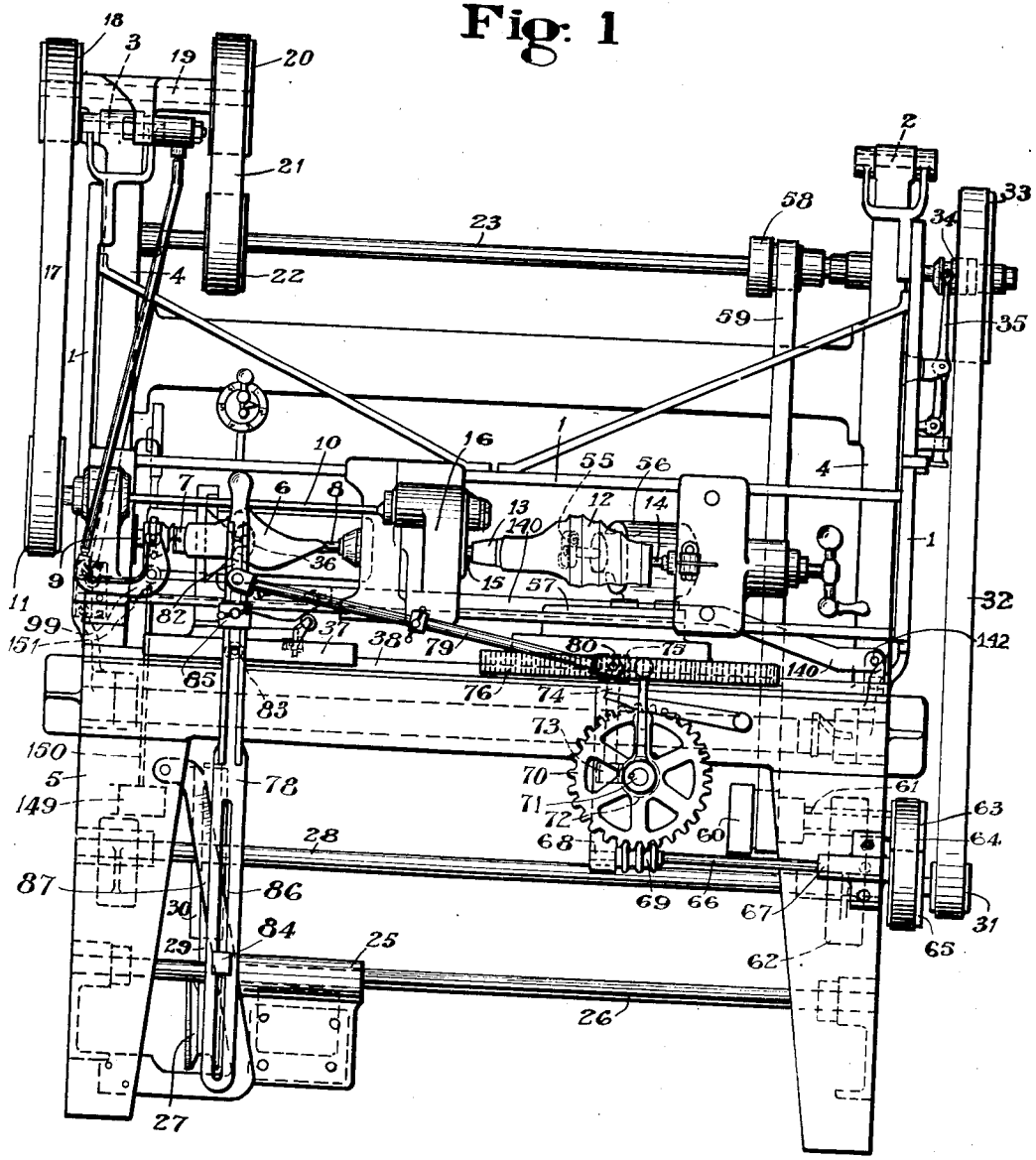
April 18, 1939. G. CLAUSING 2,154,726

TOE SPRING CORRECTION ATTACHMENT FOR LAST LATHES

Filed Nov. 14, 1936 4 Sheets-Sheet 1

Fig. 1




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TOE SPRING CORRECTION ATTACHMENT FOR LAST LATHES

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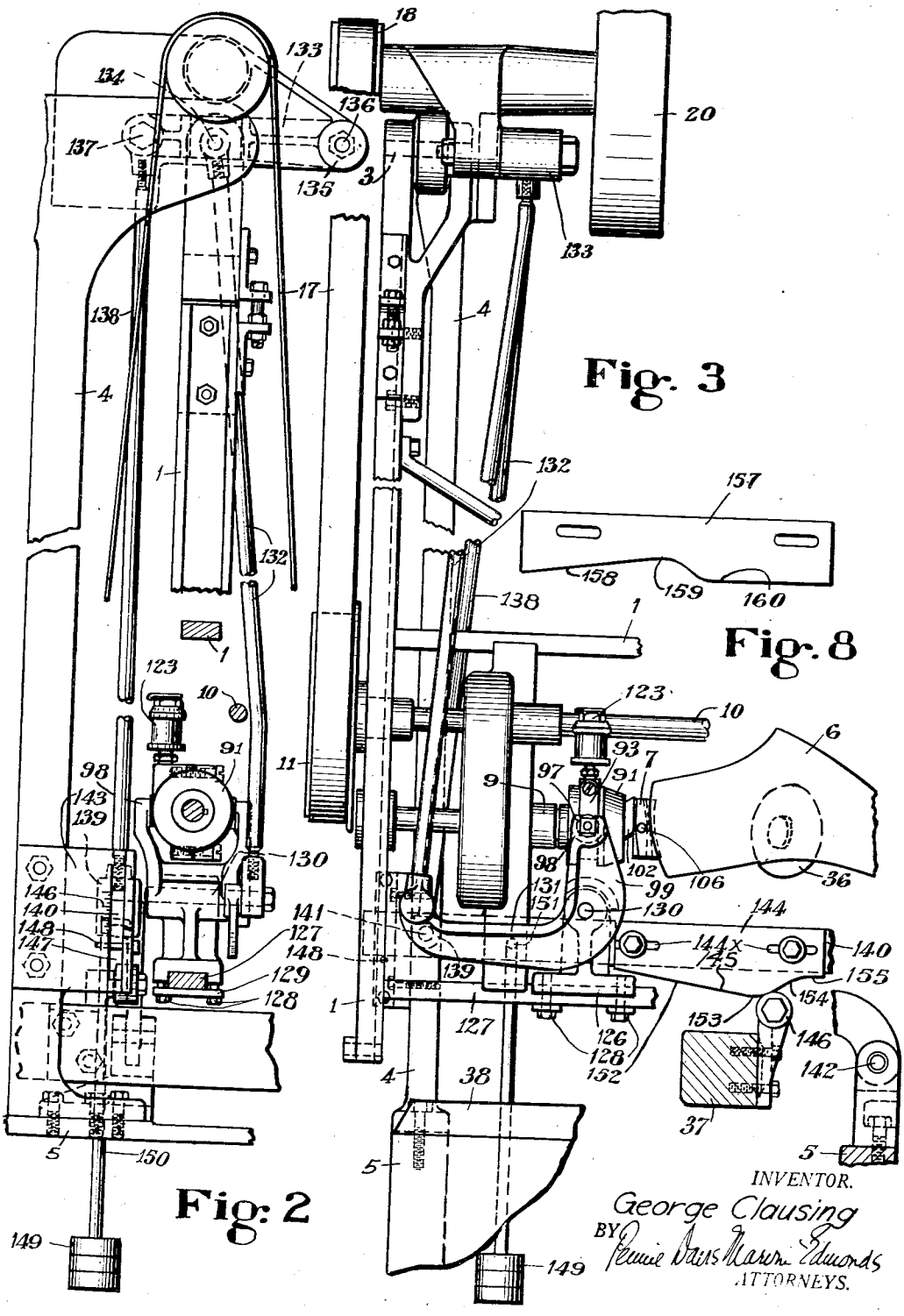



