Jan. 12, 1960 M. F. SKINKER 2,920,430

APPARATUS FOR LOADING SHEATHED WIRE HEATING UNITS

Filed May 12, 1958

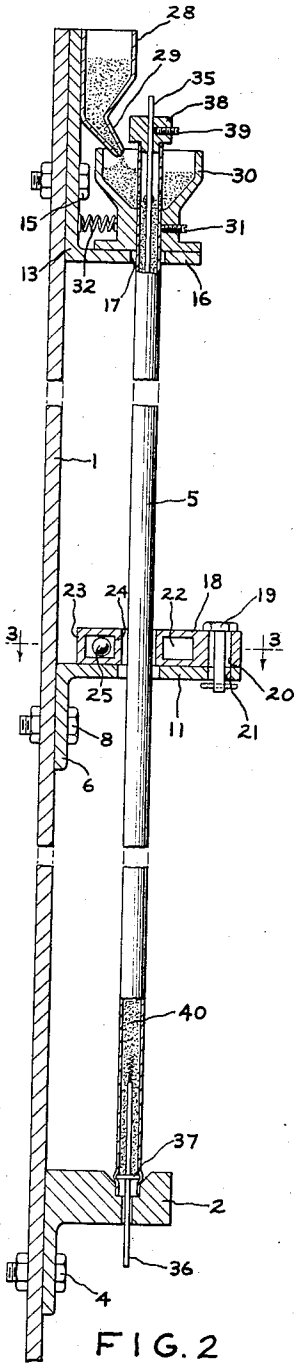


FIG. 2

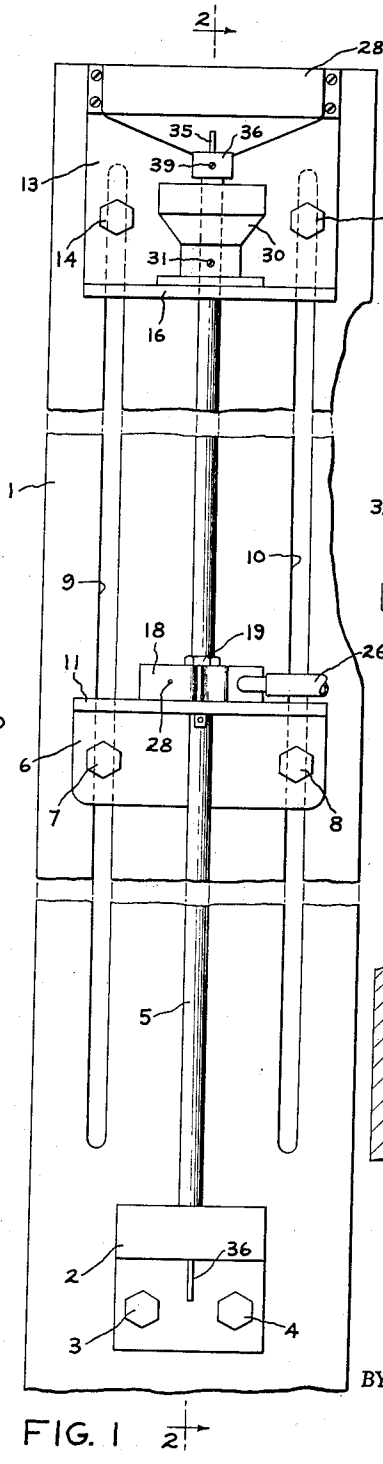


FIG. 1

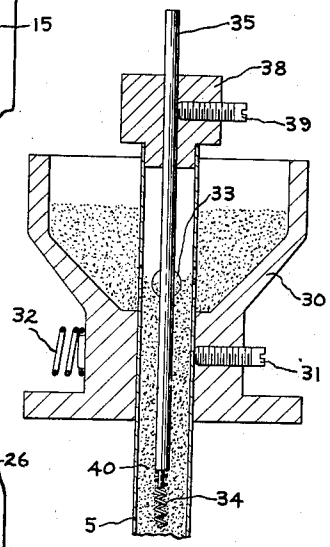


FIG. 4

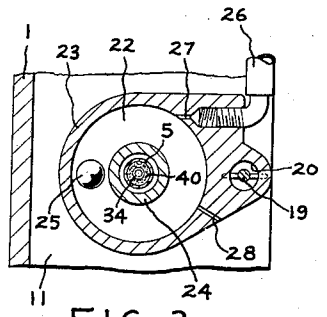


FIG. 3

INVENTOR.
MURRAY F. SKINKER

BY T. G. Dysart

HIS ATTORNEY

United States Patent Office 2,920,430
Patented Jan. 12, 1960

2,920,430

APPARATUS FOR LOADING SHEATHED WIRE HEATING UNITS

Murray F. Skinker, Cedar Point, Mich., assignor to General Electric Company, a corporation of New York

Application May 12, 1958, Serial No. 734,771

4 Claims. (Cl. 53—126)

This invention relates to apparatus for manufacturing sheathed wire heating units, and more particularly to apparatus of this character especially suited to the manufacture of heating units having a tubular sheath of relatively small diameter as compared with the diameter of the resistance element supported therein.

