United States Patent [19]

Frazier

[11] **3,761,191**

[45] **Sept. 25, 1973**

[54] **ELECTRODE NIPPLE DRILLING MACHINE**

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[22] Filed: **Sept. 27, 1971**

[21] Appl. No.: **184,140**

[52] **U.S. Cl.** **408/13,** 408/45, 408/67, 408/71, 408/90, 408/130, 408/26, 408/1

[51] **Int. Cl.** **B23b 39/20,** B23b 41/04

[58] **Field of Search** ..... 408/45, 46, 50, 52, 408/67, 71, 90, 130, 137, 26, DIG. 1

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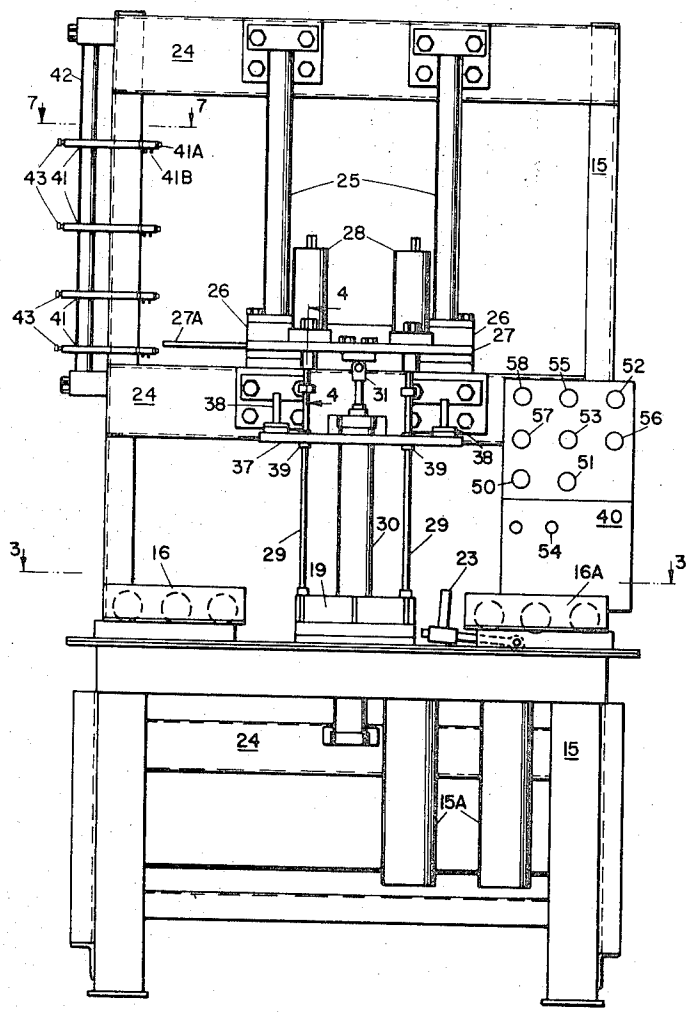
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[57] **ABSTRACT**

A machine for drilling holes in electrode nipple blanks, the holes being undercut to hold the appropriate thermosetting binder material. The machine is air driven and has a control system which permits either manual or semi-automatic operation in a preset time sequence. The nipples receive their final threading after all other operations of drilling and binder material filling have been performed, the resulting finished nipples thus require no further thread cleaning or inspection before use.

