Aug. 2, 1955 E. H. SCHMIDT 2,714,336

CAM GENERATING MACHINE

Filed Aug. 23, 1951 5 Sheets-Sheet 1

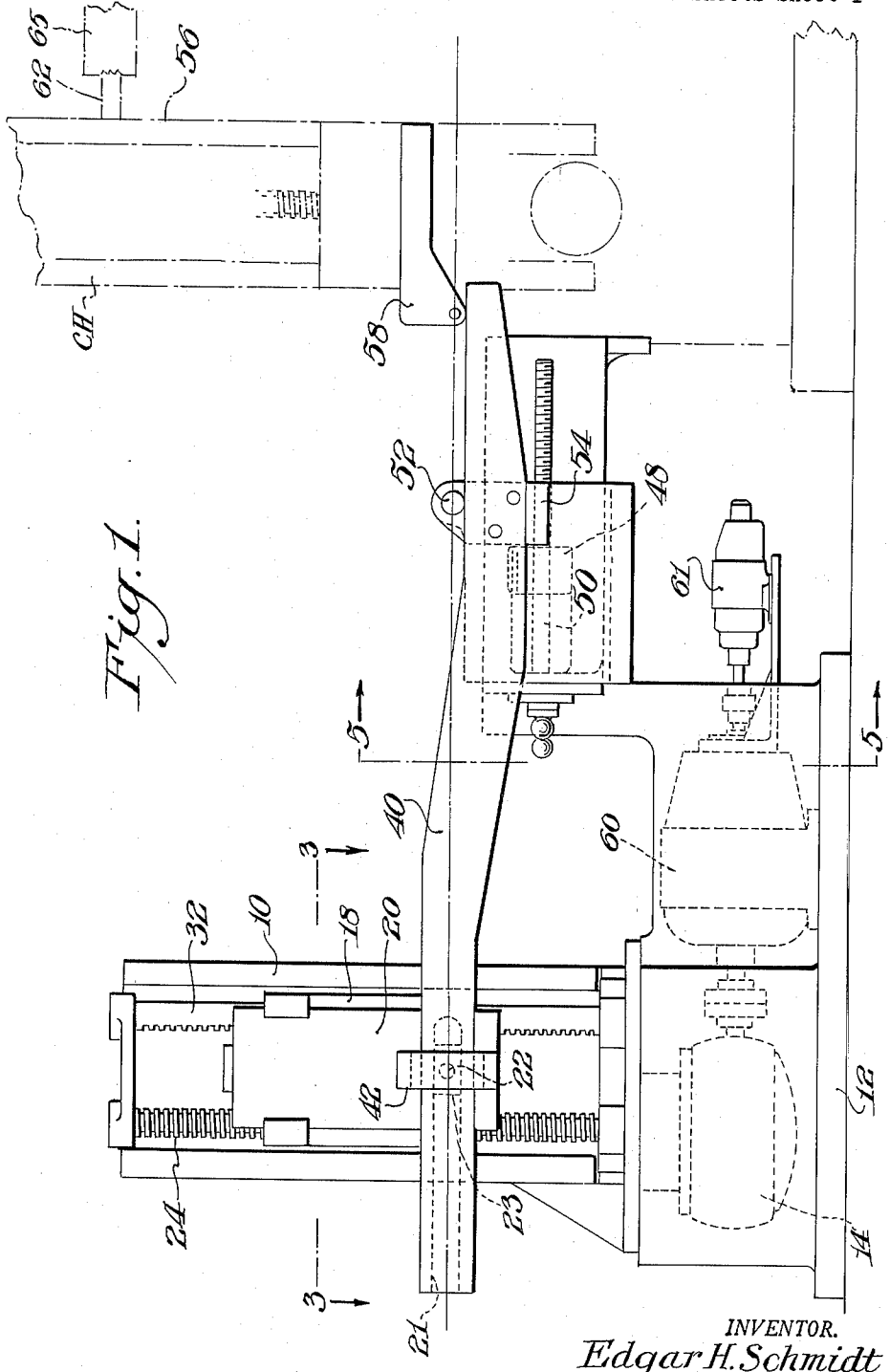


Fig. 1.

INVENTOR.
Edgar H. Schmidt
BY
Fred Olsen
ATTORNEY.

