April 18, 1939. G. CLAUSING 2,154,725

COPYING LATHE

Filed Nov. 14, 1936 3 Sheets-Sheet 1

Fig. 1

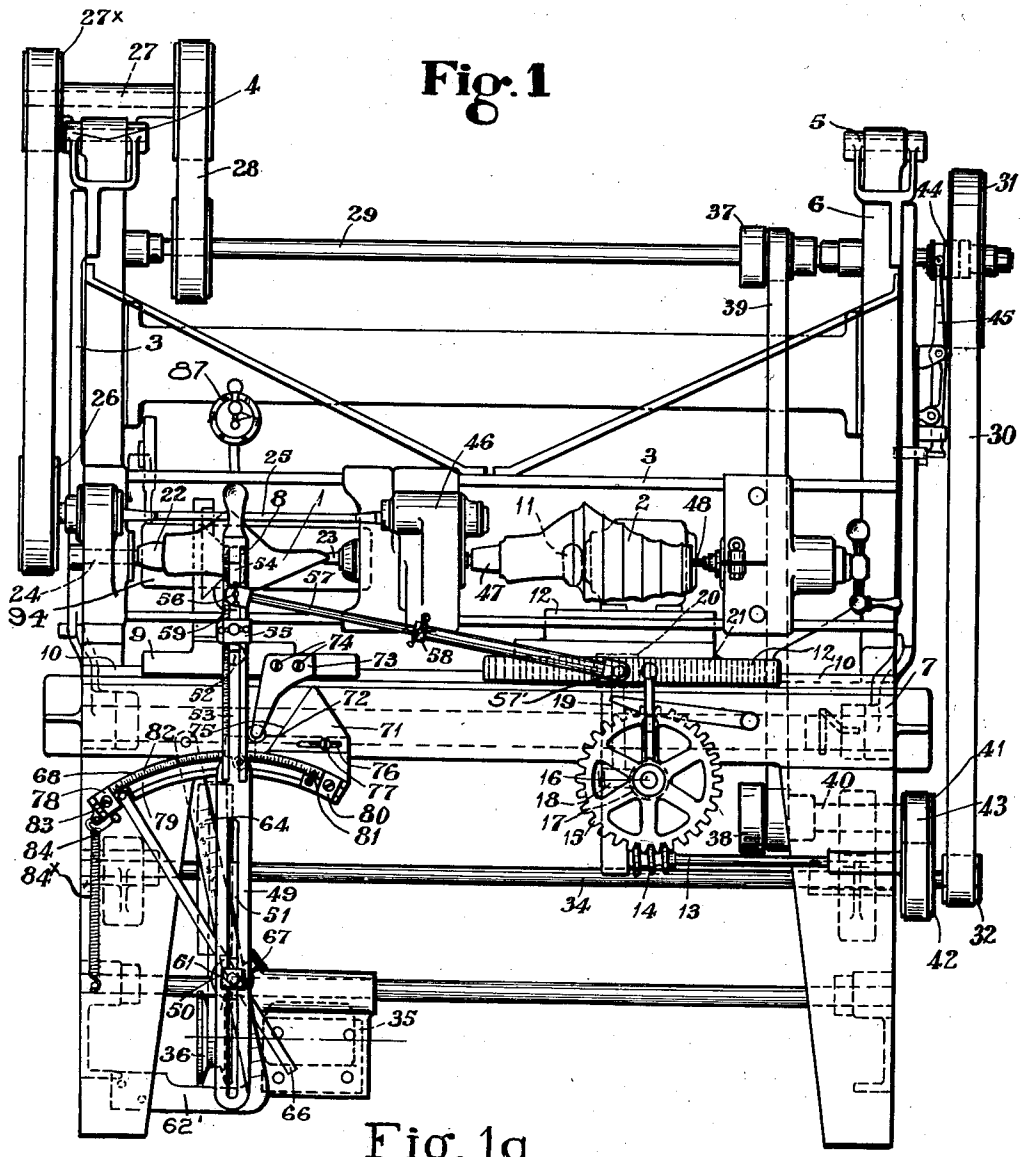
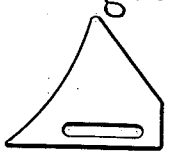


Fig. 1a



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Filed Nov. 14, 1936 3 Sheets-Sheet 2

