March 14, 1961 R. R. CARDASCIA ET AL 2,975,390

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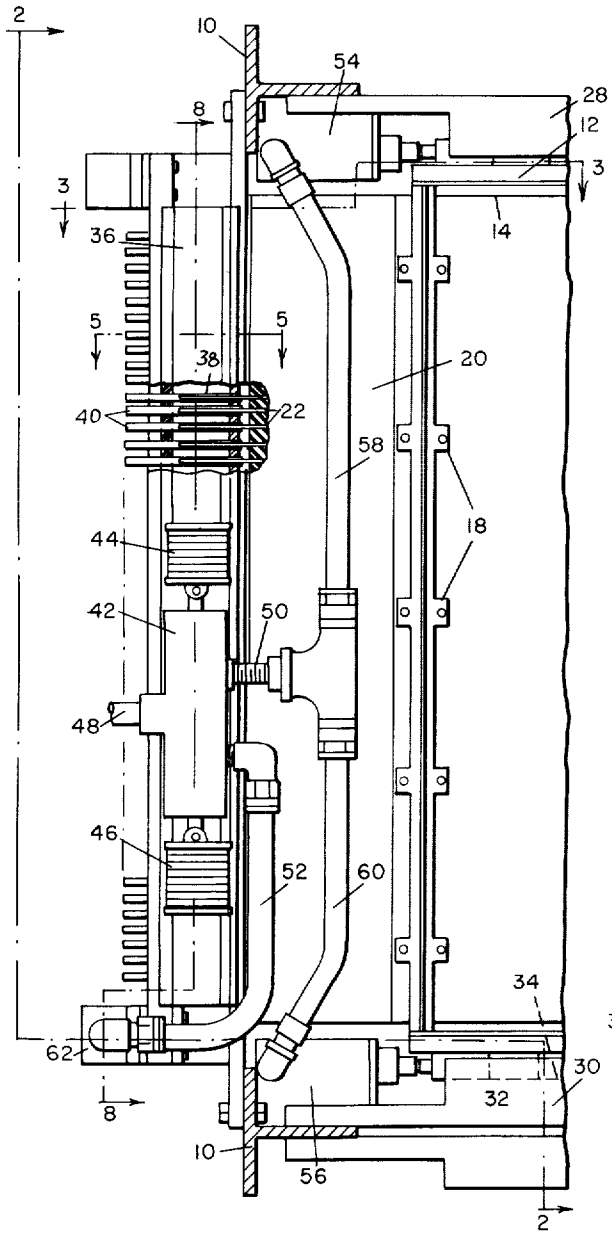


FIG. 1.

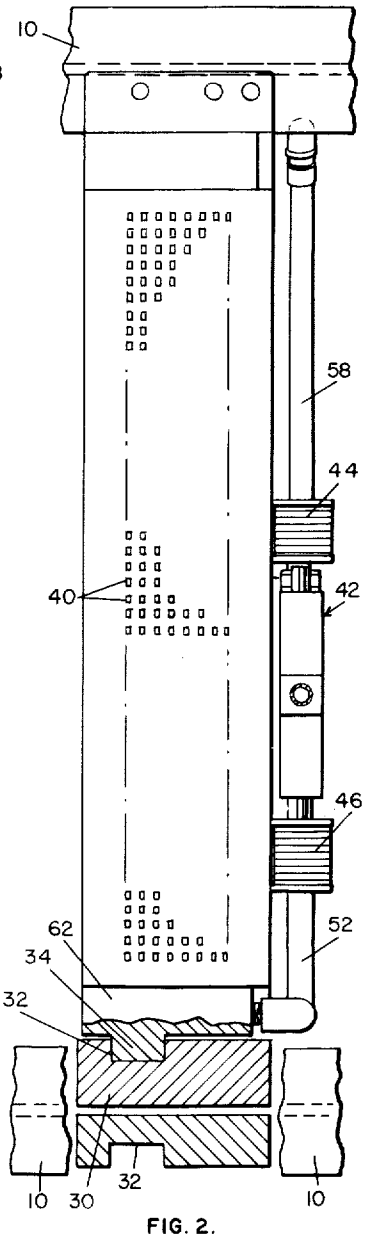


FIG. 2.

