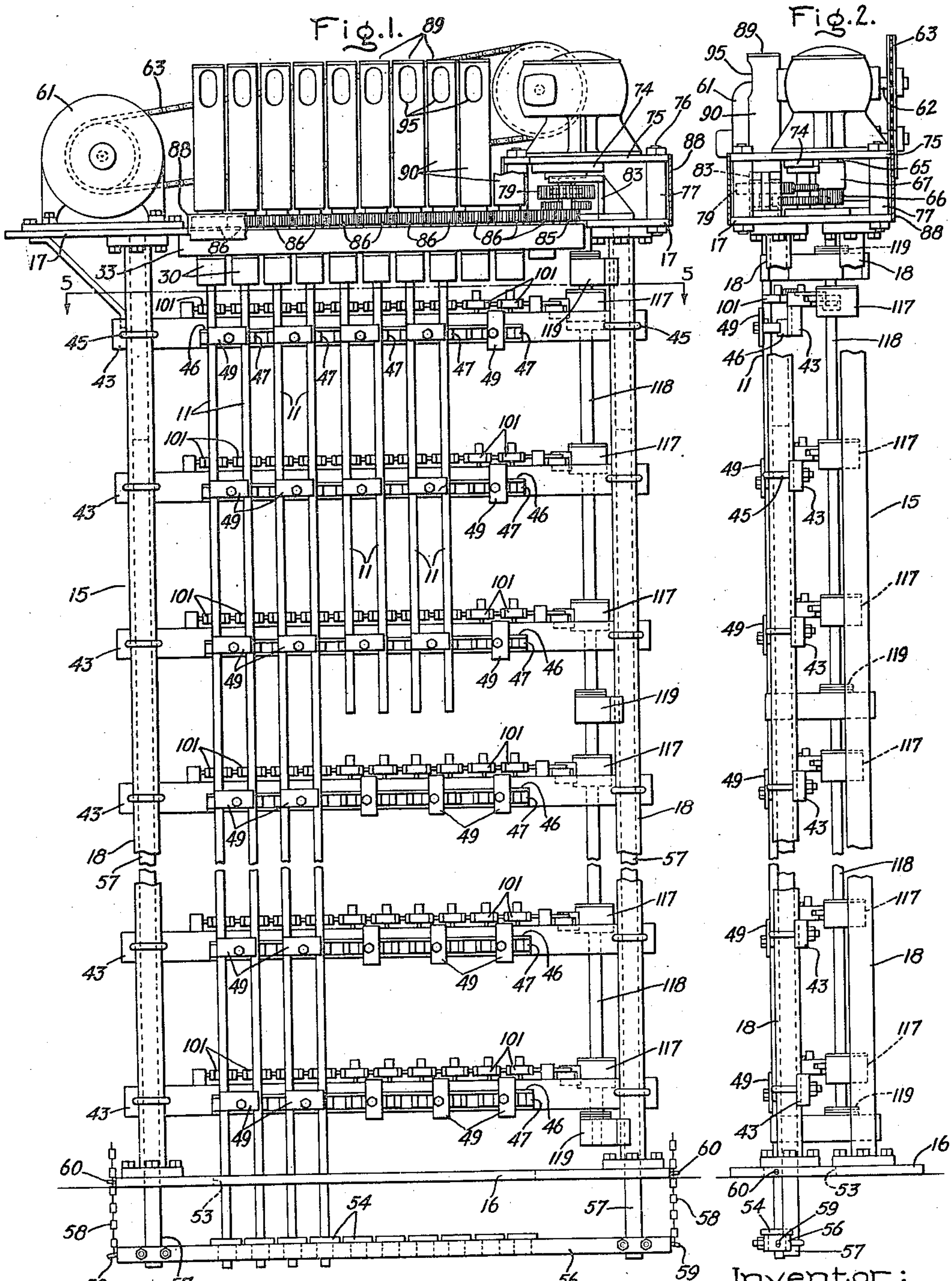
May 18, 1943 C. C. ABBOTT 2,319,573

APPARATUS FOR LOADING SHEATH WIRE HEATING UNITS

Filed July 20, 1940 4 Sheets-Sheet 1



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APPARATUS FOR LOADING SHEATH WIRE HEATING UNITS

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Fig.3.

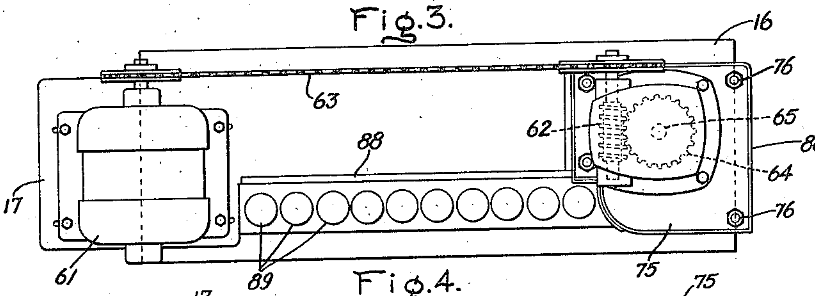


Fig.4.

