July 4, 1944. C. E. ARCHER 2,352,608

BLANK SHAPING FIXTURE

Filed Oct. 15, 1942 2 Sheets-Sheet 1

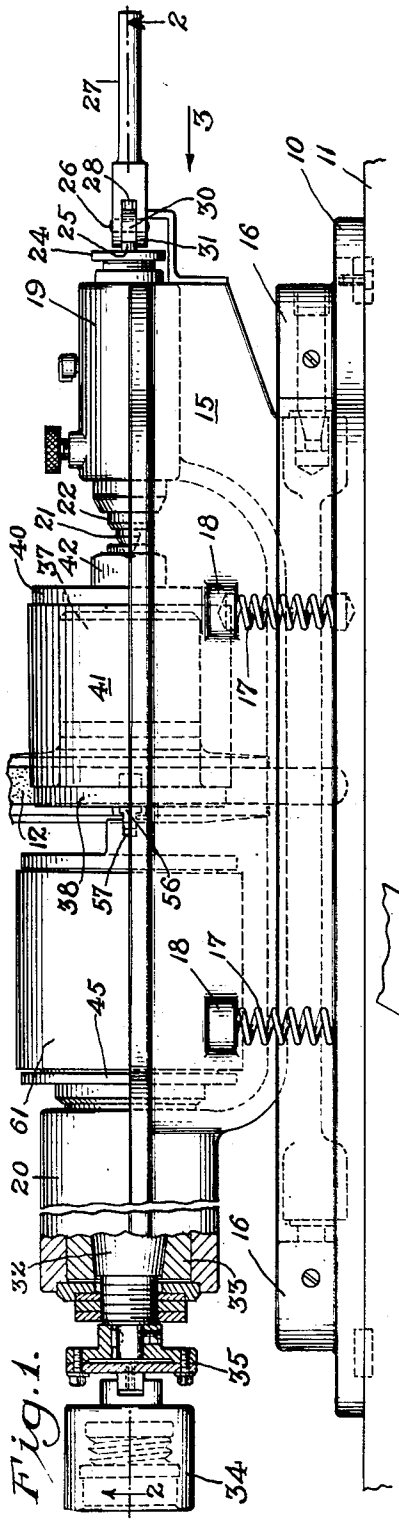


Fig. 1.

