

Dec. 17, 1957

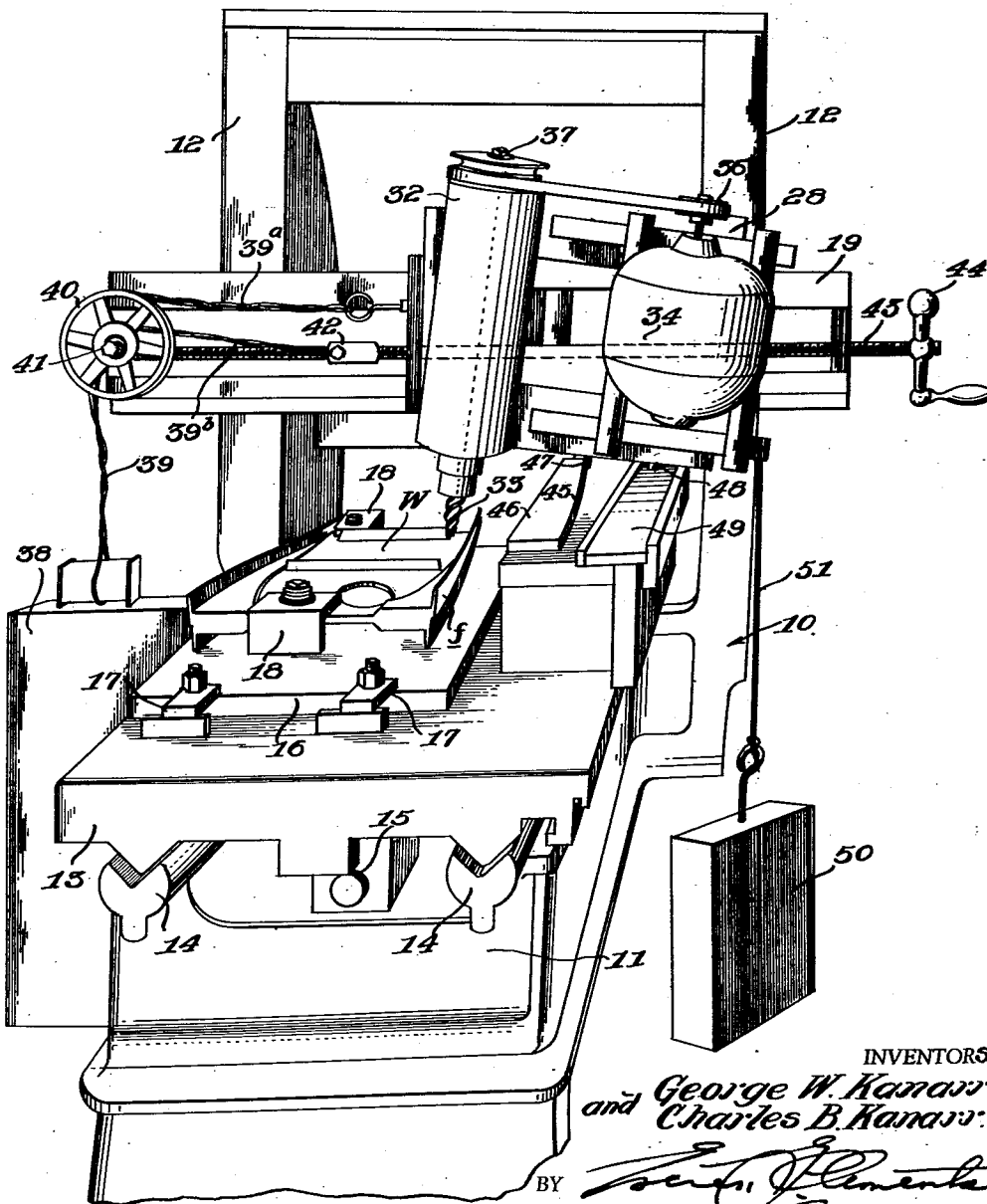
G. W. KANARR ET AL
CONTOUR MILLING MACHINE

2,816,486

Filed Dec. 29, 1952

4 Sheets-Sheet 1

Fig. 1.



