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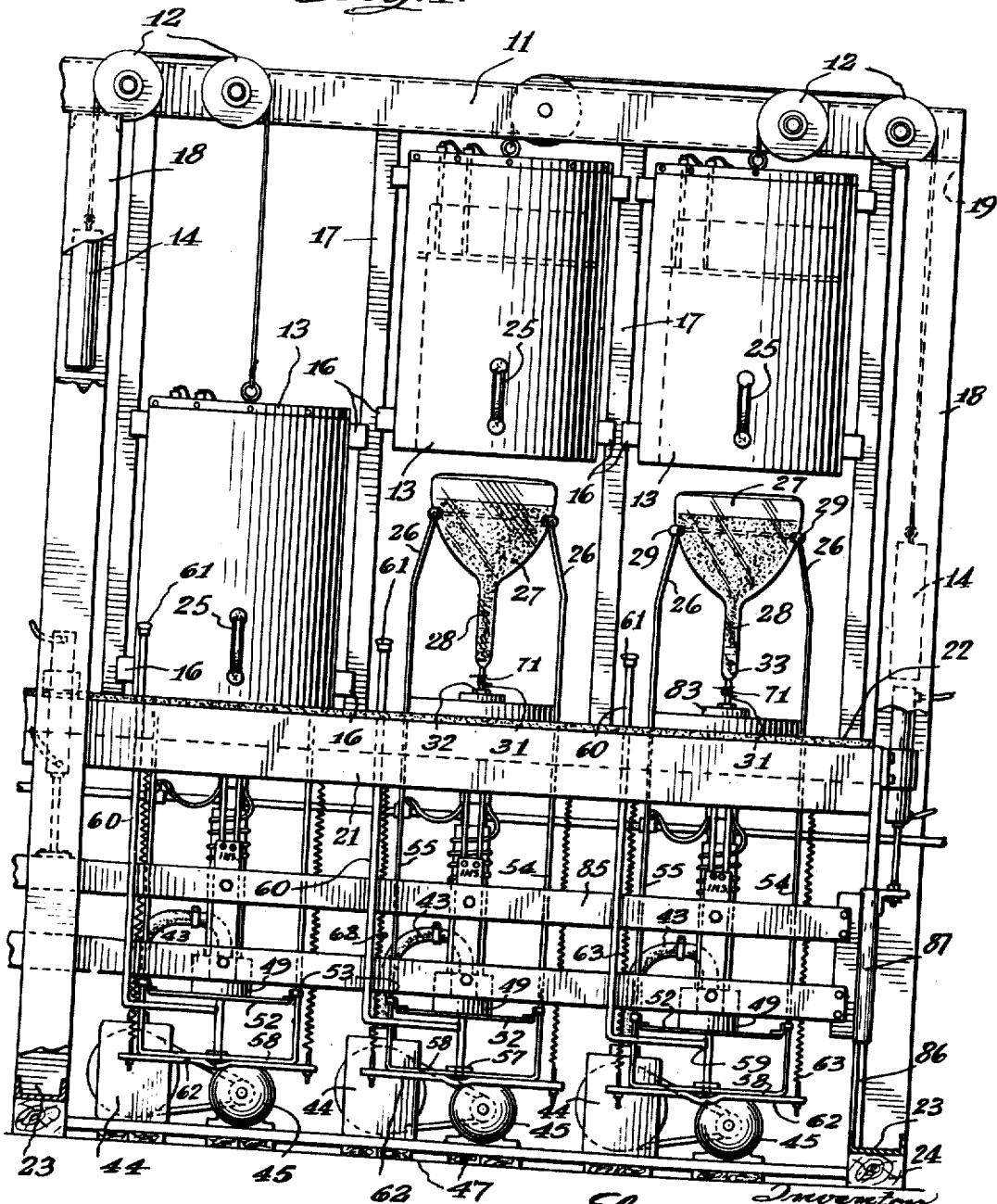
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VACUUM TUBE SEALING MECHANISM

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Fig. 1.



