PUBLISHED
MAY 4, 1943.
BY A. P. C.

C. SCHMID
MILLING MACHINES
Filed May 19, 1941

Serial No.
394,220
6 Sheets-Sheet 1

Fig.2

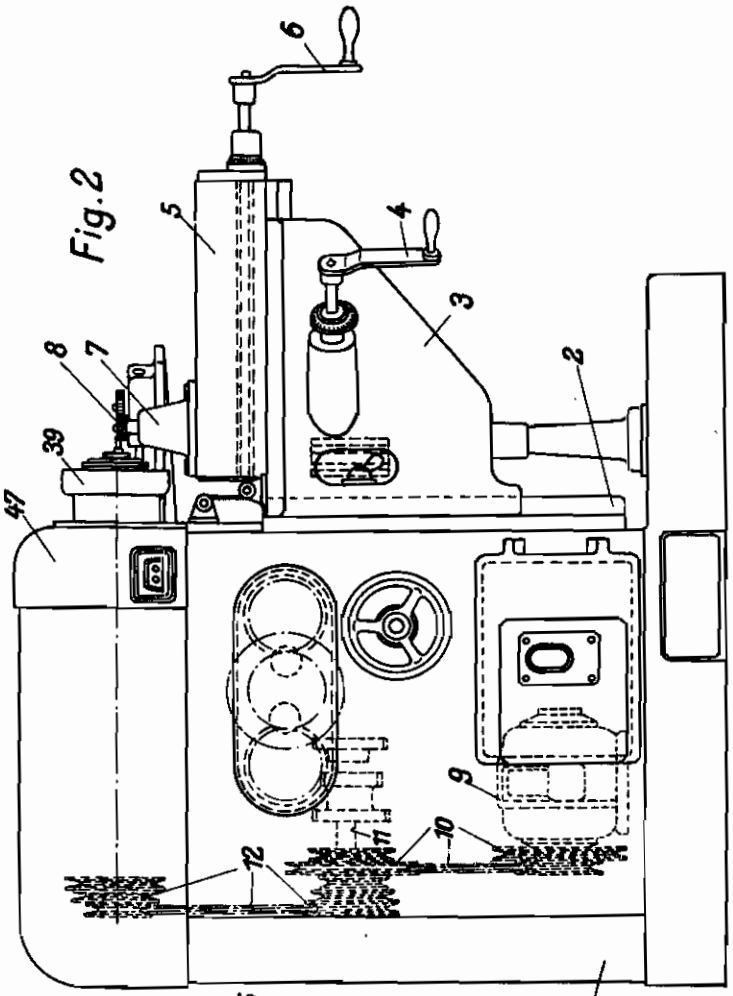
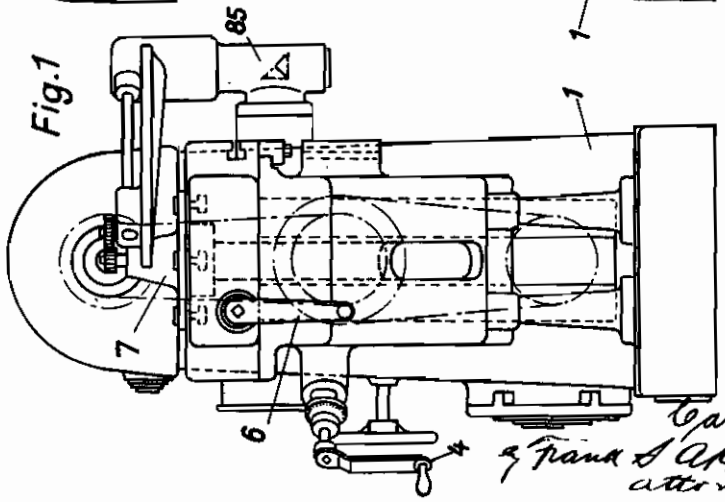