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March 14, 1961 R. R. CARDASCIA ET AL 2,975,390

PLUGGABLE UNIT

Filed Dec. 31, 1958 4 Sheets-Sheet 2

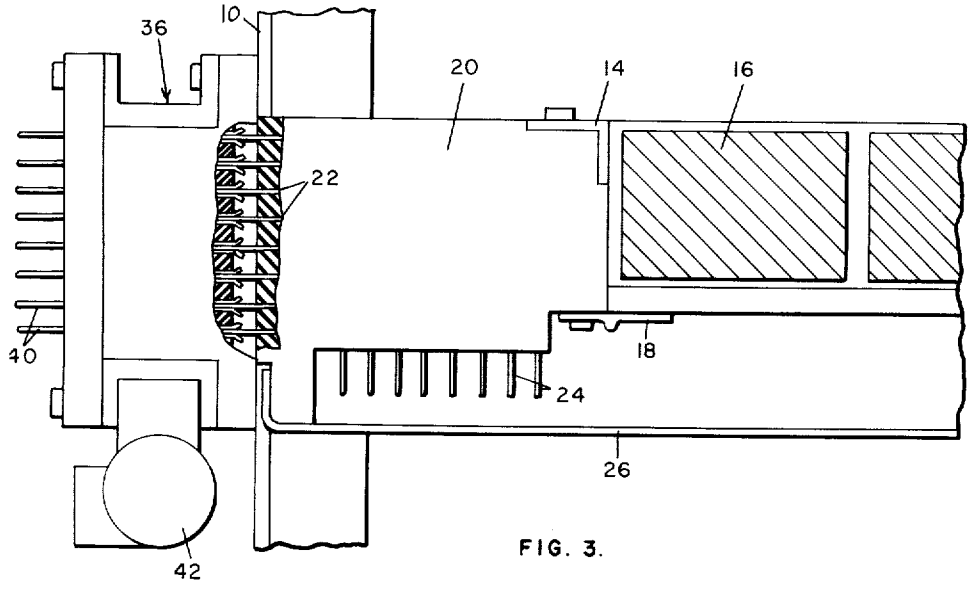


FIG. 3.

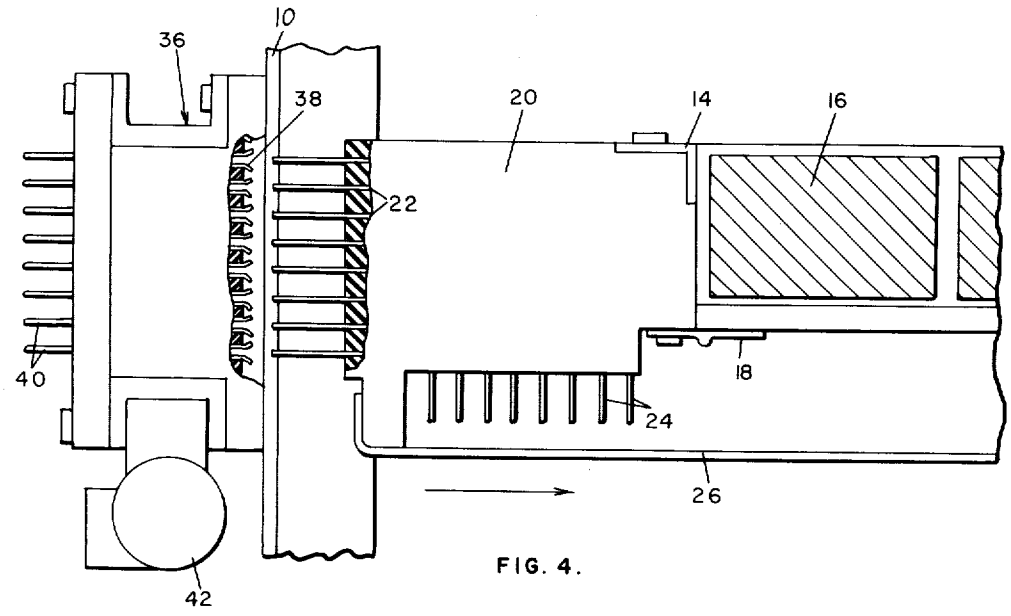


FIG. 4.

March 14, 1961 R. R. CARDASCIA ET AL 2,975,390

PLUGGABLE UNIT

Filed Dec. 31, 1958 4 Sheets-Sheet 3

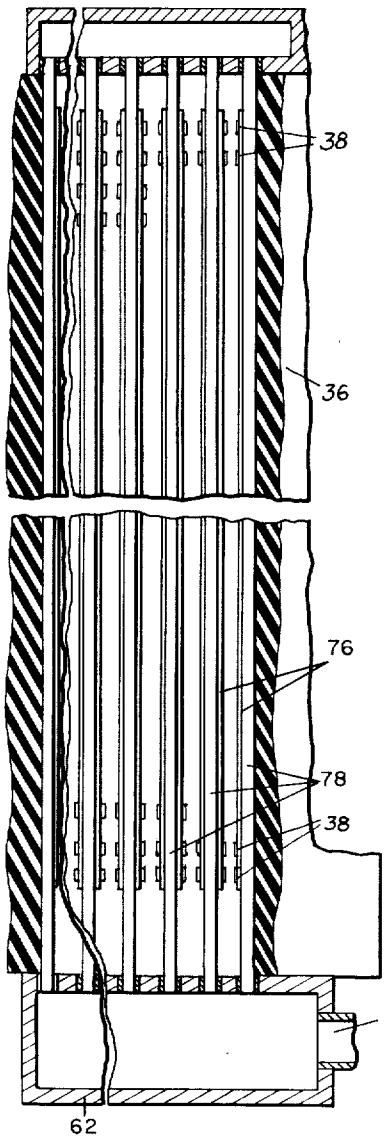


FIG. 8.