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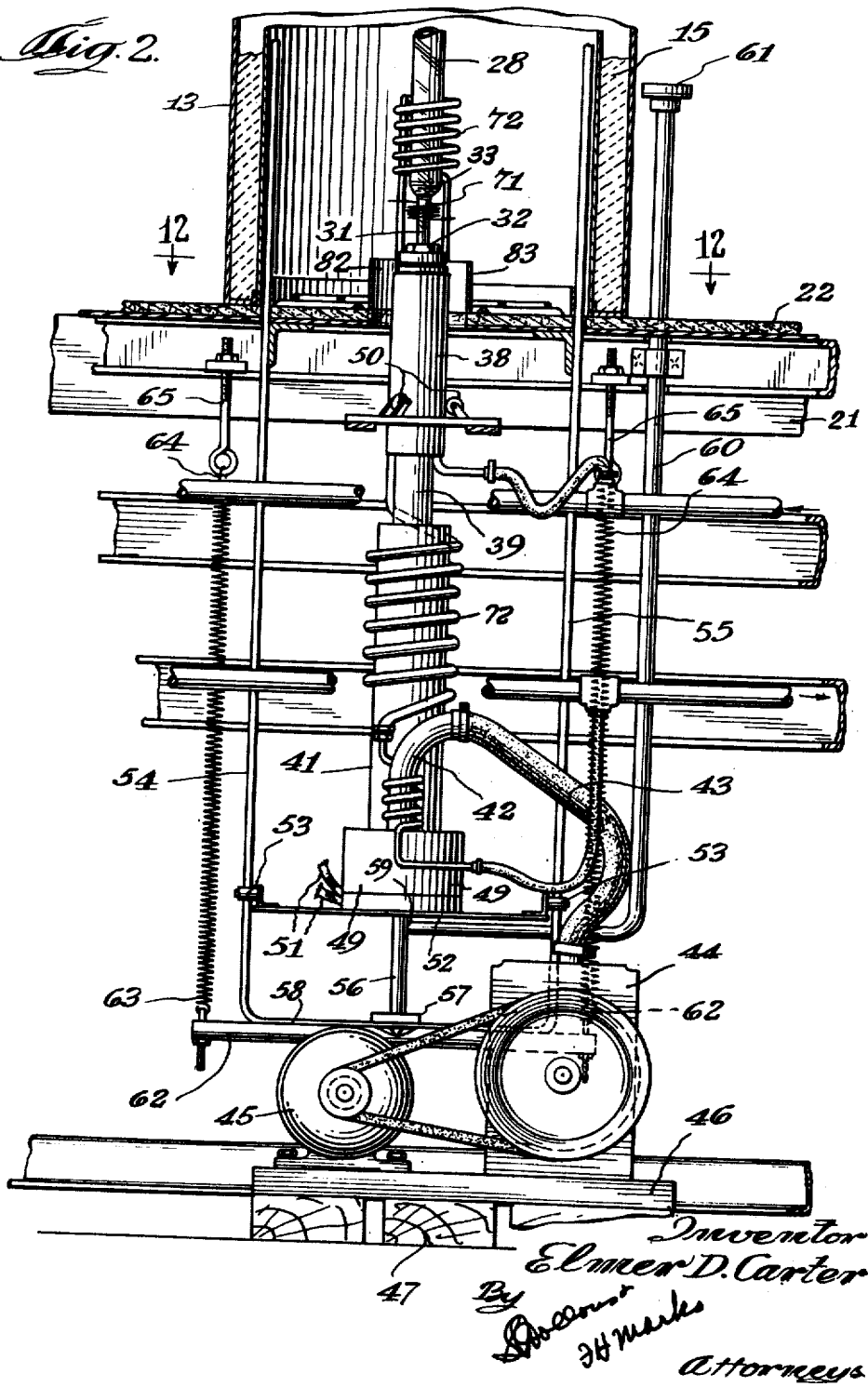
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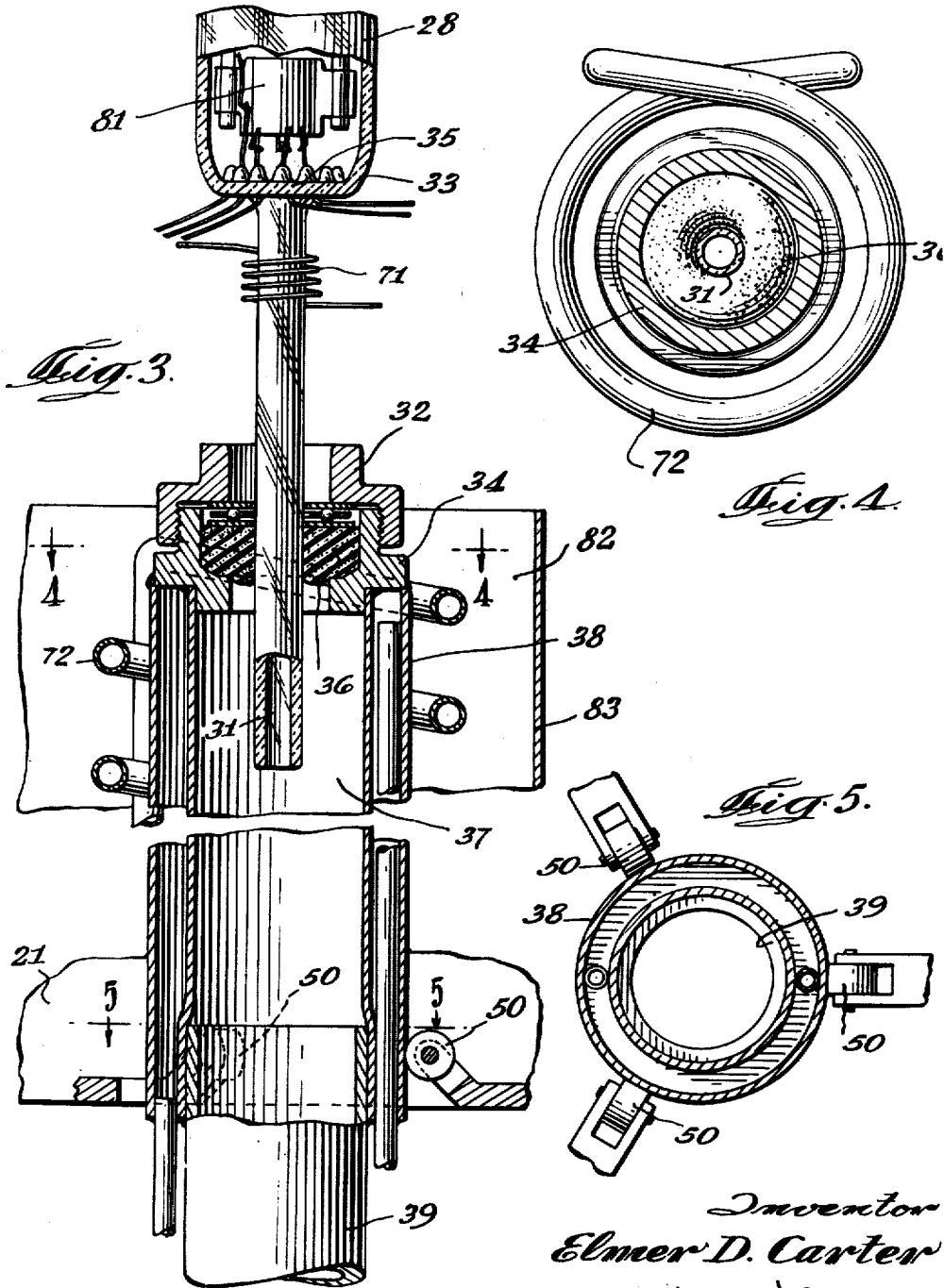