4 Claims, 9 Drawing Figures



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SHEET 1 OF 4

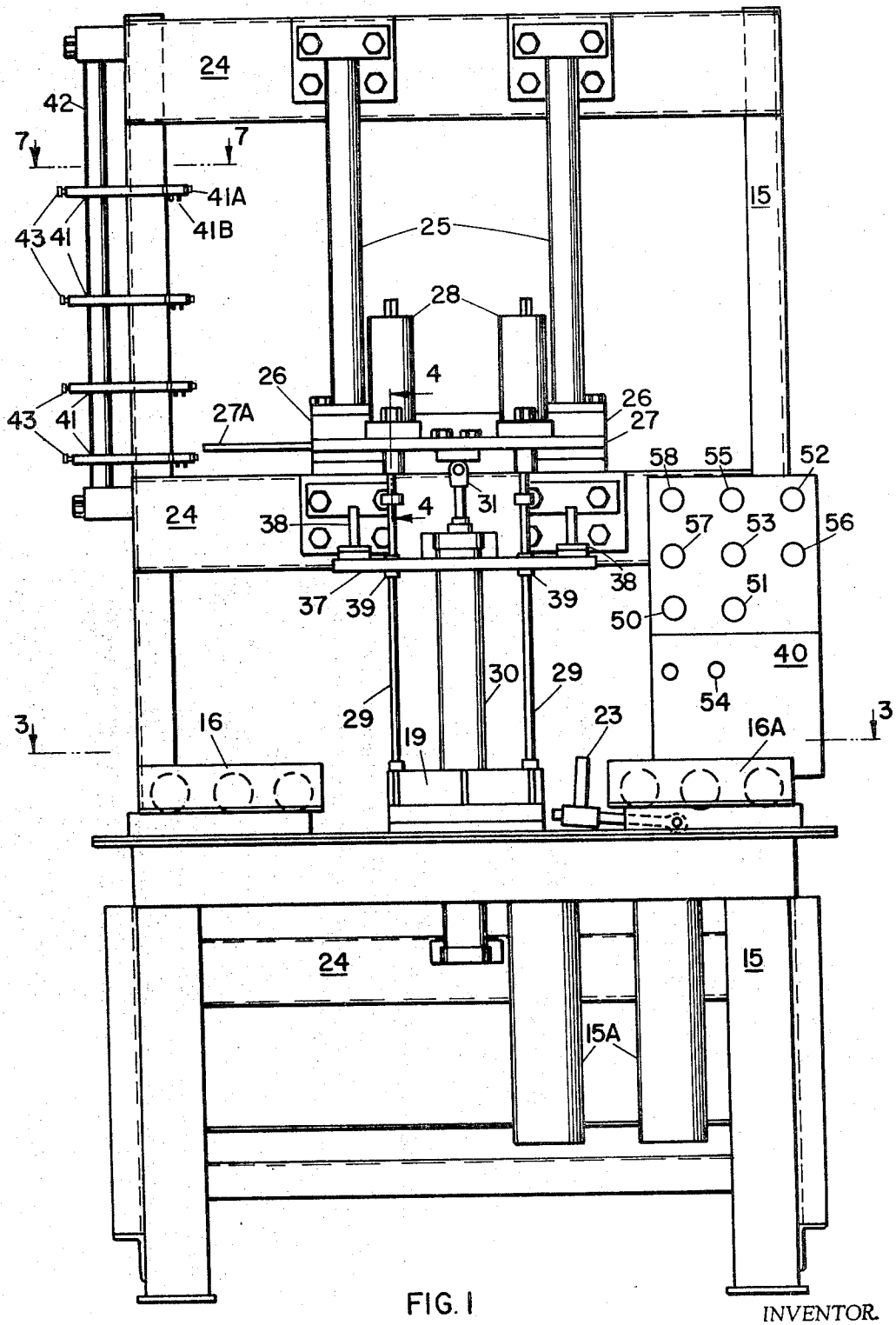


FIG. 1

