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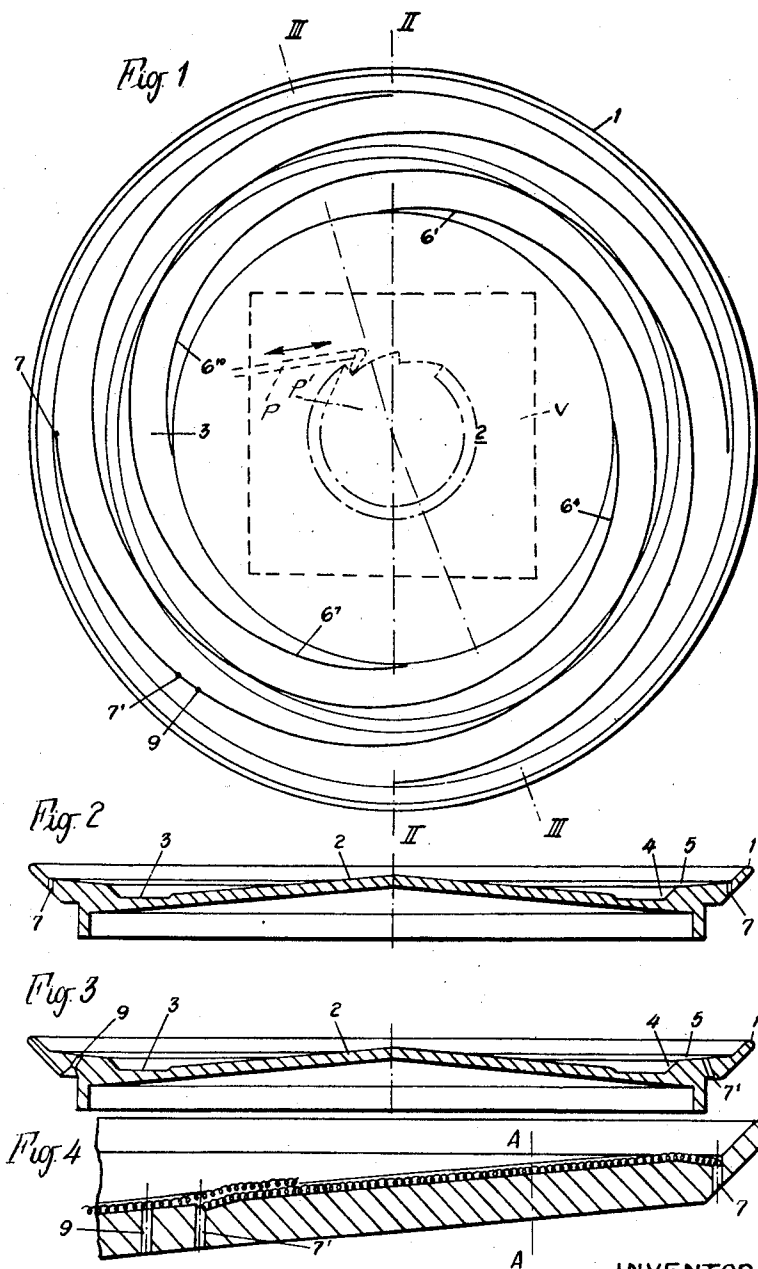
Z. DESHAW ET AL