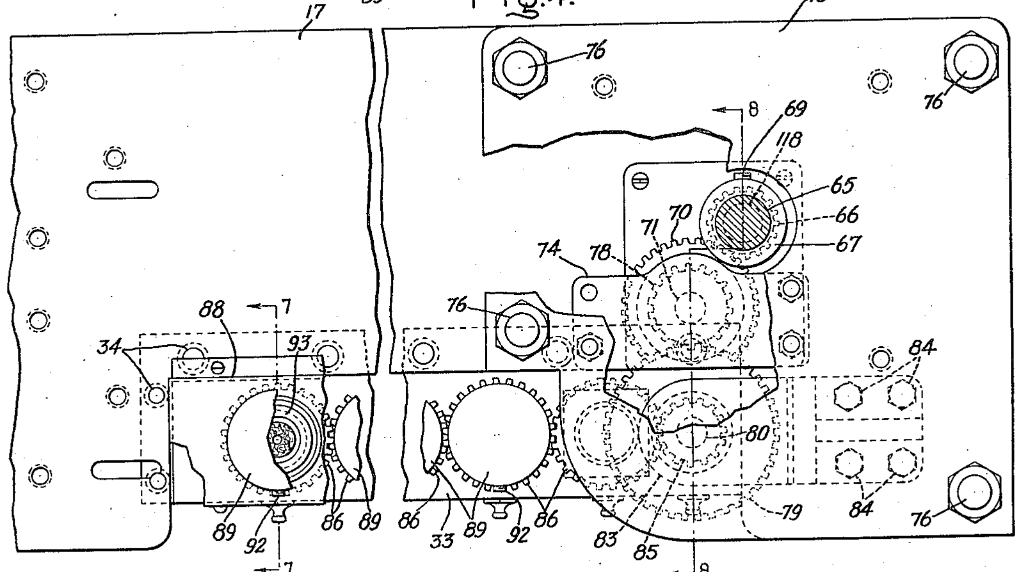
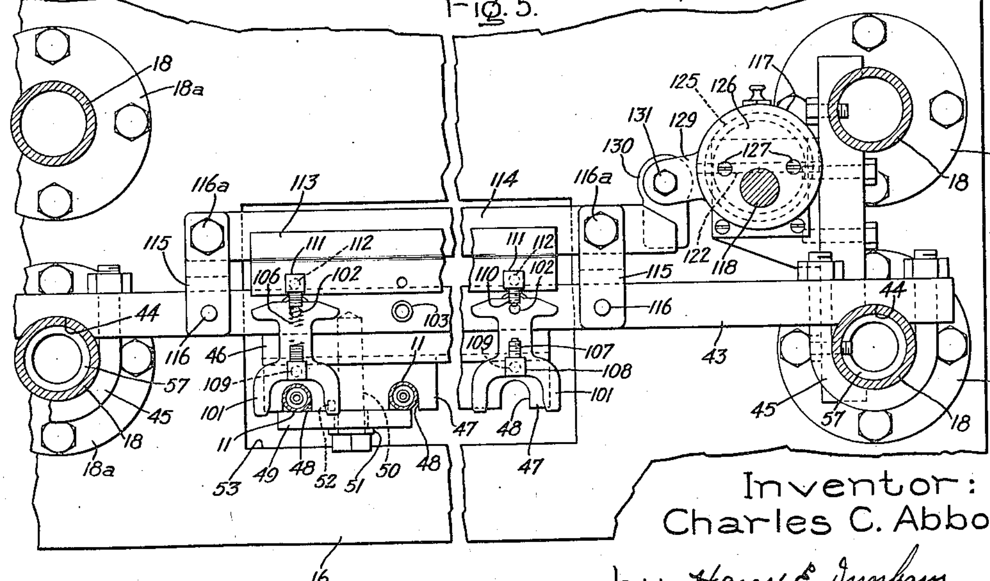


Fig.5.



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APPARATUS FOR LOADING SHEATH WIRE HEATING UNITS

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Fig. 6.

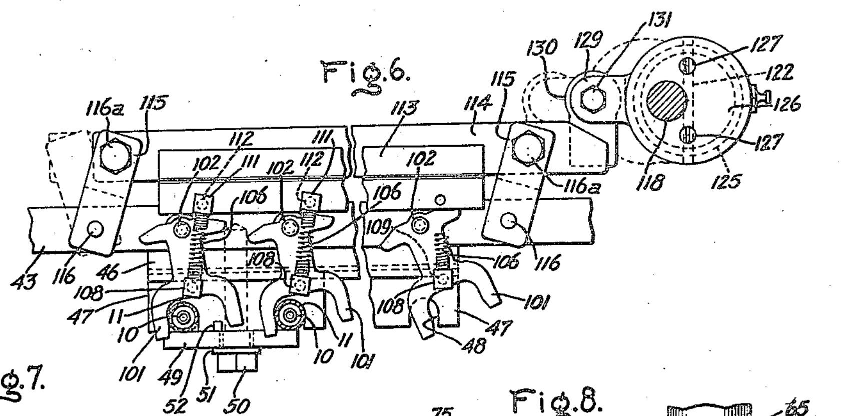


Fig. 7.

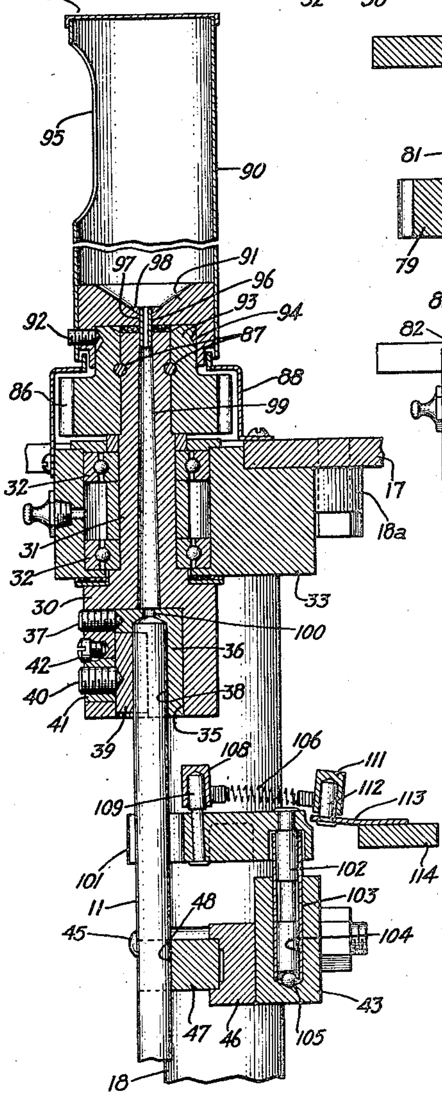
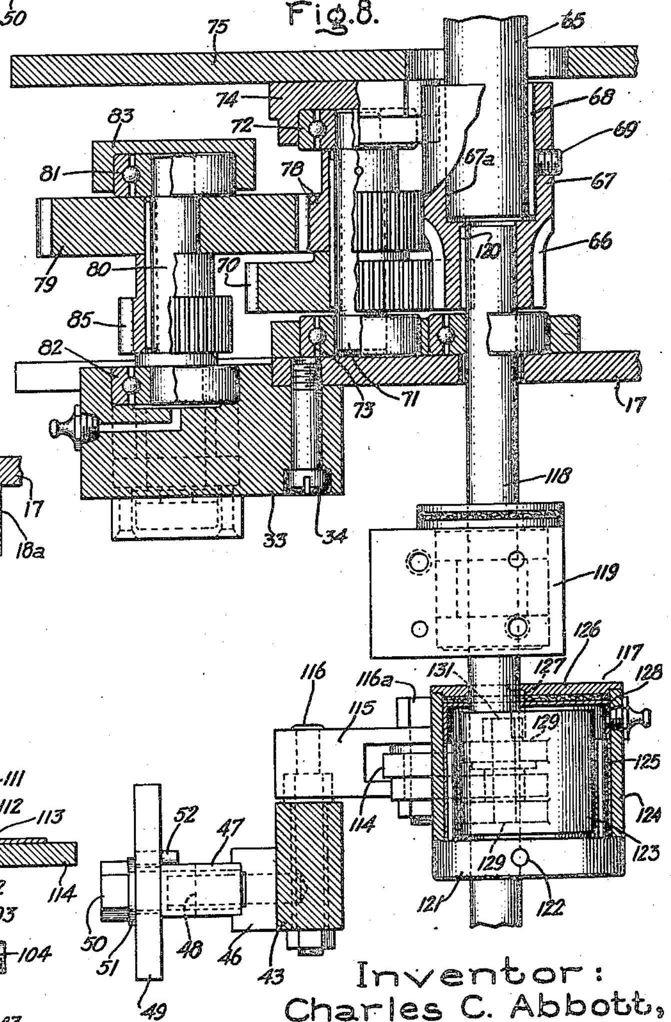


