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(54) ELECTRON TUBE SOCKET HAVING SPRING-WIRE CONTACTS

(71) We, RCA CORPORATION, a corporation organized under the laws of the State of Delaware, United States of America, of 30 Rockefeller Plaza, City and State of New York, 10020, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:

This invention relates to a novel electron-tube socket, which is particularly useful for connection to a cathode-ray tube during the high-voltage processing thereof. In the typical manufacture of a cathode-ray tube, the tube is subjected to high-voltage processing after being evacuated and sealed, as described, for example, in United States Patents No. 3,698,786 and No. 2,917,367. The tube is supported on a conveyor holder, and a socket, which is attached to a cable, is plugged onto the tube base. The tube is then transported on the conveyor, with the cable dangling below, while the tube is processed. Subsequently, when the processing is complete, the socket is withdrawn from the tube base and the tube is unloaded.

The socket is used repeatedly for a progression of tubes and so should be able to endure considerable wear through repeated pluggings and unpluggings. Replacement of the socket should be quick and easy. Also, socket contacts should not score or otherwise degrade the tube base. Prior sockets have been relatively short-lived and have required considerable labor for repair and replacement. Also socket contacts have tended to bind on the base pins during unplugging, even though the required socket withdrawal force has been only two pounds. In plastic base types where each pin is backed up along its length in a groove molded in the base, the socket contacts have tended to bind on the plastic

extending below the pins.

The electron-tube socket of the invention has a cavity therein open at one end for receiving a tube base including a plurality of longitudinally-extending pins in a circular array about an axis. Within the cavity are a plurality of spring wires arranged in a circular array about the axis. Each spring wire has a round cross-section and includes (i) a base portion that is adapted to be clamped in a fixed position within the socket; (ii) an extended portion terminating in a free end which extends towards the open end of the cavity, including a section adapted for contacting one of said pins; and (iii) a transitional portion preferably U-shaped, connecting the base portion with the extended portion and adapted to urge the contacting section against the pin. The novel socket also includes means for clamping the spring wires at the base portions thereof and longitudinally-extending recesses within the cavity adapted to maintain the extended portions of the spring wires in alignment.

Because of the spring-wire construction, particularly with the free ends towards the open end of the cavity, the socket contacts can endure more than twice as many, and as much as tenfold or more, tube insertions before failing due to fatigue or other causes, as compared with contacts of prior sockets. The spring wires themselves are inexpensive and easy to make, and can be replaced within existing sockets with less labor than is required with prior sockets.

The contacting section of the spring wire does not tend to bind on the pin or base when the socket is unplugged, even when a force of about five pounds is required to withdraw the socket. This is believed to be because, with the pivot point for the spring wire located away from the open end of the cavity and lying close to a line through

the contact point parallel to the axis, the spring wire rotates to an open unbinding position, when the socket is unplugged, at a smaller angle with respect to the contact section. In prior sockets, the pivot point for the contact is near the open end of the cavity and further from the axis, so the contact section rotates to a closed binding position at a relatively large angle when the socket is unplugged.

A further feature of the novel socket is that the extended portion of the spring wire can be preloaded or prestressed, so that the contact can apply a greater pressure against the pin without requiring much travel. The socket is provided with means for limiting the travel of the free end of the extended portion when the socket is empty, and the transitional portion urges the free end against the limiting means sufficiently to preload the wire. Thus, a desired force within an operating range can be applied to the pin by the contacting section when the socket is filled. This provides for a more positive electrical contact to the pin and reduces the chance that the socket will become unplugged as it dangles from the conveyor during tube processing.

In the drawings:

FIGURE 1 is a partially-sectional, partially-elevational view of a socket embodying the invention;

FIGURES 2 and 3 are plan and sectional views, respectively, of the socket of FIGURE 1 viewed along lines 2-2 and 3-3 of FIGURE 1;

FIGURE 4 is a force-versus-deflection diagram illustrating the prestressed feature of the spring wire in the socket of FIGURE 1; and

FIGURE 5 is a partially-sectional, partially-elevational view of another embodiment of the invention.