Fig.1



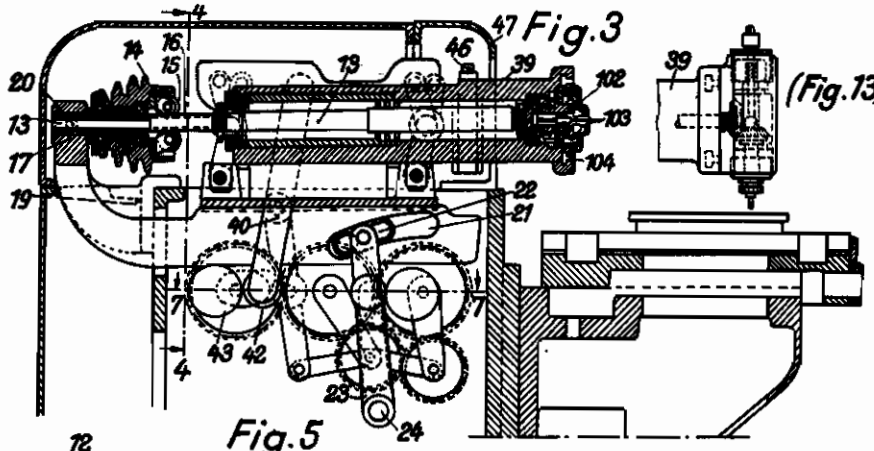
Inventor:
Carl Schmid,
by Frank S. Allenson,
attorney.

PUBLISHED
MAY 4, 1943.
BY A. P. C.

C. SCHMID
MILLING MACHINES
Filed May 19, 1941

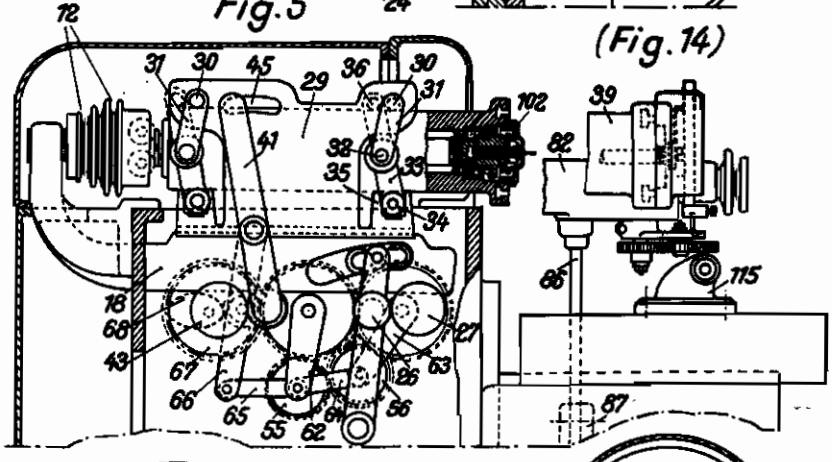
Serial No.
394,220
6 Sheets-Sheet 2

Fig.3



(Fig.13)

Fig.5



(Fig.14)

Fig.4

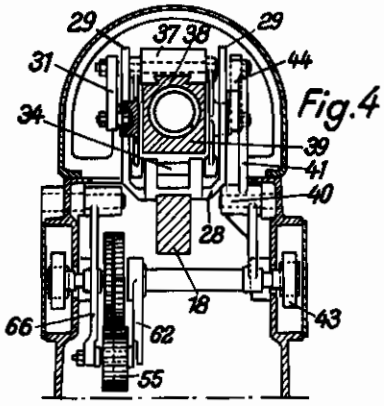
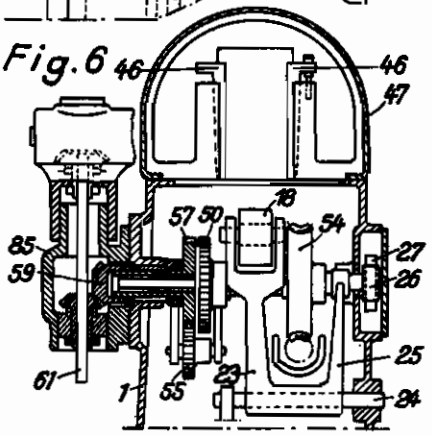


Fig.6



Inventor:
Carl Schmid
by Frank S. Ackerman,
attorney.

PUBLISHED
MAY 4, 1943.
BY A. P. C.