Fig. 3




Fig. 8

Fig. 2

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TOE SPRING CORRECTION ATTACHMENT FOR LAST LATHES

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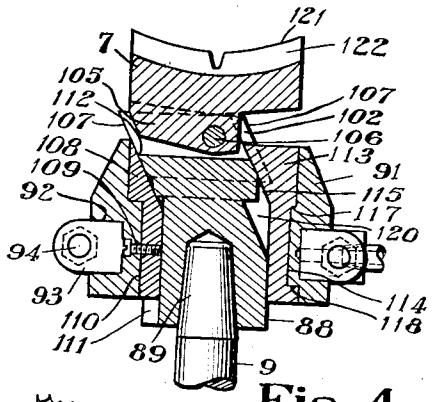



Fig. 4

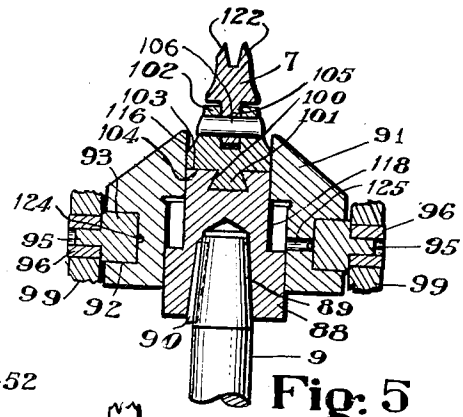



Fig. 5

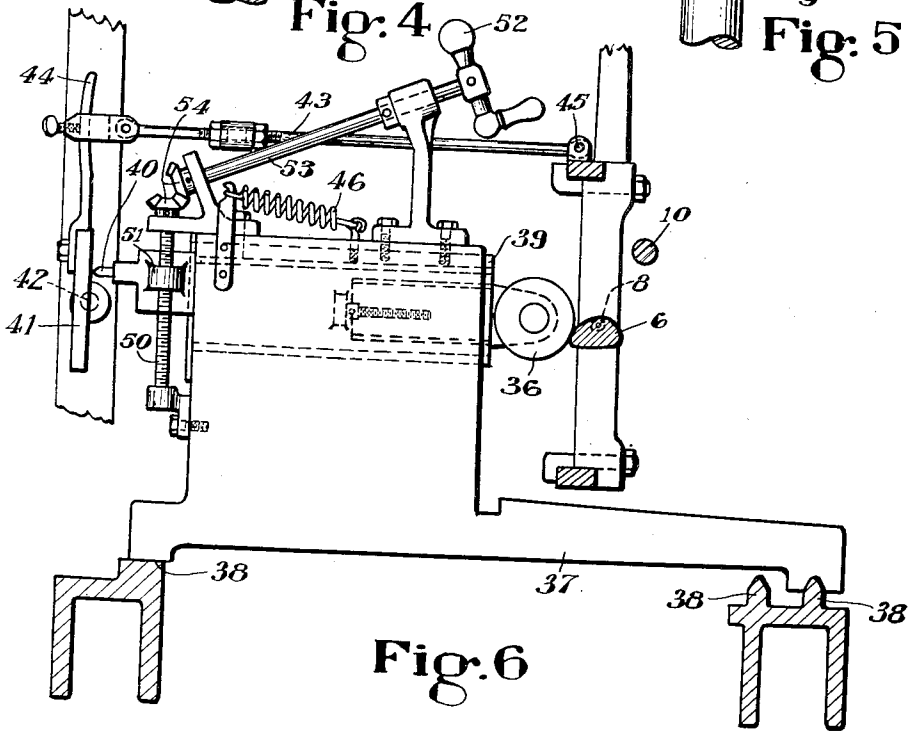



Fig. 6

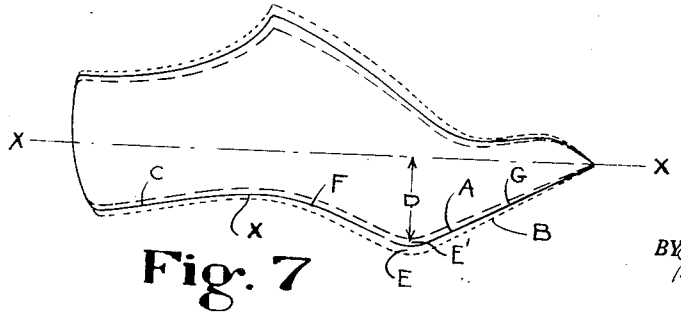



Fig. 7

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Fig. 9.

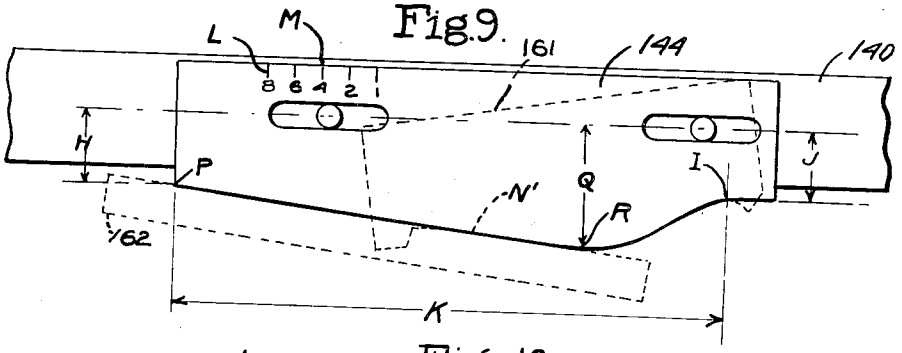



Fig. 10.