INVENTORS
George W. Kanarr
and Charles B. Kanarr.

BY *Robert J. Clements*

ATTORNEY

Dec. 17, 1957

G. W. KANARR ET AL
CONTOUR MILLING MACHINE

2,816,486

Filed Dec. 29, 1952

4 Sheets-Sheet 2

Fig. 2.

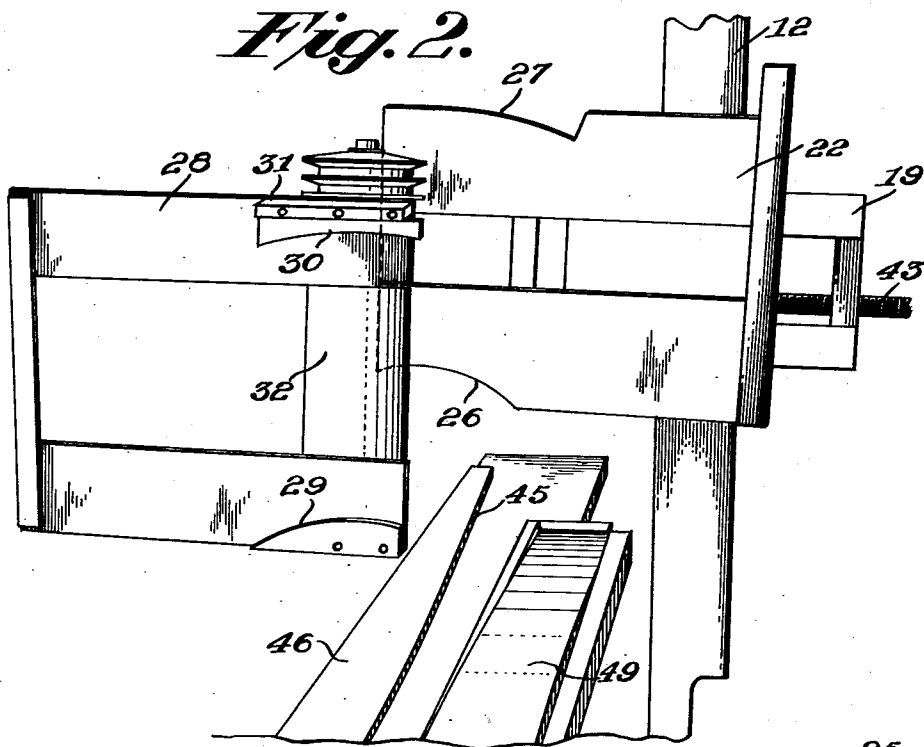
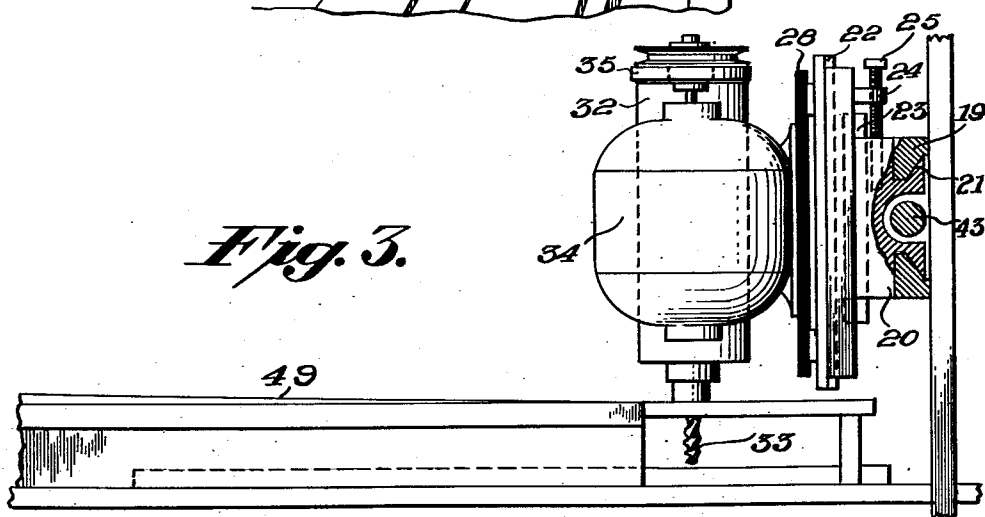


Fig. 3.