Referring to FIGURES 1, 2 and 3, the socket is cylindrical, about 3-1/16 inches in diameter, and is comprised of a cylindrical lower cap 21, a disc-shaped circuit board 23, a cylindrical spacer 25, a disc-shaped spring-wire holder 27 and an upper cap 29, all held together in that order by three screws 31. The upper cap 29 has molded therein a cavity 33 (FIGURE 2) which is adapted in size and shape to receive a cylindrical tube base 35 (a portion of which is shown in phantom) having a plurality of pins 37 arranged in a circle about an axis 39. In this embodiment, the tube base has 12 pins set in 12 of 14 equally-spaced positions, one pin having an empty space on either side thereof. The cavity also has a keyway 41 recessed therein to receive a key that is molded in the tube base.

For each pin in the tube base, there is a

spring wire 43 shaped from 40-mil-diameter round beryllium-copper alloy wire stock. Each spring wire 43 has a base portion 43a adapted to be clamped in a fixed position within the socket. In this embodiment, there are 12 spring wires of substantially equal size and shape, each spring wire 43 including a base portion 43a clamped between the upper cap 29 and the spring-wire holder 27. Each spring wire 43 includes also an extended portion 43b terminating in a free end 43c, which extends towards the open end of the socket, i.e., the end into which the tube base is inserted (the top as shown in FIGURE 1). The extended portion 43b includes also a curved contacting section 43d, which projects convexly towards the axis 39 to better adapt the spring wire 43 for contacting the pin 37. The spring wire 43 includes also a transitional portion 43e connecting the base portion 43a with the extended portion 43b and adapted to urge the contacting section 43d against the pin 37. As shown, the transitional portion 43e is U-shaped, which places most of the spring stress in that portion of the spring wire. The transitional portion 43e may be of other shapes, e.g., L-shaped or S-shaped. The socket includes a stop 45 molded into the upper cap 29 and adapted to limit the travel of the upper end 43c towards the axis 39 when the cavity is empty. In this way, the contacting section is always loaded (as shown in FIGURE 4). By loaded is meant that, when a tube base 35 is inserted in the cavity 33, the initial force at the stop 45 is some predetermined minimum value 47 which is much above zero. The force of the contacting section on the pin 37 reaches a maximum value 49 when it is fully deflected by the pin. Thus, only a small additional deflection is required to reach the desired maximum force value 49. The upper cap 29 includes also longitudinally-extending recesses 51 within the cavity which are adapted to maintain each of the extended portions 43b of the spring wires 43 in alignment.

In this embodiment, the spring wire 43 includes also an auxiliary portion 43f connected to the base portion 43a. The auxiliary section 43f has a free end 43g extending away from the open end of the cavity and somewhat outwardly from the axis 39, into spring contact with specific electrically-conducting points 53 on the circuit board 23. The layout of conducting metal areas 55 of the circuit board is shown in FIGURE 3; the metal areas are of copper metal about 0.0015 inch thick supported on a disc of glass-epoxy sheet about 1/16-inch thick and about 3-1/16 inches in diameter. Other types of printed circuit boards may be used. A binding post

57 extends through the circuit board 23 at a position inward of each of the electrically-conducting points 53. A fillet of solder 59 attaches one end end of the post 57 to the adjacent metal area 55. The extended portions of the posts 57 provide for connection of the wires of a power cable (not shown).

FIGURE 5 shows another embodiment of the invention which is similar to the preferred embodiment shown in FIGURES 1, 2 and 3 except for the omission of the circuit board 23 and the auxiliary section 43f of the spring wire. Instead, a binding post 61 is supported in the cylindrical spacer 63 of the socket, and a spring contact 65 extends from the post 61 into contact with the transitional section of the spring wire 43'. Also, no stop or other means for limiting the travel of the end of the extended portion 43b' is included.