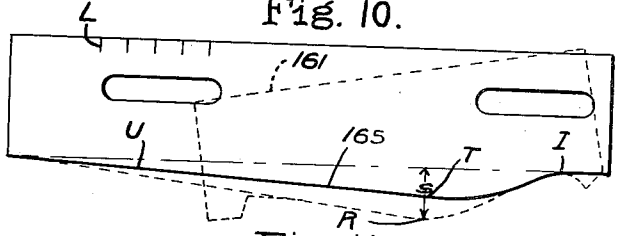



Fig. 11.

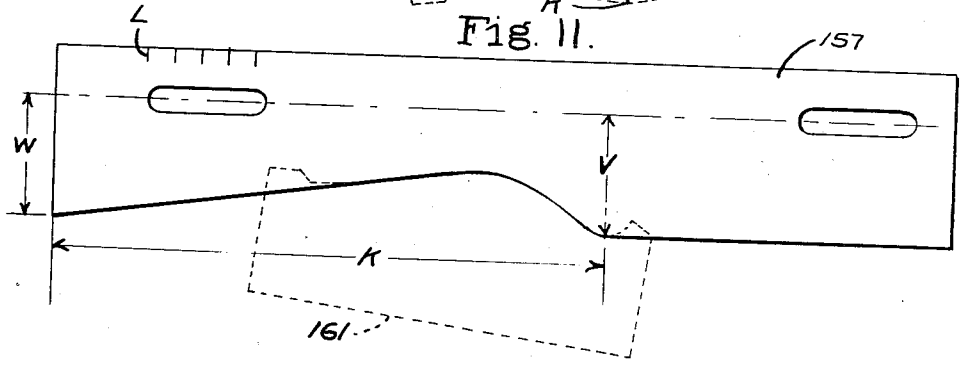
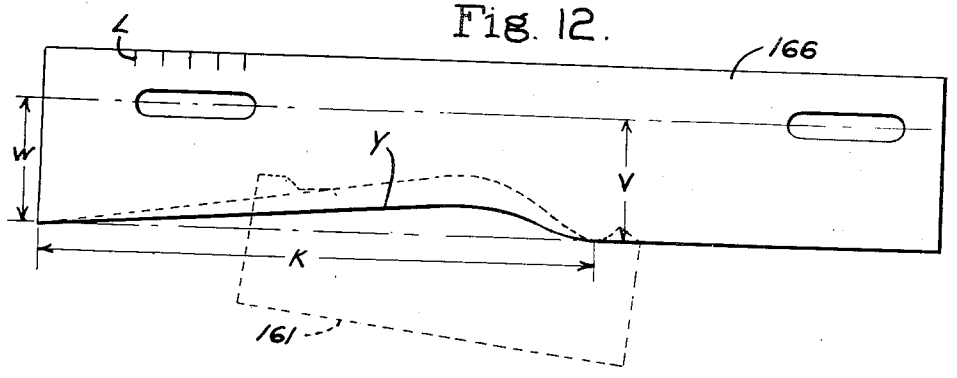



Fig. 12.




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# UNITED STATES PATENT OFFICE

2,154,726

## TOE SPRING CORRECTION ATTACHMENT FOR LAST LATHES

George Clausing, Portsmouth, Ohio, assignor to Vulcan Corporation, Portsmouth, Ohio

Application November 14, 1936, Serial No. 110,794

4 Claims. (Cl. 142—15)

This invention relates to last lathes and particularly to improvements therein which function to change the normal pantographic operation of the grading means incorporated in the lathe.

Broadly stated, the improvement referred to is capable of correcting undesirable contour changes in a last which have been introduced by the width and length grading means when producing a series of lasts larger or smaller than a model last from such model last. Such correction may well be the correction of improper toe spring in the last produced. In another of its aspects, the improvement is capable of adapting the produced last to a shoe heel of different height than that to which the model last is adapted.

It is within the normal capability of a copying lathe to reproduce a three-dimensional object in its original dimensions and contour with a high degree of accuracy. That is, with an accuracy commensurate with the usual accuracy required in the making of the last models. A very different problem is presented, however, when the model is to be reproduced in a proportionately larger or smaller size. In such instances, the pantographic amplifying and reducing means found upon the lathe does not reproduce a last in the desired direct proportion, and the problem of correctly grading a series of lasts from a model according to the required sizes, widths, heel height and toe spring is a complicated one. Those requirements which relate to corrections in heel height and toe spring are incorporated in this invention.

As a preliminary discussion leading up to the particular problem with which the present invention is concerned, a general statement will herein be set forth pointing out a requirement for producing a correctly graded series of lasts. By way of illustration, let it be assumed that a cross-section be taken of a model last at right angles to its turning axis and at the ball portion thereof, for example, in a 4B size. This cross-section will display the correct contour to insure correct fit in the shoe manufactured thereon, because the model has been fashioned correctly by the model maker. For comparison, let it now be assumed that a cross-section is made at the ball portion of a correct last in a 4D size.

Such a cross-section will be generally larger in area than in the B width model. This cross-section, however, will exhibit characteristics which depart from a figure which has been enlarged in direct proportion from the cross-section of a last of B width. For instance, it will be found that the increase in width at the ball section in a horizontal direction will be relatively great while the amount of increase at the surface of the sole is relatively smaller. It will also be found that the dimensions of the upper or comb section vary but little, except that the comb is relatively higher in the D width. Obviously, therefore, a true pantographic enlargement in these width dimensions does not fulfill the requirements for width grading. This discussion is not intended to set forth rigid rules in the design of the model lasts, but to present a general comparison of the usual characteristics of lasts in various widths. It is intended to lay the basis for a description of the manner in which a copying lathe functions when grading upwardly or downwardly from a model of a given width to produce a last of greater or less width.

It is obvious also that the model maker's requirements will not be fulfilled in producing a 4D from a 4B by adding a layer of uniform thickness to every portion of the area of the model. As will appear hereinafter, not only is such action of the lathe undesirable, but the lathe cannot accurately produce such an effect. For purposes of illustration, let the last be divided into a plurality of thin flat superposed layers, each layer being disposed in a plane substantially at right angles to the turning axis. During the turning operation, the width grading means on the lathe increases the dimensions of each of these superposed layers in direct proportion to the distance of their outline from the turning axis. This direct proportional characteristic of the lathe produces an acceptable reproduction of each of these assumed layers when grading from one width to another at the heel and toe extremities of the last. When turning at and adjacent the ball and waist section of the last, however, an undesirable relative shifting of the layers takes place which results in incorrectly reproducing the toe spring and heel height of the last. The present invention provides means for correcting toe spring and heel height, and by the same means, other variations in the last may be introduced, such as a required change in heel height from that of the model. It will be understood that the application of the principles herein set forth apply not only to grading from one width in a given size to another width in the same size, but also to any increase in width whether it be in the same size or in different sizes.