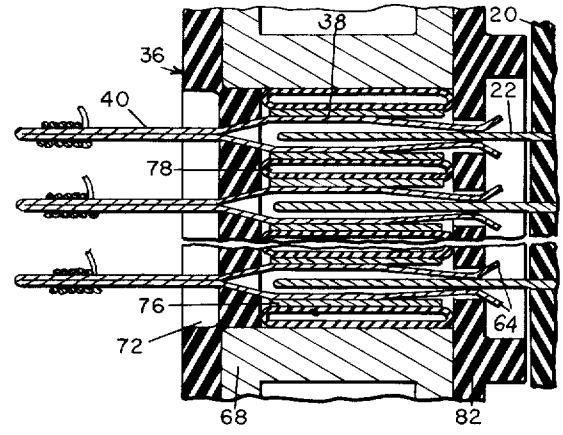


FIG. 5.

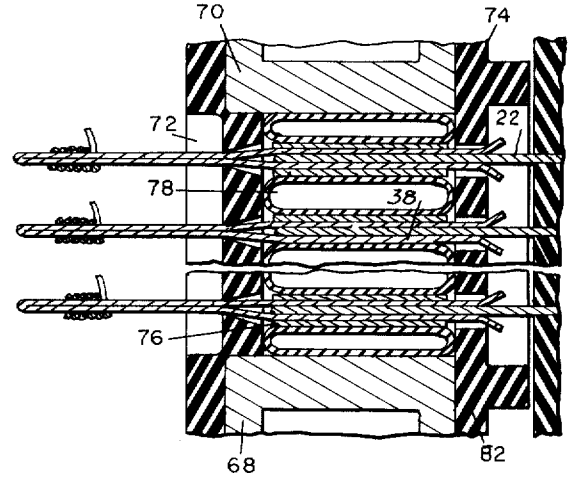


FIG. 6.

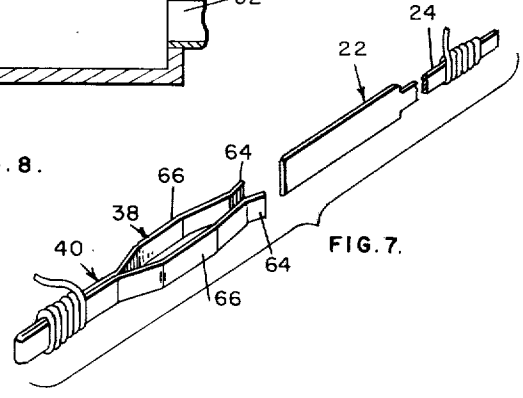


FIG. 7.

