Dec. 17, 1940. H. H. CANTERBURY 2,225,154

MOUTHPIECE FACING MACHINE

Filed Aug. 13, 1937 4 Sheets-Sheet 1

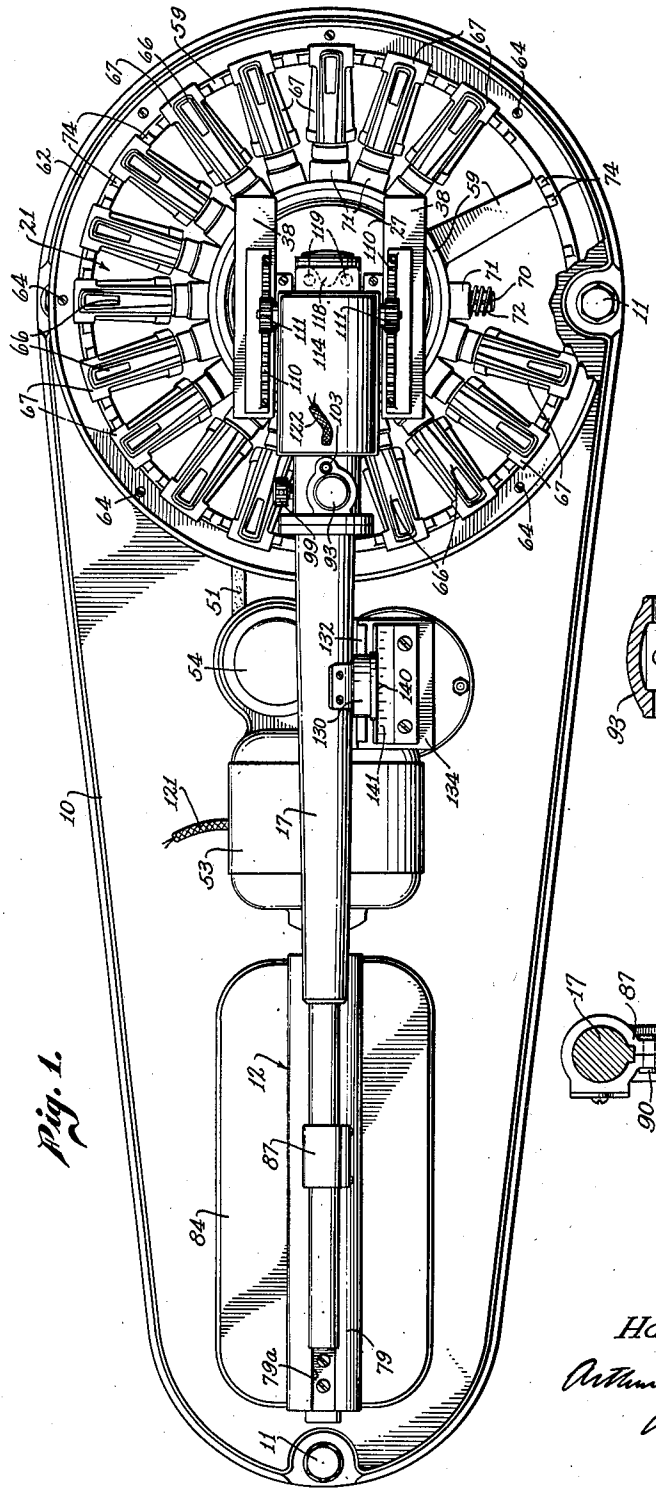


Fig. 1.

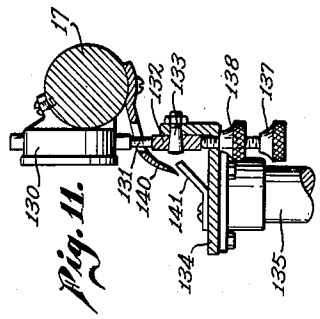


Fig. 11.

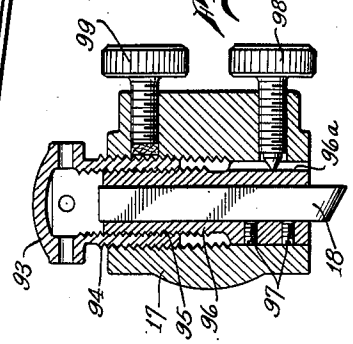


Fig. 4.

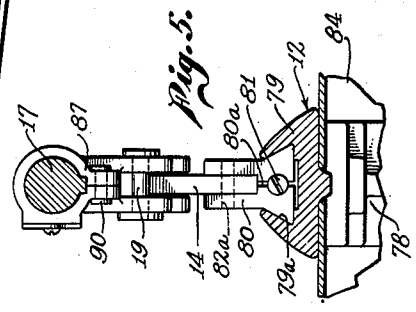


Fig. 5.

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MOUTHPIECE FACING MACHINE

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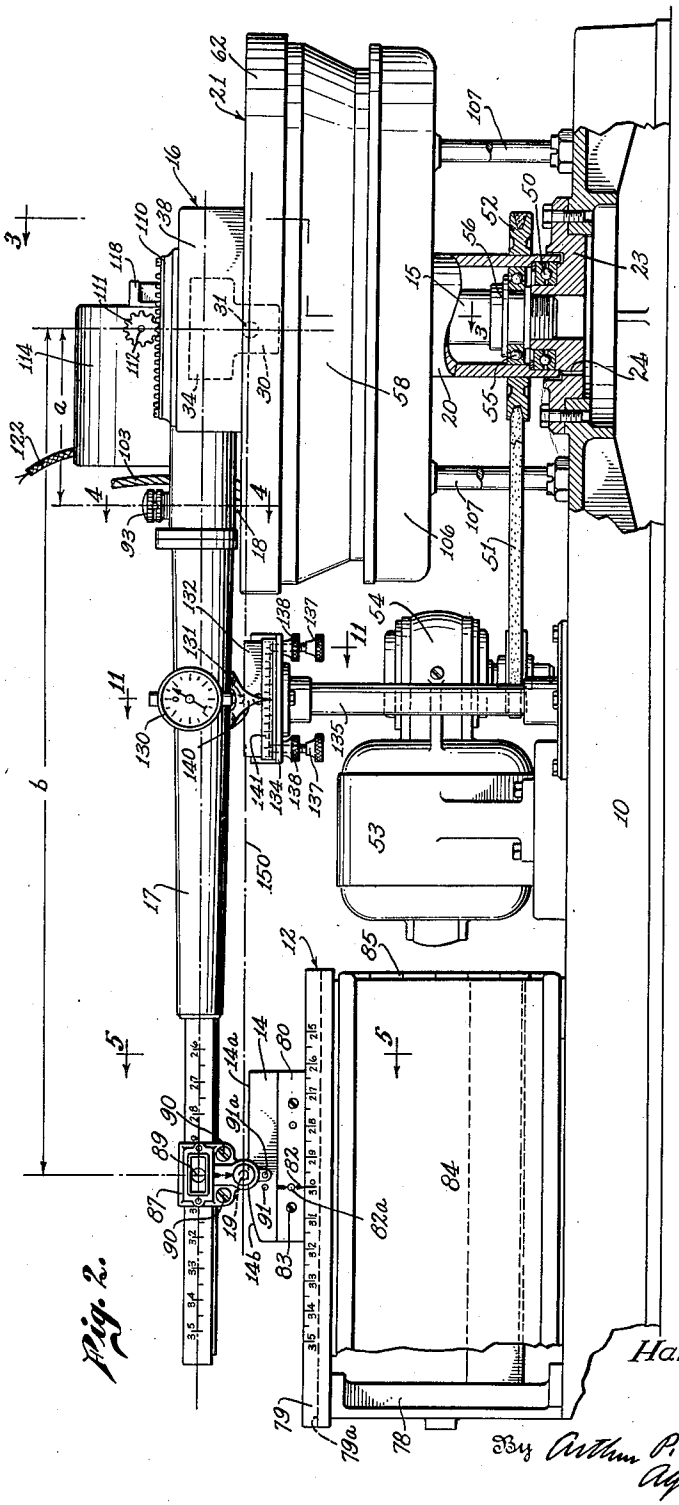


Fig. 2.

