Oct. 27, 1953 J. F. DE ANO 2,656,650

SEALING APPARATUS

Filed Nov. 20, 1951 2 Sheets-Sheet 1

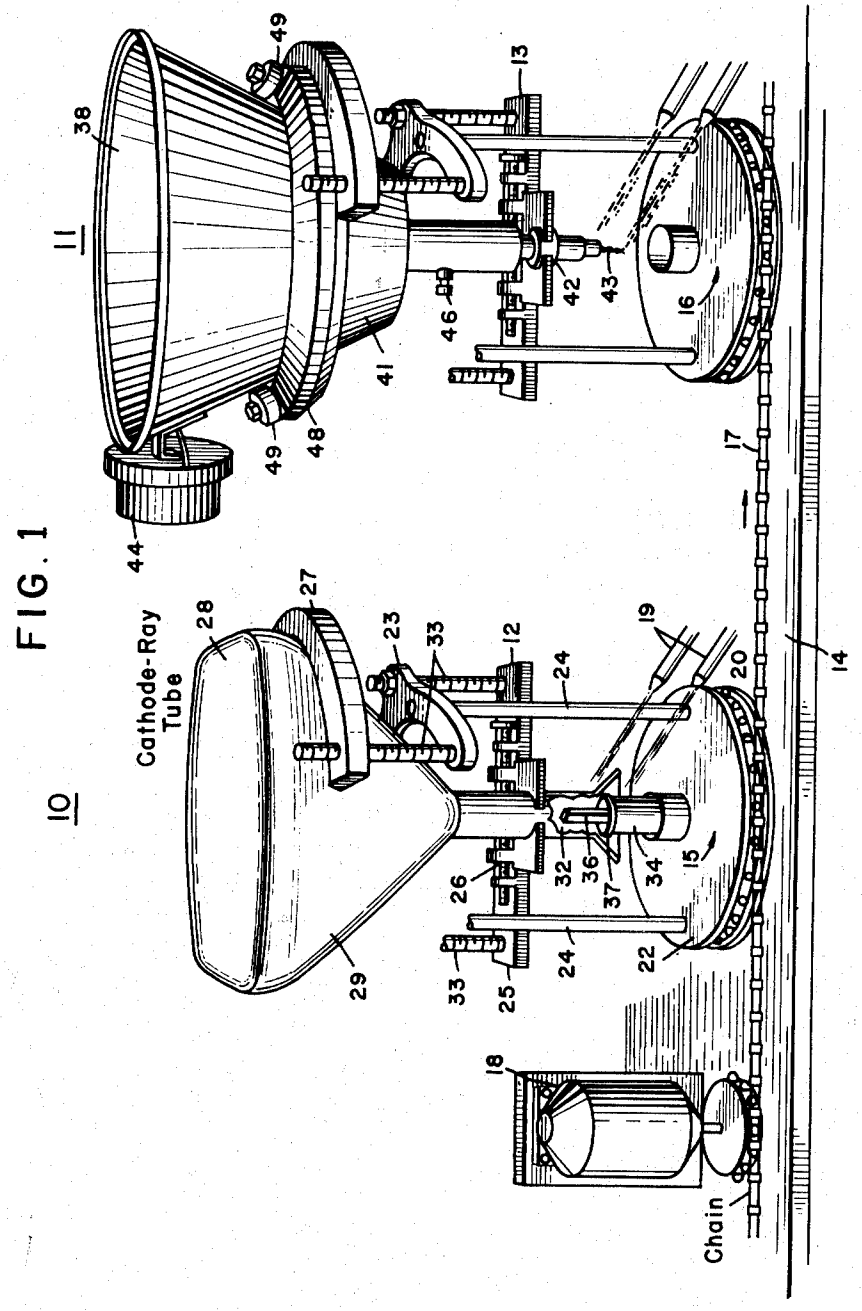


FIG. 1

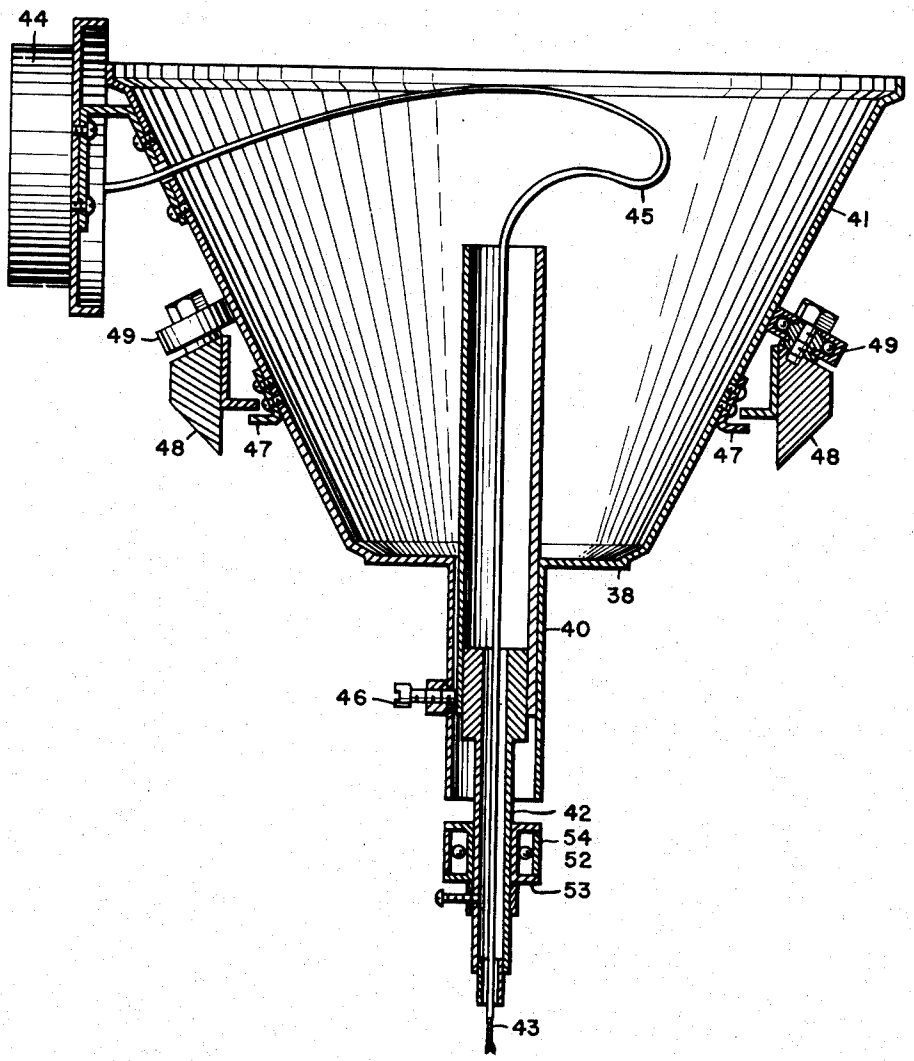
INVENTOR:
JOHN F. DE ANO
BY Francis W. Crotty
HIS ATTORNEY.

Oct. 27, 1953 J. F. DE ANO 2,656,650

SEALING APPARATUS

Filed Nov. 20, 1951 2 Sheets-Sheet 2

FIG. 2



INVENTOR:
JOHN F. DE ANO
BY Francis W. Crotty
HIS ATTORNEY.

Patented Oct. 27, 1953

2,656,650

UNITED STATES PATENT OFFICE

2,656,650

SEALING APPARATUS

John F. De Ano, Melrose Park, Ill., assignor to The Rauland Corporation, a corporation of Illinois

Application November 20, 1951, Serial No. 257,394

8 Claims. (Cl. 49—2)

1

This invention relates to sealing apparatus useful in the manufacture of electron-discharge devices and more particularly to apparatus for sealing electrode systems into the envelopes of electron-discharge devices. The invention is applicable to the manufacture of a wide variety of electron-discharge devices, such as conventional transmitting- and receiving-type tubes, but is particularly useful in the fabrication of cathode-ray tubes and will therefore be described in that connection.

