

March 16, 1926.

1,576,715

S. E. BOYNTON

LAST MAKING

Filed May 21, 1921

3 Sheets-Sheet 1

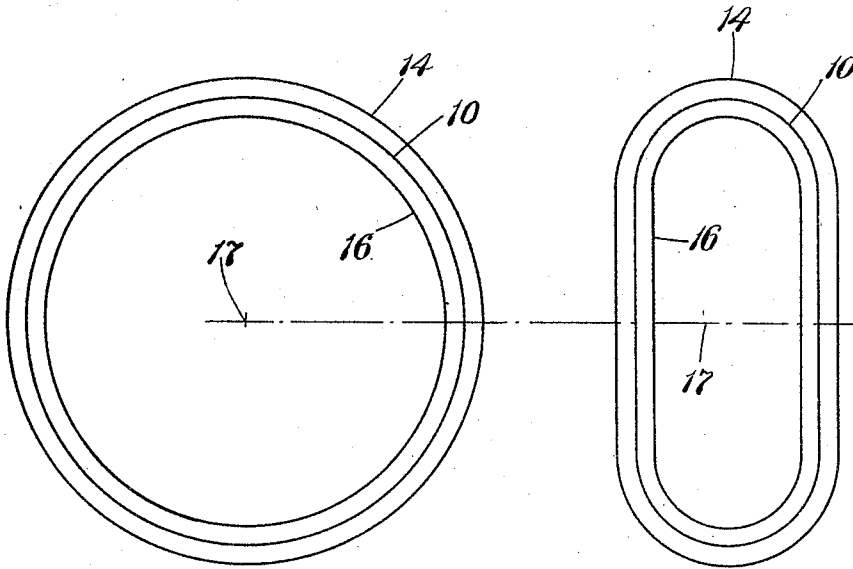


Fig. 1.

Fig. 2.

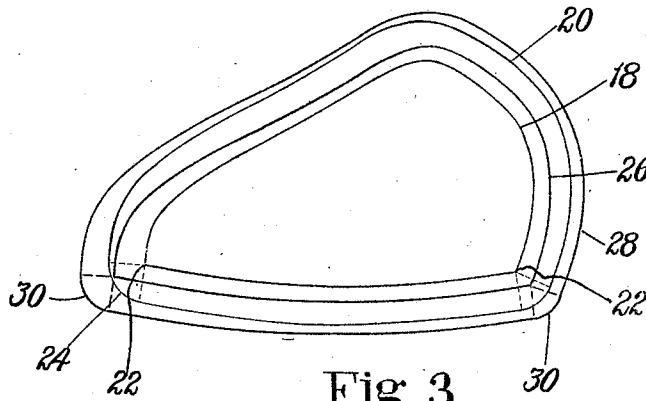


Fig. 3.

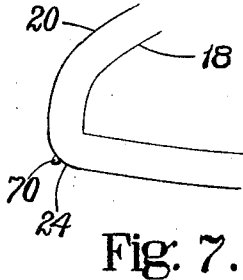


Fig. 7.

INVENTOR -
Stanley E. Boynton
By his Attorney
Nelson R. Howard

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S. E. BOYNTON

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3 Sheets-Sheet 2

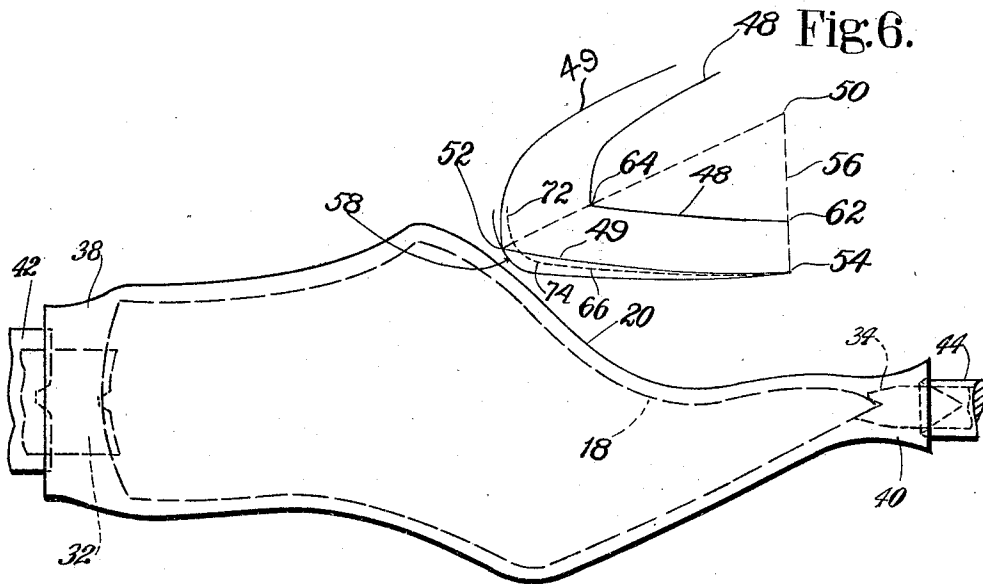


Fig. 4.