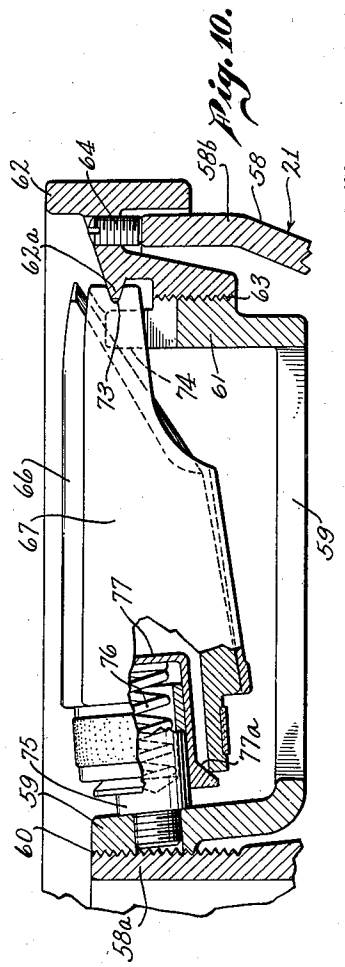


Fig. 10.

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MOUTHPIECE FACING MACHINE

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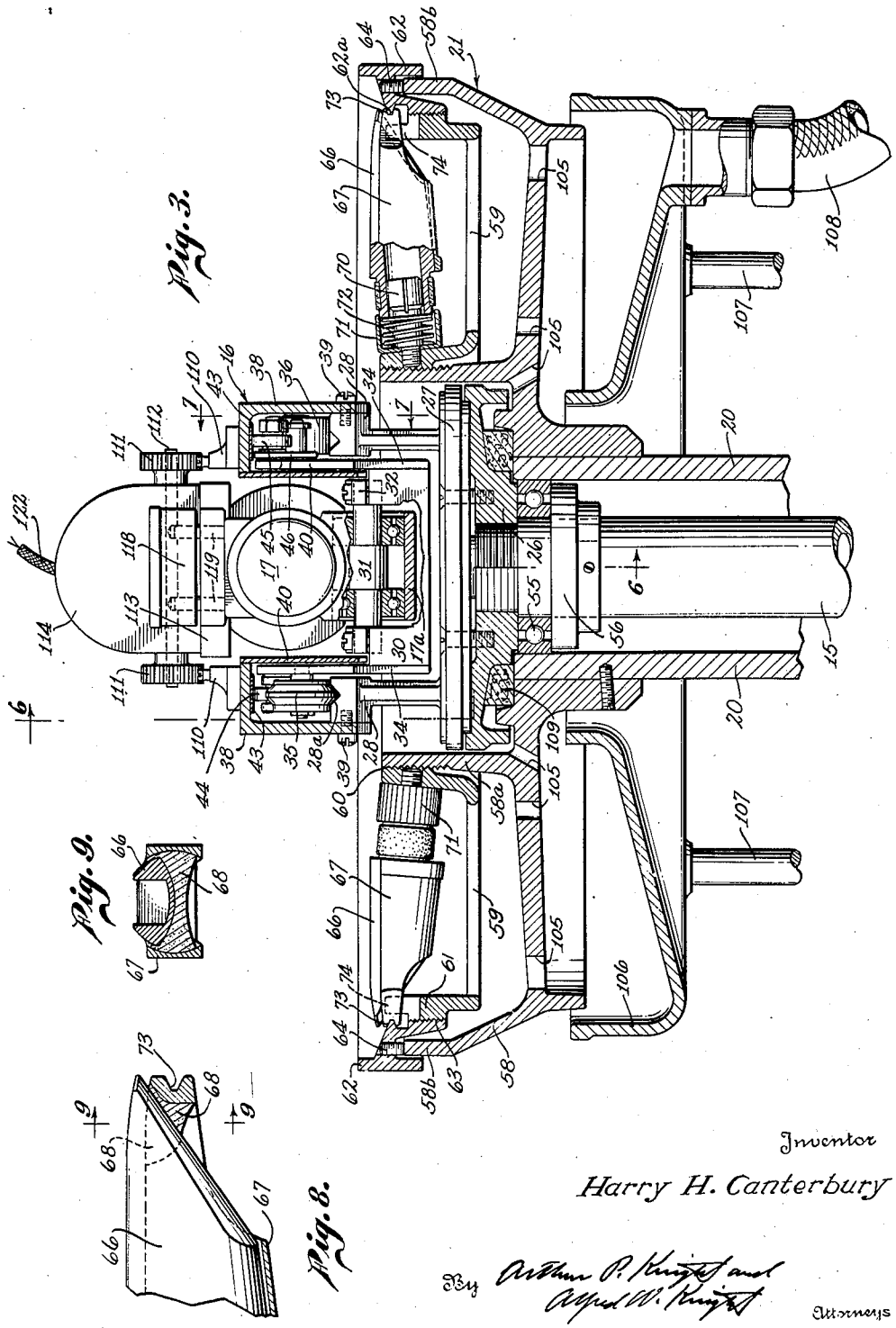


Fig. 3.

Fig. 9.

Fig. 8.

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MOUTHPIECE FACING MACHINE

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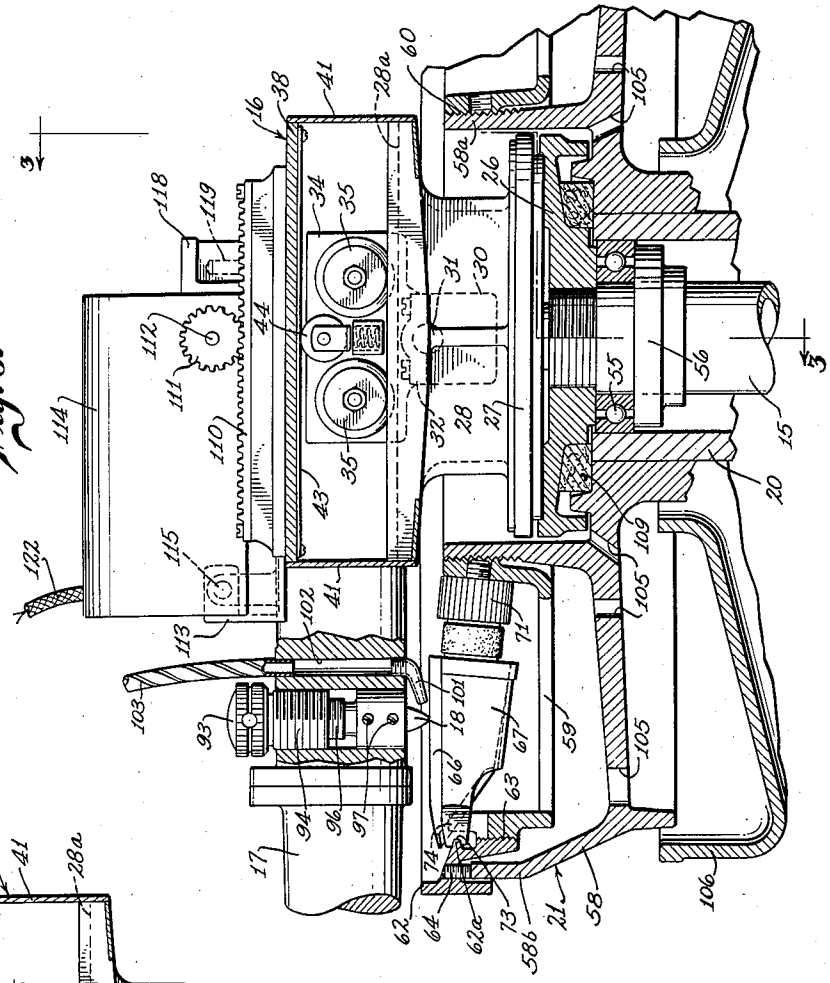


Fig. 6.

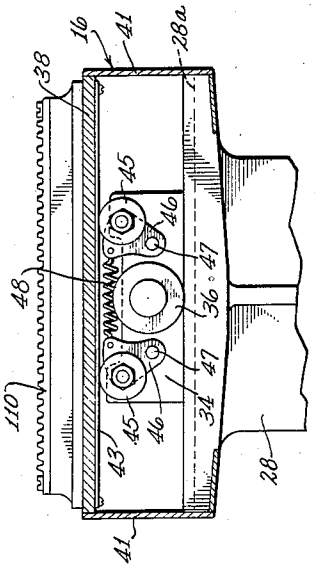


Fig. 7.