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METHOD AND APPARATUS FOR ARRANGING AND FEEDING WIRE FILAMENTS

Filed April 26, 1956

2 Sheets-Sheet 1



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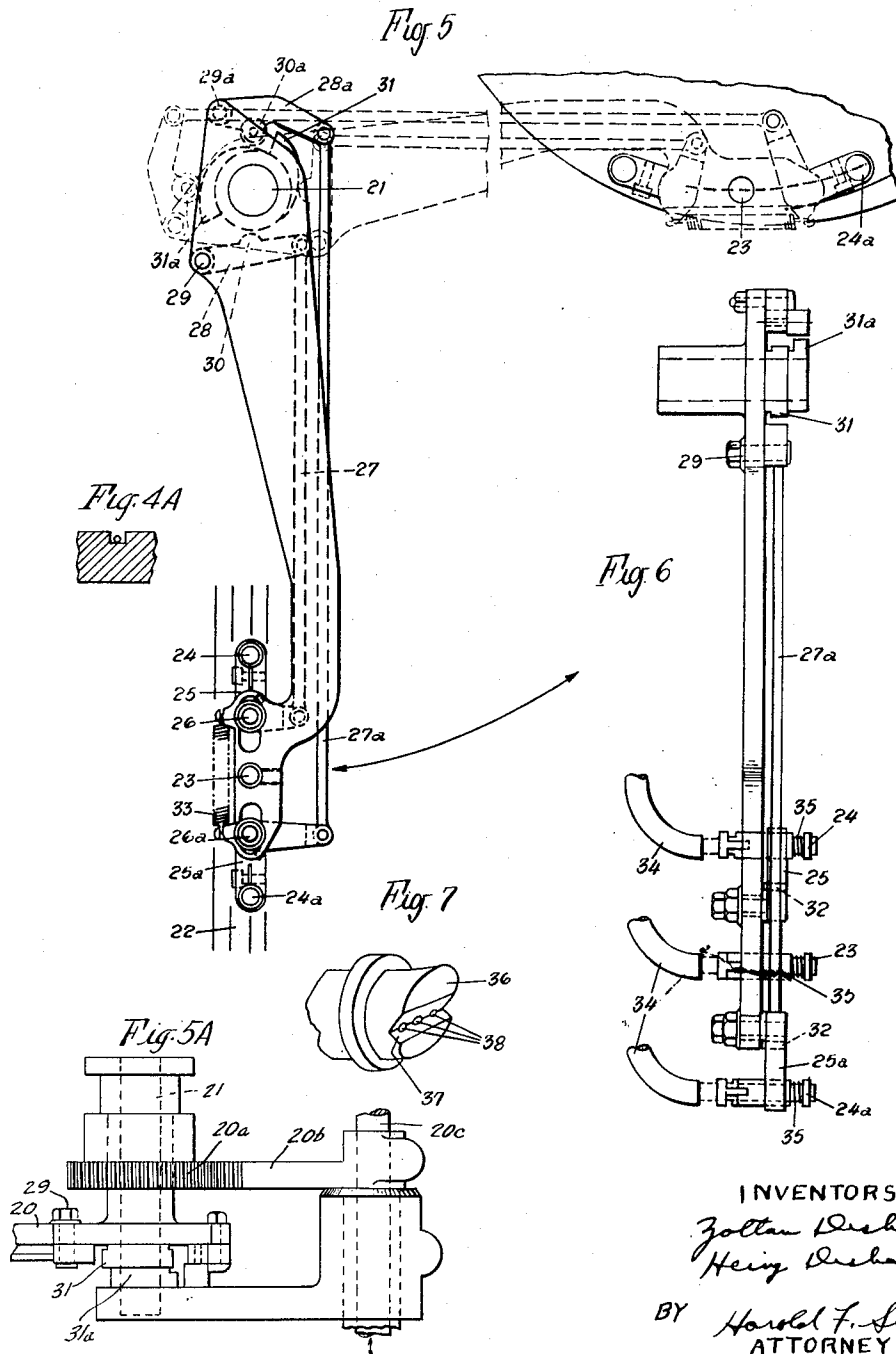
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2 Sheets-Sheet 2



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**METHOD AND APPARATUS FOR ARRANGING
AND FEEDING WIRE FILAMENTS**

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6 Claims. (Cl. 198—33)

This invention relates to a method of separating coiled wire filaments for electric incandescent lamps or other thermionic devices (hereinafter called "filaments") from a mass of such filaments and of orientating the said filaments at a delivery point or points and further relates to apparatus for use according to the said method.