A cathode-ray tube comprises two major subassemblies which are usually fabricated separately and joined together only in a later stage of the manufacturing process. One of these subassemblies is the outer shell, or envelope, of the tube; the other is the electrode system, or electron gun. The envelope comprises a cone portion carrying a fluorescent-screen-bearing face plate and a cylindrical glass neck portion adapted to receive the electron gun. The electron gun is composed of several parts, constituting the various electrodes of the system, which are usually assembled and fixed to a disc-like glass mount designed to be sealed into the neck of the envelope. When the electron gun assembly and tube envelope are both completed, there are fused or sealed together, usually through the use of semi-automatic machinery. After sealing, the tube envelopes are usually subjected to further heat treatment to anneal the glass and strengthen the sealing bond, following which they are evacuated, gettered, and based in accordance with well-known practices in the industry.

It has been found essential to maintain stringent temperature control throughout the sealing and annealing processes, in order to avoid flaws in the assembly attributable to unequal strains in the glass components. When such control is poorly maintained, the resulting flaws may be manifested by immediate damage to the assembly. On the other hand, the flaws may not be immediately apparent, but may rupture only when subjected to stresses developed upon subsequent evacuation.

Precise determination of the temperature at each operating station in the sealing and annealing process is essential to prevent losses which might otherwise result from flaws due to improper maintenance of the heat-treating cycle. While control of such flaws is an important consideration in the manufacture of all types of electron-discharge devices, it is of particular import in the case of cathode-ray tubes since the envelopes for these tubes require special costly treatment prior to final assembly. Failure of a cathode-ray tube at the final assembly stage represents not merely the loss of a simple glass envelope but the loss of a materially greater investment due to the appreciation in value occasioned by application of a fluorescent screen and an internal conductive coating.

2

Determination of these highly critical processing temperatures is not practical through maintenance of permanently installed individual temperature-measuring devices at each of the operating stations, since the work-holders utilized in transferring the tubes from station to station are required to rotate to provide for even heating of the glass. This rotation would create mechanical interference between any stationary device and the work-holders. Consequently, it has been the usual practice in the art to utilize a contact pyrometer inserted in turn at each operating station to determine the temperature produced by the heat source at that station. This method is inherently awkward in that it requires the operator properly to position the pyrometer and simultaneously to note and record the temperature. The method has a further disadvantage in that insertion of the pyrometer from above causes the operator considerable discomfort due to heat from the local heat source, and insertion from the side causes mechanical interference with the rotating work-holder currently at that operating station. If the work-holder is removed, the operator has no means to determine the proper position at which to take temperature readings. For these reasons, accurate temperature determination has required the employment of two persons, one to position the pyrometer and the other to take readings, since a single operator would find it virtually impossible to note the position of the pyrometer and simultaneously to take the necessary reading.

It is a primary object of the present invention to provide a new and improved apparatus for sealing electrode systems into electron-discharge device envelopes.

It is a more specific object of the invention to provide a new and improved device for the accurate determination of heat-treating temperatures at the various operating stations in apparatus for sealing electrode systems in electron-discharge device envelopes.

It is a further object of the invention to provide apparatus capable of achieving this accuracy of temperature determination without the necessity of incorporating elaborate and expensive devices or a multiplicity of devices and which will require a minimum of time and skill on the part of the process operator.

The invention accordingly provides apparatus for sealing electrode systems in electron-discharge device envelopes, which apparatus includes a plurality of operating stations, each having at least one localized heat source, arranged in predetermined sequence for subjecting the envelopes to a predetermined heat-treating cycle.