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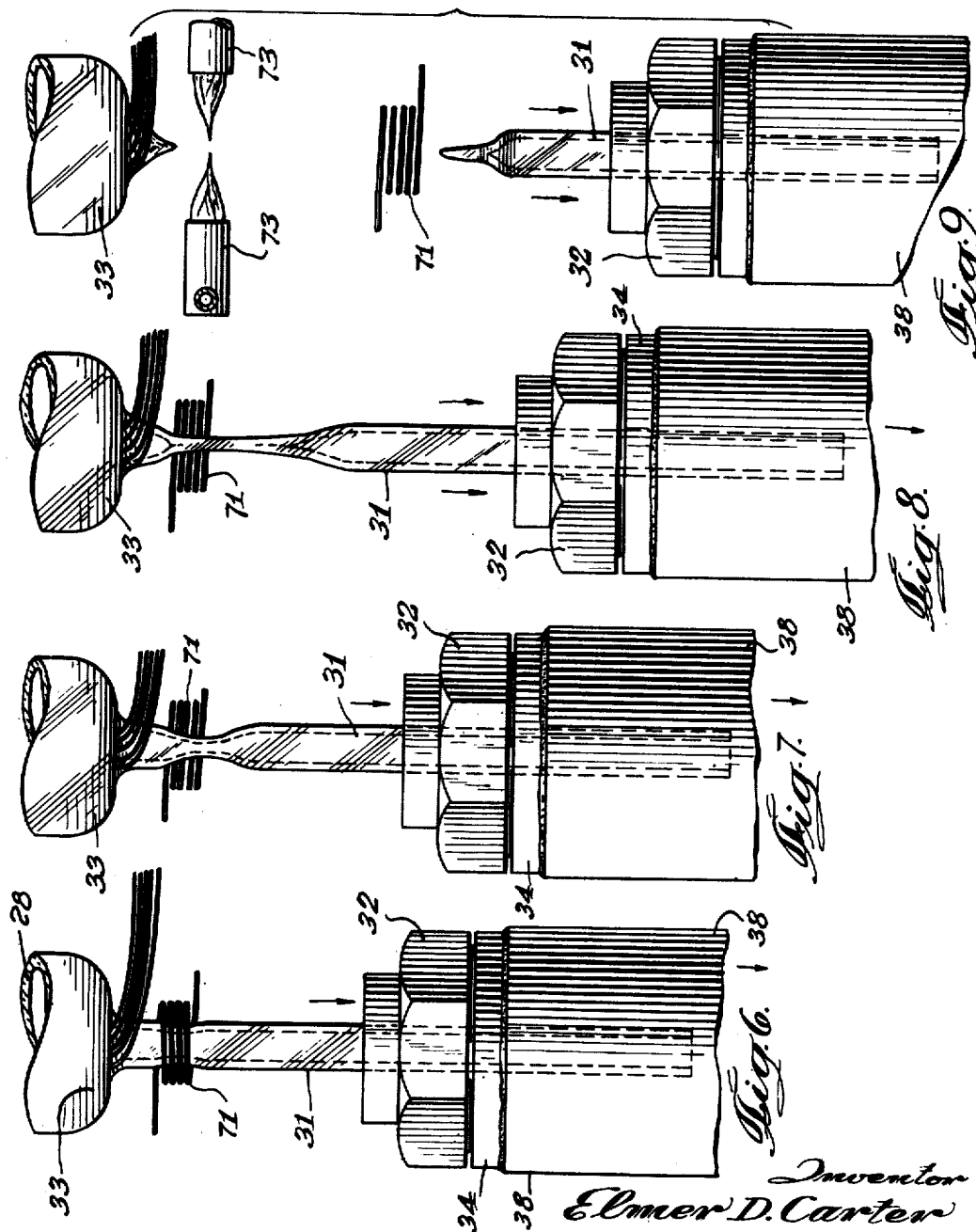
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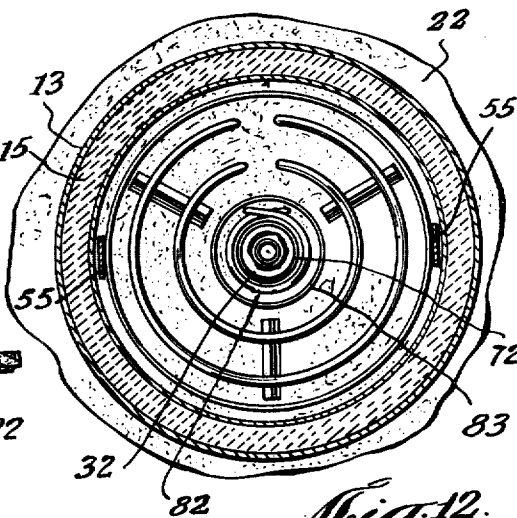
