

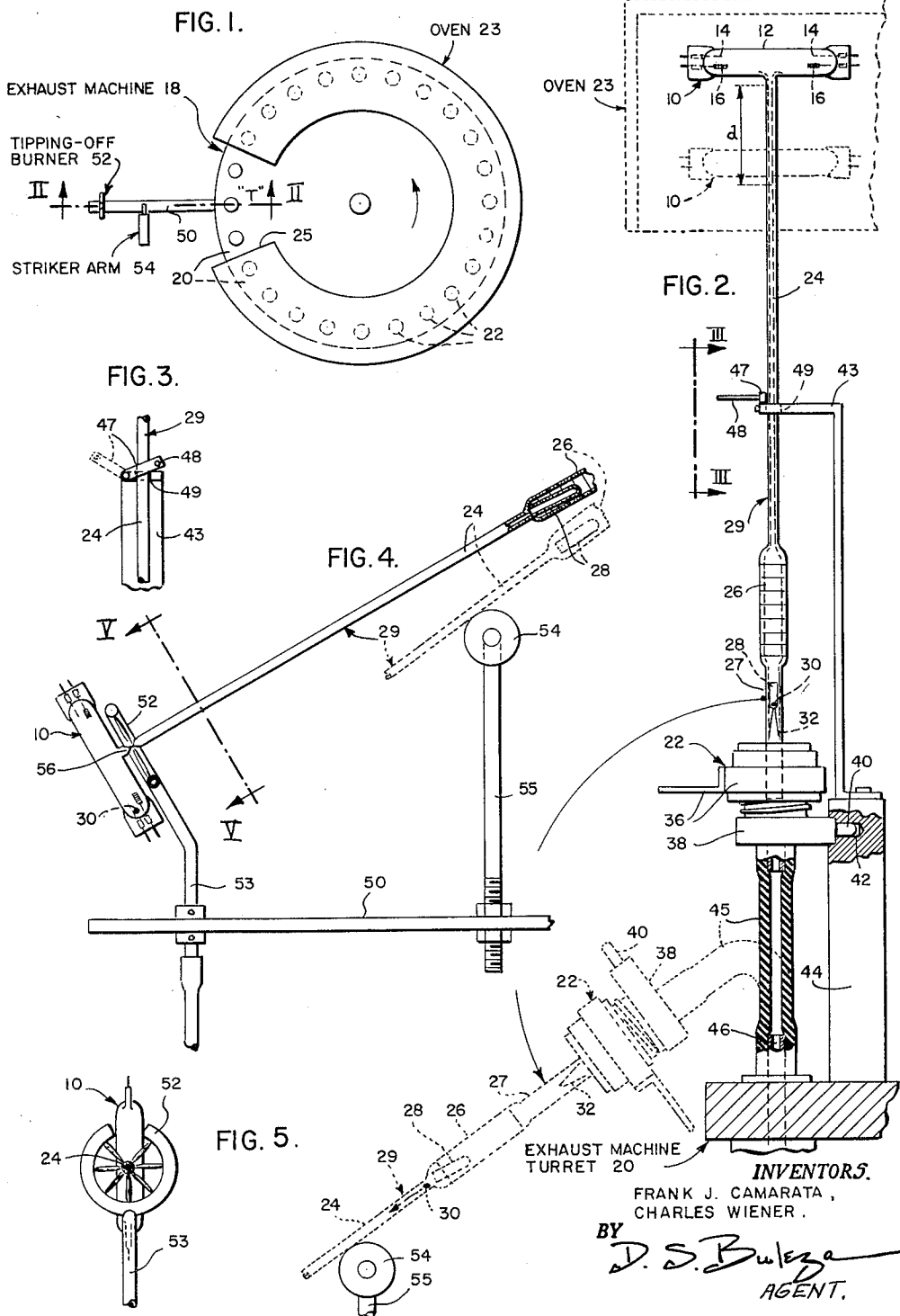
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METHOD AND APPARATUS FOR DOSING DISCHARGE DEVICES

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INVENTORS.
FRANK J. CAMARATA,
CHARLES WIENER.
BY
D. S. Bulger
AGENT.