Filaments are supplied by the filament manufacturers in the mass, i. e. in disordered array and before they can be used in the production of lamps or thermionic devices the filaments have to be separated from the mass. The filaments require to be carefully handled during separation to prevent distortion of the successive helical turns of the fine wire of which they are formed. The separation of the filaments from the mass and their positioning e. g., on a filament mount drum ready for automatic connection to the lamp or valve electrodes has hitherto been effected manually. This is a skilled task and one which is tedious and involves much physical and mental strain.

We have developed a method and apparatus for use in the same whereby the filaments may be separated automatically from a disordered mass thereof and orientated at a delivery point or points whereby, except for supervision, the said manual operation may be dispensed with and considerable economies may be effected.

The method of our invention broadly consists in feeding the filaments to a vibrating collecting zone; allowing the filaments to collect in the said collecting zone from which lead upwardly to one or more delivery points one or more grooves each being of sufficient depth and width to receive one filament but of insufficient depth or width to receive two filaments side by side in the same groove; permitting filaments to be vibrated up said groove or grooves in succession, and permitting those filaments if any which leave a groove before reaching the delivery point or points to return downwardly with a rolling motion to the collecting zone or to a lower groove.

Means may be provided in the said groove or grooves whereby each filament on reaching a delivery point is arrested and further means may be provided whereby the next succeeding filament is caused to ride over the trailing end of the arrested filament and thereby to be vibrated out of the said groove and rolled back to the collecting zone or to a lower groove.

Means may also be provided for bringing each of the said delivery points in succession to a transfer mechanism for effecting transfer of the filaments successively from each of the delivery points to a further mechanism such as a filament mounting drum.

Apparatus for use in the said method according to our invention comprises a collecting zone with one or more grooves leading upwardly therefrom to a delivery point or points each groove being of sufficient depth and width to receive a filament; means for vibrating the said collecting zone and the surrounding walls of the grooves or grooves in such manner that filaments placed therein will be moved upwardly along the groove or grooves in succession to a delivery point or points, and means such as an inclined surface or edges arranged transversely of

the groove or grooves which will permit filaments which have left a groove before reaching a delivery point to return downwardly with a rolling motion to the said collecting zone or to a lower groove.

The apparatus according to the invention may include means for bringing each delivery point in succession into registration with automatic transfer means for transferring the filaments in succession to apparatus such as a filament mount drum.

The method and apparatus according to the invention require the depth and width dimensions of the filament receiving and locating groove or grooves to be carefully selected in relation to the dimensions of the filaments to be handled. A groove which is too wide or too deep for a particular diameter of filaments will allow a second filament to lodge in the groove alongside the first filament at any given position along the length of the groove and would allow of the simultaneous delivery of two filaments at one delivery point. Conversely if the groove is too narrow or too shallow the advance of the filaments will be impeded or the vibratory movement will cause the filaments to jump out of the groove and result in intermittent delivery of filaments at the delivery point or points. Grooves of rectangular section are suitable. Filaments of a given wattage may vary slightly in diameter. We have obtained good results using rectangular sectioned grooves having a width a little less than 1.5 times the average diameter of filaments of the particular wattage in question, and depth about 1.2 times such average diameter.

A groove need not be of uniform dimensions but at least that part preceding the delivery point must not exceed the specified dimensions.

We prefer to arrange the grooves spirally, and it is convenient to provide a number of such spiral grooves which advance outwardly from a central area on which the mass of filaments in disordered array may initially be placed. Thus the surface on which the filaments are collected may be the surface of a tray having a domed, conical or like raised central portion on which the disordered mass of filaments may be placed and having filament-receiving grooves in its surface, which grooves advance spirally from around the lower level of the said central portion to points situated at a higher level at or near the rim of the tray. The tray is preferably formed from non-ferrous metal, e. g. brass, and has a polished surface.

The degree of polish is material and a high polish is desirable for the most efficient results. The delivery end of the groove or of each groove may be straight for a length corresponding substantially with the length of the filament delivered. The outer ends of the spiral grooves may be formed with stops for limiting the advance of the leading filaments in the grooves and the tray may receive indexing movements to bring each delivery point in succession in registration and in timed relation with pickup means which advances towards and away from the plate surface for picking up filaments one by one in succession, first the fully advanced filament in one groove, then the fully advanced filament in the next groove and so on.