C. SCHMID
MILLING MACHINES
Filed May 19, 1941

Serial No.
394,220
6 Sheets-Sheet 3

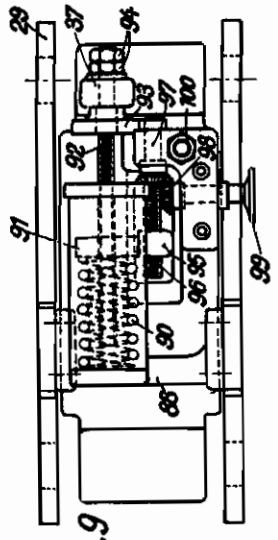


Fig.9

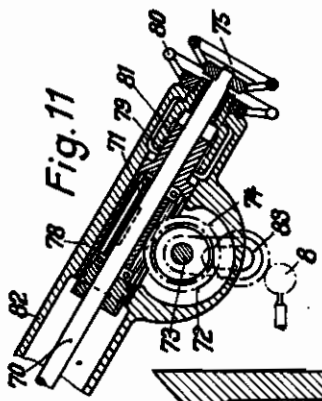


Fig.11

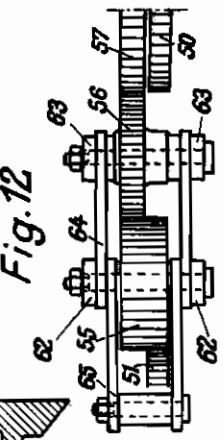


Fig.12

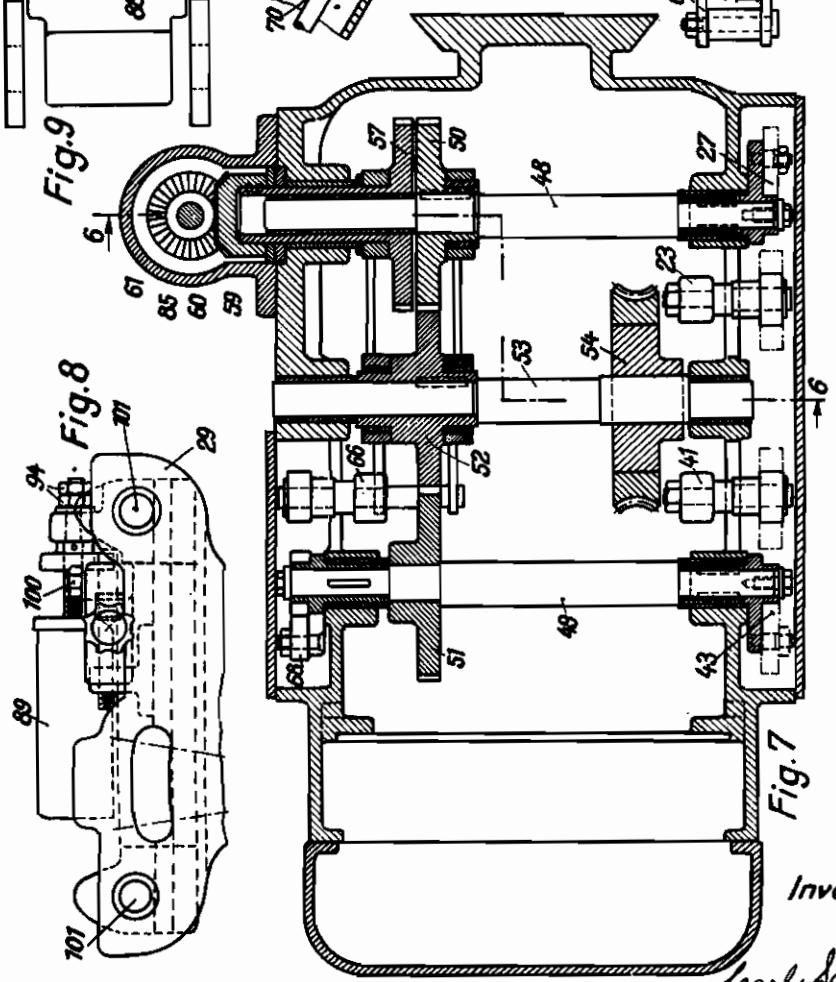


Fig.7

Fig.8

Inventor:
Carl Schmid,
by Raymond C. Ackerman,
attorney.

PUBLISHED
MAY 4, 1943.
BY A. P. C.