INVENTORS

and George W. Kanarr
Charles B. Kanarr

BY

Robert J. Rementa

ATTORNEY

Dec. 17, 1957

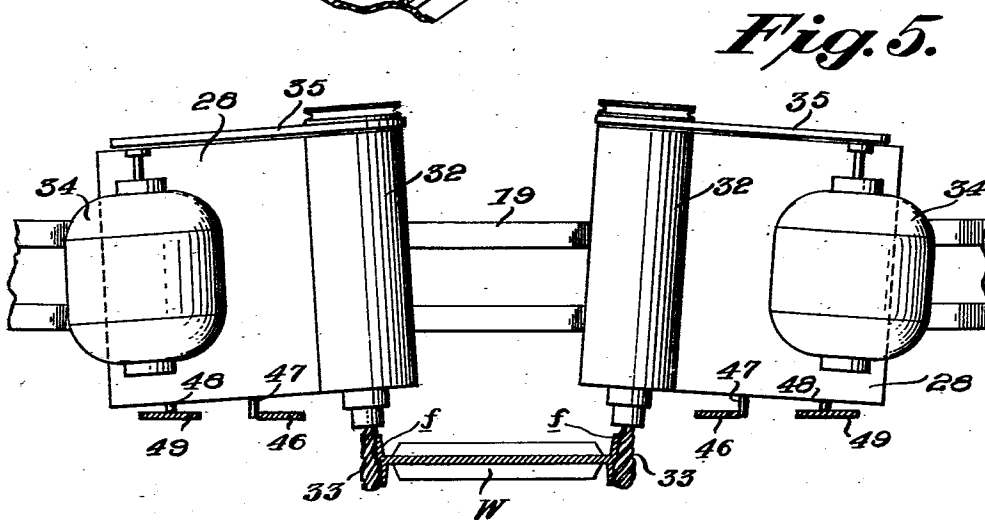
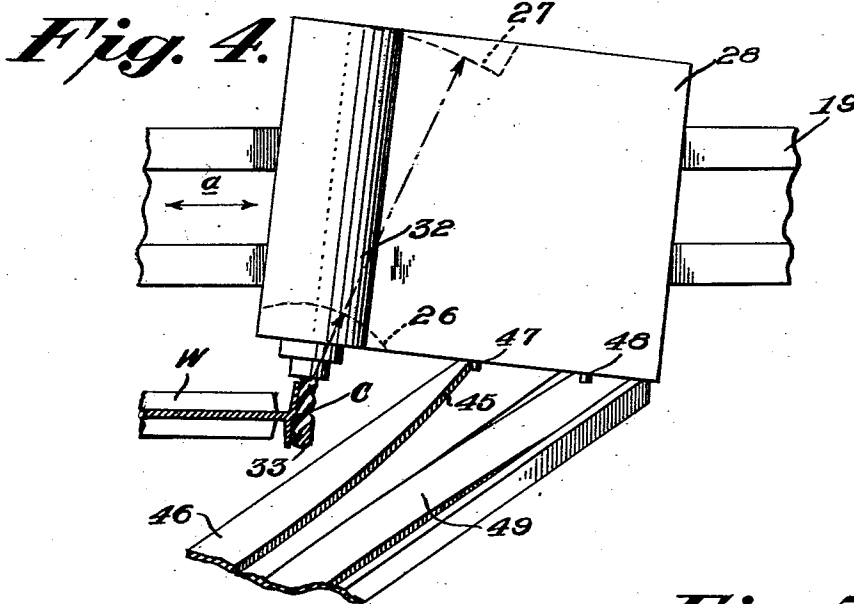
G. W. KANARR ET AL

2,816,486

CONTOUR MILLING MACHINE

Filed Dec. 29, 1952

4 Sheets-Sheet 3



INVENTORS

and George W. Kanarr.
Charles B. Kanarr.