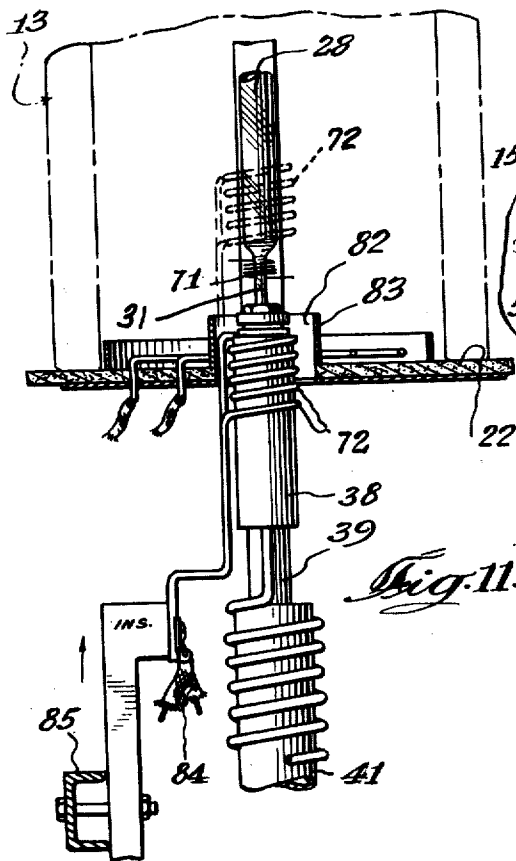
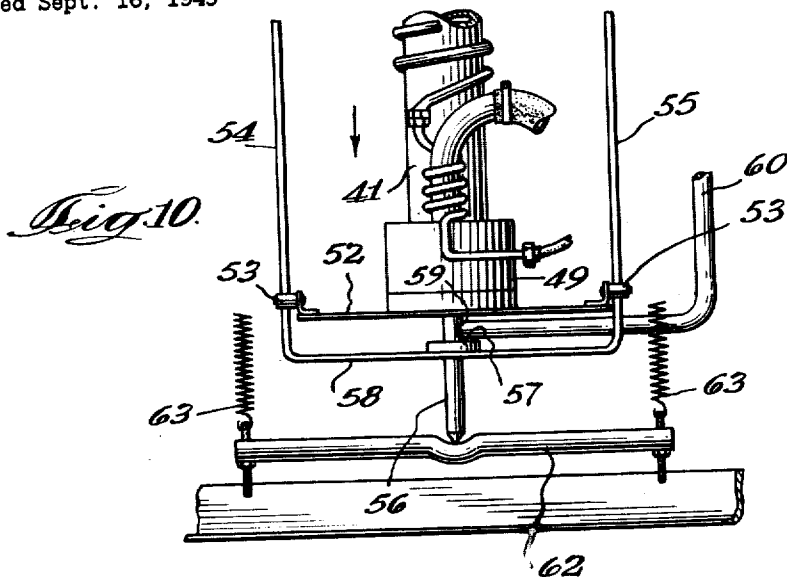
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VACUUM TUBE SEALING MECHANISM