Electric heating units of the type to which this invention pertains comprise a resistance element encased within a tubular sheath, the resistance element being imbedded in and held in spaced relation with the sheath by means of electrically insulating heat refractory and conducting material such as powdered magnesium oxide. One electric heating unit of this type is disclosed in U.S. Patent No. 1,367,341 to C. C. Abbott, granted February 1, 1921.

Heating units of the type described in the foregoing paragraph are, in current practice, commonly manufactured by means of apparatus of the general type disclosed in U.S. Patent No. 2,032,957 to A. H. Simmons, granted March 3, 1936. Such apparatus includes means for holding the sheath in a substantially upright position, means for holding the terminals of the resistance element in proper relation to the sheath, i.e., suspended along the vertical center line of the sheath, and means for feeding to the upper end of the sheath powdered magnesium oxide at a regulated rate. In order to maintain the resistance element in centered relation with respect to the sheath, an elongated tube larger than the resistance element but smaller than the inner diameter of the sheath is lowered into the sheath at the beginning of the filling operation and is then progressively withdrawn as the level of the insulating material rises within the sheath. Also, in order to compact the insulating material a reciprocating vibrating device is associated with the exterior surface of the sheath so as to continuously tap the unit as the loading operation proceeds.

While manufacturing apparatus of the type disclosed in the Simmons patent has proved to be highly useful, such apparatus is not completely satisfactory for the manufacture of sheathed heating units in which the sheath is of relatively small diameter as compared with the diameter of the resistance element supported therein. Particularly in recent years sheathed heating units of progressively smaller diameters have proved to be highly useful, and the demand for such small diameter heating units is increasing. At the time the Simmons patent was granted, heating units having a tubular sheath of an outside diameter of 0.315 inches were being produced; at the present time large quantities of heating units having a sheath diameter of 0.238 inches are being manufactured, and it appears that a substantial demand may exist in the future for heating units having a sheath diameter as small as 0.150 inches. Electric heating units of such small diameters must be manufactured in such a way that the resistance element is almost perfectly centered within the sheath because if this relation is not maintained it is apparent that the resistance element will

not be insulated from the sheath and that a short circuit may result.

Accordingly, an important object of the present invention is to provide a method and apparatus for loading sheathed wire heating units capable of producing heating units of substantially smaller sheath diameter than can be produced with the methods and apparatus now known to the art.

Another object of this invention is to provide a method and apparatus for loading sheathed wire heating units in which centering tubes and similar devices adapted to be lowered within the sheath may be completely eliminated.

Another object of this invention is to provide a method and apparatus for loading sheathed wire heating units in which the resistance element of the heating unit may be centered within the heating unit sheath solely by means of repetitive vibratory forces applied to the external surfaces of the sheath.

Further objects and advantages of this invention will become apparent as the following description proceeds, and the features of novelty which characterize the invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

Briefly stated, in accordance with one aspect of this invention I provide means for supporting a tubular heating unit sheath for limited transverse movement, means for supplying powdered insulating material to the sheath at a predetermined rate, and vibratory means for applying a repetitive circumferentially moving radial force to the sheath at a non-harmonic frequency of vibration, preferably greater than the natural frequency of the sheath, so as to maintain the resistance wire within the sheath in a centered position with respect to the inner wall of the sheath and also to compact the insulating material as it is supplied to the sheath. The essential steps of the method of my invention include the mounting of a tubular sheath so that it is free to move to a limited extent transverse to its axis along the portion thereof intermediate its ends, and the application of a repetitive circumferentially moving radial force to the sheath at a non-harmonic frequency of vibration preferably greater than the natural frequency of the sheath, as the dispensing of the powdered insulating material to the sheath proceeds.

For a better understanding of this invention reference may be made to the following description and the accompanying drawing in which:

Fig. 1 is a front elevation view of apparatus embodying my invention.

Fig. 2 is a sectional view taken along the line 2—2 in Fig. 1.

Fig. 3 is a sectional view taken along the line 3—3 in Fig. 2.

Fig. 4 is an enlarged fragmentary view of a portion of the apparatus as shown in Fig. 2.