C. SCHMID
MILLING MACHINES
Filed May 19, 1941

Serial No.
394,220
6 Sheets-Sheet 4

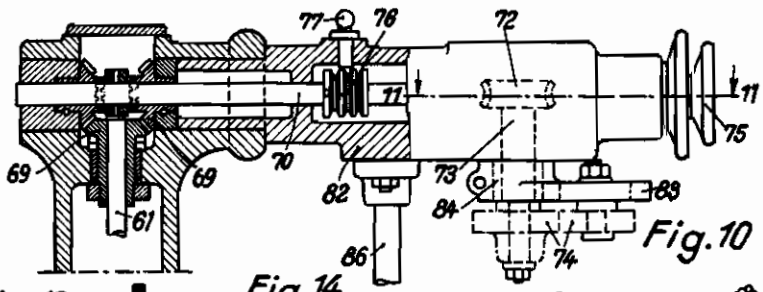


Fig. 10

Fig. 13

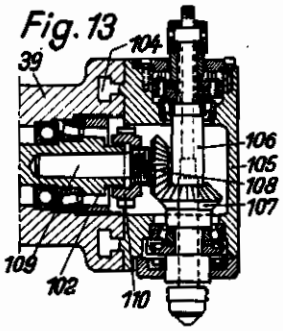


Fig. 14

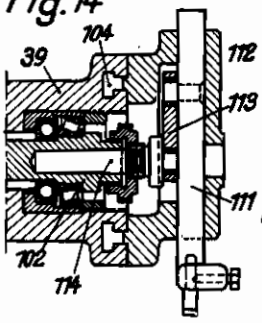


Fig. 15 Fig. 16 Fig. 17

Fig. 18 Fig. 19

Fig. 20

Fig. 23

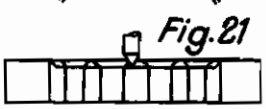


Fig. 21

Fig. 24

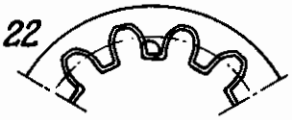


Fig. 22

Fig. 25

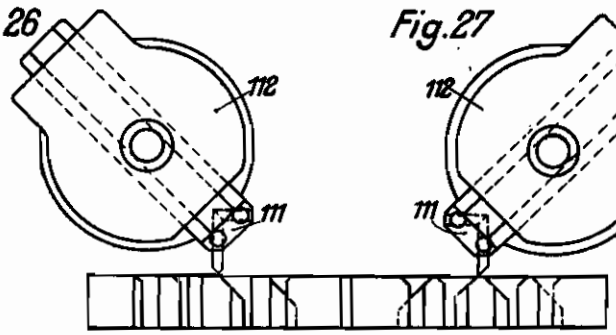


Fig. 26 Fig. 27

Inventor:
Carl Schmid,
by Frank S. Ackerman,
attorney

PUBLISHED
MAY 4, 1943.
BY A. P. C.

C. SCHMID
MILLING MACHINES
Filed May 19, 1941

Serial No.
394,220
6 Sheets-Sheet 5

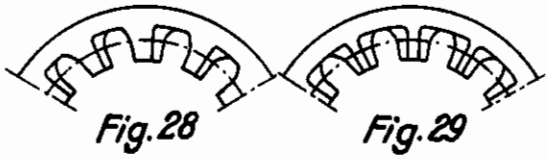


Fig. 28 Fig. 29

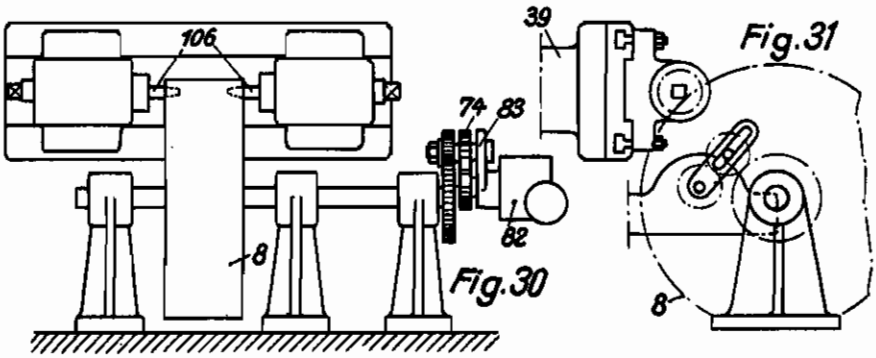
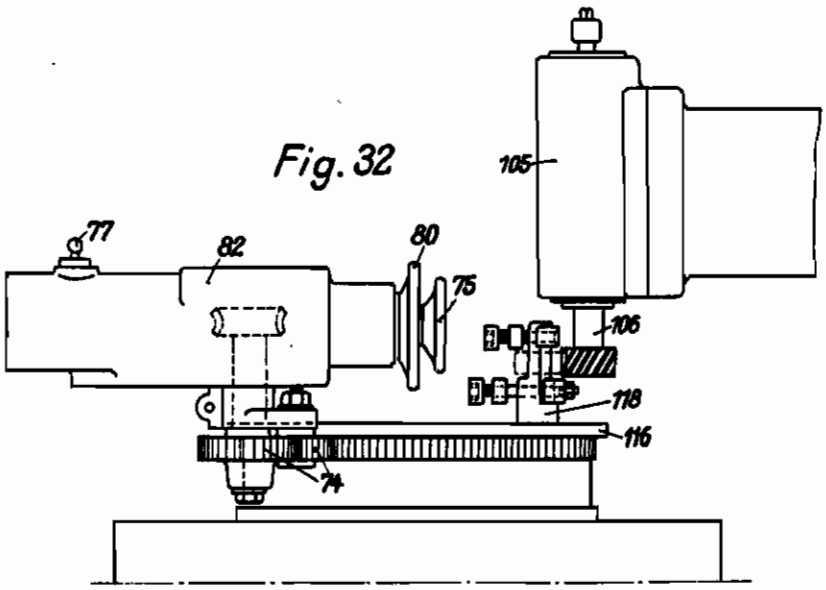


