June 23, 1959 J. S. KILBY 2,892,130

PLUG-IN CIRCUIT UNITS

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FIG. 1

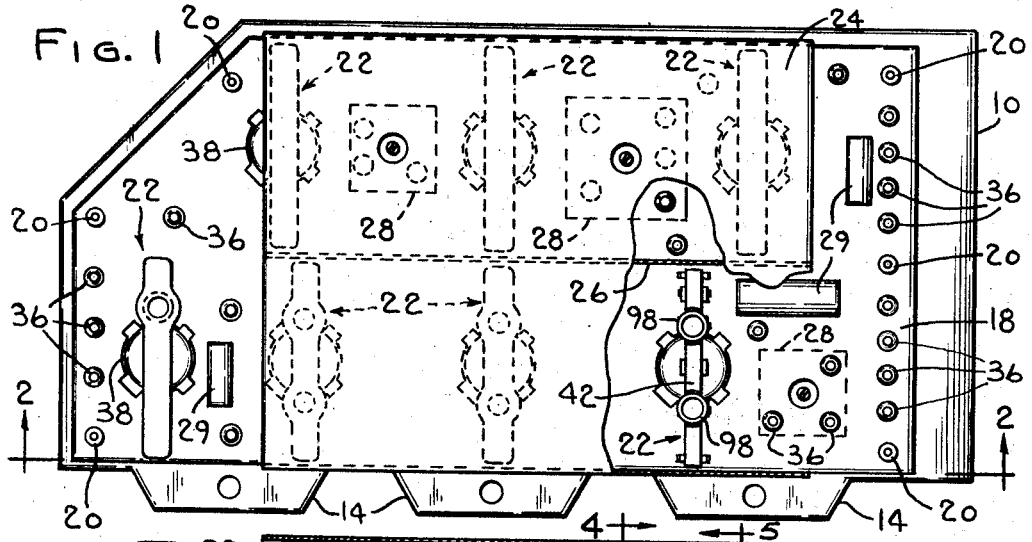
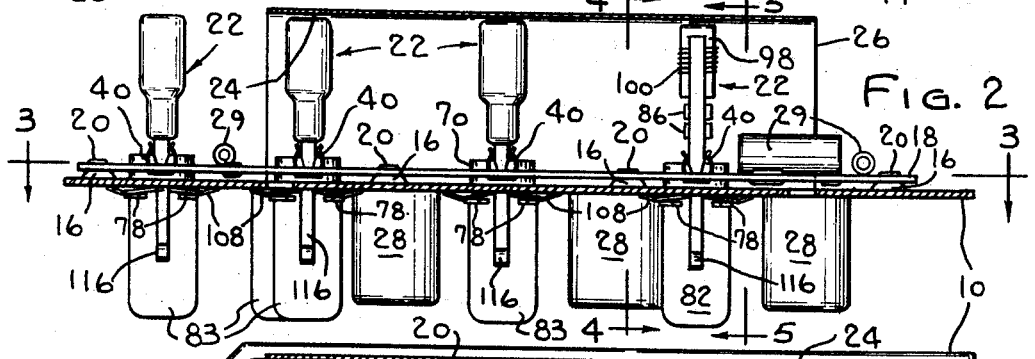