The collecting zone at the position from whence the said spiral grooves lead away is preferably in the form of a flat horizontal annulus; the central domed or conical portion having a sufficiently sloped surface to cause the filaments under the influence of gravity or vibration or both to descend to the said annulus.

The surface of the tray in which the spiral grooves are disposed may with advantage have a steeper slope near the annulus and a less steep slope near the periphery of the tray.

One form of apparatus according to the invention will now be described by way of example with reference to the accompanying drawings in which: Fig. 1 is a plan view of a tray on which the filaments are separated and orientated; Fig. 2 is a cross sectional elevation on the line II—II of Fig. 1; and, Fig. 3 is a sectional elevation on the line III—III of Fig. 1; Fig. 4 is a detail view, being a section through the outer end portion of one of the filament-receiving grooves; Fig. 4a is a transverse section on the line A—A of Fig. 4; Fig. 5 is a plan view of filament pick-up and transfer mechanism; Fig. 5a is a detail view showing mechanism for moving the pick-up arm; Fig. 6 is an elevation of part of this mechanism, and Fig. 7 is a detail view of one of the suction heads employed in the said mechanism.

Referring now to the drawings, Figs. 1 to 3, the tray is circular with a peripheral rim 1, and a raised conical centre portion 2. The portion 2 is surrounded by a flat annular zone 3 which itself is bounded by an upward slope 4 leading to a more gently sloping outer annular zone 5 extending up to the tray rim. The tray is made of brass and its surface is polished. Twelve spiral grooves 6', 6², 6³, 6⁴ . . . etc. of rectangular section, are cut in the surface of the tray. In the interests of clarity only four of these grooves, namely 6', 6⁴, 6⁷, 6¹⁰ are shown in Fig. 1, and the grooves are not shown in the cross sectional views according to Figs. 2 and 3. The spiral grooves are evenly spaced around the tray. Each groove starts from an inner position which is on the periphery of the central portion 2, i. e., on the inner boundary of the flat zone 3, and winds clockwise round the axis of the tray while progressing to a point of termination immediately inside the rim 1. Each groove has a width and depth dimension sufficient for receiving one filament but not two side by side of the size to be handled at any one position. It will be seen that starting from its inner end, each spiral groove, before it has advanced through 180° encounters and advances up the steep slope 4.

The tray surface is pierced with three holes through the bottom of each groove in an outer length of such groove. The holes in the bottom of one only of the grooves, namely groove 6', have been shown, but the bottom of each of the other grooves is in fact holed in the same manner. Referring now to the holes illustrated, one of these, marked 7, is at the outer extremity of the groove, and another 7', is spaced along the groove from hole 7, by a distance corresponding to the length of the filament. The ends of the portion of the groove between the two holes, 7, 7' are deepened as shown in Fig. 4 to extend into the said holes. When a filament is in position in the said portion of the groove, as shown in dotted lines in Fig. 4 the leading extremity of the filament abuts the far side of hole 7 which thereby forms a stop arresting further forward movement of the filament, and the trailing extremity of the filament drops below the leading extremity of the next following filament which may accordingly advance without exerting endwise pressure on the fully advanced filament. The third hole is hole 9, which is located at a point in the groove which will underlie a filament immediately following the fully advanced filament. As shown in Fig. 3 the holes 7' and 9 extend upwardly to the tray surface inclined inwardly towards the tray axis.

The means for vibrating the tray comprises a high frequency vibrator unit suggested in broken line at V, as described in "British Engineering," September 1953, page 110. The vibrator is arranged underneath the tray and is connected to it by cantilever springs set at an inclination so that the tray is subjected to simultaneous vertical and horizontal oscillation components the horizontal component imparting turning movements about the tray axis so that the filaments are literally thrown forwardly and upwardly, filaments which lodge in the grooves remaining in the grooves so that the advance of these filaments takes place along the spiral paths of the

grooves. The vibrator gives 6000 oscillations of the tray per minute. The appropriate amplitude depends on the size of the filaments. An amplitude of less than 10 thou. has been successfully used for 150 watt filaments. A higher amplitude has been used for larger filaments.