It is evident in a lady's last, that the sides and bottom of the ball section are located farthest from the turning axis which is normally through the center of the last from heel to toe. This be-

ing so, the width grading mechanism upon the last lathe increases this distance from the axis in greater proportion than it does elements at other sections along the last, for instance, at and adjacent the heel and toe extremities, these last named sections being closer to the turning axis of the last. In reproducing the model, therefore, the last lathe bends the ball portion of the produced last downwardly to such an extent that a correction must be made therein, in order to turn a last having the same heel height as the model. In other words, the layers, above referred to, are shifted one upon another an excessive amount at and adjacent to the ball section. This bending of the last or shifting of the layers decreases to practically nothing at the heel and toe extremities. Obviously, the contour of the last bottom is thereby caused to deviate from the standard requirement set up by the model maker.

Attempts are made in various ways to correct this distorted modeling of the reproduced last. One method of correcting this excessive bending of the last is by what is known as the "wedging" process. To do this, a saw cut is made substantially in the plane of the ball of the last extending from the top of the last to a point approximately ½ of the distance to the last bottom. A V-slot is then cut upwardly from the last bottom to a point closely adjacent the bottom extremity of the saw kerf. The toe part is then bent downwardly with relation to the heel part and a properly fitted wedge proportioned to insure the desired amount of correction in the toe spring is cemented in place in the saw kerf, which has been opened by the bending of the toe. This wedging of the toe causes an angle of incorrect dimensions on the heel. To correct the wedge angle of the heel, it is wedged in the same general manner as that of the toe, but in the opposite direction with the wedge at the last bottom.

This last mentioned practice is inaccurate and generally unsatisfactory. The model maker establishes a definite shape for the sole line of a correct last which must conform to an accurate template, and the wedging of the last, as above described, does not produce a last conforming to the model maker's requirements. Furthermore, the wedging operation cannot change the curved contour of the instep to conform with the conception of the model maker of what that curve should be.

It is one object of the present invention to provide means for automatically reshaping the profile of the sole line of a reproduced last, either to conform with the model or to depart from it in a predetermined manner.

A further object of the invention is to provide means for automatically correcting the toe spring of a series of lasts of various widths and sizes from a correct model.

Another object of the invention is to provide means for varying the contour of a last in accordance with a determinable controlling instrumentality such as a cam or other pattern means.

A further object of the invention is to provide means for bodily shifting a model last laterally of its turning axis during the turning operation, thereby temporarily to move its turning axis out of alignment with the axis of the shaft which rotates the model, such movement taking place in predetermined amounts and in timed relation to the progress of the turning operation.

Another object of the invention is to provide in a machine of the above indicated character, a positive stop means for accurately determining when the model last is in its normal, axial or rest position.

A still further object of the invention is to provide means whereby the heel height of a reproduced last may be varied from that of the model last as desired.

Another object of the invention is to provide a mechanism for shifting a model dog laterally of its axis, such mechanism being uneffected by the relative lateral motion between the axis of the model and the model wheel, thereby insuring that the modification or correction specified by the model maker will be accurately applied.

A further object of the invention is to provide a mechanism for correcting or modifying a last produced from a model, such mechanism being readily applied to existing lathes with practically no modification of the existing structure of the lathe.

A further object of the invention is to provide a mechanism of the type above referred to, in which excessive stresses are avoided and in which the accuracy of operation is insured over a long period of hard use. Other objects and features will more fully appear from the following specification in connection with the accompanying drawings and will be particularly pointed out in the claims.

In the drawings,

Fig. 1 is a front elevation of a last lathe embodying the invention.

Fig. 2 is an enlarged end elevation of a portion of the lathe illustrating those elements which constitute the invention.

Fig. 3 is a front elevation of the elements illustrated in Fig. 2.

Fig. 4 is a cross-section axially through the model driving and holding dog.

Fig. 5 is a cross-section through the model driving and holding dog in a plane at right angles to the section taken in Fig. 4.

Fig. 6 is a detailed view of the construction of the width grading mechanism incorporated in the lathe.

Fig. 7 is a diagrammatic outline view illustrating the correction or alteration of a graded last.

Fig. 8 is a view of a modified form of a model heel dog shifting cam.

Figs. 9, 10, 11 and 12 illustrate methods of shaping cams.

To present a complete and readily understood conception of the invention, the following detailed description will be based upon a particular embodiment thereof.

The drawings illustrate the type of last lathe having a swing frame for rotatively supporting the model and last block. It will be understood, however, that the invention may be applied to other types of last lathes. The swing frame 1 is pivotally supported at points 2 and 3 upon the super-structure 4 of the main frame 5, and the model 6 is supported in the swing frame 1 between the heel dog 7 and the toe dog 8 with the heel dog 7 movable laterally of the turning axis in a manner to be hereinafter set forth. Such dog 7 is rotated by a shaft 9 journaled in the swing frame and driven by means of gearing, not shown, from a shaft 10 which is journaled in the swing frame and has fixed upon its outer end a pulley 11. The last block 12 is received by the heel dog 13 and a toe dog 14, both of which may be of usual construction, the heel dog 13 being here shown mounted upon the end of a shaft 15 disposed in axial alignment with the

shaft 9 and driven from the shaft 10 by suitable gearing situated within the casing 16. The two dogs 7 and 13 are driven at synchronous speed either in the same or opposite directions, depending upon whether a right or a left last is being turned.

As a means for driving the shaft 10 and thereby rotating the model and the work, the pulley 11 on the shaft 10 is driven by means of a belt 17 which passes over the pulley 11 and also over a pulley 18 fixed upon a short shaft 19 journaled in the super-structure 4 closely adjacent to the pivotal point 3 between the swing frame 1 and the super-structure, (Fig. 1). Such shaft 19 has upon its opposite end a pulley 20 over which passes a belt 21 and the belt 21 also embraces a pulley 22 fixed upon a shaft 23 extending lengthwise of the machine and journaled at its ends upon the super-structure 4. The shaft 23 is driven from a motor suspended from a bracket 25 fixed upon a shaft 26, the shaft being journaled in the main frame 5, and motor desirably is provided with a variable speed pulley 27 which drives a shaft 28 by means of a belt 29 and a pulley 30 over which the belt passes. Such shaft 28 has fixed thereon another pulley 31 over which passes a belt 32 which in turn passes over another pulley 33 freely rotatable on the outer end of the shaft 23. The pulley 33 has fixed thereto one member of a clutch 34, the other member of which is splined upon a shaft 23 and is axially movable into and out of engagement with the other clutch member by means of a lever 35 fulcrumed upon the structure 4, which lever 35 may be manually or automatically operated to engage or disengage the pulley 33 with the shaft 23 thereby establishing or disengaging the drive from the motor to the model and last block.

Suitable means is provided for retracting and moving the respective toe chucks 8 and 14 into engagement with the model 6 and block 12 thereby enabling insertion or replacement thereof. Any usual means may be employed to accomplish this end.