FIG. 2



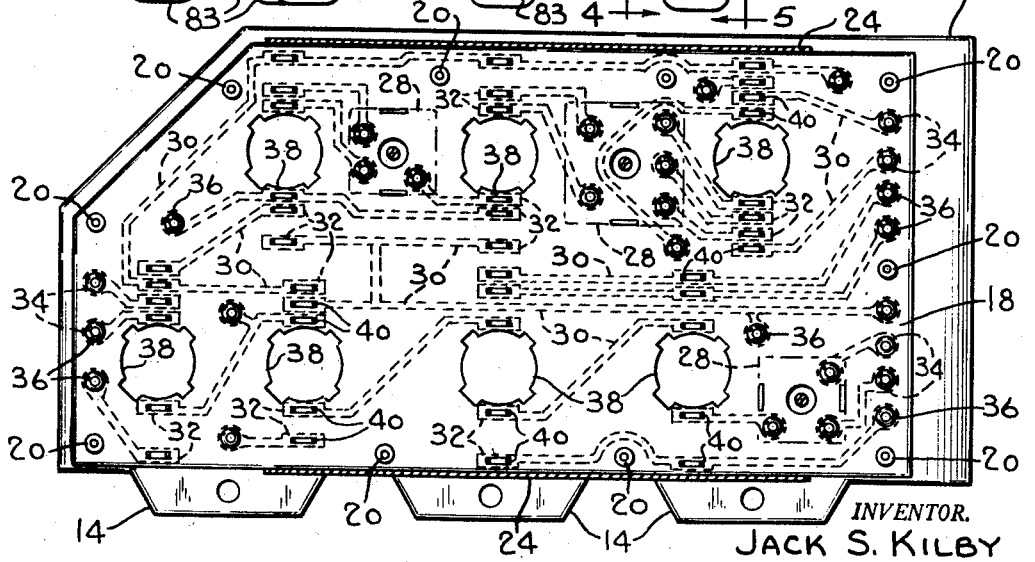


FIG. 3

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FIG. 4

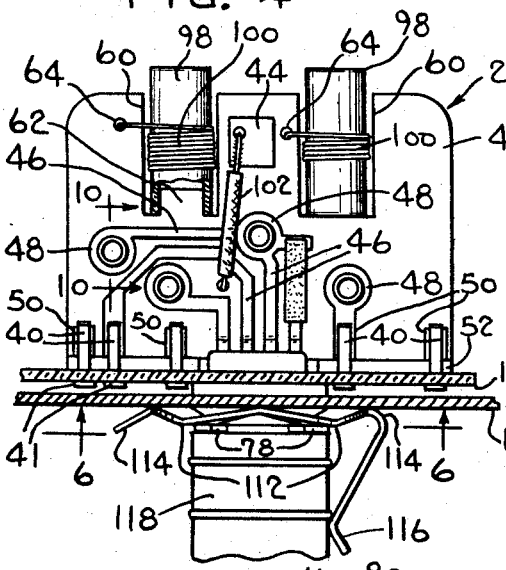
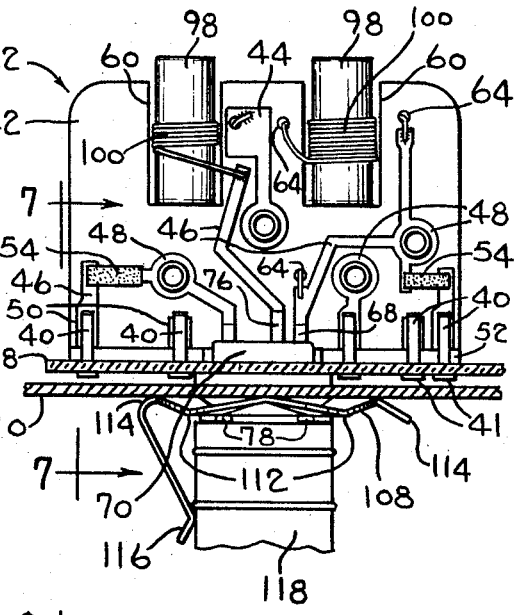


FIG. 5



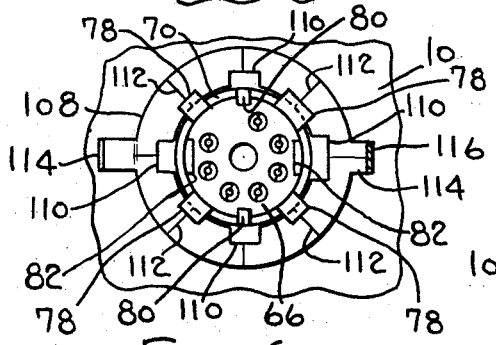


FIG. 6

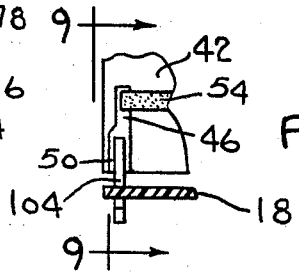


FIG. 8

FIG. 7

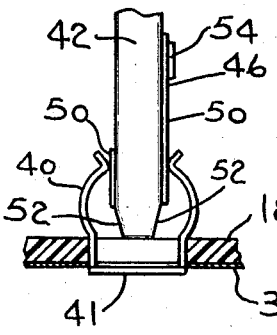
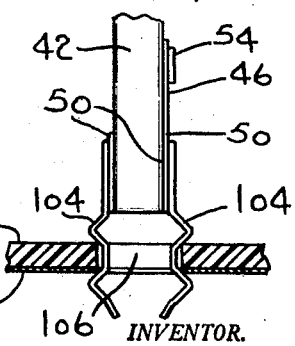


