

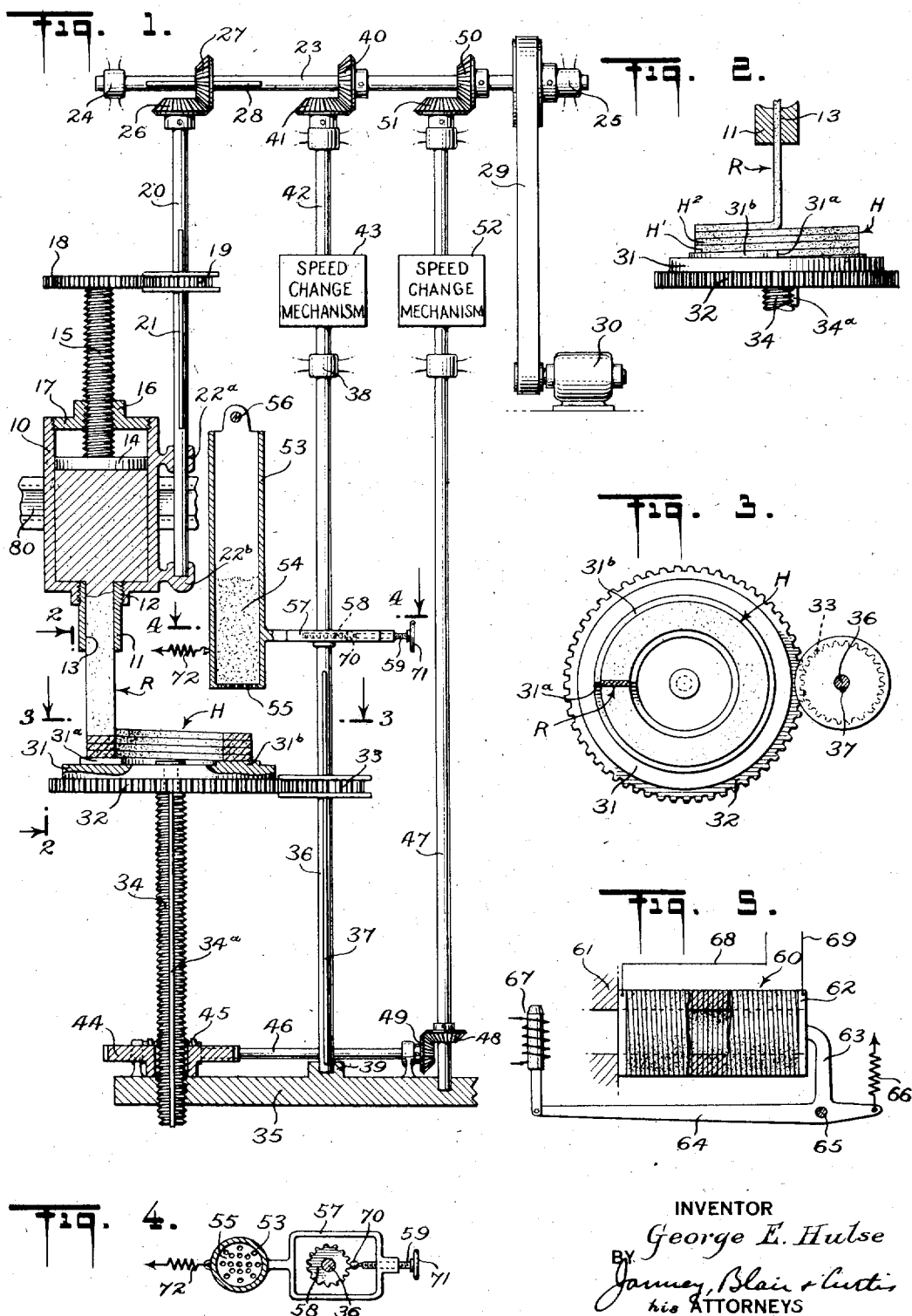
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APPARATUS FOR MAKING HELICAL CARBON FILES

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APPARATUS FOR MAKING HELICAL
CARBON FILES

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This invention relates to a method and apparatus for making a variable resistance and more particularly to a method and apparatus for making a compressible helical carbon pile variable resistance.