Aug. 2, 1955 E. H. SCHMIDT 2,714,336

CAM GENERATING MACHINE

Filed Aug. 23, 1951 5 Sheets-Sheet 2

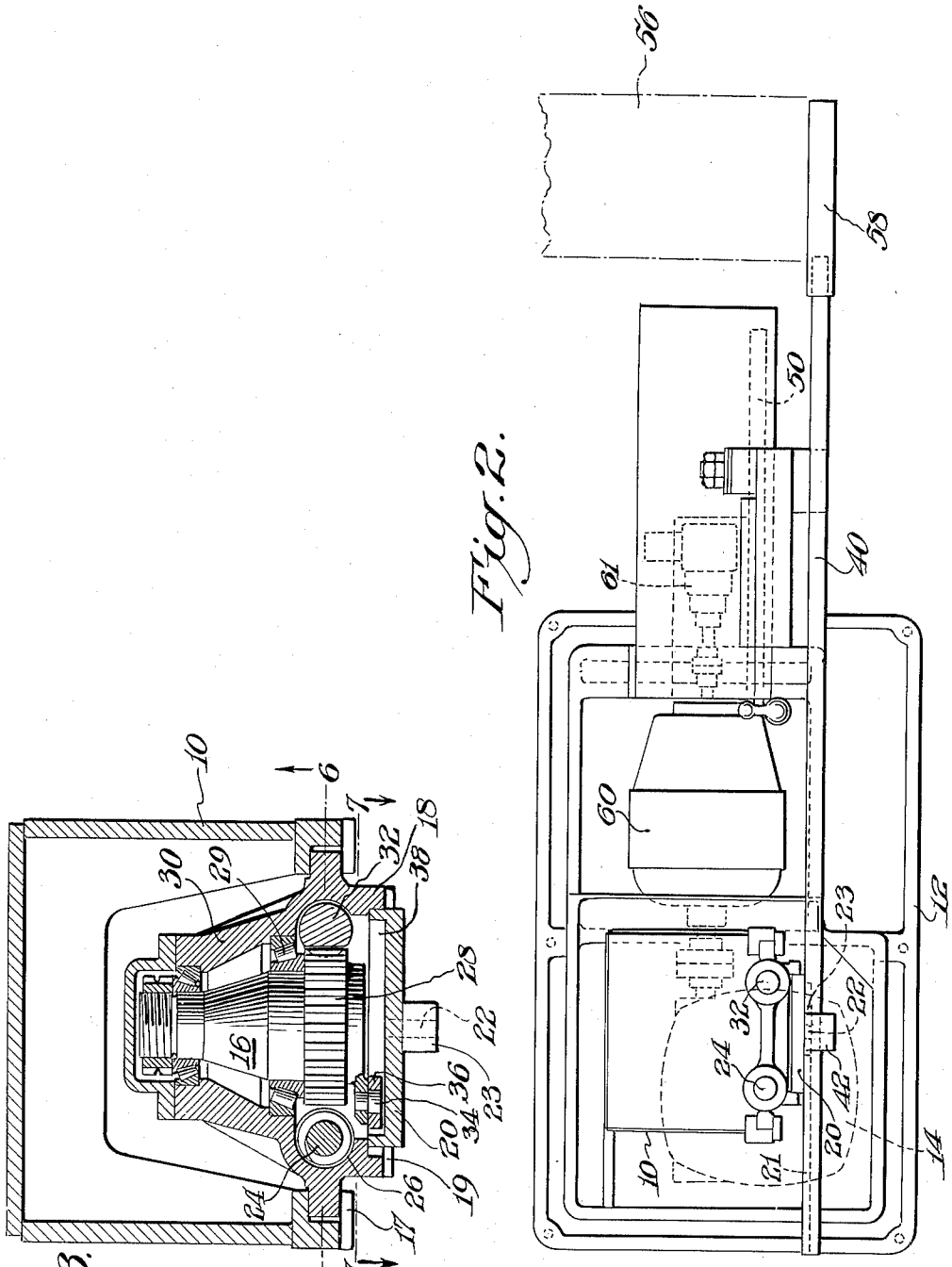


Fig. 2.

Fig. 3.

INVENTOR.
Edgar H. Schmidt
BY
Fred. Cross
ATTORNEY.

Aug. 2, 1955 E. H. SCHMIDT 2,714,336

CAM GENERATING MACHINE

Filed Aug. 23, 1951 5 Sheets-Sheet 3

Fig. 5.