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Patented Dec. 17, 1940 2,225,154

UNITED STATES PATENT OFFICE

2,225,154

MOUTHPIECE FACING MACHINE

Harry H. Canterbury, Whittier, Calif.

Application August 13, 1937, Serial No. 158,933

12 Claims. (Cl. 90—24.3)

The present invention relates generally to precision facing machines and more particularly to machines for cutting or facing blanks to form mouthpieces for musical instruments such as the saxophone, clarinet, etc. The blanks may be made of any suitable material that is hard enough to take and retain a precise shape and is free from even minute distortion produced by internal strains, temperature changes, or hygroscopic tendencies. Various materials used have been wood, hard rubber, glass, and other manufactured products such as certain synthetic resins, a typical one of the latter being the product known to the trade as "Catalin."

Mouthpieces have formerly been made by hand methods as a general rule because no mechanical means has proved especially advantageous. The manual product is fundamentally objectionable because of the inaccuracy of the curve to the face and rails over which the reed lies. Along with the general objections to an individual piece of low quality there is the objection of non-uniformity in the product as a whole, because each piece, being made individually, has its own unique characteristics and irregularities. The obvious consequence is that it is not possible to reproduce exactly, in quantity or at a reasonable cost, a mouthpiece having especially desirable playing characteristics. While the price of the ordinary hand-cut piece has not been excessive, yet the production of extra fine pieces cannot be done by hand methods at a commercially satisfactory price.

The usual mouthpiece is generally circular in cross section, tapering toward one end to form a beak, which is held between the lips of the player. On the top of the mouthpiece is a face, the major portion of which is flat and the remainder of which is curved longitudinally toward the outer or beak end of the mouthpiece. The face becomes only a pair of narrow side rails where the throat of the piece opens to the face at the beak end. The playing reed lies over the mouthpiece face and is clamped toward its inner end to the flat portion of the face, being free at its outer end to vibrate. Production of musical tones occurs by alternate stoppage and entrance of air through the space between the reed and the tip of the mouthpiece into the throat of the piece. The reed vibrates periodically in synchronism with the natural harmonic resonance of the body of air partially enclosed within the tube of the instrument, the elasticity of the reed assisting in the prolongation of the vibration. Since the playing quality of the mouthpiece depends on the completeness of the air seal, the face and rails need to conform accurately to the curvature assumed by the reed as it is deflected by the force of alternate rarefactions and condensations of air within the tube of the instrument.

The reed is clamped at its thicker portion, leaving the remainder, normally about one-half its length, free to vibrate. This free end of the reed is thinned toward the outer end in a uniform manner, and may be likened to a cantilever beam of outwardly decreasing depth; and when the reed is bent by air pressure over its surface, it assumes a regular curve generally similar to that taken by such a cantilever member under uniform loading. The outer end of the face on the mouthpiece is therefore curved longitudinally to the same curve assumed by the lower face of the reed.

The mouthpiece is most easily faced from a template, but if the template curve is identical in size with the mouthpiece curve, the desired high degree of accuracy of the latter is difficult to secure because it is difficult to make the template of sufficient accuracy. In addition to this, the mechanical linkage for reproducing the curve introduces errors of its own, with the result that the reproduced curve is even less accurate than the original template. If the template is enlarged in all dimensions, the mechanism required to reduce the curve becomes so complicated and involves so many wearing joints which introduce cumulative errors of constantly increasing magnitude that full pantographic reduction is not practical for long continued accuracy of high degree. However, a semi-pantographic reduction in which the curve of the template is reduced only along one axis offers marked advantages in that the mechanism is simpler than that for either of the above methods, continued accuracy is obtainable, and minor errors in the template surface are reduced to negligible proportions.

It is thus a general object of my invention to provide means for making mouthpieces with extreme accuracy. The accuracy must be of two kinds, for not only must the face be transversely flat and present a precise, even longitudinally curve free from minor irregularities and merging smoothly into the longitudinally flat portion of the face, but the shape of the curve must conform precisely to a predetermined shape.

It is also an object to secure uniformity of product so that a mouthpiece of desirable characteristics can be readily duplicated, not only individually but in quantity.

Subsidiary to the aims of accuracy and uniformity but nevertheless important, is also the

object of providing means for cheaply facing mouthpiece blanks on a production basis.

Another object of my invention is to provide a machine in which a standard template is used to guide the cutting tool and in which the dimensions of the face made by the tool are reduced along one axis from the dimensions of the template, but along the other axis the template and face dimensions are the same.

An additional object is to provide apparatus in which the ratio of reduction of dimensions from the template to the cut face can be varied easily and quickly to produce limitless variations in the curvature to the face within the range obtainable from a single template.

These objects are attained in a preferred form of machine constructed according to my invention by providing a cutting tool, the movement of which can be accurately controlled, and support means for holding one or a number of blanks in postiion to be moved past the tool by rotation of the supporting means. The relative movement of tool and blank removes material from the blank to form thereon the desired face. A template and follower means is provided by which one component of the tool motion is determined, and a member interconnects the follower and tool to impart the desired movement of the tool. The interconnecting member is preferably movable longitudinally, carrying the tool and follower with it, thus moving the follower over a template surface curved to produce the desired curved face on the blank. The interconnecting member is likewise pivoted at some point with the cutting tool placed a shorter distance from the pivot than the template is from the pivot. Although the invention includes placing the tool and follower on opposite sides of the pivot, it is preferred to place them both on the same side because of simplification of construction and because the paths of the tool and follower then both curve in the same direction. This longitudinal movement of the interconnecting member is one component of the movement of both follower and tool and is equal for both these elements. The curvature of the template surface produces a component of follower movement at right angles to the first component and, since the interconnecting member also swings about its pivotal mount, the corresponding component of the tool movement is determined by the ratio of the distances of the follower and tool from the pivot. Reference should also be made to my co-pending application entitled "Work holder for facing machines," Ser. No. 244,411, filed November 7, 1938, wherein I claim various aspects of means herein shown and described for holding the mouthpiece blanks in position during the facing operation.

How the above, and other objects and advantages of my invention which will become apparent are attained, will be better understood from the following description of a present preferred embodiment of my invention and the annexed drawings, in which:

Fig. 1 is a plan view of a machine for facing mouth-pieces for musical instruments constructed in accord with my invention, a portion of the blank-holding drum being broken away;

Fig. 2 is a side elevation of the mouthpiece facing machine with a portion broken away to show some parts in section.

Fig. 3 is a vertical median section on line 3—3 of Fig. 2;

Fig. 4 is a vertical section on line 4—4 of Fig. 2 of the tool holder and support arm;

Fig. 5 is a vertical section on line 5—5 of Fig. 2 showing the template and follower means in elevation;

Fig. 6 is a fragmentary section on line 6—6 of Fig. 3;

Fig. 7 is a fragmentary section on line 7—7 of Fig. 3 showing the opposite side of the cradle support from that shown in Fig. 6;

Fig. 8 is a fragmentary elevation of one end of a mouthpiece blank with the holding cartridge broken away;

Fig. 9 is a vertical section on line 9—9 of Fig. 8;

Fig. 10 is a fragmentary section as of a portion of Fig. 3 showing a variational form of mounting for the mouthpiece; and

Fig. 11 is a section on line 11—11 of Fig. 2 showing means for measuring vertical movement of the cutting tool.

Referring now more particularly to Figs. 1 and 2, it will be seen that the machine comprises in general a base 10 which can be secured to any desired foundation by means of anchor bolts 11. At the left-hand end of base 10 is bridge 12 supporting template 14. At the right-hand end of base 10 is mounted a vertical stationary post 15 upon which rests the supporting assembly generally indicated at 16 for one end of arm 17. Arm 17 interconnects cutting tool 18 with follower 19 mounted to move over the curved surface of template 14 in order to control the movement of cutting tool 18, as will be more particularly described. Also mounted at the right-hand end of base 10 is the assembly for supporting the blanks in position to engage cutting tool 18, this assembly comprising column 20 rotatably mounted upon the base and concentric with stationary post 15, and, on the upper end of column 20, rotatable drum 21 which is provided with means for supporting the blanks.