One of the objects of this invention is to provide a simple, practical, and inexpensive method for dependably making a variable pressure-responsive resistance. Another object is to provide a method for rapidly and economically forming a pressure-responsive resistance medium in the form of a continuous helix. Another object is to provide a method of the above-mentioned character that may be readily and efficiently carried on in practice with thoroughly reliable and practical results. Another object is to provide a method of the above-mentioned character that will be well adapted to meet the widely varying conditions of practical use. Another object is to provide a practical and efficient apparatus for carrying out certain steps in the above-mentioned methods and adapted to function accurately, rapidly, and with dependable results. Another object is to provide an apparatus of the above-mentioned character capable of a wide range of flexibility of action to meet the varying conditions met with in practice. Other objects will be in part obvious or in part pointed out hereinafter.

The invention accordingly consists in the features of construction, combinations of elements, arrangements of parts, and in the several steps and relation of each of said steps to one or more of the others thereof, all as will be illustratively described herein, and the scope of the application of which will be indicated in the following claims.

In the accompanying drawing, in which is shown a preferred embodiment of the mechanical features of my invention,

Figure 1 is a diagrammatic front elevation, partly in section, of an apparatus for carrying out certain steps of my method;

Figure 2 is a fragmentary side elevation as seen from the left in Figure 1;

Figure 3 is a plan view as seen along the line 3—3 of Figure 1;

Figure 4 is a horizontal sectional view as seen along the line 4—4 of Figure 1, and

Figure 5 is a front elevation partly in section, on a smaller scale, of a possible mechanical embodiment of the pressure-responsive resistance unit in practical form.

Similar reference characters refer to similar

parts throughout the several views of the drawing.

As conducive to a clearer understanding of certain features of my invention, it might here be pointed out that heretofore known pressure-responsive carbon pile resistances are characterized by many inherent deficiencies and defects. Such resistances are generally made up of a series of contacting or stacked disks or plates of carbon and are provided with suitable means for varying the compression of the pile and hence the ohmic resistance thereof. For such a pile to function appropriately, the carbon disks or plates should be warped. In use, such carbon piles have inherent limitations in heat dissipating characteristics, do not function uniformly, and at the lower pressures of compression and hence at the higher values of resistance, the major portion of the resistance is caused by only a few of the end plates which thus become overloaded, over-heated, and sometimes are subjected to rapid deterioration because of excessive sparking.

One of the dominant aims of this invention is to provide a thoroughly practical method and apparatus for achieving a pressure-responsive variable carbon resistance in which such deficiencies as those pointed out above are eliminated and many additional thoroughly practical advantages are successfully achieved, certain of which will be pointed out hereinafter.

Turning now to the drawing and more particularly to Figure 1, I first provide a chamber of suitable size preferably in the form of a cylinder whose axis extends vertically; the cylinder may be supported in any suitable manner, preferably for transverse adjustment, as along the ways 80.

At its lower end the cylinder or chamber 10 is provided with an orifice member 11 preferably removably related to the cylinder 10, as by the threaded connection at 12. The orifice member 11 has therein an orifice 13 (Figures 1 and 2) which, in horizontal cross-section, is preferably and illustratively rectangular. By way of illustration the cross-section or the orifice 13 may be such that its greater dimension is three-eighths of an inch and its lesser dimension one-eighth of an inch. The detachability of the orifice member 11 from the cylinder 10 permits it to be replaced by one in which the orifice is of different shape or dimensions, according to the practical requirements or conditions to be met. It is through this orifice 13 that the resistance ma-

material is to be ejected or extruded as will be more clearly described hereinafter.

Slidably interfitted within the cylinder 10 is a plunger or piston 14 adapted, upon downward movement, as viewed in Figure 1, to force the contents of the cylinder 10 out through the orifice 13. The downward movement of the piston 14 is preferably achieved by rotatably connecting to it a threaded plunger rod 15 which is in threaded engagement with the threaded boss 16, through which it extends, provided at the end closure member 17 of the cylinder 10, member 17 being removable from the cylinder 10 in any suitable manner to permit the cylinder or chamber 10 to be charged with the material to be extruded. Rotation of the threaded shaft or rod 15 achieves a movement of the piston 14 along the cylinder 10.

The carbon resistance material of which the pressure responsive resistance is to be made is first made up in the form of a plastic batch, the composition of which, insofar as certain features of my invention are concerned, may widely vary; for example, it may be made up of similar constituents as have heretofore been used in making up the carbon disks or plates of heretofore known compressible carbon piles.

Illustratively, the plastic material may be made up of a mixture of a suitable form of finely divided or powdered carbon and a suitable binder, the mixture having an appropriate consistency suiting it for extrusion in the device 10—14. The finely divided carbon may be ground coke, deposited carbon like lampblack, powdered graphite, or the like. The finely divided carbon may then be bituminated or otherwise mixed with a suitable bituminous or hydrocarbon binder. The binder may comprise coal tar or any suitable coal tar pitch. The resultant plastic mixture is introduced into the cylinder 10 in any suitable way.