FIG. 9



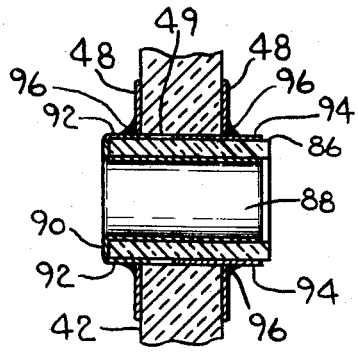


FIG. 10

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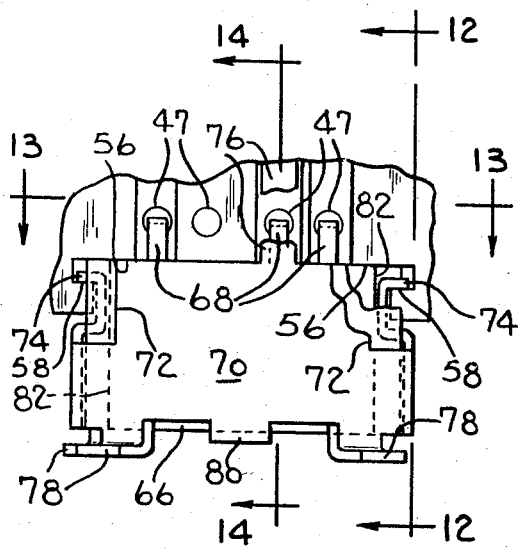

FIG. 11

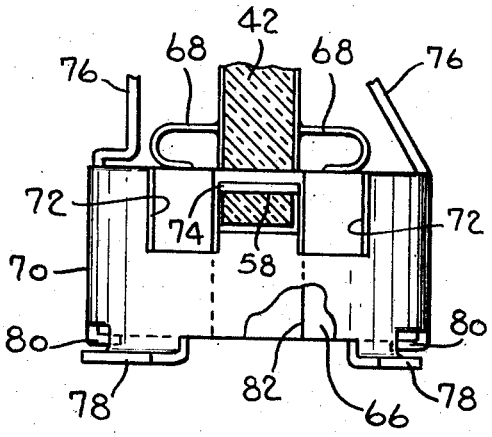

FIG. 12

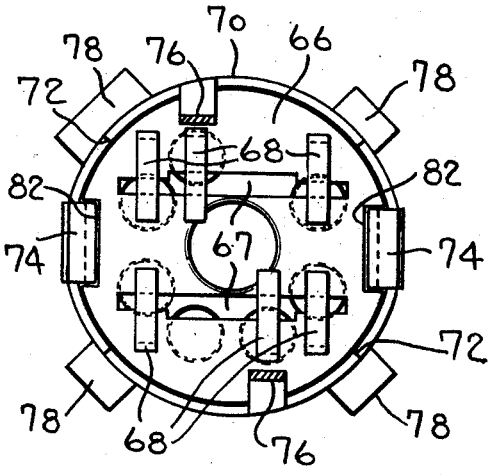

FIG. 13

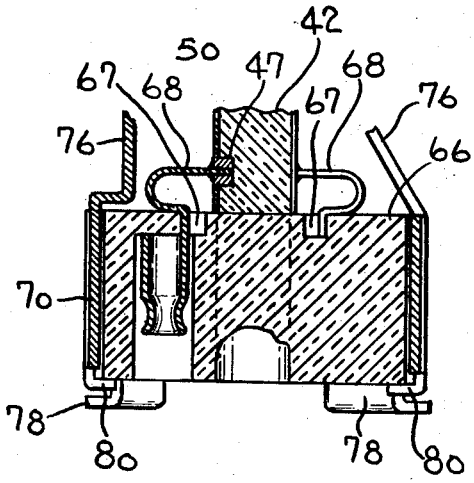

FIG. 14

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2,892,130

PLUG-IN CIRCUIT UNITS

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Application December 16, 1953, Serial No. 398,464

11 Claims. (Cl. 317—101)

This invention relates to improvements in electrical circuit units and particularly such units which embody the components required for a single stage of an electronic circuitry and are easily connected with other such units to form complete circuits for apparatus such as radio and television receivers.