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METHOD AND APPARATUS FOR DOSING DISCHARGE DEVICES

Charles Wiener, Bloomfield, and Frank J. Camarata, Montclair, N.J., assignor to Westinghouse Electric Corporation, East Pittsburgh, Pa., a corporation of Pennsylvania

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This invention relates to the manufacture of discharge devices and, more specifically, to a method and apparatus for dosing the arc tubes of high-pressure mercury discharge lamps.

In the manufacture of certain types of high-pressure discharge lamps a precisely measured quantity of vaporizable material such as mercury or the like is introduced into the arc tube after it has been evacuated. The quantity of mercury introduced must be precisely measured since it controls the operating voltage of the arc tube and, thus, of the finished lamp. The introduction of the mercury or so-called "dosing" operation is customarily carried out after the arc tube has been evacuated and charged with an ionizable starting gas on an automatic exhaust machine.

One method of dosing such arc tubes is to attach a vitreous exhaust-and-dosing tubulation to the arc tube and insert a capsule containing the measured charge of mercury into the lower end of the tubulation while the latter is held upright. The free end of the tubulation is then inserted into the head of an automatic exhaust machine which holds the tubulation and the attached arc tube in upstanding position. After the arc tube has been indexed through the exhaust machine and charged with starting gas, the tubulation is tipped off at a point adjacent the exhaust head and the severed arc tube and adjoining portion of the tubulation are inverted to transfer the mercury from the tubulation into the arc tube. The tubulation is subsequently severed from the arc tube at a point adjacent the arc tube by a second tipping-off operation thus sealing the mercury in the arc tube. Since the exhaust-and-dosing tubulation include a graded-seal section they are relatively expensive and for this reason are reconditioned and reused. Such reconditioning comprises rebuilding the tipped-off ends of the tubulation so that one end can be sealed to another arc tube and the other end inserted into the exhaust machine. This method of mercury dosing is described in detail in U.S. Patent No. 2,764,857, issued to G. F. Shaefer on October 2, 1956, and assigned to the assignee of the present invention.

With the foregoing in mind, it is the general object of this invention to provide an improved method for dosing an electric discharge device with a predetermined quantity of vaporizable material.

Another and more specific object is the provision of a method for dosing the arc tube of a high-pressure mercury discharge lamp while the tube is still attached to the automatic exhaust machine on which it is being fabricated.

Still another object is the provision of a method for dosing such arc tubes that requires only one tipping-off operation.

Another object is the provision of apparatus for practicing the aforesaid method, which apparatus is inexpensive, simple to construct and can be very readily incorporated in automatic exhaust machines of the type employed in fabricating such arc tubes.

The aforementioned objects, and other advantages which will become apparent as the description proceeds, are achieved according to the invention by connecting the heads to the exhaust machine by a flexible conduit, such as a rubber tube. This permits the heads to be swung out of the machine and, together with the inserted arc tube-

tubulation assemblies, to be inverted at the tipping-off station while they are still physically attached to the machine. The mercury is thus transferred from the tubulation into the arc tube while they are still connected to the machine so that only one tipping-off operation adjacent the arc tube is required. As a result only one end of the tubulation has to be rebuilt thereby reducing the manufacturing cost of the arc tubes. In addition, since the tubulations are progressively shortened at only one end with each use they last approximately twice as long as when they were tipped-off at both end resulting in a further savings in both labor and material.

A better understanding of the invention will be obtained from the accompanying drawing, wherein:

FIGURE 1 is a diagrammatic plan view of an automatic exhaust machine for fabricating high-pressure mercury discharge arc tubes in accordance with the invention;

FIG. 2 is a vertical view, partly in section, of the tipping-off station and one of the loaded exhaust heads of the machine along the reference line II—II of FIG. 1, in the direction of the arrows;

FIG. 3 is a front elevational view of the end of the retaining bracket and the associated segment of the exhaust tube taken along the reference line III—III of FIG. 2, in the direction of the arrows;

FIG. 4 is a fragmentary side elevational view of the tipping-off station of the machine showing the attached arc tube-tubulation assembly in the process of being tipped-off; and,

FIG. 5 is a fragmentary elevational view of the tipping-off burner and operation viewed along the reference line V—V of FIG. 4.