Considering the construction now in greater detail, there is shown in Fig. 2 an opening in the top surface of base 10 into which is fitted flanged ring 23 that is bolted to the machine base. Ring 23 provides a footing for stationary vertical post 15 which is threaded at its lower end and received in a central threaded bore in ring 23. Fig. 3 shows the upper end of post 15 to which is attached cap plate 26, preferably circular in form, the two parts being connected by a screw thread. Resting upon cap plate 26 and secured thereto by the counter-sunk screws shown or other means, is base plate 27, likewise circular in outline, which is formed with two upright rail members 28 located one on either side of the center line and parallel to each other, the two members 28 having top surfaces lying in the same horizontal plane to form a pair of parallel guide rails that define the longitudinal movement of one end of arm 17.

Placed between the two side rails 28 is cradle 30, the lower portion of which forms a bearing for pivot pin 31, supporting arm 17 as will be later described, the ends of pivot pin 31 being journaled in cradle 30 and held in place by bearing caps 32, one at each end of pin 31. Each side of the cradle has an upwardly extending side plate 34 that rises above rails 28 and carries short bearing shafts upon which are journaled rollers 35 and 36 resting on rails 28.

The shape and arrangement of rollers 35 on the left-hand side of cradle 30, as viewed in Fig. 3, is shown in elevation in Fig. 6. The left-hand rail 28 is provided with a longitudinal V-shaped groove 28a, though both rails are preferably alike

in order that they may be interchangeable, and rollers **35** are of a complementary V-shape to fit into groove **28***a*. Two rollers **35** are provided on one side plate **34**, not only in order that the cradle will move in the horizontal path defined by rails **28** but also so that the cradle will move only in the straight line of groove **28***a* and will not twist in the horizontal plane. Although either one or two rollers **35** could be used on the other side plate at the right-hand side of cradle **30**, it is preferred to support that side of the cradle with a single cylindrical roller **36** that rolls on the flat top surface of rail **28**. This construction is preferred because the cradle then rests upon a three-point support, namely, two rollers **35** and a single roller **36**, and adjusts itself accurately to the horizontal plane determined by the two rails **28**. Since linear movement is assured by rollers **35** fitting snugly within groove **28***a*, and roller **36** simply supports cradle **30** so that it will roll freely, there is no danger of binding as the result of inaccuracies in machining, as might be the case were a V-shaped roller **35** provided to roll within the groove of the right-hand rail **28**. Pivot pin **31** is mounted with its axis in a horizontal plane parallel to the plane of rails **28**, and perpendicular to the direction of movement of cradle **30**; the movement of the pivot pin axis is limited by the construction described to a single horizontal plane.

To the outside face of each rail **28** is attached an L-shaped cover **38** held in place by screws **39**. From the upper horizontal leg of each cover **38** there depends an inner dust plate **40** that extends downwardly inside of side plates **34** to a point just above the horizontal portion of cradle **30**. In a like manner, dust plates **41** (Fig. 6) are supported at each end of each rail **28** from cover **38**, sufficient clearance being allowed in all cases for free movement of cradle **30** with its side plates **34**. Cover **38** and plates **40** and **41** enclose side rails **28** and the rollers moving therealong so that no dirt or foreign material will collect upon the rails and impair the accuracy of the rails.

On the under side of the horizontal leg of each cover **38** is placed a hardened steel strip **43**, the two strips **43** above rails **28** acting as horizontal guides that cooperate with rails **28** to guide the movement of cradle **30**. On the left-hand side plate **34** shown in Fig. 6, there is resiliently mounted a single cylindrical roller **44** which presses against and rolls on the strip **43** immediately above it. On the right-hand side plate **34** shown in Fig. 7, there are two cylindrical rollers **45**, each roller being journaled on a plate **46** pivotally mounted by pins **47** to the side plate **34**. Spring **48** is attached to plates **46** and draws them together by swinging movement around their pivotal supports **47**, and thus presses rollers **45** into resilient contact with strip **43** immediately above. By means of this construction, cradle **30** has a resilient, three-point contact with the upper guide provided by the two strips **43** and the movement of the cradle is further restrained to the desired path. Inaccuracies in manufacture are compensated for by the resilient mounting of the upper rollers which exert a downward pressure that additionally stabilizes the position of the cradle as determined by the three supporting rollers **35** and **36**; but the construction is not rigid and will not oppose the guiding effect of rollers **35**.

Considering now in detail the means for supporting the blanks in a suitable predetermined position to engage cutting tool **18**, it will be seen from Fig. 2 that rotating column **20** is mounted vertically and concentrically of post **15**. The lower end of column **20** is supported on bearing **50** which transmits the load of the rotating parts to footing ring **23**. Excess oil drains from the bearing through drain hole **24**. Column **20** is rotated by means of belt **51** passing around pulley **52** attached to the lower end of column **20**, the belt being driven from motor **53** which may be of any suitable type and is preferably provided with a speed reducer **54** or other similar means for reducing the rotational speed of column **20** to within the desired limits. For the sake of unitary construction and compactness of arrangement, motor **53** is here shown as mounted on base **10**, but it will be realized that other arrangements and placement of the motor may be utilized if desired. Ball bearings **55** are placed at both the upper and lower end of column **20** and fit snugly in the space between the stationary post and the rotating column so that the column turns about the post as an axis. The bearings are held in position by means of suitable flanges **56** secured to post **15**.

Rotating drum **21** which carries the blanks is fastened to the upper end of column **20**. Drum **21** comprises several parts, including outer shell member **58** formed with a central recess in which the previously described stationary structure forming supporting assembly **16** is placed so that inner shell flange **58***a* surrounds plates **26** and **27**, the shell having a central hub by means of which it is attached to the upper end of column **20**. Drum **21** further includes spider **59** which is attached to shell **58** to rotate therewith, the connection between the shell and spider preferably being an adjustable one, for reasons which will be later mentioned, and preferably taking the form of a threaded connection, shown at **60**, by which the spider is attached to the inner flange **58***a* of the shell. Spider **59** is composed of an inner hub which engages shell flange **58***a*, and an outer rim **61**, these two parts of the spider being connected by a number of spokes, as shown in Figs. 1 and 3, the open spoke formation being preferred to permit cutting fluid to drain through the spider.

Outer ring **62** forms a portion of drum **21**, and this ring is mounted on the rim **61** of spider **59**, the connection between the two members preferably taking the form of the threaded joint **63** extending around the periphery of the spider to provide adjustability between the two members. A number of lock screws **64** are placed at suitable intervals around drum ring **62** in positions to engage the upper edge of flange **58***b* of shell **58**. When screws **64** are turned down to frictionally engage the shell flange they lock the shell and outer ring together in any selected position and also serve to prevent unintended rotation of either or both the spider or ring **62** relative to each other or relative to shell **58**. Of course, any other suitable type of locking means may be used.

Spider **59** and ring **62** are each provided with fittings by which the blanks and their holders are mounted radially of drum **21**. Each blank **66** is held in an individual cartridge **67**. The cartridge is generally circular in cross-section and tapered longitudinally to approximately the same shape as the outside of the blank **66**. Cartridge **67** is open at one end so that the blank can be inserted and moved longitudinally

of the cartridge, and is likewise open at the top throughout its entire length so that the blank is exposed to cutting tool 18 for the facing operation. Cartridge 67 encloses or surrounds at least a portion of the circumference of blank 66, preferably more than half of it so that a firm grip is obtained upon the blank. The cartridge is also open on its under side near the tip end of the blank so that a quick setting, low tensile strength cement, for example pattern makers' cement, may be inserted around the tip of the blank and between it and the cartridge. This cement, shown at 68 in Figs. 8 and 9, fills in all spaces between the blank and the surrounding cartridge and forms a bed of material shaped to fit the blank which firmly holds the blank in place against rotation or any twisting movement in the cartridge. After the blank is completely faced, it is moved longitudinally out of the cartridge, the motion breaking it away from cement 68 which may then be cleaned out of the cartridge in preparation for using the latter again. Fig. 9 is taken near the tip of the mouthpiece and shows the side rails at either side of the throat opening.

