indicator board 49 that the plunger is in its cross-connecting position and locked in that position and therefore the structure shown in FIGURES 15 to 17 positively assures this sequence of operation.

The first form of the invention also positively assures the operation of the various control switches 45 and 47 but the plungers are not positively locked in position against axial movement so that accidental operation could occur. However, the previously described form of the invention is readily adaptable to mechanical actuation of the plungers by power means making use of the control switches in their positions shown in FIGURES 3 and 13.

The parts are blackened to assist in the dissipation of heat except for the bearing surfaces between the plates and shafts.

The plungers in the drawings are shown as being in line continuing position when the plungers are in their forward positions and in cross switching position when the plungers are in their rearward position.

By simple reassembly of the switch contacts on the plungers so the cross switching contacts 31, 32, 33 is placed on the rear of the plunger instead of being on the front thereof, the cross switching will occur when the plunger is in the forward position and the line continuing arrangement will occur when the plunger is in the rear position.

The switch assembly is preferably made in modules of a desired size such as three switches wide and three switches high, for example, and several of such modules may be connected together to make any desired size of switch assembly such as nine switches wide by three switches high or nine switches wide and twelve switches high or any other combination to get any desired combination. The modules are connected so that the connections 20L, 20D or 20T are connected to corresponding end connections of adjacent switch assembly modules to obtain any desired switching effect.

It will be apparent that changes may be made in the various structures described within the spirit of the invention as defined by the valid scope of the appended claims.

What is claimed is:

1. A strip-line switch system for connecting any one of a plurality of transmitters or receivers to any one of a plurality of antennas comprising a vertically positioned flat base having a plurality of aligned plunger receiving rectangular apertures therethrough in vertical and horizontal rows, horizontally extending partition members on the front of said flat base extending between the horizontal rows of apertures, vertically extending partition members between the vertical rows of apertures on the rear of said base, front plates extending between adjacent front partition members, and rear plates extending between adjacent rear partition members, each front and each rear plate having a shaft receiving aperture and cooperating front and rear plates having their shaft receiving apertures in axial alignment with the cooperating rectangular aperture in said base, a dihedral angle guide bracket having one leg supported on the inner surface of each plate with the other leg extending transverse to said base and parallel to the axis of the cooperating shaft receiving aperture, a pair of insulators supported by one end from said one leg of each angle bracket, a strip-line section supported on the other ends of said insulators in parallel relation to the partition members and base, a strip of yieldable contact sheet material wrapped over both ends of each strip-line section and secured thereto, a figure-8 yoke embracing said insulators and connected to the associated strip-line section, a plunger for each rectangular aperture, each plunger including a front and a rear shaft slidable in the shaft receiving apertures in the corresponding front and rear plates, the front shaft having a flange on its rear end and the rear shaft having a flange on its front end and said shafts having a threaded axial bore at each end, a micro-switch operating disk on the rear shaft and an operating knob on said front shaft, a tubular insulator between the flange ends of said shafts and extending through the cooperating rectangular aperture in said base and of a length that the cooperating shafts remain supported in said plates while the flange ends of the shafts limit the axial movement, a rod threaded at both ends extending through said tubular insulator and screw threaded into the flanged ends of said shafts, a square front and a square rear contact element each having a central mounting aperture receiving said tubular insulator for electrical connection to adjacent strip-line sections to form therewith a continuous strip-line conductor, an electrical shielding sheet element on said tubu-

lar insulator between said square front and said square rear contact elements and rearwardly of said base to close the cooperating square aperture in said base to effectively shield the adjacent strip-line on the front from its crossing strip-line on the rear, a cross-switch contact including a conductive tubular body on said tubular insulator, front and rear rectangular contact elements on said tubular body of a size to engage with only one adjacent strip-line section so said cross-switch contact of each plunger may connect a single strip-line conductor on the front to its crossing single strip-line conductor on the rear whereby any strip-line conductor on the front can be connected to any strip-line conductor on the rear, and spacers on said tubular insulators to maintain said contacts in operative position when the flange stop of said shafts engage the cooperating plate.