BY

John J. Clements
ATTORNEY

1

2,816,486

CONTOUR MILLING MACHINE

George W. Kanarr and Charles B. Kanarr, Kingston, Pa.

Application December 29, 1952, Serial No. 328,443

4 Claims. (Cl. 90—13)

This invention relates to a contour milling machine.

The present invention has resulted from efforts to overcome certain problems in connection with the contouring or profiling of airplane wing reinforcing ribs from single forgings.

Prior to the present invention the reinforcements for airplane wings were in the nature of struts which were fabricated from interconnected parts capable of being bodily shaped for proper engagement of the wing covering therewith.

With the recent advent of integral, forged reinforcing webs as a substitute for such struts however, certain contouring problems arose as will later appear.

The wing reinforcing webs referred to are in the form of light weight forgings which are of elongated I-beam form in cross section and comprise a web portion having a variable width in conformity with the variable vertical depth of an airplane wing fore and aft thereof together with marginal flanges projecting from each side of the web and whose outer surfaces are adapted to engage and support the wing covering.

As is generally known, the upper and lower portions of airplane wings vary in depth from the forward to the trailing edges thereof and which circumstances alone presented no particular difficulty in the contouring of forgings of the nature above referred to so far as the general conformity of the flanges with the transverse sectional configuration of the wings was concerned.

However, due to the variable curvature of the wings between the fixed and free ends thereof, difficulty was experienced in providing the proper contour or profile of the forging flanges transversely and longitudinally thereof since it was found that in order that the flanges properly engage and support the wing coverings, the flanges must present outer surfaces which are convex lengthwise thereof and also at variable angles to the web from one end of the flanges to the other; and no machines were then available for performing this particular operation.

It is accordingly a primary object of the present invention to provide a machine which is capable of accurately contouring an upright edge surface of an elongated metallic body which is curved from end to end thereof, and wherein such surface is at uniformly variable angles to respective verticals from end to end thereof, all in a single operation.

A further object of the invention is to provide a contouring machine wherein the work is supported for movement along a horizontal axis and wherein the contouring tool is supported for joint movements both transversely of said axis and angularly about said axis.

A still further object of the invention is to provide a machine for contouring the generally vertical faces of flanges on the opposed edges of a web body wherein the body is supported for power movement along an axis and wherein a generally vertically disposed power driven milling tool is supported for simultaneous transverse and angular movements relative to said axis, together

2

with cam means controlling said angular and transverse movements.

Other objects and advantages of the invention will become apparent in the course of the following detailed description, taken in connection with the accompanying drawings, wherein:

Fig. 1 is a perspective view of the initial embodiment of the improved machine with the milling tool in inoperative position;

Fig. 2 is a fragmental perspective view more particularly showing the cooperating curved tracks on the inner and outer head members and also the cam means for effecting transverse and angular movements of the milling tool;

Fig. 3 is a fragmental longitudinal vertical sectional view particularly illustrating the mounting of the head members on the slide support;

Fig. 4 is a diagrammatic perspective view illustrating the different movements of the milling tool;

Fig. 5 is a fragmental elevational view showing the adaptation of two contouring units which are simultaneously operable on both sides of the work.

Fig. 6 is a fragmental front elevational view of a modified embodiment of the invention, the tool, driving motor being omitted;

Fig. 7 is a view as observed from the right of Fig. 6 showing the mounting of the head members, parts being omitted and other parts shown in section.

Referring now in detail to the drawing, and more particularly to Fig. 1, 10 designates a suitable frame which includes a base 11 and a pair of vertical members 12.