It is an object of this invention to provide such a unit which may be inexpensively manufactured.

Another object of this invention is to provide such a unit which may be readily assembled to and disconnected from a base plate having other circuitry to provide a multistage electronic circuit.

In obtaining these objects there is employed a base plate having on its surface conductors extending between prongs or prong receiving openings. A multiplicity of single stage units, such as frequency modifiers, video and sound amplifiers, limiters and detectors are plugged into such base plate to make the complete circuit. In its general aspects each single stage unit consists of a unit plate of insulating material having on its faces capacitor plates, resistors, conductors, and prong engaging or prong holding conductive areas. The unit plate has a bottom edge recess in which a tube socket is seated, locked and held by its connectors being secured to such conductors. When the edge of the stage unit is seated on the face of the base plate the prongs and prong holding areas engage to make the electrical connections and provide some mechanical support. The socket has locking feet which project through an opening in the base plate and are engaged by a resilient removable locking ring to hold the unit in plugged-in place. Upon removal of the locking ring the stage unit may be disconnected from the base plate and another stage unit substituted. The prongs and prong holding areas easily connect and disconnect.

Each stage unit may also include tubular capacitors mounted in apertures in the unit plate, and inductances mounted in slots in the edge of such unit plate. One solder dipping will suffice to attach the tubular capacitors, the tube socket and the inductances.

For a more detail description of this invention reference should be made to the following description of a specific embodiment read in connection with the accompanying drawings, in which:

Fig. 1 is a top plan view of a multistage electronic circuit device with changeable single stage units embodying the present invention;

Fig. 2 is a sectional view taken on the line 2—2 of Fig. 1;

Fig. 3 is a sectional view taken on the line 3—3 of Fig. 2 with the single stage units removed;

Fig. 4 is an enlarged fragmentary sectional view taken on the line 4—4 of Fig. 2;

Fig. 5 is a fragmentary enlarged sectional view taken on the line 5—5 of Fig. 2;

Fig. 6 is a fragmentary bottom plan view taken on the line 6—6 of Fig. 4 with the tube and shield removed;

Fig. 7 is an enlarged fragmentary sectional view taken on the line 7—7 of Fig. 5 showing one modification of the spring prongs and prong engaging conductive areas;

Fig. 8 is a fragmentary sectional view like Fig. 7 of another modification of the spring prong and prong engaging conductive areas;

Fig. 9 is a fragmentary sectional view taken on the line 9—9 of Fig. 8;

Fig. 10 is an enlarged fragmentary sectional view taken on the line 10—10 of Fig. 4;

Fig. 11 is an enlarged fragmentary view in side elevation of the tube socket and base plate, parts broken away and shown in section;

Fig. 12 is a view in side elevation taken from the line 12—12 of Fig. 11;

Fig. 13 is a top plan view taken from the line 13—13 of Fig. 11 with the base plate removed; and

Fig. 14 is a fragmentary sectional view taken on the line 14—14 of Fig. 11.

The assembled device forming a complete electronic circuit with multiple changeable stage units shown in Figs. 1 to 3 inclusive includes a metal mounting plate 10 to which is secured in spaced parallel relationship a base plate 18 of insulating material for mounting and electrically interconnecting single stage units 22. The metal mounting may have attached to its lower side, as indicated, a number of adjustable inductances 28, the adjusting screws of which may be reached through openings formed in the base plate and shield. The metal mounting plate 10 may be provided with apertured wings 14 by which the plate is secured to the chassis of a radio or television receiver or the like. The metal plate has upwardly raised pads 16 to which the base plate 18 is secured by eyelets 20. Some of the single stage units 22 may be shielded by a metal shield 24 and a central partition 26 both of which are removably mounted on the metal mounting plate 10 by suitable means. The single stage units 22 for example may comprise the following starting with the lower right hand corner of Fig. 1 and proceeding counterclockwise: 1st intermediate frequency amplifier (I.F.); 2nd I.F. amplifier; 3rd I.F. amplifier; video amplifier, sound amplifier, limiter and ratio detector. Various fixed resistors, capacitors or inductances indicated at 29 may be attached by connecting wires to the base plate 18.