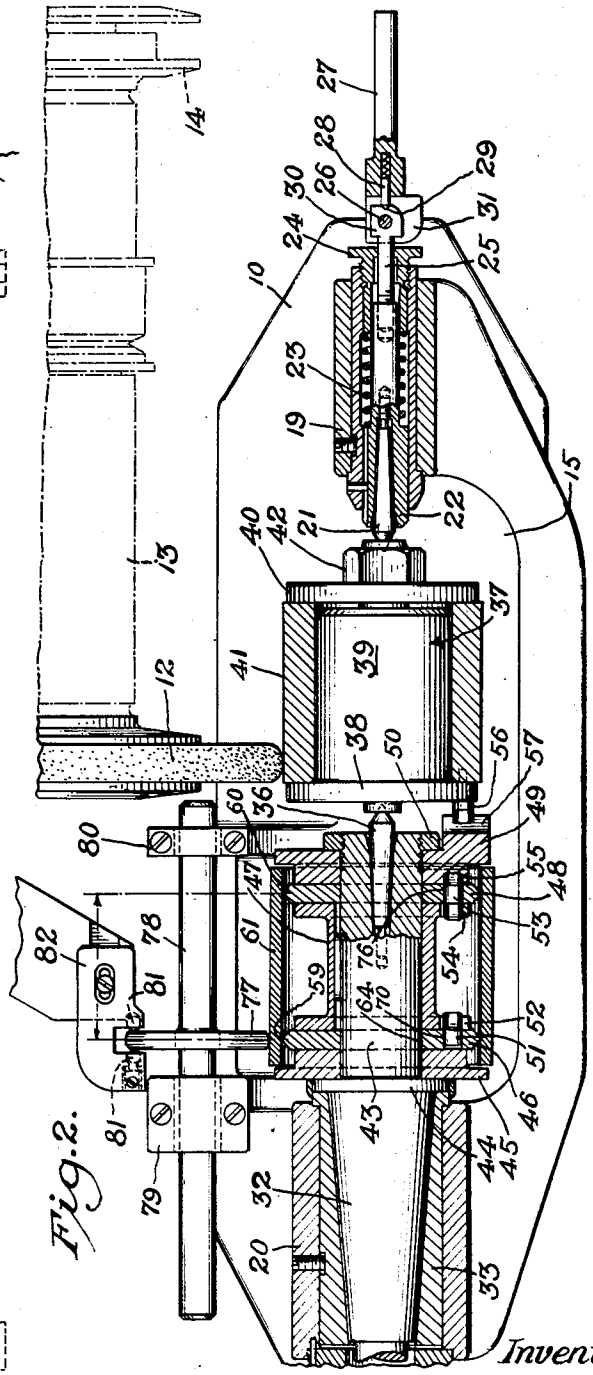


Fig. 2.

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Filed Oct. 15, 1942 2 Sheets-Sheet 2

Fig. 3.

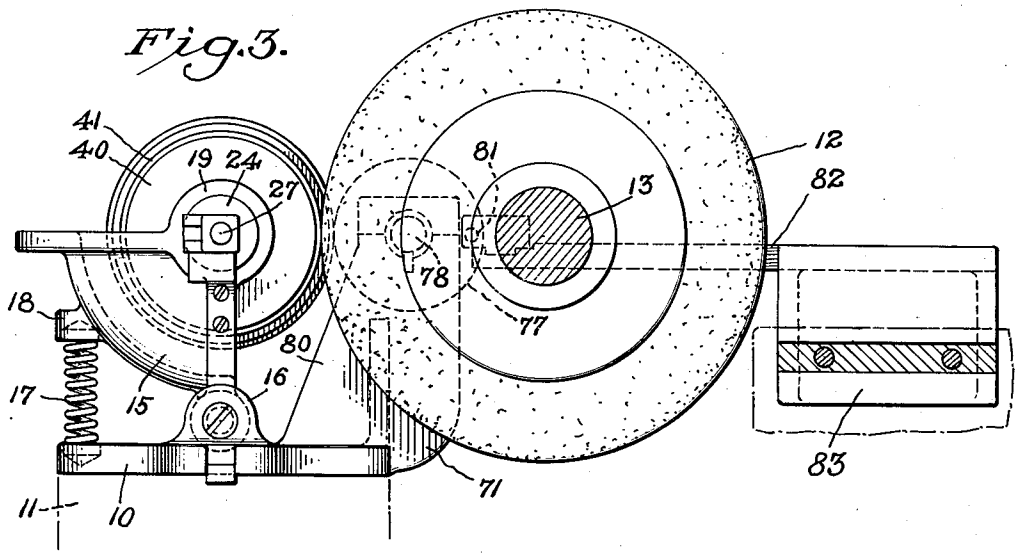


Fig. 4.

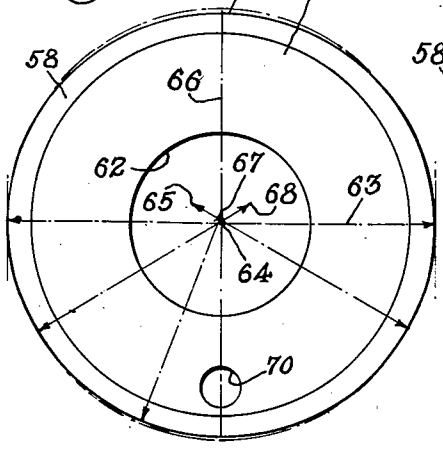


Fig. 6.

