Sept. 5, 1967 T. J. HAJDUK 3,340,035

CATHODE-RAY TUBE MANUFACTURING APPARATUS

Filed Sept. 28, 1964 2 Sheets-Sheet 1

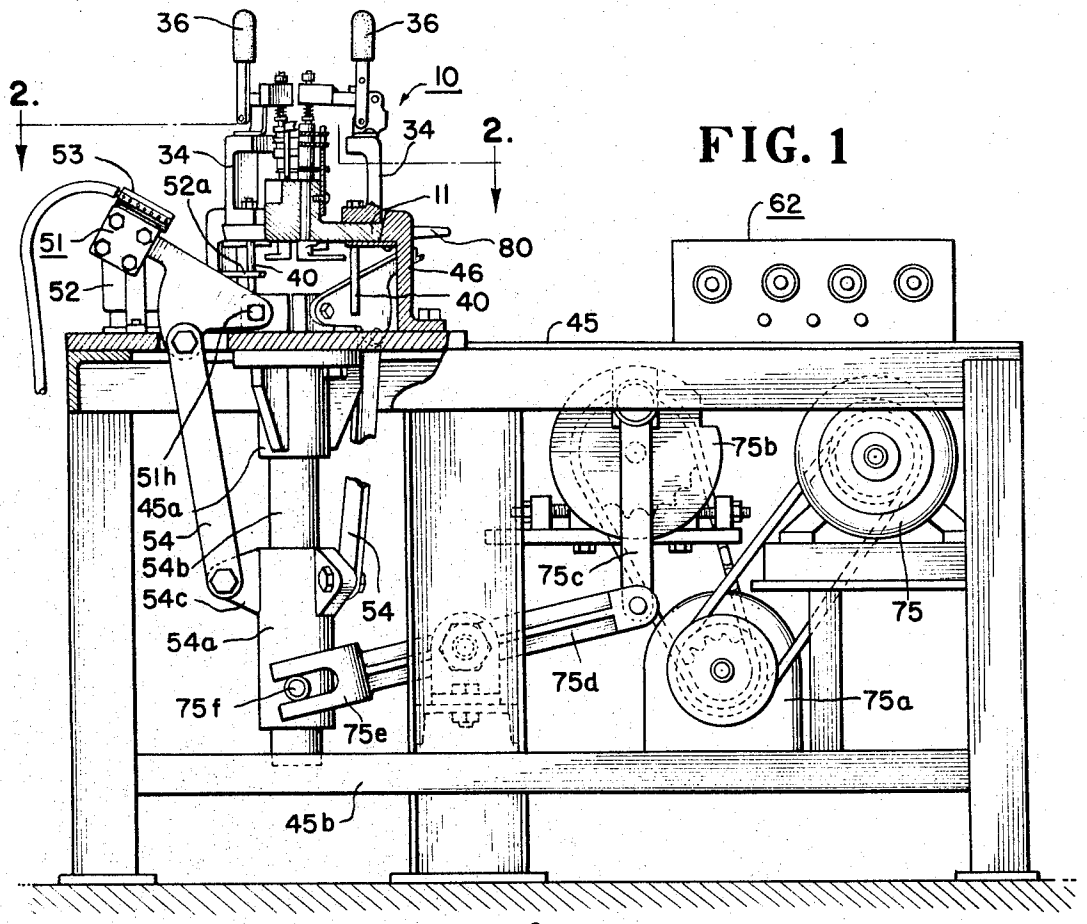


FIG. 1

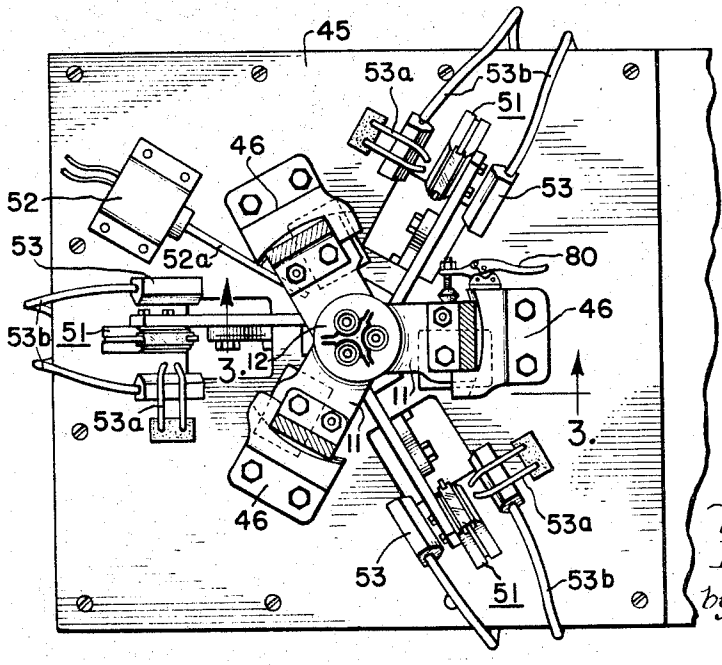


FIG. 2

INVENTORS
Thaddeus J. Hajduk
Fred Kowalski
by Francis W. Crotty
Atty.