The fitting carried on the hub of spider 59 for mounting a blank in place comprises a split plug 70 threaded into the spider hub and adapted to enter the throat of the blank as shown in Fig. 3. A cylindrical cup 71 is held between a shoulder on plug 70 and the outer face of the spider hub, cup 71 being of proper size to accommodate the exterior of blank 66. To mount the blank, the throat opening is placed over plug 70 and the blank forced into cup 71 compressing spring 72 which presses against the blank. The outer end of cartridge 67 is then lowered to bring it into alinement with lip 62*a* on outer ring 62 and the blank with its holder is permitted to move radially outward under pressure exerted by spring 72 until lip 62*a* seats in horizontal slot 73 of cartridge 67. Groove 73 extends the entire width of cartridge 67 so that the blank as a whole is held against rotation while spring 72 keeps the cartridge firmly seated against lip 62*a* at all times. The outer rim of spider 59 is provided with a number of pairs of lugs 74 properly spaced to fit snugly against the sides of cartridge 67, thus holding the cartridge against any circumferential movement around the spider when contact is had with cutting tool 18. Lip 62*a* is preferably continuous so that cartridges 67 can be mounted in any relative position of the spider and ring 62.

A variational form of fitting for mounting a blank on the hub of spider 59 is illustrated in Fig. 10. This telescope-type fitting comprises an inner sleeve 75 attached to the spider hub by a threaded stud, and an outer sleeve 77 which bears against compression spring 76 within sleeve 75. Since the outer sleeve has a diameter somewhat smaller than the diameter of the throat in blank 66, the outer sleeve is provided with a flared skirt 77*a* against which the end of the blank seats. The blank and cartridge are mounted by inserting sleeve 77 in the throat of the mouthpiece blank and compressing spring 76 sufficiently to permit groove 73 of the cartridge to engage lip 62*a* as described above. Skirt 77*a*, being conical, centers the mouthpiece with respect to the fitting, and has the further advantage that it will accommodate mouthpieces with any size of throat in the range between the minimum and maximum diameters of skirt 77*a*.

It is contemplated that in actual practice the mouthpiece blanks will be formed preliminarily to the approximate shape finally desired. This may be done by moulding the blanks, or by taking a roughing cut across the top of the blanks to form a preliminary face surface that gives approximately, say within a few thousandths of an inch, the final shape. Hence the blanks in the drawings are all shown as being ready for the final finishing cut.

After the blanks and cartridges are mounted in the drum, it may be desirable to adjust them with respect to the cutting tool. This is accomplished by first loosening lock screws 64. The spider 59 and ring 62 may then be raised or lowered together relative to tool 18, carrying all the mounted blanks bodily up or down, by turning spider 59 on threaded flange 58*a*. Because of the threaded connection 60, the spider as it rotates moves vertically relative to the flange. In a similar manner the thread at 63 can be used to tilt the blanks, since by turning ring 62 on spider 59, the ring alone may be relatively raised or lowered and to raise or lower the outer ends of the blanks and their cartridges.

At the left-hand end of base 10 is bridge 12 by which template 14 is supported in place. Bridge 12 comprises a pair of spaced upright end posts 78, only one of these end posts being shown in Figs. 2 and 5 as the other post is identical therewith. Carried by and between the top ends of posts 78 is cross bar 79 which has a longitudinally extending slot 79*a* opening to the top side of the bar and having inclined side walls as shown in Fig. 5. Mounted to slide longitudinally within the slot 79*a* is template clamp 80 in which template 14 is rigidly affixed. Clamp 80 has at each end a vertical slot 80*a* that extends longitudinally of the clamp for at least a portion of its length, though it may extend throughout the entire length of the clamp, becoming a single slot, that is, the clamp is formed in two separate halves. At each end of the clamp is a lock screw 81 threaded into a tapered bore. After the template and clamp have been moved longitudinally of cross bar 79 to place them in the desired position, lock screws 81 are then tightened and as a consequence of the forward movement of the screws in their tapered bores, the bottom wedge-shaped portion of the clamp is expanded and grips the tapered sides of the cross-bar slot 79*a*.

To enable the operator to exactly locate the template, upon one side of clamp 80 is engraved an index 82 and cross-bar 79 is provided with scale means as shown in Fig. 2, the scale being preferably graduated in inches and decimal fractions thereof. The scale may be engraved directly upon the cross-bar or it may be upon a separable member attached thereto. In order to accurately aline template 14 with index 82, both the template and clamp are provided with alining holes, the holes 82*a* in clamp 80 being placed exactly at index 82, and the hole in the template is preferably at the vertex of curved surface 14*b*. The template and index 82 are brought into precise registration by means of an alining pin (not shown) passing through these holes. This position of registration is then maintained by tightening clamp screws 83 which pass through the clamp and template, the template being a loose fit around screws 83.

It is desirable to utilize the open space beneath cross-bar 79 and between end posts 78 for storage of tools, loose parts, and any other suitable articles. For this purpose a pair of

covers 84 are hinged at 85 to an end post 78, covers 84 being placed one on each side of crossbar 79 and adapted to swing outwardly. Each cover may be provided with shelves or other means for forming storage compartments.

The top surface of template 14 has a flat horizontal portion 14a and a curved portion 14b, the latter bearing a definite mathematical relation to the curve which it is desired to impart to the cut face of the mouthpiece blank. It is in contact with this top surface of the template that follower 19 moves. In order to impart to cutting tool 18 the desired movement as determined by the motion of follower 19 over the template surface, follower 19 and tool 18 are interconnected by means of arm 17. As was described above, arm 17 is pivoted at or near one end by pin 31 on cradle 30. The connection between arm 17 and pivot pin 31 is here shown (Fig. 3) as including a pair of ball bearings within which pivot pin 31 is journaled and which are secured to arm 17 by means of a split circular shell 17a. The sides of shell 17a are contracted by means of bolts, not shown, to secure the bearings in place and pin 31 is shouldered as indicated so that the central portion of larger diameter prevents any sideways movement of arm 17 along the pivot pin. The longitudinal axis of arm 17 is parallel to the direction of cradle movement and perpendicular to the pivot axis, so that the cradle supports the arm for longitudinal movement of translation while the pivot permits swinging movement in a vertical arc.

The other end of arm 17 is attached to and supported by follower 19. The follower assembly includes rider 87 which is, as shown in Fig. 5, of generally U-shaped cross-section having at its upper end a bore adapted to receive the round end of arm 17 with sliding fit. Arm 17 is preferably provided with a rib along its lower side or other means to prevent rotation of the rider about the arm. Rotatably mounted in the two depending legs of rider 87 is roller 19 which is the follower that rolls over the top surface of template 14. It is preferred that follower 19 be a roller or similar member as shown in order to reduce friction as far as possible, but it is also within the scope of the invention to provide a fixed follower, such as a knife edge, which slides over the template surface. The sides of rider 87 extend below the template surface in order to stabilize the position of arm 17 and prevent it from being knocked sideways off the template.

Arm 17 is also provided with scale means as shown, preferably graduated in inches and decimal fractions thereof, so that the exact position of follower 19 on the arm can be definitely determined. On one side of rider 87 is placed an indexing cross hair 89 in exact vertical registration with the center of follower 19, the scale being visible underneath cross hair 89 so that the follower position can be determined by the scale. After rider 87 has been moved along arm 17 to any selected position, it is held fixed in the adjusted position by tightening clamp screws 90. Although the positions of template 14 and follower 19 can be independently ascertained and adjusted by reference to their respective associated scale means since both scales preferably have their zero point at the vertical axis of drum 21, it is more convenient to set both parts at once. To permit this the template and rider 87 are provided with bores 91 and 91a respectively. When these bores are brought into registration and a pin passed therethrough, the template and follower assemblies are locked together as one unit and movement between adjusted positions will be exactly equal for both units. This procedure simplifies adjustment of the parts. Bore 91 is in vertical alinement with index 82 and the vortex of curved surface 14b, and bores 91a are in vertical alinement with cross hair 89 so that when the template and follower assemblies are locked together, their indices are in vertical alinement.