The upper end of the threaded piston rod or screw 15 (Figure 1) has secured thereto a gear 18 which is driven by a gear 19 splined onto shaft 20, the spline being indicated at 21 and the shaft 20 being rotatably supported in any suitable bearings indicated at 22^a and 22^b. Thus, as the shaft 20 is rotated, the screw 15 is likewise rotated to move the piston 14, the splined connection between the gear 19 and the shaft 20 permitting the gear 19 to partake of this movement in an axial direction of the screw 15 while maintaining driving connection with the shaft 20.

Shaft 20 is driven from a main drive shaft 23 rotatably supported in bearings 24 and 25, the connection between the two shafts being conveniently achieved by bevel gears 26 and 27, the latter being splined to shaft 23 as is indicated at 28. The main drive shaft 23 may be driven through any suitable power transmission mechanism indicated at 29 from any suitable source of driving power, preferably reversible, and illustratively taking the form of a reversible electric motor 30.

Underneath the orifice member 11 in the cylinder 10 is positioned a rotatable table or support 31, preferably in the shape of a disk and preferably provided with gear teeth 32 to mesh with a gear 33 through which the table 31 may be rotated about its axis.

Table 31 is rotatably supported upon the upper end of a screw 34 that is coaxial with the axis of the disk 31 and is in threaded engagement with a suitable fixed support 35 which may be part of the frame (not shown) of the apparatus. As the end screw 34 is rotated, therefore, the table 31 is raised or lowered in accordance with the direc-

tion of rotation, due to the coaction of the screw 34 with its threaded support 35. Gear 33 is splined onto a shaft 36 which, like the shaft 20, extends vertically, the splined connection being indicated at 37. The shaft 36 is rotatably supported in suitable bearings 38 and 39, the splined connection between the shaft and the gear 33 permitting the latter to partake of the vertical movement of the table 31.

Shaft 36 is driven from the main drive shaft 23 through the bevel gears 40 and 41, the latter driving a shaft 42 interconnected with the shaft 36 through a speed-change mechanism generally and diagrammatically indicated at 43. The latter mechanism may be of any suitable type or construction and preferably is of the type adapted to give a wide range of change in the ratio of speed between the shafts 42 and 36.

Thus, the rate of rotation of the table 31 may be determined at will.

The rate of movement in a vertical direction of the table 31 is also preferably controllable at will and by way of illustration, the screw 34 may have a splined connection with a worm wheel 44 suitably held against movement along the screw 34, worm wheel 44 being driven by a worm 45 on a suitably supported shaft 46 which is driven by a vertical shaft 47 through the bevel gears 48 and 49.

Shaft 47 is driven from the main drive shaft 23 as by the bevel gears 50 and 51, suitable speed-change mechanism 52, like the mechanism 43 above described, being interposed between the shaft 47 and the gear 51.

By suitably setting the speed-change mechanism 52, the rate of vertical movement of the table 31 may be determined independently of its rate of rotation.

Assuming that the apparatus has been set in motion, the downward movement of the piston 14 extrudes the plastic mass of resistance material through the orifice 13, the latter emerging in a ribbon R (Figures 1 and 2) of uniform and constant cross-section, as determined by the cross-section of the orifice 13. The screw 15, moreover, being driven at a constant rate of speed, causes the ribbon R to be produced and increased in length at a correspondingly constant rate.

However, the rotating table 31 is positioned immediately underneath the orifice member 11 (Figure 1) but with the orifice and hence the extruded ribbon R aligned with and along a radius of the disk-like table 31 (see Figure 3). The emerging end of the ribbon R is laid against the shoulder 31^a (Figure 2), of what is virtually a single rotation of a helix formed, as shown at 31^b, integrally with the table 31 and hence at a point displaced from the axis of rotation of the table by a distance equivalent substantially to the radius of the ultimate helix of carbon that is to be formed. This radius may illustratively be on the order of one or two inches or so. Due to the rotation of the table 31 at a constant speed, determined by the speed-change mechanism 43, that is so proportioned to the rate of extrusion of the ribbon R through the orifice 13 that the table 31 makes one complete revolution for every length of extruded ribbon equal substantially to the product of twice the above-mentioned radius by 3.1416, the extruded ribbon is laid flat upon the helix turn 31^b of table 31 in the form of gradually rising annulus or ring, forming thus the first turn or convolution H¹, and as the extrusion and rotation of table 31 proceed, a suc-

ceeding convolution H^2 is laid down upon the first, and so on.