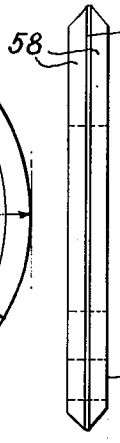
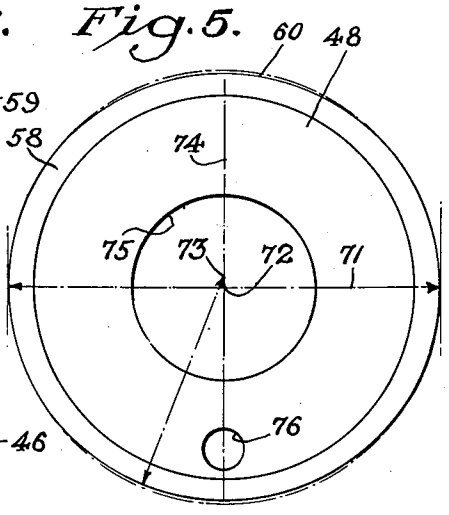


Fig. 5.



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Patented July 4, 1944 2,352,608

UNITED STATES PATENT OFFICE

2,352,608

BLANK SHAPING FIXTURE

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Application October 15, 1942, Serial No. 462,128

16 Claims. (Cl. 51—101)

My invention relates to a blank shaping fixture and more particularly to a fixture for developing master cams which are employed to control certain relative movements of a turning tool or a grinding wheel and a rotating piston in the precision production of pistons for internal combustion engines.

In high specific output engines, such as those for airplanes, the piston, which is of the solid skirt type as distinguished from a split skirt type, fits the cylinder more loosely when cold than at normal operating temperature, and it is necessary in shaping the piston to allow for this expanding action to avoid undue friction and excessive wear of the piston and cylinder wall. It is desired that the piston be truly cylindrical at the operating temperature, but it has been ascertained that due to its relative remoteness from the coolant or the air cooling fins and the differences in rigidity of the head and skirt ends, the piston is subject to substantial changes in shape over the range from atmospheric to operating temperature. In other words, a piston which is cylindrical at operating temperature has a shape other than cylindrical at atmospheric temperature and this shape will generally vary from end to end of the piston. The development of master cams for determining the "cold" shape of this piston has been a serious problem.

The required shape of the piston can only be determined empirically and it has been found that, in general, the shape of the ring groove end at atmospheric temperature will differ from the shape of the skirt end. Neither end is truly circular and their respective peripheries are composed of a plurality of circular arcs, some of which are struck from centers eccentric to the geometric axis of the piston. Because the piston is straight-sided, it is important that the longitudinal elements composing the lateral surface of the piston shall be straight lines extending between the ends of the piston. These elements are defined by the intersection with the piston lateral surface of planes passing through the longitudinal axis of the piston.

I take advantage of the foregoing factors in providing a former cam which can be used to produce master cams for piston production, and the construction of the former cam constitutes one of the objects of my invention. Its arrangement depends upon the recognition that, by reason of the straight line characteristic of the piston side wall, as defined above, the end shapes of the piston constitute limiting factors. It is only necessary, therefore, to make a former cam ring for each piston end whose profile may be a dimensional duplicate, or larger or smaller than the corresponding piston end according to some ratio, and to freely surround and bridge between these rings a beam-like element which also has a straight line characteristic, such as a cylindrical sleeve having concentric inner and outer surfaces.

When the rings are mounted for simultaneous rotation around a common axis and are related to each other in the same manner as the corresponding piston ends, it will be obvious that transverse shifts of the sleeve by the cam rings rotating within the sleeve can be translated into a movement of a master cam blank towards and away from a grinding wheel or turning tool, for example, or of the wheel or tool relative to the blank. Movement of that portion of the sleeve opposite either cam ring will be controlled by that ring and will accordingly result in a similar shaping of the corresponding end of the blank, while movements of intermediate portions of the sleeve will be effected by the conjoint action of the rings.

A further object is to provide a fixture incorporating the above former cam which is capable of being mounted on the shiftable table of a standard grinding machine and is adapted to either form master cam blanks for subsequent use in other turning or grinding machines, or to directly process pistons.

These and further objects of my invention will be set forth in the following specification, reference being had to the accompanying drawings, and the novel means by which said objects are effectuated will be definitely pointed out in the claims.

In the drawings:

Figure 1 is a side elevation of my improved fixture, partly in section, showing the same in working relation to a grinding machine.

Fig. 2 is a section along the line 2—2 in Fig. 1.