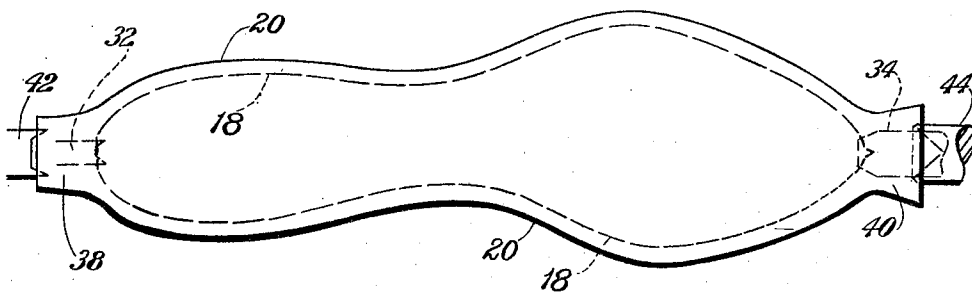


Fig. 5.

INVENTOR

Stanley E. Boynton
By his Attorney,
Nelson M. Howard

March 16 , 1926.

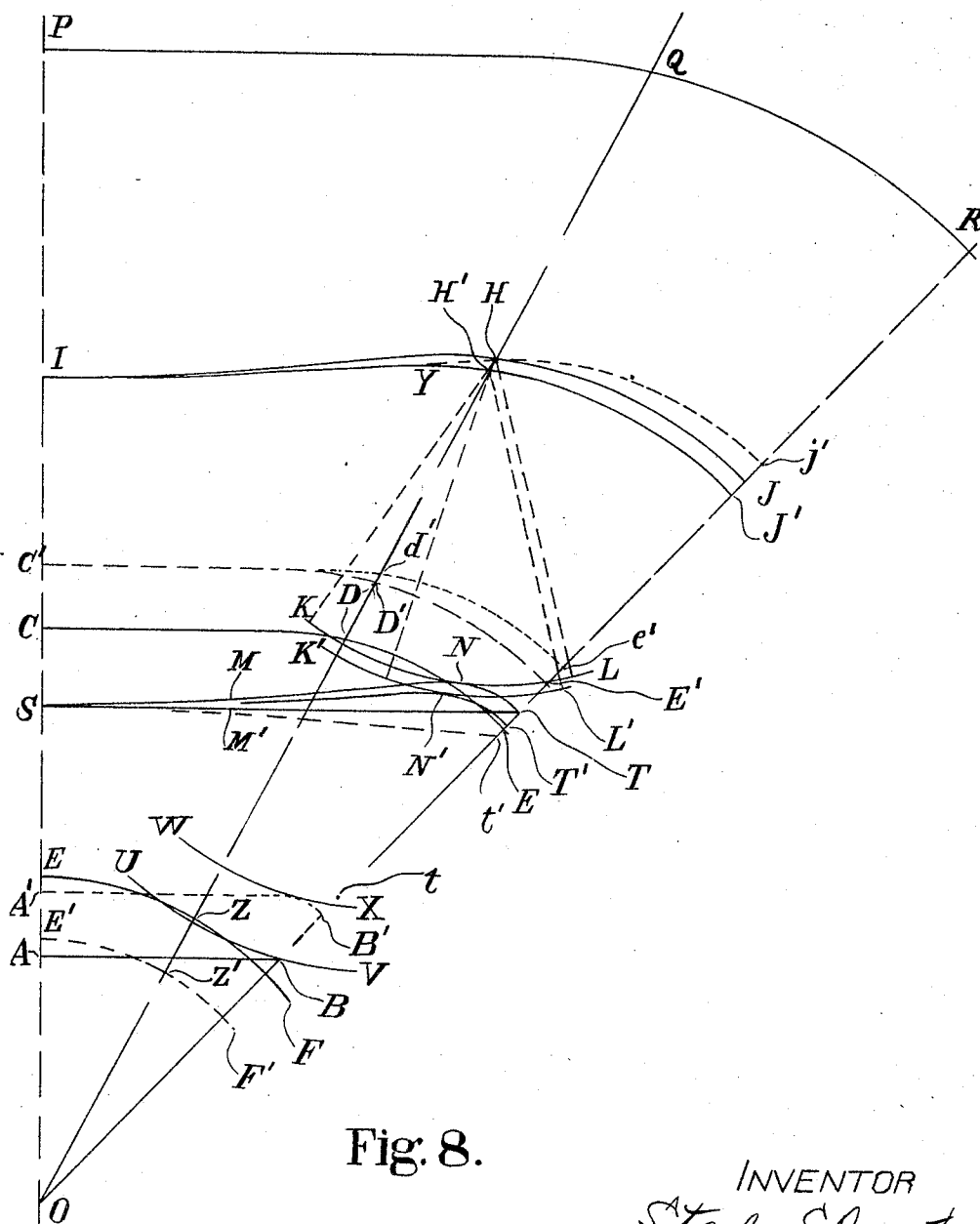
S. E. BOYNTON

LAST MAKING

Filed May 21, 1921

1,576,715

3 Sheets-Sheet 3



INVENTOR

Stanley E. Boynton
By his Attorney,
Nelson M. Howard

UNITED STATES PATENT OFFICE.

STANLEY E. BOYNTON, OF ROCHESTER, NEW YORK, ASSIGNOR TO FITZ-EMPIRE
DOUBLE PIVOT LAST COMPANY, OF AUBURN, MAINE, A CORPORATION OF MAINE.