Fig. 8.



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APPARATUS FOR LOADING SHEATH WIRE HEATING UNITS

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Fig. 9.

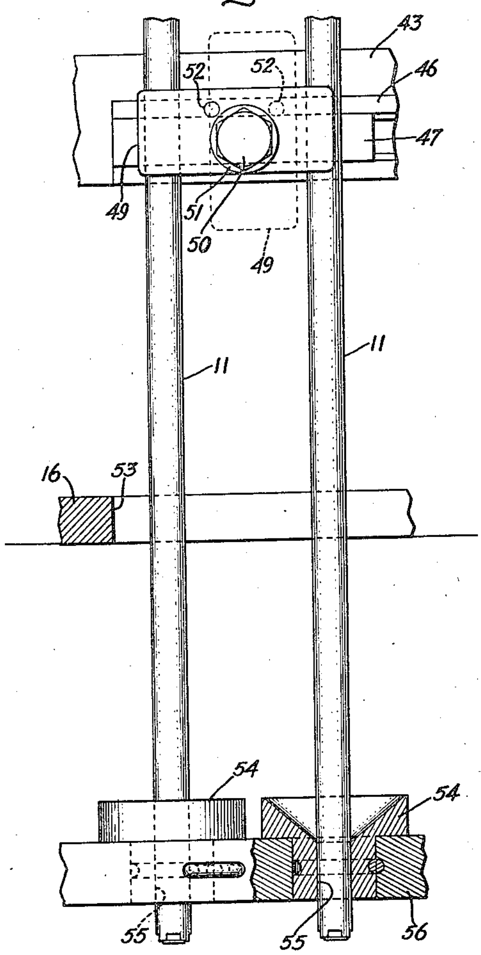


Fig. 10

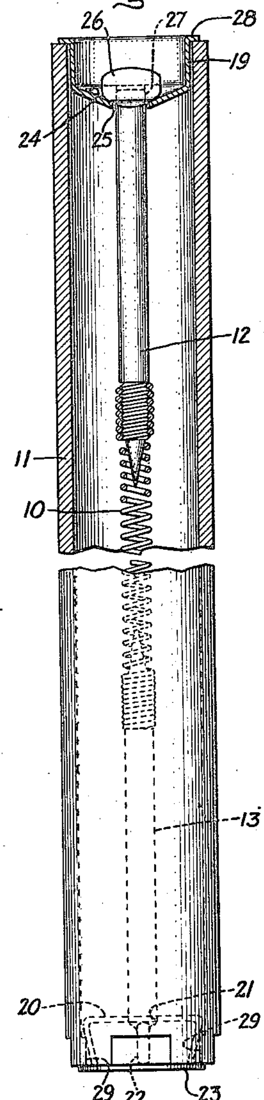


Fig. 11.

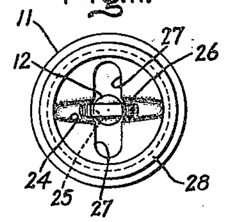


Fig. 12.

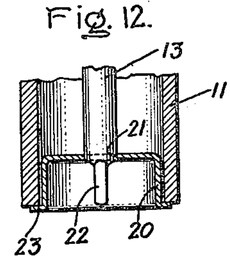
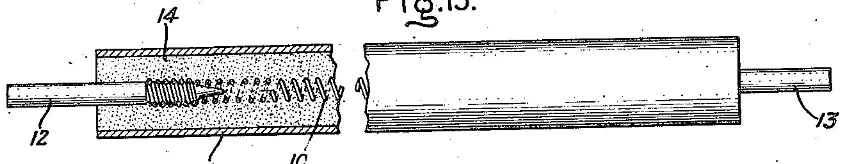


Fig. 13.



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UNITED STATES PATENT OFFICE

2,319,573

APPARATUS FOR LOADING SHEATH WIRE HEATING UNITS

Charles C. Abbott, Pittsfield, Mass., assignor to General Electric Company, a corporation of New York

Application July 20, 1940, Serial No. 346,593

9 Claims. (Cl. 226—23)

This invention relates to electric heating units, more particularly to electric heating units of the sheathed type, and it has for its object the provision of improved apparatus for loading heating units of this character with a suitable insulating medium.

This invention has particular application to electric heating units wherein a resistance conductor is encased by a sheath and is embedded in and held in spaced relation with the sheath by means of an electrically insulating, heat refractory and conducting material, such as powdered magnesium oxide. One electric heating unit of this type is described in the United States Patent No. 1,367,341 to me, dated February 1, 1921.

This invention contemplates the provision of improved apparatus for loading a heating unit of this type with its insulating material so as to embed and hold the resistance conductor in spaced relation with reference to the sheath in a simple, reliable and efficient manner.

Various machines have been devised heretofore for loading the sheaths of heaters of this character. In the main, these machines have been provided with centering devices which are inserted in the sheath so as to hold the resistance conductor centrally within the sheath during the loading operation. Also generally these machines have been provided with means acting on the insulating material to compact it as it is being loaded. This invention contemplates the provision of improved loading apparatus which obviates the necessity of providing any centering means for the resistance conductor or any auxiliary means for acting on the insulating material as it is being fed to the sheath.