When the tray is in position the pawl and ratchet pinion mechanism *p, p'* of conventional design intermittently indexes the tray and vibrator in an anti-clockwise direction (in the aspect of Fig. 1) through an angle corresponding with the angular distance between the outer extremities of the grooves. With the twelve groove tray, this angle is 30°.

When the tray is in position on its mount and the vibrator is started and a disordered mass of filaments is placed on the portion 2, the following result ensues. Under the combined action of the slope of the portion 2 and the vibration, the filaments accumulate in the flat zone 3 and advance endwise around the said zone clockwise about the tray axis. The filaments thus overlie the inner portions of the spiral grooves, i. e., the portions of the grooves in the flat zone 3. Almost at once some filaments fall into the grooves and once a filament does this, instead of being vibrated round the flat zone 3 its path of advance is now determined by its groove and in consequence it climbs the slope 4. This slope, the polish of the tray surface and the vibration contribute in ensuring that filaments which have not found their way into a groove remain in the "well" formed by the zone 3. As the filaments which have become lodged in the grooves climb to the periphery of the tray along the grooves, the groove spaces which they vacate are open to receive further filaments. In a matter of seconds each groove contains a number of filaments following one another along the groove to the tray periphery. Once a filament reaches the outer end of a spiral groove it is arrested by the stop formed by the hole 7 and it retains that predetermined position notwithstanding the continued vibration. The filament next behind it continues to advance, riding over the trailing end of the fully advanced filament which has dropped in hole 7'. This next filament therefore does not press against the fully advanced filament. Unless this next filament is previously ejected by air jets as will presently be described it becomes dislodged from the spiral groove by being vibrated over the advanced filament as aforesaid. If the vibration is allowed to continue without any steps being taken to remove the fully advanced filaments, the position is therefore that these fully advanced filaments remain in their fully advanced positions while the following filaments continue to advance and become successively dislodged from the spiral grooves on reaching and being vibrated over the fully advanced filaments; the dislodged filaments returning downwardly with a rolling motion to the said flat zone or to a lower groove. If the fully advanced filament in any groove is removed, however, the next following filament in that groove takes its place.

Once the grooves have become substantially filled the tray indexing mechanism is set in operation, also the filament pick-up and transfer mechanism shown in Figs. 5 to 7 which will now be referred to.

The filament pick-up and transfer mechanism comprises an arm 20 mounted for free rotation around a vertical spindle 21. A gear wheel 20a fixed with respect to the arm 20 engages a toothed sector 20b which is oscillated by oscillating the spindle 20c to rotate the arm through 90° first in one direction and then in the other, the outer end of the arm moving between two positions in one of which it lies over the tray and in the other of which it lies over a filament mount drum 22 having a peripheral series of parallel axial grooves for receiving in succession the filaments picked up in succession from the tray. At the extremity of its movement in each direction the spindle 20c with its sector 20b, together with the spindle 21, the arm 20 and gear wheel 20a, is given an axial reciprocatory movement by any conventional means indicated by the arrow so that the outer end of

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the arm is moved down onto the tray and away again or down onto the filament mount drum and away again, as the case may be. The outer end of the arm carries three suction heads namely a central head 23 and outer heads 24, 24a. The central head 23 is mounted on the outer end of arm 20 itself and the outer heads 24, 24a are mounted each on one of crank levers 25, 25a which are pivoted at 26, 26a to the outer end of arm 20. Each of the heads 24, 24a is mounted on one of the arms of the respective crank levers and the other arms of these levers are linked by connecting rods 27, 27a to pivoted levers 28, 28a respectively. The levers 28, 28a are pivoted to arm 20 at 29, 29a respectively and at medial positions carry rollers 30, 30a. These rollers serve as followers for fixed cams 31 and 31a which are fixed to spindle 21. The arm 20 is in Figs. 5 and 6 shown at one of its extreme positions, namely over the filament mount drum 22. In this position of the arm the three suction heads 23, 24, 24a lie in a straight line appropriate for depositing a filament held by the suction heads into one of the parallel grooves on the drum. This position of the heads 24, 24a in relation to head 23 is determined by the abutment of pins 32 on the crank levers 25, 25a against stop faces on the arm 20 (see Fig. 6) under the pressure exerted by a tension spring 33.