Referring to the drawing, the numeral 1 designates a vertically disposed frame member upon which the various components of my invention may be mounted. A fixed supporting bracket 2 is secured, by means of bolts 3 and 4 for example, to the lower end of frame member 1 so as to provide a fixed support for the lower end of a tubular sheath 5 to be loaded in the apparatus. An intermediate bracket 6 is also mounted on frame 1, it being observed that this bracket is supported by means of bolts 7 and 8 which extend through vertical slots or guides 9 and 10 in frame 1 so that the position of bracket 6 may be adjusted vertically along the length of the frame member. Bracket 6 includes a shelf portion 11 provided with an opening 12 therein of somewhat larger diameter than the diameter of sheath 5, so that the sheath is permitted limited transverse movement along the intermediate portion of its length.

Also mounted on base member 1 is an upper bracket 13 which is mounted for vertically adjustable movement by means of bolts 14 and 15 extending through vertical slots 9 and 10 respectively. Bracket 13 also includes a shelf portion 16 provided with an opening 17 through which sheath 5 extends when mounted in position for loading. Opening 17 is slightly larger in diameter than the diameter of sheath 5, so that the upper end of the sheath is free for very limited transverse movement during loading operations.

It will be understood that brackets 6 and 13 are adjustably mounted on frame member 1 so as to permit the loading of sheaths of various lengths, it being also understood that sheath 13 is clamped at a height such that the upper end of sheath 5 extends through opening 17 in shelf portion 16, and that bracket 6 will ordinarily be vertically located so that shelf portion 11 is positioned at approximately the mid-portion of sheath 5.

Shelf 11 is adapted to carry a vibratory device generally designated by the numeral 18, this device being supported on the shelf for limited movement transverse to the axis of sheath 5 by means of a stud 19 extending through a hole 20 in device 18 and a hole 21 in the shelf at least one of which is somewhat larger than the shank of stud 19.

Vibratory device 18 includes a housing arranged to surround sheath 5 to as to provide an annular chamber 22 encircling the sheath. Annular chamber 22 is formed by the top and bottom walls of vibratory device 18 and by concentric cylindrical walls 23 and 24, the latter wall having an inner diameter which is preferably larger than the outer diameter of sheath 5 but smaller than the diameter of opening 12 in shelf 11. Housed within annular chamber 22 is a rotatable member, such as a metal ball 25, which is arranged to rotate within annular chamber 22 at relatively high speeds. The mass of ball 25 relative to the masses of the housing of vibrator 18 and the sheath 5 is sufficiently high to effect some transverse movement of the sheath when the ball rotates at speeds approaching or higher than that corresponding to the natural frequency of the sheath. Force for rotating ball 25 around its orbit within the annular chamber may be supplied by a jet of compressed air delivered through a flexible hose 26 connected at one end to a supply of compressed air (not shown) and at the other end to an orifice 27 in side wall 23 of the annular chamber. It will be noted that orifice 27 is aligned so as to direct a stream of air substantially tangentially with respect to the path of travel of ball 25 so that when air is delivered to the chamber the ball may be caused to rotate within the chamber at high speed. An exit aperture 28 is provided in side wall 23, this aperture being arranged so that exhausted air from the annular chamber does not interfere with rotary movement of ball member 25. From the description thus far it will be evident that when compressed air is supplied to vibratory device 18, the resulting high speed rotary movement of ball 25 (which may be varied by varying the pressure of air supplied to chamber 22) will cause the device to move in an eccentric pattern so as to impart a repetitive circumferentially moving radial force to sheath 5.

In order to provide a regulated supply of powdered insulating material to sheath 5, a hopper 28 is secured to bracket 13 so as to be capable of dispensing powdered insulating material to the upper end of sheath 5. Hopper 28 is provided with a nozzle 29 which is positioned so as to deliver insulating material to a filler cup 30 which rests on shelf 16 and may be removably secured to the upper end of sheath 5 by means of a set screw 31, for example. It will be understood that other suitable dispensing means, such as the arrangement disclosed in the aforementioned Simmons patent, may be utilized to regulate the flow of insulating material into the sheath. Filler cup 30 may be utilized as a means for centering

sheath 5 within aperture 17 of shelf 16, a spring 32 secured at one end to bracket 13 and at the other end to cup 30 being provided for this purpose. In the present embodiment, powdered insulating material enters sheath 5 through one or more apertures 33 drilled in the end portion of the sheath (this portion of the sheath is cut off at a later stage of the manufacturing process). In loading sheaths of relatively small diameter as compared with the diameter of resistance element therein, it has been found that utilization of holes in the sheath for this purpose is more desirable than an arrangement in which at least a portion of the upper end of the sheath is maintained open so as to receive the insulating material. However, the illustrated embodiment of my invention is by way of illustration and example only, and any suitable arrangement for introducing powdered insulating material into the upper end of the sheath may be utilized.