The weight of the swing frame plus the necessary spring tension applied in the usual or any suitable manner acts to maintain the model in engagement with the model wheel 36. Such model wheel is mounted upon a carriage 37 movable in a direction parallel to the axis of the model upon ways 38 formed upon the main frame of the machine, and the carriage 37 may be of usual construction and provided with a width grading slide 39 movable horizontally upon the carriage in a direction perpendicular to the turning axis. The forward end of the slide 39 has rotatably mounted thereon the model wheel 36 and the other end of the slide 39 has mounted thereon a knife member 40 vertically adjustable with respect to the slide (Fig. 4). Such knife member 40 engages the fan board 41, which is pivoted in the main frame of the machine at 42 and is of usual construction, the fan board 41 being oscillated upon its pivots in its usual way by means of a link connection 43 adjustably pivoted at one end to an extension 44 of the fan board and at its other end to the swing frame at 45.

In operation, the knife member 40 slides lengthwise of the fan board as the carriage moves along its ways and is held thereagainst by a spring 46 secured at one end to the slide 39 and at its other end to the carriage 37. The fan board transmits motion to the slide and consequently to the wheel 36 in proportion to the distance the knife member 40 is adjusted away from the pivot points 42 and also the extent of motion transmitted by the fan board is dependent upon the degree of motion of the swing frame as it moves toward and from the model wheel. The vertical position of the knife member 40 is adjustable by means of the screw 50 which is rotatably mounted upon the carriage 37 and is prevented from relative axial movement therewith. Such screw 50 passes through the nut 51 upon the knife member 40 and as the screw is rotated by a hand wheel 52, such rotation is transmitted through a shaft 53 and a pair of beveled gears 54, one of which is secured to the screw and the other of which is secured to the shaft 53. Means are thereby provided for readily raising or lowering the knife member 40.

It is well known to those skilled in the last making art that the position of the knife member with respect to the pivot points 42 of the fan board determines the degree of grade when width grading a last. When the knife member is upon the longitudinal axis of the fan board no width grading is introduced. When, however, the knife is adjusted away from the axis of the fan board, oscillating motion of the fan board is transmitted to the model wheel, thereby increasing or decreasing the travel of the swing frame depending upon whether the knife member is above or below the fan board axis. This motion of the model wheel adds to or subtracts from the width dimensions of the last which is being turned from the block.

The block 12 is modeled or turned by a rapidly rotating cutter 55 preferably mounted on the shaft of a motor 56. Such motor is mounted on a carriage 57 which moves upon the ways 38 in a direction parallel to the carriage 37. Preferably, the axis of the cutter is disposed at an angle to the axis of the block 12, thereby to provide room for the motor frame, with the axis of the model wheel also disposed at the same angle as the motor shaft.

The two carriages 37 and 57 move in unison with their relative speed modified by the length grading means, and as the model is rotated against the model wheel, it is given a lateral bodily motion determined by its own contour. It follows that the swing frame and also the block 12 are given the same lateral motion. As the turning progresses, therefore, the model is reproduced in the block either in identical dimensions or as modified by the width and length grading means.

To feed the carriage 57 along the ways 38, the shaft 23 has secured thereto a step pulley 58 over which passes a belt 59 which, in turn, passes over another similar step pulley 60 secured to a short shaft 61 journaled in a bracket 62 rigidly secured to the main frame. Such shaft 61 has mounted thereon another pulley 63 over which passes a belt 64, which, in turn, passes over and acts to drive a pulley 65 which is secured to a shaft 66 journaled at one end on a bearing 67. Such bearing 67 is pivoted to a support to permit angular movement of the shaft 66, the shaft 66 being journaled at its other end to the bearing 68 which is movable vertically. The shaft 66 has secured thereto a worm 69, which engages a worm gear 70 keyed to a shaft 71 journaled in the main frame. Such shaft 71 has fixed thereon a spiral gear 72 meshed with a similar gear 73 mounted upon a short vertical shaft 74 journaled in the main frame and having a pinion 75 secured upon its upper end and engaging with a rack 76 fixed to the carriage 57. Rotation of

the worm 69 causes the carriage 56 to be fed along the ways 38. Any desired means may be employed to move the bearing 68 vertically, thereby to engage and disengage the worm 69 from the gear 70 thus starting and stopping the feed of the carriage.

Travel movement of the carriage 57 is transmitted to the carriage 37 by means of the length grading bar or the lever 78 and the link 79, which is pivotally connected to the carriage 57 at 80 and at its other end it is pivoted upon a block 82 adjustable lengthwise upon the upper end of the grading lever 78. The lever 78 is pivotally connected to the carriage 57 at 83 and the lower end of the lever 78 is fulcrumed upon a block 84 which is adjustable along a slot 86 in the lever.

As usual in this type of last lathe, the increment of length added to or subtracted from the model length in a produced series of lasts is determined by the position of the block 82 with respect to the pivot point 83. Such block 82 is held in adjusted position by a clamp 85. For each size of model that is employed in producing a series of lasts the fulcrum point of the grading lever must be situated in a definite position. That position which the block 84 must assume for each model size is marked upon a rigid bar 87 along which the block slides and to which it is secured during the turning operation. The elements thus far described are or may be of usual construction and it will be understood that other forms of last lathes are adaptable to the principles of the present invention.

In accordance with this invention, the supporting member for the heel chuck or dog 7 comprises a head 88 which desirably has formed therein a tapered hole 89 within which is received the tapered end of the lathe spindle 9. The head 88 desirably is secured to the spindle by means of the key 90 and the head 88 is generally cylindrical in shape at its inner end and has a collar 91 slidable axially thereon. Such collar 91 has a peripherial groove 92 therein, within which is received a ring 93 which embraces the collar, and desirably, is composed of two semi-circular sections bolted together by the bolts 94. Oppositely disposed trunnions 95 project outwardly from the ring and are received within a pair of blocks 96, which in turn, are slidably received in slots 97 formed in the ends 98 of a forked lever 99. The lever 99 moves the collar 91 axially along the head 88 in a manner and for a purpose to be set forth hereinafter.

The end of the head 88 adjacent the model is provided with a dovetailed groove 100 extending at right angles to the axis of the spindle 9. A male dovetail 101 is received within the groove 100 and is integral with a dog supporting slide 102 and the slide 102 has flat faces 103 which engage with flat faces 104 on the head 88. Thus, the thrust occasioned by the clamping of the model between the heel and toe dogs is taken up by the substantial area existing between the flat faces 103 and 104, which, when properly lubricated provides reasonably free action of the slide 102 with respect to the head 88. The end of the slide 102 adjacent the model is slotted to receive a tongue portion 105 formed on the dog 7, which dog desirably is pivoted to the slide by means of a pivot pin 106 thereby to enable the dog to seat firmly against the back of the heel.

