

March 1, 1966

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3,237,657

GRID WINDING APPARATUS

Filed Feb. 19, 1963

3 Sheets-Sheet 1

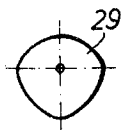
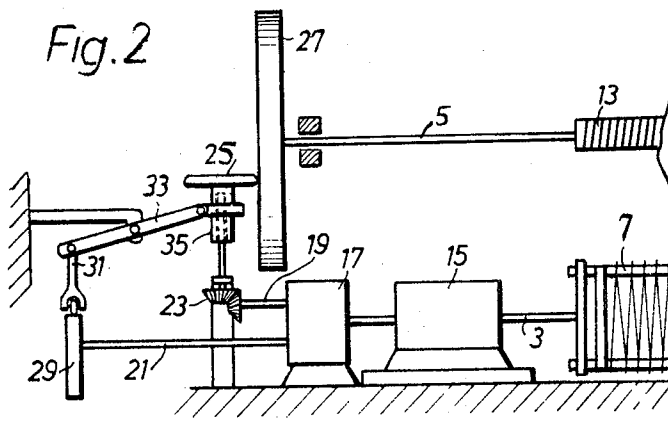
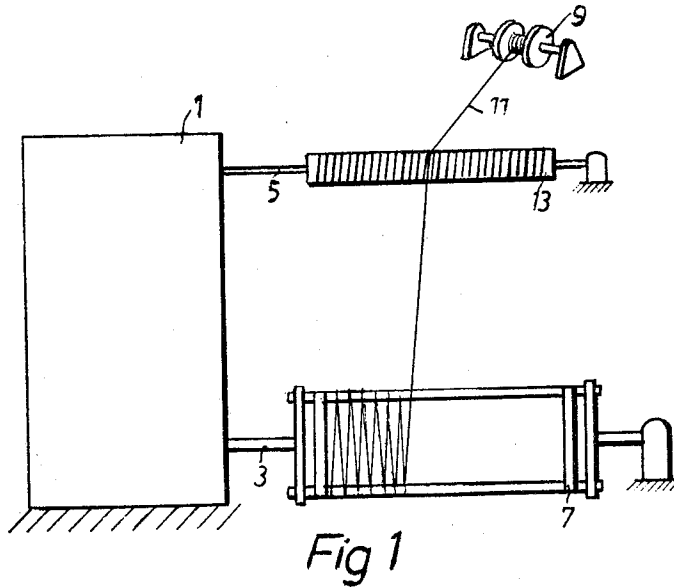


Fig. 2a

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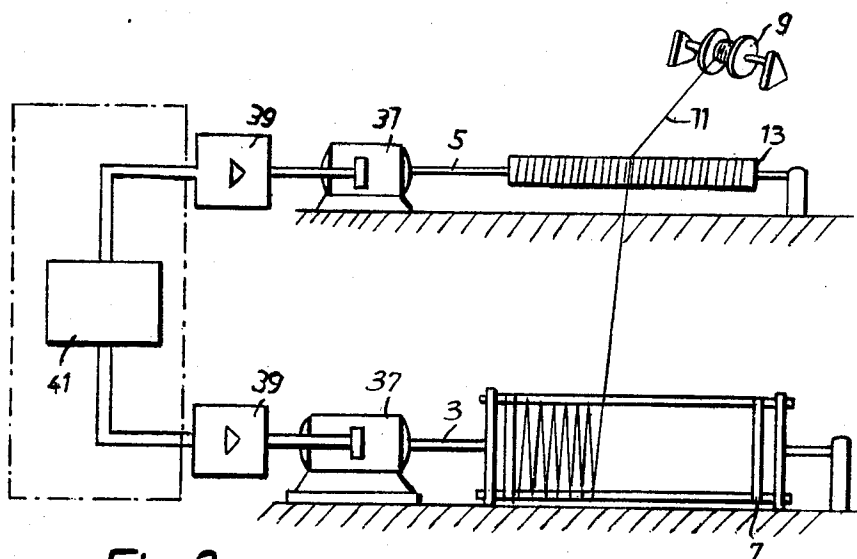