Fig. 2

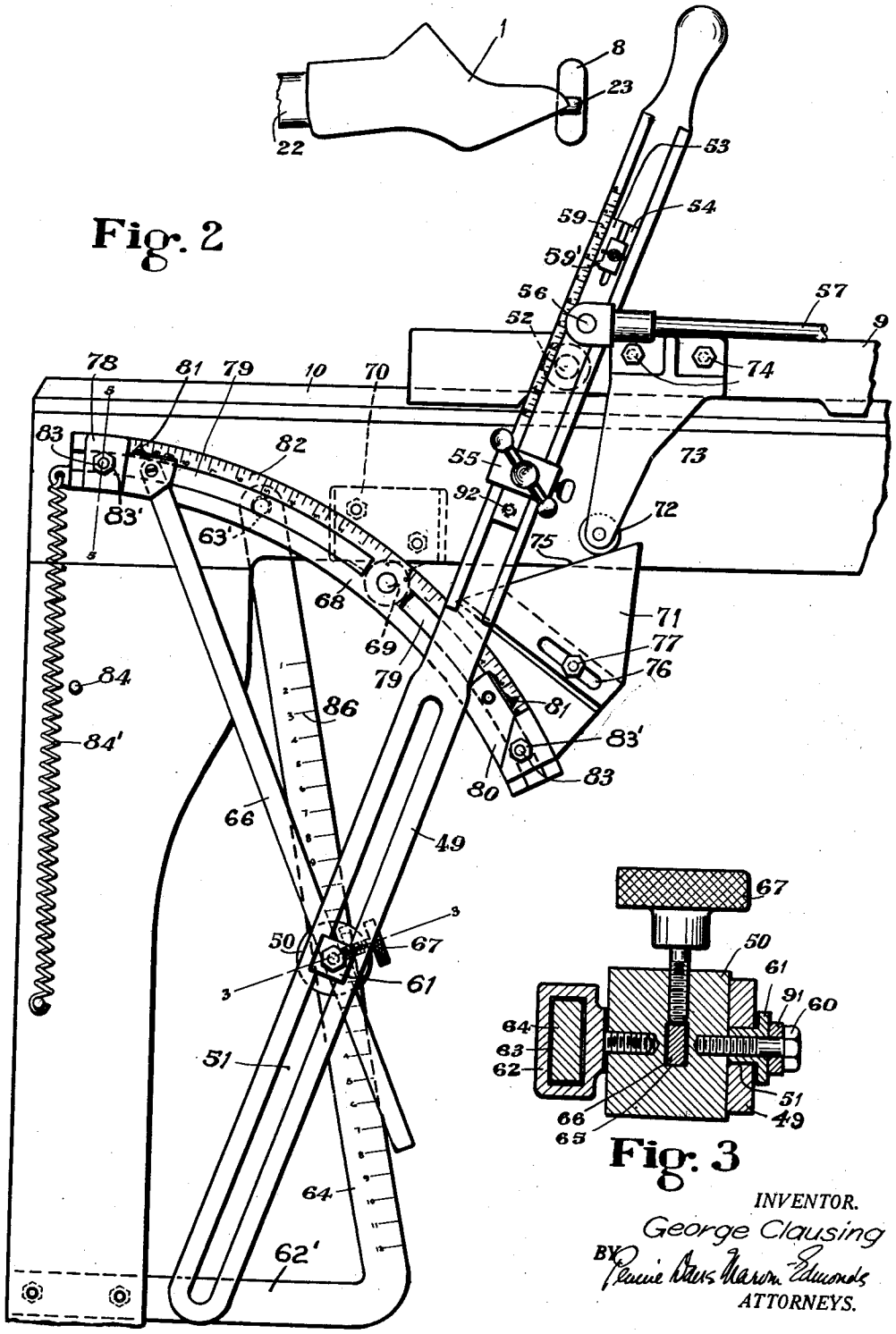


Fig. 3

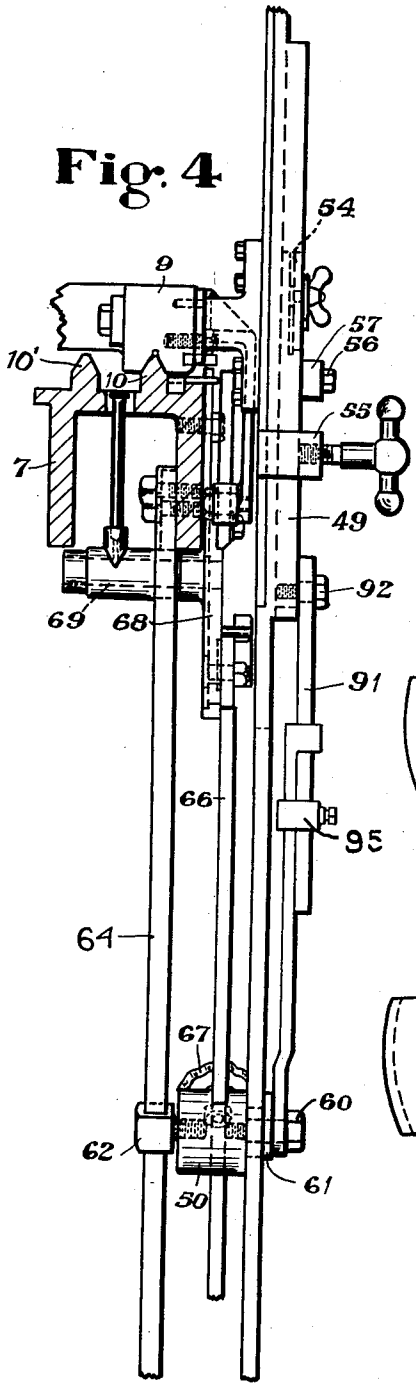
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Filed Nov. 14, 1936 3 Sheets-Sheet 3

Fig. 4



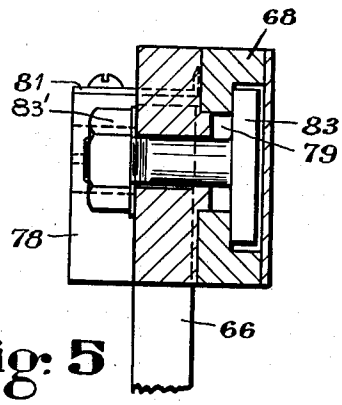


Fig. 5

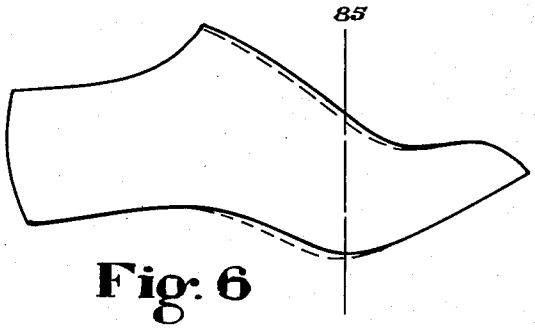


Fig. 6

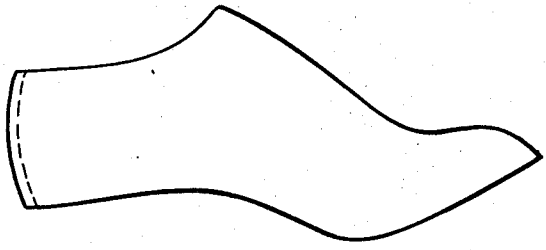


Fig. 7

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UNITED STATES PATENT OFFICE

2,154,725

COPYING LATHE

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

Application November 14, 1936, Serial No. 110,793

10 Claims. (Cl. 142—15)

This invention relates to copying lathes, and more particularly to a machine for producing irregular objects in accordance with a model pattern such as, for example, shoe lasts which are graded as to length and width for various last sizes. Specifically, the invention is directed to attachments for a last lathe which function to modify certain grading characteristics of the machine.