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14 Claims. (Cl. 316—31)

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The present invention relates to improvements in apparatus for exhausting and sealing vacuum tubes.

In the manufacture of certain classes of vacuum tubes, particularly cathode ray picture screen tubes and similar glass envelopes which assume large and unwieldy proportions, there are presented divers handling problems during assembly line progression having particular reference to the successive operations of bombardment heating drive off of surface absorption and oxidation, air exhaustion, and thereafter sealing-off to effect a preservation of the established conditions within the tube. These operations may be performed at fixed stations or in a continuously moving assembly line arrangement, the principal object to be accomplished being the utilization of efficient methods in sealing-off the tubes during the optimum exhaust and heating conditions.

In the performance of the aforescribed operations, the tubes are supported on cradles or saddles in a neck-down position with their large or flared sections uppermost. While the tubes are being heated, they are preferably confined in individual jackets. The stem portions of the tubes through which the gas exhaustion is effected are connected through airtight coupling with mechanical and diffusion pump systems. When the mechanical pump which is first operated reaches a predetermined degree of exhaustion, the diffusion or aspirator attachment is initiated into operation and through its performance residual gas elements are conditioned so as to be more effectively removed by the mechanical exhaustion.

When the optimum condition of exhaustion is attained, the tube being at this time also maintained at a high heat level, it is most appropriate to seal-off and preserve the vacuum condition without further delay.

Since previous seal-off operations have contemplated the mechanical lifting away of the tube from its stem, it has been the practice to wait until the tube has cooled substantially below the 350° Cent. temperature in order to facilitate handling. With the present invention, however, the seal-off operation is consummated by all mechanical apparatus and is permitted therefore to be performed during the optimum of conditions.

In addition to the foregoing considerations, the prompt seal-off operation is a contributing factor for more efficiently utilizing the exhaust apparatus and making it available for reloading so much sooner than where cool-off time is permitted before the tube is sealed. This efficiency is manifest in several respects not the least im-

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portant of which is the investment in exhaust apparatus for a given quantity production line.

In accordance with the present invention, alternative methods have been devised for accomplishing this operation and for thereafter separating the tube from the offal stem.

Since the tube is of considerable weight and is essentially an unwieldy device to be handled even when cold, it has been found an onerous and difficult task to be performed by a single attendant in severing the seal-off tube and thereafter separating the picture bottle from it. In accordance with the present invention, therefore, it is sought to obviate these difficulties by the provision of a unique type of pump support structure and clamping chuck whereby following the seal-off operation the tube may be permitted to remain in its supporting cradle and, instead, the offal stem drawn away by the manipulation of a favorably balanced pump and chuck supporting structure that may be actuated by means of a simple offset rod.

A principal object of the present invention, therefore, is one of providing a novel type of vacuum tube exhausting apparatus in which the exhausting pump and its associated elements are rendered mobile so as to be quickly and conveniently drawn away from the tube.

Another object of the present invention is to provide a counterpoised pump and exhaust structure for vacuum tube sealing apparatus which may be manipulated by the administration of but small physical effort and which may be so counterbalanced as to draw way from the seal-off stub at precisely the correct acceleration which will attenuate the stem so as to properly produce the seal-off.

Further and additional objects of the present invention are such as will be evident during the course of the following detailed description and such as will be better understood during an explanation of the operation as will follow hereinafter. Accordingly, attention is now directed to the accompanying drawings and to the following detailed specification in both of which like reference numerals designate corresponding parts throughout, and in which:

Fig. 1 is a side elevational view of a battery frame structure in which a plurality of heat treating air exhausting and sealing-off apparatuses may be incorporated in close proximity to one another. In this figure various stations are illustrated in different positions.

Fig. 2 is an enlarged transverse sectional view of a portion of the apparatus illustrated in Fig. 1

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observed from a rearmost vantage point and featuring the exhausting pump apparatus and its related subtable structure;

Fig. 3 is an enlarged detail sectional view of the apparatus which is located adjacent the seal-off tube including the coupling chuck, its backing gland and the bombardment coil in fragmentary section;

Fig. 4 is an enlarged transverse sectional detail view taken approximately on line 4—4 of Fig. 3;

Fig. 5 is an enlarged fragmentary sectional view taken approximately on line 5—5 of Fig. 3;

Figs. 6, 7, 8 and 9 are a succession of enlarged detailed elevational views of the seal-off operation in progressive stages of advancement;

Fig. 10 is a fragmentary detail view of the counterbalancing structure featuring the manner of securing the counterpoised springs to the floating pump support framework;

Fig. 11 is an enlarged transverse sectional view of the improved apparatus featured in Figs. 2 and 10; and

Fig. 12 is a transverse sectional view taken approximately on line 12—12 of Fig. 2.

In the drawings, the reference numeral 11 designates an overhead channel framework within which are journaled a plurality of sheave wheels 12 to accommodate the overhead systems including the furnace jackets 13 and their counterbalancing weights 14.

The furnace jackets 13, see also Fig. 2, are essentially cylindrical enclosures of double thicknesses of metal between which an intervening space is filled with heat insulating material 15. The jackets are confined to parallel vertical movement by having guide projections 16 which straddle flange or guide elements 17 at convenient locations of the adjacent framework.

A plurality of vertical support channels 18 riveted to the cross channel members 19 give support to the overhead beams 11, while at table level there are provided skirting angle irons as at 21 upon which there rests a thickness of fire-resistant table covering such as the asbestos sheet 22. The upright channels 18 extend down to the floor where they rest on transverse channel members 23 preferably on cushioning blocks 24. By engaging the handles 25 on each of the furnace jackets 13 they may be raised and lowered to assume the various positions illustrated in Fig. 1.

When the jackets are in their raised positions, there may be installed upon or removed from the supporting yokes 26 the picture tube bottles 27 which theretofore have already undergone various stages of manufacturing assembly, including the installation of the gun structure into the neck 28 of the tube and thereafter the burning-off of the skirting flange as a bond is established between the neck portion 28 of the tube and the glass end wafer through which the terminal wires of the gun element protrude.

The tubes are proportioned so that they will rest with their converging or funnel shaped intermediate sections seated between the opposed arcuate segments 29 of the yoke members 26, which segments may be encased with a heat resistant and yet resilient material. While in this position, the tubes are practically centered and held at such elevation as to permit a significant length of the sealing-off stem 31 to intervene between the chuck nut 32 and the wafer generally designated by the reference numeral 33, which is the region whereat the neck 28 has been cut off

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by heat bonding with the wafer element 35, see particularly Fig. 3.