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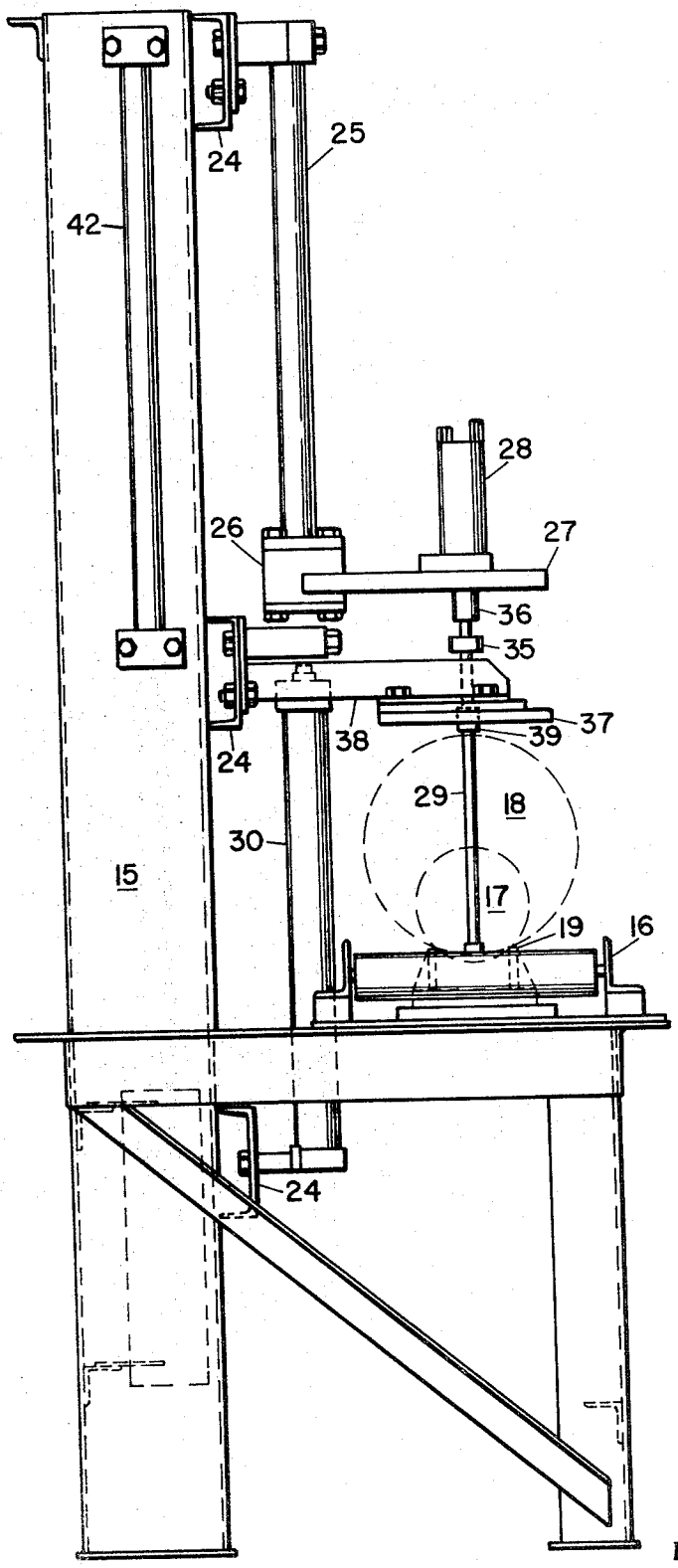


FIG. 2

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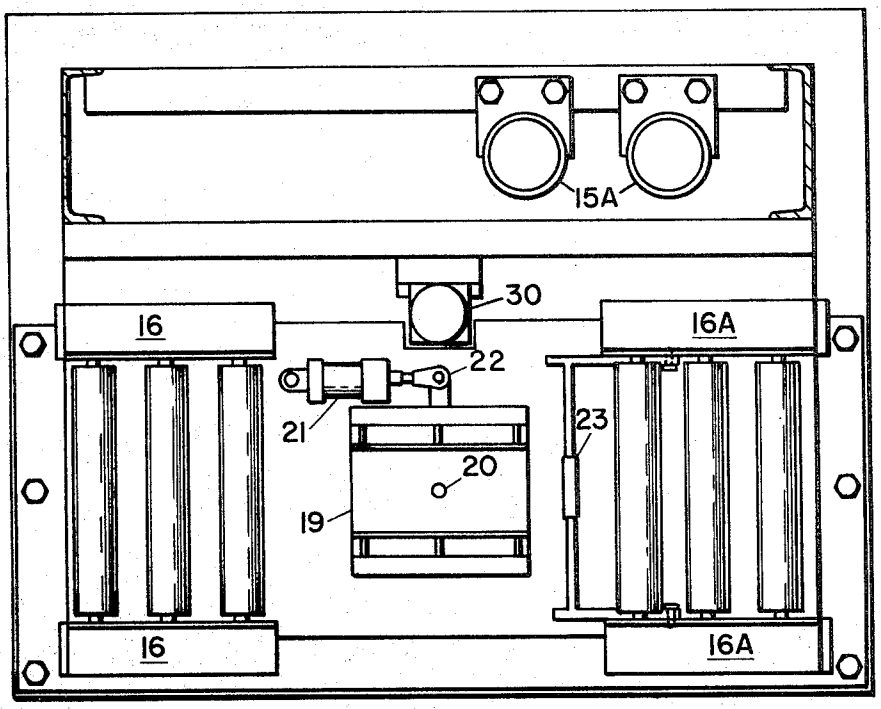