Fig. 3 is an end view of the fixture looking in the direction of the arrow 3 in Fig. 1.

Figs. 4 and 5 are elevations of two of the former cam rings utilized in my fixture.

Fig. 6 is an edgewise view of either of the rings shown in Figs. 4 and 5, but for purpose of description will be regarded as a view of the ring shown in Fig. 4.

By way of example, my inproved fixture is shown in connection with a standard metal removing machine and comprises a bed plate 10 keyed or otherwise secured to a table 11 of the

machine. The table is given a reciprocating or traversing movement relative to a cutting tool 12 which is secured to a spindle 13 that is driven by a pulley 14 forming part of the machine. The cutting tool may be of any suitable character, and in the present instance is shown as a grinding wheel, the fixture forming part of a grinding machine.

A cradle 15 is rockably mounted on a pair of bearings 16 secured to the bed plate 10, and is urged in a clockwise direction as viewed in Fig. 3, i. e., toward the grinding wheel 12, by means of springs 17 whose lower ends rest on the bed plate 10 while the upper ends extend within pockets 18 forming part of the cradle 15.

The cradle 15 is provided with a tailstock 19 and a headstock 20 which are spaced from each other as illustrated in Figs. 1 and 2 to receive therebetween a former cam and the work to be shaped as hereinafter described. A tail center 21 is mounted in a plunger 22 that is reciprocable within the tailstock 19, but is held against rotation relative thereto and is normally urged toward the left, as viewed in Fig. 2, by a helical spring 23 adjustably loaded by a bushing 24 threaded interiorly of the tailstock. A stem 25 has one end threaded in the plunger 22 and extends outwardly through the head of the bushing 24 for pivotal connection by means of a pin 26 with a release handle 27. When the tail center 21 is in the work engaging position illustrated in Fig. 2, the handle 27 is held in position by means of a spring actuated detent pin 28 that seats in a recess 29 provided in a head 30 forming part of the stem 25. The handle 27 is also provided with a cam surface 31 which, when the handle 27 is rocked downwardly from the position shown in Fig. 2, bears against the end surface of the bushing 24, and thereby withdraws the plunger 22 and the associated tail center 21 toward the right, or in a releasing direction.

The tapered end of a spindle 32 is journaled in bearings 33 in the headstock 20 and extends leftward beyond the latter for connection by means of a universal coupling 35 to a driving head 34 forming part of the grinding machine, thus permitting rocking movement of the cradle 15. The right end of the spindle 32 carries a live center 36 between which and the tail center 21 is supported an arbor 37 comprising an integrally formed flange 38 and cylindrical body 39 and a disk 40. A cam blank 41 is slipped over the body 39 and is clamped between the flange 38 and disk 40 by a nut 42 that is threaded on the right end of the arbor 37.

That portion of the spindle 32 which extends to the right of the headstock 20 is cylindrical, as indicated by the numeral 43, and at the junction of the spindle portions 32 and 43 is formed a flange 44. Between the flange 44 and the right end of the spindle portion 43 is mounted a former cam assembly which constitutes one of the features of my invention. In succession and beginning at the flange 44, this cam assembly comprises a disk 45, a cam ring 46, a spacerspool 47 keyed to the portion 43, a cam ring 48, a disk 49 and a nut 50 which is threaded on the right end of the portion 43 and serves to clamp the indicated parts of the cam assembly against the flange 44. The cam ring 46 carries a pin 51 which is received within a slot 52 provided in the adjacent end of the spool 47, while the cam ring 48 carries a pin 53 whose opposite ends are respectively received in a solt 54 provided in an adjacent end of the spood 47 and a slot 55 in the disk 49. The pins 51 and 53 accordingly register the cam rings with respect to the spool 47 and hence with respect to each other. Driving engagement with the arbor 37 is secured by a pin 56 mounted in the flange 38, one end of which extends into a slot 57 provided in the adjacent side of the disk 49 while the opposite end seats in cam blank 41 thereby registering this blank relative to the cam rings 46 and 48.