Fig. 3

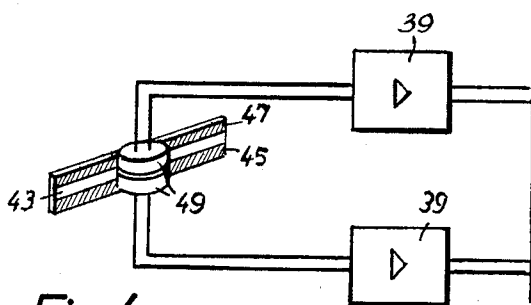


Fig. 4

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3 Sheets-Sheet 3

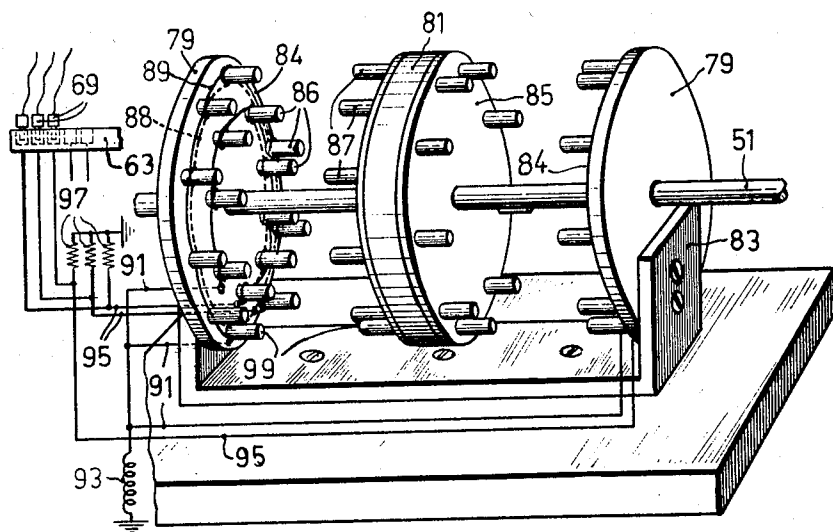
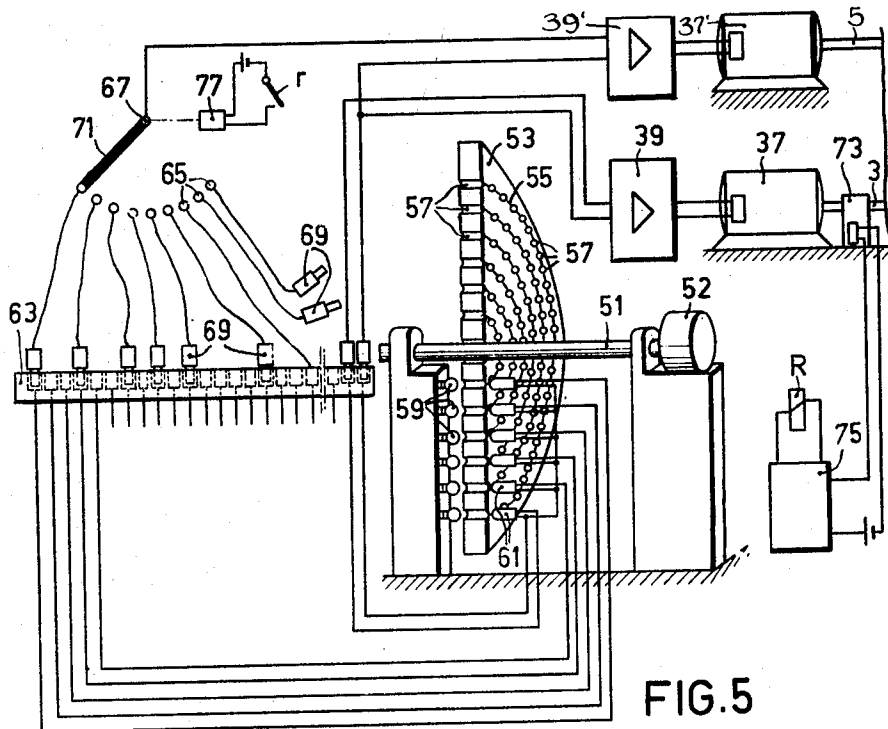