FIG. 3

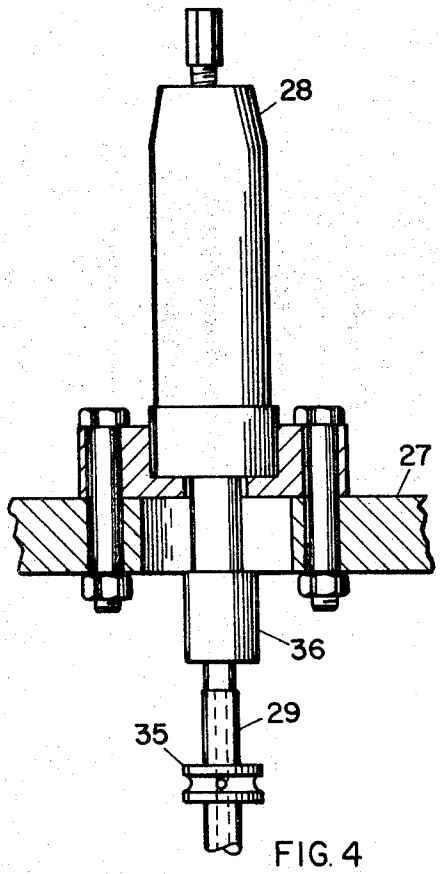


FIG. 4

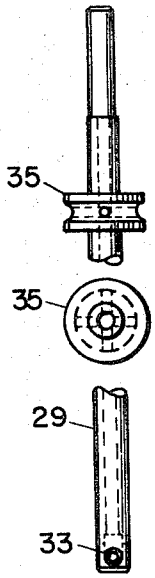


FIG. 5

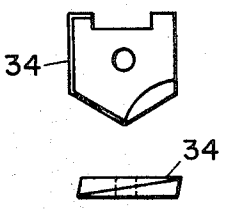


FIG. 6

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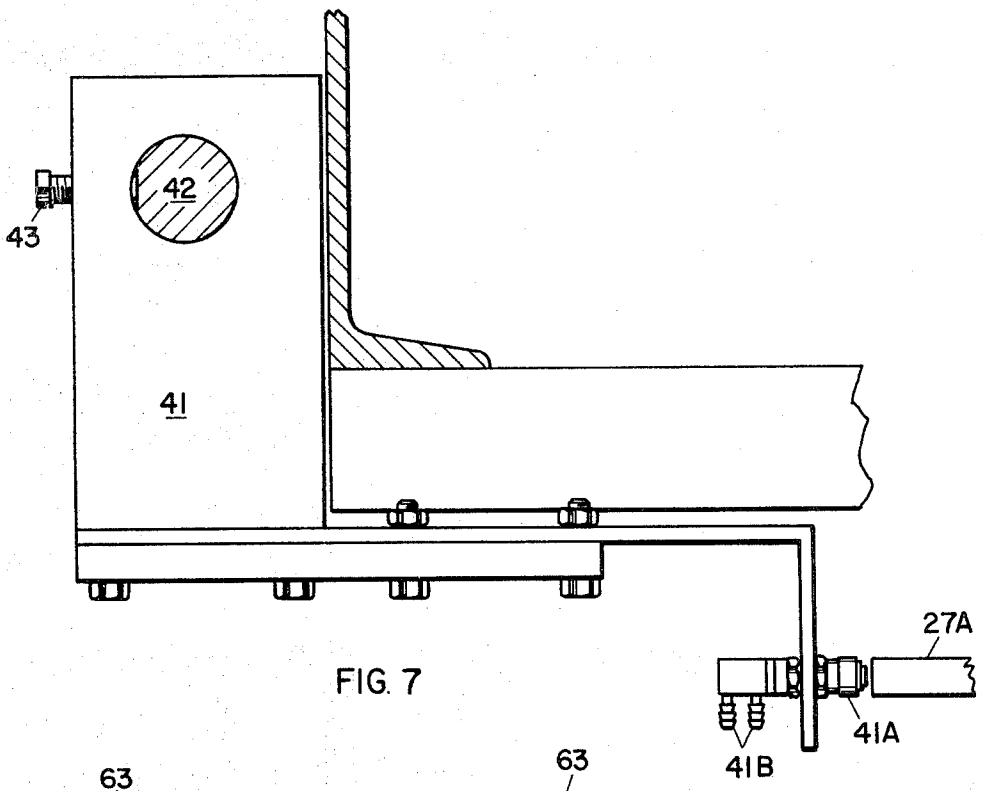