2. The invention according to claim 1 in which an operating knob is screw threadedly attached to the outer end of the shaft, and a microswitch actuating disk is screw threadedly secured to the outer end of the rear shaft, a pair of microswitches for each plunger, one microswitch being actuated by said disk when the plunger is in the rear position and the other microswitch being actuated when the plunger is in its front position, and means responsive to said microswitches to indicate the position of the plunger and other means responsive to the microswitches to prevent energization of the associated strip line until the plunger is at the limit of movement.

3. The invention according to claim 1 in which an annunciator having indications corresponding to each plunger is mounted at a distant location, and means are actuated by each plunger to control said annunciator to indicate the condition of its associated plunger.

4. A strip-line switch system for connecting any one of a plurality of transmitters or receivers to any one of a plurality of antennas comprising a base having a plurality of switch receiving apertures therethrough, first partition members on one side of said base extending between lines of apertures, second partition members on other sides of said base extending transversely to said first partition members between lines of apertures, plates on one side of said base extending between adjacent first partition members, and plates extending between said second partition members, each plate having a shaft receiving aperture and cooperating plates having their shaft receiving apertures in axial alignment with the cooperating aperture in said base, a guide having a leg extending transverse to said base and parallel to the axis of the cooperating shaft receiving aperture, insulators supported by one end from said plates, a strip-line section supported on the other ends of said insulators in parallel relation to the partition members and base, a strip of yieldable contact sheet material wrapped over each strip-line section, a plunger for each aperture in said base, each plunger including a shaft at each end in the shaft receiving apertures in the corresponding plates, an elongated insulator between the inner ends of said shafts and extending through the cooperating aperture in said base and of a length that said shafts remain supported in said plates between the limits of axial movement, a one side contact and another side contact mounted on said elongated insulator for electrical connection to adjacent strip-line sections to form therewith a continuous strip-line conductor, an electrical shielding sheet element on said tubular insulator between said one side contact and said other side contact and on the other side of said base to close the cooperating aperture in said base to effectively shield the adjacent strip-lines on the one side from the strip-line on the other side, a cross-switch including a conductive tubular body on said elongated insulator, one side and other side contact elements on said tubular body of a size to engage with only one adjacent strip conductor section so said cross switch connects a single strip-line conductor on the one side to a single strip-line conductor on the other side whereby any strip-line conductor on one side can be connected to any strip-line conductor on the other side.

5. A switching system comprising a conductive base plate having a pluraiity of apertures therethrough, a plurality of strip-line section conductors insulatingly supported between adjacent apertures with the strip-line sections on one side of said base extending in a transverse direction to the strip-line sections on the other side of said base, a plunger for each aperture, each plunger being mounted for movement through its cooperating aperture, each plunger comprising strip-line section connecting contacts for continuing the strip-line sections on one side into continuous strip-lines and other strip-line connecting contacts for continuing the strip-line sections on the other side into continuous other strip-lines when a plunger is in one position, cross-switch contacts including contact elements on said plunger for connecting one strip-line section on one side of the base to a strip-line section on the other side of said base when the plunger is in the other position.

6. A switching system comprising a base, first strip-line section conductors insulatingly supported on said base, second strip-line section conductors insulatingly supported on said base and extending transversely to said first strip-line sections, plungers mounted for movement on said base adjacent the crossings of the strip-line section conductors, plungers comprising strip-line section continuing contacts for continuing the strip-line sections into continuous strip lines when a plunger is in one position, cross-switch contacts including contact elements on said plunger for cross connecting one of said first strip-line sections to one of said second strip-line sections when the plunger is in the other position.

7. A switch structure comprising a base having an aperture therethrough, strip-line sections insulatingly mounted on opposite sides of said base, and terminating adjacent to and within the projected outline of said aperture, an apertured plate mounted in space relation on each side of said base with the aperture thereof in axial alignment with the base aperture, a plunger including shafts mounted for sliding movement in said apertures in said plate and an insulator between said shafts, a pair of symmetrical contacts on said insulator spaced apart the distance between the strip-line sections on opposite sides of said base, another contact including a conductive body and unsymmetrical contact elements spaced apart the distance between said strip-line sections on opposite sides of said base, and stop means to limit movement of said plunger so said plunger will be in either the position where said pair of contacts are engaging said strip-line sections on opposite sides of said base for continuing the strip lines or in the other position where said another contact engages said strip line sections on opposite sides of said base cross connecting said strip lines on opposite sides of said base.