In accordance with this invention, in one form thereof, the sheath with the resistance element and its terminals assembled with it is placed in an upright position. The insulating material is fed into the upper end of the sheath. The sheath is rotated continuously as the insulating material is fed in, and as the sheath is being filled a series of impacting blows are imparted laterally to the sheath to settle the insulating material. When long sheaths are being filled it is preferable to apply the blows to the sheath at spaced intervals throughout its length. By thus rotating the sheath and rapidly hammering it, I have found that the resistance conductor remains in its proper position with relation to the sheath, and moreover, I have found that the insulating material is compacted in the sheath to a substantially uniform density throughout the length of the sheath.

For a more complete understanding of this invention, reference should be had to the accompanying drawings in which Fig. 1 is a fragmentary vertical front elevation of apparatus for loading sheathed heating units arranged in accordance with this invention; Fig. 2 is a fragmentary side elevation of the loading apparatus shown in Fig. 1; Fig. 3 is a top plan view of the loading apparatus shown in Figs. 1 and 2; Fig. 4 is an enlarged fragmentary top plan view of a portion of the apparatus shown in Figs. 1–3 inclusive; Fig. 5 is an enlarged fragmentary sectional view taken through the line 5—5 of Fig. 1 and looking in the direction of the arrows; Fig. 6 is an enlarged fragmentary view similar to Fig. 5 but showing certain of the elements in different operative positions; Fig. 7 is an enlarged sectional view taken through the line 7—7 of Fig. 4 and looking in the direction of the arrows; Fig. 8 is an enlarged sectional view taken through the line 8—8 of Fig. 4 and looking in the direction of the arrows; Fig. 9 is an enlarged front elevation of a portion of the loading apparatus shown in Fig. 1, parts being shown in section so as to illustrate certain details of construction; Fig. 10 is an enlarged fragmentary elevation, partly in section, of a sheathed electric heating unit showing the various elements of the unit in assembled relation just prior to the loading operation; Fig. 11 is a view of the end of the assembly of Fig. 10, the view being taken from above; Fig. 12 is a sectional view of the lower end of the sheath, as viewed in Fig. 10, prior to certain processing operations; and Fig. 13 is an elevation, partly in section, of a finished electric heating unit of the type to which this invention is particularly applicable.

Referring to the drawings, this invention has been illustrated in one form in connection with apparatus for loading electric heating units of the sheathed type, such as described and claimed in United States Patent No. 1,367,341, referred to above. Referring to Fig. 13 a heating unit of this type has been illustrated. As shown in this figure, the heating unit comprises a helical resistance conductor 10 encased in a metallic sheath 11. Suitable terminals 12 and 13 are mechanically and electrically connected to the ends of the resistance element 10. The resistance element is threaded on the terminals as shown and as fully described in my United States Patent No. 1,494,938, granted May 30, 1924. The resistance element 10 is embedded in and is held in spaced relation with reference to the sheath 11 by a suitable powdered heat refractory and conducting, electrically insulating material 14, such as powdered magnesium oxide. The magnesium oxide functions to hold the coiled resistance conductor 10 so that its axis is substantially in the longitudinal center line of the sheath, and it further functions to conduct heat from the resistance element to the sheath. The inner ends of the terminals 12 and 13, as shown, are also embedded in the insulating material 14, and are insulated from the sheath 11 and held in spaced relation with it by means of the powdered insulating material.

The apparatus arranged in accordance with this invention for loading the insulating material 14 into the sheath 11 comprises a framework 15 which includes a floor plate 16, and a main top plate 17 which is supported on the floor plate by means of four columns 18 arranged in pairs adjacent the ends of the plates, as clearly shown in the drawings. The columns 18 are of tubular form and at their upper and lower ends are provided with flanges 18*a* which are bolted to the plates 16 and 17 respectively.

It is contemplated that the apparatus will load a plurality of sheaths at the same time, but it is understood that the machine is equally applicable to a machine wherein only one sheath is loaded at a time.

The sheaths 11 are arranged to be supported in upright positions in the framework 15 and are supported in the framework so that they may be given a continuous rotary motion during the loading operation. Prior to insertion in the machine for loading, each sheath is treated in the following manner: The resistance conductor 10, which is assembled with its terminals 12 and 13, is mounted in suitable cup-shaped washers 19 and 20 located in the ends of the sheath which function to hold the conductor and terminals in their central positions in the sheath. As shown in Fig. 12, the lower cup-shaped washer 20 is provided with a centrally arranged aperture 21 through which the lower terminal 13 is inserted The lower terminal 13 is provided with an enlarged head 22 which prevents the terminal from passing inwardly through the washer. The washer is further provided with an outwardly-extending flange 23 which engages the lower end of the sheath, as shown in Fig. 12. The upper cup-shaped washer 19, as shown in Figs. 10 and 11, is provided with a transversely-arranged depressed bottom section 24 which at the center is provided with an aperture 25 through which the terminal 12 is directed. The terminal 12 is provided with an enlarged head 26 which rests in the depressed section 24 so as to prevent the terminal from passing through the aperture. The cup washer 19 in its bottom wall is further provided with relatively large openings 27 which merge into the centrally arranged opening 25 as clearly shown in Figs. 10 and 11. This washer also is provided with an outwardly extending flange 28 which engages the upper end of the sheath, as shown in Fig. 10.

In assembling the resistance conductor with the sheath, it will be understood that the lower terminal 13 will be provided with its flattened head 22, then this terminal will be assembled with its washer 20, and then the terminal is connected to one end of the resistance conductor 10. Then the upper terminal, which will have been provided with its head 27, will be attached to the other end of the resistance conductor. Then the assembly of the resistance conductor, terminals and cup 20 will be inserted through the sheath so that the lower cup bears against the lower end of the sheath, as shown in Fig. 12. Then the end of the upper terminal 12 is withdrawn from the sheath for assembly with its cup 19, which then is inserted in the sheath so that its flange 28 bears against the upper end of the sheath, as shown in Fig. 10. It will be understood that in assembling the upper terminal with the cup 19, the head 26 of the terminal will be inserted through the openings 27, and then the cup turned 45° so that the head can be received in the depressed section 24.

Then the sheath is crimped at the lower end, as shown in Fig. 10, so as to provide inwardly offset sections 29 at this end of the sheath. These sections 29 bend the walls of the lower cup inwardly, as shown, and thereby firmly anchor the cup to the sheath.