However, as the convolutions thus laid increase, the spacing between the table 31 and the orifice member 11 correspondingly increases inasmuch as the speed-change mechanism 52 is set to rotate the table screw 34 at such a speed that the table 31 is moved downwardly at substantially the same rate that the vertical dimension of the helix, indicated at H in Figures 1 and 2, increases.

During the above-described steps and actions, I cause the application to the ribbon R as fast as it is being laid onto the support or onto convolutions already laid a suitable material having the characteristic of preventing adjacent convolutions of the ribbon from adhering to each other or from becoming united. Preferably I apply to the ribbon R, as it is being laid in the form of the convolutions, dry powdered graphite, applying it in a uniform layer upon the upper face of the uppermost convolution.

To carry out this step more effectively, I provide a container 53 for receiving a supply 54 of powdered graphite, the container 53 having a bottom 55, removable in any suitable way, made in the form of a sieve or otherwise provided with a suitable number of suitably dimensioned perforations or apertures.

Container 53 is supported so that its sieve-like bottom 55 is in the rotary path of movement of the ribbon R as the latter is carried about the axis of the table 31 due to the rotation of the latter and is vibrated continuously so as to cause the powdered graphite to be sifted through the apertured bottom 55 and onto the laid ribbon of plastic resistance material.

Illustratively the container 53 may be pivotally supported as at 56 and at its opposite and lower end has secured thereto a yoke 57. (see Figures 1 and 4) through which the vertical shaft 36 extends, the yoke being of sufficient dimensions to freely permit the rotation therein of a toothed gear-like member 58 secured to and rotated by the shaft 36.

At its right-hand end the yoke 57 has threaded therethrough a stem 59, the inner end of which is provided with a suitable device 70, which may be in the form of a roller if desired, for engaging the toothed member 58 and at its outer end is provided with a hand wheel 71. A spring 72 (Figures 1 and 4) tends to swing the container 53 and yoke 57 toward the left, thus to maintain the member 70 in engagement with the toothed member 58.

As the toothed member 58 rotates with the shaft 36, therefore, the coaction therewith of the roller 70 and the spring 72 causes a steady and uniform vibration of the container 53, thus to cause a correspondingly steady and uniform emission and distribution of powdered graphite onto the rotating convolution as the latter is being formed on the rotating table 31.

In Figures 1 and 2 the helix H is shown partially completed and more specifically is shown as having about four convolutions already formed. The above-described steps are continued until the desired number of convolutions of the helix H has been formed; for example, it might be desired to form twenty or thirty complete turns or convolutions.

Then the apparatus is halted and the helix is submitted to a suitable heat treatment which, for example, may consist in firing the helix at a temperature which may vary throughout wide limits, depending upon the materials employed

in the plastic resistance mixture and depending also upon the ultimate resistivity desired. For example, the temperature during the heat treatment may vary from 400° C. to 900° C. The bituminous or other hydrocarbon binder, during this heat treatment, is in part evaporated and in part caused to react with the powdered carbon to cause the particles of the latter to adhere just as though the ultimate helix were formed of a solid carbon material.

The powdered graphite is removed from in between the convolutions of the helix and the adjacent faces of the convolutions cleansed or smoothed off in any suitable manner, whereupon the helix is ready to be assembled in the resistance device.

In Figure 5 I have diagrammatically shown a possible embodiment of the helical carbon ribbon into an electrically controlled variable resistance device. The helix of carbon, in Figure 5, is indicated at 60 and its one end may be anchored or secured to a suitable fixed support 61 while its other or free end may be connected to a metal plate 62 with which is connected one arm 63 of a bell crank lever 64 pivoted as at 65; a spring 66 acts on the lever 64 to swing the latter in a direction to compress the helix 60 while an electromagnet or solenoid or any other suitable means indicated at 67 may be utilized to act in opposition to the spring 66 to effect a decrease in the pressure of compression of the carbon helix 60 and thus to increase the resistance of the circuit 68—69 in which the helix 60 is included.

The helix resulting from my process is inherently resilient, acting like a helical spring tending to expand, this tendency being dependent upon such factors as the diameter of the helix, the thickness of the ribbon, the spacing between adjacent convolutions, and hence upon the pitch of the helix.