The described sockets have one or more of the advantages over prior sockets of lower initial cost, lower costs for repair and/or replacement, less chance of damage to the tube base, and easier and/or more reliable contact to the pins. This results from one or more of the features of unitary spring-wire construction, placement of the pivot point and spring stress points as indicated, and preloading of the spring wire. Another important feature is the round i.e. curvilinear cross-section of the spring wire, which provides the least chance of arcing when a high voltage is applied and the least chance of scoring the tube base when the socket is withdrawn.

The sockets are especially useful wherever tubes are to be processed or tested and require the same socket to be plugged and unplugged on a progression of tubes. In a cathode-ray-tube-making factory, this would include the electrical-aging processors, the test sets, and the attached-yoke assembly machines. The sockets are also particularly adapted to be plugged on small tube bases where there is little room for making contact to the pins. The pivot point can be closer to the axis, than in prior sockets and adequate contact area and pressure can be applied to pins that are closely spaced to one another as well as to the exhaust tubulation of the tube.

WHAT WE CLAIM IS:

1. An electron-tube socket having a cavity therein open at one end for receiving a tube base including a plurality of pins in a circular array about an axis, wherein said socket comprises

A. a plurality of spring wires arranged in

a circular array about said axis, each spring wire having a round cross-section and including

(i) a base portion adapted to be clamped in a fixed position within said socket,

(ii) an extended portion terminating in a free end which extends towards the open end of said cavity and including a contacting section adapted for contacting one of said pins, and

(iii) a transitional portion connecting said base portion with said extended portion and adapted to urge said contacting section against said one pin;

B. means for clamping said spring wires at said base portions thereof in said fixed positions within said socket; and

C. longitudinally-extending recesses within said cavity adapted to maintain said extended portions of said spring wires in alignment.

2. A socket according to claim 1, wherein said transitional portion includes a pivot point around which said extended portion rotates when a tube base is inserted in said cavity, the length of said extended portion between said transitional portion and said contacting section being substantially parallel to said axis.

3. A socket according to claim 1 or 2, wherein means are further included for limiting travel of said free end of said extended portion towards said axis.

4. A socket according to claim 3, wherein said transitional portion urges said free end against said limiting means sufficiently to preload said wire.

5. A socket according to any preceding claim, wherein at least some of said spring wires each include also an auxiliary portion connected to said base portion and have another free end extending away from said open end of said cavity, said auxiliary portion being adapted to make spring contact to a circuit board contained in said socket.

6. A socket according to any preceding claim, wherein said contacting section is adapted for contacting said one pin by having a curved portion which projects convexly toward said axis.

7. An electron tube socket substantially as hereinbefore described with reference to Figures 1-3 or Figure 5 of the accompanying drawings.

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(ii) an extended portion terminating in a free end which extends towards the open end of said cavity and including a contacting section adapted for contacting one of said pins, and

(iii) a transitional portion connecting said base portion with said extended portion and adapted to urge said contacting section against said one pin;

B. means for clamping said spring wires at said base portions thereof in said fixed positions within said socket; and

C. longitudinally-extending recesses within said cavity adapted to maintain said extended portions of said spring wires in alignment.

2. A socket according to claim 1, wherein said transitional portion includes a pivot point around which said extended portion rotates when a tube base is inserted in said cavity, the length of said extended portion between said transitional portion and said contacting section being substantially parallel to said axis.

3. A socket according to claim 1 or 2, wherein means are further included for limiting travel of said free end of said extended portion towards said axis.

4. A socket according to claim 3, wherein said transitional portion urges said free end against said limiting means sufficiently to preload said wire.

5. A socket according to any preceding claim, wherein at least some of said spring wires each include also an auxiliary portion connected to said base portion and have another free end extending away from said open end of said cavity, said auxiliary portion being adapted to make spring contact to a circuit board contained in said socket.

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