The means for holding the resistance conductor in the sheath while it is being loaded with the insulating material 12 comprising the cup-shaped members 19 and 20 are described and claimed in the copending application of Frank E. Finlayson, Serial No. 370,705, filed December 18, 1940, now Patent No. 2,269,195, dated January 6, 1942, and which is assigned to the same assignee as this invention.

The assembly is now ready for the loading process. As pointed out previously, the assembly is supported in a vertical position in the framework 15. For this purpose, the framework is provided with a series of rotatably mounted heads 30, one for each of the sheaths. The supporting head 30 is shown more clearly in Fig. 7. As shown, the supporting head 30 is provided with an elongated shaft 31 which is journaled in suitable ball bearings 32 which rotatably support the head in a transverse beam 33. Not only do the bearings 32 support the head 30 for rotation in the beam 33, but they are also arranged to support the head in a vertical position, that is, they further function to prevent the head from moving vertically with reference to the beam. The beam 33 is rigidly secured to the top plate 17 by any suitable means such as screw fastening devices 34 (Figs. 4 and 8). As shown, the head 30 is provided in its lower end with a cylindrical recess or socket 35 in which a suitable sleeve 36 is inserted. The sleeve 36 is secured in the socket 35 by means of a set-screw 37. The sleeve 36 is provided with a centrally-arranged socket 38 which receives the upper end of the sheath 11, as clearly shown in Fig. 7. An arcuate section of the sleve 36 is cut away through an angle of about 130°, and inserted in this arcuate section is an arcuate clamping plate 39 which is arranged to be moved inwardly tightly against the sheath to hold it in the sleeve by means of a set-screw 40. The plate 39 is not quite as long as the slot so that its lower end is spaced slightly above the lower end of the sleeve 36. This provides a ledge on the back of the sleeve which assists the operator in inserting the sheath into the sleeve. The set-screw 40 is threaded in a circular plate 41 which is screwed into a tapped aperture provided for it in the head. The plate 41 may be replaced when the threads become worn as they do at times due to the action of the dust of the magnesium oxide insulation. The plate 41 is further secured to the head by means of screw 42 which has its head countersunk into the plate, as shown, and which prevents the plate 41 from unscrewing when the set-screw 40 is operated.

The sheath 11 extends downwardly through the framework 15 from the supporting head 30 and at intervals along the length of the sheath, it is further secured in its proper vertical position in the framework. For this purpose, a series of vertically spaced transverse beams 43 are secured to the front tubular columns 18. As shown more clearly in Fig. 5, the ends of the beams 43 are provided with arcuate-shaped recesses 44 which are fitted to the outer rear surfaces of the front tubular columns 18. These ends of the beams are rigidly clamped to these columns by means of hairpin shaped clamping bars 45. Secured to the forward vertical face of each beam is an elongated, channel-shaped plate 46, clearly shown in Figs. 1, 5, 6, 7 and 8. Mounted in the channel plate 46 is a series of centering plates 47, one being provided for each pair of sheaths, as shown more clearly in Figs. 5 and 9. Each centering plate 47 is provided with arcuate-shaped recesses 48 for receiving the sheaths, as shown in Fig. 5. The recesses or slots 48 are adapted to be closed by means of a closure plate 49, which when in its closed position, shown in Fig. 1 at the left, and in Fig. 5, holds the sheaths in their vertically spaced-apart positions. The closure plates, however, may be swung from these closed positions to open positions, shown at the right of Fig. 1, and in dotted lines in Fig. 9, so as to open the slots to permit the removal of the sheaths.

The channel plate 46, the centering plates 47 and the closure plates 49 are secured together and to their associated transverse beam 43 by means of screws 50 which are directed through apertures provided for them in the plates 46, 47 and 49 and which are received in tapped holes provided for them in the beam 43. A collar or bushing 51 is interposed between the head of each of the screws and the front surface of the closure plate 49 and is so proportioned as to provide for relatively free rotary movement of the associated closure plate 49 on the screw.

Each closure plate 49 is provided with a pin 52 which is arranged to engage the upper surface of the associated centering plate 47 to hold the closure plate 49 in its closed position, as shown in Fig. 9, and also to engage this upper surface to hold the plate in its open position, as shown in dotted lines in this figure. The plate 49, as shown in Fig. 9, is positioned in eccentric relation on the screw 50 so that it will hold the pin 52 by gravity in each of these positions against the upper surface of the centering plate 47.

When very long sheaths are to be filled, such as the four sheaths on the left-hand side of Fig. 1, they are caused to extend downwardly through the floor plate 16 and the floor, the plate 16 being provided with an enlarged aperture 53 for this purpose, and the floor, of course, being provided with a similar aperture. Preferably, the lower ends of these sheaths will be mounted in suitable centering bushings 54. The centering bushings 54 are provided with centrally arranged centering apertures 55 for receiving the lower ends of the sheaths, as shown in Fig. 9. The centering bushings 54 are mounted in a transverse beam 56. The ends of the beam 56 are secured to upright cylindrical tubes 57 which are directed upwardly through the front tubular standards 18, as clearly shown in Figs. 1 and 5. These members 57 function to guide the beam 56 so that it can move vertically with reference to the floor plate 16. The transverse beam 56 is secured in its proper position with relation to the floor plate by means of chains 58, the links of which are arranged to be directed over pins 59 provided for them on the ends of the beam 56 and similar pins 60 provided for them on the floor plate 16. It will be understood that the position of the beam 56 and hence of the centering bushings 54 may thereby be adjusted. This will take care of sheaths of various lengths. The shorter sheaths, shown in the center of the apparatus in Fig. 1, are correctly supported by means of the rotating supporting heads 30 and the centering plates 47 provided for them, as previously described.