The peripheral surface of the cam ring 46 is symmetrically beveled as indicated by the numeral 58 in Fig. 6 to provide a land 59 centrally disposed between the opposite faces or flanks of the ring. A similar land 60 is likewise formed around the cam ring 48 and freely surrounding and bridged between these lands in a cylindrical sleeve 61 having concentric inner and outer surfaces. Endwise movement of the sleeve 61 relative to the cam rings is prevented by the disks 45 and 49 which are appropriately shouldered for this purpose, but the ends of the sleeve 61 are not gripped by the disks 45 and 49.

The cam ring 46 is intended to serve as a guide for shaping the left end of the blank 41, while the ring 48 serves a similar purpose in connection with the right end thereof. When used to process a piston having the characteristics above described, the shaped left end of the blank would control the shaping of the piston adjacent the skirt end, while the shaped right end of the blank would control the shaping of the piston at the ring groove end.

The ring 46 is provided with a circular axial opening 62 having a diameter sufficient to provide a snug fit on the spindle portion 43. For reasons noted, the periphery of the land 59 is not circular, but is composed of a plurality of arcs which are struck from centers that are determined empirically. Since the curvature of one-half of the land 59 is identical with the other half it will be convenient to consider this shaping with respect to that portion of the ring 46 which is disposed below the horizontal diameter 63 in Fig. 4. Moving clockwise around the ring beginning at the right end of the diameter 63, the land 59 is successively composed of arcs struck from the geometric center 64 of the ring, a center 65 above the diameter 63 and to the left of a diameter 66 normal thereto, a center 67 above the diameter 63 and on the diameter 66, a center 68 located above the diameter 63 and to the right of the diameter 66, and finally an arc struck from the geometric center 64. The foregoing centers are appropriately duplicated and correspondingly arranged for the arcs of the land 59 in the upper half of the ring 46. The ring also includes an aperture 70 in which is mounted the registering pin 51 to which reference has already been made.

The peripheral shape of the land 60 for the ring 48 is somewhat simpler for the condition specified, since it is intended to form that end of the blank 41 which will shape the head end of the piston. Due to its more rigid construction, the head end is less subject to deformation over the temperature range from atmospheric to operating. As before, the land shape is duplicated on opposite sides of any given diameter of the ring and, considering the horizontal diameter 71 in Fig. 51 as a starting point and directing attention to the lower half of the ring, moving clockwise from the right end of the diameter 71, the land is composed of arcs successively struck from the geometric center 72 of the ring, a center 73 disposed above the diameter 71 and on the

diameter 74 normal thereto and finally from the geometric center 72. The arcs for the upper half of the land 60 would be similarly formed and, in this connection, a center corresponding to the center 73 would be located on the diameter 74 below the diameter 71. The ring 48 also includes a circular aperture 75 concentric with the center 72 and whose diameter is such that the ring 48 fits the spindle portion 43 snugly and also includes an aperture 76 which receives the registering pin 53.

It will be understood that the centers for the several arcs above described for both cam rings may vary for different designs of pistons or for any type of master cam or other blank or part which it is desired to form.

A disk 77 rides on the outer surface of the sleeve 61 and is secured to a shaft 78 that is supported for rotary and endwise movement in and relative to bearings 79 and 80 carried by the bed plate 10. The disk 77 is held against endwise movement by means of a pair of balls 81 which straddle and bear on the opposite face of the disk 77 and are carried in an arm 82 that is supported by a fixed part 83 of the grinding machine.