Sept. 5, 1967 T. J. HAJDUK 3,340,035

CATHODE-RAY TUBE MANUFACTURING APPARATUS

Filed Sept. 28, 1964 2 Sheets-Sheet 2

FIG. 3

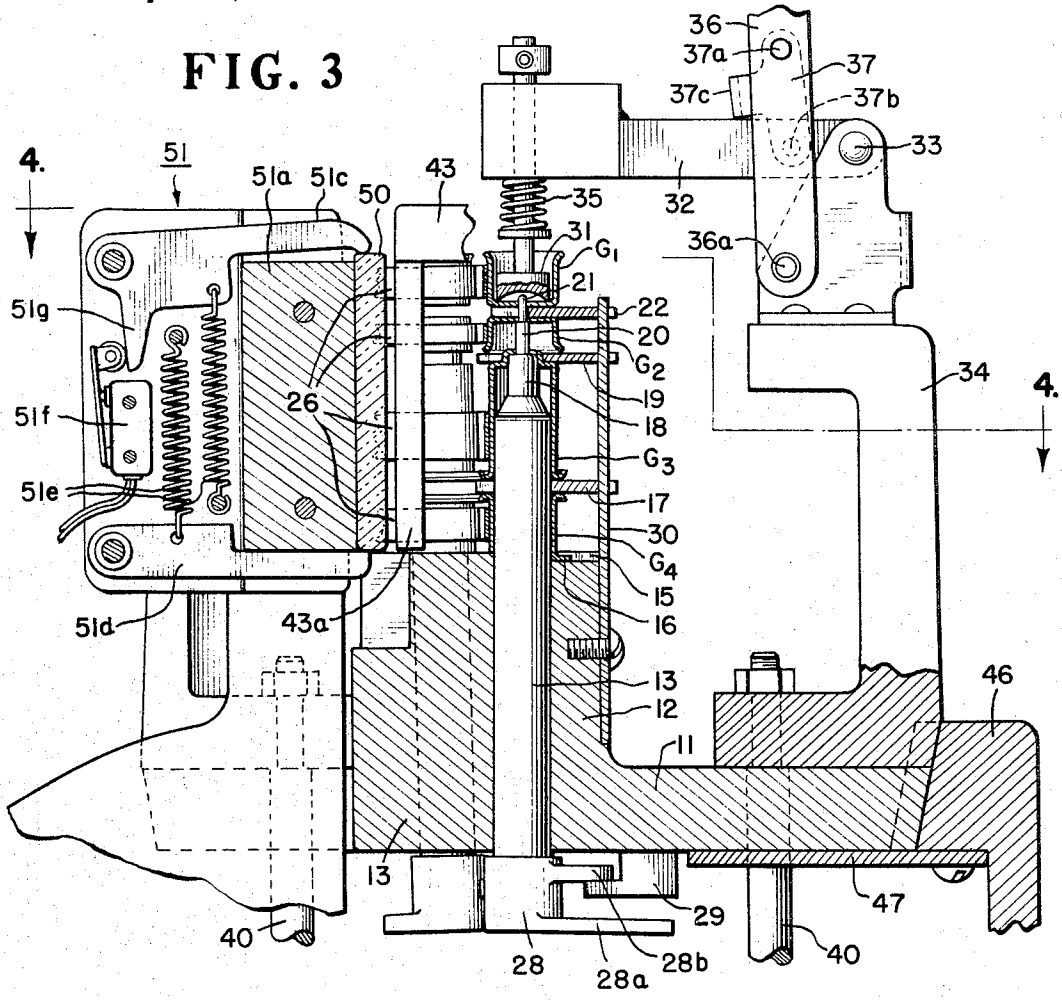
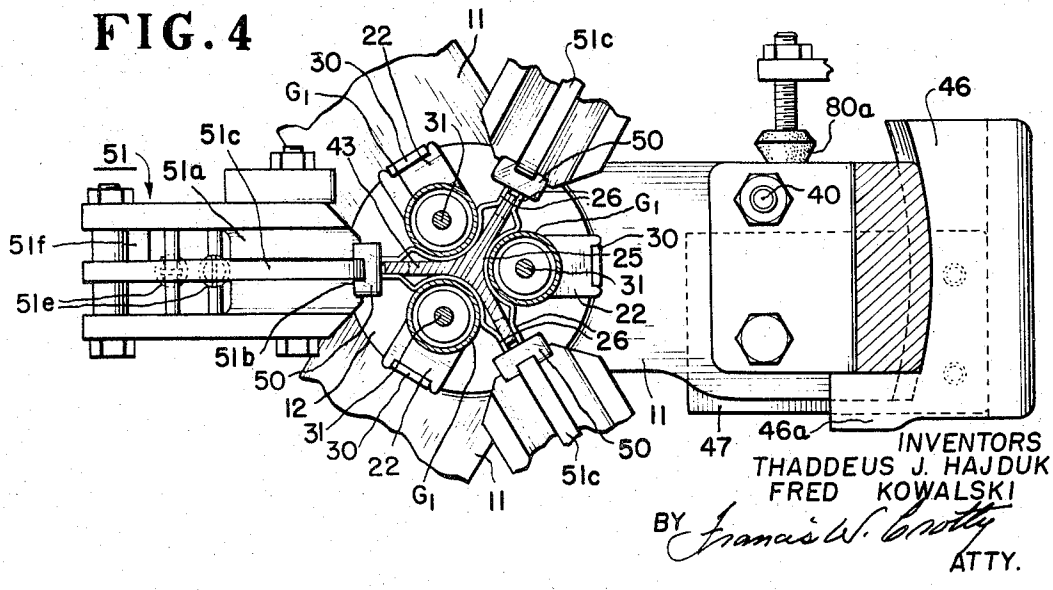


FIG. 4



INVENTORS
THADDEUS J. HAJDUK
FRED KOWALSKI

BY Francis W. Crotty
ATTY.