FIG. 6

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GRID WINDING APPARATUS

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7 Claims. (Cl. 140—71.5)

The invention relates to a winding machine for grids, preferably stretched grids suitable for use in electric discharge valves. Said grids having different pitches between turns in the longitudinal direction of the grid, controlled by a wire guide, and a pitch setting spindle.

The grid winding machines used in the manufacture of electron valves comprise a rotating winding spindle, in which a grid frame is clamped and furthermore a rotating pitch setting spindle for guiding the grid wire. The grid wire is wound from a supply reel, via a substantially helical groove on the pitch setting spindle, onto the grid frame. The pitch of the groove and the speed of rotation of the pitch setting spindle determine the pitch of the windings on the grid, since the grid wire moves across the spindle with a given speed.

It is known to drive the winding spindle and the pitch setting spindle at different though uniform speeds, for example by coupling the pitch setting spindle via a transmission gear with the winding spindle. In order to wind wires with different pitches on a grid frame, it is known to provide a guide sleeve on the pitch setting spindle, said sleeve having groove portions of different pitches. Thus, with a uniform speed of rotation of the pitch setting spindle grid regions of different pitches can be obtained on a grid frame. However, the guide sleeves can be manufactured only with difficulty. Also change-over of the winding machine from one winding rate to another is troublesome.

It is furthermore known to replace the pitch setting spindle by a wire guide. In such apparatus the winding spindle rotates with constant speed while the wire guide is moved parallel to the winding spindle by sudden or jerky movements. These movements of the wire guide are controlled by pulses, which are derived from a punched tape or from a sound recording tape. This apparatus also permits the manufacturing of grids having different pitches, but the jerk-wise variation in the movement of the wire guide adversely affects the accuracy of the winding. Otherwise, such apparatus attains only low winding speeds.

The disadvantages described of the known grid winding machines are avoided in accordance with the invention by the provision of control-members by which the difference between the rotary speeds of the pitch setting spindle and the winding spindle can be varied during the winding operation without abrupt changes.

The winding machine according to the invention permits rapidly and very accurately winding grids having a variable pitch. Moreover, the winding pattern can be varied within a very short time.

The control-members of the winding machine according to the invention may comprise a frictional drive controlled by a cam disc, between the pitch setting spindle and the winding spindle.

In a preferred embodiment of the invention the spindles are driven separately by synchronous motors, to which control-currents of different frequencies are fed from an electrical control-device. The synchronous motor of the winding spindle is driven preferably by a control-current of constant frequency and the synchronous motor of the pitch setting spindle is driven in order of

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succession by control-currents of different frequencies. The electrical control-device may be constructed in various ways. The control-currents for the two motors may be derived from a prepared recording tape. The control-currents may furthermore be obtained from a generator, which produces all currents required for driving separately from each other. Such a generator may consist, for example, of at least one rotating disc having a number of holes defining on concentric circles on the disc, the number of holes in each circle being different. Each circle of holes receives light from a lamp on one side of the disc; on the other side of the disc a photoelectric cell is arranged for each circle of holes; it converts the light pulses traversing the apertured disc into current pulses. The control-currents produced in the separate photo-cells are fed at will in order of succession to the motor of the pitch setting spindle. The change-over from a control-current of a given frequency to the chosen, next-following control-current of a different frequency is carried out by means of control-pulses which may be derived from a pulse generator arranged on the winding spindle.