The broad principles of the invention are applicable to copying lathes of any type, but the invention will be herein considered in connection with a copying lathe for turning various sized shoe lasts in accordance with a model last of given size characteristics, and which lathes have the usual grading means acting to pantographically amplify or reduce the dimensions of a given model in the shoe lasts which are reproduced from such model. A shoe last is made up of two parts, as termed in the trade, to-wit, a fore or toe part and a back or heel part which extends from the end of the fore part rearwardly. The fore and back parts of a last always have a definite length ratio, and this ratio varies in different model lasts.

In the turning of shoe lasts from a model last on the ordinary last copying lathe it is found that the length increase or decrease of the fore and back parts of different sized lasts produced from a model of a given size, and having a definite length ratio between the fore and back parts, is in direct proportion to the over-all length of the last whereby the length ratio between the produced last fore and back parts varies from one size to another over that length ratio between the fore and back parts of the model last. This results in error in the desired size length of fore and back parts in the larger and smaller sized lasts produced from the model. Such error is not due to the over-all stick length of the last, but is due to the length ratio between the fore and back parts of the model last, and which ratio is not to be had in different sized lasts produced from the model except by manual adjustment of the copying lathe grading mechanism at some point during turning of the lasts being produced.

It is one object of the present invention to provide automatic means operable not only to make such grading corrections or changes as have heretofore had to be made manually but also to provide means for automatically changing the grade according to some predetermined requirement which may necessitate a change in the grading factor during the period in which the attachment is effective.

A further object of the invention is to provide a grade changing attachment for copying lathes having incorporated therein means for varying the degree of change occasioned by the attachment.

A further object of the invention is to provide an attachment which automatically distributes the total calculated grading correction or change in a desired manner throughout a predetermined portion of the object being produced.

A further object of the invention is to provide a grade changing attachment which may automatically be rendered active throughout a selected period in the grading operation and automatically rendered inactive throughout the remaining period.

A further object of the invention is to provide an attachment which places under the control of the operator a means for automatically controlling the over all or stick length of the graded objects in accordance with the stick-length of the model even though the standard grading means is adjusted to grade in accordance with a requirement unrelated to the stick length of the model. Other objects and features of the invention 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. 1A is an illustration of a modified form of grade changing cam.

Fig. 2 is an enlarged front elevation of a portion of the lathe showing certain parts thereof in a different position from that shown in Fig. 1.

Fig. 3 is a sectional view taken on line 3—3, Fig. 2.

Fig. 4 is a side elevation of the parts shown in Fig. 3, showing a portion of the main frame in cross section, and other connected parts.

Fig. 5 is a sectional view taken on line 5—5, Fig. 2.

Fig. 6 is a diagrammatic view illustrating a change in the shape of a last which may be effected by use of this invention.

Fig. 7 is a diagrammatic view similar to Fig. 6 illustrating another change which may be effected in a last by the use of this invention.

The invention herein described is applicable to any type of copying lathe, and a shoe last copying lathe is herein shown in which a model 1 and a work piece 2 are rotatably mounted in a

swing frame 3 which is pivoted at its upper ends at 4 and 5 to the superstructure 6 of the main frame 7 of the machine (Fig. 1). The weight of the frame 3, plus the usual spring tension or weight means employed in such machines, causes the model to continuously engage a model wheel 8 rotatably mounted on a carriage 9 which is slidably mounted on ways 10 on the main frame 7. The model wheel 8 is held stationary in its position laterally of the ways 10 except in so far as it may be moved by the width grading mechanism which may be of the usual or any desired construction and will not be described in detail since it forms no part of the present invention.

The model and work piece are suitably rotated, and rotation of the model causes the frame 3 to have a swinging motion which is determined by the contour of the model. This motion is transmitted to the last block or work piece 2 which is rotated at the same speed as the model in the path of a rapidly revolving laterally stationary cutter 11 to thus reproduce the model from the block or work piece as the model wheel and cutter are moved along the longitudinal axes of the model and block or work piece.

As shown, the cutter 11 is suitably driven as, for example, by the motor shown and is mounted on a carriage 12 which is slidable on the ways 10' parallel to the ways 10 carrying the carriage 9. The carriages 9 and 12 are fed along the ways 10 and 10' by means of a driven shaft 13 which has secured thereto a worm 14 which meshes with a worm gear 15 fixed to the end of a driven shaft 16 journaled upon the main frame 7. The shaft 16 has mounted on its end opposite to the end which carried the worm gear 15 a pinion 17 which meshes with a complementary pinion 18 mounted on one end of a vertical shaft 19 journaled in the main frame. The upper end of the shaft 19 has fixed thereto a pinion 20 which meshes with a rack 21 fixed to the carriage 12.

The carriage 12 is connected to the carriage 9 by means of a grading mechanism to be described, and rotation of the shaft 13 serves to feed the two carriages carrying the model wheel and the cutter along the longitudinal axes of the model and work piece as is usual in this type of machine. Suitable means are provided to vary the speed of the feed.

As shown in Figs. 1 and 2 of the drawings, the model 1 is received between a heel dog 22 and a toe dog 23, and the model 1 is rotated by a driven shaft 24 which is journaled in the swing frame 3 and receives the dog 22 upon its inner end. The shaft 24 is gear driven from a countershaft 25 journaled in the swing frame 3 and the outer end of the shaft 25 has secured thereto a pulley 26 which is belt driven from a drive shaft 27 journaled in the super-structure 7 situated adjacent to the axis upon which the frame 3 swings and having a pulley 27X fixed thereto. Such shaft 27 may be driven in any suitable manner such as by means of a belt 28 from a countershaft 29 journaled upon the super-structure of the machine. The shaft 29 is in turn driven by a belt 30 passing over a pulley 31 on the shaft 29 and a pulley 32 on the shaft 34 journaled on the main frame. Such shaft 34 is in turn driven by a motor 35 in any suitable manner as by a variable speed drive 36.