The end faces 107 of the slide 102 are parallel and disposed at an angle of substantially 27° with respect to the axis of the spindle, the angle being of any suitable degree depending upon the amount of motion desired in the slide 102. One of the end faces 107 is engaged by a cam member 108 fixedly mounted by means of a screw 109 within a slot 110 in the collar 91 and such cam member 108 has sufficient depth to project into a slot 111 in the head 88 and is slidably received therein. This cam member 108 forms a spline between the head 88 and the collar 91. The end of the cam member 108 adjacent to the model has a cam face 112 disposed at the same angle as the adjacent face 107 of the slide 102. Another cam member 113 is secured in the collar 88 in oppositely disposed relation to the cam member 108, and a slot 114 is formed in the bore of the collar within which is received the cam member 113. The end of this cam member 113 adjacent to the model has a cam face 115 disposed at the same angle as the adjacent end face 107 of the slide 102.

The end of the collar 88 adjacent to the model desirably has formed therein a rectangular opening 116 through which the cams 108 and 113 project. The junction of the rectangular opening and the adjacent end of the slot 114 forms a shoulder 117, while the other end of the slot 114 has formed therein a recess 118. As shown, the outer face of the cam member 113 is formed with projecting portions which fit over the shoulders 117 and 118 while the inner face of the cam member engages the cylindrical portion of the head 88. The cam member 113 is placed in position before the head 88 is inserted in the collar and when it is so inserted serves to retain the cam member in its proper position.

The two cam faces 112 and 115 embrace the end faces 107 of the slide 102, and when the collar 91 is moved axially along the head 88, the slide 102 moves at right angles to the axis upon which the head rotates by reason of the cam action between the faces 107, 112 and 115. Since the dog 7 is pivoted to the slide 102, the dog also is moved laterally, carrying the heel end of the model with it. The head 88 is recessed at 120 to permit the cam 113 to enter the head when the collar 91 is retracted to its maximum amount. The face 121 of the dog 7 desirably is concave in form to conform with the contour of the back of the heel of the model and, as is usual, this face is provided with sharp edge tines 122 which are forced into the wood of the model when pressure is applied at the toe dog.

An oil cup 123 is provided for lubricating all of the moving parts of the assembled dog shifting mechanism, the outlet of the oil cup communicating with a peripherial groove 124 at the bottom of the groove 92 in the collar 88. Thus, the surplus oil which accumulates in the groove 124 flows through a drilled hole 125 and from this point acts to lubricate the bearing surfaces between the head and the collar and also the sliding surfaces at the dovetailed connection between the head and the slide 102 as well as all of the cam faces. As above pointed out, the slide 102 is shifted laterally by movement of the lever 99 which acts through the link 93 to move the collar 91 axially of the head 88. Such lever 99 is fulcrumed upon a block 126 rigidly secured to the horizontal bar 127 at the lower end of the swing frame. The block 126 is secured in place upon the bar by means of screws 128 which pass through plates 129 and have screw threaded engagement with the block. The lever 99 is pivoted to the block by means of a pivot pin 130. A horizontal arm 131 of the lever has pivoted to its outer end, a

long link 132 which is pivoted at its other end upon a substantially horizontal lever 133 at 134. Such lever 133 is fulcrumed upon an extension 135 of the lathe super-structure at 136, and the outer end of the lever 133 has pivoted thereto at 137 a link 138 which extends downwardly and has upon its lower end a clevis connection 139 which embraces and is pivoted to a long horizontal lever 140 at 141. The lever 140 extends substantially the full width of the last lathe and is pivoted at 142 upon the main frame and the free end of the lever 140 is guided vertically within a bracket 143 secured to the main frame.

As shown, the lever 140 is provided with a detachable cam 144 having a cam face 145 which is engaged by a cam roll 146 rotatably mounted upon a bracket fixed to the carriage 37. Such cam 144 desirably is adjustable lengthwise of the lever 140, such adjustment being provided for by a screw and slot connection 144X with the lever. As the carriage 37 is fed along the ways, the lever 140 will be moved in accordance with the shape of the cam face 145, and the motion of the lever will be transmitted to the dog 7 through the link 138, the lever 133, the link 132 and the lever 99.

Referring to Fig. 2, the pivot point 134 is situated in axial alignment with the pivot point 3 between the swing frame and the lathe superstructure when the collar 91 is at the mid point of its travel along the head 88. A minimum movement is therefore given to the pivot point 134 away from its position of axial alignment with the pivot 3, and by thus confining the pivot point 134 closely adjacent the pivot point of the swing frame, the function of the mechanism above described for moving the dog 7 is practically uneffected by movement of the swing frame during the turning operation.

Obviously, the cam 144, (Fig. 3) may be shaped to fulfill the requirements of any given problem. To further provide the operator with a means for establishing and checking the operation of the device, the guide bracket 143 is provided with a scale 146, (Fig. 2) to the side of the guiding slot 147 within which the end of the lever 140 moves. By noting the position of the lever with respect to the scale, the operator may determine how much throw the cam is transmitting to the dog 7. Desirably, the scale should be calibrated to indicate known increments of motion of the dog 7.

The lever 140 and its cam 144 may be held against the roll 146 in any desirable manner. As herein shown, removable weights 149 are suspended upon a rod 150. The rod 150 is suspended upon the lever 140 at 151. The upward movement of the lever 140 is imparted thereto by the throw of the cam as the carriage 37 moves along the ways while the downward movement of the lever is imparted by the weights 149.

It is highly desirable that the operator be provided with a ready means for returning the dog to its neutral position or that position wherein the normal turning axis of a model when clamped in turning position is in alignment with the axis of the driving shaft 9. This may be effected in any suitable manner and as herein shown, a stop pin 148 (Fig. 2) is placed in an aperture in the plate 143 in correct position to stop the travel of the lever 140 in its downward movement at the point where the dog 7 is in its neutral position. For operation of the machine requiring downward motion of the lever 140 beyond this point the pin 148 is removed.

As previously pointed out, the width and length grading means cause incorrect modeling of the last produced when grading from one width to another in the same size, or when grading from a 4 to a 6 size, which automatically requires a change in width of the last. The present invention functions to correct the error in the modeling of the last which causes an incorrect toe spring and heel height. Briefly stated, the above described machine accomplishes the correction by shifting the normal turning axis of the model away from the axis of the driving spindle. By normal turning axis, is meant that axis upon which the model is rotated in the lathe during a normal turning operation. To accomplish the desired correction, the cam 144 is designed to give the proper corrective motion to the dog 7. Such a cam has a substantially straight portion 152 disposed at a small angle from the horizontal, the end of this portion 152 adjacent the heel dog being nearer to the lathe axis than the other end. This straight portion connects with a convexly curved portion 153, the high point of which determines the maximum throw of the cam and, in turn, connects with a concave portion 154. Such concave portion of the cam causes a relatively rapid drop of the lever 140 and causes the dog 7 to smoothly return to the initial position, above described. Obviously, the correction accomplishes much more than the simple wedging operation many times employed to crudely correct the toe spring of a last as hereinbefore mentioned. The contour of every section of the last turned under the principles of the present invention is predetermined and under the direct control of the model maker and the lathe operator by the simple expedient of designing a cam.