While the present invention may be advantageously employed in the manufacture of various types of sealed electrical devices such as electronic tubes or the like, it is especially adapted for use in conjunction with the manufacture of arc tubes for high-pressure mercury discharge lamps and it has accordingly been so illustrated and will be so described.

Apparatus

As shown in FIG. 2, the arc tube 10 is of conventional design and consists, in general, of a tubular envelope 12 of quartz or the like that is sealed at each end and contains a pair of auxiliary starting electrodes 14 and a pair of main electrodes 16 anchored in the press seals. To facilitate the exhaust, gas-filling and mercury-dosing operations, a section 24 of quartz tubing is sealed to the arc tube 10 and to a graded-seal 26 which is, in turn, fused to a length 27 of hard glass such as "Nonex" or the like. The aforesaid section of quartz tubing serves as an exhaust tube and the graded-seal and hard glass sections together comprise a vitreous hollow dosing assembly. The combination of these elements, in turn, provides an exhaust-and-dosing tubulation 29 that is attached to and depends laterally from the arc tube, as is illustrated in FIG. 2.

The embryonic arc tubes are evacuated and filled with an ionizable starting gas such as argon by means of an automatic exhaust machine 18 of the type shown diagrammatically in FIG. 1. As there shown, such machines consist in general of a rotatable turret 20 that is mounted on a frame (not shown) and is indexed through a series of exhaust and gas-filling stations. The turret is provided with a plurality of spaced exhaust heads 22 that are disposed around the periphery of the turret and centrally located with respect to an annular oven 23 that is attached to the frame and located a predetermined distance above the turret. Such automatic exhaust machines are well known in the art and are so constructed that partly fabricated arc tube assemblies inserted into and carried by each of the exhaust heads 22 are subjected to a predeter-

mined exhaust schedule and charged with starting gas as they are indexed through the machine to the last position which comprises a tipping-off station, designated by the reference character "T" in FIG. 1.

Returning to FIG. 2, it will be noted that the depending exhaust-and-dosing tubulation 29 is of such length that the arc tube 10 is substantially horizontally disposed in the upper portion of the oven 23 when the open or lower end of the tubulation 29 is inserted into the exhaust head 22.

The exhaust head 22 is of conventional design and comprises a rotatable housing 36 that contains a compression rubber (not shown) and is threadedly coupled to a male member 38. This male member is provided with a pin 40 that fits into an aperture 42 in an alignment stud 44 attached to the turret 20. The male member 38 is accordingly held stationary by the engaged pin so that when the housing 36 is rotated in the proper direction the compression rubber firmly grips the inserted end of the tubulation 29 and effects an hermetic seal therewith. In contrast to the prior art exhaust machines the nipple on the exhaust head 22 according to the present invention is connected to the nipple extension 46 of the exhaust port of the machine by a flexible conduit 45, such as a rubber tube or the like, as shown in FIG. 2. Thus, when the arc tube-tubulation assembly is inserted into and hermetically gripped by the compression rubber in the exhaust head 22 it is connected to the exhaust port of the machine 18 by means of the flexible conduit 45. This permits both the head 22 and the arc tube assembly to be pulled out of the machine and inverted without disconnecting them from the vacuum system.

In order to maintain the tubulation 29 in substantially vertical position while the arc tube is on the turret 20 the quartz exhaust tubing 24 is seated in the slotted end of an L-shaped bracket 43 that is fastened to the stud 44 or the turret. The bracket is of sufficient length that the quartz tubing is held at a point sufficiently remote from the exhaust head 22 to maintain the arc tube-tubulation assembly rigid and upright as it is indexed through the exhaust machine 18.

As shown in FIG. 2, and more particularly in FIG. 3, a locking device such as a hinged latch 47 having a lever 48 is attached to the laterally extending end portion of the bracket 43 to retain the tubulation 29 in an upright position after it is inserted into the slot 49 provided in the end of the bracket.