March 14, 1961 R. R. CARDASCIA ET AL 2,975,390

PLUGGABLE UNIT

Filed Dec. 31, 1958 4 Sheets-Sheet 4

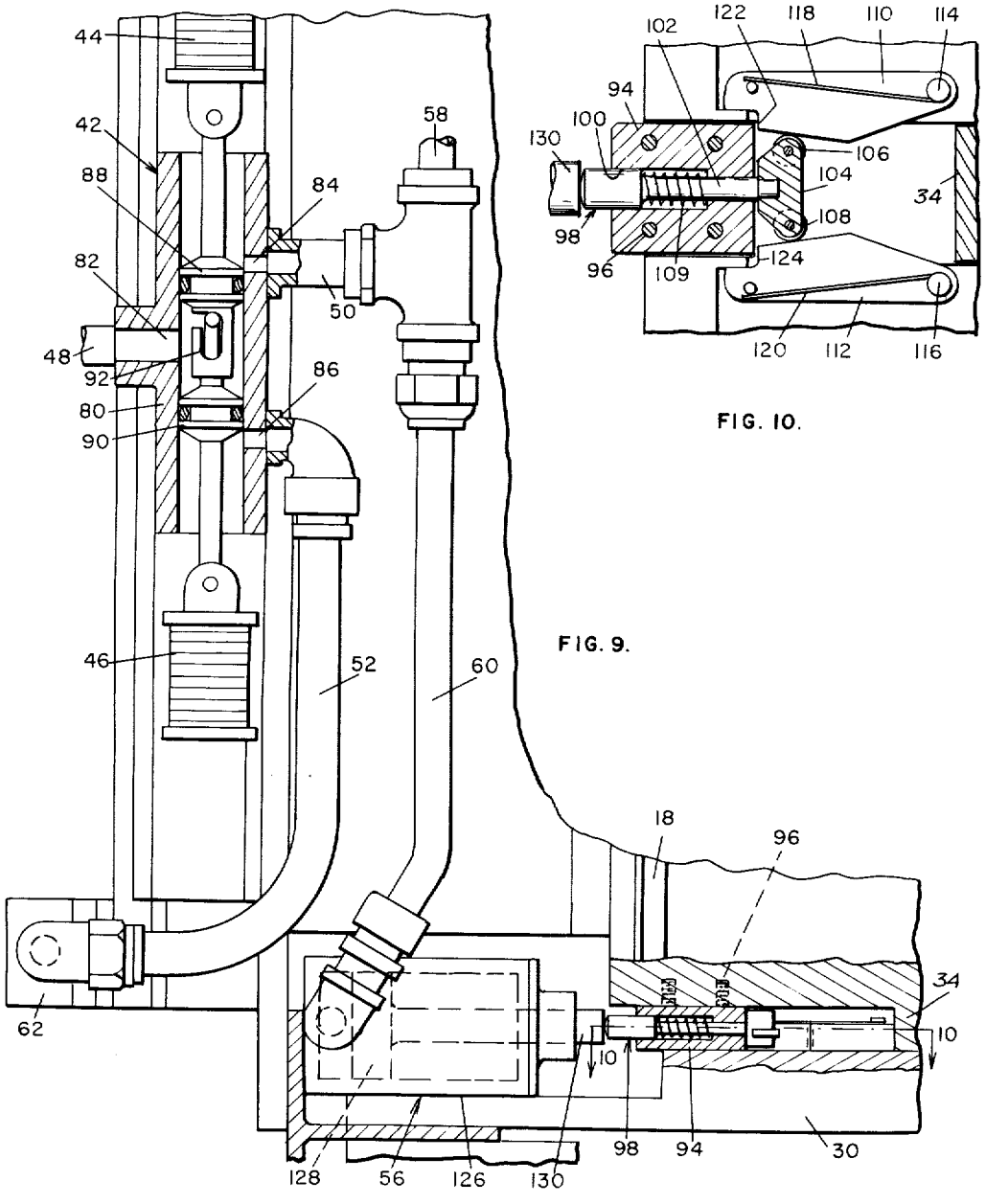


FIG. 9.

FIG. 10.

United States Patent Office 2,975,390
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2,975,390

PLUGGABLE UNIT

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Filed Dec. 31, 1958, Ser. No. 784,130

10 Claims. (Cl. 339—45)

This invention relates to electrical connection devices and more particularly to a pluggable connector device of the type adapted to complete a multiplicity of circuits substantially simultaneously.

Such multiple connector devices are finding an increasing number of applications as electrical and control circuitry become larger and more complex. Certain problems, however, accompany this increasing size and complexity and particular difficulties have been encountered in pluggable connector devices adapted to connect a large number of circuits. Each contact is completed by sliding a male connector member into a cooperating female connector member. In conventional pluggable units a substantial frictional force is provided between the two members to provide a suitable contact of low electrical resistance between the cooperating members and to provide a wiping action of sufficient magnitude to remove any surface oxide film on those members. Where the number of connections is in the order of one hundred or more the total force required to suitably connect the pluggable unit is of substantial magnitude and mechanical devices, such as screw jacks, have been resorted to. However, when even larger numbers of contacts are provided in individual pluggable units, as is frequently desirable in digital computer equipment for example, the resultant forces are of such a magnitude that even the best mechanical devices are not completely suitable.

Accordingly, it is an object of this invention to provide an improved electrical contact structure suitable for use with large pluggable units.

Another object of the invention is to provide a pluggable unit contact operating mechanism which is actuated by fluid means and which permits the easy insertion and removal of large pluggable units from their cooperating receptacles.

Still another object of the invention is to provide an improved pluggable unit structure in which the problem of alignment between cooperating sets of contacts is minimal.

The invention provides a pluggable unit connector device which has a multiplicity of male contacts and a cooperating receptacle carrying female contacts which are initially open so that they offer little or no resistance to the insertion to the pluggable unit. Associated with the receptacle is a fluid actuated means which operates the female contact members to close them firmly against the male contacts in a wiping action after the unit has been locked in position. As the female contacts are open initially, the alignment of the male contact portions relative thereto is no longer a critical problem. A fluid operated ejection means is provided which, after the release of the fluid pressure on the female members, acts to unlock the removable pluggable unit and to move it away from the receptacle such that there is clearance between the cooperating sets of contacts. A structure embodying the principles of the invention has been employed in conjunction with a digital computer pluggable

unit which has six hundred contacts of the knife type mounted in an area of approximately one-eighth square foot. If the conventional type of pluggable unit contact structure had been utilized, a force of about one thousand pounds would be required to insert and to remove the unit. The unit, according to the invention, is compact and easily operated, and has exceptionally good mechanical and electrical reliability.