The shaft 29 has mounted thereon a step pulley 37 which drives another similar step pulley 38 by means of a belt 39. Such pulley 38 is fixed to a shaft 40 journaled on the main frame and the shaft 39 has mounted on its end opposite to that upon which the pulley 38 is mounted a pulley 41 which acts to drive a pulley 42 fixed to the shaft 13 through a belt 43. Thus, the power necessary to feed the carriages 9 and 12 is derived from the motor 35 and the speed of the feed may be changed by shifting the belt 39 from step to step upon the pulleys 37 and 38. The pulley 31 is freely rotatable on the shaft 29 and has secured thereto one member of a clutch 44, the other member of the clutch being splined upon the shaft 29 and movable into and out of engagement with its cooperating clutch member fixed to the pulley 31 by means of a lever 45 pivoted upon the frame of the machine. Such lever 45 may be actuated manually or by a suitable means which automatically disengages the clutch 44 when the turning operation has been completed, thereby discontinuing the feed of the carriages and rotation of the model and the last which has been turned.

To rotate the model and the work piece simultaneously the inner end of the shaft 25 extends into a gear casing 46 fixed upon the swing frame 3, and a suitable train of gears is provided within the casing 46 for rotating a work piece supporting heel dog 47. Such dog 47 is received upon the end of a shaft rotatably mounted in the gear casing 46 in axial alignment with the shaft 24 and is driven at the same speed as the shaft 24 and either in the same or in the opposite direction depending upon whether the last being produced is a left or a right as is well understood in the art. The dog 47 engages the heel end of the work piece 11 while the other end of the work piece is supported by a toe dog 48. It is considered unnecessary to describe the further details of the machine since they form no part of the present invention. The elements of the last lathe thus far described are or may be of usual construction.

As is customary in shoe last copying lathes, the lathe shown is provided with a length grading mechanism which forms the connection between the model wheel carriage 9 and the driven cutter carriage 12 to cause simultaneous movement of the carriages, and which is so arranged as to produce a variable movement of the carriages 9 and 12 longitudinally of the model and work piece in a definite speed ratio whereby to result in longer or shorter lasts which are shape duplicates of the model and thus produce various size lengths in the reproduced lasts. In the length grading mechanism herein shown, and which forms the subject matter of this invention, a grading lever 49 is arranged to fulcrum on a fulcrum block 50 (Figs. 1, 2 and 3) which is adjustable lengthwise of the lever 49 by being disposed in a slot 51 in the lever. The upper end of the lever 49 is pivotally attached to the carriage 9 at 52, and such upper end of the lever 49 is provided with a channeled groove, 53, in which is disposed a movable fulcrum block 54. Such fulcrum block 54 is adjustable along the groove 53 and is held in adjusted position by a clamp 55, and is provided with a pivot stud 56. One end of a link 57 is pivoted on the stud 56, the opposite end of the link 57 being pivotally secured to the driven carriage 12 as at 57'. Such link 57 is made up of two telescopic sections 58 whereby the length of the link 57 and the relative positions of the carriages 9 and 12 may be adjusted as desired. Thus, movement of the driven carriage 12 along the longitudinal axis of the work piece 2 by the mechanism hereinbefore described causes movement of the model wheel carriage 9 along the longitudinal axis of the model 1, the ratio of movement between the

carriages being determined by the position of the fulcrum of the lever 49 on the block 50 and the fulcrum of the link 57 on the block 54 relative to the fulcrum of the lever 49 on the carriage 9. The relative starting positions of the carriages 9 and 12, and thus the relative starting positions of the model wheel and cutter, may be adjusted by lengthening or shortening the link 57.

As shown in Figs. 3 and 4 of the drawings, the fulcrum block 50 is provided with a screw 60 passing through a block 61, the block 61 being slidable in the slot 51 of the grading lever 49. The fulcrum block 50 is also provided with a guide member 62 having an aperture 63 which receives a bar 64. Such bar 64 is secured to the main frame 7 at its upper end as at 63' and to an arm 62' at its lower end. Thus, the bar 64 is disposed at an acute angle to the vertical and provides a means for determining the length of the lever arm formed by the grading lever 49 between the fulcrum block 50 and the pivot 52. The horizontal position of the fulcrum block must be shifted to properly position the grading lever when grading from models of various sizes thereby correcting errors which are introduced by an improper angular travel of the lever from its vertical position throughout the grading operation, and the angular position of the bar 64 is calculated to introduce the correct amount of horizontal travel of the fulcrum block as it is moved along the bar. The guide member 62 is rotatable relative to the fulcrum block 50.

The fulcrum block 50 is also provided with an aperture 65 within which is slidably received a link 66, a clamping screw 67 being provided for securing the fulcrum block 50 in the desired position on such link 66. As shown, the uppermost end of the link 66 is pivotally connected to a quadrant lever 68 which is, in turn, pivotally mounted at 69 on a bracket 70 on the main frame 7, the lowermost end of the link 66 being free and the link being rigidly connected to the fulcrum block 50 at a point between its two ends. With this construction, it will be seen that movement of the quadrant lever 68 about its pivot 69 will result in movement of the fulcrum block 50 relative to the bar 64 and grading lever 49 unless the pivotal connection between the link 66 and the quadrant lever 68 coincides with the pivotal mounting 69 of the quadrant lever on the bracket 70. Thus, the length of the lever arm between the block 50 and the pivot 52 may be varied.

To vary the length of the lever arm 49 between the fulcrum block 50 and the pivot point 52 and thus vary the speed ratio of movement between the carriages 9 and 12, one end of the quadrant lever 68 is provided with a cam 71 which is so disposed as to be in the path of a cam follower 72 rotatably mounted on a bracket 73 which is rigidly secured to the model wheel carrying carriage 9 by means of screws 74, Figs. 1 and 2, the cam being provided with suitably shaped face 75. Thus, as the model carrying carriage 9 moves along the ways 10 the follower 72 will engage the cam face 75 and rotate the quadrant lever 68 about its pivot 69 to move the link 66 and produce movement of the fulcrum block 50 to vary the length of the lever arm 49 between the fulcrum block 50 and the pivot 52 and thus vary the speed ratio of movement between the carriages 9 and 12.

In order to render the position of the cam 71 adjustable in the direction of the length of the quadrant lever 68 and thereby the point in the travel of the carriage 9 when the cam follower 72 will engage the cam face 75 of the cam 72, the cam is provided with an elongated slot 76 in which is received a clamping stud bolt 77 which is fixed to the quadrant lever 68. The shape of the cam face 75 is so designed that movement of the carriage 9 will impart a predetermined rotational movement to the quadrant lever 68 about its pivot 69 and thereby a predetermined up or down movement of the link 66 and fulcrum block 50.