The suction heads are connected by flexible lines 34 through a manifold to a vacuum pump (not shown). A valve (not shown) is operated in timed relation to the movements of the filament pick-up arm so as to transmit and interrupt the suction to the suction heads at the appropriate times during the operation of the pick-up mechanism. Assuming the arm 20 in Figs. 5 and 6 to be stationary above the filament mount drum 22 with a filament held by the heads 23, 24, 24a; the spindle 21, with arm 20, is now lowered so that the held filament is lowered into the underlying groove of the filament mount drum whereupon the suction to the heads is interrupted and the filament is released into the groove. In interrupting the vacuum we arrange for the vacuum lines 34 to be placed in communication with atmosphere to prevent the filament clinging to the suction heads under residual vacuum in the said lines. The spindle 21 now rises to lift the head away from the drum, returning the arm to the position shown in Figs. 5 and 6. Now the arm 20 is turned anticlockwise (in the aspect of Fig. 5) about spindle 21 so that the arm 20 is moved from its full line to its dotted line position in which the suction heads lie over the tray. During this movement the rollers 30, 30a on the pivoted levers 28, 28a follow onto the high parts of the cams 31, 31a and the levers 28, 28a are turned relatively to the arm 20 exerting a pull on connecting rod 27 and a push on connecting rod 27a. The resulting movement of the connecting rods causes the crank levers 25, 25a to turn on their pivots against the pull of the tension spring 33 so as to move the suction heads 24 and 24a relatively to the central head 23 and by the time the outer end of the arm 20 reaches its dotted line position over the vibrating tray, the three suction heads lie on an arc corresponding with the arc of curvature of a filament lying in the fully advanced position at the pick-up station. The spindle 21 now lowers again to lower the suction heads onto the surface of the tray whereupon suction is established in the heads and the filament is drawn onto the heads and held by them while the arm 20 is raised again, returned to its full line position above the filament mount drum, and lowered to bring the suction heads immediately above the next vacant groove on the drum 22, which groove has been brought into the correct position by indexing of the drum.

On the lowering of the arm 20 for picking up a filament the suction heads are actually pressed onto the tray surface and as shown in Fig. 6 the heads are seated on compression springs 35 which allow the heads to yield as they reach the tray.

Fig. 7 shows in more detail the construction of the suc-

tion heads. Each head has a sloped end face 36 which accords with the slope of the surface of the tray at the position onto which the head is lowered for picking up a filament, and the said end face has a groove 37 into which open three suction holes 38 communicating with the appertaining vacuum line. When a filament is drawn from the tray by the suction through the holes 38 it is drawn into and held located by the grooves 37 in the three suction heads.

The indexing of the tray serves to bring the outer lengths of the grooves, occupied by the fully advanced filaments, in succession to the pick-up station and takes place in timed relation to the movements of the pick-up and transfer mechanism so that a fully advanced filament is in position for picking up as the suction heads descend onto the tray. Assuming that groove 6' is for the moment at the pick-up station, the suction heads descend onto the fully advanced filament in that groove and as the filament is reached a suction is established in the said heads and the filament is drawn into the grooves 37 in the heads and removed from the tray as the heads swing upwards. Thereupon the tray is indexed anticlockwise to bring the fully advanced filament in the next groove into position for removal. Meanwhile the vibration continues and the fully advanced position in groove 6' vacated by the last filament removed becomes occupied by a following filament in the groove which following filament then remains against the forward stop ready to be picked up when it has been indexed round to the pickup station.