Fig. 30 Fig. 31

Fig. 32



Inventor:
Carl Schmid,
by Frank L. Appleman,
attorney.

PUBLISHED
MAY 4, 1943.
BY A. P. C.

C. SCHMID
MILLING MACHINES
Filed May 19, 1941

Serial No.
394,220
6 Sheets-Sheet 6

Fig. 33

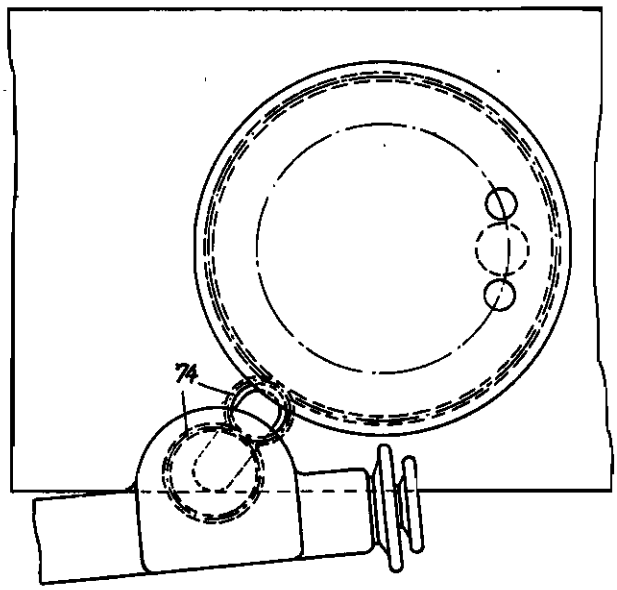


Fig. 34

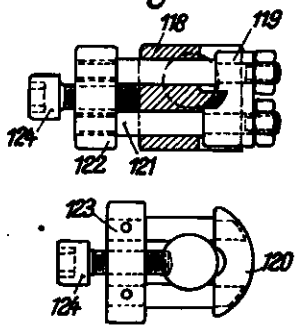
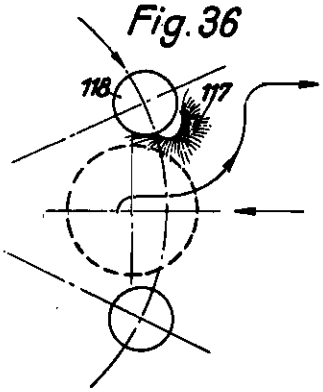


Fig. 35

Fig. 36



Inventor:
Carl Schmid,
by Frank S. Ashleman,
Attorney.

Published May 4, 1943

Serial No. 394,220

ALIEN PROPERTY CUSTODIAN

MILLING MACHINES

Carl Schmid, Leipzig, Germany; vested in the Alien Property Custodian

Application filed May 19, 1941

This invention relates to a duplicating milling machine for rounding off the edges of gear teeth.