To provide a means for further varying the effect of rotation of the quadrant lever 68 on the fulcrum block 50, other than that obtained by the shape of the cam face 75, the link 66 is pivoted to the quadrant lever 68 on a block 78 which is adjustable along an arcuate groove 79 formed in the quadrant lever. As shown, the groove 79 is, in this instance, interrupted at the pivot point 69 of the lever, and another block 80, similar to the block 78, is slidably received within the section of the groove 79 to the right of the pivot point 69. Each of the blocks 78 and 80 are provided with pointers 81 which coact with a scale 82 on the quadrant lever 68 thereby to accurately determine the position of the blocks 78 and 80 along the lever 68, and when it is desired to make adjustments along either section of the groove 79, the link 66 is secured to the block in that section. The respective blocks are provided with clamping bolts 83 having nuts 83' thereon for locking the blocks in the desired position in the groove. Thus, the amount of throw which rotation of the quadrant lever 68 transmits to the link 66 and fulcrum block 50 may be varied as desired.

The radius of the groove 79 is of the proper length to cause a minimum movement of the lever 68 and fulcrum block 50 throughout the adjusting movement of the blocks 78 and 80. The usual model size is size 4 and in ordinary practice the model size varies only a slight degree from a size 4. The variation likely to be met with in the majority of cases may be ascertained and a length of radius which will constitute a compromise between the extremes of such variation be determined and adopted for use in the lathe.

The grading lever 49 functions to vary the relative degree of movement between the carriages 9 and 12, and the necessary amplification for each size in a series of lasts is determined by adjusting the block 54 along the groove 53 to change the length of the lever arm between the pivots 56 and 52 relative to the length of the lever arm between the pivot 52 and fulcrum block 50. A suitable scale 59 is provided by means of which the operator determines the correct position of the block 54 and pivot 56 to produce the correct length of lever arm for various last sizes so far as length is concerned. A pointer 59' is provided which cooperates with the scale 59, and this pointer is made adjustable along the length of the block 54 whereby the proper cooperation may be had between the pointer and the scale when the pivot block 56 coincides with the pivot 62. The functions of such an adjustable pointer are well known in the last copying lathe art.

The normal or rest position of the lever 68 is determined by a stop pin 84 on the frame of the machine (Fig. 1). The lever 68 is held against the pin by a tension spring 84' secured at one end to the lever and at its other end to the machine frame as shown in Fig. 1. The

pin 84 and the spring 84' thereby determines the rest position of the fulcrum block 50.

As is usual in this type of machine during grading operations, the position of the fulcrum block 50 along the bar 64 is dependent upon the size of the model which is in use at the time. A scale 86 is formed on the bar 64 which is graduated in size. The fulcrum block is moved along the bar 64 until a selected edge of the slide member 62 registers with the size mark corresponding to the size of the model in use. The clamping screw 67 is then tightened upon the link 66.

In the operation of this apparatus, and considering a copying lathe without the attachment forming the subject matter of this invention, a model shoe last 1 of known size and length characteristics is clamped between the heel and toe dogs 22 and 23, Fig. 1. Assuming that the model last 1 is a size 4B and the last has an over-all stick length of 10 inches, and it is desired to produce other size 4B lasts therefrom, a suitable rough wood block 2 is clamped between the heel and toe dogs 47 and 48. Since an exact size and shape duplicate is to be cut from the model 1, the link 57 which connects the two carriages 9 and 12 is positioned with the pivot 56 coincident with the pivot 52 of the grading lever 49 and adjusted as to length so that the model wheel 8 and cutter 11 are at the same respective positions relative to the model 1 and last block 2. The width grading mechanism, generally indicated at 87, having been suitably adjusted, the copying lathe is operated in the well known manner to reproduce the model 1 from the last block 2.

To produce a series of lasts in length sizes which differ from the size 4B model last, the same 4B model is left clamped between the heel and toe dogs 22 and 23 and a suitable block is clamped between the heel and toe dogs 47 and 48. Then, the fulcrum block 50 is set along the bar 64 until the top edge of the fulcrum block registers with a graduation 86 on the bar which corresponds to the stick measurement of the model last 1. For example, if the stick measurement of the size 4B model is 3, then the top edge of the fulcrum block 50 is moved to register with the graduation 3 on the bar 64. With the fulcrum block 50 clamped in such adjusted position, the effective length of the lever arm between the fulcrum block 50 and the pivot 52 is determined.

The fulcrum block having been properly set to determine the length of the lever arm between the fulcrum block 50 and the pivot 52, the block 54 is moved along the bar 49 until the pointer 59' registers with the proper graduation on the scale 59. In the case a size 5B last is to be cut from the size 4B model, the block 54 is moved upwardly until the pointer registers with the graduation 1 on the scale, thus indicating one size over the model last. Movement of the block 54 upwardly increases the distance between the pivot 52 and the pivot 56, thus determining the length of the lever arm between those pivots. Thus, the effective length of the lever arms on each side of the pivot 52, or that pivot on which grading bar 49 is connected to the carriage 9, is determined and the relative speed and extent of movement of the carriage 9 with respect to the carriage 12, the length of the lever arms being such that, with the fulcrum block 50 set at 3 and the bar 53 at 1, the last cut from the model will be one size longer than the model whose stick measurement is 3. That is, the length of the two grading lever arms are such relative to the connection between the carriage 9 and the connection with the grading lever 49 that the normal length increase of ⅓ of an inch will be added to the length of a cut last from one size to another. Size grading of lasts from models of varying stick length may be accomplished by proper adjustment of the fulcrum block 50, and various size length lasts may be graded from a given model by proper adjustment of the block 54 along the grading lever 49 to change the position of the pivot 56 relative to the pivot 52, and thus the relative travel between the carriages 9 and 12 across the model and the work piece respectively.