Moreover, it is hollow throughout and, with annular supports 61 and 62 at its ends to expose the interior walls of the helix to the atmosphere, excellent heat dissipating qualities are given the resistance unit.

Moreover, the above-described resiliency achieves a uniformity of action of the variable compressible resistance device throughout its entire range of change of resistance; there is no sparking between adjacent contacting convolutions for together they form a continuous electrical circuit. Also, there is uniformity of distribution of work throughout the entire length of the helical ribbon and thus long life is assured. Moreover, I am enabled to achieve a far lesser minimum value of resistance with a far less applied pressure of compression than has heretofore been possible with known types of carbon pile resistances intended to have an equivalent range of change of resistance.

Should I desire to increase the pitch of the helix, I increase the thickness of the layer of powdered graphite and increase the rate at which the table 31 is lowered so as to compensate for the increased rate at which the vertical dimension of the helix (ribbon R plus the layer of graphite) increases. I achieve a change in the rate of lowering of the table 31 by increasing the rate of drive of the screw 34, appropriately setting the variable speed mechanism 52 (Figure 1) and I may increase the quantity of powdered graphite applied to the ribbon as it is being wound in the form of a helix by replacing the perforated or sieve-like bottom 55 of the con-

tainer 53 with one that is of coarser mesh or that has larger perforations.

If I wish to wind a helix of different diameter, I shift the cylinder 10 to the right or left, as viewed in Figure 1 and along a radius of the table 31, the chamber 10 being suitably mounted by ways 80 (not shown in detail) adapted to permit such lateral shifting while the splined connection between the gear 27 and the shaft 23 maintains the drive of the piston 14 throughout the change of position that is given the chamber 10.

The locus of operation of the sieve-like bottom 55 of the container 53 may be shifted, also along a radius of the table 31, by suitably setting the screw stem 59 (Figures 1 and 4) by hand wheel 71, thus to shift laterally the lower end of the container 53.

Should such factors as change in the diameter of the helix into which the extruded ribbon of plastic resistance material is being wound necessitate a change in the speed of rotation of the table 31, speed-change mechanism 43 may be appropriately set.

Thus by appropriately determining the rate of rotation of the table 31 and the rate of relative vertical displacement between it and the orifice 13, I am enabled to wind various diameters of helixes and various thicknesses of ribbons and by such and other features already abovementioned I am enabled to determine at will the pitch and other characteristics of the resultant helix.

The piston 14 and the table 31 I return to their uppermost or starting positions, when necessary, by reversing the direction of rotation of the screws 15 and 34, respectively; this may be accomplished by reversing the direction of drive of the reversible motor 30.

It will thus be seen that there has been provided in this invention an art and apparatus in which the various objects hereinabove pointed out together with many practical advantages are successfully achieved.

As many possible embodiments may be made of the mechanical features of the above invention and as the art herein described might be varied in various parts, all without departing from the scope of the invention, it is to be understood that all matter hereinabove set forth or shown in the accompanying drawing is to be interpreted as illustrative and not in a limiting sense.

I claim:

1. In apparatus of the character described, in combination, a container having an opening in the bottom portion thereof and adapted to hold a plastic substance, means adapted to feed said substance at a constant rate from said opening, a rotatable support below said opening in said container and positioned to receive said plastic substance, means adapted to rotate said support at a predetermined constant rate, means adapted to lower said support at a predetermined constant rate, and means operatively connecting all of said means to proportion the operative speeds thereof whereby the interaction of all of said means forms a helix on said support having uniform registering convolutions.

2. In apparatus of the character described, in combination, a container having an opening in the bottom portion thereof and adapted to hold a plastic substance, means adapted to feed said substance at a constant rate from said opening, a rotatable support below said opening in said container and positioned to receive said plastic substance, means adapted to rotate said support

at a predetermined constant rate, means adapted to lower said support at a predetermined constant rate, and means operatively connecting all of said means whereby the interaction of all of said means forms a helix on said support having uniform registering convolutions, said lowering means adapted to move said support away from said opening a distance equal to the vertical thickness of one of said convolutions during each revolution of said support.

3. In apparatus of the character described, in combination, a container having an opening in the bottom portion thereof and adapted to hold a plastic substance, means adapted to feed said substance at a constant rate from said opening, a rotatable support below said opening in said container and positioned to receive said plastic substance, means adapted to rotate said support at a predetermined constant rate, means adapted to lower said support at a predetermined constant rate, means operatively connecting all of said means whereby the interaction of all of said means forms a helix on said support having uniform registering convolutions, a container for a non-adhesive powder suspended above said support and having an opening over that portion of said support on which said convolutions are formed, and means adapted to sprinkle said powder from said container on said convolutions during the operation of all of said means.