A graphic illustration of certain of the corrections which may be made by the present invention are illustrated in Fig. 7. This figure illustrates in outline a woman's last, showing in full lines the contour of a correct last, for example, in a size 6B while superposed thereon and shown in dotted lines is the outline of an uncorrected 6B last, graded from a size 4B model and in dash lines is shown the outline of a last which has been turned and graded from an 8B to a 6B, for example, without correction of the error introduced by the width grading mechanism. For illustration, a woman's last was selected to be used in connection with a relatively high heel, such as a 2½" or size 20/8 heel, since the error caused by width grading is more pronounced in a last of this type.

Referring now to the dotted line in Fig. 7, it will be noted that the bottom profile of the model has been bent downwardly at the ball section an appreciable amount, thus causing the angle which the sole line A makes with the axis X—X of the model to be increased. Thus, when the last represented by the dotted line is placed in correct tread position, the line of the heel C will be situated too high and consequently the angle of the wedge of the heel line will be incorrect and will not properly receive a standardized heel which has been designed for the particular model in question. The chief cause for such error is apparent. The width grader or fan board has amplified the distance D in the model from the axis to the ball an amount E; while as the turning operation progressed along the fore part from heel to toe, the dimension E is gradually decreased until the tip of the toe is reached where the width grading amplification is practically "0". The angle of the sole line is thus distorted into an incorrect angle. Obviously, the error illustrated by the dotted line also is present, when grading from a model of a given length and width to a model of

the same length, but whose width is increased, for example, in grading from a 4B to a 4C or 4D.

Referring now to the dash line in Fig. 7, the problem is to change the contour of the last bottom to conform to the corrected contour as shown by the full line. It will be obvious that in grading from a large size model to a small size reproduction the dimension D has been decreased an amount E'. In this latter case, the angle between axis A—B and the sole line G of the fore part has been reduced. When this last is placed in tread position, the line of the heel bottom will be disposed in a position below that which it normally should assume, thus preventing a standardized heel from being placed in proper relative position to the last. The remedy is to increase this angle until it is equal to that of the model, as shown in full lines in Fig. 7.

The corrected motion of the model resulting from the action of the cam during the travel of the model wheel throughout the length of the model will now be followed. At the start of the turning operation, the heel end of the model is deflected the maximum amount, so that the bottom surface thereof is moved inwardly toward the rotational axis. Since the heel height and toe spring are to be corrected, it naturally follows that the heel end of the model should have its maximum deflection at this time. As the turning operation progresses, the roll **146** engages the portion **152** of the cam which causes the model to approach its normal turning axis. Thus, when the point **153** is reached, the model wheel is engaging the model at the point X indicated in Fig. 7, which is a point slightly in advance of the forward end of the recess in which the heel plate of the last is secured. From this point, the roll **146** traverses the portion **154** of the cam which permits the lever **140** to descend smoothly and with the changing rate of deceleration thereby tapering off the corrective action of the cam until the end portion **155** is reached when the lever will again be in the same position as when the turning operation was initiated.

From this point in the turning operation, the cam is inoperative and the remaining portion of the fore part is copied with no shifting movement of the model. In the finished last thus produced, the depressed dotted outline illustrated in Fig. 7 is moved upward to the correct full line position. The correct heel height and toe spring are thereby established. One method of visualizing what has taken place during this corrective turning operation is to assume that the last has been divided into an infinite number of transverse planes or laminae. Let it now be assumed that these laminae have been shifted one upon another, thereby to modify the contour of the bottom profile of the last according to a predetermined system introduced by the cam.

It will be well to point out the adjustment which takes place in the width grading mechanism to bring about a reduction in width as compared to an increase in width. As shown in Fig. 4, the knife member **40** is situated above the pivot **42**. In this case, the width grading mechanism increases the width of the last which is being turned, whereas, in the example, which is at present under discussion, where it is desired to reduce the width of the model in the last being turned, the knife member **40** is adjusted to a position below the pivot **42** of the fan board.

To correct a last which is reduced in width, it is necessary to design a cam along the lines of that shown in Fig. 8. This cam produces motions of the dog **7** opposite in direction and degree to that of the cam **144** at corresponding positions of the model wheel along the model. This cam has an angularly disposed portion **158**, the left hand extremity of which is situated a correct distance with respect to the roll **146** to cause the heel dog **7** to assume its predetermined initial corrective position. This portion **158** slopes upwardly in a substantially straight line until it reaches the portion **159** of the cam where maximum deflection of the dog **7** has taken place. At this point, the heel of the model has been shifted the necessary amount to cause the sole line reproduced in the block being turned to assume its correct position so that when the last is placed in correct tread position, it will receive a heel which it has been designed to receive. At this time, the roll **146** is contacting the point X upon the model.

From the portion **159** of the cam, its face slopes downward with a smooth curve until it reaches the portion **160** of the cam. The portion **160** maintains the roll **146** in a fixed position throughout the remainder of the turning operation, such position being proper to produce the correct deflection of the model from its normal turning axis to move the portion G of the sole face in the last produced from its incorrect position shown in dotted lines, Fig. 7 to the correct position shown in the full line. The portion **160** of the cam is reached just as the model wheel engages the ball portion of the last.

It will be noted that in each case, the dog **7** moves the heel end of the model only and that the deflection of the axis of the model from the lathe spindle axis is greatest at the heel end for a given movement of the cam end and diminishes to "0" at the toe. Therefore, irrespective of what the deflection of the heel may be, all deflection will diminish to "0" at the toe extremity. Regardless of the fact that the lever **140** will be held in its upward position by the portion **160** of the cam **157**, the deflection of the dog **7** will diminish to substantially "0" at the extremity of the toe when the turning has reached this point.

No mention has thus far been made of the contour of the upper portion of the last. The dotted line and the dash line illustrate respectively the contour of the upper portion of the last which is formed by the width grading mechanism without correction in the first case when increasing the width of the model and the second case when decreasing the width of the model. It will be noted that the outline of the comb has been raised a considerable amount in increasing the width of the last. Such a change is desirable and produces a correct modeling in this part of the last. The contour in the portion of the last from the top of the comb rearwardly to the heel is not critical and no correction is necessary in this part of the last. Along the upper surface of the fore part, the dimensions thereof are slightly changed. Such changes are, however, in the direction of actual correction rather than in the wrong direction and the changes take place in substantially the proper proportion to produce a correct contour at this portion of the last.

The design of the cams for use in the present invention may be accomplished in any desired manner. One method is to make a series of measurements along the sole bottom of an uncorrected last and compare such measurements with a correct sole bottom template. The variation of the uncorrected last from the correct template may then be plotted upon the cam, the

increments calculated in terms of the velocity ratio between the lever 140 and the dog 7.