FIG. 7

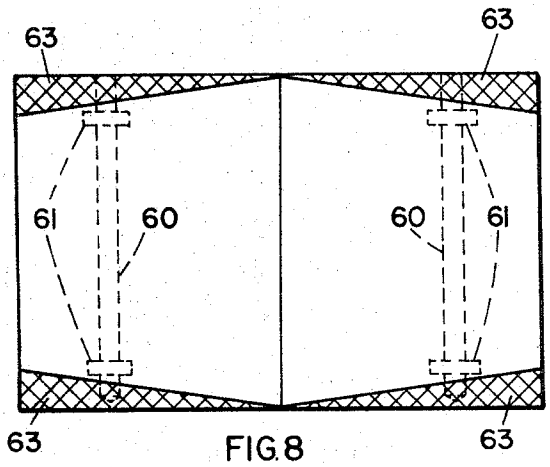


FIG. 8

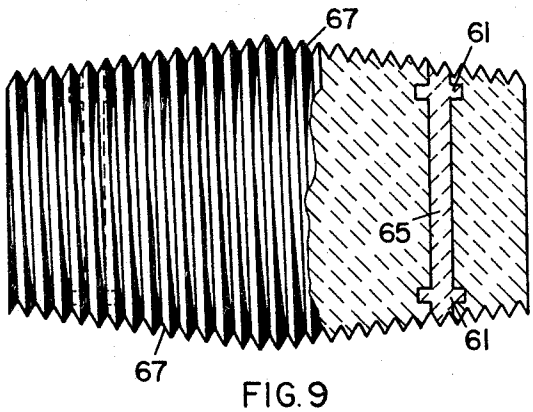


FIG. 9

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ELECTRODE NIPPLE DRILLING MACHINE

BACKGROUND OF THE INVENTION

This invention relates to connecting pins, more commonly known as nipples, for joining cylindrical electrodes made of carbon or graphite in end to end relation. Such electrodes are employed in electric arc furnaces for conducting electric current from a holder through the electrode to metal or minerals, such as ores, being treated within the furnace. Such electrodes may carry several thousand amperes of electric current. In size they may range from little more than an inch up to 3 feet or more in diameter and the large ones are commonly 5 or 6 feet or more in length and may weigh several thousand pounds.

In furnace operation the electrode is gradually consumed at the arc end, this requires a gradual feeding of the electrode into the furnace. To eliminate furnace shutdowns, it is customary to provide the ends of the electrodes with axial screw threaded sockets, so that a new electrode section may be joined, end to end, to the short length by the use of a screw-threaded nipple. Such nipples are usually made of material having a similar composition to that of the electrodes. As the electrode is gradually consumed at its inner end it will be slowly fed into the furnace and new sections will be added from time to time as required.

For satisfactory operation these joints between electrode sections should have low electrical resistance. To ensure proper contact, the adjacent ends of the electrodes should meet in a close-fitting face to face relation which should be continuously maintained while the furnace is in operation. During operation the electrode undergoes severe conditions of temperature and vibration. A permanently tight mechanical joint between the electrode section is desirable, not only to keep electrical resistance low, but also to prevent relative rotational movement between the electrodes and the nipple. For this purpose, a bonding material such as pitch may be applied to the nipple threads, usually by forming suitable channels in the nipple and casting the pitch into these channels. The nipple, containing solidified pitch, is then screwed into place between the two electrode sections. Furnace heat warms the joint, melting the bonding material which flows into the nipple threads. As the joint becomes hotter, the bonding material carbonizes and locks the threaded parts of the joint together. A wide variety of materials have been used as bonding material and various types of channels have been formed in the nipples to hold the material during joint assembly. Some of these prior designs are referred to in U.S. Pat. No. 3,419,296, most of these were unsatisfactory, either because the bonding material channels weakened the nipple or else were not designed to release an adequate amount of material to the joint threads.