United States Patent Office 3,340,035 Patented Sept. 5, 1967

3,340,035 CATHODE-RAY TUBE MANUFACTURING APPARATUS

Thaddeus J. Hajduk, Chicago, and Fred Kowalski, Park Ridge, Ill., assignors to The Rauland Corporation, Chicago, Ill., a corporation of Illinois

Filed Sept. 28, 1964, Ser. No. 399,478
11 Claims. (Cl. 65—154)

The present invention concerns an apparatus for making an electron gun assembly for a three-gun cathode-ray tube such as currently used in color television receivers. The invention is directed, more particularly, to what is referred to as "beading" and comprises an improved apparatus for accomplishing this step in the manufacture of a multi-gun tube.

It is convenient to describe the invention in the environment of a cathode-ray tube in which the electron gun assembly includes cylindrical electrodes for controlling, forming and focusing into a beam electrons emitted by a heated cathode. It is common practice to provide each of the electrodes with mounting straps spaced on the external periphery of the electrode. If the electrode series of a gun is mounted on a suitable mandrel with interposed spacers, the electrodes may conveniently be arranged in a desired array and with chosen interelectrode spacings. Generally, the electrodes are rotatable on the mandrel to the end that their mounting straps may be aligned. If the straps are now embedded in elongated pillars of insulating material, referred to as beading elements, the electrode series will have been formed into an array with preselected interelectrode spacings.

This subassembly has been formed heretofore by depositing a beading element in a holder and heating an exposed surface thereof until it has softened. Thereafter, the electrode series supported on its mandrel is positioned over and in alignment with the beading element and the straps are then forced into its softened surface. After a sufficient cooling period, the bead sets and its affixation to the mounting straps of the electrodes is complete. Repeating this process puts a second bead on the other series of straps of the assembled electrodes and completes the subassembly. Although this practice is acceptable, it is time consuming and, accordingly, it has been proposed that both beads be applied at the same time. While such a procedure may be readily established for a single gun assembly, it presents formidable problems when attempted for a three-gun color tube assembly. In such an assembly, it is common practice to employ mechanical convergence so that the position of the electron guns relative to one another is most important and misaligning of the electrodes on their respective mandrels during the beading operation can easily lead to a reject assembly. And yet, it is highly desirable both to speed up the beading function and to perform it in a way which minimizes the possibility of impairing the electrode alignment. These objectives are satisfied through the apparatus to be described.

Accordingly, it is a principal object of the invention to provide an improved apparatus for performing the beading operation in the manufacture of a multi-gun assembly.

It is another and specific object of the invention to provide an apparatus for making the three-gun assembly of a color cathode-ray tube which minimizes the possibility of misaligning the gun elements relative to each other.

The three guns constituting the gun assembly of a tri-color cathode-ray tube individually include cylindrical electrodes each of which has a pair of mounting straps angularly spaced approximately 120° on the external periphery thereof. The beading apparatus of the invention

for assembling the three guns comprises a workholder including three mandrels positioned at the apices of an equilateral triangle for individually supporting the electrodes and interposed spacing elements of each of the three guns to establish a preselected electrode array with predetermined interelectrode spacings and with the mounting straps of each of the guns in substantial alignment and in approximate parallel relation to straps of the remaining two guns. Three bead holders individually releasably hold an elongated beading element of insulating material for movement between a heating position and a beading position. Means are provided for heating one surface of each of the beading elements to a softened condition. There are further means for simultaneously displacing each of the bead holders from its heating position to its beading position to drive the straps of two of the guns into each one of the beading elements and for retracting each of the bead holders from its beading position after a predetermined cooling period.

The mechanism for displacing the bead holders preferably features a linkage system similar to that of an umbrella in that a sleeve, displaced along a vertical shaft, moves the three bead holders simultaneously. It is also preferred that the sleeve be crank driven to execute harmonic motion, moving slowly from the heating position, then accelerating to approach the beading position quickly and finally decelerating to be presented to the beading position with minimum impact.

The features of the present invention which are believed to be novel are set forth with particularity in the appended claims. The invention, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying drawings, in the several figures of which like reference numerals identify like elements, and in which:

FIGURE 1 is an elevational view of the beading apparatus of the invention to be used in fabricating the gun assembly of a three-gun tri-color cathode-ray tube;

FIGURE 2 is a view, partially in section, taken along line 2—2 of FIGURE 1;

FIGURE 3 is an enlarged detailed view taken on line 3—3 of FIGURE 2; and

FIGURE 4 is an enlarged detailed view of the section designated by a line 4—4 of FIGURE 3.

The beading apparatus comprises a removable workholder or fixture **10**. The use of a removable fixture is convenient in that it permits the components of the three guns to be assembled at one work station and then loaded into the beading machine to receive its beading elements. The workholder has a base **11** which supports three mandrels positioned at the apices of an equilateral triangle. As shown more clearly in FIGURE 3, base **11** has a central hub-like section **12** with three longitudinally extending apertures each of which receives one mandrel **13**. The three mandrels, particularly as to the portions thereof which serve to support the gun electrodes during the beading operation, are the same structurally with one portion of nearly the same dimension as the inner diameter of a cylindrical electrode G_4. One end of electrode G_4 has one or more orienting straps **16** to be received in slots **15** milled in the upper surface of hub section **12** of workholder **10**. If electrode G_4 is threaded over the mandrel with its tab **16** inserted into slot **15**, this electrode is supported in a predetermined orientation and against rotation. The next element threaded over the mandrel is a spacer **17** which is followed by an electrode G_3. One end of this electrode has a reduced diameter section and mandrel **13**, likewise, has a reduced diameter section **18** which accommodates the smaller end of electrode G_3. The next succeeding element of the stack is a spacer **19** followed by a cylindrical electrode G_2.