A more practical method, however, is as follows: Assuming first, a cam is to be designed to correct a last which is to be graded from a model of a given size to a last of a different length but of the same width denomination. Such a cam is illustrated in Fig. 9 and is similar to and functions in the same manner as the cam illustrated in Fig. 3. The necessary shift of the dog 7 from its normal turning position is first determined at the initial position of the model wheel upon the model, which in this example, is at the heel extremity. From this amount of shift, the dimension H, (Fig. 9) is calculated and extends from the center of the attaching screws for the cam to the left hand end of the cam face. This dimension is laid off on the cam blank. The dimension J which is equal to the dimension H is then laid off at the right hand end of the cam blank.

To obtain the correct contour for the curved portions of the cam a shank template 161 is used as a marking guide. A point I is now established at a distance J from the center of the attaching screws and at a measured distance K from the left hand end of the cam blank. This dimension is properly determined to cause the roll 146 to reach the highest point on the cam when the model wheel has reached the point X in Fig. 7. The shank template 161 is now placed upon the cam blank at the low point of its concave portion at the ball end thereof coincident with the point I on the cam blank. A straight edge 162 is then brought into register with a portion N' of the template which is practically straight and extends towards the right from the high point thereof to a point near the heel end of the template. The straight edge and the template are then moved together into such position that the straight edge registers with the point P at the left hand end of the cam blank. A line is then drawn using the template and the straight edge as a guide and the cam is cut upon this line. The distance Q thus determined will produce the correct maximum throw of the dog 7 at the point X on the model.

The correction introduced by this particular cam will correctly grade from a 4B to a 6B in a last having a specified heel height, for example, a 16/8 heel. This cam is suitable for making the usual series of model lasts which includes every other size, for instance, a series including sizes 4, 6 and 8 in a B width, in which the 4 is used to make the 6 and the 6 is used to make the 8. In turning this series, the cam must be shifted longitudinally of the lever 140 when changing from size to size. To do this, an arbitrary reference mark M is made upon the lever 140 and a series of index marks L are made on the cam to register with the reference mark M. These index marks are spaced the correct distance to locate the high point R of the cam correctly for the last model size indicated.

To obtain a complete series of models including width variations, another cam 163 is designed. This cam is to have a much reduced throw as compared to the cam 144, and is designed to effect the necessary correction when grading from a 4B to a 4C. The same general procedure is followed to design this cam as that employed in designing cam 144. A contour curve 164, shown in dotted lines and identical to the contour of cam 144, is first laid out upon the cam blank. The distance S which represents the maximum throw of the cam is measured. The desired throw of the cam in the problem now under consideration is substantially ½ that of the total throw, represented by the dimension S. The high point T of the cam now under construction is laid off upon the cam blank measuring inwardly the distance ½ S toward the center line of the attaching screws from the point R. From the high point thus determined, a smooth curve is drawn from the Point I to the high point T using the contour 164 as a guide for interpolating the points along the curve. The remaining curved portion of the contour 165 is drawn in to smoothly meet the straight portion U of the curve. Index marks L are then inscribed upon the cam to properly locate its position along the lever 140. It is abvious that a cam having any desired maximum throw may be designed by selecting the proper shank template and properly calculating the dimensions above set forth.

The same general method is used in producing the cam 156 shown in Fig. 8 as that which is employed to produce the above described cams. This cam 156 is employed in correcting the grading operation which produces, for example, a 2B from a 4B model. In this problem, the curve of the cam is concave instead of convex. The shank template 161 in this case is turned over so that its convexity extends upwardly. The low point of the concave curve at the bottom of the template is placed upon a point on the cam blank determined by the dimensions K and V. The dimension V is found by calculating the necessary throw of the dog 7 to effect the necessary correction, such dimension being transferred to the cam blank in terms of the necessary movement of the lever 140. The dimension W is then laid off equal to the dimension, since the starting position of the dog is the same as its final position. The contour curve of the cam 157 is then drawn by the aid of the template straight edge in the same manner described in connection with the cam 144. The index markings L are then inscribed upon the completed cam.

The cam 166 shown in Fig. 12 is used for correcting a last which is graded, for example, from a 4B to a 4A size. In this cam, the dimensions V and W are used in the same manner as that employed to determine the shape of the cam 157. The extent of concavity in this cam is less by substantially ½ than that of the cam 157. The contour curve Y is then determined by using the curves of the cam 157 as a guide in the same general manner employed in calculating the curve of the cam shown in Fig. 10. The index markings L are then marked on the cam.

The cams shown in Figs. 9, 10, 11 and 12 represent a set which will enable the lathe operator to produce a series of correct model lasts from a single model produced by the model maker according to a required style and heel height. When the heel height or the style or both are varied in the model, a new set of cams must be produced.

If desired, the curve of the cam shown in Fig. 11 may be laid out by using the cam shown in Fig. 9 as a template. Also, the cam shown in Fig. 12 may be laid out by using the cam shown in Fig. 10 as a template.

Having thus described the invention, what is desired to be secured by Letters Patent, is:

1. In a last lathe having model wheel and cutter carriages, means for rotatively supporting a model last comprising heel and toe dogs engag-

ing the ends of the model, a driven spindle for rotating the model and dogs, a free inner end on said spindle projecting beyond the spindle bearing, a head detachably secured to said inner end of the spindle having means therein for receiving and guiding one of said dogs laterally therein, a sleeve upon the head, rotating with and slidable axially thereof, cams upon the inner periphery of said sleeve engaging and moving said dog upon axial movement thereof, a lever fulcrumed upon the lathe frame to swing in a vertical plane, a cam on said lever, a co-operating follower on one of the carriages of the lathe, and a lever and linkage system for transmitting the movement developed by said cam and follower to said sleeve and dog.

2. A last lathe having the elements defined in claim 1 together with yielding pressure means for maintaining the cam secured to the lever in engagement with its co-operating follower.

3. A last lathe having the elements defined in claim 1 together with yielding pressure means for maintaining the cam secured to the lever in engagement with its co-operating follower and positive stop means for determining the initial position of the lever carrying the cam thereby determining the initial position of the laterally movable dog.

4. In a last lathe having model wheel and cutter carriages movable rectilinearly of the lathe frame, a swing frame, a driven spindle mounted in said swing frame operable to rotate the model, a head detachably secured to the inner free end of said spindle and rotating therewith, a dog for engaging the ends of said model, means in said head for receiving and guiding said dog laterally of the spindle axis, a sleeve slidable axially upon said head, cams upon the inner periphery of said sleeve engaging and moving said dog upon axial movement of said sleeve, a lever extending parallel to the spindle axis and fulcrumed on the lathe frame to swing in a vertical plane, a co-operating cam and follower, one of which is mounted on said lever and the other on one of said carriages and acting upon movement of the carriage to actuate said lever, a link connected to said lever and extending substantially vertically upward, a second lever fulcrumed on the lathe frame adjacent the pivot of said swing frame, a pivotal connection between said second lever and said link lying substantially upon a radial line from the swing frame pivot to the axis of said spindle, and a second link connected at one end to said second lever and at its other end to a bell crank lever fulcrumed upon said swing frame and operable to move said sleeve.

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