A bonding material such as hot pitch is easily cast into a nipple recess, but may shrink and drop out when cold. In U.S. Pat. No. 2,941,829 a nipple is described in which circumferential grooves are provided for holding the bonding material. These grooves are under-cut on a lathe and then filled with bonding material, using a special casting ring attachment. A second lathe operation is then required to finish the nipple. A similar design is shown in U.S. Pat. No. 3,419,296 in which undercut slots are formed in a direction parallel to the axis of the nipple, these slots are located beneath the

nipple threads and provide reservoirs for pitch. While the connecting nipples described in the prior art have been fairly satisfactory, a definite need still exists for a nipple which can be easily manufactured with the minimum of machining, which is strong enough to resist breakage during installation and use, and which can retain an adequate amount of bonding agent. It is therefore, an object of the invention to provide an improved nipple for joining carbonaceous electrodes, as well as a method and apparatus for manufacturing such nipples.

SUMMARY OF THE INVENTION

The invention provides an improved machine and process for the drilling of carbonaceous bodies which may be made into nipples for joining carbonaceous electrodes. The machine comprises a frame with one or more roller supports mounted thereon, a body support with means for giving this support a limited traverse movement, a carriage having one or more drills capable of vertical movement, and means for controlling the vertical movement of the drills and the corresponding movement of the carbonaceous body or nipple blank upon the body support. The process comprises drilling one or more blind holes in the nipple blank, then moving the blank slightly during drilling to produce undercuts within the holes. The holes are filled with a suitable thermosetting bonding material and the nipple blank is then tapered and threaded to give the finished article.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a front view of the nipple drilling machine.

FIGS. 2 and 3 show side and top views, respectively of the same machine.

FIG. 4 shows an enlarged view of one of the air motors and its connection to a drilling shaft.

FIGS. 5 and 6 show details, respectively, of a drilling shaft and drill bit.

FIG. 7 shows details of the air stream sensing devices for vertical carriage control.

FIG. 8 shows a carbonaceous body such as a nipple blank, after drilling, ready for final tapering and threading.

FIG. 9 shows a partial section of a completed nipple, after tapering and threading.

DESCRIPTION OF THE INVENTION

A front view of the drilling machine of the invention is shown in FIG. 1. This comprises a rigid steel frame work 15, suitably braced to withstand heavy loading and mechanical vibrations. A. horizontal part of the frame is arranged to carry two sets of triple roller supports 16 and 16A. These bear the weight of the carbonaceous body or nipple blank while it is fed to the machine. In this description, the term "carbonaceous" refers to materials comprising not only the various commercial grades of carbon but also the various grades of partially or fully graphitized carbon or graphite commonly available. In FIG. 2, the outlines of two different sizes of blanks 17 and 18 are shown as they would be in position for drilling. The mid part of the nipple blank rests upon a body support 19. This is pivoted at its center 20 (see FIG. 3) to allow a limited degree of traverse motion, this motion being imparted by the air cylinder 21 and connecting link 22.

A stop device 23 acts to limit the movement of the nipple blank as it enters the machine from the left side. The stop device and body support position the nipple blank in the proper location for drilling; the stop device 23 may be adjusted to compensate for various lengths of nipple blanks.

Three cross members 24 (see FIG. 1) are fastened to the frame 15 and act as supports for two circular shafts 25 and air/hydraulic cylinder 30. The shafts 25 are guides for the ball bushings 26 which support a drill carriage 27. The drill carriage supports two air motors 28 which turn the drills 29. The drill carriage 27, along with motors 28 and drills 29 can move in a vertical direction, guided and supported by the ball bushings 26 sliding upon the circular shafts 25. This vertical movement is provided and controlled by air/hydraulic cylinder 30, acting through connecting link 31.