The known kinds of rounding off machines operating on the "Cross" principle and rounding off only the top of the tooth by means of a form cutter guided in a semicircle fail to satisfy modern requirements, particularly with respect to the sliding gears of controlling mechanisms, which demand rounding off of the entire outline of the tooth or teeth to prevent carbonization of the tooth material during hardening and the development of cracks due to heat treatment. It is further necessary to permit different forms of rounding off for various tooth profiles. Sliding gears and couplings if used in connection with multi-splined shafts mesh for instance in a manner requiring one-sided chamfering, and internally toothed gears having weakly dimensioned rims frequently cannot be suitably worked with a cutter as otherwise the narrow rim would be weakened too much.

In the known machines for trimming gear teeth the burr is removed by passing a blade between the tooth surfaces of an inclined gear for knocking off the burr at the ends of the teeth. However, as they do not round off the entire outline of a tooth, such machines, in numerous instances, are unable to meet the requirements of mechanical engineering.

It is the object of the invention to eliminate the above-mentioned defects of the known rounding off and trimming machines by providing a milling machine which in addition to the known trimming and rounding off of the top permits also rounding off of the edges of the teeth on their entire outline as well as adjustment to different forms of rounding and adaptation to the various forms of teeth used.

The milling machine according to the invention is provided with a cam-controlled milling cutter guided along the outline of a tooth while the work is rotating. In case of cam control the number of teeth is immaterial and only a few cams are required. When the teeth of tapering toothed rims and of bevel gears are to be trimmed, the cutter can follow the angle without trouble, and this applies also to gear wheels whose teeth alternately project and recede to insure easy coupling, the cam controlling the feed of the work being then doubled and the feed correspondingly adapted. A cam-controlled machine affords, moreover, the advantage of obviating the necessity of bothersome adjustments for similar wheels, which at present requires a tool setter. All that is needed is to put on the particular cam to have the machine ready for operation. Without time-consuming calculations the contour of the cam can be marked out directly on the disc by following the outline of a tooth with a pin possessing the diameter of the cutter and pressed against the tooth profile by hand.

In order to enable the machine to comply with all requirements the spindle head of the horizontally working cutter can be exchanged for a vertical cutter spindle set or a slotting outfit so as to provide a possibility of trimming or chamfering with the latter teeth that cannot be worked by cutters.

One form of the invention is illustrated by way of example in the accompanying drawing, in which

Figure 1 is a front view of a machine according to the invention;

Fig. 2 is a side view thereof;

Fig. 3 is a vertical partial section in the direction of the cutter spindle;

Fig. 4 is a cross section on the line 4—4, of Fig. 3;

Fig. 5 is a section of the casing in the direction of the spindle and shows also the inner parts of which only the spindle head is shown in vertical section as in Fig. 3;

Fig. 6 is a partial section on the broken line 6—6, of Fig. 7;

Fig. 7 is a horizontal section on an enlarged scale of the casing and the shaft bearings on the line 7—7, of Fig. 3;

Figs. 8 and 9 are, respectively, a partial view and a partial plan of the guide of the spindle bearing body;

Fig. 10 is a view, partly in vertical section, of the feeding mechanism for the work;

Fig. 11 is a horizontal partial section on the line 11—11, of Fig. 10;

Fig. 12 is a partial view of the arrangement of the gears for varying the feed of the gearing;

Fig. 13 is a section taken in the direction of the spindle of the head and bearing body thereof with an attachment for a vertically working milling spindle;

Fig. 14 is a section taken in the direction of the tool guide of the head of the spindle and bearing body thereof with attachment for a slotting outfit;

Figs. 15 to 19 show a number of rounding off and chamfering forms that can be made with a horizontal cutter;

Figs. 20 to 22 show how teeth can be rounded off or trimmed over their entire outline by means of a vertical cutter; Fig. 20 indicating a spur gear and Figs. 21 and 22 being, respectively, a section

and a view of a toothed wheel provided with internal toothing;

Figs. 23 to 25 show the chamfering of the tooth edge producible with the aid of a vertical cutter; Fig. 23 indicating a spur gear and Figs. 24 and 25 being, respectively, a section and a view of a toothed wheel provided with internal toothing;

Figs. 26 and 27 show the slotting outfit in operative position for chamfering the tooth edges of an internally toothed wheel;

Figs. 28 and 29 are corresponding partial views of the work;

Figs. 30 and 31 are two views of an attachment with two oppositely disposed milling spindles for simultaneously trimming the teeth on both sides;

Figs. 32 and 33 are, respectively, an elevation and a plan of an arrangement for using the machine as profiling attachment;

Figs. 34 and 35 are, respectively, a view and a section of the means for holding the work; and

Fig. 36 is a diagram of the paths of motion of the work and tool.