The apparatus also includes a plurality of spaced rotatable work-holders, relatively movable with respect to the operating stations, for transferring the envelopes and electrode systems to each of the operating stations in sequence. A driving apparatus is provided to effect rotation of the work-holders. A support member, generally simulating one of the envelopes in physical configuration, is removably installed in one of the work-holders, and a temperature-indicating device is mounted on this support member. A thermally sensitive device is operatively connected to the temperature-indicating device and fixed to the support member in such a position that it registers the heat treating temperature at the particular operating station momentarily occupied by the work-holder in which the support member is currently installed. Friction coupling means is provided between the driving apparatus and the support member to permit arrestment of the rotation of the support member independently of rotation of the remainder of the work-holders.

The features of the present invention which are believed to be novel are set forth with particularity in the appended claims but its organization and manner of operation, 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 elements are indicated by like reference numerals, and in which:

Figure 1 is a view, partly schematic, of a portion of a sealing machine constructed in accordance with the invention, showing two operating stations at one of which a cathode-ray tube is being processed and at the other of which a temperature determination is being made, and

Figure 2 is a sectional view of the temperature-measuring portion of the apparatus of Figure 1.

The sealing machinery of the present invention may consist of a number of operating stations each comprising a localized heat source. The heat sources are preadjusted to suitable operating temperatures in accordance with a predetermined heat-treating cycle. A plurality of work-holders are used to support a tube envelope and an electron gun mount assembly in suitable juxtaposition at each of the operating stations and are further employed to transfer the parts from station to station in sequence through the predetermined heat-treating cycle. This transfer may conveniently be accomplished by circularly disposing the operating stations and by arranging the work-holders on a rotatable circular turntable within the circle formed by the operating stations.

In Figure 1, only two operating stations 10 and 11 of such an apparatus are shown, it being understood that a sufficient number of additional similar operating stations, not shown, are also provided to perform the several steps of the sealing and annealing process. Two work-holders 12 and 13 are shown at operating stations 10 and 11, respectively, and are mounted on a turntable 14 which is arranged to transfer work-holders 12 and 13 from operating station to operating station as by means of a motor drive system (not shown) or in any other suitable manner. Work-holders 12 and 13 are arranged for continuous rotation, as indicated by arrows 15 and 16, by means of a linkage 17, such as a chain drive, a belt drive, or other similar power transfer means, actuated by a power source 18, which may be an electrical motor or any other suitable source of mechanical power. Power source 18 and linkage 17 constitute the driving apparatus for rotating work-holders 12 and 13 and the remainder of the work-holders (not shown). A pair of gas jets 19, or other localized heat source, are provided at operating station 10 and are connected to a source (not shown) of suitable gaseous combustible material in any known fashion. Similar heat sources are provided at each of the operating stations.

Work-holder 12, in position at operating station 10, comprises a base 22 which is rotatably mounted on turntable 14. Rotatable base 22 is provided with suitable connection means such as a sprocket 20 to complete a mechanical coupling to linkage 17 and thus effect transmission of the power necessary for rotation. An intermediate ring 23 is supported by a pair of rods 24 mounted on base 22, and a clamp base 25 is adjustably suspended from ring 23 in a position somewhat above localized heat source 19. A clamp 26 is mounted in the center of clamp base 25, the central opening formed by the two sides of clamp 26 being generally circular in shape. An envelope support ring 27 is adjustably mounted on intermediate ring 23.

A cathode-ray tube envelope 28 is inserted in work-holder 12, the upper or cone portion 29 of the tube envelope resting on envelope support ring 27 and the lower or neck portion 32 of the cathode-ray tube 28 being engaged by clamp 26. Since the dimensions of cone portion 29 and neck portion 32 of cathode-ray tube 28 may vary with the particular size of the tube being processed, the exact positioning of envelope support ring 27 and clamp base 25 with respect to intermediate ring 23 may require adjustment in order to bring neck portion 32 into proper juxtaposition with localized heat source 19. This adjustment has been provided for by the adjustable mounting of these members with respect to intermediate ring 23 through the medium of several threaded adjustment rods 33.

A vertically movable plunger 34 is mounted on base 22 and is rotatable therewith. Plunger 34 serves as a support for an electron gun mount assembly comprising an electrode system 36 shown schematically in the drawing, and a glass mount 37. The vertical position of plunger 34 is regulated to locate glass mount 37 in suitable juxtaposition with localized heat source 19.