The principal function of the base plate 18 is to provide electrical interconnection for the single stage units 22. It also functions, in cooperation with the mounting plate 10, to provide mechanical support for such units. The base plate 18 is made of a rigid insulating material and has formed on the lower face thereof a plurality of non-crossing conductive paths indicated at 30 in the broken lines. These paths have at desired places enlarged rectangular areas 32 and enlarged circular areas 34. The paths and the areas may be made by the etching method described in Patent No. 2,441,960, issued May 26, 1949, to Paul Eisler. The rectangular and circular areas may have holes of like shape, in any event rectangular holes and circular holes are punched in such areas and through the base plate 18 so that such areas may be reached from the top side of such base plate. For the sake of conveniently attaching wire connectors and the fixed resistances and capacitors 29 and the like circular holes may have eyelets 36 extending through the base plate. In alinement with a selected line of rectangular areas 32 the base plate and mounting plate are provided with tube receiving holes 38 which have angularly spaced notches. These holes will receive a tube socket having angularly spaced locking feet when the feet are properly alined with the notches. As is shown in Figs. 5 and 7, spring prongs 40 joined by a bridge portion 41 are inserted through the

rectangular openings from the bottom and the bridge portion **41** are soldered to the rectangular areas **32**. Thus the prongs are electrically secured to the conductive paths **30** and mechanically secured to the base plate.

The single stage units indicated generally at **22** vary in their electrical circuit functions as pointed out. Therefore each unit has components differing in number and electrical characteristics mounted thereon. However, all units are made in the same manner and are very similar structurally. Therefore, only one unit will be described in detail. Each single stage unit is mounted on a ceramic plate **42** which is capable of providing a structural support for the stage unit as well as providing the dielectric for certain capacitors, the electrodes **44** of which are mounted on opposite sides of the plate **42**. The electrodes **44** as well as conductors **46** and prong engaging areas **50** are applied to the surface of the plate **42** by the silver paint method well known in the printed circuit art. Some of the conductors have circular portions **48** which surround holes **49** (see Fig. 10) extending through the plate **42**. The prong engaging conductive areas **50** are placed adjacent the lower edge on both sides of the plate **42** so that they are frictionally engaged by the prongs **40** (see Fig. 7) when the unit **22** is seated on the base plate **18**. The conductors **46** which lead to the tube socket connectors may have shallow recesses **47** which receive the ends of such connectors. The bottom edge of the plate **42** may be beveled at **52** (see Fig. 7) to facilitate the proper insertion of the plate **42** into the spring prongs **40**. Resistances **54** are placed where required. They are screened onto the plate and overlie the conductors in a manner well known to those skilled in the printed circuit art. As is shown in Fig. 11, the bottom edge of the plate **42** has recess **56** with top notches forming socket locking shoulders **58**. The tube socket and method of locking it to the plate is hereinafter described. The top edge of the plate **42** has a pair of slots **60** with upwardly extending tongues **62** at their bottoms. The slots accommodate fixed tubular inductances. The plate **42** also has, where necessary, small holes **64** through which wire may pass from one to the other side of such plate.

The tube socket (see Figs. 11 to 14 inclusive) is specially constructed for the single stage unit so that it may be mounted on the lower edge of the plate **42** with its longitudinal axis parallel to the plane of such plate. This socket has an inner cylindrical ceramic member **66** with cylindrical chambers opening at the bottom thereof and terminating at the top in upper rectangular outlets **67**. These outlets are arranged in parallel rows spaced about the thickness of the plate **42**. Tube receiving terminals have prong engagers in such chambers with connectors **68** of rectangular cross section extending through the outlets **67**. These connectors are bent as shown in Fig. 14 so that the ends thereof may be seated in the small recesses **47** when the tube socket is seated. A metallic cover **70** for the tube socket has locking fingers **74** projecting from the bottom of slots **72**. These fingers have outturned ends engaging the shoulders **58** to hold the cover **70** in the recess **56**. There are soldering lugs **76** which extend upwardly as shown and are soldered to certain of the conductors **46** to make the cover a ground and secure it to the plate **42**. The cover has at its bottom end four angularly spaced locking feet **78** which will slide through the holes **38** when properly alined and project below the mounting plate **10**. Intermediate these locking feet is a pair of tabs **80** which are bent over the bottom of the ceramic body **66** to hold the cover on it. The metal cover **70** is first inserted in the recess **56** with the locking fingers **74** positioned on the shoulders **58**. Then the ceramic body **66**, with its connectors assembled, is inserted within the cover **70**. The ceramic body **66** has on its side slots **82** which receive the locking fingers **74** and overlap the sides of the recess **56**. This prevents rotative movement of the socket and prevents it from becoming unseated while being soldered. In the seated position of the socket the connectors **68** fit in the recesses **47** and soldering lugs **76** overlap certain of the conductors **46** so that upon dip soldering both the ceramic body **66** and the metallic cover **70** will be electrically connected and mechanically secured to the plate **42**. An electronic tube **83** of well known design is removably fitted in the tube socket after the unit **22** is secured to the base plate **18**.