As hereinbefore stated, the length increase or decrease of the different sized lasts produced from a model of given size, and having a definite length ratio between the fore and back parts, is in direct proportion to the over-all length of the last. That is, considering the length change of one-third of an inch from one size to the next, such length change is evenly distributed throughout the entire length of the last being cut. Assuming that there is a length ratio of two to one between the fore and back parts of the model last, for illustrative purposes only, then the normal size length increase of one-third of an inch will be distributed evenly between the back and fore parts, two-thirds of the length increase being in the fore part. This same will be true where lasts smaller than the model are produced, two-thirds of the length decrease being taken from the fore part and one-third from the back part.

However, should the length ratio between the back and fore parts of the last be in a ratio of other than a two to one ratio, for example, in a ratio of two to three-fourths such as might be found in a last having a very long pointed toe, then the one-third of an inch increase or decrease in the size from the model will not be taken evenly from the back and fore parts of the last produced. That is, the greater portion of the one-third of an inch length size increase or decrease, greater than that desired, will be added to or taken from the fore part, while a lesser portion of the one-third of an inch size length increase or decrease than desired will be added on or taken from the last back part. This undesirable distribution of the size length increase or decrease between the last back and fore parts is primarily due to the fact that the lathe, as ordinarily constructed, is capable of only one speed ratio of movement between the model wheel and the cutter carriage during the cutting of a last, unless the operation of the lathe is stopped and manual adjustment made to change the speed ratio at some point in the turning operation. The result of such single speed ratio of movement by the model wheel and the cutter carriage during the turning of a last, and the addition or removal of an amount greater or less than that desired on one part of the last as compared with the other, is to reproduce a last from the model which has a back part or a fore part which is either too long or too short, and a last which does not have the same length ratio between the parts as that of the model.

The foregoing matter has set forth some of the normal characteristics of a standard last lathe. It has, also, been pointed out that the grading of lasts to their proper size lengths and proper fit from a model last of a given style, that certain variations in the grading ratio of the lathe throughout the turning of a last, are desirable and are not done automatically at the present

time. The present invention supplies automatic means in the form of the segment 68, its associated elements, the cam 71 and the elements associated therewith.

The particular problem of producing a correctly fitting series of size graded lasts will now be considered. In accomplishing this desired end, the stylist and the model maker must be free to create shoe designs which are unrestricted by any rigid mechanical limitations, such as the relative length between the fore and heel part. This condition imposes upon the last maker the task of producing an accurately fitting series of lasts reproduced from a model, the design of which does not follow a rigidly imposed condition. In practicing the present invention, this fact is recognized and means are adopted to overcome the mechanical limitation of the present grading machines, as will be pointed out in detail hereinafter.

To produce correct fit in all sizes, the standard length grade ratio for the heel or back part of the last is first established. To prepare the last lathe to produce the corrected series of lasts, the operator must adjust the standard grading adjustment on the lathe in accordance with the standard length grade ratio for the heel or back part. This adjustment is then unchanged throughout the production of a complete series of sizes. This adjustment insures that the heel or back part of all the lasts produced, will be correcly cut up to the transverse plane of the last indicated by the line 85. This adjustment of the machine is accomplished by shifting the fulcrum block 50 along the bar 64 to a point, depending upon the size of the model being used and shifting the block 54 within the channel slot 53 in accordance with the length ratio desired, in the manner hereinbefore set forth. If the cutting of the last were continued to complete the forepart thereof with no further change in the grading ratio, the length of the completed last would be correct, only in the special case where the fore part of the model was one of specific length, which, when amplified at the same ratio as the heel, would produce a correct fixed length. Reproduction from model of other dimensions will not be correct. Throughout the cutting of the forepart, therefore, the grading ratio must be modified. This modification of the grading ratio takes place automatically, through the medium of the segment 68 and the cam 71.

For purposes of illustration, it will be assumed that the last which would be turned on the lathe as now adjusted and without the effect of the function of the segment 68 and the cam 71, is too short in over-all length. To facilitate this description, segment 68 and the cam 71 with their associated elements will be hereinafter called the grade changing means. To produce a correct last, the grade changing means must now be adjusted to add length to the fore part.

To accomplish this change of grade, certain adjustments must be made in the grade changing means. The cam 71 must be adjusted longitudinally into such position that it will be engaged by the cam follower 72 at that point in the travel of the carriage 9 when the model wheel has reached the plane indicated by the line 85 on the model. Continued movement of the carriage 9, therefore, causes the cam follower 72 in engaging the cam 71 to rock the segment 68 about its pivot point, thus raising the fulcrum 50 through the medium of the link 66.

The manner in which the operator proceeds to produce a series of corrected lasts will now be described. Let it be assumed that the first last of the series is to be the model size. To produce this size, the block 54 is adjusted to align the axis of the pivot point 56 with the axis of the pivot point 52. The block 78 is then moved along the segment 68 until the pivot point of its connection with the link 66 coincides with the pivot 69. Under such conditions, the grade changing means does not function and a last is produced from the block 2, which is an exact duplicate of the model 1. It will be assumed throughout the grading of a series of lasts that the width grade remains unchanged. To produce the next last in the series, for instance, the 4½, if the model size 4 is assumed, the machine must be adjusted. To produce the 4½ size, the block 54 is moved in the usual manner to produce a 4½ last. The block 78 is then moved along segment 68 into correct position to make the correction on a 4½ last. By making similar adjustments for each size, a complete series of corrected lasts may be produced.

As shown in Figs. 1 and 2, the cam 71 is designed to produce a substantially uniform correction or change of grade throughout the turning of the fore part of the last.

It is obvious that the rate at which the change in grade is introduced is dependent upon the shape of the cam face 75 of the cam 71. The shape of the cam face 75 may be varied at will to accomplish the desired results. A modified form of the cam 71 is illustrated in Fig. 1A. The cam shown in this figure has a concavely curved face, which, when engaged by the follower 72 would effect a slow, gradual application of the change of grade through its initial movement and a relatively fast change of grade throughout the turning of the forward part of the toe portion of the last. The use of a cam to obtain this change of grade is an important phase of the invention, since it provides a completely flexible means of controlling the manner in which the change of grade is accomplished. Furthermore, the point at which the change of grade takes place is flexible and is determined by a longitudinal adjustment of the position of the cam. A cam could be so designed as to cause a change in grade throughout a selected portion of the turning of a last and then cause the segment 68 to return to its normal position shown in Fig. 1, throughout the remainder of the turning operation.