Work-holder 13 at operating station 11 is constructed in the same manner as work-holder 12 at operating station 10. However, work-holder 13 supports a temperature-determining device 38 instead of the cathode-ray tube envelope supported in work-holder 12. Temperature-determining device 38 comprises a support member generally simulating a cathode-ray tube envelope in physical configuration. A cone portion 41 of temperature-determining device 38 is retained by the work-holder 13 in a manner similar to that in which cone portion 29 of cathode-ray tube 28 is held in work-holder 12, and a neck portion 42 of temperature-determining device 38 is clamped in work-holder 13 in precisely the same manner as that employed in clamping neck portion 32 of cathode-ray tube 28 in work-holder 12. A thermocouple 43 or other thermally sensitive device is fixed to neck portion 42 in a suitable position to register the heat-treating temperature at each operating station in sequence as turntable 14 is rotated to transport work-holder 13 from station to station. A temperature-indicating device 44, operatively connected to thermocouple 43, is mounted on the periph-

ery of cone portion 41 in a manner to be more fully described in connection with Figure 2.

In carrying out the sealing process, cathode-ray tube envelope 28 is mounted in the work-holder as indicated, the position of envelope support ring 27 and clamp base 25 being so adjusted as to place neck portion 32 of envelope 28 in position to be heated by the flames from gas jets 19. Electron gun mount assembly 36, 37 is placed on vertically adjustable plunger 34 and plunger 34 is adjusted to place glass mount 37 in such position that it is also heated by the flames from heat source 19. If it is assumed that operating station 10 is the initial stage of the process, the temperature of neck portion 32 and glass mount 37 is increased over room temperature by a predetermined amount while the work-holder occupies this particular operation station. After a predetermined time during which the temperature of these parts is increased to the maximum permissible at this station, the work-holder is transported to the next operating station, in this case operating station 11. The temperature of the glass parts is further elevated at this succeeding station, after which work-holder 12 is transferred to the next operating station in the process. Thus, as work-holder 12 progresses through the sequence of operating stations, the temperature of neck portion 32 of envelope 28 and glass mount 37 is increased until work-holder 12 reaches an operating station which maintains a temperature sufficiently high to permit fusion of glass neck portion 32 and glass mount 37. At this operating station, a further short movement of plunger 34 raises glass mount 37 until its periphery is in contact with the inner surface of neck 32. At this operating station, therefore, mount 37 and neck 32 are fused together and the electron gun mount assembly is effectively sealed into the envelope. Further operating stations in the complete process provide a graduated lowering of the temperature of the now-fused mount 37 and neck portion 32 and further serve to anneal and strengthen the newly formed bond between these two members.

The progress of work-holder 13 through the sealing and annealing stages is performed in exactly the same manner and sequence as that followed by work-holder 12. When the work-holder occupies operating station 11, the position of thermocouple 43 makes it possible to determine the exact temperature to which next portion 32 and glass mount 37 will be subjected when they reach operating station 11. This determination of the heat treating temperature at operating station 11 is effected by noting and reading temperature-indicating device 44, since this device is operatively connected with thermocouple 43. As work-holder 13, and therefore temperature-determining device 38, proceeds in sequence through the operating stations of the sealing and annealing apparatus, a series of temperature readings are made and gas jets 19 are adjusted until the temperature readings conform with the desired temperatures of the heat-treating cycle. Thus, an exact record of the temperature at each of the operating stations in their proper sequence is obtained and precise adjustment of each heat source is effected.