However, the generator may comprise at least one rotating disc and one stationary disc. The rotating disc is provided along a number of concentric circles with a number of the same magnetic poles, while on corresponding circles of the opposing stationary disc, there are provided ferro-magnetic pins opposite the magnetic poles, on which a switching wire interconnecting all pins of a circle is wound.

The invention will be described more fully with reference to the accompanying drawing.

FIG. 1 shows diagrammatically a winding device according to the invention, in which the pitch setting spindle and the winding spindle can be rotated by a common control-member.

FIG. 2 shows the coupling of the winding spindle with the pitch setting spindle by means of a friction drive.

FIG. 3 shows a winding spindle and a pitch setting spindle driven by separate synchronous motors, fed by an electrical control-device.

FIG. 4 shows diagrammatically the obtainment of control-currents from a recording tape.

FIG. 5 illustrates the production of a control-frequency by means of a generator comprising an apertured disc according to the invention.

FIG. 6 illustrates the production of the control-frequencies by means of a generator comprising magnetic pins according to the invention.

A control-device 1, shown diagrammatically in FIG. 1, drives a winding spindle 3 and a pitch setting spindle or guide spindle 5 of a grid winding device. On the winding spindle 3 is fastened a grid frame 7. The grid frame 7, rotating with the winding spindle 3, draws a grid wire 11 from a supply reel 9. Between the supply reel 9 and the grid frame 7 the grid wire 11 passes along a guide sleeve 13, arranged on the pitch setting spindle. The outer surface of said sleeve is provided with a helical, uninterrupted groove extending throughout the length of the sleeve. Since the pitch setting spindle 5 rotates during the winding operation, the grid wire guided along it passes through the groove from one end of the sleeve to the other. If the speed of the pitch setting spindle 5 remains constant during the whole winding operation, a grid of constant pitch is wound on the grid frame 7. In accordance with the invention a given winding programme is imposed on the control-device 1, according to which the pitch setting spindle 5 can be adjusted to different speeds. The grid wire 11 is then guided more rapidly or more slowly along the sleeve 13 in accordance with the varying speed of the pitch setting spindle. Thus corresponding regions of different pitches are wound on the grid frame 7.

A very simple embodiment of the control-device 1 is formed by the friction drive shown in FIG. 2. The winding spindle 3 is set rotating by a motor 15. At the same time the motor 15 drives a driving gear 17, which comprises two driving shafts 19 and 21 having different speeds of rotation. Via bevel gear wheels 23 a friction wheel 25 is coupled with the driving shaft 19. The friction wheel 25 exerts a pressure on a disc 27, seated on the pitch setting spindle 5.

The transmission ratio between the winding spindle 3 and the pitch setting spindle 5 is determined by a cam disc 29, shown in FIG. 2a. This cam disc is arranged on the second driving shaft 21 of the drive 17. The periphery of the cam disc 29 is scanned by an arm 31, which is connected by means of a lever 33 with the shaft 35 of the friction wheel 25. Under the control of the cam disc 29 the scanning arm 31 and the friction wheel 25 move radially with respect to the pitch setting spindle 5. Thus the transmission ratio of the friction drive is varied, so that the pitch setting spindle 5 rotates with a correspondingly variable speed with respect to the winding spindle 3.

FIG. 3 shows a different control-device. The winding spindle 3 and the pitch setting spindle 5 are driven by synchronous motors 37 and 37', to which via amplifiers 39 and 39' control-currents are fed from an electrical control-device 41. The control-device 41 feeds the synchronous motor 37 on the winding spindle 3 by a control-current of constant frequency, whereas the synchronous motor 37' of the pitch setting spindle 5 receives control-currents of different frequencies. Said control-currents may be derived in a simple manner from a recording tape 43 shown in FIG. 4. The track 45 of said recording tape 43 has a constant frequency and the other track 47 has different frequencies in accordance with the winding programme. The tracks 45 and 47 are scanned by separate scanning heads 49, which feed the induced control-currents via the amplifiers 39 and 39' to the synchronous motors 37 and 37'.

FIGS. 5 and 6 show generators operating on different principles, for producing a fairly great number of control-currents of different frequencies. In accordance with a given programme said control-currents of different frequencies can be fed at will to the synchronous motor 37' of the pitch setting spindle 5.

As shown in FIG. 5 the control-currents are produced by photo-electric agency. A shaft 51, driven by a synchronous motor 52, has fastened to it a disc 53. On concentric circles 55 of different diameters the disc 53 has holes 57, the number of which per circle decreases from the periphery of the disc towards the centre thereof. The disc 53 shown in the drawing is provided, for the sake of clarity, with only six of circles. In practice the generator comprises a disc having 40 to 60 circles, each having 20 to 60 holes.

On one side of the disc 53 there are arranged a number of lamps 59. Each lamp 59 is located in front of a circle of apertures 55. On the other side of the disc, opposite the lamps 59, photo-electric cells 61 are provided. When the disc 53 rotates, light pulses are passed through the disc through the apertures 57 per revolution of the disc in accordance with the number of apertures of the individual circles 55. The light pulses are converted in the photo-cells 61 into current pulses, which form in common an alternating current of a frequency corresponding to the number of apertures and the speed of revolution.

A connecting terminal of each photo-cell 61 is connected to the inputs of the two amplifiers 39 and 39'. The other connecting terminal is connected to a setting panel 63, into which for example ten pins 69 can be inserted, which are connected to selector contacts 65 of a rotatable selector switch. The wiper 71 of the selector 67 is capable of contacting in order of succession the separate selector contacts 65. Thus control-currents of different frequencies can be fed in order of succession to the amplifier 39' and to the synchronous motor 37' of

the pitch setting spindle 5. The frequencies are chosen on the panel 63.

For changing over the selector switch 67 to the next-following selector contact 65 there is provided a pulse generator 73, which may be arranged on the winding spindle 3. For the supply of the pulses use may be made of a cam (not shown) arranged on the winding spindle. The pulse generator 73 supplies the pulses produced therein per revolution of the winding spindle 3 to a counting and controlling member 75. By means of said counting and controlling member 75 it can be determined after so many revolutions of the winding spindle 3, when the wiper 71 of the selector 67 will be changed over to the next-following selector contact 65. When the desired number of revolutions of spindle 3 is reached, the counting and controlling member 75 supplies a control-pulse by which the relay R is energized. Thus the relay contact *r* is closed. The switching magnet 77 of the selector switch 67, included in the current circuit of the relay contact *r*, moves the wiper 71 to the next-following selector contact 65. In the same manner, by means of the pulse generator 73 and of the counting and controlling member 75 and of the selector switch 67, control-currents of the frequencies chosen in accordance with the winding programme are fed in order of succession to the synchronous motor 37' of the pitch setting spindle 5. In order to vary the winding programme only the pins 69 need be set to the new frequency and the counting and controlling member 75 need only be adjusted to the new winding rate.

The generator shown in FIG. 6 is a modification of only the disc system of the invention disclosed in FIG. 5. Otherwise the programme is chosen by means of the same members as shown in FIG. 5. Instead of the apertured disc 53, three solid discs 79, 81 are used. The discs 79 are fastened to a frame 83. A shaft 51, driven by the motor 52 shown in FIG. 5 passes through the centres of the discs. Between the discs 79 the shaft 51 is provided with a disc 81. Pins are provided on the discs 79 and on the disc 81 on a number of concentric circles. On corresponding circles of opposite faces 84, 85 of discs 79, 81 there are provided equal numbers of iron pins 86, 87. Since also the generator shown in FIG. 6 must produce about 40 to 60 control-currents of different frequencies the stationary discs 79 and the two sides of the rotating discs 81 are provided with about 20 to 30 circles of pins 88. The number of pins 86, 87 per circle 88 decreases from the peripheries of the discs towards the centres thereof, like with the apertured circles 55 of FIG. 5. For the sake of clarity only a few circles of pins 88 are indicated. All pins 86 of the separate circles 88 of the stationary discs 79 are provided with windings 89, which are connected consecutively in each circle 88. For the first and the last pin 86 of each circle 88 the beginning of the wires and the ends thereof are conducted away from the generator.