A table 13 is supported on the base 11 for movement longitudinally thereof on suitable tracks 14. Suitable means are provided for power movement of the table 13 longitudinally of the tracks 14 and which may include a screw 15 driven by a motor at the opposite end of the frame, or the table may be provided with a toothed rack underneath one edge thereof adapted to be gear driven by a motor suitably supported on one side of the frame. The particular means by which the table is moved is, however, of little consequence, so far as the present invention is concerned.

A work support 16 is adjustably supported on the table 13 by means of suitable clamps 17 and on which work support the work W is adapted to be secured by suitable clamps 18.

A transverse slide support 19 is rigidly supported on the vertical members 12 at a substantial distance above the table 13. A block 20 has a transverse sliding engagement with the slide support 19 as is indicated at 21 in Fig. 3 and a head member 22 is vertically adjustably connected with the block as at 23 and which adjustment may be effected by any suitable means, such as a lug 24 on the head member 22 traversed by a screw 25 threaded into the block 20.

The head member 22 is provided with a pair of concentric tracks 26 and 27 which as is more clearly shown in Fig. 2 are disposed at the inner upper and lower corners thereof.

A second head member 28 is provided with arcuate tracks 29 and 30 which respectively coast with the tracks 26 and 27 on the head member 22 for arcuate movement of the head member 28 on the head member 22 about a point C (Fig. 4) which will be hereinafter more specifically referred to. The head member 28 may be removably supported on the head member 22 by plates secured to a block 31 on head member 28 above track 30 and to the track 29 and which plates slidably engage the rear face of the head member 22.

Rigidly supported by the head member 28 is a cylindrical casing 32 in which is rotatably supported a mill-

ing tool 33 and the tool is driven by a motor 34 rigidly supported by head member 28 through a belt 35 operatively engaged with pulleys 36 and 37 respectively secured to the motor shaft and a tool operating shaft within casing 32.

The head members 22 and 28 together with the tool 33 and motor 34 are urged transversely of the frame and lengthwise of the slide support 19 by means of a weight 38 to which corresponding ends of a multi-strand cable 39 are secured. A portion of said strands 39^a extend about the periphery of a pulley 40 which is rotatably supported on the slide support 19 and the other ends of such strands are connected to the head member 22. The remaining portion of the cable strands 39^b extend about the periphery of the hub 41 of the pulley 40 and which have their other ends secured to a nut 42 operatively engaged with a threaded rod 43 extending through the slide support and having its opposite ends rotatably journaled therein. The rod 43 is provided with an operating handle 44 upon turning of which in one direction the weight 38 may be supported from the rod 43, and upon turning of which in opposite direction, the weight will be supported directly from the head member 22 to constantly urge same together with the tool 33 and into working contact with an adjacent flange *f* of the work W.

The movement of the head members and tool toward the work W is limited by means of a vertical longitudinally curved cam surface 45 on one edge of an elongated plate 46 which is constantly engaged by a follower 47 depending from head member 22, and the head member 28 is rotated on head member 22 about tracks 26—26, 29—30 by means of a follower 48 engageable with a vertically inclined cam face 49 extending generally parallel with plate 46. The follower 48 is maintained in operative cam face engaging position by means of a weight 50 which is connected to head member 28 by means of a cable 51.

In the use of the machine, the work W is clamped on the work support 16 as indicated in Fig. 1. The milling tool 33 is disposed against the outer wall of flange *f* as indicated in Fig. 4 with the followers 47 and 48 engaging their respective cam faces 46 and 49.

The motor 34 is set into operation and the table 13 is moved lengthwise thereof carrying the work W with it past the contacting tool 33. The tool 33 will be urged against the flange *f* by means of weight 38 and as governed by cam face 45.

Simultaneously therewith the tool 33 will pivot in a vertical plane about a point C which is disposed intermediate the top and lower edges of the flange and the angular range of such pivotal action will be governed by the cam face 49.

While in the particular work being milled as herein disclosed, the angular range of movement of the tool is only about 4° from end to end of the flange, such range for such work or other work may be varied by adjustment of the cam surface or the substitution of a cam of greater or less pitch for the one disclosed.