Other objects and advantages of the invention will be seen as the following description of a preferred embodiment progresses, in conjunction with the drawings, in which:

Fig. 1 is a side view of a portion of the pluggable unit structure and cooperating receptacle which incorporates principles of the invention;

Fig. 2 is an end view, in partial section, taken along the line **2—2** of Fig. 1;

Fig. 3 is a top view of the structure taken along the line **3—3** of Fig. 1;

Fig. 4 is a view similar to that of Fig. 3 with the pluggable unit contacts separated from the cooperating receptacle contacts;

Fig. 5 is a sectional view of the cooperating contacts taken along the line **5—5** of Fig. 1;

Fig. 6 is a sectional view corresponding to that of Fig. 5 in which fluid pressure has been applied to the female contacts;

Fig. 7 is a perspective view of the fixed and movable contact elements;

Fig. 8 is an elevational view of the contact structure of the receptacle taken along the line **8—8** of Fig. 1;

Fig. 9 is a view of the fluid control system associated with the apparatus of Fig. 1; and

Fig. 10 is a sectional view of a portion of the locking and ejection apparatus, taken along the line **10—10** of Fig. 9.

A preferred embodiment of the invention includes a fixed frame structure designed to receive several pluggable units which are positioned in three horizontal rows. Each pluggable unit carries one hundred encapsulated units of one or more circuits secured to a frame with their leads connected via a terminal block to six hundred male contact members arranged in eight columns of seventy-five contacts each. The fixed frame carries a terminal block which has a similar number of female contact members correspondingly arranged. These members are initially spaced apart to facilitate the proper positioning of the pluggable unit relative thereto. After the pluggable unit is locked in place, air pressure is applied via a control valve and bladder arrangement to force the fixed contact members into firm engagement with the movable members, thus providing excellent electrical connections.

When it is desired to remove the pluggable unit, the control valve is operated to release the air pressure on the bladder and simultaneously to operate an ejector mechanism which unlocks the unit and forces it outwardly away from the fixed terminal block. The entire pluggable unit may then be easily removed from the frame by hand.

A detailed understanding of this preferred embodiment of the invention may be obtained with reference to the drawings. In Figs. 1 and 2 there are shown two views of the fixed frame structure **10** which is adapted to receive a plurality of pluggable units **12**, one of which is shown. As each of the receptacles in the frame and the cooperating pluggable unit is similar, only one will be shown and described.

The pluggable unit **12** includes a frame **14** adapted to carry one hundred encapsulated units of one or more circuits **16** (see Fig. 3). These are logical circuits suitable for use in a digital computer, for example, and are

supported by suitable fastening means (not shown) from the apertured frame tongues **18**. A terminal block **20**, of suitable insulating material such as molded melamine, which contains six hundred knife type contact members **22** is positioned rearwardly of and bolted to the circuitry supporting frame **14**. Terminals **24** associated with those contacts are brought out to the side of the terminal block as shown in Figs. 3 and 4, and connections may be made thereto, as required, by conventional means such as wire wrapping. A cover plate **26** is provided which is fastened over those terminals.

The fixed frame includes upper and lower structural members **28** and **30** which extend forwardly and define an aperture to receive the pluggable unit. Each member has a channel **32** adapted to receive a cooperating rail **34** positioned on the movable pluggable unit **12**.

Mounted in the rear of each receptacle portion of the frame is an insulating terminal block generally indicated at **36** in which are positioned six hundred female contact members which cooperate with corresponding contacts **22**. Each of these contact members has a contact portion **38** positioned within the terminal block and a terminal portion **40** which extends rearwardly of the terminal block and to which a suitable connection may be made by conventional means.

Mounted on the terminal block **36** is a control valve **42** which has two solenoid actuators **44** and **46** associated therewith (Fig. 1). This valve controls the flow of air from a supply (not shown) through line **48** to lines **50** and **52**. Positioned at the top and bottom of each receptacle are pluggable unit ejector mechanism cylinders **54** and **56** which are connected to line **50** via lines **58** and **60** respectively. The ejector mechanisms act to unlock the pluggable unit and to force it way from the fixed connectors in a manner hereinafter described in detail. Line **52** is connected to a chamber **62** associated with the female contact operating mechanism.