In accordance with an adaptation of packing gland illustrated in Fig. 3, the chuck nut 32 is drawn down upon a nipple section 34, and by so doing, there is applied a compression onto the resilient gland washer 36. This establishes an airtight seal between the internal chamber 37 of the water cooled sleeve 38 and the sealing-off stem 31 which is now to become separated by localized heating and attenuation treatment after a manner of practice generally resembling the heretofore known procedure.

It is to be understood that all the operations which are requisite to be performed before the sealing-off are consummated in the usual manner and that it is presumed that the next step of procedure is to effect the disjunction of the stem 31 in the sealing-off operation to permanently enclose the evacuated space within the tube proper. The space within the tube now communicates through the stem 31 with the exhaust conduit 39 which passes through a diffusion pump generally designated 41. Thereafter this communication continues out of the diffusion pump through a rigid tube 42, thence a flexible connecting tube 43 with the exhaust orifice of a mechanical pump mechanism generally indicated 44 driven by an electric motor 45.

In Fig. 2 it will be readily observed that the motor and mechanical pump are a combined unit carried by a base 46 which is rigid in the foundation structure 47. Through the flexible linkage tube 43 the exhaust communication is extended through the floating aspirator or diffusion pump 41, the supporting structure of which will now be explained.

Pump 41 consists essentially of a vapor generating base structure 48 which is made effective by heating, and a self-contained electric heating element serviced through the wires 51. The pump and all of its super-structure is carried upon a strap element or ball 52 and confined against rotation by having a pair of straddling guide rollers 53 at each side between which there passes an upstanding guide element 54 or 55. On the lower surface of the supporting strap 52 there is secured a downwardly extending rod 56 which passes through an opening in the flange 57 and cross-strap 58 and to this fulcrum rod 56 there may be secured as by welding at 59 the manipulator rod 60 which extends sidewardly and then upwardly to be capped by a convenient knob 61 suitable for manipulation. The raising and lowering of the assembly which includes the diffusion pump, the chuck nut and its cooling jacket 38, as well as the other members carried upon the base 52, is an operation which is carefully guided so as to maintain concentric alignment with the stem 31. This guidance is safeguarded not only by the rollers 53 and their guide rods 54 and 55, but also there are provided three equally spaced guide rollers 62 around the outermost sleeve 38 journaled on horizontal axes whereby the upper end of the described assembly is securely confined against any effects or forces tending towards distortion.

It will be observed that the downwardly extending rod 56 is loosely fitted after the manner of a fulcrum seating in the center of a crossbeam 63 at whose ends there are connected the lower extremities 64 of a pair of counterpoise springs, preferably of the coil type whose upper extremities 64 are carried by the adjustment eyebolts 65 through which tension may be regulated. The

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physical characteristics of the counterbalancing springs are calculated to be marginally inadequate to sustain the full weight of the aspirator pumps and the additional superstructure which is balanced on the fulcrum rods 56 and which is carried by the cross-member 62 on the indicated arrangement of weight distribution between the two springs. In this way it becomes necessary during the attachment of the chuck nut and gland 32—36 to the stem 31 for an operator to first lift the knob 61 to its full height, which is the condition shown in Fig. 2, so that the nut 32 may be disposed to engage the stem 31 at as high a point as possible leaving the maximum dimension to be utilized in the attenuation when the glass of the stem becomes softened.

The heat which is applied to the stem requires to have sufficient calorific intensity to raise the temperature of the glass to its flowing point in order to achieve the condition which has been portrayed by the successive stages of Figs. 6 to 9, inclusive. Under one mode of operation a manually held gas burner jet with two forked burner elements opposing each other has been utilized in order to first temper and then concentrate in the attainments of localized heating collapse in the wall of the stem 31. This type of burner is illustrated in Fig. 9 in which the two frames address one another effecting a maximum heat cone at a common vortex or at slightly spaced flame cone centers. In carrying on the operation with the gas flame method of treatment, close attendance is usually a prerequisite since the so-called tempering treatment requires that the adjacent areas to the collapse zone of the stem be moderately heat conditioned in order to avoid setting up severe stresses, such as are consequent from the characteristic poor heat conductivity of glass.

On the other hand, it is proposed that as an alternative treatment a heat induction coil of the high frequency type, or of any other radial heat type, be employed in which the tempering operation of a battery of stations may be regulated under a single supervision and brought up to collapse temperatures gradually enough to avoid shock stresses. This type of heating coil designated 71 may be supported in any suitable manner from adjacent conducting buses, or it may be made to perform as a disappearing coil after the manner of the bombardment helix 72 which will be discussed later.

After the temperature of the glass has been raised to the softening point, an initial manifestation of collapse, such as that shown in Fig. 7, will occur due in part to the attenuation of the tube by reason of the preponderance of weight which is designed in accordance with the characteristic of the balancing springs and partially to the air pressure differences between the outer and inner spaces.

When the attenuation has reached its maximum effects, such as that illustrated in Figs. 8 and 9, an intense localized heat device such as the gas frame apparatus 73 may be employed to effect the final parting of the two sections of the tube. Thereafter, the operator may re-establish momentary contact between the two disjoined and attenuated portions of the tube 31 to effect a closure of the remaining fissure after the glass tubing has been parted by raising the control knob 61.