To graphically illustrate the manner in which the above described use of the invention modifies a last, reference may be had to Fig. 6 wherein the full lines illustrate the corrected last and the dotted lines illustrate the contour of the last that is uncorrected or unmodified. From an inspection of this figure, it will be noted that the heel or back part of the last is short before the correction is made. A correct normal length of the heel part is shown in full line, while the over-all length of the last remains unchanged.

Another application of the invention will now be described, in which it is possible to add to or subtract from the length of a portion of a model, a fixed amount in each size, and at the same time, maintain the remaining dimensions of the model unchanged. A specific example of the application of the invention to this principle is the addition of a constant increment of length to a heel part throughout a series of graded lasts to allow for the saw cut which is made at the hinge in a hinged last. Such addition to the length of the heel part is usually approximately $\frac{1}{16}$".

To illustrate the necessary procedure in such

a problem, it will be assumed that the model to be reproduced has a fore part and a heel part, whose lengths are in the proportion of two to one. This problem may be applied to a last having any ratio between its fore and heel part. A ratio of two to one is chosen to simplify the figures. Assuming it is desired to add $\frac{1}{16}$'' to the heel part, the over-all or stick length of the model must be increased $\frac{1}{16}$'' plus $\frac{3}{32}$'' or $\frac{3}{32}$''. This increase in length is obtained by adjusting the block **54** the necessary amount and is the same for each size and must be added to the size increment of length added to or subtracted from the model in the size produced. The $\frac{3}{32}$'' which is thus added to the fore part, however, is not wanted. The grade changing means is, therefore, adjusted to remove $\frac{3}{32}$'' from the fore part. To do this, the link **66** is removed from its position shown in the drawings and pivotally connected to the block **80** situated on the opposite side of the pivot **69**. The block **80** is then adjusted along the slot **79** until a position is reached, which will remove $\frac{1}{32}$'' from the fore part. Under these conditions, as the follower engages the cam **71**, the fulcrum block is moved downward, thereby reducing the relative velocity of the carriages **9** and **12**, thus shortening the fore part.

Fig. 7 in the drawings illustrates in outline, a last which has been modified in accordance with the above described problem and shows in full line, a last to which the desired increment of length has been added to the heel part. The dotted line indicates the length of the unmodified last.

To further exemplify the usefulness of the invention the manner of its use in connection with another requirement relating to the growing of lasts will be set forth. In turning a last of "A" width, for example, from a model of "B" width the shoe or last designer required that the "A" last be a slight degree shorter than the "B" last in each size. In this case, as in the other examples above set forth, it is essential in correctly proportioned lasts to avoid changing the heel part in any degree from the correct standard requirement. The regular grading adjustment is, therefore, in this case restricted to that which will produce a correct heel part and the proper adjustments are made on the standard pantographic means to insure a correct heel part. The width grading adjustment is made in the usual manner by manipulating the adjustment **87**. The grade changing means is then employed to shorten the last the required amount to obtain this result, such reduction in length taking place in the fore part only. The link **66** is connected to the block **80** and the block is positioned at the proper location along the slot **79** to reduce the fore part the necessary amount which in an average case is substantially $\frac{1}{16}$''. In producing lasts wider than the model or B last it is required to add a slight amount to the length of the last, which obviously may be accomplished in the same manner as above described for reducing the length of the last produced, the only difference in procedure being in the adjustment of the pivot point of the link **66** with the lever **68**. In this latter case, the block **78** is positioned at some point along the slot **79** to the left of the pivot point **69**.

In turning lasts whose widths are narrower or wider than the model width, a condition arises which requires special treatment. This condition applies only in the case where a model is being duplicated in the model size in a narrower or wider width. For example, when a 4A last is being produced from a 4B model. As in the case where other sizes are being produced, the 4A must be shorter than the 4B. Under the normal circumstances, to produce a 4 size from a 4 size model, the block **54** is adjusted to place the pivot point **56** therein, upon the pivot point **52** between the grading lever **49** and the carriage **9**. Under such conditions, there can be no difference in the velocity of the two carriages **9** and **12**, thereby preventing an automatic reduction or increase in the length of the produced last.

Automatic means are provided by the present invention to overcome this condition. A link **91** is provided, which is connected at one end to the fulcrum block **50**, and at its other end to the block **54** as shown in Fig. 4 only. Any convenient means may be employed to make such connection, such as providing the link with apertures at both ends within which is received at its lower end, the screw **60**, the other end of the link being connected to the block **54** by means of a screw **92**. With the link **91** in position and the block **80** adjusted to a predetermined distance from the pivot point **69**, movement of the segments **68** will depress the pivot point **69** below the pivot point **52**, thereby reducing the relative velocity between the two carriages, thus shortening the fore part the necessary amount, depending upon the position of the block **80**. During this operation, the clamp **55**, which normally secures the block **54** to the grading lever, is loosened to permit the block **54** to move. If it is desired to add to the length of the fore part, the link **66** is transferred to the block **78** and the block **78** is adjusted along the groove **79** to provide the necessary lengthening of the fore part.

For other operations, the link **91** is disconnected at one of its ends or entirely removed. The link **91** is adjustable in length by making the link in two overlying sections with a clamp **95** adapted to secure the two sections in adjusted position. This adjustability permits the fulcrum block **50** to be placed in position along the bar **64** corresponding to the size of the model in use, as indicated by the scale **86**.

Obviously, the same procedure as above described in connection with lengthening or shortening the fore part in all sizes independently of the heel part may be employed to automatically change the style of a model. In other words, it may be desired to produce a series of lasts having the same general contour in the fore part as that of a model which may be available but it may be desired that the fore part be more pointed or that the fore part may be shorter. With the attachment, it is possible to turn a model having these characteristics without the necessity of first producing a hand-made model.

I claim:

1. A last lathe comprising model and work-holding instrumentalities, a model wheel carriage having a model wheel thereon, a cutter carriage having a driven cutter thereon, a pantographic grading lever having means connected thereto for interconnecting said carriages and having a movable fulcrum, a grade changing lever having a connection for moving said fulcrum, a removable cam on said lever having a working face of irregular pattern and a cam follower on one of said carriages engaging said cam at a predetermined point in the travel of said carriages whereby said grade changing lever is caused to shift the fulcrum of said grading lever in accordance with the cam, thereby changing the pantographic

velocity ratio of said grading lever in a non-uniform manner.