The fixed contact member is a flat metal strip of uniform width which is folded upon itself at the terminal end of the member to provide a two ply member having a terminal portion **40** where the two plies contact each other and a contact portion **38** where the two plies are spaced apart as shown in Figs. 5–7. Each ply in the contact portion **38** includes a lip **64**, and a flat portion **66** substantially parallel to and coextensive with the corresponding portion of the other ply. The connector has its point of narrowest width adjacent the lips **64** which spread outwardly from that point to provide an access aperture for entrance of the cooperating movable contact member **22**. That member is a flat knife type of contact and is formed with its terminal portion **24** from a single thickness of metal. The fixed contact may be manufactured from beryllium copper and the knife contact from Phosphor bronze, for example.

The fixed female contact members are mounted within the terminal block **36** which has two end walls **68, 70** and two apertured side walls **72, 74** (Figs. 5–6). The terminal portion **40** passes through walls **72** whose apertures are designed to conform to the transition portion between the terminal portion and the parallel contact portions **66**. The lip portions **64** pass through apertures in the opposite wall **74**. Disposed outside of the flat portions and in contact therewith are thin flat sheets **76** of flexible acrylite and interposed between the sheets are inflatable bladders **78** which are positioned between the columns of contacts and are connected at one end to the chamber **62** and at the other end to a blind chamber as shown in Fig. 8. The flat sheets **76** provide an even distribution of pressure when the bladders are inflated and additionally provide a degree of protection to the bladders against damage, from sharp contact edges for example.

In operation, the pluggable unit **12** is inserted into its cooperating receptacle with the rails **34** positioned in the channels **32** such that accurate alignment of the male contacts **22** with the cooperating female contacts **38** is assured. As the male contacts **22** are inserted into the female contacts **38**, the lip portions **64** of latter are spaced apart so that there is negligible friction between the two sets of contact members. Additionally, the outwardly angled lips guide the knife blade contacts **22** so that absolute alignment of the two types of contacts with each other is not essential. This permits the pluggable unit to be quickly and easily inserted in a manual operation in sharp contarst with conventional types of pluggable units having fewer connections which demand critical alignment and require complex mechanical insertion assistance. When the pluggable unit is properly positioned, it is locked in place by mechanical means and the control valve **42** is actuated by the solenoid **46** to supply air pressure via line **56** to the female contact actuating mechanism which operates to inflate the bladders **78** and close the female contacts **38** on the cooperating male contacts in a wiping action, particularly adjacent the lip portions, which are forced forwardly and remove any oxide film that may have formed, thereby achieving suitable contacts of low electrical resistivity.

The control valve **42** is shown in section in Fig. 9. It includes a casing **80** having an inlet line port **82** and two control ports **84** and **86**. Two valve members **88** and **90** are housed within the valve casing. Each valve member includes a valve head which carries an O-ring sealing member and a valve stem which is connected to the associated solenoid **44** and **46** respectively. The valves are connected together by a lost motion connection **92** which comprises a T member attached to the valve **90** which slides in a slotted hook member attached to the valve **88**.

When a pluggable unit is not positioned in energizable condition in the receptacle the valve members are in the position as shown in Fig. 9. In that circumstance both line **50** and line **52** are connected to the atmosphere through discharge ports formed by the open ends of the valve casing cylinder. After a pluggable unit has been inserted into the receptacle frame, solenoid **46** is energized and moves the valve **90** in a downward direction as shown in Fig. 7, thereby connecting the air inlet line **48** with line **52** through ports **82** and **86**, and applying air pressure to the chamber **62** to inflate the bladders **78**, thereby closing the female contacts on the cooperating male contacts. The lost motion connection **92** permit valve member **90** to move independently of valve member **88** in this manner. The valve remains in this position until solenoid **44** is energized.

When it is desired to remove the pluggable unit from the frame, the solenoid **44** is energized. This energization may be initiated manually as by pressing a push button or automatically as a result of an error signal generated by the associated equipment upon detection of a fault in the connected pluggable unit. When the solenoid **44** is energized, the valve member **88** is moved upwardly and through the lost motion connection **92**, the valve member **90** simultaneously is carried from its lower position upwardly back to the position shown in Fig. 7. This operation disconnects line **52** from the air supply (connecting it to the associated discharge port and permitting deflation of the bladders) and simultaneously connect line **50** to the air supply via line **48** and ports **82** and **84**. Air pressure thus is supplied through lines **58** and **60** to the pluggable unit ejector mechanisms **54** and **56**. The ejector mechanisms operate to unlock the pluggable unit and move it outwardly from the fixed terminal block **36**, to the position as indicated in Fig. 4. In that position the male contacts **22** are completely clear of the female contacts **38**. Upon de-energization of the solenoid **44** the valve member **88** is returned to the position of Fig. 7 by spring biasing means (not shown).