The single stage unit **22** also incorporates high rating tubular capacitors in such way that they may be easily installed and connected and not require additional space. To accomplish this the tubular capacitor includes a ceramic tube **86** made of a well known material to provide a relatively high dielectric constant. This tube has an inner electrode **88** which has a portion **90** extending around one end of the tube **86** and a small portion **92** on the outside of the tube **86**. An outer electrode **94** is spaced from the portion **92** and extends nearly to the other end of the tube **86**. The tubular capacitor is snugly fitted in the hole **49** so that portion **92** of the inner electrode will be adjacent the circular portions **48** on one side of the plate **42** and the outer electrode **94** will be adjacent the circular portions **48** on the other side of the plate **42**. As so placed, the space between the portion **92** and the outer electrode **94** will be within the hole **49**. When the plate **42** and capacitor **86** are dipped in solder, fillets of solder **96** will electrically and mechanically connect each electrode to the adjacent circular portions **48**. Solder will not enter between the hole **49** and the tube to close the space between the electrodes. The end of the tube **86** opposite the portion **90** may be covered with a non-conductive material which will prevent the solder from bridging across such end and connecting the inner and outer electrodes.

Wire wound inductances of desired values have their coils **100** on an insulating supporting tube **98**. These tubes with their wires are temporarily cemented in place in the slots **60** with the tongues **62** projecting into the tubes **98** as shown in Fig. 4. The ends of coils **100** in some instances are soldered to conductors on the same side of the plate **42** as the end leaves the coil. In other instances the ends pass through the holes **64** in such plate and are soldered to conductors on the side of the plate **42** opposite to which the end leaves the coil. If it is necessary for any conductor or wire to cross over and be insulated from a conductor on the plate, an insulating sleeve **102** may be placed on such wire.

A single solder dipping operation electrically connects and mechanically attaches all of the tubular capacitors, all of the connectors **68** of the tube socket and all of the ends of the wire coils **100** to the respective conductive areas on the plate **42**. In case the modified form of spring prongs shown in Fig. 9 are used these may be also soldered to the body **42** at the same dipping. This method of assembly thus makes a saving in manufacturing cost.

Instead of securing the spring prongs to the base plate **18**, a modified form of prong **104** shown in Figs. 8 and 9 may be directly secured to the ceramic plate **42**. Each of the prongs **104** has a pair of spaced humps which engage opposite sides of the base plate **18** when the spring prongs are inserted through a hole **106** in such plate. The humps will make electrical contact with the conductive area **32** surounding such hole. In this modification the edge of the single stage unit may be spaced from the side of the base plate **18**.

The tube socket is also utilized to form a mechanical lock for holding the single stage unit **22** to the base plate **18**. As previously described, the base plate **18** and the metal mounting plate **10** are provided with alined holes **38** having circumferential angularly spaced notches. One of these notches and one of the locking feet **78** of the tube socket may be slightly larger than the others so that the single stage unit **22** can be inserted in only one position. When the single stage unit

is seated as shown in Figs. 4 and 5, the locking feet **78** project below the mounting plate **10**. A locking ring **108** has a central hole, the periphery of which has angularly spaced notches **110** which will permit the ring to be slid over the tube socket and its locking feet **78**. The locking ring **108** between its notches **110** has low lines **112** which form camming surfaces adjacent such notches. After the locking ring has been placed over the tube socket it is rotated through approximately 45° while the camming surfaces draw the locking feet 78 down to resiliently lock the tube socket and the single stage unit **22** in place. It is preferable to provide the locking ring **108** with a pair of radial wings **114** by which such ring may be grasped for rotation. One of such wings may have a downward finger **116** which is biased inwardly to form a gripper for holding a tube shield **118** in place.