One end of electrode G_2 is closed but has a central aperture for admitting an electron beam. The mandrel is stepped down in dimension successively with a section **20** which corresponds to the opening provided in the reduced section of electrode G_3 to a final section **21** which matches in diameter the aperture of electrode G_2 and the beam aperture of a further electrode G_1 which is spaced from G_2 by a spacer **22**.

The enlarged view of FIGURE 4 illustrates the location of the three mandrels at the apices of an equilateral gun triangle. This view also illustrates that the cylindrical electrodes are provided with mounting straps angularly spaced on their external periphery. More particularly, each electrode has a band **25** with a span of approximately 120° affixed to its outer periphery and the free ends **26** of the band serve as the electrode mounting straps. Obviously, each mandrel **13** has a length sufficient to accommodate the electrode series and also to be received within its recess in hub section **12** as a support.

In the three-gun assembly, it is conventional practice to have the guns mechanically converged rather than being supported with their axes parallel to one another. This is done to ease the convergence problem of the color tube into which the gun assembly is to be incorporated. Since the guns are mechanically converged, it is helpful to arrange that at least two, if not all three, of mandrels **13** recede within hub **12** of fixture **10**. Accordingly, the length of the mandrel is sufficient to project through hub **12** and its lower extremity has a fitting **28** with a finger piece **28***a* that may be grasped by an operator to rotate the spindle about its own axis. There is also a locking flange **28***b* which may rest upon a stop **29** suspended from base **11**. With this structure, the mandrel may be locked in the position shown in FIGURE 3 and retained in that position while the electrodes G_1–G_4 and spacer elements **17**, **19**, **22** are threaded thereover. It is also retained in this position throughout the beading operation. When that operation has been completed and the subassembly is to be removed, finger piece **28***a* may be rotated to release the mandrel permitting it to descend within hub **12** and facilitating removal of the subassembly. The fixture is sufficiently flexible if two of mandrels **13** are adjustable in the described fashion and a pair of such mandrels is illustrated in FIGURE 3. The third may or may not be permanently fixed in the beading position.

It will be observed in FIGURE 3 that a support post **30** extends vertically from hub **12** in parallel relation to an assigned mandrel **13** and the free end of each spacer element **17**, **19**, **22** threads thereover. By variously shaping the cross section of this support post at different levels with a matching configuration at the terminal portions of the spacers, keying may be introduced to assist the operator in arranging the spacers only in their preferred order in the electrode stack. Of course, a similar support post is associated with each of the three mandrels.

A pressure pad **31** rests within electrode G_1. It may be put under pressure to clamp the electrodes during a beading operation. To that end, the pad is carried at the free end of a clamp lever **32** which is pivoted at **33** to a stand **34** secured to base **11**. A handle **36** is also pivoted to stand **34** at point **36***a* and is coupled to lever **32** by means of a link **37** pivoted at **37***a* to handle **36** and at **37***b* to lever **32**. Link **37** also carries a pressure block **37***c* for engaging lever **32** acting as a stop. A compression spring **35** is interposed between pad **31** and lever **32**. If handle **36** is rotated clockwise about its pivot **36***a*, lever **32** rotates in the same direction about its pivot **33** and pad **31** is moved clear of the axis of mandrel **13**, freeing the mandrel for loading or unloading. When the mandrel has been loaded with electrodes G_1–G_4 and the interelectrode spacers, preparatory to a beading operation, handle **36** is rotated in a counterclockwise direction to the position shown in FIGURE 3. This moves lever **32** in the same direction and inserts pad **31** into electrode G_1. Stop block **37***c* rests on lever **32** and all pivots **36***a*, **37***a* and **37***b* are in

substantial alignment locking lever **32** against upward movement until such time as handle **36** shall have been rotated in a clockwise direction. Consequently, the electrode stack supported by mandrel **13** is clamped under pressure during the beading operation.

As shown in the enlarged view of FIGURE 4, base **11** has three arms extending from hub **12** and spaced approximately 120° apart. A rod **40** extends downwardly from each of the radial arms of base **11** and collectively the three rods serve as legs upon which fixture **10** is able to rest while the electrode elements and spacers are threaded on the several mandrels, this of course being accomplished at a loading station and not with the fixture installed in the beading machine.

Again with particular reference to FIGURE 4, it is clear that in threading electrode elements over mandrels **13**, bands **25** of all electrodes are positioned inwardly toward the center of the gun assembly. Additionally, the straps **26** are formed or shaped so that when the electrodes are properly oriented about their individual mandrels, the electrode straps of each gun are in approximate parallel relation to electrode straps of the remaining two guns. This is illustrated in FIGURE 4 and the precise orientation is achieved by means of a spline gauge **43**. The spline gauge has a web at the top and three depending fingers **43***a*, one shown in FIGURE 3, which may be threaded down between the pairs of the parallel arranged straps **26** to establish the desired orientation of the various electrode series. Gauge **43** is retained in position throughout the beading process.

Workholder **10** is removably installed in a framework secured to the horizontal or table portion **45** of the beading machine. The frame has three elements **46** which are essentially Z-shaped and, as shown in FIGURE 3, a thin plate **47** extends from the under face of the top free end of each such element to serve as a shelf upon which one arm of fixture base **11** may rest. It is essential that workholder **10** not only be supported within the beading apparatus but it must also be properly oriented in order that the beading elements may be presented in a proper relation to electrode straps **26** to which they are to be attached. For that reason, one end **46***a* of each of the support elements **46** serves as a stop against which the arm of base **11** which it supports is to come to rest in determining the orientation of fixture **10** within the beading machine. As indicated in FIGURE 4, stop portion **46***a* may have a flange section under which an arm of base **11** is to slide so that once the fixture has been properly homed within the beading machine it must be rotated in a counterclockwise direction to be removed. This facilitates an interlock protection that will be described. One of the support elements **46** carries a clamp **80** (FIGURE 2) which may be manually closed against one of the arms of base **11** of fixture **10** to retain the fiixture locked securely in position in the beading machine. The detail of FIGURE 4 shows the clamp **80***a* engaging an arm of base **11** in this locking function.