8. The invention according to claim 7 in which dihedral angle guide brackets are mounted on said plates and maintain said contacts in alignment with the strip-line section.

9. The invention according to claim 7 in which the insulator supports an electrically conductive element which closes the aperture in said base when said first contacts are engaging said strip-line sections.

10. A switch for selectively connecting sections of two strip lines to provide continuations of each strip line or cross connection between strip lines comprising a base, strip line sections insulatingly mounted on said base, a member mounted for movement across the strip lines, said member including first contacts operable for continuing the strip lines as separate conductors insulated from each other when the member is in one position, and including other contacts for cross-connecting said strip line sections while breaking the connection of said first contacts with the strip line sections when the member is in the other position, said strip-line sections being on

opposite sides of said base, and said base being provided with an aperture through which said member with said contacts passes, said member carrying an electrical shielding element for closing said aperture when said first contacts are in engagement with said strip-line sections.

11. The invention according to claim 6 in which auxiliary contacts are mounted to be operated by said plunger to indicate the position of the plunger.

12. A strip-line section comprising a conductive bar, a pair of studs projecting from one surface of said bar, a resilient strip of conductive material having slots formed in each end thereof wrapped around said bar longitudinally thereof, said resilient strip being formed into a loop where said strip bends around the end of said bar, said loop having longitudinally extending slits forming independently movable contacts for engaging a movable switch contact element and insulators mounted on said studs for supporting said strip line section from a conductive support, and a conductive figure-8 shaped yoke embracing said insulators and electrically connected to said bar.

13. The invention according to claim 6 in which auxiliary contacts are mounted to be operated by said plunger to control the flow of power to the strip lines being opened or closed.

14. A plunger for switching comprising a pair of shafts arranged in axially spaced axial alignment, an insulator between said shafts, a pair of symmetrical first contacts mounted on said insulator in axially spaced relation and insulated from each other, a second contact including a conductive body mounted on said insulator and having a pair of space contact elements spaced apart the same distance as said first contacts, said second contact elements being unsymmetrical, and means to secure said contacts in spaced relation on said insulator whereby said first and symmetrical contacts may be used to continue strip-line sections into a continuous strip-line and said second contact may be used to cross-connect one strip-line section of one of said strip-lines to a strip-line section of the other strip-line.

15. An operating shaft for a switch comprising a shaft core with an axially threaded bore at each end and having a cylindrical recess at one end, a shaft locking sleeve freely rotatable on said shaft core, a tubular insulator having one end received in said cylindrical recess of said shaft core, a rod threaded at each end passing through said tubular insulator and threaded into the one end of said shaft core, a first washer mounted on said tubular insulator abutting said one end of said shaft core, a second washer on the other end of said shaft core, said shaft sleeve being of less length than said shaft core, whereby said shaft sleeve will freely rotate and be limited in longitudinal movement along said shaft core by said first and second washers, a bearing plate having a shaft receiving aperture rotatably supporting said shaft locking sleeve while permitting longitudinal movement of said shaft sleeve with said shaft core in an axial direction in said aperture, said bearing plate having a cam receiving slot communicating with the shaft receiving aperture, cam means extending from adjacent said one end of said shaft sleeve a distance corresponding to the axial movement of said plunger less the thickness of said bearing plate, a second cam means between said first cam means and said other end and spaced 180 degrees from said first cam means and axially therefrom the thickness of said plate whereby said first cam means may be located outwardly of said plate, micro-switches mounted on the outer surface of said plate, each microswitch having an actuating arm located for operation by said cam means, and stops limiting the rotation of said shaft locking sleeve whereby said actuating arms of said microswitches serve as detents to releasably retain said shaft locking sleeve in two angular positions.