Before describing the operation of my invention, the structure of the electric heating unit of which tubular sheath 5 is a part will be briefly described. Located within sheath 5 and positioned generally along the center line thereof is a resistance element 34 which in the present embodiment is illustrated as being in the form of a helix. However it will be understood that resistance elements having other shapes, including in particular a straight wire resistance element, may be utilized in heating units loaded with the apparatus of the present invention. The ends of resistance element 34 are fixedly secured to terminals 35 and 36 respectively, it being understood that the parts are electrically connected as well as mechanically secured together. Terminal 36 is secured to the lower end of sheath 5 by means of a collar 37 the periphery of which is secured to the sheath by means of crimping or otherwise forming the sheath so as to hold the parts in the relationship shown. For the purpose of holding resistance element 34 in centered position during the loading operation, upper terminal 35 is centered and secured to the upper end of sheath 5 by means of a plug 38 provided with a set screw 39 arranged to bear against a portion of the terminal extending through an aperture in the plug. It will be understood that after sheath 5 is loaded with powdered insulating material, such as magnesium oxide designated by the numeral 40, assembly of the heating unit is completed by cutting off the portion of the upper end of sheath 5 at a point immediately below opening 33 and sealing both ends of the heating unit by means well known in the art.

The mode of operation of my invention, with particular reference to the apparatus illustrated in the drawing by way of example, will now be described. First, of course, resistance element 34 is assembled within sheath 5 as described above and illustrated in Fig. 2, and the lower end of the sheath is then placed in bracket 2 with the upper portion thereof extending through openings 12 and 17 in brackets 6 and 13 respectively.

After the parts have been mounted in the position illustrated, the flow of powdered insulating material from hopper 28 to filler cup 30 is begun, and at the same time compressed air is supplied through flexible hose 26 to vibratory device 18, thus initiating rotary movement of ball 25 in annular chamber 22. Rotation of ball 25 causes vibratory device 18 to move in an eccentric pattern around the sheath, it being evident that the line of contact between wall 24 of vibrator 18 and the surface of the sheath constantly moves around the circumference of the sheath, and inwardly directed radial force is applied along that line. So long as the frequency of vibration of the vibratory device 18 (which is a function of the rotary speed of the rotating member therein) is appreciably greater than the natural frequency of the sheath, but is not a harmonic frequency thereof, the resistance element within the sheath is maintained substantially in the center thereof, and at the same time the resulting continuously

rotating radial forces provide the vibration needed to compact the insulating material. It will be understood that as used in this specification the "natural frequency" of the sheath is its natural frequency of vibration in directions transverse to the axis of the sheath when it is supported at both ends. It will also be understood that the frequency of vibration of vibratory device **18** should not equal a harmonic frequency of the natural frequency of the sheath, since excessive transverse movement of the sheath would occur under these conditions.

By way of example, a vibratory frequency of the order of 100 cycles per second has been found to be suitable for making heating units ranging in outer diameter from approximately 0.150 inch to 0.300 inch and in length from four to six feet. Frequencies of this order of magnitude, which in the apparatus illustrated in the drawing are produced by rotation of ball **25** at a speed of the order of 6,000 revolutions per minute, are advantageous in that they are substantially above the natural frequencies of the sheaths of the aforementioned heating units, and are in the range in which the harmonic frequencies are relatively far apart, thus minimizing the need for precise regulation of vibration frequency.

It is believed that the constantly rotating impact force applied to the sheath is transmitted from the inner surface of the sheath to the resistance wire either directly or, as the insulating material level rises, through the insulating material itself, the result being that the resistance element is forced to the center of the sheath by the resultant of the forces acting on it. The centering action induced by the repetitive circumferentially moving radial forces generated by vibratory device **18** extends to the portions of the resistance element adjacent the ends of the sheath as well as the mid-portion of the sheath. In this connection, it will be evident that relatively greater centering action is required at the mid-portion of the resistance element than near the ends which are held in position by terminals **35** and **36**.

It will of course be understood that the method of my invention may be practiced with apparatus of various types, and is not limited to the particular apparatus described above. The essential step of my method is the application of a repetitive circumferentially moving radial force to an intermediate position of the sheath at a non-harmonic frequency of vibration greater than the natural frequency of the sheath, and in practicing my method any suitable means for applying such a force may be utilized.