Figure 2 is a sectional detail view of temperature-determining device 38. As previously indicated, a temperature-indicating device 44 is mounted on the periphery of cone portion 41 and thermocouple 43 is fixed to neck portion 42 of device 38. A pair of flexible connector leads 45

provide an operative connection between thermocouple 43 and temperature-indicating device 44 so that device 44 registers the operating temperature at the position occupied by thermocouple 43. Neck portion 42 is slidably supported within an extension 40 of cone portion 41, and a thumb screw 46 is provided on extension 40 for fixing neck portion 42 to cone portion 41 while permitting vertical adjustment of thermocouple 43. A plurality of outwardly extending flanges 47, or alternatively a single peripheral outwardly extending flange, are affixed to cone portion 41, and a frame member 48 is retained in peripherally encompassing relation with cone portion 41 by flanges 47. A plurality of rotary bearings 49 are mounted on frame member 48 to engage cone portion 41 and provide frictional coupling between cone portion 41 and frame member 48 when device 38 is installed in one of the work-holders. Frame member 48 is so formed as to fit on envelope support ring 27 and supports cone portion 41 through the frictional coupling of bearing 49. Another rotary bearing 52 is mounted with an inner race 53 in engagement with neck portion 42 and provides means for frictional coupling between neck portion 42 and the work-holder through an outer race 54 of bearing 52 which is engaged by clamp 26 (Figure 1).

As previously mentioned, the physical configuration of the tube envelopes being processed may vary to a considerable extent, and it is therefore desirable to provide means for analogous variation in the configuration of temperature-determining device 38. Insofar as the sealing apparatus is concerned, the only physical variation of importance is the extension of neck portion 42 in relation to cone portion 41. Variation in the length of this extension is possible through adjustment of the position of neck portion 42 with relation to cone portion 41, which may be effected through use of thumb screw 46. Thus the position of thermocouple 43 in relation to the localized heat source at the operating station currently occupied by work-holder 13 may be regulated exactly to insure correct registration of the heat-treating temperature.

As shown in Figure 1, temperature-determining device 38, when installed in work-holder 13, rotates with the work-holder. For convenience in reading temperature-indicating device 44, it is desirable to provide for arrestment of the rotation of cone portion 41 and neck portion 42 without impeding the rotation of work-holder 13. Rotary bearings 49 and 52 provide frictional coupling between work-holder 13 and device 38 and permit the operator to arrest device 38 independently of rotation of work-holder 13 by simply grasping temperature-indicating device 44. This provision for arrestment of temperature-determining device 38 independently of rotation of work-holder 13 is useful when a chain drive is employed since, in that event, it is not possible to arrest rotation of work-holder 13 without jamming linkage 17 and therefore simultaneously arresting all other work-holders in the apparatus. When connecting means 29 and linkage 17 provide for frictional coupling as is the case when a belt drive is employed, it is possible to arrest the rotary motion of work-holder 13 without affecting the rotation of the other work-holders in the system. In such a case there is no necessity for providing frictional coupling between work-holder 13 and temperature-determining

device 38, and flange 47, frame member 48, and bearings 49 and 52 are not required.

In practice, the exact temperature gradations of the required heat-treating cycle are determined by calculation or from experience, and the localized heat sources, such as heat source 19, are adjusted to approximate the desired temperature at each of the operating stations 10, 11, etc. of the sealing apparatus. Temperature-determining device 38 is then installed in one of the work-holders and proceeds through the heat-treating cycle, registering the temperature developed at each of the operating stations. Deviations from the required temperatures are noted and fine adjustments are made until a complete test run with device 38 indicates accurate presetting of the heat-treating temperatures at all operating stations. Device 38 may then be removed from the work-holder, if the operator so desires, and the sealing apparatus may be utilized for sealing electron gun mount assemblies into cathode-ray tube envelopes without encountering excessive breakage due to uncontrolled heat stresses.

Experience has indicated that once the proper heat-treating temperatures have been accurately established, the sealing operation may be continued for several hours without significant difficulty. However, since the localized heat sources are adjustable and are somewhat subject to uncalculated variation, it is possible that they may become slightly maladjusted and produce undesired thermal conditions at the various operating stations. This situation is evidenced by a noticeable increase in the number of flaws encountered, with a resulting increase in breakage and loss of the completed tubes. When this condition becomes evident, or at periodic intervals frequent enough to avoid such difficulty, the temperature-determining device 38 may again be installed in one of the work-holders and a thorough check may again be made of the prevailing heat-treating temperatures at the individual operating stations.