While the tray is stationary, the hole 9 which is spaced slightly behind the trailing end of the filament to be picked up registers with an air pipe through which an air jet is forced just prior to the descent of the pick-up heads onto the said filament. At the same time a second air jet is delivered from a pipe (not shown) so as to pass over the tray surface inwardly towards the tray centre along a radial path intersecting the jet emerging from the hole 9. The delivery of the said air jets causes any second filament in the groove which might otherwise be picked up together with the fully advanced filament to lift from the groove and to be blown towards the centre of the tray.

If necessary further air jets may be operated in the region from which pick-up is to be made, just before the moment of pick-up, for clearing the tray surface at the pick-up position of any "stray" filaments, i. e. any filaments which are not in a groove but which have partly progressed to the periphery of the tray.

The invention is not limited to any particularly type of vibrating mechanism or to any particular form of vibratory movement, and any suitable variation of the mechanism and/or vibratory movement hereinbefore particularly described may be adopted for bringing about the required movement of the filaments to cause them to lodge in and progress upwardly along the grooves.

Instead of the filaments advancing up to a stop for pick up from the surface they may be vibrated along and out of the outer end of the groove or grooves, e. g. directly onto a locating groove or grooves on another part.

The following table gives examples of groove depth and width dimensions which we have used with good results for lamp filaments of the size specified, the grooves being of rectangular section:

Filament wattage and diameter	Groove depth mm.	Groove width mm.
100 (dia. .342 mm.)	.4	.50
150 (dia. .42 mm.)	.53	.62
200 (dia. .544 mm.)	.61	.75

We would point out that in designing apparatus for handling particular filaments, where the filament receiving and locating grooves are to follow a curved, e. g., a spiral course, some attention should be given to the sharpness of curvature of the groove courses since the lengthwise

curving of a filament opens its successive windings on one side and if this opening is excessive it will encourage engagement of grooved with ungrooved filaments during their movements on the vibrating surface. For handling 150 watt filaments having a diameter of .462 mm. and a length of 70 mm. we successfully used apparatus as described with reference to the accompanying drawings incorporating a tray with a diameter a little over 7½ inches, and a raised central portion with a diameter of 4¾ inches.

In view of the need for grooves of different dimensions for handling filaments of different size, apparatus according to the invention will preferably be adapted for fitting with a selected one of two or more trays, plates or the like according to the filaments to be handled at a given time.

Instead of providing pick-up mechanism which transfers the filaments from the tray to a filament mount drum, the pick-up mechanism may be designed for transferring the filaments from the tray directly to lamp electrodes.

As will be apparent from the foregoing description the application of the principle of vibration feeding along grooves to the separation and orientation of filaments raises different problems from those likely to be met with in applying the like principle to the feeding of parts requiring machining or grinding to machines such as centre-less grinders. We are now fully aware of the latter proposal but inasmuch as such parts are of a very different degree of robustness from the delicate filaments of the kind hereinbefore described and inasmuch as intermittency of feed in the feed of parts to a centre-less grinder does not affect the quality of the final product whereas intermittency in the feed of filaments to automatic lamp making machinery may result in the assembly of lamp parts without filaments, there is no comparison between the two proposals and apparatus proposed for the feeding of parts to a centre-less grinder using vibration feeding would be unsuitable for the separation and orientation of filaments.

What we claim is:

1. Apparatus for automatically feeding coiled-wire filaments from a disordered mass to at least one delivery point with the filaments in a predetermined orientation, comprising a surface which has a receiving area on which a mass of filaments may be placed, at least one groove formed in said surface, said groove extending into said receiving area and upwardly from said area to a delivery point, said groove being of sufficient depth and width to receive a filament; means for vibrating said surface in such manner as to cause filaments dropping into said groove at the receiving area to advance along said groove in succession to said delivery point, means for arresting each filament on reaching said delivery point preparatory to removal means which serves while a filament is at said delivery point to prevent a following filament from endwise abutting and displacing the filament at the delivery point by causing said following filament to be placed from the groove so that it can roll back towards said receiving area, and means for returning to said receiving area filaments located away from said area but not in said groove.