LAST MAKING.

Application filed May 21, 1921. Serial No. 471,395.

To all whom it may concern:

Be it known that I, STANLEY E. BOYNTON, a citizen of the United States, residing at Rochester, in the county of Monroe and State of New York, have invented certain Improvements in Last Making, of which the following description, in connection with the accompanying drawings, is a specification, like reference characters on the drawings indicating like parts in the several figures.

This invention relates to pattern copying, and is set forth with especial reference to the development and use of models for last turning.

Lasts are turned in a copying lathe from a model. The same model is generally used in turning several lasts of different dimensions by the aid of so-called "grading mechanisms" which magnify or reduce the model dimensions (in general pantographically). It has not been found possible, in the production of the best class of work, to grade from one model a last having too great a difference from it in dimensions, because, for example, of the excessive variations in toe spring resulting from such a procedure. The width grader magnifies all dimensions perpendicular to the axis of rotation of the model in the same proportion, which causes the ball of the wide last to drop farther below the line joining the lower heel corner and toe tip than does the ball of the model. The resulting bowing down of the sole profile has no anatomical relation to the human foot, and causes much trouble in the shoe factory in that it requires heels of many heights and variations in the angle between the heel seat and the horizontal to make neat looking shoes. Further, the shoes are often tipped up on heels too high for them in order to bring down the toe tip of the wide last to the same "spring" as in the model size. A similar difficulty is found in the manufacture of lasts narrower than the model.

In the production of the best work these difficulties have been attacked by making a number of models in different sizes and widths so that the grading range will not be so great and by re-shaping or bending them by cutting slits in the upper and lower sides of the waist of the wide ones, for example, the slits extending toward each other nearly to the center of the last, and driving a wedge

into the upper slit until the lower one closes. This, in effect, bends the wide model in a vertical plane and takes out the exaggerated toe spring.

This procedure has numerous serious objections, among which are that it is very expensive, requiring much skilled hand labor in finishing the models, and entails delay which is often prohibitive.

For example, in the production of the best grade of women's work, according to this practice, models are made in the 4, 6, and 8 lengths of all the widths AA to EE, seven in number, and in special cases even from AAA to EEE, nine in number. The fundamental model is the 4B, and the others are made from it by ordinary grading and subsequent wedging. These 21-27 models are then used in the lathe and are graded up and down in the ordinary manner, in order to obtain the complete run of lasts.

This procedure, as noted, is very expensive. The model making is all highly skilled hand work, and all models when properly shaped, have to be hand smoothed and supplied with a row of tacks the heads of which are filed up to a sharp edge by hand, along all their corners in order to prevent rounding off of the corners under the model wheel pressure. This must be very accurately done, as the sole pattern of the last depends on it. In the case of all pointed toed models, a metal plate must also be placed in the tread surface at the toe, to keep the tip from breaking in the lathe. Another source of expense is the hand finishing of the heel and toe ends of all models, which must be done in order to enable the model maker to check up the accuracy of his wedging process. This operation requires extreme skill, and even then leaves something to be desired on the score of accuracy. A complete set of models costs (1921) about \$500.00. Duplicates can be made by 1:1 reproduction in the last lathe and "tacked up" at about \$5.00 each. A second objection is the time required to produce these models. The last making business is essentially a custom business. Lasts are never kept on hand and sold from stock; there are too many variations in style. A shoe manufacturer, having worked out the shape of his 4B model with the last maker to a satisfactory conclusion, wants his lasts immediately. The style may change and the shoes

be rendered unsalable in two weeks. The original 21-27 models must be made and if the order is large, duplicates must be made so that a number of lathes can be kept going on the same size. Frequently this one order is the only one ever received on this model and in addition to the delay in production, the whole matter is thus extremely expensive.

In the third place, the 21-27 models only partially correct the toe spring difficulty since there are in all in the range 1-9, AA to EE, counting the half sizes $(9+8) \times 7 = 119$ lasts only 21 of which are right, the others being graded from them. A fourth objection is that the whole model making process is a matter of rule of thumb. The desired result is attained generally only after repeated trials, and if the models are broken or lost, the whole work has to be done over again.

The present invention provides a novel procedure and apparatus by which these and other difficulties may be advantageously attacked. I have discovered that much of the expensive hand labor can be avoided by the use of over- and under-size model wheels in the last lathe, in order to apply (positively and negatively, respectively) a layer of uniform thickness to the work piece which would normally be produced by the same machine in the same adjustment, but with a regular model wheel. The United States Letters Patent No. 1,352,518, issued Sept. 14, 1920 on the application of P. F. W. C. Krippendorf, shows a machine adapted for use in practicing this novel procedure. I propose, by means of such a machine, for example, to turn lasts by means of an undersize model wheel from oversize models, that is, from models equivalent to lasts of the set desired plus a laterally uniform layer all over their surfaces, these models being produced by an oversize model wheel, as described in said Letters Patent. Such an oversize model will have circularly rounded edges corresponding to the sharp edges of the last to which it corresponds, and all the expense of tacking them is thus avoided, no tacks being necessary. In addition, the oversize model can be hung on its own stubs in turning from it and the expense of end finishing is avoided. I have also found it unnecessary to smooth such models, as their roughness does not injure the smaller last turned from them.