The various supporting heads 30 are arranged to be rotated as the sheaths are being filled so that the sheaths themselves are continuously rotated as they are being filled by means of a suitable electric motor 61 which is mounted upon the upper supporting plate 17—at the left side of the plate, as viewed in Fig. 1. This electric motor drives a suitable worn 62 by means of a chain drive 63. The worm 62 is mounted on a transverse shaft, as clearly shown in Figs. 2 and 3, and it drives a worm wheel 64 mounted on a vertical shaft 65. The vertical shaft 65 drives a gear member 66, shown more clearly in Fig. 8. The gear 66 is provided with a cylindrical head 67 having a socket 67a which receives the lower end of the shaft 65 and to which the head is secured so as to rotate with it by a key 68. The head 67 is secured to the shaft 65 to prevent longitudinal movement of the gear 66 with reference to the shaft by means of a set-screw 69. The gear 66 meshes with a gear 70 which is keyed to a vertically positioned shaft 71 that is mounted in bearings 72 and 73. The bearing 73 is supported on the upper main plate 17, while the bearing 72 is mounted in a plate 74 which in turn is mounted on a plate 75. The plate 75 is secured in vertically spaced relation to the plate 17 by means of bolts 76. It will be understood that suitable bushings or collars 77 (Figs. 1 and 2) surround the bolt 76 so as to support the plate 75 in spaced relation with reference to the plate 17.

Also keyed to the shaft 71 is a gear 78 which meshes with a gear 79 that is keyed to a vertically positioned shaft 80. The shaft 80 is mounted in bearings 81 and 82. The bearing 81 is mounted in a bracket 83, which as shown in Fig. 1 has a Z-shape, and which as shown in this figure is mounted upon the plate 17; it is secured to the plate 17 in any suitable manner, as by bolts 84 (Fig. 4). The lower bearing 82 is mounted in the transverse bearm 33.

Also keyed to the shaft 80 is a gear 85 which meshes with a series of gears 86 which intermesh with each other, as clearly shown in Fig. 1. Each gear 86 functions to drive one of the rotary supporting heads 30. As shown more clearly in Fig. 7, each gear 86 is mounted upon the shaft 31 of the associated head 30 and is secured to it by means of suitable pins 87. The series of gears 86 preferably are covered by means of a dust-proof casing 88 supported by the plate 17 and the transverse beam 33.

It will be observed in view of the foregoing description that when the motor 61 is operated it will operate through the gear train comprising the gears 66, 70, 78, 79, 85 and 86 so as to rotate the supporting heads 30, and hence, the sheaths 11 attached to them. The gearing, it will be observed, reduces the speed between the motor and the heads. The gearing is such that the heads preferably will be operated at around 20–25 revolutions per minute. In other words, if a motor having a speed of 1200 revolutions per minute, for example, is used, the gear train will be so arranged as to reduce this speed to around 20–25 motions per minute of the head.

Suitable means are provided for feeding the powdered insulating material 14 to the sheaths as they are being rotated by the motor 61. For this purpose, there is mounted on each of the supporting heads a suitable hopper 89. Each hopper 89 comprises a suitable vertically positioned cylindrical bin 90 which in its bottom is provided with a cylindrical funnel or conical-shaped feed device 91. The bin 90 is secured to the funnel-shaped member 91 in any manner as by welding, and the assembly of the bin 90 and feed device 91 are secured to the gear 86 by means of three set-screws 92; as shown, the gear 86 is provided with an upright reduced extension 93 which is provided with a peripheral recess 94 that is arranged to receive the set-screws 92 so as to clamp the feed device 89 to the gear 86. The bin 90 is provided with a vertically arranged elongated opening 95 through which the insulating material is fed to the bin. The funnel-shaped discharge member 91 is provided with a centrally arranged opening 96 in which is fitted a suitable tubular member 97. This member 97 is secured to the member 91 in any suitable manner as by a brazed joint 98. The discharge tube 97 empties into a centrally arranged opening 99 provided in the shaft 31 of the supporting head 30. The opening 99 flares outwardly, that is, enlarges gradually as it approaches the head 30, as clearly shown in Fig. 7. This passageway 99 in turn empties into a reduced passageway 100 provided in the sleeve 36, and this passageway 100 in turn empties directly into the upper end of the sheath 11, the powder entering the sheath through the openings 27 in the upper cupped washer 19. The axes of the discharge tube 97, of the passageway 99 and of the opening 100 all are coincident with each other and with the axis of rotation of the head 30.

Suitable means are provided for applying to each sheath a plurality of impacting blows as the sheath is being filled with the insulating material. Preferably, a series of blows will be applied to the sheath at spaced points along its length. For this purpose, suitable vibrating hammers 101 are provided spaced at intervals along the length of the sheath. In the specific example illustrated in Fig. 1 a set of six hammers is provided for each of the long sheaths at the left. Preferably, the hammers will be arranged in banks so as to apply the impacting blows at substantially the same points of each sheath. When shorter sheaths are being filled, a smaller number of the hammers will be effective, as with the four central sheaths in Fig. 1.

As shown more clearly in Figs. 5 and 6, the hammers are formed in the shape of a widened U, and they are so arranged and positioned in the apparatus that the legs of the U straddle the sheath 11 with which the hammers are associated. The hammers are supported on the transverse beams 43. For this purpose, each hammer is rigidly secured to a vertically positioned shaft 102 which is shown more clearly in Fig. 7. The shaft 102 is received in a bushing 103 which in turn is mounted in a cylindrical bearing 104 provided for it in the beam 43, as clearly shown in Fig. 7. Interposed between the lower end of the shaft 102 and the bottom wall of the bearing 104 is a ball thrust bearing 105.

Each hammer is arranged to be rapidly oscillated so as to cause its legs to alternately strike the sheath by suitable means such as an over-center spring 106. The spring 106 at one end is secured on a stud 107, Fig. 5, which in turn is rigidly secured to a cap 108. The cap 108 is arranged to oscillate on a pin 109 which is rigidly secured to the hammer 101. The opposite end of each spring is secured to a stud 110 which is mounted on a cap 111 that is arranged to oscillate on a pin 112. As shown more clearly in Fig 7, the caps 108 and 111 are provided with longitudinally arranged bores which receive the pins 109 and 112 respectively. These pins function to support the caps so that the latter can be oscillated on them.

The pins 112 of each bank of hammers 101 are rigidly secured to a plate 113 which in turn is rigidly secured to a plate 114. The plate 114 is mounted upon the associated beam 43 by means of a pair of forked links 115. The links 115, as shown, are pivotally connected to the beam 43 by means of pins 116, and to the plate 114 by bolts 116*a*.