From the foregoing, it will be understood that as the spindle 32 rotates, the table 11 is given a motion of reciprocation and traverse relative to the grinding wheel 12 so that cam blank 41 and sleeve 61 similarly move with respect to the wheel 12 and the disk 77 and the springs 17 constantly bear the blank 41 against the wheel 12 and the sleeve 61 against the disk 77. If it be considered that the fixture is employed to shape the cam blank 41 for the subsequent processing of pistons of the character described and that the cam rings 46 and 48 have peripheral shapes corresponding to the portions of the piston lateral surface adjacent the skirt and head ends, respectively, it will be obvious that when the disk 77 is opposite the ring 46, the left end of the cam blank 41 will have imparted thereto a shape similar to the shape of the cam ring 46 and when the disk 77 is opposite the cam ring 48, the right end of the blank 41 will be shaped similar to the last mentioned cam ring. During this operation, the free relation between the sleeve 61 and rings 46 and 48 is effective, in conjunction with the springs 17, to rock the cradle 15, thereby varying the distance between the axes of the wheel 12 and the blank 41. The sleeve 61 is internally cylindrical and, therefore, cannot have full peripheral contact with either of the cams. Due to the biasing force of the springs 17, the cam follower 77 will cause the inside longitudinal straight line element of the sleeve 61 to contact the peripheries of the cams 46 and 48 in the axial plane of rotation as shown by Fig. 2. There is a relative floating movement or adaptation of the sleeve transaxially in each increment of rotation of the cams 46 and 48 as determined by the shapes of the cams, and the conjoint action thereof serves to define a straight line element in any angular position of rotation defining the form at all longitudinal points between the cams. Accordingly, the shaping of the blank 41 is accomplished by a combination of two movements: one longitudinally of the blank axis and across the peripheral surface of the grinding wheel, and the other transversely of the blank axis.

An important feature of the invention resides in the recognition that since it is desired that that piston be straight-sided, the end shapes of the piston constitute limiting factors, regardless of their particular forms and whether or not symmetrically related, and intermediate shapes can be precisely obtained by means of the straight-sided sleeve 61. In other words, when the disk 77 rides any portion of the sleeve 61 between the rings 46 and 48, the shape which is thereby given to the corresponding portion of the cam blank 41 is a function of the conjoint action of the rings 46 and 48.

It will be further understood that while my improved fixture is more directly intended for the production of cam blanks that are subsequently used in other machines for the final processing of pistons, such pistons may be shaped directly in my fixture by substituting the same for the cam blank 41.

I claim as my invention:

1. A blank shaping fixture for mounting on a machine having a material removing tool comprising a carrier, the tool and carrier being arranged for relative traverse and movements toward and from each other, means on the carrier for rotatably supporting a blank for shaping in contact with the tool, and a rotary former cam for controlling said to and fro movement during said relative traverse comprising a pair of spaced cam rings having peripheral shapes similar to the final shaping of the respective ends of the blank and a sleeve freely encircling and bridged between the rings.

2. A blank shaping fixture for mounting on a machine having a material removing tool comprising a carrier, the tool and carrier being arranged for relative traverse and movements toward and from each other, means on the carrier for rotatably supporting a blank for shaping in contact with the tool, and a rotary former cam for controlling said to and fro movement during said relative traverse comprising a pair of spaced cam rings having peripheral shapes similar to the final shaping of the respective ends of the blank and a cylindrical sleeve having concentric inner and outer surfaces freely encircling and bridged between the rings.

3. A blank shaping fixture for mounting on a machine having a material removing tool comprising a carrier, the tool and carrier being arranged for relative traverse, means on the carrier for rotatably supporting a blank for shaping in contact with the tool, a rotary former cam on the carrier comprising a pair of spaced cam rings having peripheral shapes similar to the final shaping of the respective ends of the blank, a sleeve freely encircling and bridged between the rings, and a part cooperating with the sleeve for effecting a relative to and fro movement of the carrier and tool during traverse.

4. A blank shaping fixture for mounting on a machine having a material removing tool comprising a carrier, the tool and carrier being arranged for relative traverse, means on the carrier for rotatably supporting a blank for shaping in contact with the tool, a rotary former cam comprising a pair of spaced cam rings having peripheral shapes similar to the final shaping of the respective ends of the blank, a cylindrical sleeve having concentric inner and outer surfaces freely encircling and bridged betwen the rings, and a part cooperating with the sleeve for effecting a relative to and fro movement of the carrier and tool during traverse.

5. A blank shaping fixture for mounting on a machine having a material removing tool comprising a bed traversable relative to the tool, a carrier rockable on the bed, means on the carrier for rotatably supporting a blank for shap-

ing, spring means active against the carrier for resiliently holding the blank in contact with the tool, a rotary former cam on the carrier comprising a pair of spaced cam rings having peripheral shapes similar to the final shaping of the respective ends of the blank, a sleeve freely encircling and bridged between the rings, and a part cooperating with the sleeve and held against traversing movement relative to the tool for effecting a to and fro movement of the carrier relative to the tool.