The arrangement and configuration of the improved apparatus for sealing electron guns into cathode-ray tube envelopes as described enables the operator to maintain an accurate check on the exact heat-treating temperature at each operating station at the precise position desired. It is not necessary that the operator exercise particular skill or judgment in the positioning of a thermally sensitive device such as a contact pyrometer; he is therefore free to concentrate on properly observing and recording the temperature itself. The invention permits accurate determination of the critical temperatures of the sealing process in their predetermined sequence without requiring elaborate and complex individual installations at each operating station. It further permits determination of those temperatures while requiring only intermittent attendance by a single operator. Use of the invention has effected a substantial reduction in the number of flaws produced in operation of the process and has led to a consequent marked reduction in the losses therefrom.

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

I claim:

1. Apparatus for sealing electrode systems into electron-discharge device envelopes including: a plurality of operating stations, each having at least one localized heat source, arranged in predetermined sequence for subjecting said envelopes to a predetermined heat-treating cycle; a plurality of spaced rotatable work-holders relatively movable with respect to said operating stations for transferring said envelopes and said electrode systems to each of said operating stations in sequence; driving apparatus for rotating said work-holders; a support member, generally simulating one of said envelopes in physical configuration, removably installed in one of said work-holders; a temperature-indicating device mounted on said support member; a thermally sensitive device operatively connected to said temperature-indicating device and fixed to said support member in a position to register the heat treating temperature at the particular operating station momentarily occupied by said one rotatable work-holder; and friction coupling means between said driving apparatus and said support member to permit arrestment of rotation of said support member independently of rotation of the remainder of said work-holders.

2. Apparatus for sealing electrode systems into electron-discharge device envelopes including: a plurality of operating stations, each having at least one localized heat source, arranged in predetermined sequence for subjecting said envelopes to a predetermined heat-treating cycle; a plurality of spaced rotatable work-holders relatively movable with respect to said operating stations for transferring said envelopes and said electrode systems to each of said operating stations in sequence; driving apparatus for rotating said work-holders; a support member, generally simulating one of said envelopes in physical configuration, removably installed in one of said work-holders; a temperature-indicating device mounted on said support member; a thermally sensitive device operatively connected to said temperature-indicating device and fixed to said support member in a position to register the heat treating temperature at the particular operating station momentarily occupied by said one rotatable work-holder; and friction coupling means between said work-holder and said support member to permit arrestment of rotation of said support member independently of rotation of said work-holder.

3. Apparatus for sealing electron gun mounts into cathode-ray tube envelopes including: a plurality of operating stations, each having at least one localized heat source, arranged in predetermined sequence for subjecting said envelopes to a predetermined heat-treating cycle; a plurality of spaced rotatable work-holders relatively movable with respect to said operating stations for transferring said envelopes and said electron gun mounts to each of said operating stations in sequence; driving apparatus for rotating said work-holders; a support member, generally simulating a cathode-ray tube envelope in physical configuration, removably installed in one of said work-holders; a temperature - indicating device mounted on said support member; a thermally sensitive device operatively connected to said temperature-indicating device and fixed to said support member in a position to register the heat treating temperature at the particular operating station momentarily occupied by said one rotat-

able work-holder; and means, including at least one friction coupling device, for coupling said driving apparatus to said one work-holder and for coupling said one work-holder to said support member to permit arrestment of rotation of said support member independently of rotation of the remainder of said work-holders.