The plate 114 and hence the plate 113 is given a rocking motion back and forth to move between its solid line position of Fig. 6 and its dotted line position of this figure so as to move the caps 111, and hence the ends of the springs 106 attached to these caps through reciprocatory paths of motion. The path of motion of each spring is such that the end of the spring will be moved back and forth across the center of movement of its associated hammer, which of course is the center of the hammer's pin 102, so that the hammer is alternately oscillated back and forth to cause its two arms to alternately strike the opposite sides of the sheath. For the purpose of reciprocating the plates 114, suitable eccentric devices 117 are provided, one of these eccentric devices being provided for each bank of hammers 101. The eccentric devices 117 are driven from the motor 61 through a vertically-positioned shaft 118, which is in vertical alignment with the shaft 65. The shaft 118 is supported in a vertical position in the frame 15 by means of a plurality of bearings 119 attached to the framework 15 in any suitable manner. As shown more clearly in Fig. 8, the upper end of the shaft 118 is received in a bore provided for it in the gear 66 and it is rigidly secured to rotate with the gear by means of a suitable key 120.

Each eccentric device 117 comprises a base or collar 121 which is rigidly secured to the shaft 118 by means of a suitable pin 122. The base 121 is provided with an upright cylindrical section 123 which is rigidly secured to the base 121. If desired, the members 121 and 123 may be integrally formed into one piece. The members 121 and 123 are eccentrically mounted upon the shaft 118. Surrounding the section 123 is a sleeve 124 and interposed between this sleeve and the section 123 is a suitable pin bearing 125. The sleeve 124 is closed at the top by means of a cover member 126 which is rigidly secured to the section 123 by screw fastening devices 127, and which may rotate with reference to the sleeve. Also secured to the member 123 and to the cover 126 by the screws 127 is a cup-shaped member 128 which extends downwardly so as to hold the pin bearing 125 in place, and which has a sliding engagement with the sleeve 124. The sleeve 124 carries on its outer wall a pair of vertically positioned lugs 129, which are pivotally connected to a member 130 by means of a bolt 131. The member 130 is rigidly secured to the associated plate 114 in any suitable manner as by welding.

It will be observed that in view of this construction when the shaft 118 is rotated the eccentrically positioned member 123 will be rotated with it and this rotation of the member 123 will impart an oscillating motion to the lugs 129 and hence to the plate 114. In other words, when the motor 61 is operating to rotate the sheaths 11, the plate 114 will be continuously reciprocated so as to oscillate the hammers in the manner previously described to impart impacting blows to the sheaths.

In making the electric heating units in this apparatus, the assembly shown in Fig. 10 will be made in the manner previously described. The upper ends of the sheaths in which the cups 19 are mounted will then be inserted in the sleeves 36 and the set-screws 40 will be screwed inwardly to cause the plates 39 to clamp the sheaths. At this time the closure plates 49 of course will be in their open positions, as shown in Figs. 8 and 9 and also at the right-hand side of Fig. 1. Then these closure plates will be moved to close their associated slots 48. If the sheaths are very long so as to extend downwardly through the floor plate 16, the lower ends of these members will be fitted into the centering bushings 54. This may be accomplished by moving the beam 56 upwardly to its proper position and attaching it to the floor plate 16 by the chains 58.

Then assuming that the bins 90 have been filled with the insulating material 14, the motor 61 will be started. This operation will continuously rotate the sheaths and also the hoppers 89 that are mounted on their rotating supporting members 30 so that the insulating material will feed into the sheaths where it is retained at the bottom by the lower cupped-washers 20. At the same time, the motor will cause the operation of the hammers 101 to apply to the sheaths a series of impacting blows. It is to be understood that inasmuch as the bins are rotated and the sheaths are being hammered continuously by the hammers 101, the insulating material will be sufficiently jarred or vibrated to cause it to flow through the tube 96 at a substantially even rate of flow.

The number of impacting blows imparted to each sheath by each hammer, of course, depends upon the speed of the shaft 118. In the specific example illustrated, it is contemplated that each hammer will be operated at around 200 cycles per minute. This means, of course, that each hammer will strike the sheath about 400 times per minute, and as there are a plurality of hammers spaced at intervals along the length of each sheath this number of blows will be multiplied by the number of hammers provided. In the specific example given where there are six hammers provided for each sheath, that is for the long sheath, about 2400 blows per minute will be imparted. These blows, it will be observed are applied throughout the length of the sheath. It has been found that by rotating each sheath and by thus imparting to it a large number of blows per minute throughout its length that the insulating material is densely compacted in the sheath. Moreover, the density of the material throughout the length of the sheath is substantially uniform.

It has been further found that it is unnecessary to provide the apparatus with a mechanically operated centering device for the resistance conductor 10. The rotary motion imparted to the sheaths distributes the insulating material around the conductor in such a fashion that it remains central and is held centrally throughout the loading operation.

When the sheaths have been loaded, the motor 61 is stopped, the set-screws 40 are screwed outwardly to release the sheaths and the closure plates 49 are opened so as to permit withdrawal of the sheaths from the apparatus. It is to be understood that when the sheaths have been filled and the motor stopped, the space 99 of each head 30 will be filled with the insulating material, and that the sheaths can be removed from the apparatus and a new sheath inserted for loading without losing the insulating material from the feeding means. This is because the bins are no longer being rotated and vibrated, and the insulating material because of its density chokes the passageway, so to speak. However, when the new sheaths have been inserted and the mechanism again started, the feed of the insulating material will be resumed.

After the sheaths have been withdrawn they may be reduced in diameter in any suitable way as by swaging so as to reduce the diameter of the sheaths and to increase their length to thereby highly compact the insulating material 14 into a hard dense mass. Prior to swaging, the upper ends of the sheaths are crimped in the same manner as the lower so as to clamp the upper washers 19 to the sheaths and then the openings 27 in the upper washers 19 are sealed in any suitable manner, as by a suitable varnish.

After this, the ends of the sheath may be severed so as to remove the sections that are clamped to the cups 19 and 20 and so as to remove the headed sections 22 and 26 provided on the terminals.

While I have shown a particular embodiment of my invention, it will be understood, of course, that I do not wish to be limited thereto since many modifications may be made, and I, therefore, contemplate by the appended claims to cover any such modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. Apparatus for loading granular insulating material into the sheath of a sheath wire heating unit that is provided with a sheath, and a resistance element within the sheath located in the central longitudinal axis thereof and embedded in and held in its spaced relation with the sheath when the insulating material is loaded into the sheath, comprising a supply reservoir for said insulating material, means rotatably supporting said sheath in an upright position so that it can be revolved on its longitudinal axis and also rotatably supporting said supply reservoir on said axis, said supply reservoir having a discharge opening in said axis communicating with the upper end of said sheath, and means for continuously rotating said reservoir and sheath while said insulating material is being fed into said sheath.