The insides of the flanges *f* may be finished similarly to the outsides by shorter tools 33', as indicated in Fig. 1. As is indicated in the diagrammatic view in Fig. 4 the tool 33 is moved laterally of the work W in the direction of arrows *a* by the cooperating cam 47 and weight 38 and the follower 47 while pivotal movement of the tool about center C is effected by the weight 50 and cooperating cam follower 48 and cam 49.

The above described machine may be duplicated as in Fig. 5 wherein two heads and cooperating tools are shown for simultaneous operation on both flanges *f* of the work W.

While the weight and cable arrangement 38 to 42 heretofore described has proven satisfactory for maintaining the follower 47 in contact with the curved cam surface 45, such was in fact provided as an adjunct to the already prevailing cross head of a milling machine

which included the handle rotatable screw 43, and notwithstanding the satisfactory operation of the weighted structure it has been found advisable to provide a more automatic construction for this purpose for the saving of time and inconvenience in the operation of the machine.

In connection with the above, attention is now directed to Figs. 6 and 7 of the drawings wherein the slide support 19' is not provided with a threaded rod as in the first embodiment of the invention but which is secured to a suitable frame structure such as the vertical members 12 in Fig. 1. In this modified embodiment of the invention, a saddle 52 has upper and lower slidable connections 53 and 54 with the slide support 19' and the saddle is movable along the slide support under the action of means later referred to.

A head member 55 is supported by the saddle 52 for vertical adjustment relative thereto by any suitable means as designated at 56. A second head member 57 is supported by the head member 55 and is provided with a tool drive shaft supporting casing 32' and which drive shaft is in operative driving connection with a milling tool 33'.

In lieu of the weight-cable actuating means in the first embodiment of the invention, the saddle 52 is actuated by a double action air cylinder 58 suitably secured to the slide support 19' as indicated at 59, and which cylinder is provided with a piston 60 carried by one end of a rod 61 and whose opposite end is connected to the saddle 52. The opposite ends of the cylinder 58 are in communication with suitable hoses 62, 63 which extend to a suitable pressure regulator and two-way valve having exhausts.

While the head member 55 is vertically adjustable relative to the saddle 52 it is longitudinally movable therewith. The head member 55 is provided with an extension 64 from which depends a cam follower 47' which is maintained by the air cylinder-piston arrangement against a cam surface 45' on an edge of a plate 46' for controlling the movement of the tool 33' laterally of the work flange *f*'. By proper manipulation of the referred to two-way valve the direction of the piston 60 may be reversed with a resulting movement of head member 55 and a retraction of the follower 47' from the cam surface 45'.

While it is within the range of possibility to impart arcuate movement of the head member 57 on the head member 55 by an air cylinder arrangement as above and which may later be found to be more satisfactory, such movement is at present effected by weight means as in the first embodiment of the invention.

For this purpose, the head member 57 is provided with an extension 65 which overlies the cam 49' and from which depends the cam engageable follower 48'. A suitable weight 66 is supported from the free end of extension 65 as by means of a cable 67, and which weight is operative to maintain the follower 48' in bearing engagement with the cam 49'.

It is to be particularly observed that in Fig. 6 the milling tool 33' is shown vertically disposed and out of working engagement with the work flange *f*' and with a corresponding spacing of the follower 48' from the cam 49'. This showing is for the purpose of more clearly illustrating the arcuate movement of the head member 57 about a point C which is disposed at one side of and intermediate the ends of the tool 33'.

It is, of course, to be understood that in operation the tool is brought into operative contact with flange *f*' and the follower 48' brought into contact with cam 49'. It is to be further understood that in this modified embodiment of the invention, the arrangement may be substantially different from that shown, particularly as relates to the head members 55 and 57 it being sufficient only to have the head members provided with suitable followers operatively engageable with the cams 45' and 49'.

5

A further distinction between the modified embodiment of Figs. 6 and 7 and that of Figs. 1 to 5 is the manner in which the outer head member is connected to the inner head member for arcuate movement about the point C which is disposed at one side of and intermediate the ends of the milling tool.