16. A switch comprising strip-line sections and contacts cooperable with said strip-line sections, a plunger operating shaft including a shaft core with axially threaded bore at each end and having a cylindrical recess at one end, a locking sleeve freely rotatable on said shaft core, a tubular insulator received in said cylindrical recess of said shaft core, a rod threaded at each end passing through said tubular insulator and threaded into the one end of said shaft core, a guide shaft threaded to the other end of said rod, a first washer mounted on said tubular insulator abutting said one end of said shaft core, a second washer on the other end of said shaft core, said locking sleeve being of less length than said shaft core, whereby said locking sleeve may freely rotate while being prevented from longitudinal movement relative to said shaft core, a bearing plate having a locking shaft receiving aperture rotatably supporting said locking sleeve while permitting longitudinal movement of said locking sleeve with said plunger in an axial direction in said bore, said plate having a cam receiving slot therein communicating with the shaft receiving aperture, a first cam on said locking sleeve extending from adjacent said one end of said shaft sleeve a distance corresponding to the axial movement of said plunger less the thickness of said plate, a second cam on said locking sleeve between said first cam and said other end and spaced 180 degrees from said first cam and spaced longitudinally the thickness of said plate from said first cam whereby said first cam may be located outwardly of said plate to operate microswitches or be located inwardly of said plate so that said second cam may operate other microswitches, microswitches mounted outwardly on said plate and having actuating arms located for operation by said cams, and stops engageable with said cams limiting the rotation of said sleeve whereby said actuating arms of said microswitches serve as detents to retain said sleeve releasably in two angular positions, and contacts on said tubular insulator for cooperation with said strip-line sections to connect said strip-line sections in continuous strip-lines or in crossing connections, ceramic insulating spacers between said contacts and yieldable nylon washers between said ceramic insulating spacers and said contacts, said rod serving to clamp said contacts and spacers securely together.

17. A switch operating handle mechanism for controlling a reciprocating plunger comprising a circular apertured bearing, a cylindrical sleeve rotatably mounted in the circular aperture, a core within said sleeve for connection to a switch structure, a slot extending radially from said circular aperture, a first cam extending along one side of said sleeve adjacent one end thereof, a second cam spaced an axial and angular distance from said first cam, a first stop on said bearing for engagement by said first cam, a second stop on said bearing for engagement by said second cam, microswitches having spring biased arms in the path of said cams when said sleeve is rotated from a position where said second cam is in alignment with said slot to a position where said second cam engages its stop, said spring biased arms being so positioned that when either of said cams is in engagement with its cooperating stop, said cooperating arm will yieldably maintain said sleeve against rotation thereby locking said sleeve against accidental movement in an axial direction.

18. An operating handle mechanism for controlling a reciprocating plunger comprising a circular apertured bearing, a cylindrical sleeve rotatably mounted in the circular aperture, a core within said sleeve for connection to a mechanism to be operated, a slot extending radially from said circular aperture, a first cam extending along one side of said sleeve adjacent one end thereof, a second cam spaced an axial and angular distance from said first cam, a first stop on said bearing for engagement by said first cam, a second stop on said bearing for engagement by said second cam, spring biased arms in the path of said cams when said sleeve is rotated from a position where said second cam is in alignment with said slot to a position where said second cam engages its stop, said spring biased arms being so positioned that when either of said cams is in

engagement with its cooperating stop, said cooperating arm will yieldably maintain said sleeve against rotation thereby locking said sleeve against accidental movement in an axial direction.

19. The invention according to claim 1 in which the parts are blackened.

20. The invention according to claim 6 in which a plurality of a said switching system is arranged in modular relation thereby increasing the number of switches and increasing the possible combinations of the switching connections.

21. The invention according to claim 6 in which power means are provided to actuate each plunger for remote control thereof.

22. The invention according to claim 6 in which auxiliary contacts are mounted to be operated by said plunger to indicate the position of the plunger and additional auxiliary contacts are operated to control the flow of power to the strip lines being opened or closed.

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ROBERT K. SCHAEFER, *Primary Examiner.*

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,223,812 December 14, 1965

Charles S. Wright et al.

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

In the grant, line 3, after "Virginia," insert -- assignors to Delta Electronics, Inc., of Alexandria, Virginia, a corporation of Virginia, --; line 12, for "Charles S. Wright and Kenneth Owen, their heirs" read -- Delta Electronics, Inc., its successors --; in the heading to the printed specification, lines 3 and 4, for "Charles S. Wright, 6700 Jansen Court, and Kenneth Owen, 6481 Hibbling Ave., both of Springfield, Va." read -- Charles S. Wright, and Kenneth Owen, both of Springfield, Va., assignors to Delta Electronics, Inc., Alexandria, Va., a corporation of Virginia --.

Signed and sealed this 3rd day of October 1967.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents