

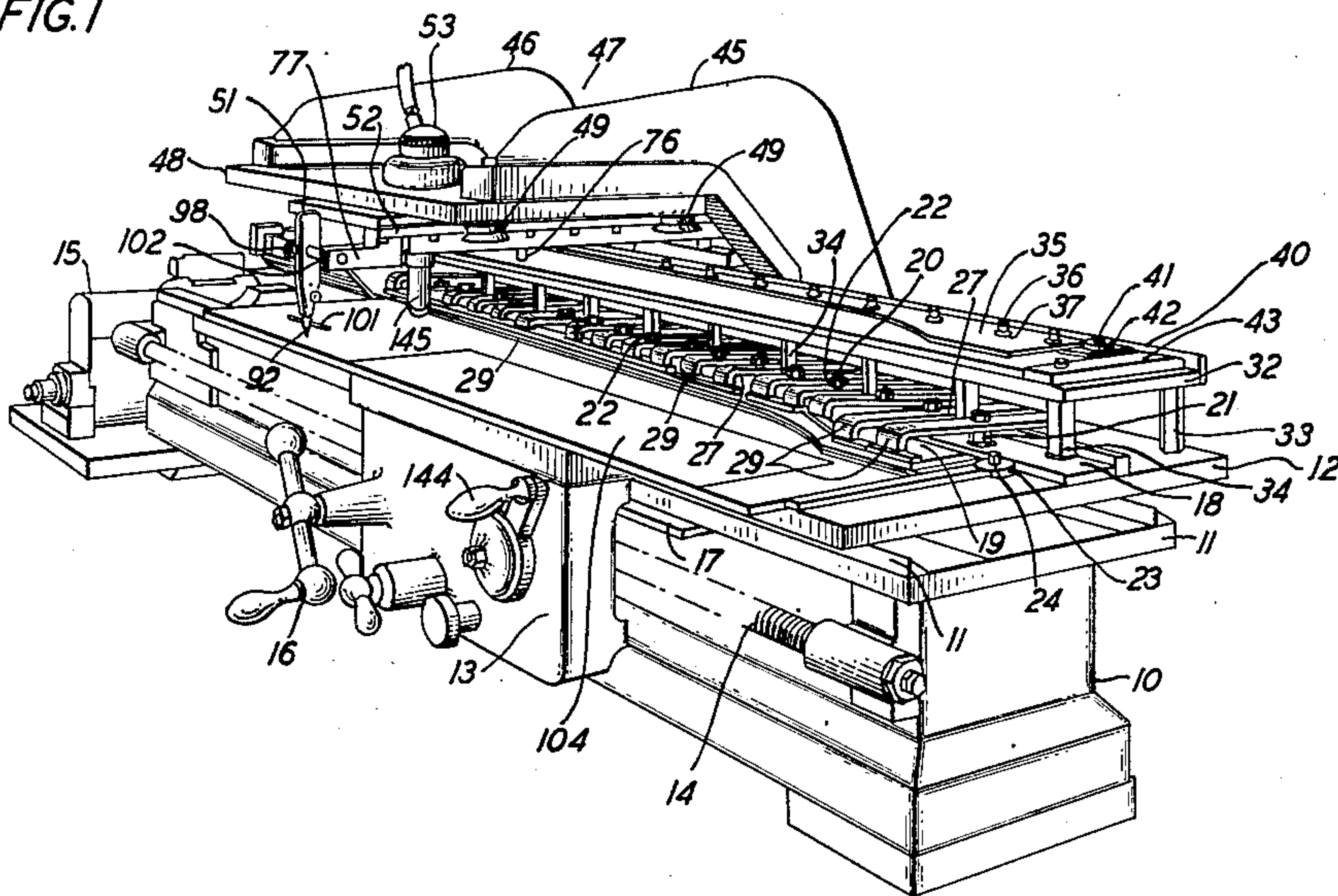
Dec. 17, 1946.

W. J. KINDERMANN ET AL
APPARATUS FOR AND METHOD OF MAKING CONTOURED
ELECTRICAL RESISTANCE CARDS
Filed May 3, 1944

2,412,619

3 Sheets-Sheet 1

FIG. 1



Dec. 17, 1946.

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2,412,619

3 Sheets-Sheet 2

FIG. 3

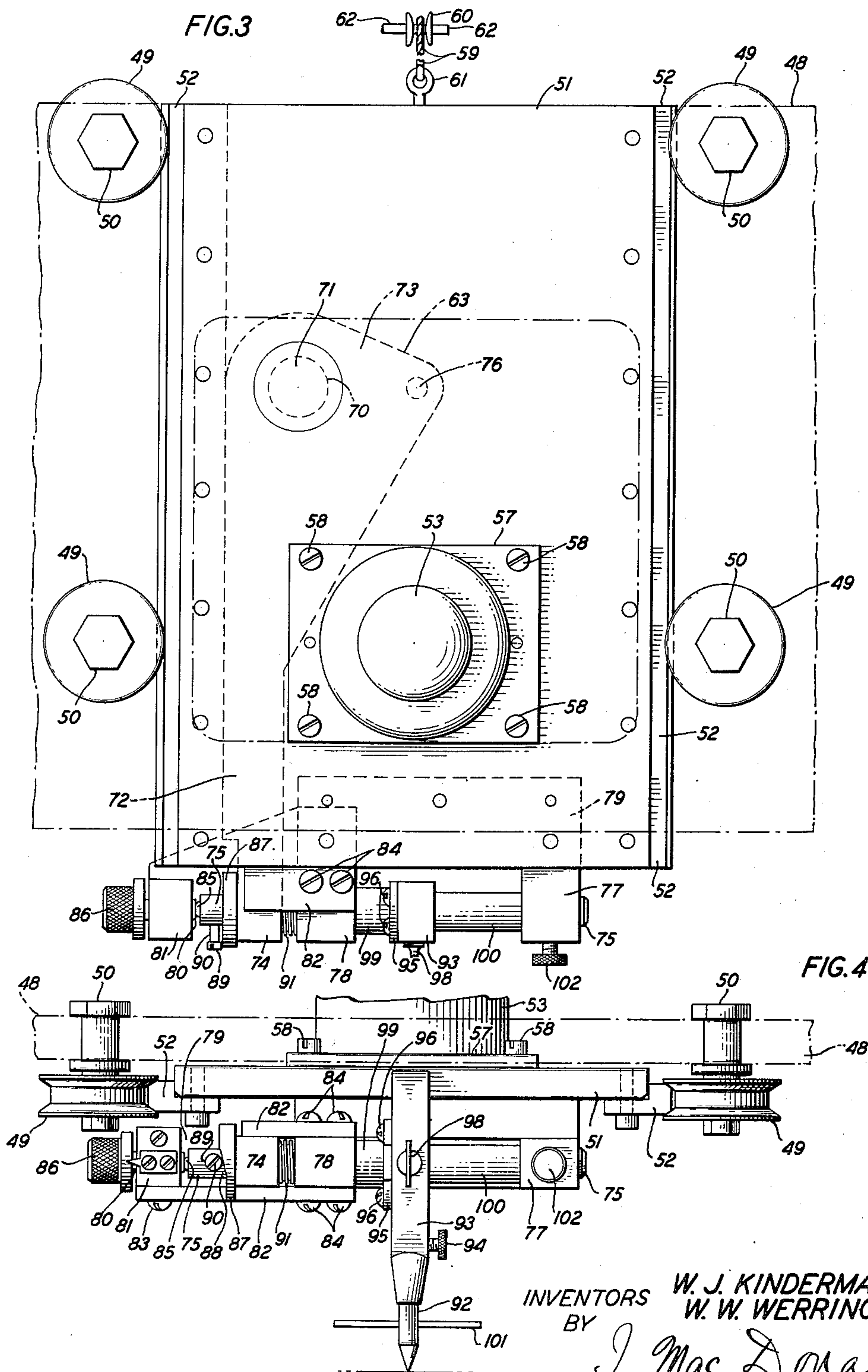


FIG. 4

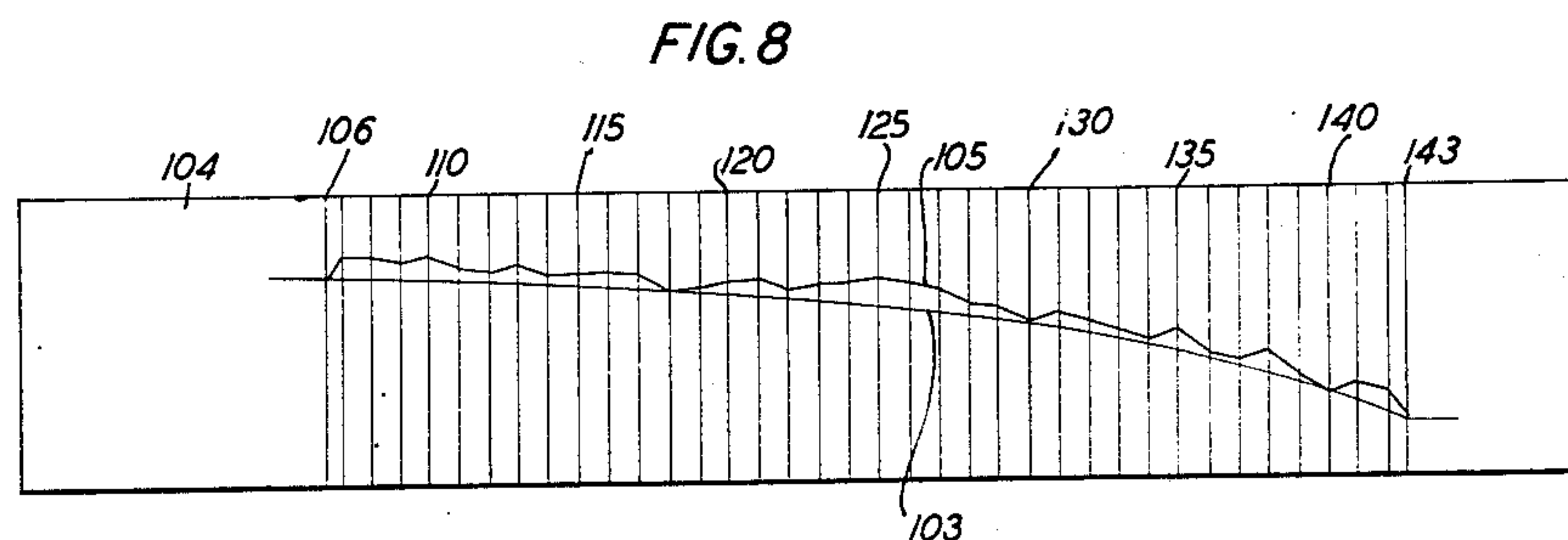
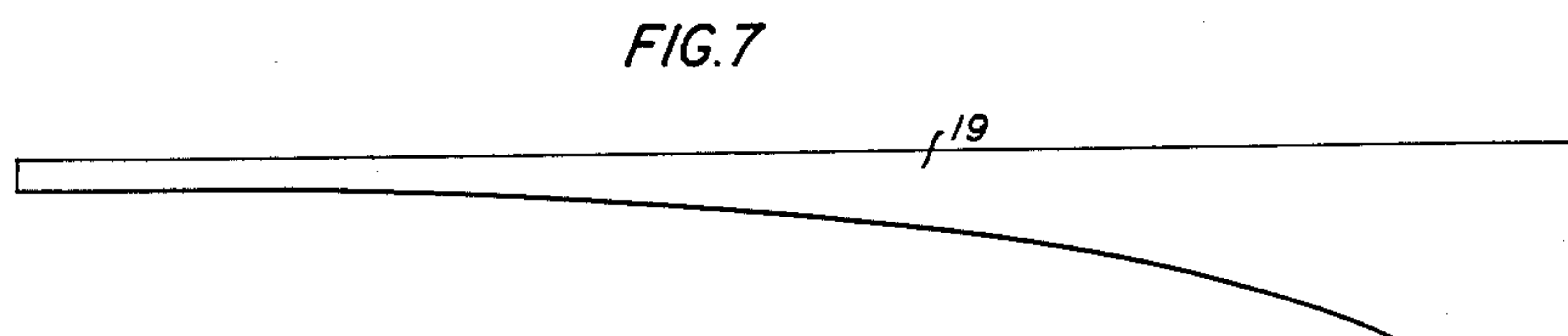
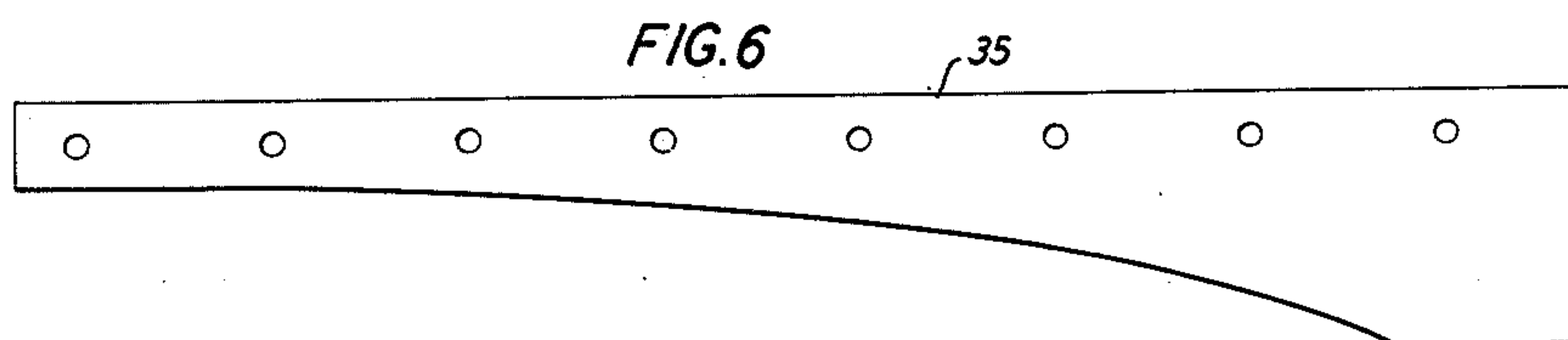
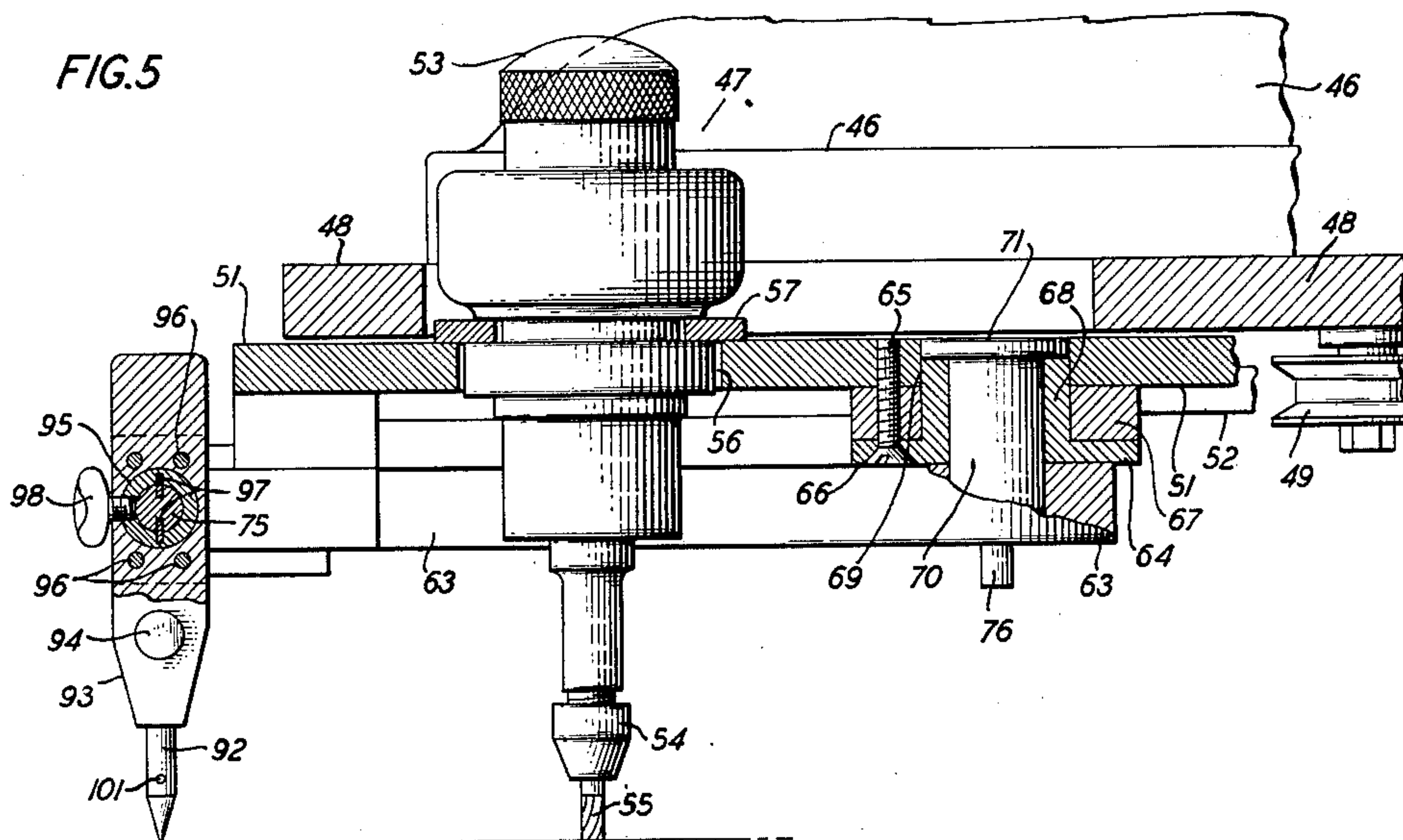
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3 Sheets-Sheet 3



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APPARATUS FOR AND METHOD OF MAKING
CONTOURED ELECTRICAL RESISTANCE
CARDS

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Application May 3, 1944, Serial No. 533,996

9 Claims. (Cl. 90—13)

1

This invention relates to card making and more particularly to apparatus for and a method of making cards of predetermined precise forms.

An object of the invention is to provide means for accurately making cards suitable for use as supports for windings of wire used as resistance elements in functionally precise electrical potentiometers.

The present invention provides a method of and means for accurately making a card without first making a templet of the precise form and dimensions required in the card and permits the use of a templet somewhat inaccurate in form and dimensions compared with the form and dimensions of the card required. The invention also provides a method of and means for making accurately profiled flat templets or cams.

A feature of the invention resides in a profiler head equipped with a cutting tool to cut a contoured edge of a card.

Another feature resides in a stylus means for controlling the cutting tool.

Another feature resides in means provided for parallel adjustments in the width of the card.

Another feature resides in means provided for supporting the card and a templet of the card.

Another feature resides in the method of making a card of required form.

In the drawings:

Fig. 1 is a view, in perspective, of a card cutting machine including the invention, the templet and card being supported in the machine;

Fig. 2 is an enlarged view, in perspective, of an end portion of the machine;

Fig. 3 is an enlarged top plan view of the profiler head;

Fig. 4 is a front view of part of the profiler head and drawn to the same scale as Fig. 3;

Fig. 5 is a side view, partly in section, of the profiler head shown in Fig. 3;

Fig. 6 is a plan view of a templet;

Fig. 7 is a plan view of a card; and

Fig. 8 is a plan view of a correction chart used in finish profiling a card.

In some precision potentiometers, now required, a resistance element is employed comprising a card with resistance wire wound on the card. The wire-wound card is supported in the potentiometer so that a wiper contact may successively engage the turns of wire on the card. In some cases in order to meet certain requirements of resistance values at predetermined points on the resistance element the card is made so that one long edge portion is not parallel with the other but is of a predetermined curved form so that the

2

card varies in width along certain portions of the card. Precision is required in making the cards and efforts have been made to cut cards to required dimensions and forms by first making a templet of the required pattern and using this as a guide for a cutting tool or as a guide for a scribe to mark the required pattern of the card on a strip of material from which the card is to be made by cutting the material along the scribed line on the material. This procedure of making the cards has been found unsatisfactory in some respects because it is difficult and expensive to make a templet of the precise dimensions required and when the templet is laid on a sheet of material and used as a guide for a scribe or cutting tool moved along the sheet of material and bearing against the edge of the templet the card pattern will not be exactly the same as the templet but will be slightly oversize and inaccurate in some other respects due to the difficulty of accurately locating the templet relative to the work piece and errors that are introduced in the cutting process.

In making cards in accordance with the present invention a plan of the desired card is made indicating the length and thickness of the card and the width the card should be at predetermined points. The plan of the card is laid out on a sheet of material suitable for use as a templet when cut to the required form. The material used in the templet is a matter of choice but it will be assumed merely for the purpose of describing the invention that the templet is made of sheet metal and is substantially rigid. It will also be assumed in the interest of simplifying the explanation of the invention and not in the sense of a limitation thereof that the card will have one long finished straight edge and the opposite long edge or portion thereof will be of curved form. Also, that at one end of the card the short edge portion is straight and right angular with respect to the long straight edge portion. The pattern of the card is indicated on the templet material by making conical prick-punch marks in the sheet metal at predetermined spaced coordinate points and lines are scribed on the material to connect with the prick-punch marks in succession and indicate more fully the outline of the templet. Spaced apertures are formed in the templet to receive stud bolts by means of which the templet may be bolted in place in a card making machine. To provide a bolting space on the templet and allow forming therein of the apertures for the stud bolts the templet is made wider at all points than the card by some fixed dimension. Thus, at any point, the width of the templet is approximately

3

equal to the width of the desired card plus the fixed dimension which has been added to provide space for the clamping apertures. After the pattern of the card is laid out and clearly indicated on the templet material the templet is cut from the sheet metal by sawing slightly outside the scribed lines, care being taken to insure that the saw does not remove the outline marks on the material. After the templet has been cut the edges are filed or machined down to the scribed line thereby bisecting the prick-punch marks as closely as hand working will permit. When the templet is made it is an approximate pattern of the desired card. Although the card is held to the closest tolerance possible in machining methods the necessary accuracy in the templet is only that which is possible for hand filing.

The templet is first used in marking a rough outline of the card on a sheet of material from which the card is to be made. The sheet material employed is a matter of choice but is usually insulating material and quite often hard rubber and will be hereinafter called in this specification a sheet of insulating material.

After the templet of the desired card is made the templet is laid on the sheet of insulating material and the outline of the card is marked on the sheet of insulating material, the templet being used as a guide for the marking tool. The sheet of insulating material is then cut along the marked lines to obtain a card having, in general, the outline of the card required but approximately one-eighth inch greater in width. Two or more cards are made in this manner and the cards are subsequently finish profiled in the card cutting machine of the present invention.

The card cutting machine as shown in Fig. 1 comprises a bed 10 with spaced tracks 11 formed thereon to support a platen 12 which is arranged to slide along the tracks 11. The platen 12 is attached to an apron 13 which extends over the front portion of the machine and is operable lengthwise of the machine by means of a lead screw 14, the apron 13 having means, not shown, but supported therein and engaging the lead screw 14 and the lead screw 14 being driven by means of a motor and gears, not shown, but which may be located in a driving head 15. The apron 13 is also equipped with means to release the apron and parts contained therein from driving engagement with the lead screw 14. Manually operable means comprising a handle 16 supported on the apron 13 and a rack 17 attached to the bed 10 are provided to move the platen 12 along the tracks 11, the handle 16 being gear connected to the rack 17 by means of a pinion, not shown, but having mechanical connection with the handle 16.

Extending lengthwise of the platen 12 and secured to the upper surface thereof is a flat bar 18 which serves as a straight edge against which the long straight edge of the card 19 may be placed. The bar 18 is apertured at spaced points to accommodate stud bolts 20 mounted on the platen 12 and arranged to extend upwardly through the apertures in the bar 18. The stud bolts 20 are equipped with nuts 21 and 22, the nuts 21 serving in cooperation with the stud bolts 20 to hold the bar 18 in place on the platen 12. An end stop 23 of annular form is provided near one end of the platen 12 to bear against one end of the card 19. The end stop 23 is removably supported on a pin 24 mounted on and extending upwardly from the upper surface of the platen 12. The pin 24 and the end stop 23 are

4

located forwardly of the forward edge of the bar 18 so that the end point of bearing of one end of the card 19 against the end stop 23 will be forward of the forward edge of the bar 18. It will be seen, therefore, that when the card 19 is placed in required position on the upper surface of the platen 12 and so that the long straight edge of the card 19 is against the forward edge of the bar 18 and one end of the card 19 is against the peripheral edge of the end stop 23 the point of engagement of the end portion of the card 19 with the end stop 23 will be truly right angular with respect to the straight edge provided by the bar 18. The point of contact establishes a reference point on the card from which any other point along the abscissa or straight edge may be determined by measurement. One end of the bar 18 is secured to the platen 12 by means of a screw 25 and a relatively long block 26 is mounted on the upper surface of the platen 12 in parallel relation with the rear surface of the bar 18.