As will be noted in FIG. 2, the aligning stud 44 and retaining bracket 43 are located on the inboard side of both the arc tube-tubulation assembly and the head 22 so that the latter can be swung as a unit out of the machine away from the turret 20 when the locking latch 47 is opened and the head 22 is at the tipping-off station "T" (see FIG. 1). An opening 25 in the oven 23 is also provided at this station, as shown in FIG. 1, to allow the arc tube to be withdrawn in the manner described.

Each of the heads 22 of the exhaust machine 18 are provided with a flexible conduit, an aligning stud, a retaining bracket, etc., and are identical with the head described. The heads and the aforesaid auxiliary components are indexed through the various positions of the machine 18 by the turret 20.

As shown in FIG. 1, and more particularly in FIGS. 4 and 5, a support 50 attached to the frame or other suitable stationary part of the exhaust machine 18 is also provided at the tipping-off station "T" and extends radially outward from the machine. A padded laterally-extending striker arm 54 is attached to and held at a predetermined height above the support 50 by means of an upright 55 (see FIG. 4). At a predetermined distance beyond the striker arm 54 an annular tipping-off burner 52 is attached to the support 50 by a length of metal tubing 53 that is bent so as to tilt the burner a predetermined angle away from the vertical toward the free end of the support 50 (as shown in FIG. 4) and is connected to a

suitable gas supply (not shown). The burner 52 also opens upwardly, as shown in FIG. 5.

The striker arm 54 is located a predetermined distance below and beyond the exhaust heads 22 when the latter are sequentially positioned at the tipping-off station "T" as shown in FIG. 2, and the tipping-off burner 52 is located a predetermined distance below and beyond the striker arm 54, as shown in FIG. 4. Moreover, the support 50, the striker arm 54 and the tipping-off burner 52 are in substantial alignment with and adjacent to the tipping-off station "T" of the exhaust machine 18, as is shown in FIG. 1.

Method of dosing

After the exhaust tube portion 24 of the arc tube 10 is sealed to the vitreous dosing assembly consisting of the conjoined graded-seal 26 and hard glass tube 27 to form the tubulation 29, the resultant assembly is held in an upright position with the open end of the tubulation facing downwardly. A capsule 28 (see FIG. 2) containing a measured amount of mercury 30 is then inserted into the lower end of tubulation 29 and retained therein by means of a V-shaped metal clip 32. The arc tube-tubulation assembly is then inserted vertically into the empty exhaust head 22 of the exhaust machine 18 at the tipping-off station "T" and clamped therein by actuating the housing 36. The quartz tubing 24 or upper end of the tubulation 29 is concurrently seated and locked in the slotted end of the retaining bracket 43. The arc tube assembly is then indexed through the machine 18 and the oven 23 and evacuated and filled with ionizable starting gas in the usual manner through the tubulation 29 and flexible conduit 45.

When the arc tube assembly reaches the tipping-off station "T" the locking latch 47 is raised and the arc tube 10, attached tubulation 29 and the head 22 are pulled out of the machine and swung as a unit through an arc by bending the flexible conduit 45 until the assembly is inverted. In other words, the flexible conduit 45 is bent through an angle, approximately 110° or 120° for example, such that the arc tube-tubulation assembly and the attached head 22 together with the adjoining portion of the flexible conduit are swung as a unit out of the machine (and about an axis that passes through the bent portion of the conduit) until they occupy the inverted position shown in broken outline in FIG. 2. The arc tube is thus located below the vitreous tubulation 29 whereupon the freely contained capsule 28 in the hard glass section 27 falls into the graded-seal portion 26 and the contained charge of mercury 30 is transferred by gravity from the tubulation into the arc tube, as indicated by the arrow in the broken line portion of FIG. 2.

To insure that all of the mercury 30 falls into the arc tube 10 the tubulation 29 is preferably mechanically shocked by gently tapping it against the padded striker arm 54 after the assembly has been inverted, as shown by the broken line portions of FIGS. 2 and 4. The capsule 28 is retained in the graded-seal section 26 insofar as the diameter of the exhaust tubing 24 is smaller than that of the capsule.