Another important advantage of the invention arises in connection with the problem of sharp corner reproduction. It is well known that sharp corners are inaccurately reproduced when the width grader is operating, due to the lack of proper proportion between the cutter and model wheel. The procedure just suggested, in another aspect,

provides the possibility of easily width grading the corners at a different rate from the other portions of the last, whereby this difficulty of corner reproduction can be minimized.

Accordingly, my invention may be defined broadly in one aspect as the copy turning of a last from an oversize model in a lathe having an undersize model wheel. In this connection, important features of the invention consist in the oversize model, as herein defined, and in the combination of such a model with a copy turning lathe having an undersize model wheel.

This and other aspects and advantages of the invention will be better understood from the following description of the preferred procedure illustrated by the accompanying drawings in which,

Fig. 1 illustrates in side elevation the relative sizes and operative positions of the cutter and the regular, over- and under-size model wheels.

Fig. 2 illustrates in front elevation the relation between the model wheels.

Fig. 3 illustrate diagrammatically a cross-section of the 4B (model) last in relation to the same cross section of the oversize 4B and oversize 6D last and of the exact size 6D last.

Figs. 4 and 5 illustrate in elevation and plan the ordinary last and the oversize model corresponding to it.

Fig. 6 illustrates the so-called round corner difficulty in width grading.

Fig. 7 illustrates the method of dealing with this difficulty by means of the present invention.

Fig. 8 is a diagram illustrating generally the width grading difficulty and its treatment by the present invention.

The standard model wheel illustrated diagrammatically at 10 in Figs. 1 and 2 is 3.5 inches in diameter and .75 inch in radius at the face. The cutter is of the same effective dimensions. This particular size has been adopted only for convenience, as the invention is universally applicable. The oversize model wheel 14 is $3\frac{5}{8}$ inches in diameter and $11/12$ inch in radius at the face. The undersize model wheel 16 is $3\frac{1}{8}$ inches in diameter and $7/12$ inch in radius at the face. The over- and under-size wheels are therefore equivalent to the standard wheel plus and minus a uniform layer $1/8$ inch thick all over its effective surface. The irregular sized model wheels are normally mounted in the last lathe on the same axis 17 as the regular sized wheel, there being no change in adjustment for them, and the width grading mechanism of the lathe operates exactly as usual.

In practicing this invention in the simplest manner, the regular 4B model is placed in the last lathe and a 4B oversize model

turned from it by means of an oversize model wheel. The wheel is mounted on the same spindle 17 as the regular model wheel, the wheels being merely interchanged, the width grading mechanism being otherwise undisturbed, and being set at zero for the operation. The oversize wheel is taken as $\frac{1}{8}$ inch greater in diametral radius and in radius of rim cross-section than the standard wheel and cutter, and will therefore simply cause the cutter to cut $\frac{1}{8}$ inch too high everywhere, including the ends of the last, as explained by Krippendorf in the patent referred to.

Figs. 1 and 2 illustrate the relation of the cutter and standard wheel 10, and the oversize wheel 14. Fig. 3 shows the relation between the 4B model 18 and the oversize 4B model 20, the oversize allowance being much exaggerated. The sharp corners 22 of the model section are transformed into circular arcs 24 in the oversize 4B, as is easily seen from the nature of the operation by which it is produced.

The oversize 4B model 20 is then placed in the model side of the machine and used as a model, with an undersize model wheel 16 mounted on the same spindle 17, the width grader now being used in the ordinary manner. The wheel 16 is undersize in the same way and degree as the wheel 14 is oversize. It should now be observed that the oversize allowance on the model and the undersize allowance on the wheel just correspond, so that the distance between the spindle 17 and the axis of rotation of the model will be the same as it would be if grading with a regular model and regular model wheel, and the grading action of the machine will therefore be the same as in the old practice, and the last cut by the cutter will be the same as that produced in an ordinary machine with the same width grader setting.

Advantages gained by my invention are numerous. Any last, for example, a 6D, turned as above, can be used in the same way to generate a 6D oversize model, which can be used to turn a 6D, with an undersize model wheel, with zero width grader setting. The actual production can therefore be gotten out without any width grading at all, and consequently by comparatively unskilled operators.

It is unnecessary to tack up the oversize model as it has been found that the round edges are undamaged by the continued rolling of the model wheel, and this expense in time and money is therefore avoided. The round edges also reduce the jar on the machine as the model wheel rolls to and from them, as compared with the sharp edges of a normal model. Another very important advantage resides in the avoidance of expense in trimming the ends of the oversize models. The oversize models are mounted

in the ordinary lathe on their stubs, the original dog marks being used to place them. Accordingly no metallic reinforcement in the tread surface at the toe is necessary, since the toe of even a pointed toe oversize model is amply strong. A fuller discussion of this point in another connection will be found below. It has also been found quite unnecessary to smooth off the spiral ridge formed by the cutter on their surfaces, as this roughness causes no perceptible inaccuracy in the standard lasts turned from them under these conditions. Another considerable item of skilled hand labor expense is thus avoided.