The operation of the unlocking and ejector mechanism may be understood with reference to Figs. 9 and 10. The rail **34** on the pluggable unit frame **14** is terminated short of the rear end of the pluggable unit frame and

a block **94** having the same width as the rail **34** is aligned with but spaced from the rail and attached to the frame by bolts **96**. Positioned within a cylindrical passageway in this block is a plunger mechanism **98**. The plunger mechanism includes a rod having a head portion **100** and a reduced shank portion **102** which passes through a wall of the block. A cross member **104** having a pair of rollers **106** and **108** mounted thereon is pinned to the forward end of the shank **102**. A spring **109**, positioned on the shank **102**, acts against the head **100** to hold the cross member **104** in contact with the block.

Positioned on either side of the channels **32** in the fixed frame members **30** adjacent the rear end thereof are locking arms **110** and **112** which are adapted to pivot about pins **114** and **116** respectively and which are biased inwardly toward the center of the channel by springs **118** and **120** respectively. As the pluggable unit is moved inward towards the fixed terminal block **36**, the leading surface of the block **94** contacts the locking arms **110** and **112** and cams them outwardly to permit the block to move past. After it has moved past the springs **118** and **120** pivot the locking arms back to the position shown in Fig. 10 so that their stop surfaces **122** and **124** respectively pivot in front of block **94** locking the unit in place with the two groups of contact members properly positioned and preventing manual removal of the pluggable unit.

Each ejector mechanism includes a cylinder **126** in which is mounted a piston **128** which is connected to a piston rod **130**, the end of which is adapted to contact the plunger **98**. When the control valve is operated to apply air pressure through line **60** to the ejector cylinder **126** the piston rod **130** is forced forward thereby moving the plunger **98** forward and compressing spring **109**. The initial movement of the plunger moves the cross bar **104** and associated rollers **106** and **108** to cam the locking arms **110** and **112** apart, thereby permitting movement of block **94** and the pluggable unit frame. Further forward movement of the piston rod **130** drives the block and the pluggable unit outwardly away from the fixed contact terminal block, thereby separating the male and the female contacts as shown in Fig. 4. As the air pressure on the bladder has been relieved by this time (through the coordinated operation of the control valve **42**), the pluggable unit moves freely and only a moderate amount of force is required to move the pluggable unit the necessary distance outwardly. The unit that has been ejected is clearly indicated as it protrudes a short but easily noticed distance from the fixed frame structure, and it may thereafter be completely removed by hand.

Thus it will be seen that the invention provides an improved pluggable unit system whereby the connection and disconnection of pluggable unit connection devices is greatly facilitated. The system provides coordinated operation of pneumatically controlled electrical contacts and pluggable unit locking and ejection mechanisms. Devices constructed according to principles of the invention may have several hundred pairs of cooperating contacts and each unit may be inserted and removed from a cooperating receptacle by hand in contrast with pluggable unit systems utilizing conventional types of connector components which require complex jacking mechanisms to overcome the tremendous frictional forces associated therewith. While a preferred embodiment of the invention has been shown and described herein it will be understood that the invention is not intended to be limited thereto or to details thereof and departures may be made therefrom within the spirit and scope of the invention as defined in the following claims.

We claim:

1. A pluggable unit assembly adapted simultaneously to complete a multiplicity of electrical circuits comprising a fixed receptacle having a group of female contact members mounted therein, a movable unit having a group of male contact members, said female contact members having contact portions normally spaced apart to receive corresponding male contact portions, fluid operated means including inflatable bladders disposed adjacent said contact portions on either side thereof and adapted to be inflated to urge said contact portions toward one another and into engagement with corresponding male contacts when said male contacts are positioned therebetween, fluid operated pluggable unit ejection means adapted to slide said movable unit so that said male contacts move away from said female contacts including control means adapted simultaneously to deflate said bladders to release said contacts and to operate said ejection means to slide said movable unit outwardly relative to said receptacle.

2. An electrical connector assembly of the pluggable unit type comprising a receptacle having a group of female contact members mounted therein aligned in a plurality of rows, each of said contact members having two coextensive parallel spaced contact portions, a pluggable unit having a group of male contact members adapted to coact with said group of female contact members, each of said male contact members being adapted to be inserted between said spaced portions of a corresponding female contact member, and pressure applying means comprising an inflatable bladder disposed outwardly of said spaced portions of each row of said female contact members, a flat flexible insulating sheet positioned between each bladder and the associated contact portions and control means adapted to inflate said bladders to urge said portions toward one another in a wiping action with said male contact members whereby electrical connections of low resistivity are obtained between corresponding members of said groups.

3. The apparatus as claimed in claim 2 and further including a pressure operated ejector mechanism associated with said receptacle and adapted to be operated to move said group of male contacts away from said group of female contacts.