After all of the mercury 30 has dropped into the arc tube 10 the arc tube-tubulation assembly is raised slightly and the portion of the exhaust tubing 24 immediately adjacent the arc tube is inserted into the annular burner 52 and tipped-off, as shown in FIGS. 4 and 5, to form a short seal tip 56. The severed portion of the vitreous exhaust-and-dosing tubulation 29 is then removed from the exhaust head 22 and the latter is swung back into its original position in the machine above the turret 20. The tubulation 29 is subsequently rebuilt and sealed to another arc tube and reloaded with mercury and the above-described cycle is repeated.

In order to prevent opening the exhaust system to the atmosphere and contaminating it, the arc tube-tubulation assembly is preferably isolated from the system as

by a pinch clamp (not shown) on the machine before the arc tube is tipped-off.

Since the sealed tip is discarded the length of the dosing-and-exhaust tubulation 29 decreases each time the tubulation is reconditioned. When the decrease in length is such that the tubulation is shorter by a total distance "d" (see FIG. 2) and the arc tube is located in the lower portion of the oven 23, as shown by the broken outline of the arc tube in FIG. 2, then a new length of quartz tubing 24 is substituted for the short one. However, since only one tipping-off operation is required in accordance with this invention the composite tubulation 29 can be used approximately twice as long as heretofore before any such major reconstruction is required.

It will be appreciated from the foregoing that the present invention constitutes an improvement over the dosing method and apparatus disclosed in the aforementioned U.S. Patent No. 2,764,857 of Schaefer wherein a second tipping-off operation is employed to physically separate the arc tube tubulation assembly from the exhaust machine so that the assembly can be inverted preparatory to dosing. The present invention accordingly not only provides a more efficient method and apparatus for mercury dosing such arc tubes but markedly reduces the amount of labor and quartz tubing required to recondition the tubulations and, thus, proportionately reduces the manufacturing cost of the arc tubes.

While one embodiment has been illustrated and described in detail, it will be obvious that various modifications in both the method and apparatus can be made without departing from the spirit and scope of the invention. For example, while the invention has been described with reference to dosing the arc tube of a high-pressure mercury discharge lamp with a predetermined quantity of mercury, it will be obvious to those skilled in the art that it can also be used to dose such arc tubes or similar devices with predetermined quantities of other vaporizable materials such as zinc, cadmium or the halides of various metals, either in powdered or solid form. Moreover, metallic as well as vitreous exhaust-and-dosing tubulations can also be employed providing they are made of a material that can be hermetically sealed off and readily severed.

We claim as our invention:

1. In the manufacture of an electrical device, the method of introducing a predetermined quantity of material into said device before it is sealed, which method comprises, placing the material in a tubulation that is attached to and extends downwardly from said device, connecting the free end of said tubulation to a flexible conduit that is connected to an exhaust system, exhausting said device through said tubulation and conduit, temporarily deforming said flexible conduit and swinging said device and the attached tubulation about a predetermined axis that is spaced from and is so oriented with respect to said device that the device and the portion of said tubulation containing said material are inverted and said material is transferred by gravity into said device while it is still connected to the exhaust system, and then hermetically sealing off and severing said tubulation while said device is in such inverted position thereby to retain the transferred material in said device and disconnect the latter from the exhaust system.

2. The method of dosing an arc tube with vaporizable material during the regular sequence of operations required to fabricate said arc tube, which method comprises, sealing a vitreous tubulation to said arc tube, orienting said arc tube so that said tubulation points downwardly, placing a measured quantity of the vaporizable material into said tubulation, connecting the free end of said downwardly extending tubulation to an exhaust system with a flexible conduit, exhausting said arc tube through said tubulation and conduit, bending said flexible conduit and swinging said arc tube and tubula-

tion as a unit about a predetermined axis that is spaced from and is so oriented with respect to said arc tube that the arc tube is inverted and the vaporizable material gravitates from the tubulation into the arc tube while the latter is still physically connected to the exhaust system by said flexible conduit, and then tipping-off said vitreous tubulation while said arc tube is retained in such inverted position thereby to seal the vaporizable material in said arc tube and sever the tube from said tubulation.