A detailed plan of the drill shaft and cutting bit is shown in FIGS. 5 and 6. The drill shaft 29 is made from heavy wall tubing with a hole 33 at one end for the attachment of the cutter bit 34 (see FIG. 6). Both side and end views of the bit are shown in FIG. 6 and it should be emphasized that the bit is somewhat larger than the shaft and is designed to cut, not only at the tip during downward motion, but also with the side of the bit as well. This permits an appreciable undercut when the work is moved a short distance in a plane perpendicular to the drill shaft. During drilling, a stream of air is supplied through the rotary fitting 35 (see FIG. 5), the air then passing down through the hollow drill shaft to the bit. This constant air flow carries out carbon chips and keeps the hole clean. FIG. 4 is an enlarged view of the air motor 28, showing its attachment to the drill carriage 27 and the attachment of drill shaft 29 to the air motor through the chuck 36. Air line connections to the air motor 28 and the rotary fitting 35 are not shown.

It is apparent from the description of the drilling apparatus that the drill shafts are rather long, in relation to their diameter, and may be prone to breakage, especially at great drilling depths. The drills are therefore supported by a horizontal support plate 37 (see FIG. 1) which is rigidly attached to the cross member 24 by two brackets 38. The drill shafts pass through non-friction bushings 39 in the support plate 37. During operation, this support plate helps guide the drills and greatly reduces their tendency to vibrate.

The vertical movements of the drill carriage are controlled by suitable solenoid air valves in an air over hydraulic circuit which in turn controls hydraulic oil supply to cylinder 30. The solenoid air valves, as well as supplemental equipment such as relays, power supply and push button controls, are housed in a control box 40 which is attached to the right front of the machine. Control may be either manual or automatic with a preset drilling program. Four adjustable air sensor units 41 are mounted on the left front side of the machine as shown in FIG. 1. These units may be adjusted in vertical relation upon the circular support shaft 42. An enlarged top view of one of these units is shown in FIG. 7. This shows the air sensor unit 41 as a right-angle shaped member, supporting the sensor air jet nozzle 41A. One of the two tubular connectors 41B is attached to an air supply source (not shown in FIG. 7) and a constant stream of air flows from this through the nozzle 41A. When the nozzle flow is interrupted momentarily, as by the drill carriage extension rod 27A, an air pulse signal is sent through the second of the tubular connectors 41B to the control box 40. The control mechanism here then activates air flow to cylinder 30 which positions the drill carriage accordingly. The air sensor units 41 may be readily adjusted to varying heights and intervals corresponding to the drilling operations required for varying sizes of nipple blanks. The sensor units are held in place on shaft 42 by suitable set screws 43.

In FIG. 1, two air over oil tanks 15A are shown attached to the lower part of the frame 15, below control box 40. The purpose of the air/hydraulic circuit is to provide precision feed rate control while drilling and especially to prevent drifting while performing the elongation functions of the cycle.

For operation, air and electrical power are turned on at control buttons 50 and 51. Control button 52 is then pushed to elevate the drill carriage to its highest position, this is governed by the setting of the topmost air sensor unit 41. A nipple blank is then brought to the machine and placed on roller support 16 from which it is moved into place on body support 19, the blank being positioned thereon by meeting the nipple stop device 23. Control button 53 is then pushed to start the drill motors, drilling speed being regulated by adjustment control 54. Control button 55 is then depressed to start the drilling operation and the drills move down through the nipple blank until they reach their lower limit of travel, set by the lowest air sensor unit 41. This part of the operation gives two straight blind holes in the nipple blank, the drills stopping just short of complete penetration. Button 52 is then pressed to raise the drill carriage to the level of the second air sensor unit and at this point the drill carriage stops, although the drills continue their rotation. At this point, control button 56 is pushed to activate air cylinder 21 (see FIG. 3). This gives a slight momentary traverse motion to the body support 19, shifting the nipple blank correspondingly and causing the drill bits to cut into their holes in a sidewise fashion, producing an undercut cavity. When control button 56 is released, the body support and the nipple blank return to their original position. Control button 52 is again pushed to raise the drill carrier to the next higher position where it is stopped again by the third air sensor unit 41. At this level the undercutting step is repeated, followed by complete withdrawal of the drill carriage to its original starting position. The stop device 23 is then depressed and the nipple blank rolled off the machine on roller support 16A. Suitable conveyor tracks not shown in the drawings may be used, both to convey the nipple blanks to the drilling machine and for removal of blanks after drilling.