4. The apparatus as claimed in claim 3 and further including control means adapted to release said pressure applying means and to operate said ejection mechanism substantially simultaneously in a coordinated operation.

5. An electrical connector assembly of the pluggable unit type comprising a fixed receptacle having a group of female contact members aligned in a plurality of rows and columns and mounted in a terminal block structure, each of said contact members having two coextensive oppositely disposed contact portions, a movable pluggable unit adapted to be inserted into said receptacle and locked therein, said pluggable unit having a group of male contacts correspondingly aligned and adapted to coact with said group of female contacts, each of said male contact members being adapted to be inserted between the opposed portions of a corresponding female contact member, flexible sheet members disposed between the columns of female contacts within the terminal block on either side of said opposed portions, an inflatable bladder positioned between each pair of said sheet members, said bladders being adapted to urge said portions towards one another into firm engagement with associated male contact members when inflated, a source of fluid pressure, and a control valve adapted to connect said source to said bladders to inflate the latter, whereby electrical connections of low resistivity are obtained between corresponding contact members of said groups.

6. The electrical connector assembly as claimed in claim 5 and further including a pressure operated ejector mechanism associated with said fixed receptacle, a second control valve adapted to apply pressure from said source to said ejector mechanism, said ejector mechanism being adapted when activated to unlock said pluggable unit and move it relative to said receptacle such that said male contacts are spaced from said female contacts, said second control valve being adapted substantially simultane-

ously to release the pressure on said bladder, thereby permitting said opposed contact portions to move apart and to connect said ejector mechanism to said source to permit removal of said pluggable unit from said receptacle.

7. A compact pluggable electrical contact unit assembly including a receptacle and a cooperating pluggable unit adapted to be easily inserted into and removed from said receptacle, said pluggable unit including a multiplicity of flat blade contact elements aligned in a plurality of rows and said receptacle having corresponding cooperating contacts, each said cooperating contact comprising two coextensive members having spaced apart, substantially parallel portions which define a space therebetween, an insulating plate disposed to the outside of each row of said contact members from said space and an inflatable bladder associated with each row of contact portions and disposed adjacent each plate, said pluggable unit being adapted to be positioned in said receptacle so that the blades are inserted between the cooperating contact members, a source of fluid pressure, and valve means adapted to apply fluid pressure from said source to said bladders to inflate them so that said contact members are urged toward one another against said blades in a wiping action to complete electrical circuits between said blade contacts and the cooperating receptacle contact members.

8. The apparatus as claimed in claim 7 and further including mechanical locking means disposed in said receptacle adapted to prevent manual removal of said pluggable unit when said contact blades are positioned between said receptacle contact portions and a fluid pressure control means adapted to deflate said bladder to release the pressure on said blades, to unlock said mechanical means, and to move the pluggable unit so that the blades are moved outwardly relative to said cooperating contact portions whereby the entire pluggable unit may then be manually withdrawn from the cooperating receptacle with ease.

9. A control system for a pluggable electrical contact unit assembly having a receptacle and a cooperating pluggable unit adapted to be positioned in said receptacle, said receptacle having a multiplicity of contacts aligned in a plurality of rows, each said contact having two substantially parallel spaced portions defining a space therebetween, an insulating plate disposed against each said portion on the side thereof opposite said space and extending the length of the row, and inflatable tubes positioned between said rows of contacts, said pluggable unit having cooperating contact members adapted to be aligned in said receptacle with said cooperating contact member positioned between said contact portions, said control system including first means to inflate said tubes when said pluggable unit contact members are positioned in said space to force said contact portions towards one another to provide firm electrical contact between said contact portions and said cooperating contact members and second means operative substantially simultaneous to deflate said tubes, thereby reducing the pressure of said contact portions on said cooperating contact members, and to move said pluggable unit outwardly of said receptacle so that said cooperating contact members are moved relative to said contact portions.

10. The system as claimed in claim 9 further including a source of fluid pressure, and a control valve mechanism, wherein said first means is adapted to actuate said control valve mechanism to apply fluid pressure from said source to inflate said bladders and said second means is adapted to actuate said control valve mechanism to deflate said bladders and force said pluggable unit outwardly of said receptacle.

References Cited in the file of this patent

UNITED STATES PATENTS

1,501,157	Woernley	July 15, 1924
2,636,068	Perkins	Apr. 21, 1953
2,654,872	Saul et al.	Oct. 6, 1953
2,673,227	Hubert	Mar. 23, 1954
2,685,071	McCreary	July 27, 1954
2,757,225	Dunn	July 31, 1956
2,827,312	Spencer	Mar. 18, 1858
2,852,463	Gutzmer	Sept. 16, 1958
2,881,404	Kamm	Apr. 7, 1959
2,883,638	Mark	Apr. 21, 1959