The interlock to which reference has been made is designated **52** in FIGURE 2. It is supported on horizontal shelf **45** of the beading machine and is a microswitch **52** with a switch operator **52***a* projecting radially inwardly toward the center of fixture **10** but beneath the level of its base **11**. In this position, it is in the path of a leg **40** of the fixture so that counterclockwise rotation of the fixture required to release it from the beading machine actuates microswitch **52**.

The beads to be attached to the electrode straps are made of glass or insulating ceramic material and are releasably held by three bead holders for movement between a heating position and a beading position. One of the three bead holders **51** is shown in detail in FIGURES 3 and 4. It comprises a block **51***a* with a slot **51***b* dimensioned to receive one of the beading elements **50**. It is preferred that the slot be electro-polished to prevent the slot **51***b* by spring-pressed fingers or clamps **51***c*, **51***d*

pivoted to the body of holder 51 and urged in clamping positions by springs 51*e*. Each finger may engage an end of bead 50 releasably to retain the bead within slot 51*b* of holder 51.

It would be unproductive to perform a beading cycle unless each of the three holders 51 contained a beading element. Consequently, each holder 51 accommodates a microswitch 51*f* that may be actuated by a finger portion 51*g* of clamp 51*c*. With a beading element in position, microswitch 51*f* will have been actuated to permit the beading operation to be performed, whereas in the absence of a beading element, finger 51*c* assumes an extreme clockwise position and opens microswitch 51*f* to prevent a beading cycle. As illustrated in FIGURE 3, holder 51 is in a beading position presenting bead 50 to the aligned electrode mounting straps 26.

The heating position of the bead holder is that shown in FIGURES 1 and 2 where the means for heating one surface of each beading element 50 to a softened condition are heaters 53. There is associated with each heater a pair of starting electrodes 53*a*. These electrodes are energized when it is desired to ignite the heater in order to soften beads 50 in the beading cycle. The conduits 53*b* indicate gas lines which feed the heaters.

Movement of each holder 51 between its heating and beading positions is along a median line of the gun triangle. To that end, each bead holder 51 is pivoted at 51*h* to a sleeve 45*a* affixed to the frame of the machine and is moved by means of links 54 which connect at one end to the bead holder so that movement of link 54 may displace the bead holder about its pivot 51*h*. Preferably, an eccentric is employed as the pivot pin coupling link 54 to holder 51 in order to facilitate adjustment of the beading depth. Since the three-gun beading machine has three such holders there are three links 54 and a common actuator connects to their free ends in order that they may be displaced simultaneously. Preferably, the common actuator is a sleeve 54*a* (FIGURE 1) slidable upon a vertical post 54*b* which is disposed coaxially of the triangle including the gun mandrels. That is to say, the axis of post 54*b* extends through the center of the gun triangle. Sleeve 54*a* has three flanges 54*c* and a pin pivotally connects each flange to the lower end of a link 54. Post 54*b* is supported by sleeve 45*a* and a shelf 45*b* constituting a part of the stationary frame of the beading machine.

In order to accomplish a beading cycle, it is necessary to slide sleeve 54*a* first vertically upwardly and then downwardly of post 54*b*. This is accomplished by means of a driving motor 75 which is coupled through a speed reducing arrangement 75*a* to a solenoid controlled half-revolution clutch 75*b*. The clutch affords a coupling to a crank 75*c* which connects to one end of a pivoted lever 75*d*. The opposite end of that lever terminates in a fork 75*e* which engages pins 75*f* projecting from opposite sides of sleeve 54*a*. This completes a coupling from motor 75, through the speed reduction arrangement 75*a*, clutch 75*b*, crank 75*c* and lever 75*d* to sleeve 54*a*.

A programming arrangement 62, not shown in detail because it is of conventional construction, controls the circuitry by which the machine is placed into operation to perform the beading cycle when a starting switch (not shown) has been actuated. The circuits programmed thereby include the control for the solenoid which permits clutch 75*b* to respond and institute a half revolution drive of the clutch at particular intervals in the beading cycle. It further includes an excitation circuit for ignition electrodes 53*a* to fire heaters 53 only during certain program intervals. And, its control circuits further include microswitches 51*f* and 52 arranged so that beading cannot be accomplished unless each workholder 51 contains a beading element 50 and also preventing what is known as double beading.

In describing the operation of the beading apparatus, it will be assumed that fixture 10 is initially removed from the beading machine and is to be loaded with the cylindrical electrode elements from which a three-gun assembly is to be fabricated. With fixture 10 in its loading station, finger portions 28*a* are manipulated to raise mandrels 13 and lock them in the position shown in FIGURE 3. It is assumed now that all three mandrels are elevated and in position to receive the electrode elements. The loading is the same for each mandrel.