The machine is provided with a box-shaped frame 1 on the front side of which a bracket 3 is displaceable on a vertical guide 2 and can be adjusted by means of a hand crank 4. On the top of the bracket 3 a working table 5 can be horizontally displaced and adjusted by the hand crank 6, as indicated in Fig. 2. An exchangeable holder 7 for a toothed wheel 8 to be milled is secured to the table 5.

Inside the frame 1 a driving motor 8 is mounted which transmits its drive to a milling spindle 13 through a V-belt gear 10, an intermediate shaft 11 and a second V-belt gear 12. A pulley 14 of the V-belt gear 12 is disposed on the spindle 13 and drives the spindle 13 by means of rolls 15 engaging trapezoidal longitudinal grooves 16 of the spindle and arranged on the pulley 14 which runs in ball bearings on a bushing 17 in which the rear end of the spindle 13 is disposed. The bushing 17 is secured to the rear end of a rocker arm 18 mounted in a supporting block 19 by means of cone rollers 20 as shown in Fig. 3.

At its other free end the rocker arm 18 has a curved slot 21 in which a roller member 22 is guided and articulated to the forked end of another rocker arm 23 arranged in the machine frame at 24. The arm 23 is equipped with a roller arm 25 whose roller 26 moves on the circumference of a disc cam 27, as shown in Figs. 5 and 6.

To the upper side of the free front end of the swinging arm 18, which generally extends in horizontal direction, a trough-like guide 28 of U-shaped cross section is secured to the exterior of whose side walls 29, Fig. 4, by means of pins 30, lever arms 31 of a lever guide system are articulated, the free ends of which are flexibly connected by pins 32 with two-armed levers 33. The lower ends of the levers 33 are connected in pairs by pins 34 and vertically guided in forks disposed at the bottom of the trough 28. The upper ends of the levers 33 guided in a straight line are connected in pairs by pins 36 on which a bridge guide 37 is positioned having a dovetailed groove on its underside in which a bearing body 39 is guided by means of a gib 38 for accommodating the milling spindle 13 running therein in ball bearings. The bearing body 39 is guided at the rear end between faces arranged on the insides of the walls 28, and the front end thereof is guided between keys 46, Fig. 6, arranged in the front portion 47 of a hoodlike covering of the spindle 13.

On the inside of a side wall of the machine frame 1 a double-armed lever 41 is movably disposed at 40, Fig. 5, whose lower end is provided with a roller 42 passing over the circumference of a disc cam 43. The upper end of the lever 41 is positioned in a guide 44 rotatably connected with the guide 37 through a slot 45 in one of the walls 29. The disc cams 27, 43 serving, respectively, for regulating the vertical position of the spindle 13 by means of the lever 23 and the arm 18 and the longitudianl adjustment of the spindle through the lever 41 are mounted in the frame 1 on transversely disposed shafts 48, 49 which are driven by a toothed wheel 52 through the medium of gear wheels 50, 51. On the shaft 53 of the toothed wheel 52 a worm wheel 54 is in mesh with a worm, not shown, arranged on the intermediate shaft 11.

By means of planet pinions 55, 56 the toothed wheel 52 drives also a gear wheel 57 loosely rotatably disposed on the shaft 48 and mounted with a hub extension 58 in a side wall of the machine frame 1. To the end of the extension 58 projecting from the outside of the frame 1 a bevel gear 58 is keyed which meshes with a bevel gear 60 on a vertical shaft 61. The planet pinions 55, 56 are supported by arms 62, 63 movable about the shafts 53, 48 and flexibly connected by bars 64. The arms 62 are further hinged to an arm 66, articulated at 40 to the frame 1, by link bars 65, and the arm 66 is fitted with a lateral roller 67 moving over the circumference of a disc cam 68. The cam 68 is mounted on the shaft 49 and by means of the planetary gearing described regulates the speed of rotation of the gear wheel 57 which drives the toothed wheel 8 to be milled with the aid of the bevel gearing 59, 60, the shaft 61, a change speed gear 68, a shaft 70, a worm gearing 71, 72, a shaft 73 and gear wheels 74, the direction of rotation being adjusted by displacing the shaft 70 by means of a hand wheel 75, and an adjusting sleeve 76 on the shaft 70 secures the adjustment made through the medium of an index 77. The worm 71, non-rotatably yet displaceably mounted on the shaft 70 by key and slot, is guided without play in a casing 78 having at one end a threaded plug 78 on which a nut 81 firmly united with a hand wheel 80 is provided, both the nut and the wheel being secured in the bearing housing 82. The gear wheel 74 meshing with the work 8 is arranged in a gear quadrant 83 clamped to a projection 84 of the bearing housing 82 and serving for pressing the gear wheel against the work. The entire housing 82 is rotatably inserted in a bore at the upper end of a bearing body 85 secured to the frame 1 for the vertical shaft 81 and is held in position by a support 86 attached to the base of the table 5 by a clamp 87.