L-shaped bars 27 are provided to retain the card 19 in required place on the platen 12. Each bar 27 is mounted on a stud bolt 20 and comprises a relatively long straight leg portion 28 terminating at one end in an angularly disposed foot portion 29. The leg portion 28 is provided with an elongated aperture 30 to accommodate a stud bolt 20 and the leg portion 28 is disposed between the nut 21 and the nut 22 which cooperate with the stud bolt 20 to hold the bar 27 in adjusted position. The foot portion 29 extends downwardly toward the upper surface of the platen 12 and may be clamped down into engagement with a block 31 disposed between the lower end of the foot portion 29 and the upper surface of the card 19. The long block 26 is located rearwardly of the stud bolts 20 and serves as a rest for the portions of bars 27 extending rearwardly of the stud bolts 20.

An elevated platform 32 supported on posts 33 and 34 is mounted on the platen 12, the platform 32 being located above the plane of the platen 12 and extending lengthwise of the platen 12 and in parallel spaced relation therewith. The platform 32 is located above and rearwardly of the position of the card 19 and provides a means of support for a templet 35. Spaced stud bolts 36 equipped with flanged nuts 37 are mounted on the platform 32 to hold the templet 35 in position. A plate 38 apertured to accommodate the stud bolts 36 is supported on the platform 32 and on the plate 38 a flat strip 39 also apertured to accommodate the stud bolts 36 is supported to serve as a rest for the templet 35, the strip 39 being narrower than the templet 35 and serving to hold the templet 35 above the plane of the plate 38. A back wall 40 extends along the rear of the platform 32 to provide a straight edge for one long edge of the templet 35. Removably mounted on a pin 41 extending upwardly from one end portion of the strip 39 is an annular end stop 42 for one end of the templet 35 and a rectangular bar 43 secured by means of screws 44 to the platform 32 is provided as an end stop for the plate 38. The point of contact establishes a reference point on the templet corresponding to a similar point on the card.

Extending upwardly from and secured to the back of the base 10 are two spaced arms 45 and 46 the upper ends of which extend transversely over and in parallel spaced relation with the platform 32 and the platen 12. The arms 45 and 46 are stationary and serve as supports in a

5

profler head 47 under which the platen 12 is operated along the bed 10. Secured to the under surface of the upper portions of the arms 45 and 46 is an apertured plate 48 in the four corner portions of which are mounted peripherally grooved wheels 49 extending downwardly below the under surface of the plate 48. The wheels 49 are rotatably supported on bolts 50 and cooperate to form supporting means for a carriage 51 provided with tracks 52—52 engaging in and supported by the wheels 49. The carriage 51 is slidable transversely of the bed 10 and the platen 12 and provides a movable support for a motor 53 equipped with a chuck 54 in which a rotatable cutting tool 55 is supported. The motor 53 extends through an aperture 56 formed in the carriage 51 and is secured to an apertured mounting plate 57 which is securely fastened by means of screws 58 to the carriage 51. It will be seen that the carriage 51 is movable transversely of the platen 12 to permit the motor 53 and the cutting tool 55 carried thereby to be moved transversely with respect to the bed 10 of the machine and relative to a card 19 supported on the platen 12. The carriage 51 is normally urged toward the back of the machine by means of a weight, not shown, but which is attached to a tow line 59 extending over a pulley 60, one end of the tow line 59 being secured to a ring bolt 61 mounted on the carriage 51 and the pulley 60 being suitably supported rearwardly of the carriage 51. The pulley 60 may be supported, for instance, on a shaft 62 extending between and supported on the arms 45 and 46 and the weight on the tow line 59 being located below the upper surface of the bed 10 of the machine.

A lever 63 is pivotally mounted in a bearing 64 supported on the under surface of the carriage 51, the bearing 64 being secured in place by means of screws 65 which extend through a flange 66 on the bearing and through a spacer ring 67 located between the flange 66 and the lower surface of the carriage 51 and then into the carriage 51. An annular boss 68 on the bearing 64 extends into an aperture 69 formed in the carriage 51 but does not extend to the upper surface of the carriage 51. A relatively large stem 70 is mounted in the lever 63 and extends upwardly therefrom into the bearing 64, the upper end of the stem 70 having an annular flange 71 disposed in the aperture 69 and bearing on the upper end of the boss 68 of the bearing 64. The lever 63 comprises an arm 72 and a relatively wide body 73. The arm 72 extends forwardly of the forward end of the carriage 51 and the outer end portion 74 of the arm 72 is transversely apertured to loosely receive a shaft 75. Supported in and extending downwardly from the body 73 and located to the right of the pivotal point of support of the lever 63 is a pin 76 which will hereinafter be called a follower 76. The follower 76 is arranged to engage an edge of the templet 35 and will follow the edge of the templet 35 and in cooperation with the templet 35 will cause the carriage 51 to move transversely of the platen 12.

It will be seen as shown in Fig. 3 that the follower 76 is located to the rear of the position of the motor 53 and directly in line with the center of the motor 53. It will also be seen in this figure that the lever 63 may be operated in the manner of a bell crank lever to move the follower 76 relative to the motor 53 to change the distance between the follower 76 and the motor 53.

The shaft 75 is supported in spaced bearings 77 and 78 extending from a support 79 mounted

6

on the forward portion of the carriage 51, the bearings 77 and 78 extending forwardly of the forward end of the carriage 51 and so that the shaft 75 extends in parallel spaced relation with the forward end of the carriage 51. The shaft 75 extends transversely through the outer end portion 74 of the lever 63 and is supported at one end by means of an end thrust bearing 79 comprising a screw 80 adjustably supported in a block 81 mounted on a support 82 by means of screws 83, the support 82 being secured by means of screws 84 to the bearing 78. A pin 85 mounted in an end of the shaft 75 and having a hemispherical head is located between the screw 80 and the end of the shaft 75. A turning knob 86 is provided on one end of the screw 80 to provide a means for turning the screw 80.

Mounted on one side of the outer end portion 74 of the lever 63 is a ring 87 through which the shaft 75 extends. The ring 87 is securely fastened to the outer end portion 74 of the lever 63 and is formed on its outer face to provide a cam surface 88 which is engaged by a round head portion 89 of a screw 90 mounted on the shaft 75 and extending radially of the shaft 75. Supported on the shaft 75 and located between the bearing 78 and the outer end portion 74 of the lever 63 is a spring 91 which constantly urges the outer end portion 74 of the lever 63 toward the screw 90 and so that the cam surface 88 on the ring 87 bears against the round head 89 on the screw 90. When the shaft 75 is rotated so that the round head 89 on the screw 90 is engaged by relatively high parts of the cam surface 88 the outer end portion 74 of the lever 63 is moved against the action of the spring 91 and toward the bearing 78. This movement of the lever 63 causes the follower 76 to move further away from the center of the motor 53. When the shaft 75 is rotated to move the screw 90 so that the round head 89 of the screw 90 is moved into engagement with a low portion of the cam surface 88 the spring 91 causes the lever 63 to move so that the follower 76 comes nearer the position of the motor 53. When the follower 76 is against the templet 35 motion between follower and motor against the action of the spring is also against the pull of the weight on the tow line 59.

The shaft 75 may be rotated by manual operation of a stylus 92 secured in a holder 93 by means of a setscrew 94. The holder 93 is transversely apertured to accommodate a flanged bushing 95 secured to the holder 93 by means of screws 96 and the bushing 95 is keyed to the shaft 75 by means of keys 97. Movement of the holder 93 and bushing 95 lengthwise of the shaft 75 may be accomplished only when a thumb screw 98 is released from engagement with the shaft 75, the thumb screw 98 being mounted in a tapped hole in the holder 93 and projecting through the bushing 95 and being operable to engage the shaft 75. Spacer sleeves 99 and 100 are mounted on the shaft 75 to prevent extensive movements of the holder 93 lengthwise of the shaft 75, the sleeve 99 being disposed between the flanged end of the bushing 95 and the bearing 78 and the sleeve 100 being disposed between the holder 93 and the bearing 77. To facilitate manual movement of the stylus 92 to cause rotation of the shaft 75 a handle 101 is provided on the stylus 92, the handle 101 extending through a transverse aperture formed in the stylus 92.

The mechanical means for moving the follower 76 relative to the center of the motor 53

to change the distance between the follower 76 and the cutting tool 55 and involving the stylus 92, the stylus holder 93, the shaft 75, the screw 89, the cam ring 87 and the lever 63 is constructed and arranged so that the distance of movement of the follower 76 will be much less than the distance of corresponding movement of the lowermost end of the stylus 92. The ratio will depend on the form and arrangement of the lever 63, the form of the cam surface 88 on the ring 87 and the distance the lower end of the stylus 92 is from the axial line of the shaft 75. In an actual set-up of the machine now made the ratio is 75 to 1 and it will be assumed merely for the purpose of further explaining the invention and not in the sense of a limitation thereof that the follower 76 is moved one seventy-fifth of the distance the lowermost point of the stylus 92 is moved transversely of the platen 12.

A thumb screw 102 mounted in a tapped hole in the bearing 77 and operable to engage the shaft 75 is provided to hold the shaft 75 against rotational movement. When the thumb screw 102 is tightened to hold the shaft 75 against rotational movement the stylus 92 cannot be operated to cause movement of the follower 76. In this case a forward movement of the follower 76 will cause a corresponding movement of the carriage 51 and the stylus 92.

The turning knob 86 and the screw 80 provide a means for initially adjusting the lever 63 to set the follower 76 at a required distance from the position of the cutting tool 55, the thumb screw 102 being loosened to permit longitudinal movement of the shaft 75 prior to turning the knob 86. Turning of knob 86 and screw 80 also permits fixed parallel adjustment to be made in the width of the card independently of the operation of stylus 92. In high accuracy potentiometers such adjustments are necessary to compensate for variation in the card thickness. The knob 86 may be graduated to obtain .001 inch increment changes in the distance between the follower 76 and cutter 55.

The stylus 92 may be used to perform two functions one of which is to make a line 103 on a sheet 104 supported on the platen 12, the sheet 104 being later used as a plan of correction in profiling the card. The other function of the stylus 92 is to follow a correction line 105 made on the sheet 104 and showing in magnified form corrections that must be made in the card originally produced in order to make the card satisfactory for the requirements.

The sheet 104 is shown in Fig. 8 and will hereinafter be called the correction sheet 104 and may be a rectangular sheet of paper or other material suitable for having records made thereon. The correction sheet 104 is of sufficient length and width to have made thereon a pattern of the curved edge of the templet 35 and indications in magnified form of changes to be made in the curved edge of the card cut in accordance with the templet.

The correction sheet 104 is placed on the platen 12 forwardly of the positions of the card 19 and the templet 35 and so that it will pass under the stylus 92 when the platen 12 is moved lengthwise of the bed 10 of the machine, the correction sheet 104 being secured in place by means of some adhesive material. A convenient way of securing the correction sheet 104 in place is to apply strips of adhesive tape to the correction sheet 104 and the platen 12. A line 103 is made on the correction sheet 104 to repre-

sent the curved edge of the templet 35 and the correspondingly curved edge of the card cut in accordance with the templet. The line 103 is made by means of the stylus 92 which is arranged to press downwardly on the correction sheet 104 when the machine is operated to make the platen 12 carry the correction sheet 104 under the stylus 92. The line 103 may be simply a scratch mark made on the correction sheet 104 by the point of the stylus 92. A more readily distinguishable line 103 may be made however by placing a sheet of carbon paper between the point of the stylus 92 and the upper surface of the correction sheet 104 and so that the stylus 92 and the sheet of carbon paper will cooperate to produce a carbon line on the correction sheet 104.

The machine is first operated to make the curved edge on the card conform to the curved edge on the templet and to make the line 103 on the correction sheet 104. In this case the templet 35 is secured in required position on the elevated platform 32, the card 19 is secured in a corresponding position on the platen 12, the correction sheet 104 is mounted forwardly of the card 19 on the platen 12 and the shaft 75 is held against movement by means of the thumb screw 102 and the screw 80. Under this condition the follower 76 bears against the curved edge of the templet 35 and the cutting tool 55 bears against the curved edge of the card 19 since the carriage 51 is urged toward the rear of the machine by the weight on the end of the tow line 59.

When the machine is operated with the parts in the condition above indicated and the motor 53 is operated to rotate the cutting tool 55 the curved edge of the card 19 is accurately profiled to conform to the curved edge of the templet 35 since the platen 12 is moved lengthwise of the machine under the action of the lead screw 14 and the cutting tool 55 is rotating and bearing against the curved edge of the card 19 while the carriage 51 is, in effect, cammed by means of the templet 35 against the action of the weight on the tow line 59. The stylus 92 makes the line 103 on the correction sheet 104 since the correction sheet 104 is moved under the stylus 92 while the stylus 92 is bearing against the correction sheet 104 or against a piece of carbon paper laid over the correction sheet 104. The line 103 corresponds to the curved edge of the templet 35 since the stylus 92 is moved under the action of the carriage 51.

After the card 19 has been profiled and the line 103 has been made on the correction sheet 104 in the manner above described the bars 27 are loosened by suitably turning the nuts 22 and the card 19 is removed from the machine. The card 19 is then measured for width at certain predetermined points and notations are made of any differences in the width of the card at these points from what is required in the desired card. The card is usually found to be a few thousandths of an inch too wide or narrow at the points measured since the templet 35 in being made is not filed to the precise limits required in the profile of the card and other errors are introduced in mounting the templet in the machine and in the cutting process. Spaced lines are made on the correction sheet 104 to indicate thereon the points at which the card 19 is measured. The lines just previously mentioned extend directly across the correction sheet 104 from one long edge portion to the other and cross the line 103 and may be any number required to indicate the

points at which the card 19 is measured. In Fig. 8 the lines are numbered 106 to 143, inclusive, and indicate that the card 19 has been measured at 38 points and that some of the points of measurement are closer together than others. Wherever the card 19 is found to be overwidth a dot is made on the correction sheet 104 to indicate at what point the card 19 is overwidth and how much the card 19 is overwidth at this point. The overwidth indications are magnified with respect to the actual overwidth measurement in order that the operator of the machine may more readily see at what point the card 19 is overwidth and how much the card is overwidth at the points indicated. The magnification will be of the same order as is obtained in the movement of the stylus 92 relative to the movement of the follower 76 under the action of the lever 63. It will be assumed as above mentioned that the ratio is 75 to 1. Under this condition the overwidth indications are shown as magnified 75 to 1 and a one thousandth of an inch overwidth of the card 19 at any predetermined point will be indicated as seventy-five times that, at a corresponding point on the correction sheet 104. For instance, at line 106 the card 19 is correct in width and at certain other points the card 19 is overwidth one seventy-fifth of the amount indicated by the line 105 which is drawn to connect the dots made on the lines 106 to 143 in order that an operator of the machine may more readily see the error indications and guide the stylus 92 to the points required when the card 19 is being finish profiled.

In finish profiling, another card 19 is placed in the exact position in the machine as the previous card and the bars 27 are operated to hold the card 19 in place. The thumb screw 102 is operated to release the shaft 75 for rotation, the shaft 75 being manually rotatable by means of the stylus 92. The stylus 92 is moved to clear the point from the correction sheet 104 and turn the shaft 75 so that the low portion of the cam ring 87 is engaging the head 89 of the screw 90. The platen 12 is then moved along the bed 10 by manual operation of the handle 16, the apron 13 having been previously unclutched from the lead screw 14. When the platen 12 has been moved to bring the card 19 and the templet 35 to a required starting point and the operator is ready to finish profile the card 19 the apron 13 is clutched to the lead screw 14, by manual operation of the handle 144. The stylus 92 is then placed on the beginning of the line 105 and the machine is started to finish profile the card 19.

While the machine is operating to finish profile the card, the stylus 92 is manually held by the operator grasping the handle 101 and the operator keeps the stylus 92 on the correction line 105 on the correction sheet 104 during this second operation of the machine. When the point of the stylus 92 is swung inwardly toward the cutting tool 55 the shaft 75 is rotated so that the round head portion 89 of the screw 90 moves toward a low portion of the cam surface 88 allowing the spring 91 to move the outer end portion 74 of the lever 63 toward the left of the position shown in Figs. 3 and 4. This movement results in a movement of the follower 76 toward the cutting tool 55 and therefore reduces the distance of the follower 76 from the cutting tool 55. Since the carriage 51 carrying the lever 63 and the motor 53 is being urged rearwardly of the machine under the pull of the weight on the tow line 59 the follower 76 is kept against

the curved edge of the templet 35. Under this condition the cutting tool 55 operates to cut material from the engaged edge of the card to an extent permitted by the follower 76 and its instant point of engagement on the templet 35. When the follower 76 is moved nearer the cutting tool 55 more material will be cut from the edge of the card than when the follower 76 is more distantly positioned from the cutting tool 55. By manually keeping the stylus on the correction line 105 the operator controls the position of the follower 76 relative to the cutting tool 55 and consequently the depth to which the cutting tool 55 cuts the edge of the card. Assuming as above explained that the ratio of movement of the stylus 92 and the resultant effect on the cutting tool 55 is 75 to 1 an inward movement of the stylus 92 toward the cutting tool 55 seventy-five thousandths of an inch will increase the depth of cut made by the cutting tool 55 in the edge of the card one thousandth part of an inch. It will be seen, therefore, that as the platen 12 is being driven along the bed of the machine to move the card and templet longitudinally the cutting tool 55 will profile the engaged edge of the card 19 and the depth of cut will be changing in accordance with the movements imparted to the stylus by the operator.

The operation of the rotating cutting tool 55 against the edge of the card 19 creates dust-like particles of material cut from the card 19. To prevent an accumulation of the dust-like particles on the cutting tool 55 and on the edge of the card 19 a vacuum cleaner apparatus may be employed, the nozzle 145 of the vacuum cleaner apparatus being mounted on the carriage 51 of the profiler head 47 and relatively close to the cutting tool 55.

We do not consider our invention to be limited to the particular machine or form of the parts shown and described since other means may be employed for the same purpose, but only by the appended claims.

What is claimed is:

1. A machine for cutting an edge of a card to a precise predetermined pattern comprising a support for the card, a support for a templet of the card, a carriage operable to move transversely of the card, means to urge said carriage toward the support for the templet, means to cause relative movement of said supports and said carriage, a cutting tool and a driving means for said cutting tool supported on said carriage, a lever pivotally supported on said carriage, a follower supported on said lever and spaced from said cutting tool, said follower being operable to bear against the templet to control the engagement of said cutting tool against an edge of the card and a manually operated stylus carried by said carriage and mechanically connected to said lever and operable to move said lever to change the spacing of said follower relative to said cutting tool.

2. A machine for finish profiling an edge of a card to a precise predetermined pattern comprising a support for the card, a support for a templet of the card, a profiler head extending over and in spaced relation with said supports, means to cause relative movement of said supports and said profiler head, a carriage slidably supported in said profiler head and operable to move transversely of said supports, a cutting tool and means to drive said cutting tool supported on said carriage, means to urge said carriage toward the support for the templet, a

lever pivotally supported on said carriage, a follower supported on said lever and operable to bear against the templet, said follower being spaced from said cutting tool, a rotatable shaft supported on said carriage and extending transversely through said lever, a cam on said lever, means on said shaft and engaging said cam to move said lever in one direction when said shaft is rotated in one direction, means to return said lever to normal position when said shaft is rotated to normal position and a stylus supported on said shaft and manually operable to rotate said shaft to change the spacing of said follower from said cutting tool.

3. A machine for profiling an edge of a card comprising means to support the card, means to support a templet of the card, a carriage, a cutting tool carried by said carriage and operable to cut the edge of the card, a follower carried by said carriage, said follower being spaced from said cutting tool and being operable to engage the templet to control the operation of said cutting tool in accordance with the templet, means to urge said carriage and said follower toward said templet and a manually operable stylus carried by said carriage and mechanically connected to said follower and operable to change the spacing of said follower relative to said cutting tool.

4. A machine for finish profiling an edge of a card comprising a platen to support the card, means to move said platen longitudinally, a platform on said platen to support a templet of the card, a carriage extending over said platen and platform and movable transversely of said platen, a cutting tool operable to rotate against an edge of the card to profile the edge of the card, a motor supported on said carriage and carrying said cutting tool, said motor being operable to rotate said cutting tool, a pivotally supported lever carried by said carriage, a follower supported on said lever and operable to engage the templet to control the movement of said carriage transversely of said platen, said follower being spaced from said cutting tool, means to urge said carriage in a direction to keep said follower against the templet, a rotatable shaft supported on said carriage, a cam mechanism mechanically connecting said shaft to said lever, and a manually operable stylus supported on said shaft and providing a means to manually rotate said shaft to change the spacing of said follower relative to said cutting tool.

5. A machine for profiling an edge of a card cut according to a templet and for finish profiling the edge of the card according to a correction sheet having a correction pattern thereon comprising supporting means for the card, the templet and the correction sheet, a head supported in spaced relation with said supporting means, means to cause relative movement of said supporting means and said head, a carriage in said head and operable transversely of said supporting means, a cutting tool and means for operating said cutting tool carried by said carriage, a follower spaced from said cutting tool and movably supported in said carriage, said follower being operable to engage the templet, means to urge said carriage in a direction to keep said follower against the templet, a stylus carried by said carriage and operable to follow the correction pattern on the correction sheet, a motion transmitting mechanism between said stylus and said follower and serving to mechanically connect said stylus to said follower and said stylus being manually operable to change the spacing of said fol-

lower relative to said cutting tool to make said cutting tool finish profile the edge of the card according to the correction line on the correction sheet.

6. A machine for profiling an edge of a card according to a templet of the card and for finish profiling the edge of the card according to a correction line made on a correction sheet and showing in proportionately magnified form errors found in the form of the edge line of the card comprising supporting means for the card, the templet and the correction sheet, a profiler head, means to cause relative movement of said supporting means and said profiler head, a cutting tool carried in said profiler head and operable to cut the edge of the card, a follower carried in said profiler head in variable spaced relation with said cutting tool and operable to engage the templet, a stylus carried by said profiler head and operable to engage and follow the correction line on the correction sheet and means forming a mechanical driving connection between said stylus and said follower and operable to transmit movements of said stylus to said follower to change the spacing of said follower relative to said cutting tool in required reduced proportions to make said cutting tool profile the edge of the card correctly and in required proportion to the errors found in the card and indicated in magnified form by the correction line shown on the correction sheet.

7. A machine for profiling an edge of a card according to a templet of the card and for later finish profiling the edge of the card according to a correction sheet having a line thereon showing in proportionately magnified form errors found in the form of the edge line of the card comprising supporting means for the templet, the card and the correction sheet, a profiler head extending transversely of and in spaced relation with said supporting means, means to cause relative movement of said supporting means and said profiler head, a motor driven cutting tool carried in said profiler head and operable to cut the edge of the card, a follower carried in said profiler head in spaced relation with said cutting tool, said follower being arranged to engage said templet and being operable to move relative to said cutting tool, a manually operable stylus carried by said profiler head and in spaced relation with said cutting tool, said stylus being operable to traverse the correction sheet and move relative to said cutting tool, means forming a mechanical driving connection between said stylus and said follower and operable to transmit movements of said stylus to said follower to change the spacing of said follower relative to said cutting tool in required reduced proportions to make said cutting tool profile the edge of the card correctly and in required proportion to the errors found in the card and shown in magnified form on the correction sheet and releasable holding means for said stylus to hold said stylus against movement relative to said cutting tool.

8. A method of making a card of precise form and dimensions from sheet material comprising making a rough templet of the card required, cutting a card from sheet material in accordance with the templet, measuring the card from point to point and making notations of errors found in the dimensions of the card at the points measured, preparing a pattern of an edge of the card, making a line on the pattern to indicate in magnified form and in comparison with the pattern of the edge line of the card, the errors found in the form of the edge line of the card and finish-

13

ing off the edge of the card to make the card have the required form and dimensions while observing the errors shown by the line in magnified form on the pattern.

9. A machine for cutting an edge of a card to a precise predetermined pattern comprising a support for the card, a support for a templet, a cutting tool operable to engage and cut an edge of the card, means to operate said cutting tool, means to cause relative movement of said supports and said cutting tool, a follower spaced from said cutting tool and engageable with an edge of the templet to limit the depth said cutting tool may cut the edge of the card, a movable lever support for said follower, stylus means, movable shaft means supporting said stylus means and in mechanical

14

connection with said movable lever support, said stylus means and said movable shaft means being cooperable to move said movable lever support to continuously vary the distance between said follower and said cutting tool to correct errors determined by measurement of a test card in cutting subsequent cards, and adjustable setting means in engagement with said movable shaft means and operable to move said shaft means to superimpose a fixed change in the distance between said cutting tool and said follower independently of the distance varying action of said stylus means.

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