3. In the manufacture of an electrical device having an envelope with a depending exhaust tube, the method of evacuating and introducing a predetermined amount of vaporizable material into said envelope before it is sealed, which method comprises; connecting said exhaust tube to a hollow dosing assembly that contains said predetermined amount of vaporizable material and extends downwardly from said exhaust tube and is swingable from such position, connecting said swingable dosing assembly to an exhaust system, evacuating said envelope through the exhaust tube and downwardly extending dosing assembly, swinging said dosing assembly and the attached envelope and exhaust tube as a unit about a predetermined axis that is spaced from and is so oriented with respect to said envelope that said envelope is located below the contained charge of vaporizable material and the latter is transferred by gravity into said envelope while it is still physically connected to the exhaust system, and then severing and hermetically sealing off said exhaust tube while said envelope is in such lowered position thereby to seal the transferred vaporizable material within the detached envelope.

4. In the manufacture of an arc tube for a high-pressure vapor discharge lamp, the method of evacuating said arc tube and dosing it with a predetermined quantity of vaporizable material before it is sealed off from the atmosphere, which method comprises; sealing a section of vitreous tubing to said arc tube, connecting the free end of said tubing to a hollow dosing assembly that contains said predetermined amount of vaporizable material and extends downwardly from said tubing and is swingable from such position, connecting said swingable dosing assembly to an exhaust system, evacuating said arc tube through said vitreous tubing and downwardly extending dosing assembly, swinging said dosing assembly and the attached arc tube and vitreous tubing as a unit about a predetermined axis that is spaced from and is so oriented with respect to said arc tube that said arc tube is located below the contained charge of vaporizable material and the latter falls into the arc tube while said tube is still physically connected to the exhaust system, and then severing and hermetically sealing off said vitreous tubing while said arc tube is in such lowered position thereby to seal the transferred vaporizable material within the detached arc tube.

5. In an exhaust machine for fabricating arc tubes adapted for use in high-pressure vapor discharge lamps, the combination of; a support structure, an exhaust head having means for receiving and compressively gripping a tubulation, means for evacuating an arc tube including a port mounted on said support structure, and means swingably connecting said exhaust head to said port and adapted to permit said head to be swung relative to said port and support structure through an angle such that the head can be inverted without physically disconnecting it from the exhaust machine.

6. In an automatic exhaust machine that includes a frame and a rotatable turret that is provided with a plurality of exhaust ports and indexes through a plurality of work stations, the combination which comprises, an exhaust head for each of said exhaust ports, a flexible conduit connecting each of the exhaust heads to the respective exhaust ports and adapted to permit said heads to be swung away from said turret into an inverted position and subsequently returned to its original position

in the machine, and means on said turret for releasably retaining each of said swingable exhaust heads and the adjoining portion of the associated conduit in an upright position at the periphery of said turret when an exhaust tubulation is inserted into the respective heads.

7. The automatic exhaust machine set forth in claim 6 wherein, said retaining means comprises a pin attached to each of said swingable exhaust heads, an aligning stud mounted on said turret on the inboard side of each of said exhaust heads and having an aperture dimensioned and disposed to receive said pin when the respective heads and adjoining portions of said flexible conduits are in predetermined upright relationship with respect to said turret, an upstanding bracket carried by said turret and located on the inboard side of each of said exhaust heads, and means on the free end of bracket for receiving an exhaust tubulation inserted into said exhaust head and releasably holding said tubulation in upstanding relationship with respect to said turret.

8. The automatic exhaust machine set forth in claim 7 wherein, said machine includes a tipping-off station, and a tipping-off burner and a laterally extending striker arm are attached to a stationary part of the

machine and disposed below the respective exhaust heads and in substantial alignment with said tipping-off station.

9. In an exhaust machine, the combination of an exhaust head, a flexible conduit connecting said exhaust head to the exhaust system of said machine and adapted to permit said head to be swung out of the machine and inverted and then be returned to its original position in the machine, and means stationary with respect to said swingable exhaust head for releasably retaining a device tubulation inserted into said head in upstanding position relative to said head.

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20 FRANK E. BAILEY, *Primary Examiner.*

TRAVIS S. McGEHEE, *Examiner.*