4. In apparatus of the character described, in combination, a container having an opening in the bottom portion thereof and adapted to hold a plastic substance, a plunger reciprocally disposed within said container, means adapted to force said plunger toward said opening to extrude said plastic substance therefrom at a constant rate, a rotatable support below said opening positioned to receive said plastic substance, means adapted to rotate said support at a predetermined constant rate, and means operatively connecting all of said means to proportion the operative speeds thereof, whereby the interaction of all of said means forms a helix on said support having uniform registering convolutions.

5. In apparatus of the character described, in combination, a container having an opening in the bottom portion thereof and adapted to hold a plastic substance, a nozzle disposed in said opening, a plunger reciprocally disposed within said container adapted to extrude said substance at a constant rate from said container through said nozzle, driving means for said plunger, a rotatable support below said orifice and positioned to receive therefrom said plastic substance, means adapted to rotate said support at a predetermined constant rate, means adapted to lower said support at a predetermined constant rate, and means operatively connecting all of said means to proportion the operative speeds thereof whereby the interaction of all of said means forms a helix on said support having uniform registering convolutions.

6. In apparatus of the character described, in combination, a container having an opening in the bottom portion thereof and adapted to hold a plastic substance, means adapted to feed said substance at a constant rate from said opening, a table below said opening in said container positioned to receive said plastic substance, a threaded shaft supporting said table, means adapted to rotate said table at a predetermined constant rate, rotatable means threaded on said shaft and anchored so that upon rotation thereof said shaft

and said table are lowered at a predetermined constant rate, and means forming a driving connection between all of said means whereby the interaction thereof forms on said table a helix having uniform registering convolutions.

7. In apparatus of the character described, in combination, a driving member, a plurality of driven members connected to said driving member, means including a container having an opening in the bottom portion thereof and adapted to hold a plastic substance, extruding means in said container adapted to force said substance through said opening, means forming a driving connection between said last-mentioned means and one of said driven members, a rotatable support below said opening positioned to receive said plastic substance, means forming a driving connection between said support and another of said driven members to rotate said support at a predetermined constant rate whereby a helix having uniform registering convolutions may be formed on said support.

8. In apparatus of the character described, in combination, a driving member, a plurality of driven members having a driving connection with said driving member, a container having an opening in the bottom portion thereof and adapted to hold a plastic substance, means in said container adapted to extrude said substance through said opening, means forming a driving connection between said last-mentioned means and one of said driven members, a rotatable support below said opening and positioned to receive said plastic substance upon extrusion thereof from said container, means forming a driving connection including speed change mechanism between said rotatable support and another of said driven members to rotate said support, lowering means connected to said support, and means forming a driving connection including speed change mechanism between another of said driven members and said lowering means to lower said support.

9. In apparatus of the character described, in combination, a driving member, a plurality of driven members connected to said driving member, means including a container having an open-

ing in the bottom portion thereof and adapted to hold a plastic substance, extruding means in said container adapted to force said substance through said opening, means forming a driving connection between said last-mentioned means and one of said driven members, a rotatable support below said opening positioned to receive said plastic substance, means forming a driving connection between said support and another of said driven members to rotate said support at a predetermined constant rate, lowering means connected to said support and adapted to move said support away from said opening, and means forming a driving connection between said lowering means and another of said driven members.

10. In apparatus of the character described, in combination, a drive shaft, a plurality of shafts mechanically connected to said drive shaft and driven thereby, a container adapted to receive a plastic material, means forming an orifice communicating with the interior of said container, an extruding plunger in said container adapted to extrude said material through said orifice, a driving connection between said plunger and one of said driven shafts, a rotatable table below said orifice positioned to receive said plastic substance upon extrusion from said orifice, driving means between said rotatable table and another of said driven shafts for rotating said table whereby said plastic material may be deposited in a helix on said table, a threaded shaft associated with said table, an anchored threaded member threaded on said shaft, a driving connection between said threaded member and another of said driven shafts whereby operation of said last-mentioned driven shaft rotates said threaded member to lower said threaded shaft and said rotatable table at a predetermined constant rate to maintain said convolutions uniform as they are laid on said table, a container for a non-adhesive powder suspended above said table and having an opening over that portion of said table on which said convolutions are formed, and means adapted to sprinkle said powder from said container on said convolutions during the formation thereof.

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