2. Apparatus for automatically feeding coiled-wire filaments from a disordered mass to a plurality of delivery points with the filaments in a predetermined orientation, comprising a surface which has a receiving area on which a mass of filaments may be placed, a plurality of grooves formed in said surface, said grooves being formed partly in said receiving area so that filaments in said area can drop into said grooves, and extending out of said receiving area, up the said slope, to a corresponding number of delivery points, said grooves being of sufficient depth and width to receive filaments in single file, means for vibrating said surface to cause filaments to advance from said receiving area along said grooves to said delivery points,

means in the form of a slope in said surface to cause filaments located away from said receiving area but not in said grooves to roll back to said area, and means for automatically removing filaments in succession first from one delivery point and then from the next thereby to leave opportunity between successive filament removals from each delivery point for such delivery point to become again occupied.

3. Apparatus for automatically feeding coiled-wire filaments from a disordered mass to delivery points, with the filaments in a predetermined orientation, comprising a surface which has a receiving area on which a mass of filaments may be placed, a plurality of grooves of sufficient depth and width each to receive filaments in single file, formed in said surface, said grooves being formed partly in said receiving area so that filaments in said area can drop into said grooves and extending out of said receiving area, up said slope, to a corresponding number of delivery points, means for vibrating said surface to cause filaments dropping into said grooves in the receiving area to advance along said grooves to said delivery points to give a continuous supply of filaments in a predetermined position and orientation for picking up one by one and means for causing filaments located away from said area but not in a groove to roll back to said receiving area.

4. Apparatus for automatically feeding coiled-wire filaments from a disordered mass to a plurality of delivery points with the filaments in a predetermined orientation, comprising a surface which has a receiving area on which a mass of filaments may be placed, a plurality of grooves formed in said surface and leading away from said area to a corresponding number of delivery points, said grooves being each of a depth and width sufficient to receive a filament; means for vibrating said surface in such manner as to cause filaments to advance along said grooves in succession to said delivery points, means for arresting each filament on reaching a delivery point, preparatory to removal, means in the form of a deepening of each groove in the region occupied by the trailing end of a filament when at the delivery point for allowing such trailing end to fall beneath the path of advance of an immediately following filament in the groove thereby to prevent endwise abutment pressure of said following filament against the filament at the delivery point and to cause such following filament to be vibrationally displaced from said groove, and means including a slope in said surface and air jetting means for causing filaments located away from said area but not in a groove to roll back to said receiving area.

5. Apparatus for automatically feeding coiled-wire filaments from a disordered mass to a plurality of delivery points with the filaments in predetermined orientation, comprising a surface which has a central receiving area on which a mass of filaments may be placed, a plurality of grooves formed in said surface, said grooves leading across said receiving area and spirally outwards to delivery points radially outwards from said receiving area, means for vibrating said surface in such manner as to cause filaments dropping into said grooves at the receiving area to advance along said grooves in succession to said delivery points, means for arresting each filament on reaching a delivery point, and means which serves while a filament is at said delivery point to prevent a following filament from endwise abutting and displacing the filament at the delivery point by causing said following filament to be displaced from the groove, a slope in said surface for rolling back to said receiving area filaments located away from the said area but not in a groove, and means movable alternately up to and away from said surface for removing filaments in succession from said delivery points and means for indexing said surface in timed relation to the movements of said pick-up means for bringing said delivery points one by one in succession to said pick-up means.

6. Apparatus according to claim 5, wherein said pick-

up means comprises suction heads movable into contact with said surface, suction orifices in said heads for registering with filaments at the successive delivery points, and means for relatively displacing said heads in timed relation to the movements of said pick-up means for moving said heads out of alignment for picking up each filament curved in correspondence with the curvature of said grooves at the delivery points and moving said heads into alignment prior to release of each picked up filament.

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