Attention will now be given to an additional operation which is performed earlier in sequence to the aforescribed cut-off operation, but

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which concerns an adjunct apparatus designed to make the procedure more expeditious to perform and more precise in its results. The so-called gun structure generally designated 81 in Fig. 3 consists of a metallic assembly, including the cathode element as well as one or more anodic accelerators in concentric alignment. According to conventional practice, with this gun assembly there is also made accessory an expendable oxidation cartridge known as a "getter" which is designed to be fired for the purpose of removing gases which are given off particularly by the oxide coated cathode when that element becomes heated during the normal operation of the tube.

Before the sealing-off operation, as above described, is completed, it is considered preferred practice to raise the temperature of the entire gun structure to a measured maximum degree such that there will be driven off from all metallic surfaces foreign adherence and oxidation, but this so-called bombarding temperature must be carefully regulated so that it does not approach the degree of intensity requisite to firing the aforescribed "getter." Towards these ends there is provided the already mentioned induction heating coil or helix 72, the diameter of whose convolutions are so proportioned that they may encompass the neck 28 of the tube, while yet be small enough to be received within the dimensions afforded by an opening 82 circumscribed with an upstanding sleeve 83.

Since the so-called bombarding operations are practices which require for their successful consummation merely well engineered electrical regulation, a series of such bombardment operations can be accurately and effectively carried on simultaneously through the efforts of a single attendant. With this in mind, the table structure 22 has been so designed as to afford the disappearing recess 82 through which the coil 72 may be made to recede and the several coils for batteries of such installations may receive their high frequency power communication in parallel or over individual cables 84 carried by a common channel member 85 which is capable of being lifted in parallelism, safeguarded by the guide rods 86 and the guide sleeves 87 through which they pass.

The making of the induction coils 72 to be so manifestly convenient in their simultaneous function as well as in their simultaneous withdrawal from the fields in which subsequent operations are intended to be consummated is an achievement which has been observed to materially reduce spoilage hazards as well as to maintain consistency under high production factory processes.

While the present invention has been explained and described with reference to certain arbitrary chosen embodiments and exemplary illustrations, it will be understood, nevertheless, that numerous modifications may be incorporated without departing from the essential spirit or scope thereof. Accordingly, it is intended not to be limited by the particulars of the accompanying drawings nor by the language chosen in the foregoing description, except as indicated in the hereunto appended claims.

The invention claimed is:

1. In a tube exhausting and sealing apparatus, a fixture for supporting a tube to be evacuated in vertical position with its exhaust communicating stem downward, a carriage supporting a system of exhaust pumps and a coupling chuck in

concentric alignment with the stem of said tube, roller guides for confining said carriage and its system of pumps to vertical movement in axial alignment with said tube, counterpoise elements for supporting the weight of said carriage and its pumps, a manual lift implement for raising and lowering said carriage through a limited range of movements, and a heating element encircling said exhausting stem for raising the temperature of said stem thereat to the melting point after said tube has been exhausted of its air content by said system of pumps.

2. A production line tube exhausting and sealing apparatus comprising, a fixture for supporting a tube in vertical stem-down position, a system of exhaust pumps carried by a floating carriage in concentric alignment with the stem of said tube, a coupling chuck communicating with said system of pumps in axial alignment and said stem, guides for confining said carriage and its system of pumps in vertical movement, coil springs for supporting the weight of said carriage and its pumps, a manipulator for raising and lowering said carriage and its carried pumps, and a heating element disposable at a horizontal level transverse of said exhausting stem for thereat raising the temperature of said stem to the melting point, whereby the preponderance of weight of said carriage and pumps is utilized to alternate said stem at its level of melting point.

3. In a tube exhausting and sealing apparatus, a supporting fixture for maintaining a picture tube having a neck portion in stem-down position, apparatus to evacuate the air content of said tube while in this position, a cylindrical enclosure jacket movable vertically between tube covering and tube exposure positions, a platform at a horizontal table level having a well portion in concentric alignment with the stem of the tube, a heat radial helix of a diameter to encircle the neck portion of a tube and to be recedable into said well portion of said platform, and a second heat radial helix of a diameter adapted to encircle the stem of the tube, said first mentioned helix being adaptable to raise the temperature within the neck of the tube to a sufficient degree to effect heat bombardment of the contents within said tube neck portion and said second helix being electrically stimulated to raise the temperature of the stem portion of said tube to its melting point.

4. In a picture tube exhausting and sealing apparatus, a support for maintaining a picture tube in upright position with its exhaust stem downward, a floating assembly including an aspirator, pump, and a coupling chuck in axial alignment with the stem of said picture tube resting in said support, spring means counterbalancing the weight of said floating assembly, and a manipulator integrally associated with said assembly and extending upwardly in a vertical direction offset from the axial center of said tube and chuck alignment, for raising and lowering said assembly towards and away from said tube stem.