6. A blank shaping fixture for mounting on a machine having a material removing tool comprising a bed traversable relative to the tool, a carrier rockable on the bed, means on the carrier for rotatably supporting a blank for shaping, spring means active against the carrier for resiliently holding the blank in contact with the tool, a rotary former cam on the carrier comprising a pair of spaced cam rings having peripheral shapes similar to the final shaping of the respective ends of the blank, a cylindrical sleeve having concentric inner and outer surfaces and freely encircling and bridged between the rings, and a part cooperating with the sleeve and held against traversing movement relative to the tool for effecting a to and fro movement of the carrier relative to the tool.

7. A blank shaping fixture for mounting on a machine having a material removing tool comprising a bed traversable relative to the tool, a carrier rockable on the bed and biased toward the tool, means on the carrier for rotatably supporting a blank for shaping in contact with the tool, a rotary former cam on the carrier comprising a pair of spaced cam rings having peripheral shapes similar to the final shaping of the respective ends of the blank, a sleeve freely encircling and bridged between the rings, and a rotatable disk riding on the periphery of the sleeve and held against traverse relative to the tool for effecting a to and fro movement of the carrier relative to the tool.

8. In mechanism for shaping the peripheral surface of a blank, the combination of a material removing tool, a carrier, means on the carrier for rotatably supporting a blank for shaping in contact with the tool, means for relatively traversing the tool and carrier, a rotary former cam on the carrier comprising a pair of spaced cam rings having peripheral shapes similar to the final shaping of the respective ends of the blank, a sleeve freely encircling and bridged between the rings, and a part cooperating with the sleeve and held against traverse relative to the tool for effecting a to and fro movement of the carrier relative to the tool.

9. In mechanism for shaping the peripheral surface of a blank, the combination of a material removing tool, a carrier, means on the carrier for rotatably supporting a blank for shaping in contact with the tool, means for relatively traversing the tool and carrier, a rotary former cam on the carrier comprising a pair of spaced cam rings having peripheral shapes similar to the final shaping of the respective ends of the blank, a cylindrical sleeve having concentric inner and outer surfaces freely encircling and bridged between the rings, and a part cooperating with the sleeve and held against traverse relative to the tool for effecting a to and fro movement of the carrier relative to the tool.

10. Former cam means for controlling the relative to and fro movement of a material removing tool and a blank whose peripheral surface is to be shaped, comprising a pair of spaced cam rings having peripheral shapes similar to the final shaping of the respective ends of the blank, and a radially floating sleeve freely encircling and bridged between the rings for engagement with a part traversable relative to the sleeve.

11. Former cam means for controlling the relative to and fro movements of a material removing tool and a blank whose peripheral surface is to be shaped, comprising a pair of spaced cam rings having peripheral shapes similar to the final shaping of the respective ends of the blank, and a cylindrical sleeve having concentric inner and outer surfaces freely encircling and bridged between the rings for engagement with a part traversable relative to the sleeve.

12. A blank shaping fixture for mounting on a machine having a material removing tool comprising a bed traversable relative to the tool axially of the blank, a carrier on said bed movable transversely toward and from the tool and being biased in one direction, means on said carrier for rotatably supporting a blank for shaping in contact with the tool, a former cam rotatable on the carrier in timed relation with the blank and comprising a pair of axially spaced rotary cams having different peripheral shapes corresponding to the form to be produced respectively on the opposite ends of the blank, a cylindrical sleeve encircling said cams and adapted for internal contact therewith, a cam follower held against traverse relative to the tool and engaging the outer periphery of said sleeve to determine the position of said carrier in opposition to the biasing force, said sleeve being confined against longitudinal movement relative to said cams and being traversable with the blank relative to said follower in a direction axially of the blank, whereby said follower will cause successive longitudinal straight line elements of said sleeve to contact and bridge said cams so as to define the form throughout the length of the blank as determined by the respective shapes of said cams.