At a position on arm 17 intermediate pivot 31 and follower 19 is placed cutting tool 18, although the scope of my invention includes placing the cutting tool and follower on opposite sides of the pivot 31. The tool-holding assembly is shown in detail in Fig. 4. This assembly comprises sleeve 93 externally threaded at 94 to fit within a threaded bore in arm 17 and internally threaded at 95 to receive the threaded upper end of shank 96. Tool 18 is held within shank 96 by means of set screws 97. The upper or bit end of tool 18 is preferably square in cross-section or otherwise shaped so that it can be held firmly and accurately within shank 96 without rotating therein, set screws 97 thus being relied upon only to keep the cutting tool from moving longitudinally within the holding shank.

The lower end of shank 96 is provided with a V-shaped slot 96a along one side; and lock screw 98 threaded into arm 17 has a sharp point engageable within slot 96a to keep shank 96 from rotating relative to the arm. At the same time vertical movement of the cutting tool is permitted since shank 96 can move longitudinally within the arm. Such vertical movement is required to allow adjustment of the cutting edge of the tool with respect to the blanks as they pass underneath the tool, and this movement is effected by turning sleeve 93. The outer and inner threads 94 and 95 on sleeve 93 are of different pitches so that the net movement of the cutting tool produced by each rotation of sleeve 93 is equal to the difference in pitch of the threads 94 and 95. Both threads are conventional right-hand threads and, in order that the cutting tool will move downwardly with right-hand rotation of sleeve 93, the inner thread is a finer one of smaller pitch than outer thread 94. After tool 18 has been adjusted to the proper height, sleeve 93 is locked against rotation by means of thumb screw 99, a block of wood or other relatively softer material being preferably interposed between the end of screw 99 and sleeve 93 as shown in Fig. 4 so that the sleeve threads will not be injured.

It will be realized that the cutting tool and the mounting therefor may take any one of a wide variety of forms. The mounting herein illustrated is preferred because it is readily adapted to commercially available tools of the type illustrated which have square bits; and also because the differential thread arrangement on sleeve 93 produces very small movement of the cutting tool for relatively large and easily ascertained movements of the adjusting sleeve 93. Obviously, the difference in pitches between threads 94 and 95 may be reduced to a very small value, so that any desired accuracy in the adjustment of the cutting tool can be obtained. Cutting tool 18 itself may be of any suitable material, as for example some commercial type of tool steel. However, greater accuracy and longer life can be obtained with a tool having a cutting edge formed by a tip of some very hard substance, as for example a commercial tungsten

carbide alloy. Consequently, a tool of this latter type is preferred.

Cutting fluid of a suitable nature is supplied to the forward cutting edge of a suitable nature is supplied to the forward cutting edge of tool 18 by nozzle 101 attached to the lower end of bore 102 extending vertically through arm 17. The cutting fluid is supplied to bore 102 by means of a flexible hose 103 from a pump or other source, not shown. The cutting fluid runs down off the blanks through the open spaces between the spokes of spider 59 and then into pan 106 through a series of drain holes 105 in shell 58. As shown in Fig. 3, pan 106 is in the form of an annular trough supported on a number of posts 107 (Fig. 3) resting at their lower ends on base 10. The cutting fluid drains from pan 106 through outlet hose 108 which preferably leads to a pump in order to provide continuous recirculation of the cutting fluid.

A depending annular flange is placed around the periphery of shell 58 as shown to keep the cutting fluid from splashing out of pan 106. In order to prevent the cutting fluid from working into the bearings for column 20, the rim of cap plate 26 has a depending flange and the hub of shell 20 has an upstanding flange, as seen in Figs. 3 and 6. The bearings within column 20 are further sealed by providing a felt washer 109 that fills the space between cap plate 26 and the upper end of column 20.

As has been described above, arm 17 is mounted to move longitudinally. It will be apparent from Fig. 6 that the longitudinal movement of arm 17 causes tool 18 to traverse the length of a mouthpiece blank 66 so that the successive material-removing cuts taken as the blank is carried past the tool move gradually outwardly toward the tip of the blank to form the transversely flattened face desired. This traversing movement of the tool is controlled by a rack and pinion arrangement which causes the entire arm and its supports to move longitudinally, cradle 30 moving along rails 28 and follower 19 moving over the top surface of template 14.

On the top surface of each side cover 38 is mounted a rack 110, and in engagement with each rack is a pinion 111 mounted upon a common shaft 112. Shaft 112 is driven by a motor and speed-reducing mechanism of any desired conventional design, the motor and speed reducer being carried on a frame 113 and enclosed within housing 114. The details of these pieces of apparatus are not shown since various types of mechanism commercially available may be used, but it is preferred to use mechanism which will produce a speed of revolution of pinion 111 of the order of three or four revolutions per hour, since with the proportions shown it only requires approximately one revolution of pinion 111 for tool 18 to traverse the entire length of a blank 66.

Motor frame 113 is mounted at its forward end to arm 17, preferably by means of a ball and socket joint at 115. This type of connection is preferred since it, together with the two pinions 111, provides a three-point support for the weight of the motor and frame and allows sufficient freedom of movement around a horizontal axis that the weight is distributed equally upon the two pinions. A further advantage of this construction is that pinions 111 may be readily disengaged from rack 110. At the rear end of frame 113 is placed a lift 118 by which the frame may be grasped and raised to swing it about ball and socket joint 115. This is done when arm 17 is to be moved back, that is, to the right as in Fig. 6, to start another cut across one or more mouthpiece blanks 66. Motor frame 113 is held against any lateral movement with respect to arm 17 and pinions 111 are alined with respect to their respective racks by a pair of guide pins 119 (Fig. 3) secured at their lower ends to arm 17. Suitably spaced bores are provided in lift 118 which fit over and engage pins 119 when the motor frame is lowered to engage the pinions with the racks.

Electric power is supplied through leads 121 (Fig. 1) to the main drive motor 53 and through leads 122 to the motor within housing 114. Because the electrical connections to these motors will be readily apparent to those skilled in the art, no electrical wiring diagram is illustrated. It is sufficient that a manually operated switch be placed in each of the electric lines 121 and 122 in order to control separately the supply of current to the two motors. However, it is entirely within the scope of the invention to interconnect the two motors or to make various other modifications in the electric circuit such as supplying automatic switches or relays for tripping the switches in order to prevent the cutting tool from overrunning.

It is desirable, though not necessary, to have measuring means indicating the exact position of cutting tool 18 so that the actual curve cut upon the mouthpiece will be indicated at all times during the cutting operation. For this purpose dial gauge 130 is attached to arm 17 in such a way that plunger 131 of the gauge rides over a polished plane surface on the top side of bar 132. Bar 132 is pivotally mounted at 133 to the upstanding leg of angle bracket 134 which is in turn attached to the upper end of post 135 bolted at its lower end to base 10. At each end of bar 132 is an adjusting screw 137 provided with a lock nut 138, and by means of these two adjusting screws the upper surface of bar 132 may be made accurately horizontal and parallel to the horizontal plane determined by rails 28. The position of cutting tool 18 along the longitudinal axis of arm 17 is indicated by pointer 140 attached to arm 17 and cooperating with fixed scale 141 attached to the lower leg of angle bracket 134. Scale 141 may have its zero placed at any convenient point, and in cooperation with pointer 140 indicates at any time the horizontal position or movement of tool 18. After dial gauge 139 has been set to zero with bar 132 in an absolutely horizontal position, vertical movement of tool 18 with reference to the datum plane established by bar 132 is indicated by the dial gauge. Although dial gauge 130 may read the actual movement of arm 17 at the gauge, it is more convenient to convert it to a direct reading instrument. This is easily done by locating the center of the gauge at exactly twice the distance from the pivot 31 that tool 18 is from pivot 31. Then by recalibrating the scale on gauge 130 to half its absolute value, the readings on the dial then give directly the actual vertical movement of tool 18.