The discs 79 consist of ferro-magnetic material, for example sheet iron and the disc 81 consists of an axially magnetised permanent magnet and two iron sheets arranged on the head faces thereof. When the disc 81 with the shaft 51 rotates, the iron pins 87, which are moved along the iron pins 86 provided with the wire windings 89 and forming small, identical magnet poles, induce currents into the wires wound around the pins 86. The number of pins of the separate circles 88 corresponds to the frequency of the control-currents obtainable from the circles per revolution of the disc. The identical inputs of the switching wire 91 of the separate circles 88 are directly connected to each other. The junctions of the inputs of the wire are connected to an earth-connected choke 93. The wire ends 95 are connected to earth-connected resistors 97. From the junctions of the wire ends 95 and the resistors 97 the control-current leads of FIG. 6 are taken towards the switching panel 63. The choke 93 included in the control-current circuit only serves for the upper limitation of the control-currents fed to the amplifiers 39.

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In FIG. 6 the discs 79 and 81 are shown at a large distance from each other, for the sake of clarity, however in practice the front faces 99 of the pins 86 and 87 are closely spaced from each other.

What is claimed is:

1. Apparatus for winding electron tube grids and the like comprising; means for rotatably supporting a grid frame member, a synchronous motor for driving said first mentioned means, rotatable means for guiding wire to be wound on said grid frame, a synchronous motor for driving said rotatable means, frequency generator means for simultaneously producing all frequencies required for winding said grids, and means coupled with each of said synchronous motors and said frequency generator means for determining the speed variations of at least one of said motors.

2. Apparatus for winding electron tube grids and the like comprising; a winding spindle for rotatably supporting a grid frame member, a synchronous motor for driving said winding spindle, a pitch setting spindle for guiding wire to be wound on said grid frame, a synchronous motor for driving said pitch setting spindle means, and plural frequency generator means for simultaneously producing a plurality of different frequencies and frequency selecting means coupled with said generator means and each of said synchronous motors for successively feeding pulse to said motors for determining the speed of said motors.

3. Apparatus according to claim 2, characterized in that said frequency generator comprises at least one rotating disc having a number of apertures therethrough defining a number of concentric circles on said disc, a light source on one side of said disc aligned with each said circle, a photo-electric cell means on the opposite side of said disc aligned with each said light source for converting the light pulses passed by the rotating disc to the photo-cell into current pulses.

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4. Apparatus according to claim 3, characterized in that the control-currents produced in the separate photo-cell means can be fed at will in order of succession to the synchronous motor driving the pitch setting spindle and also to the synchronous motor driving the winding spindle.

5. Apparatus according to claim 2, characterized in that the said frequency selecting means comprises a pulse generator and associated switching means coupled with the said winding spindle and the said frequency generator.

6. Apparatus according to claim 2, characterized in that the said frequency generator comprises at least one rotating disc, the surfaces of said disc having a plurality of identical magnetic poles defining a plurality of concentric circles, a pair of stationary discs opposite said surfaces having corresponding ferromagnetic pins opposite said magnetic poles, and turns of a wire, interconnecting all said ferromagnetic pins of a circle, said wire coupling said generator with said selecting means.

7. Apparatus according to claim 6, characterized in that the rotating disc consists of an axially magnetized, permanent magnet having on both sides a ferromagnetic disc, the latter discs being provided with the said magnetic poles.

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