As shown in Figs. 8 and 9, between the walls 29 and a connecting transverse locking bar 88 a cylinder 89 is provided in which a compression spring 90 is disposed which acts upon the bridge guide 37 by means of a plate 91, a spindle 92 and a hand wheel 93, whereby the spindle bearing body 39 is forced into the work 8 in accordance with the disc cam 43. The return of the body 39 is positively effected by the disc cam 43, and the hand wheel 93, in conjunction with nuts 94, serves for regulating the compressive stress of the spring 90.

On the bearing body 39 of the spindle 13 a nut 95 is provided with a screwed-in spindle 98 disposed on the guide 37 in a bearing 97. The screw spindle 98 is connected with an adjusting shaft

by a cone drive 98, and the shaft has a hand wheel 99, so that by turning the hand wheel 99 the bearing body 39 can be adjusted relative to the guide 37 on which it is guided. A screw 100 serves for clamping both parts, and the bores 101 in the side walls 29 receive the link pins of the guide levers 31.

The milling spindle head 102 is equipped for interchangeably fixing therein a cutter 103. The free end of the bearing body 39 of the milling spindle 13 is provided with an undercut slot 104 for fastening screws which after removal of the cutter permit the connection of attachments and the coupling of the milling spindle with the shaft end of the attachments comprising for instance those having a vertical milling spindle, or a slotter, or a profiling outfit.

As shown in Fig. 13, an attachment provided with vertieally working milling spindle and permitting the working of the edges of the teeth in such manner that the tool follows the toothing contour of the work comprises for instance a casing 105 in which a vertical milling spindle 106 is arranged. A bevel gear 107 on the spindle 106 meshes with a bevel gear 108 whose shaft end 109, instead of a horizontal cutter, is fixed in the spindle head 102 by means of a screw cap 110.

In the attachment fitted with slotting tool shown in Fig. 14 a tool holder 111 is vertically displaceably guided in the casing 112 and is actuated by a crank or an eccentric 113 whose shaft end 114 is fixed in the spindle head 102 in the manner described.

With a horizontally acting cutter the tooth edge is worked only in the top portion of the tooth while with the aid of a form cutter and correspondingly shaped cams for the cutter motion in the vertical plane various rounding-off and chamfering forms are obtainable. During working of sections of the edge approaching more or less the vertical plane of motion of the cutter the feed of the work is slowed down due to the action of the correspondingly shaped cam 68.

When a cutter operating vertically to the work is employed, the tooth edge can be trimmed or rounded off or chamfered over its entire outline, as indicated in Figs. 20 to 25.

The slotting outfit is used for instance for small gear wheels and small teeth in cases when working with a cutter is not possible. By means of a universal support 115, Fig. 5, secured to the table the gear wheel to be milled can be adjusted in any direction to suit the tooth profile.

By the twin arrangement of an attachment provided with a cutter operating vertically to the driving spindle and by securing the work on a horizontal shaft the work can be simultaneously worked on both sides, as indicated in Figs. 30 and 31.

The machine may serve also as profiling attachment. For this purpose an attachment with vertical milling spindle is employed and a round table 116 driven by the gear wheels 74 placed on the machine table. By correspondingly controlling the spindle motions and the rotary speed of the table, radial, tangential and curved milling operations may be performed with the aid of a vertical cutter.

Figs. 32 to 36 show for instance the working of a turbine blade 117. The work is fixed in a body 118 secured to the table 116 by means of two clamps 119, 120 connected by pins 121 to cross members 112 through each of which a set screw 124 passes and is supported on the other side by the body 118.

Fig. 36 shows the relative paths of motion of the tool and work.

CARL SCHMID.