First grid G_4 is placed on the mandrel and oriented by inserting tab 16 into slot 15. This is followed by stacking on the mandrel spacer 17, grid G_3, spacer 19, grid G_2, spacer 22 and finally grid G_1. Each electrode is positioned with its band 25 facing toward the center of the gun triangle. When all of the mandrels have been threaded or loaded with these elements, spline gauge 43 is inserted between the aligned and approximately parallel pairs of straps 26 as indicated in FIGURE 4. The spline gauge orients electrodes G_1–G_3 from or with reference to electrode G_4 which is held against rotation by its tab 16 which is nested within slot 15 of base 11. This establishes the electrodes of each gun in a preselected array on its mandrel with predetermined interelectrode spacings and with the mounting straps of each gun in alignment and in parallel relation to straps of the other two guns. Handle 36 is now rotated in a counterclockwise direction to bring clamp pad 31 into electrode G_1 of one gun and to apply a clamping pressure to all the electrodes thereof. This clamping is similarly performed for each of the gun assemblies and fixture 10 is now loaded and ready to be installed in position in the beading machine.

It will be assumed that sleeve 54*a* is in its lowermost position (FIGURE 1) presenting all the bead holders 51 to the heating position. The frame 46 for receiving beading fixture 10 is now readily accessible and the fixture is inserted, resting upon shelves 47 and turned in a clockwise direction to home the arms of base 11 against stops 46*a*. Lock 80 is now actuated releasably locking fixture 10 in the beading machine and with the appropriate orientation.

While holders 51 are in the heating position and heaters 53 are off, an operator manually loads the beading elements 50 in each such holder. Loading of the bead in each holder actuates microswitches 51*f* which is necessary to condition timer 62 to control a beading cycle. When holders 51 have all been loaded and fixture 10 has been properly secured in position, the starting switch is actuated. It is distinctly preferred that the machine be provided with a pair of starting switches requiring the operator to use both hands to initiate the cycle. These switches are placed at the peripheral portion of the machine so that the operator must be away from the heaters before the starting switches may be actuated.

When the starting switch has been closed, timer 62 is energized and applies a potential for a very short interval to starting electrodes 53*a* of each heater. The timer also opens a valve (not shown) which supplies gas to the heaters which are now fired. The fires are trained on the exposed face of each bead 50 and after a suitable heating interval, usually three seconds, that surface of the beads becomes sufficiently soft that a mounting strap may readily be inserted into it. At this point, timer 62 shuts off the gas supply to the heaters.

After the heating interval has passed, timer 62 energizes the solenoid controlling clutch 75 to permit one half revolution. In this half-revolution of the clutch, crank 75*c* and lever 75*d* slide sleeve 54*a* up post 54*b*. This simultaneously displaces each of bead holders 51 from its heating position of FIGURE 1 along a median line of one side of the gun triangle to its beading position of FIGURE 3. The softened surfaces of the beads are driven against electrode straps 26, each bead being driven against two aligned and parallel series of straps 26. Since the arrangement is symmetrical and the beads are applied simultaneously with the same force against the three alignments of mounting straps, the forces are symmetrical and balance out so that there is no net force tending to disturb the alignment of the electrodes on their mandrels. Moreover, the half-

revolution clutch **75***b* causes the motion or action of bead holders **51** to be harmonic, that is to say, the action starts slowly and smoothly, accelerates rapidly and then terminates in a smooth, constant deceleration. This permits fast action of the bead holders to prevent chilling of the beads and yet presentation of the beads to straps **26** without a shock force that would tend to distort and disturb the alignment accuracy of the guns in the gun triangle. Holders **51** are retained in their beading position for a cooling period during which the beads set and become integrated with straps **26**. An interval of 15 seconds is usually sufficient. After the cooling interval, program timer **62** again energizes clutch **75***d* and sleeve **54***a* is returned to the position of FIGURE 1, displacing holders **51** from the beading to the heating position. Inasmuch as each holder releasably supports a bead **50**, the return of the holders to the heating positions strips the beads from the holders, leaving the beads in an integrated assembly with the electrode series of the three-gun assembly. At this juncture, timer **62** will have completed its cycle, a beading operation shall have been finished and the machine shut off.

The operator may now remove fixture **10** from the machine. This is accomplished by rotating the fixture in a counterclockwise direction which actuates microswitch **52** and prepares timer **62** for the next succeeding beading operation. With the fixture removed from the beading machine, spline gauge **43** is removed from the gun assembly. This is accomplished by inserting a knock out pin in the center and at the bottom of the multi-gun assembly. Finger pieces **28** are again manipulated to withdraw mandrels **13** from the gun assemblies. The assembly may now be removed from the workholder and its spacer elements may, likewise, be withdrawn freeing the completed three-gun assembly. This is to say, completed insofar as the electrodes have been secured to insulating posts **50** to maintain the electrodes in a preselected array with a predetermined interelectrode spacing and with a predetermined electrode alignment.

Switch **72** must be actuated before a second beading cycle is initiated and actuation of this switch is accomplished by removing workholder **10** from the machine. Accordingly, double beading or a multiplicity of beading cycles cannot be performed on a single assembly of electrode elements.

While a particular embodiment of the present invention has been shown and described, it is apparent that changes and modifications may be made therein without departing from the invention in its broader aspects. The aim of the appended claims, therefore, is to cover all such changes and modifications as fall within the true spirit and scope of the invention.

We claim:

1. Apparatus for making a three-gun assembly for a cathode-ray tube individually including cylindrical electrodes each of which has a pair of mounting straps angularly spaced approximately 120 degrees on the external periphery thereof, said apparatus comprising:

a workholder including three mandrels positioned at the apices of an equilateral triangle for individually supporting the electrodes and interposed spacing elements of each of said guns to establish therfor a preselected electrode array with predetermined interelectrode spacings and with said mounting straps of each of said guns in substantial alignment and in approximate parallel relation to straps of the remaining two guns;

three bead holders for individually releasably holding an elongated beading element of insulating material for movement between a heating position and a beading position;

means for heating one surface of each of said beading elements to a softened condition;

and means for simultaneously displacing each of said bead holders from its heating position to its beading position to drive said straps of two of said guns into each of said beading elements and for retracting each of said bead holders from its beading position after a predetermined cooling period.