Thus, in the first embodiment the weight of the outer head member 28 is supported on the upper arcuate track 27, while in accordance with the modified embodiment the weight of the outer head member 57 is supported on the lower track 67 with the upper part of said member being movable along the concentric track of greater radius 68. While either form of mounting of the outer head member is satisfactory, it has been found that less resistance is encountered with the modified construction of Figs. 6 and 7.

While in both embodiments of the invention the milling tool is disclosed as effecting a convex surface lengthwise of the work, it is obvious that the form of cam 45 may be readily modified whereby such surface may be concave or of various forms as may be desired. Regardless of the many possible variations in the construction, the basic feature of the present invention is a longitudinally movable work support, a generally upright milling tool disposed above the work support, means for rotating the tool and means automatically operative upon longitudinal movement of the work support for bodily moving said tool at right angles to the work support and angularly about an axis parallel to said support and which axis intersects said tool in a point at the work engaging side thereof and intermediate its ends.

Having set forth our invention in accordance with certain structural embodiments thereof, what we claim and desire to secure by U. S. Letters Patent is:

1. A machine for profiling an edge surface on a work piece which is curved in a longitudinal direction and variable in angular relation in a direction substantially at a right angle to the longitudinal extent, said machine comprising, in combination, a fixed base member, a work supporting table supported on said base member for movement longitudinally thereof, means for longitudinally moving said table, an upright frame at one end of said table and rigid with said base, a substantially horizontal elongated slide support rigid with said upright frame and disposed above said table transversely of said longitudinal movement thereof, a slide member movable on said slide support transversely of said table, biasing means urging said slide member to move in one direction longitudinally of said slide support, a head mounted on said slide member, said head comprising a first member supported by said slide member for vertical adjustment relative thereto and being movable therewith longitudinally of said slide support, said head comprising a second member, mating arcuate guides on said first and second members having a center of curvature adjacent said work

6

supporting table for swinging movement of said second member on said first member, gravity actuated means operatively engaged with said second head member for swinging same on said first head member about said center of curvature, a substantially vertical housing supported by said second head member, a shaft journaled in said housing having a milling tool supported at its lower end, power means connected to the upper end of said shaft for rotating same, a pair of cams rigidly supported by said table and extending longitudinally thereof, one of said cams facing laterally and the other cam facing vertically, a cam follower on said first head member held into engagement with said first cam by said biasing means for moving said first head member in opposition to said biasing means during longitudinal movement of the table, and another cam follower on said second head member held into engagement with said second cam for moving said second head member during movement of said first head member, whereby upon simple longitudinal movement of the table said milling tool is moved both vertically and transversely relative to said work piece in profiling the edge surface thereof.

2. The structure according to claim 1, wherein said means for urging said slide member to move in one direction longitudinally of said slide support comprises a pulley rotatably supported on said slide support adjacent one end thereof, a cable trained over said pulley and having one end thereof secured to said first head member and a weight connected to the other end of the cable.

3. The structure according to claim 1 wherein said means for urging said slide member to move in one direction longitudinally of said slide support comprises a double action air cylinder supported by said slide support, a piston movably disposed in said cylinder and having a piston rod extending through one end of the cylinder with the outer end thereof connected to said slide member, and an air hose opening into said cylinder at each side of said piston for movement of same and the said slide member in said one direction and in an opposite direction.

4. The structure according to claim 1 wherein said means for swinging said second head member about said center of curvature comprises a cable having one end thereof connected to said second member laterally of one end thereof, and a weight connected to the opposite end of said cable.

References Cited in the file of this patent

UNITED STATES PATENTS

2,357,790	Turchan et al. -----	Sept. 5, 1944
2,424,031	Heer -----	July 15, 1947
2,674,160	Martellotti -----	Apr. 6, 1954
2,675,743	Martellotti et al. -----	Apr. 20, 1954
2,753,244	Dubosclard -----	July 3, 1956