13. A blank shaping fixture for mounting on a machine having a material removing tool comprising a bed traversable relative to the tool axially of the tool, a carrier on said bed movable transversely toward and from the tool and being biased in one direction, means on said carrier for rotatably supporting a blank for shaping in contact with the tool, a former cam rotatable on the carrier in timed relation with the blank and comprising a pair of axially spaced rotary cams independently rotatably adjustable to vary their relative angular phase and having unlike peripheral shapes corresponding to the form to be produced respectively on the opposite ends of the blank, a sleeve of transversely symmetrical form encircling said cams and adapted for internal contact therewith along longitudinal straight line elements, a cam follower held against traverse relative to the tool and engaging the outer periphery of said sleeve to determine the position of said carrier in opposition to the biasing force, said sleeve and cams being traversable with the blank relative to said follower in a direction axially of the blank, whereby said follower will cause successive longitudinal straight line elements of said sleeve to contact and bridge said cams so as to define the form throughout the length of the blank as determined by the respective shapes of said cams.

14. A blank shaping fixture for mounting on a machine having a material removing tool comprising a bed traversable relative to the tool, a

carrier on said bed movable transversely toward and from the tool and being biased in one direction, means including a drive shaft on said carried for rotatably supporting a blank for shaping in contact with the tool, a rotatable former cam on said shaft comprising a pair of axially spaced rotary cams having V-shaped peripheral faces corresponding to the form to be produced respectively on the opposite ends of the blank, a sleeve loosely encircling said cams and adapted for internal contact with said faces, a rotary cam follower held against traverse relative to the tool and peripherally engaging the outer periphery of said sleeve to determine the position of said carrier in opposition to the biasing force, said sleeve being traversable with the blank relative to said follower in a direction axially of the blank, whereby said follower will cause successive longitudinal elements of said sleeve upon engagement by said follower to contact and bridge said cams so as to define the form throughout the length of the blank as determined by the respective shapes of said cams.

15. A blank shaping fixture for mounting on a machine having a material removing tool comprising a bed traversable relative to the tool, a carrier mounted on said bed movable transversely toward and from the tool and being biased in one direction, means on said carrier for rotatably supporting a blank for shaping in contact with the tool, a rotatable former cam mounted on said carrier for transverse movement thereby with the blank, means for rotating the blank and said former cam in positive timed relation, said former cam comprising a pair of axially spaced rotary cams having peripheral faces contoured to correspond to the form to be produced respectively on the opposite ends of the blank, a longitudinal bridge member contacting at opposite ends against the faces of said rotary cams at one side in a predetermined axial plane of said former cam, and being subject to angular variation relative to the axis of said former cam in accordance with the relative radial dimensions of said rotary cams in each increment of rotation of the latter through said plane to determine the form to be produced on the blank at successive points intermediate the opposite ends, and a cam follower held against traverse relative to the tool and arranged to travel along said bridge member in contact therewith in opposition to the biasing force to determine the transverse position of said carrier in the rotation of said former cam throughout the traverse of said bed relative to the tool.

16. A blank turning device comprising, in combination, a rotary former cam, a cam follower coacting with said former cam, means for effecting relative traverse between said cam and said cam follower axially of said cam, means for effecting relative movement between said cam and said cam follower transversely of the axis of said cam in accordance with the contour of said cam, a cutting tool, a support for a rotary blank to be turned, means for rotating said cam and said support in timed relation, means for effecting relative traverse through cutting engagement between said tool and the blank axially of the blank and in timed relation to the traverse between said cam and said cam follower, and means responsive to the relative transverse movement between said cam follower and the axis of said cam for relatively positioning said tool and the blank in timed relation transversely of the axis of the blank, said cam comprising a pair of relatively fixed and axially spaced rotary cam disks having peripheral faces contoured to correspond to the form to be produced respectively on the opposite ends of the blank, and a longitudinal bridge member operatively contacted on one side by said cam follower and operatively contacting on the other side and at opposite ends against the faces of said cam disks in a predetermined axial plane of said cam, said bridge member being supported for angular adaptation relative to the axis of said cam in accordance with the relative radial dimensions of said cam disks in each increment of rotation of the latter through said plane.

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