2. Apparatus for loading granular insulating material into the sheath of a sheath wire heating unit that is provided with a sheath, and a resistance element within the sheath located in the central longitudinal axis thereof and embedded in and held in its spaced relation with the sheath when the insulating material is loaded into the

sheath, comprising a head, means rotatably mounting said head, attaching means connecting one end of said sheath to said head to support said sheath from said head in a vertical position with said central longitudinal axis coincident with the axis of rotation of said head, a supply reservoir for said insulating material connected to said head so as to be rotated thereby, conduit means for conducting said insulating material from said reservoir to the upper end of said sheath and constructed and arranged to regulate the flow of the insulating material to said sheath, means for vibrating said sheath as it is being filled, and means for continuously rotating said head, reservoir and sheath while said insulating material is fed in and while said sheath is being vibrated so as to distribute and compact said insulating material in said sheath around said resistance element without displacing said resistance element from said central longitudinal axis.

3. Apparatus for loading granular insulating material into the sheath of a sheath wire heating unit that is provided with a sheath, and a resistance element within the sheath located in the central longitudinal axis thereof and embedded in and held in its spaced relation with the sheath when the insulating material is loaded into the sheath, comprising means for supporting said sheath for rotation on a vertical axis coincident with the longitudinal central axis of said sheath, a reservoir for said insulating material, means for supporting said reservoir for rotation on an axis coincident with the longitudinal central axis of said sheath, said reservoir being provided with a conical-shaped bottom wall tapering downwardly to the center where a discharge opening of predetermined diameter is provided in said axis, means for conducting insulating material from said opening to the upper end of said sheath, and means for rotating said reservoir and sheath continuously as said sheath is being filled.

4. Apparatus for loading granular insulating material into the sheath of a sheath wire heating unit that is provided with a sheath, and a resistance element within the sheath located in the central longitudinal axis thereof and embedded in and held in its spaced relation with the sheath when the insulating material is loaded into the sheath, comprising a head, means rotatably mounting said head, means on said head for gripping said sheath so that the sheath is suspended downwardly from the head in a vertical position for rotation with its longitudinal axis coincident with the axis of rotation of said head, a reservoir for said insulating material mounted on said head for rotation by the head having a conical-shaped bottom wall tapering downwardly to a circular discharge opening of predetermined diameter located in said axis of rotation, said head having a passageway in said axis of rotation connecting said opening with the upper end of said sheath, means for rotating said head, reservoir and sheath, and means for imparting intermittent impacting blows to said sheath at points spaced at intervals along its length.

5. Apparatus for loading granular insulating material into the sheath of a sheath wire heating unit that is provided with a sheath, and a resistance element within the sheath located in the central longitudinal axis thereof and embedded in and held in its spaced relation with the sheath when the insulating material is loaded into the sheath, comprising a head, means mounting said head for rotation on a vertical axis, means on said head for gripping said sheath so that the sheath is suspended downwardly from the head in a vertical position for rotation with its longitudinal axis coincident with the axis of rotation of said head, a reservoir for said insulating material mounted on said head for rotation by the head having a conical-shaped bottom wall tapering downwardly to a circular discharge opening of predetermined diameter located in said axis of rotation, and said head having a passageway in said axis of rotation connecting said opening with the upper end of said sheath, means for rotating said head, reservoir and sheath, means for imparting intermittent impacting blows to said sheath at points spaced at intervals along its length, and means spaced at intervals along said sheath for holding it in its axis of rotation.

6. Apparatus for loading insulating material into the sheath of a sheath wire heating unit provided with a sheath, a resistance element within the sheath and granulated insulating material within the sheath embedding the resistance element, comprising means for holding said sheath in an upright position, means for feeding said insulating material into the upper end of said sheath, a hammer having an arm arranged to strike said sheath, means pivotally mounting said hammer so that when it is alternately rotated in opposite directions said arm strikes said sheath and then moves away from it, an over-center spring having one end connected to said hammer, and means for reciprocating the other end of said spring between limiting positions so related to the axis of rotation of said hammer that the hammer is alternately rotated in said opposite direction when said end is reciprocated.

7. Apparatus for loading insulating material into the sheath of a sheath wire heating unit provided with a sheath, a resistance element within the sheath and granulated insulating material within the sheath embedding the resistance element, comprising means for holding said sheath in an upright position, means for feeding said insulating material into the upper end of said sheath, a hammer having a U shape, a pin pivotally mounting said hammer with its legs straddling said sheath for rotation on an axis substantially parallel with the axis of said sheath, a spring having one end attached to said hammer at a point between said pin and said sheath, and having its opposite end extending beyond said pin, a reciprocating member, means attaching the opposite end of said spring to said reciprocating member, and means for reciprocating said member while said insulating material flows into said sheath.

8. Apparatus for loading insulating material into the sheath of a sheath wire heating unit provided with a sheath, a resistance element within the sheath and granulated insulating material within the sheath embedding the resistance element, comprising means for holding said sheath in an upright position, means for feeding said insulating material into the upper end of said sheath, means for rotating said sheath while said insulating material flows into said sheath, a hammer having an arm arranged to strike said sheath, means pivotally mounting said hammer so that when it is alternately rotated in opposite directions said arm strikes said sheath and then moves away from it, an over-center spring having one end connected to said hammer, and means for reciprocating the other end of said

spring between limiting positions so related to the axis of rotation of said hammer that the hammer is alternately rotated in said opposite direction when said end is reciprocated.

9. Apparatus for loading granulated insulating material into the sheath of a sheath-wire heating unit provided with a resistance element within the sheath and embedded within said insulating material, comprising a head, means mounting said head for rotation on a vertical axis, said head being provided with a longitudinal bore having its longitudinal axis in the axis of rotation of said head, said bore being constructed and arranged to receive one end of said sheath, means for clamping said end to said head, a reservoir for said insulating material mounted on said head for rotation by the head and having a conical-shaped bottom wall tapering downwardly to a circular discharge opening of predetermined diameter located in said axis of rotation, and said head having a longitudinal passageway in its axis of rotation leading from said opening to said bore, said longitudinal passageway having a gradually increasing diameter as it progresses from said opening to a point adjacent said bore where it is abruptly reduced to a relatively small diameter, and means for rotating said head, reservoir and sheath.

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