In the production of a great deal of work a single 4B model is used for the whole run, the toe spring difficulty being ignored. In this case many duplicate 4B models would be used and the present invention makes it unnecessary to tack up any of them as two or three lasts can be turned from an untacked model before the edges begin to round up, and the original hand-made 4B can be used to turn several oversize 4B models which in turn can be used to provide an unlimited number of standard 4B models from each of which several oversize models can be generated. These models can be used to generate any lasts of the system, for example, a 6D, as above described, and the 6D, untacked and untrimmed, can be used to generate an oversize 6D model which can be used by the unskilled operator in getting out the actual production.

The 6D is illustrated in Fig. 3 at 26, and the oversize 6D at 28. It will have round corners 30. The oversize allowances in Fig. 3 are not shown consistently, in order to secure better separation of the different outlines. All this is done without any tacking, and without any end trimming or smoothing after the initial collaboration of the model maker and shoe manufacturer in the production of the first 4B. In case the full set of corrected toe spring models is desired and has to be made by hand, the original, untacked 4B can be used as just described to produce the 4, 6, 8, AA-EE lasts which are taken to the model maker to be wedged, and these, untacked, can be used to produce oversize models, in the same way. All tacking is thus avoided, as well as all end-trimming except for the wedged models, and no smoothing is necessary at all, except on the first 4B, which is shaped for approval.

The oversize 6D model can be produced in still another way. Suppose an oversize wheel to be mounted in the lathe, and its spindle moved back on the grading slide by the amount of the radial oversize allowance. This can be done by the so-called "wood-up" screw which adjusts the model wheel on the width grading slide, and will bring the face of the wheel into the axis of revolution of

- the model when the width grading slide is at zero, irrespective of the setting of the grader. If then the grader is set to produce a 6D, the grading slide will move so as to produce a 6D with an oversize cutter like the model wheel. The cutter, being relatively undersize, will cut too high everywhere by the same amount, and a 6D oversize model will be produced.
- 10 The same effect would be produced by the use of the standard wheel and undersize cutter, with the standard adjustment of the wood-up screw, but it is more practical to interchange wheels than to change or reset the cutters. The words "oversize" and "undersize" wherein are intended to refer to the relation between the model wheel and cutter, but do not imply a fixed standard of either.
- 20 The present invention also provides a means of dealing with the so-called "round corner problem." It is well understood that in cutting lasts in the last lathe by means of the width grader, the ratio of the diameters of the cutter and model wheel should be equal to the magnification multiplying factor which expresses the lateral linear relation between the work and the model. If the cutter and model wheel have the proper relative size, the figure consisting of the model and model wheel will be geometrically similar to the figure comprising the work and cutter at every instant, and the reproduction will be geometrically accurate.
- 30 Since it is not practically feasible to adjust the relation of the diameters of the model wheel and cutter for every problem in last turning, the machine is either used as it is with the model wheel and cutter of the same diameter, or one or two extra model wheels of different diameters are provided and the machine is adjusted as closely as possible to the ideal conditions in any particular case. The resulting performance is diagrammatically illustrated in Fig. 6. We will suppose that the machine is adjusted to grade up, that is, to produce a wider last than the model and that the model wheel is of the same diameter as the cutter, that is that the machine is being used in its standard condition. The outline 48 is that of the model, and the outline 49 is the ideal outline of the graded last which it is desired to produce. 50 is the position of the mechanical axis of rotation in the machine. It is found that the point at the sharp corner 52 and the point 54 where the tangent is perpendicular to the radius vector 56 are accurately reproduced, but that the remainder of the periphery is distorted as indicated in the figure, a superfluous layer 58 of rapidly increasing thickness as we go from the point 54 to the corner 52 being added to the ideal outline. This creates a round corner at 52 on the last produced instead of the desired sharp corner and makes it necessary to trim the edges of the last up by hand in order to produce the proper effect. This problem may be very advantageously dealt with by means of the present invention as follows, a numerical example being taken in order to make the matter clear. An ideal action of the width grader would grade the point 62 into the point 54 and the point 64 into the point 52 and all points of the line 62—64 into points of the line 54—49—52. Suppose that the length 50—62 is one inch and the length 50—64 is two inches. Suppose that the length 50—54 is $1\frac{1}{8}$ inches. Then the length 50—52 will be $2\frac{1}{4}$ inches, that is, increased in the same ratio, and this will be true of all corresponding points in the figure. The width grading factor, which we will call G , is therefore $9/8$. Now suppose that an oversize model has been made directly from the original model 48 with the width grader set at zero and that the oversize allowance is $1/6$ inch, as assumed heretofore in the specification. The distance from 50 to the point corresponding to 62 on the oversize model will be $7/6$ inches. The distance from 50 to the point corresponding to 64 on the oversize model will be $13/6$ inches. We will now grade from the oversize model with an undersize wheel, but with the machine readjusted as explained above so that the grading action corresponds to the undersize wheel. In order to secure the point 54 in the final last, we must multiply the $7/6$ inches by a factor g such that the product is just $1/6$ inch greater than the required distance 50—54 = $9/8$ inches, and the relatively oversize cutter will then cut this $1/6$ inch off. Or:
- $$7/6 \times g - \frac{1}{6} = \frac{9}{8} \text{ whence } g = 31/28$$
- Generally, if M is the model radius vector, G the grading ratio desired, o the oversize allowance, and g the actual width grader setting necessary to produce G in the work:
- $$g = \frac{GM + o}{M + o}$$
- Accordingly, in order to grade the point 64 into the point 52, we must have the width grader setting
- $$g = \frac{9/8 \times 2 + 1/6}{2 + 1/6} = \frac{29}{26}$$
- which is greater than the value previously found for the point 62. In other words, the accurate production of the last desired from the oversize model requires a different width grading ratio at every point, whereas of course only one width grading factor is practically feasible throughout the reproduction. If we accept the one which corresponds to the point 54, it will be too small