While the above operation has been described in terms of manual control the machine is not limited to this mode. The control system also permits semiautomatic operation which is activated after a carbonaceous body or nipple blank is in position and the control button 57 is pushed. The drill carriage then descends and carries out the complete sequence of drilling operations, after which it rises to permit removal of the drilled nipple blank and replacement by a fresh blank. Pressing control button 57 starts the drilling cycle again. Action may be stopped at any time with control button 58.

A side view of a nipple blank after drilling is shown in FIG. 8. This shows clearly the long blind holes 60

and undercut cavities **61.** After drilling, the nipple blank is rotated 180° around its longer axis to shake out loose carbon chips. The blank is then rotated back to its original position and the holes filled with hot pitch or other appropriate bonding material. The nipple blank is then ready for final machining to form a nipple, in which the taper will be cut and the nipple threaded, the material removed being shown in areas **63.** It is apparent from FIG. **8** that final machining operations will open the blind ends of the holes, giving a finished nipple with four openings from which the bonding material will flow when the nipple is in use.

The function of the undercut cavities is also apparent, since these lock the bonding material in the nipple holes and prevent fall-out, even when the material cools and shrinks. Since the bonding material is added before final machining, no additional operations are required after the nipple threads are cut and the nipple is ready for use without further cleaning or inspection. A partial section of a completed nipple is shown in FIG. **9,** the nipple having the bonding material **65** in place with the threads **67** which are cut as the final operation.

While the machine of the invention has been described in operation with two drills, it may also be adapted to single drill operation as well. Single drilling might be used for nipple blanks in which the two holes were drilled in right angle relation to each other. This would be done by drilling the first hole, then advancing the nipple blank and rotating it by 90° before the second drilling. This might result in a nipple which was more resistant to breakage than one in which the holes were drilled parallel to each other.

While the drills and control devices of the machine as described are preferably operated by compressed air, the machine is not restricted to this power source alone since other rotary means, such as electric motors, might be used for the drills and suitable electric sensing units might be provided for controling the movement of the drill carriage and for positioning the carriage in its vertical movements throughout the complete sequence of drilling operations.

The operation of the machine has been described preferably for the drilling of carbonaceous nipple blanks, the blanks being subsequently processed to give improved nipples for joining carbonaceous electrodes. The machine is not limited to nipple blanks, but may be adapted to perform similar drilling operations on other shapes of carbonaceous bodies which may be not only circular but also multi-sided, such as square or hexagonal shapes. While the drills preferably enter the carbonaceous body from a perpendicular or vertical direction, the drill carriage and carriage guides may be adapted for drilling at an angle to the perpendicular, if so required by the dimensions of the body.

What is claimed is:

1. A machine for drilling undercut holes in a carbonaceous body, the machine comprising:

1. a frame;
2. a drill carriage mounted on the frame for movement toward and away from the cylindrical body;
3. a movable support for the body and means for moving the support; said support being mounted on the frame and capable of traverse slidable movement around a vertical pivot in axial alignment parallel to the axis of the drill, the traverse movement being perpendicular to the movement of the drill carriage;
4. a drill having a driving means for rotation and operationally associated with said drill carriage for drilling a hole in the body, said drill including a cutting bit having a head larger than the drill shaft whereby undercut slots are produced in the hole within the body when the body support and body are moved in traverse movement; and
5. control means including adjustable air sensor units for controlling the movement of the drill carriage toward and away from the body support.

2. A machine according to claim **1** in which the means for moving the said body support is an air cylinder.

3. A machine according to claim **1** wherein said control means also controls the sequence of drilling operations upon the body.

4. A machine according to claim **1** wherein the drill has a hollow shaft and means for forcing a stream of air through the hollow shaft during drilling, whereby to carry out carbon chips from the body.

* * * * *