4. Apparatus for sealing electrode systems into electron-discharge device envelopes including: a plurality of operating stations, each having at least one localized heat source, arranged in predetermined sequence for subjecting said envelopes to a predetermined heat-treating cycle; a plurality of spaced rotatable work-holders relatively movable with respect to said operating stations for transferring said envelopes and said electrode systems to each of said operating stations in sequence; driving apparatus for rotating said work-holders; a support member, generally simulating one of said envelopes in physical configuration, removably installed in one of said work-holders; a temperature-indicating device mounted on said support member; a thermally sensitive device operatively connected to said temperature-indicating device and fixed to said support member in a position to register the heat treating temperature at the particular operating station momentarily occupied by said one rotatable work-holder; a peripheral frame member adapted to be supported in said work-holder and frictionally coupled to said support member and providing support therefor; and a rotary bearing having an inner race in engagement with said support member and an outer race engaged by said work-holder, whereby rotation of said support member may be arrested independently of rotation of said work-holder.

5. Apparatus for sealing electrode systems into electron-discharge device envelopes including: a plurality of operating stations, each having at least one localized heat source, arranged in predetermined sequence for subjecting said envelopes to a predetermined heat-treating cycle; a plurality of spaced rotatable work-holders relatively movable with respect to said operating stations for transferring said envelopes and said electrode systems to each of said operating stations in sequence; driving apparatus for rotating said work-holders; a support member, generally simulating one of said envelopes in physical configuration, removably installed in one of said work-holders; a temperature-indicating device mounted on said support member; a thermally sensitive device operatively connected to said temperature-indicating device and fixed to said support member in a position to register the heat treating temperature at the particular operating station momentarily occupied by said one rotatable work-holder; an outwardly extending flange fixed to said support member; a frame member retained by said flange; a first rotary bearing supported by said frame member in engagement with said support member when said support member is installed in said work-holder; and another rotary bearing having an inner race in engagement with said work-holder, whereby rotation of said support member may be arrested independently of rotation of said work-holder.

6. In apparatus for sealing electrode systems into electron-discharge device envelopes, of the type comprising a plurality of rotatable work-holders in juxtaposition with respective localized heat sources: a support member generally simulating one of said envelopes in physical configuration; a temperature-indicating device mounted on said support member; a thermocouple operatively connected to said temperature-indicating device and adjustably fixed to said support member in a position to register the heat-treating temperature of said localized heat source when said support member is installed in one of said work-holders; and friction coupling means between said work-holder and said support member to permit arrestment of rotation of said support member independently of rotation of the remainder of said work-holders.

7. In apparatus for sealing electrode systems into electron-discharge device envelopes, of the type comprising at least one rotatable work-holder in juxtaposition with at least one localized heat source: a support member generally simulating one of said envelopes in physical configuration; a temperature-indicating device mounted on said support member; a thermally sensitive device operatively connected to said temperature-indicating device and fixed to said support member in a position to register the heat-treating temperature of said localized heat source when said support member is installed in said work-holder; a peripheral frame member adapted to be supported in said work-holder and frictionally coupled to said support member and providing support therefor; and a rotary bearing having an inner race in engagement with said support member and an outer race engaged by said work-holder, whereby rotation of said support member may be arrested independently of rotation of said work-holder.

8. In apparatus for sealing electron gun mounts into cathode-ray tube envelopes, of the type comprising at least one rotatable work-holder in juxtaposition with at least one localized heat source: a support member comprising a cone portion and a neck portion and generally simulating a cathode-ray tube envelope, said neck portion being axially adjustable with respect to said cone portion; a temperature-indicating device mounted on said support member a thermocouple operatively connected to said temperature-indicating device and fixed to said neck portion in a position to register the heat-treating temperature of said localized heat source when said support member is installed in said work-holder; an outwardly extending flange affixed to said cone portion; a frame member retained by said flange; a first rotary bearing supported by said frame member in engagement with said cone portion when said support member is installed in said work-holder; and another rotary bearing having an inner race in engagement with said neck portion and an outer race engaged by said work-holder, whereby rotation of said support member may be arrested independently of rotation of said work-holder.

JOHN F. DE ANO.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
1,563,104	Pedersen	Nov. 24, 1925
2,058,880	Hunt	Oct. 27, 1936
2,237,186	Malloy	Apr. 1, 1941
2,418,763	Eisler	Apr. 8, 1947
2,434,664	Malloy	Jan. 20, 1948