for the outlying portions of the last at 52 and therefore this outlying portion of the last near the corner will be reproduced too small, though its general form with rounded corner will be preserved as shown in the dotted line 66 in Fig. 6. This will have the effect of cutting off the bulge 58 which is, of course, desirable. It will also have the undesirable effect of cutting off the point 52. This is avoided by building out the rounded corner 24 (Figs. 3 and 7) of the oversize model, preferably by driving a row of tacks 70 along it as shown in Fig. 7. These tacks lift the model wheel and cutter away from the model and work as the swing around the corner takes place and allow the shape of the corner to be determined by the tangents at the portions 72 and 74 of the line 66, which will make a substantially sharp corner. As a matter of practice, it is found that in grading up five sizes from a 4B model, the bulge 58 is largely cut off and that a substantially correct last is produced by this procedure. It is of course clear that all the advantages enumerated in connection with the first procedure discussed in here also in the second, since the tacking here is not an exact operation. The tacks act only as a guard, and do not have to be filed up to fit anything.

The above discussion has been written from the standpoint of increased magnification, but the same advantages are found in grading down from a model. The corner difficulty in grading down by the ordinary practice appears in cutting off of the ideal corner completely. The corner produced is sharp but is within the desired outline of the last to be produced. A consideration of the formula given above will show that if a 4B oversize model is used and the width grader set for accurate reproduction of the point 62 in the center of the sole, the grader setting g will now be too large for the point 64 at the corner; and the normally cut-off corner will therefore be restored to this extent by the irregular width grade secured by my novel method. (This can be seen readily by differentiating the above formula; whence

$$\frac{dg}{dM} = \frac{(G-1)o}{(M+o)^2}$$

which shows that g increases or decreases with M according as G is greater or less than unity.)

This grading phenomenon is illustrated generally and more clearly in Fig. 8 which is drawn to scale. O is the center of rotation of the model, and OAB is the model, having a corner at B . It is unnecessary to consider the phenomenon except on one side of the line OB running to the corner, as the results will be similar on both sides of this line. The magnification factor, G , adopted

is 2, and OST is the desired graded result. The radius of the cutter is AC , and CDE is the path of the center of an equivalent model wheel, as it rolls around the model. (We may regard the whole machine as rotating around the model and work, and shall treat the problem as if a slide frame instead of a swing frame were being used). Consider the instant when the center of the model wheel is at D . The distance to be graded is the distance of the model wheel face from O , which is the length OD minus the model wheel radius. This subtraction is dealt with once for all most easily by drawing the arc EF with radius equal to AC about O as center. The length to be graded is then ZD . The point H is then taken so that $ZH=2ZD$, and represents the position of the cutter center. All points of the path IHJ may be thus obtained.

The envelope $SMNT$ of all arcs KL struck from points of IHJ , with radius HK equal to that of the cutter, is the outline of the graded work. The corner point T is accurately reproduced, but the bulge at N is manifest. If now the cutter were of twice the diameter of the model wheel, its center would be found at Q on the path PQR , such that $HQ=AC$. Its movement due to the grade is the same as before, and its center is the distance AC behind the model wheel center to start with, due to its double diameter. In general, $HQ=(G-1)AC$. It will be found that ST is the envelope of all arcs struck from points of PQR with radius $G \times AC$, and the reproduction is then perfect.

In practising the present invention in the aspect being discussed, a large model wheel $D'UV$ is first used so that the cutter $D'WX$ cuts out the oversize model outline $A'B'$. The model wheel center path $C'D'E'$ is outside of the path CDE by the amount of the oversize allowance AA' . When the small model wheel $OE'F'$ is used on the oversize model $A'B'$, its center will pass over the same path CDE as under the old practice. $Z'D$ is now the length to be graded, but the grading factor g must now be chosen to magnify OA' to a value larger than OS by the quantity AA' in order to permit the subtraction of AA' by the cutter which is now larger in radius than the model wheel by the quantity AA' . The factor g is then

$$\frac{OS+AA'}{OA'}$$

which is 1.8 in this example. Accordingly $Z'H'=1.8Z'D$, and $IH'J'$ is the path of the cutter center. The cutter $H'K'L'$ cuts out the outline $SM'N'T'$, which lies within the outline $SMNT$, produced under the old practice, so that the bulge at N is reduced.

The placing of a tack at the point t

moves the arc $D'E'$ out to $d'e'$, and the curve YJ' to Yj' . The line cut by the cutter under these circumstances is not drawn, to avoid complicating the figure, but it is
 5 evident that the resulting corner will be drawn out beyond the point T' .

The problem of grading down is a similar one. The attempt to grade the figure OST down from a similar figure twice as large,
 10 by the old practice, will result in the figure $OS't'$, and the variable grading feature of the present invention can be utilized to hold the point S and move the point t' out, a track being also used if necessary.