5. In a tube exhausting and sealing apparatus, a supporting fixture for nesting a picture tube in stem-down position, a horizontal platform at table level beneath the stem of said tube, having a well portion in concentric alignment with the tube, a bombardment coil heater adapted to encircle the neck portion of a tube and to recede into said well portion of said platform, and a radiant heater of a diameter adapted to encircle

the stem of a tube, said bombardment coil heater being to raise the temperature within the neck of the tube to a sufficient degree to effect molecular dispersion of surface absorbed gases from mechanism within the tube and said radiant heater being stimulated to raise the temperature of the stem portion of said tube to its softening point.

6. In combination, a support for maintaining picture tubes in upright position with the exhausting stems thereof downward in vertical alignment, a floating carriage assembly including a system of exhaust apparatus and a coupling chuck in axial alignment with the stem of a picture tube resting in said support, spring means counterbalancing the weight of said carriage assembly, means for raising and lowering said carriage assembly towards and away from said tube stems, and a counterbalance for a portion of the weight of said carriage assembly so that said assembly will be permitted to descend under gravitation of a portion only of its weight when the exhaust stem to which it is coupled at said chuck becomes softened.

7. In a vacuum tube exhausting apparatus, means for holding a tube envelope to be evacuated in vertical alignment with its exhaust and seal-off stem downward, a platform at table level having a well aperture in axial alignment with the stem of the tube, a system of exhaust pumps communicating with a chuck in vertical axial alignment with said stem and carried by a floating support, means for guiding said support in vertical parallel movement, a manipulator integrally associated with said support and extending sidewardly and upwardly through said platform, tension adjustable counterbalancing elements for sustaining a portion of the weight of said support and its carried elements, and an electrically controlled heater encircling to the stem of said tube between said chuck and the neck of said tube for raising the temperature of said stem to its softening point whereby the preponderance of the weight of said support and its elements will attenuate said stem as its melting point is approached.

8. An assembly line machine comprising, a table level platform, a plurality of supports on said platform for holding picture tube bottles stem-down for gas evacuation, said platform having well openings in axial alignment with the stems of said bottles when held on said supports, a plurality of radiant heating coils of a diameter which will marginally encompass the necks of picture tubes and yet be submersible in said platform well openings, and a rack traversing a plurality of said supports having electrical connections with and affording physical support for said plurality of radiant heating coils so that pluralities of picture tubes may be thereby heat treated concurrently.

9. In an apparatus for exhausting vacuum tubes the combination including, a fixture for supporting a vacuum tube in a position with its exhaust stem downward, an exhaust pump assembly for extracting the gas content of a tube thus supported, comprising a carriage supported on springs and movable through a limited distance vertically towards and away from said tube, guide rollers for confining said assembly to vertical parallel movement, and a manipulator for raising and lowering said assembly in consort with or in opposition to the effect of its springs.

10. In an apparatus for conditioning and exhausting vacuum tubes the combination includ-

ing, a saddle for supporting a vacuum tube in a vertical position with their exhaust stems downward, an exhaust pump assembly comprising mechanical and aspirator devices for extracting the gaseous content of a tube thus supported, a central fulcrum projection extending downwardly from said assembly, a balancing beam for supporting said fulcrum projection, spring means at opposite ends of said balancing beam having a distended lift tension approximating but not surpassing the weight of said beam fulcrum rod and said exhaust pump assembly at predetermined level, guide rollers for confining said assembly to vertical parallel movement, a manipulator including a handle for raising and lowering said assembly in consort with or in opposition to the effect of said spring means, and limit devices for determining the movement in a vertical direction of said assembly.

11. In a vacuum tube sealing machine, a fixture for maintaining a vacuum tube envelope in a vertical position with its exhaust communication port directed downward, a carriage supporting a coupling element for connection with said port portion and a system of exhaust pump elements confined in guide apparatus below said fixture so as to be movable in a vertical direction toward and away from a tube port of a tube resting in said fixture, weight counter-balancing means for sustaining a portion of the weight of said carriage and its supported elements, and a heating implement for softening the communication port portion of the tube whereby the preponderance of weight of said carriage and its elements may function to attenuate said port portion.

12. A production line machine for treating cathode ray picture tubes which comprises, a supporting cradle for holding a picture tube envelope in neck-down position, a system of exhaust devices for coupling to an exhaust tube extending from the neck of said picture tube, a heat implement for softening the exhaust tube, and apparatus for separating said supporting

cradle from said exhaust devices when said exhausting tube has reached its softening temperature.

13. A method of manufacturing vacuum tubes of cathode ray picture screen magnitudes which comprises supporting a tube envelope which is in readiness for exhausting and sealing with its exhausting stem downward, supporting an evacuating and exhausting system in a vertically movable confinement space beneath the envelope communicative with said stem, counterpoising the weight of said evacuating and exhausting system to resolve a marginal preponderance to said system, heating the exhausting stem to melting point after the envelope gases have been exhausted and evacuated, and structure-sealing said stem by the attenuation effect produced by the descent of said system weight preponderance.

14. A method of structure-sealing glass stem vacuum tube envelopes which comprises the steps of supporting a horizontal alignment of vacuum tube envelopes with their glass tabulation stems downward at a gas elimination station of an assembly line, connecting to each stem a gas evacuating system of apparatus which is confined for limited vertical movement and whose gross weight is partially counterpoised, heating an intermediate portion of each stem until it achieves melting temperature, and collapsing said stem portion under evacuation pressure as the weight preponderance of the system attenuated said portion to sealing structure.

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