From the foregoing structural description, it will be seen that certain general relations have been established between the several parts of the mechanism provided for facing the mouthpiece blanks. Arm 17 has two distinct movements, one of translation and one of rotation, that are both of relatively limited extent and lie

in a single vertical plane passing through the axis of arm 17 perpendicularly to the horizontal path of rotation of drum 21 and the blanks carried thereby. The rotational movement of the drum carries one or more blanks 66 past cutting tool 18, and the relative movement of the blanks and tool removes material from the blanks to produce the desired face on them; this drum movement may thus be termed a cut-producing movement. The arm movement of translation is horizontal and determined by the supports of arm 17, namely, cradle 30 and rider 87. Rails 28 confine cradle 30 and pivot 31 to movement only in a straight line in a horizontal plane, while template surface 14a likewise confines initial movement of rider 87 and follower 19 to horizontal movement parallel to rails 28. The top plane surface of bar 132 is adjusted to a horizontal position parallel to surfaces 14a and 28, and when in this position, dial 130 records no change as the arm moves along these guiding surfaces. In this way the alinement of these three parallel horizontal surfaces can be checked and it can be seen when the cutting edge of tool 18 is moving in a truly horizontal plane. This translatory movement of the cutting tool can be described as a traversing movement since its purpose is to cause the cutting tool to traverse the length of a blank 66 so that cuts on the blanks are successive and closely spaced. Because of the rigid interconnection between tool 18 and follower 19, the horizontal component of the tool movement represented by this translatory or traversing motion is at all times exactly equal to the horizontal component or translatory movement of the follower moving over the template.

While the movement of translation of arm 17 and the parts attached thereto continues to take place as the arm moves the follower over the curved surface 14b of the template, the movement of the arm during this latter stage is no longer only one of translation since there now occurs rotational movement of the arm about the axis of pivot 31. The curved surface 14b bears a definite mathematical relation to the curve desired to be cut on the mouthpiece blank, as will be further explained, but it will be seen that the curves of the template and the finished mouthpiece are not exact duplicates since the rotational movement of the cutting tool is less than the rotational movement of the follower as the former is closer to the center of rotation. The linear extent of this movement of the cutting tool and follower is determined by the distances a and b (Fig. 2) by which these elements are removed from the axis of pivot 31. Because these two lever arms are unequal in length, the tool movement will be a fixed fraction of the follower movement, the fraction being represented by the ratio a/b. Because the rotational movement of the cutting tool is of such small magnitude, it normally being of the order of two millimeters, it may be considered as simply the vertical component of the composite tool movement and as being perpendicular, or substantially so, to the horizontal component or traversing movement of the tool. Likewise, the rotational movement of follower 19 is described as being the vertical component of the follower movement.

Although it is not necessary to observe such a relation, it is decidedly advantageous that the axis of pivot 31, the cutting tip of tool 18, and a known point on the follower 19 lie in a common horizontal plane as indicated in Fig. 2 at 150. Such a construction greatly simplifies the arrangement of the parts, eliminates compensations and corrections otherwise required, and makes for greater accuracy in the final product. The follower point to be placed in plane 150 is a known point within the follower which it is desired to move over a predetermined path having a definite mathematical relation to the face curve to be produced on the mouthpiece blank. With a fixed follower, this point may be the point of contact of the follower with the template, and in this case template surface 14a lies also in plane 150; with a roller follower constructed as shown, the rotational axis of the follower is the point placed in plane 150. In the first instance, the curved surface 14b coincides with the predetermined path of the follower point; in the latter instance, curve 14b is preferably compensated slightly to produce the identical movement of the follower axis that would be had with the point of a fixed follower, such compensation arising from the fact that the arcuate path of the follower axis and the template surface 14b have a constantly changing vertical spacing between them and this change in the vertical distance between the template and the follower axis must be allowed for in producing the proper motion of the axis. Such compensation is preferred because with the roller follower, it is actually the curved path taken by the selected point on the follower that is reduced in vertical dimension to determine the shape of the mouthpiece curve, rather than the curve of the template itself, although the latter is referred to in the following description since the template produces the physical guiding surface and the axis path bears a fixed relation thereto.

The vertex of curve 14b where it joins flat 14a is alined vertically with index 82, and when the follower is directly above the template index, it is then ready to curve the mouthpiece face longitudinally upon added movement toward the left, that is, toward the tip of a blank as it passes under the cutting tool. Any movement of the template alone along the bridge has the effect of shifting bodily the location of the curve on the mouthpiece face by an equal distance, but the movement does not change the characteristic shape of the curve. The shape of the curve may be changed either by moving rider 87 alone with reference to the template or by moving the rider and template together, since by either of these movements the distance b is changed so that the value of the ratio a/b is altered. The shape of the cut face, although changed, still bears a definite similarity to the face produced before such movement of the follower, as will become apparent.

The construction described may be conveniently termed a semi-pantagraphic arrangement for transferring the predetermined curve on a standard template to the curve on the face cut in the mouthpiece blank. This is because, considering the template and the cut face as two mathematical curves, the distances along the X axis are equal, but the ordinates along the Y axis are reduced by the fixed fraction a/b. Although the distance a is not changeable in any given machine, the distance b may be varied over a considerable range as has been explained. The result is that within the physical limits of the dimension b, an infinite number of curves all belonging to the same mathematical family may be cut on mouthpiece blanks from a single standard template by the simple procedure of moving

the template and follower closer or farther from pivot 31.

The changes in shape of the face curves thus possible can be most easily described by analogy with the following example. Visualize a face curve formed using the distance *b* shown in the drawings, as being drawn upon a sheet of elastic material, such as rubber, held in a frame having rigid side pieces in such a manner that the sheet is placed under an initial tension along the Y axis alone, while there is no tension on the X axis. Moving the follower inwardly to shorten distance *b* has the effect of increasing the ratio *a/b* so that the vertical component of tool movement and consequently the ordinates of the curve produced are increased. This is comparable to spreading farther apart the top and bottom sides of the frame holding the elastic sheet so that all dimensions of the imaginary curve along the Y axis are proportionately increased without changing dimensions along the X axis. Movement of follower 18 outwardly on arm 17 reverses the procedure and decreases the ratio *a/b*. The proportionate movement of tool 13 is then less and is comparable to allowing the top and bottom sides of the frame to come nearer one another, thus shrinking the ordinates of the imaginary curve on the elastic sheet without changing the value of the dimensions along the X axis. As far as the mouthpiece blank itself is concerned, the final result of these changes is that the opening between the tip of the mouthpiece and the reed in its neutral position is respectively increased or decreased by moving follower 19 inwardly to decrease the distance *b* or moving it outwardly to increase distance *b*. All curves within the range that can be cut thus on a mouthpiece from a single standard template are similar to each other and to the template in that they follow the same general mathematical formula, but differ from each other in that the coefficients of the terms in the formula for the curve are changed progressively as the ratio *a/b* is changed.

Having described a preferred embodiment of my invention, it will be realized that changes in the design, arrangement, and location of parts may be made without departing from the scope of my invention; consequently it is to be understood that the foregoing description is to be considered as illustrative of, rather than limitative upon, the claims appended hereto.

I claim:

1. In a machine for cutting faces on blanks to form mouthpieces for musical instruments, the combination of a tool having a cutting edge; rotatable blank supporting means for mounting a blank in a predetermined position to engage the cutting tool; drive means rotating said supporting means to move the blank past the cutting edge of the tool to remove material from the blank and form a face thereon; cooperating template and follower means adapted to produce movement of a point within the follower over a path bearing a mathematical relation to the contour desired for the mouthpiece face; and rigid means interconnecting said follower and cutting tool so arranged that one component of the cutting edge movement is equal to the corresponding component of movement of said follower point and the other component of the cutting edge movement at right angles to the first-mentioned component is a predetermined fixed fraction of the corresponding other component of movement of said follower point.

2. In a machine for cutting faces on blanks to form mouthpieces for musical instruments, the combination of a tool having a cutting edge; rotatable blank supporting means for mounting a blank in a predetermined position to engage the cutting tool; drive means rotating said supporting means to move the blank past the cutting edge of the tool to remove material from the blank and form a face thereon; cooperating template and follower means adapted to produce movement of a point within the follower over a path bearing a mathematical relation to the contour desired for the mouthpiece face; and a rigid arm rigidly interconnecting the follower and the cutting tool, said arm having a pivotal mounting on a support capable of linear movement only and carrying the tool at a fixed position closer to the pivotal mounting than the follower is to the pivotal mounting, all so arranged that one component of movement of said follower point moves the arm longitudinally and produces a similar and equal component of movement of the cutting edge and the other component of movement of said follower point at right angles to the first-mentioned component produces a similar component of movement of the cutting edge proportional to the ratio between the fixed distances of the tool and the follower from the arm pivot.