The proportions in Fig. 8 have been selected to exaggerate the phenomena produced, and the showing there should not be quantitatively attributed to the last cutting problem. The errors in last cutting, where
 20 the extreme grading factor is less than 1.2, are much smaller, and the correction by the new practice is correspondingly better.

The present invention is of particular value when used in connection with the so-called "toe spring lathe", patented Dec. 14,
 25 1920, No. 1,362,183 on the application of L. B. Whipple, No. 1,362,184 on the application of E. J. Prindle, and No. 1,362,185 on the application of S. E. Boynton.

This machine provides for the arbitrary control of the sole profile in connection with width grading, so that the last is automatically "bent" during its production. Models
 30 with corrected toe spring can be produced directly and accurately on this machine, the operation being a perfectly definite one, exactly and mechanically repeatable at any future time.

The present invention improves still further the practice contemplated by the inventors of this machine, eliminating expensive skilled hand labor which still remained even after the expensive hand-bending step was done away with. It is not
 40 advisable to use this toe spring lathe directly in the production of commercial lasts, as the machine is expensive and cannot be entrusted to the ordinary lathe operator. It is essentially a model making machine and its product prior to the present invention
 50 had to be hand smoothed and tacked before being sent to the commercial last turner. End finishing was also necessary, because the toes of the exact size models produced
 55 are not strong enough without reinforcement.

The present invention enables the product of the toe spring lathe to be used directly in the ordinary lathe, avoiding all expense of hand labor in model preparation. I propose, in the preferred practice of my invention, to use the toe spring lathe equipped with the Krippendorf over- and under-size
 60 model wheels, in one of the ways described, to produce, for example, a 6D model from

the original hand-made 4B, with perfectly adjusted toe spring, the 6D being oversize everywhere, by a uniformly thick layer, and then to place this oversize model in the ordinary last lathe by means of its own dog
 70 marks, without any end trimming, smoothing or skilled tacking, with an undersize model wheel which will remove the uniform layer, and turn the 6D last, and, if desired, other adjacent members of the system
 75 from it.

The oversize models are so cheap that it is regarded as good practice to make an oversize model corresponding to every size and width, thereby obtaining exact accuracy as to toe spring in all lasts. These models can be used in the ordinary lathe with its graders set at zero, so that the actual commercial production can be got out with comparatively unskilled labor, since the machines will
 80 require no adjustment. These models are so cheap that they are finally turned down into actual lasts and sold, as it is cheaper to make than to store them. The toe spring can also be corrected in the toe spring lathe
 85 by producing a whole set of differently corrected oversize 4B models which will grade into the desired corrected 6D, etc., in the ordinary lathe with undersize model wheel. I regard the practices suggested in this paragraph as within the scope of my invention. It should also be noted that since the phenomena treated herein appear in the transverse cross-section of a solid work piece, the
 90 invention is also fully applicable to two-dimensional pattern reproduction.

The question of irregular sized model wheels involved in this invention should not be confused with the matter of accurate reproduction of sharp corners in width grading in which over- and under-size model wheels are also used, as suggested above. In order to effect accurate width grading reproduction, it is necessary that the system composed of the model wheel and model be
 100 geometrically similar to the system composed of the cutter and block, which necessitates changing the model wheel (or cutter) with each change of grade so the lateral and diametral relations of the model wheel and the cutter will be proportional to the same relations of the model and block. The over- and under-size model wheels used are placed in the machine with their front faces in line with that of the cutter so that the axis of
 105 revolution of the model and block in the swing frame would touch them both at the same time if the swing frame were swung in far enough. This brings their axes behind and in front of the cutter axis, respectively, and the procedure does not produce over-or under-size models, but is simply a matter of accurate geometric reproduction. The practice of the present invention, according to the first method described, places all
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 130

the model wheels upon the same axis, so that the faces of the irregular sized wheels are not in line with that of the cutter.

Another difference between the two practices can also be seen by a consideration of the actual sizes of the wheels used. In grading a 6D from a 4B for accurate corner reproduction, the standard model wheel being assumed as $3\frac{1}{2}$ inches in diameter, the actual model wheel should be $8/9 \times 3\frac{1}{2}$ inches in diameter, or $3\frac{1}{9}$ inches. (The 6D last is nine inches in circumference where the 4B is eight inches and the model wheel and cutter must have a diameter ratio of about 8:9). The described practice of the present invention requires both oversize and undersize model wheels in the same problem and the amount of over- and under-sizing is independent of the amount of grade, and is indeed quite arbitrary in all cases. The particular value suggested in the above examples has been found to work satisfactorily in practice, but can of course be varied to suit individual conditions.

Another important advantage of the oversize model resides in its use in roughing down last blocks. It is becoming more and more the practice to place the rough last block in a heavy "roughing lathe" which leaves the block perhaps $\frac{1}{4}$ inch oversize before it is sent to the ordinary last lathe. The latter machine is used, therefore, only as a finisher, and is found to work much more smoothly, due to the small quantity of wood it has to remove. The heavy roughing cutters can also be dropped and the expense of keeping them in order is avoided. The use of the ordinary model in the roughing lathe has been found disadvantageous because the duty on it is so heavy in this large and rapidly cutting machine that it is often broken out of its suspending centers, being especially weak at the toe. The use of the oversize model provided by the present invention obviates this difficulty, among others, by virtue of its heavy stubs and the large centers which they can accommodate.