2. A last lathe comprising model and work-holding instrumentalities, a model wheel carriage having a model wheel thereon, a cutter carriage having a driven cutter thereon, a pantographic grading lever pivoted on one of said carriages and having a movable fulcrum, a link connecting said lever and the other of said carriages and having a movable pivoted connection with said lever adapted to adjust the velocity ratio between said carriages, a detachable rigid link connecting said movable pivot and said fulcrum, a grade changing lever pivoted on the lathe frame having a connection for moving said fulcrum, and pattern control means acting through said grade changing lever to shift said fulcrum and said pivot point in accordance with said pattern during movement of the carriages, thereby to change the velocity ratio of said carriages automatically throughout a selected portion of the carriage travel when said pivot point upon said grading lever is in axial alignment with the pivot between said lever and the carriage.

3. A last lathe comprising means for holding a model, means for holding a work piece, means for revolving the model and work piece simultaneously, a model wheel for engaging the model, a cutter for reproducing the model from the work piece, means for causing relative longitudinal movement between the model and the model wheel, the work piece and the cutter, a pantographic length grading means operable to grade a series of lasts by adding or subtracting a predetermined size increment of length between successive last sizes and means acting automatically to change said size increment of length including a cam having a working face of a required, irregular pattern acting through said increment changing means to change said length increment by changing the rate of change of velocity between the model and workpiece in a non-uniform manner.

4. A last lathe comprising means for holding the model, means for holding a work piece, a model wheel carriage having a model wheel thereon, a pantographic grading lever interconnecting said carriages and having a movable fulcrum point, means on said grading lever for adjusting the relative velocities of said carriages as they move during the turning operation thereby to determine the increment of length added to or subtracted from the model length when producing a series of graded lasts, a projection on one of said carriages, a cam having an irregular working face designed to transmit a non-uniform motion engaged by said projection at a predetermined point in the travel of the carriage acting to transfer motion of the carriage to said fulcrum point continuously throughout a selected portion of the turning operation whereby a portion of the last is graded according to one requirement and the remaining portion graded according to another requirement wherein the change of grade is made by adding or subtracting a succession of unequal increments of length to the last throughout a selected portion thereof.

5. A last lathe comprising means for holding the model, means for holding a work piece, a model wheel carriage having a model wheel thereon, a cutter carriage having a driven cutter thereon, a pantographic grading lever interconnecting said carriages, means on said lever for adjusting the relative velocities of said carriages throughout their movement during the turning operation thereby to determine the increment of length added to or subtracted from the model length for each size in producing a series of graded lasts, a lever pivoted on the frame, a cam secured upon said lever and having a working face of irregular contour for transmitting a non-uniform motion, a cam follower secured to one of said carriages and adapted to engage said cam throughout a portion of the travel of said carriage, a link pivoted to said lever and adjustably secured at its other end to said fulcrum whereby motion of said carriage is transferred to said fulcrum, and means for adjusting the point of connection of said link and said lever along the length of the lever either on one side or the other of the axis upon which said lever is pivoted to the frame.

6. A last lathe comprising means for holding a model, means for holding a work piece, means for rotating a model and work piece simultaneously, a model wheel carriage having a model wheel thereon, a cutter carriage having a cutter thereon, a pantographic grading lever pviotally connected to one of said carriages and having a movable fulcrum point, a link having a movable pivotal connection with said lever, said link being pivoted at its other end to the other carriage, means actuated by movement of said carriages operable to shift the position of said fulcrum, a detachable rigid link connecting said movable pivot point and said fulcrum whereby motion of the fulcrum is transmitted to said movable pivot point thereby providing automatic means for adding to or subtracting from a selected portion of the length of the last being produced when the lathe is adjusted to reproduce the model size.

7. A last lathe comprising model and work holding instrumentalities, a model wheel carriage having a model wheel thereon, a cutter carriage having a driven cutter thereon, a pantographic grading lever having means connected thereto for inter-connecting said carriages and having a movable fulcrum, a grade changing lever having a connection for moving said fulcrum, a cam on said lever, means adjustably to secure said cam on said grade-changing lever whereby said cam may be positioned to be engaged by its co-operating follower at a selected point in the travel of said carriages.

8. A last lathe comprising model and work holding instrumentalities, a model wheel carriage having a model wheel thereon, a cutter carriage having a driven cutter thereon, a pantographic grading lever having means connected thereto for inter-connecting said carriages and having a movable fulcrum, a grade changing lever pivotally mounted on the lathe frame, a connection on said lever for moving said fulcrum, a cam on said lever, adjusting means for adjusting said cam longitudinally of said lever, a cam follower on one of said carriages engaging said cam at a point in the travel of said carriages determined by the longitudinal adjustment of said cam.

9. A last lathe comprising model and work holding instrumentalities, a model wheel carriage having a model wheel thereon, a cutter carriage having a driven cutter thereon, a pantographic grading lever having means connected thereto for inter-connecting said carriages and having a movable fulcrum, a grade changing lever pivotally mounted on the lathe frame, a connection on said lever for moving said fulcrum, a cam having a face disposed at an acute angle to the travel of said carriages, means for ad-

justably mounting said cam on said lever and a cam follower on one of said carriages engaging said cam at a point in the travel of said carriages determined by the adjustment of said cam.

10. A last lathe comprising model and work holding instrumentalities, a model wheel carriage having a model wheel thereon, a cutter carriage having a driven cutter thereon, a pantographic grading lever having means connected thereto for inter-connecting said carriages and having a movable fulcrum, a grade changing lever pivotally mounted on the lathe frame, a spring and a fixed stop for positively determining the initial position of said lever, a connection on said lever for moving said fulcrum, a cam on said lever, adjusting means for adjusting the longitudinal position of said cam on said lever and a cam follower on one of said carriages engaging said cam at a point in the travel of said carriages determined by the longitudinal adjustment of said cam.

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