3. In a machine for cutting faces on blanks to form mouthpieces for musical instruments, the combination of a tool having a cutting edge; rotatable blank supporting means for mounting a blank in a radial position thereon to engage the tool; drive means rotating said supporting means to move the whole blank intermittently past the cutting edge of the tool to remove material from the blank and form a face thereon; a fixed template having a curved surface bearing a mathematical relation to the curve desired for the mouthpiece face; a follower movable linearly over the template surface; and a rigid member imparting to the tool movement governed by the movement of the follower over the template surface.

4. In a machine for cutting faces on blanks to form mouthpieces for musical instruments, the combination of a tool having a cutting edge; a rotatable drum mounting a plurality of blanks in radial positions thereon to engage the tool; drive means rotating the drum to move the blanks successively past the cutting edge of the tool to remove material from the blanks and form similar faces thereon; a fixed template having a curved surface bearing a mathematical relation to the curve desired for each mouthpiece face; a follower movable linearly over the template surface; and a rigid member imparting to the tool movement governed by the movement of the follower over the template surface.

5. In a machine for cutting faces on blanks to form mouthpieces for musical instruments, the combination of a tool having a cutting edge; rotatable blank supporting means for mounting a blank in a predetermined position to engage the cutting tool; drive means rotating said supporting means to move the blank past the cutting edge of the tool to remove material from the blank and form a face thereon; a template having a curved surface bearing a mathematical relation to the curve desired for the mouthpiece face; a follower movable over the template surface; a member imparting to the tool movement governed by the movement of the follower over the template surface; and an indicating gauge secured to the last-mentioned member indicat-

ing the movement of said member from a fixed datum plane.

6. In a machine for cutting faces on blanks to form mouthpieces for musical instruments, the combination of a base; a post attached to the base; a pair of rails secured to the post; a cradle mounted to move along and be guided by the rails; an arm pivotally mounted on the cradle; a template having a curved surface having a mathematical relation to the curve desired for the mouthpiece face; a follower attached to the arm and riding over the template; a cutting tool carried by the arm; a column rotatably mounted on the base and concentric with the post; a blank support on the column for supporting a blank in position for engagement with the tool; drive means to rotate the column and blank support; and means to move the arm and cradle along the rails radially of the blank support.

7. In a machine for cutting faces on blanks to form mouthpieces for musical instruments, the combination of a tool having a cutting edge; a rotatable drum mounting a plurality of blanks in position to engage the tool, said drum comprising a rotatably mounted shell, a spider adjustably mounted on the shell to rotate therewith, a ring adjustably mounted on the spider, locking means on the ring engaging the shell to hold the spider and ring against movement relative thereto, fittings on the spider adapted to support one end of a blank, and fittings on the ring adapted to support the opposite end of a blank in a position radially of the drum; drive means rotating the drum to move the blanks successively past the cutting edge of the tool to remove material from the blanks and form similar faces thereon; a template having a curved surface bearing a mathematical relation to the curve desired for each mouthpiece face; a follower movable over the template surface; and a member imparting to the tool movement governed by the movement of the follower over the template surface.

8. In a machine for cutting faces on blanks to form mouthpieces for musical instruments, the combination of a tool having a cutting edge; rotatable means for mounting a blank in position to engage the tool; said rotatable means comprising a rotatably mounted shell, a spider adjustably mounted on the shell to rotate therewith, a ring adjustably mounted on the spider, locking means on the ring engaging the shell to hold the spider and ring against movement relative thereto, a cartridge enclosing a portion of the mouthpiece blank and open for its entire length for a portion of its circumference, cementing means around a portion of the mouthpiece blank engaging the cartridge to hold the blank firmly against rotational movement within the cartridge, fittings on the spider adapted to support one end of the blank, and fittings on the ring adapted to support the opposite end of the blank; drive means rotating the blank mounting means to move the blank past the cutting edge of the tool to form a face thereon; a template having a curved surface bearing a mathematical relation to the curve desired for said mouthpiece face; a follower movable over the template surface; and a member imparting to the tool movement governed by the movement of the follower over the template surface.

9. In a machine for cutting faces on blanks to form mouthpieces for musical instruments, the combination of a tool having a cutting edge; a rotatable drum mounting a plurality of blanks in position to engage the tool, said drum comprising a rotatably mounted shell, a spider adjustably mounted on the shell to rotate therewith, a ring adjustably mounted on the spider, locking means on the ring engaging the shell to hold the spider and ring against movement relative thereto, a plurality of cartridges each enclosing a portion of a mouthpiece blank and open for its entire length for a portion of its circumference, cementing means in each cartridge around a portion of the enclosed mouthpiece blank engaging the cartridge to hold the blank firmly against rotational movement within the cartridge, fittings on the spider adapted to engage the outer ends of each blank, and fittings on the ring adapted to engage the inner ends of each cartridge to mount the blanks in positions radial of the drum; drive means rotating the drum to move the blanks successively past the cutting edge of the tool to remove material from the blanks and form similar faces thereon; a template having a curved surface bearing a mathematical relation to the curve desired for each mouthpiece face; a follower movable over the template surface; and a member imparting to the tool movement governed by the movement of the follower over the template surface.

10. In a machine for cutting faces on blanks to form mouthpieces for musical instruments, the combination of a tool having a cutting edge; a rotatable blank support mounting the blank to engage intermittently the cutting tool and moving the blank past the tool in a circular path having its center outside the blank; a template having a curved surface bearing a mathematical relation to the curve desired for the mouthpiece face; a followed movable over the template surface; a rigid arm extending radially of the blank support and mounted for longitudinal movement, the follower and cutting tool being mounted on said arm at fixed positions relative to each other, said arm imparting to the tool movement over a curved path; and drive means for rotating the blank support and for moving the arm.

11. In a machine for cutting faces on blanks to form mouthpieces for musical instruments, the combination of a tool having a cutting edge; a rotatable blank support mounting the blank to engage intermittently the cutting tool and moving the blank past the tool in a circular path having its center outside the blank; a template having a curved surface bearing a mathematical relation to the curve desired for the mouthpiece face; a follower movable over the template surface; a rigid arm extending radially of the blank support, the follower being attached to the arm near one end and the cutting tool being attached to the arm intermediate the ends at positions fixed with respect to each other; a traveling pivot supporting the other end of the arm at a fixed point on the arm and capable with the arm of linear movement longitudinally of the arm to move the follower over the template, said arm imparting to the tool movement over a curved path; and drive means for rotating the blank support and for moving the arm.

12. In a machine for cutting faces on blanks to form mouthpieces for musical instruments, the combination of a tool having a cutting edge; blank supporting means rotatable about a vertical axis and holding a blank with the longitudinal axis of the blank substantially horizontal and radial of the supporting means; drive means rotating the blank supporting means to move the

blank in a substantially horizontal circular path past the cutting edge of the tool to form a face on the blank; a template having a vertically curved surface bearing a mathematical relation to the curve desired for the mouthpiece face; a follower movable over the template surface; a rigid arm carrying the cutting tool and follower at fixed positions thereon to move the tool vertically in a direction perpendicular to both said movement of the blank and the longitudinal axis of the blank to curve the mouthpiece face; means including said follower supporting the arm near each end for longitudinal linear movement and vertical pivotal movement about a pivot fixed with respect to the follower and cutting tool; and means moving the arm longitudinally to move the tool longitudinally of the blank and to move the follower over the template.

HARRY H. CANTERBURY.

CERTIFICATE OF CORRECTION.

Patent No. 2,225,154. December 17, 1940.

HARRY H. CANTERBURY.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 1, second column, line 45, for the word "longitudinally" read --longitudinal--; page 2, first column, line 21, for "postiion" read --position--; line 55; for "November" read --December--; page 5, second column, line 6, for "vortex" read --vertex--; page 6, first column, lines 4 and 5, strike out "of a suitable nature is supplied to the forward cutting edge"; 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 11th day of February, A. D. 1941.

Henry Van Arsdale,
Acting Commissioner of Patents.

(Seal)