This is illustrated in Figs. 4 and 5.

The outline 18 may now represent that of an ordinary last, suspended on the heel dog 32 and toe dog 34. The outline 20 represents that of the corresponding oversize last with the stubs 38, 40 on which it was turned, suspended on the much larger and heavier dogs 42 and 44. This last used as a model is amply strong to withstand the stresses of the roughing lathe, and its use makes any grading structure unnecessary in that machine, consequently diminishing the investment and labor expense.

Having described my invention, what I claim as new and desire to secure by Letters Patent of the United States is:—

1. That improvement in the art of pattern copying which consists in cutting the work

from an oversize model in a pattern copying machine having a wheel which is undersize to the same extent that the model is oversize.

2. That improvement in the art of pattern copying which consists in producing an oversize model and using it as a model in a pattern copying machine equipped with a model wheel which is undersize to the same extent that the model is oversize to produce the work piece desired.

3. That improvement in the art of last making which consists in producing an oversize model in a lathe with an oversize model wheel and turning therefrom a last in a lathe having a model wheel which is undersize to the same extent that the model is oversize.

4. That improvement in the art of last making which consists in producing an oversize model with corrected toe spring and turning a last from it in a last lathe with a model wheel which is undersize to the same extent that the model is oversize.

5. That improvement in the art of last making which consists in producing an oversize model in a lathe with an oversize model wheel and turning a last therefrom in a lathe with a model wheel undersize to the same extent that the model is oversize, using a toe-spring lathe to correct the toe spring.

6. An oversize model for last cutting equivalent in lateral dimensions to a standard model of the same style plus a laterally uniform thickness of material and having rounded edges in its bottom where the standard model has sharp edges.

7. An oversize model as defined in claim 6 having the stubs and dog marks by which it was turned.

8. An oversize model equivalent to a last of the set under consideration, plus a uniformly thick layer all over its surface, except at those places corresponding to the corners of the said last, where the round corners produced by the uniform layer are built up.

9. An oversize model equivalent to a last of the set under consideration, plus a uniformly thick layer all over its surface with projecting tacks except at those places corresponding to the corners of the said last, where the round corners produced by the uniform layer are built up.

10. The combination of a copying machine having an undersize model wheel, and a model which is oversize to the same extent that the model wheel is undersize.

11. The combination of a last lathe having an undersize model wheel, with its axis, except for width grading movement, in line with that of the cutter, and a model which is oversize to the same extent that the model wheel is undersize.

12. The combination of a last lathe with an undersize model wheel and a model which is oversize to the same extent that the model wheel is undersize.
- 5 13. The combination of a last lathe with an undersize model wheel and width grading mechanism adjusted to correspond to a cutter-size model wheel, and an oversize model.
- 10 14. The combination of a last lathe having an undersize model wheel and a correspondingly oversize model having its original stubs and dog marks, the said marks fitting the dogs of the said lathe.
- 15 15. A last lathe having a model wheel and cutter of different diameters, and width grading mechanism adjusted to put the faces of the model wheel and cutter simultaneously upon the axes of the model and block
- 20 respectively.
16. That improvement in the art of last making which consists in width grading from points not in the contour of the model, and effecting a compensation to produce a
- 25 graded result as if from the model-contour itself.
17. That improvement in the art of pattern reproduction which consists in grading from a contour generally uniformly separated from that of the model, and effecting
- 30 a compensation whereby the actual magnification factor is made to vary from point to point to effect approximate grading from the model-contour itself.
- 35 18. That improvement in the art of last making which consists in supporting an oversize model in a roughing lathe by the stubs on which it was turned, copy turning
- from it an oversize block by substantially 1:1 reproduction, suspending this block in the ordinary last lathe by means of the stubs on which it was turned, and turning out of it a last in the ordinary manner.
19. That improvement in the art of last production which consists in providing an ordinary model, copy turning from it an oversize model, copy turning from the oversize model a desired number of models of desired dimensions, copy turning oversize models from these latter models, and getting out the commercial production from the latter named oversize models.
20. That improvement in the art of last production which consists in providing an ordinary model, copy turning from it an oversize model, copy turning from the oversize model a desired number of models of desired dimensions, correcting the toe spring of the latter models, copy turning oversize models from these latter models, and getting out the commercial production from the latter named oversize models.
21. That improvement in the art of last production which consists in providing an ordinary model, copy turning from it an oversize model, producing from the oversize model a desired number of models of desired dimensions with corrected toe springs, copy turning oversize models from these latter models, and getting out the commercial production from the latter named oversize models.
- In testimony whereof I have signed my name to this specification.
- STANLEY E. BOYNTON.

Certificate of Correction.

It is hereby certified that in Letters Patent No. 1,576,715, granted March 16, 1926, upon the application of Stanley E. Boynton, of Rochester, New York, for an improvement in "Last Making," an error appears in the printed specification requiring correction as follows: Page 7, line 67, claim 1, before the word "wheel" insert the word *model*; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 15th day of June, A. D. 1926.

[SEAL.]

M. J. MOORE,
Acting Commissioner of Patents.