What I claim and desire to secure by this patent is:

1. In an electronic unit, an insulating plate having an opening therethrough, conductors on opposite sides of said plate adjacent the ends of said opening, a tubular capacitor in said opening, said capacitor having an inner electrode extending around one end thereof and terminating with an edge on the outside of said electrode, an outer electrode on said capacitor having its edge spaced from said first edge, said spacing being within said opening, and a metallic cementing material mechanically and electrically connecting said outer electrode to a conductor on one side of said plate and said inner electrode to a conductor on the other side of said plate.

2. In an electronic circuit unit, an insulating plate having conductors bonded on the surface thereof, holes through said plate and conductors, a slot cut in the periphery of said plate and having a bottom provided with an outwardly extending tongue, an insulating supporting tube having an external wire coil inductance mounted in said slot with the axis of said tube parallel to the plane of said plate and with said tongue inserted in an end of said tubular inductance, and the wire of said inductance passing through said holes and secured to said conductors.

3. In a single stage unit a ceramic plate having a plurality of conductors bonded to the surface on opposite sides thereof, a recess in the edge of said plate having an edge adjacent said conductors, small recesses in the sides of said plate adjacent said recess, a tube socket placed in said recess, said tube socket having rectangular outlets parallel with and adjacent the sides of said plate, flat connectors extending through said outlets and bent so that the ends thereof seat in said small recesses on opposite sides of said plate and are connectible with said conductors, and cementing means electrically and structurally interconnecting said connectors to said conductors.

4. The combination as claimed in claim 3 in which said tube socket has a metal cover and said cover has grounding terminals on opposite sides of said plate in alinement with conductors thereon and said cementing means electrically and mechanically interconnects said conductors and said terminals.

5. The combination as claimed in claim 4 in which said cover has locking feet extending radially thereof to provide means for holding said unit to a base plate.

6. The combination as claimed in claim 5 in which said cover has locking fingers and said recess has shoulders engaged by said locking fingers.

7. The combination as claimed in claim 6 in which said socket has slots which receive the edges of said recess to lock said socket against rotation with respect to said plate.

8. In an electronic single stage unit, a ceramic plate capable of providing a support for said unit, said plate having electrical components including conductors on

opposite faces thereof, an opening through said plate having ends adjacent said conductors, a tubular capacitor in said opening having an inner electrode extending around one end thereof and positioned adjacent the conductor on one side of said plate, an outer electrode on said capacitor adjacent a conductor on the other side of said plate, a tube socket at the edge of said plate, said socket having connectors extending on opposite sides of said plate in alinement with conductors on said plate, said tubular capacitor and said tube socket being simultaneously soldered by a single dip.

9. A multistage electronic circuit having replaceable single stage units comprising a metal mounting plate, an insulating base plate secured to said mounting plate in parallel spaced relation thereto, a plurality of conductors on one face of said base plate, holes through said conductors and said base plate, spring prongs mounted in said holes and extending from the other face of said base plate, tube socket receiving openings in said base plate and mounting plate, a single stage unit including a plate having an electronic circuit with prong engaging areas on an edge of said plate, an electronic tube socket secured to said edge of said unit and projecting therebeyond, said single stage unit being mounted with its edge toward the face of said base plate and said prongs engaging said prong engaging areas with said tube socket projecting through said holes and means for locking said tube socket to said metal mounting plate.

10. The combination as claimed in claim 9 in which said locking means includes alined notches in the periphery of said openings adapted to permit the passage of locking feet therethrough, locking feet on the outer end of said tube socket adapted to fit through said notches and overlap the periphery of said openings, and spaced from the outer face of said metal mounting plate, and an inherently biased locking ring having camming surfaces engaging said metal mounting plate and said locking feet to hold said unit tightly assembled to said base plate.

11. A multistage electronic circuit having replaceable single stage units comprising a metal mounting plate, an insulating base plate secured to said mounting plate in parallel spaced relation thereto, a plurality of conductors on one face of said base plate, said mounting plate and base plate having a tube socket receiving opening, a single stage unit including a plate having an electronic circuit with prong engaging areas, a recess in one edge of said plate, an electronic tube socket secured in said recess and projecting through said opening, said single stage unit being mounted with said one edge toward the face of said base plate, prongs engaging said prong engaging areas and said conductors, and means for locking said tube socket to said metal mounting plate.

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