2. Apparatus for making a three-gun assembly for a cathode-ray tube individually including cylindrical electrodes each of which has a pair of mounting straps angularly spaced approximately 120 degrees on the external periphery thereof, said apparatus comprising:

a workholder including three mandrels positioned at the apices of an equilateral triangle for individually supporting the electrodes and interposed spacing elements of each of said guns to establish therefor a preselected electrode array with predetermined interelectrode spacings and with said mounting straps of each of said guns in substantial alignment and in approximate parallel relation to straps of the remaining two guns;

three bead holders for individually releasably holding an elongated beading element of insulating material for movement between a heating position and a beading position;

means for heating one surface of each of said beading elements to a softened condition;

and means for simultaneously displacing each of said bead holders from its heating position to its beading position to drive said straps of two of said guns into each of said beading elements and for retracting each of said bead holders from its beading position after a predetermined cooling period, said displacing means moving said bead holders with equal force along median lines of said triangle to exert balanced pressures against said guns.

3. Apparatus for making a three-gun assembly for a cathode-ray tube individually including cylindrical electrodes each of which has a pair of mounting straps angularly spaced approximately 120 degrees on the external periphery thereof, said apparatus comprising:

a workholder including three mandrels positioned at the apices of an equilateral triangle for individually supporting the electrodes and interposed spacing elements of each of said guns to establish therefor a preselected electrode array with predetermined interelectrode spacings and with said mounting straps of each of said guns in substantial alignment and in approximate parallel relation to straps of the remaining two guns;

three bead holders for individually releasably holding an elongated beading element of insulating material and individually mounted for pivotal movement along a median line of said triangle between a heating position and a beading position;

means for heating one surface of each of said beading elements to a softened condition;

and means for simultaneously displacing each of said bead holders from its heating position to its beading position to drive said straps of two of said guns into each of said beading elements and for retracting each of said bead holders from its beading position after a predetermined cooling period said displacing means comprising a mechanism for effecting harmonic motion of said bead holders between its aforesaid positions.

4. Apparatus for making a three-gun assembly for a cathode-ray tube individually including cylindrical electrodes each of which has a pair of mounting straps angularly spaced approximately 120 degrees on the external periphery thereof, said apparatus comprising:

a workholder including three mandrels positioned at the apices of an equilateral triangle for individually supporting the electrodes and interposed spacing elements of each of said guns to establish therefor a preselected electrode array with predetermined interelectrode spacings and with said mounting straps of each of said guns in substantial alignment and

in approximate parallel relation to straps of the remaining two guns;

three bead holders for individually releasably holding an elongated beading element of insulating material and individually mounted for pivotal movement along a median line of said triangle between a heating position and a beading position;

means for heating one surface of each of said beading elements to a softened condition;

a link for each of said bead holders connected at one end to its associated bead holder for effecting pivotal displacement thereof between a heating position and a beading position;

a common actuator connected to the other end of each of said links and displaceable to move said three bead holders simultaneously;

and a timer for displacing said actuator to move said bead holders to said beading position after said beading elements have been softened and to return said bead holders to said heating position after a given cooling period.

5. Apparatus for making a three-gun assembly for a cathode-ray tube individually including cylindrical electrodes each of which has a pair of mounting straps angularly spaced approximately 120 degrees on the external periphery thereof, said apparatus comprising:

a workholder including three mandrels positioned at the apices of an equilateral triangle for individually supporting the electrodes and interposed spacing elements of each of said guns to establish therefor a preselected electrode array with predetermined interelectrode spacings and with said mounting straps of each of said guns in substantial alignment and in approximate parallel relation to straps of the remaining two guns;

three bead holders for individually releasably holding an elongated beading element of insulating material and individually mounted for movement along a median line of said triangle between a heating position and a beading position;

means for heating one surface of each of said beading elements to a softened condition;

a link for each of said bead holders connected at one end to its associated bead holder for effecting displacement thereof between a heating position and a beading position;

a vertical support extending coaxially of said triangle;

a sleeve slidable on said vertical support and connected to the other end of each of said links to move said three bead holders simultaneously;

and means for displacing said sleeve along said vertical support.

6. Apparatus for making a three-gun assembly for a cathode-ray tube individually including cylindrical electrodes each of which has a pair of mounting straps angularly spaced approximately 120 degrees on the external periphery thereof, said apparatus comprising:

a workholder including three mandrels positioned at the apices of an equilateral triangle for individually supporting the electrodes and interposed spacing elements of each of said guns to establish therefor a preselected electrode array with predetermined interelectrode spacings and with said mounting straps of each of said guns in substantial alignment and in approximate parallel relation to straps of the remaining two guns;

three bead holders for individually releasably holding an elongated beading element of insulating material and individually mounted for movement along a median line of said triangle between a heating position and a beading position;

means for heating one surface of each of said beading elements to a softened condition;

a link for each of said bead holders connected at one end to its associated bead holders for effecting displacement thereof between a heating position and a beading position;

a vertical support extending coaxially of said triangle;

a sleeve slidable on said vertical support and connected to the other end of each of said links to move said three bead holders simultaneously;

and means including a drive motor, a half-revolution clutch, and a crank connected to said sleeve for displacing said sleeve along said vertical support.