While I have shown and described particular embodiments of the method and apparatus of my invention, I do not desire the invention to be limited to the particular construction and method steps disclosed, and I intend by the appended claims to cover all modifications within the true spirit and scope of my invention.

What I claim is:

1. Apparatus for loading sheathed wire heating units of the type having a resistance wire embedded in powdered insulating material within a tubular sheath comprising: means for supporting said sheath at one end thereof, means for supplying said insulating material to said sheath at a predetermined rate, and vibratory means for applying a repetitive circumferentially moving radial force to a portion of said sheath spaced from said one end at a non-harmonic frequency of vibration greater than the natural frequency of said sheath, said vibratory means including a housing having an annular chamber encircling said sheath, a rotatable member movable in said chamber, and means for rotating said member in said chamber so as to impart said moving radial force to said sheath, whereby said resistance wire is maintained in a centered position with respect to the inner wall of said sheath and said insulating material is compacted therein.

2. Apparatus for loading sheathed wire heating units of the type having a resistance wire embedded in powdered insulating material within a tubular sheath comprising:

means for supporting said sheath at one end thereof, means for supplying said insulating material to said sheath at a predetermined rate, shelf means fixedly secured with respect to said supporting means and located intermediate the ends of said sheath, said shelf means having an opening larger than said sheath through which the latter extends when supported by said supporting means, a housing adapted to surround said sheath movably supported on said shelf means, said housing having an annular chamber encircling said sheath, a rotatable member movable in said chamber, and means for rotating said member in said chamber so as to impart a repetitive circumferentially moving radial force to said sheath at a non-harmonic frequency of vibration greater than the natural frequency of said sheath.

3. Apparatus for loading sheathed wire heating units of the type having a resistance wire embedded in powdered insulating material within a tubular sheath comprising: frame structure for supporting said sheath in an upright position including means for securing the lower end of the sheath in fixed relation thereto, a first bracket mounted on said frame structure adjacent the upper end of said sheath, said first bracket including a first horizontal shelf portion having an opening therein sufficiently large to accommodate said sheath and permit limited movement of the upper end thereof, a filler cup adapted to rest on said first shelf portion and to be clamped to the upper end of said sheath, a hopper supported above said cup and adapted to supply powdered insulating material thereto at a regulated rate, a second bracket mounted on said frame structure adjacent the mid-portion of said sheath, said second bracket including a second horizontal shelf portion having an opening therein sufficiently large to accommodate said sheath and permit limited movement of the midportion thereof, and a vibratory device supported on said second shelf portion for limited movement transverse to the axis of said sheath, said vibratory device including means for applying a repetitive circumferentially moving radial force to said sheath at a non-harmonic frequency of vibration greater than the natural frequency of said sheath, whereby said resistance wire is maintained in a centered position with respect to the inner wall of said sheath and said insulating material is compacted therein.

4. Apparatus for loading sheathed wire heating units of the type having a resistance wire embedded in powdered insulating material within a tubular sheath comprising: frame structure for supporting said sheath in an upright position including means for securing the lower end of the sheath in fixed relation thereto, a first bracket mounted on said frame structure adjacent the upper end of said sheath, said first bracket including a first horizontal shelf portion having an opening therein sufficiently large to accommodate said sheath and permit limited movement of the upper end thereof, a filler cup adapted to rest on said first shelf portion and to be clamped to the upper end of said sheath, a hopper supported above said cup and adapted to supply powdered insulating material thereto at a regulated rate, a second bracket mounted on said frame structure adjacent the mid-portion of said sheath, said second bracket including a second horizontal shelf portion having an opening therein sufficiently large to accommodate said sheath and permit limited movement of the mid-portion thereof, and a vibratory device supported on said second shelf portion for limited movement transverse to the axis of said sheath, said vibratory device including an annular chamber encircling said sheath, a rotatable member in said chamber, said vibratory device having an orifice therein for directing compressed air into said chamber tangentially with respect to the circular path of movement of said rotatable member, whereby said rotatable member may be rotated in said chamber at a speed sufficiently high to cause said vibratory device to impart a repetitive circumferentially moving radial

force to the adjacent portion of said sheath at a non-harmonic frequency of vibration greater than the natural frequency of said sheath.

References Cited in the file of this patent

UNITED STATES PATENTS

1,754,003 Johnson-Vea et al. ---------- Apr. 8, 1930
2,032,957 Simmons ---------- Mar. 3, 1936
2,316,683 Finlayson et al. ---------- Apr. 13, 1943
2,319,573 Abbott ---------- May 18, 1943
2,740,187 Jacobs et al. ---------- Apr. 3, 1956
2,853,765 Wemhoener ---------- Sept. 30, 1958