7. Apparatus for making a three-gun assembly for a cathode-ray tube individually including cylindrical electrodes each of which has a pair of mounting straps angularly spaced approximately 120 degrees on the external periphery thereof, said apparatus comprising:

a workholder including three mandrels positioned at the apices of an equilateral triangle for individually supporting the electrodes and interposed spacing elements of each of said guns to establish therefor a preselected electrode array with predetermined interelectrode spacings and with said mounting straps of each of said guns in substantial alignment and in approximate parallel relation to straps of the remaining two guns;

clamps included in said workholder and individually associated with one of said mandrels for maintaining the electrode array of each of said mandrels under a predetermined clamping pressure during the beading operation;

three bead holders for individually releasably holding an elongated beading element of insulating material for movement between a heating position and a beading position;

means for heating one surface of each of said beading elements to a softened condition;

and means for simultaneously displacing each of said bead holders from its heating position to its beading position to drive said straps of two of said guns into each of said beading elements and for retracting each of said bead holders from its beading position after a predetermined cooling period.

8. Apparatus for making a three-gun assembly for a cathode-ray tube individually including cylindrical electrodes each of which has a pair of mounting straps angularly spaced approximately 120 degrees on the external periphery thereof, said apparatus comprising:

a workholder including three mandrels positioned at the apices of an equilateral triangle for individually supporting the electrodes and interposed spacing elements of each of said guns to establish therefor a preselected electrode array with predetermined interelectrode spacings and with said mounting straps of each of said guns in substantial alignment and in approximate parallel relation to straps of the remaining two guns;

three bead holders for individually releasably holding an elongated beading element of insulating material for movement between a heating position and a beading position;

each of said bead holders including a pair of spring pressed clamps for engaging the opposite ends of one of said beading elements;

means for heating one surface of each of said beading elements to a softened condition;

and means for simultaneously displacing each of said bead holders from its heating position to its beading position to drive said straps of two of said guns into each of said beading elements and for retracting each of said bead holders from its beading position after a predetermined cooling period.

9. Apparatus for making a three-gun assembly for a cathode-ray tube individually including cylindrical electrodes each of which has a pair of mounting straps angularly spaced approximately 120 degrees on the external periphery thereof, said apparatus comprising:

a workholder including three mandrels positioned at the apices of an equilateral triangle for individually supporting the electrodes and interposed spacing elements of each of said guns to establish therefor a preselected electrode array with predetermined interelectrode spacings and with said mounting straps of each of said guns in substantial alignment and in approximate parallel relation to straps of the remaining two guns;

three bead holders for individually releasably holding an elongated beading element of insulating material for movement between a heating position and a beading position;

means for heating one surface of each of said beading elements to a softened condition;

means for simultaneously displacing each of said bead holders from its heating position to its beading position to drive said straps of two of said guns into each of said beading elements and for retracting each of said bead holders from its beading position after a predetermined cooling period;

and a program timer for firing said heating means for a given interval at the start of a beading cycle, and for controlling said displacing means to move said bead holders to said beading position after said given interval and to displace said bead holders from said beading position to said heating position after a given cooling period.

10. Apparatus for making a three-gun assembly for a cathode-ray tube individually including cylindrical electrodes each of which has a pair of mounting straps angularly spaced approximately 120 degrees on the external periphery thereof, said apparatus comprising:

a removable workholder including three mandrels positioned at the apices of an equilateral triangle for individually supporting the electrodes and interposed spacing elements of each of said guns to establish therefor a preselected electrode array with predetermined interelectrode spacings and with said mounting straps of each of said guns in substantial alignment and in approximate parallel relation to straps of the remaining two guns;

three bead holders for individually releasably holding an elongated beading element of insulating material for movement between a heating position and a beading position;

means for heating one surface of each of said beading elements to a softened condition;

means for simultaneously displacing each of said bead holders from its heating position to its beading position to drive said straps of two of said guns into each of said beading elements and for retracting each of said bead holders from its beading position after a predetermined cooling period;

a program timer for firing said heating means for a given interval at the start of a beading cycle, and for controlling said displacing means to move said bead holders to said beading position after said given interval and to displace said bead holders from said beading position to said heating position after a given cooling period;

and an interlock actuated by removal of said workholder for conditioning said program timer for controlling a beading cycle.

11. Apparatus for making a three-gun assembly for a cathode-ray tube individually including cylindrical electrodes each of which has a pair of mounting straps angularly spaced approximately 120 degrees on the external periphery thereof, said apparatus comprising:

a workholder including three mandrels positioned at the apices of an equilateral triangle for individually supporting the electrodes and interposed spacing elements of each of said guns to establish therefor a preselected electrode array with predetermined interelectrode spacings and with said mounting straps of each of said guns in substantial alignment and in approximate parallel relation to straps of the remaining two guns;

three bead holders for individually releasably holding an elongated beading element of insulating material for movement between a heating position and a beading position;

means for heating one surface of each of said beading elements to a softened condition;

means for simultaneously displacing each of said bead holders from its heating position to its beading position to drive said straps of two of said guns into each of said beading elements and for retracting each of said bead holders from its beading position after a predetermined cooling period;

and interlocks actuated in response to the positioning of said beading elements in said bead holders for preparing said apparatus to initiate a beading cycle.

References Cited

UNITED STATES PATENTS

2,600,076	6/1952	Schelling	65—155 XR
2,707,848	5/1955	Pityo	65—155 XR
2,950,568	8/1960	Kissinger et al.	65—154

DONALL H. SYLVESTER, *Primary Examiner.*

F. W. MIGA, *Assistant Examiner.*