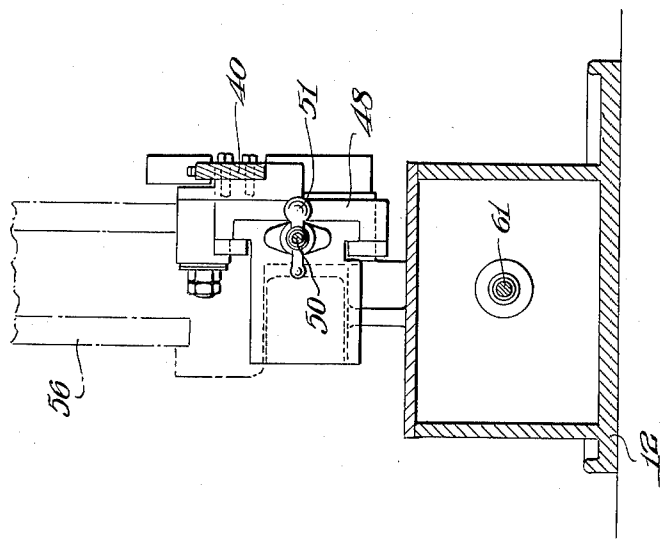
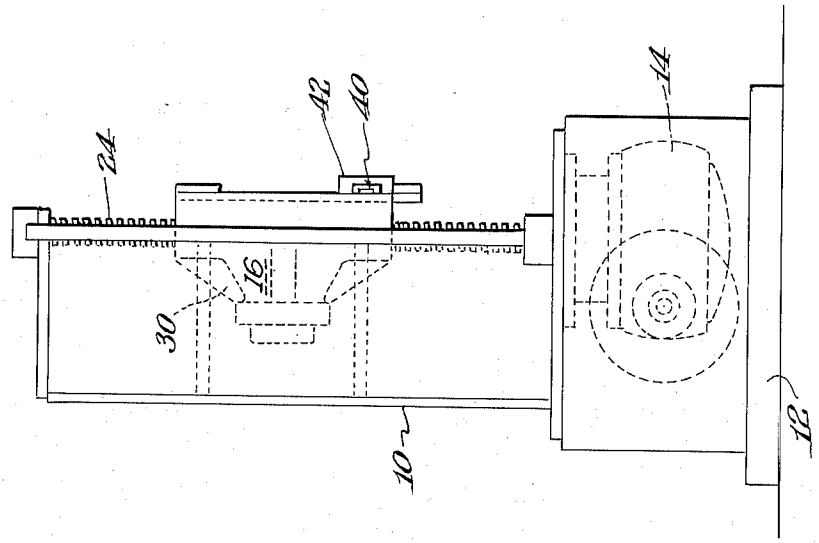


Fig. 4.



INVENTOR.
Edgar H. Schmidt
BY
Fred Olsen
ATTORNEY

Aug. 2, 1955 E. H. SCHMIDT 2,714,336

CAM GENERATING MACHINE

Filed Aug. 23, 1951 5 Sheets-Sheet 4

Fig. 6.

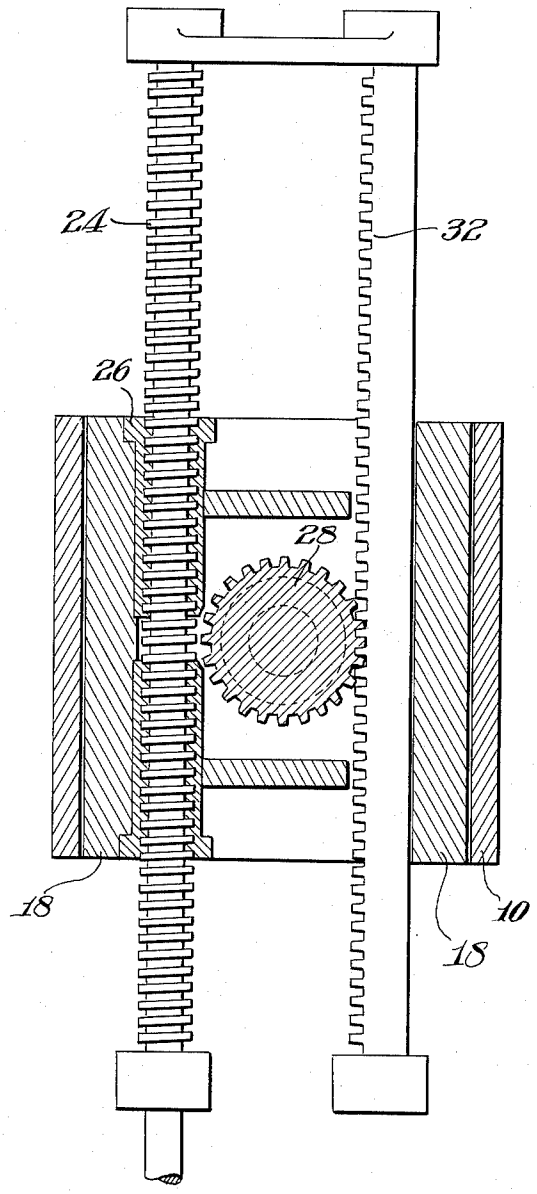
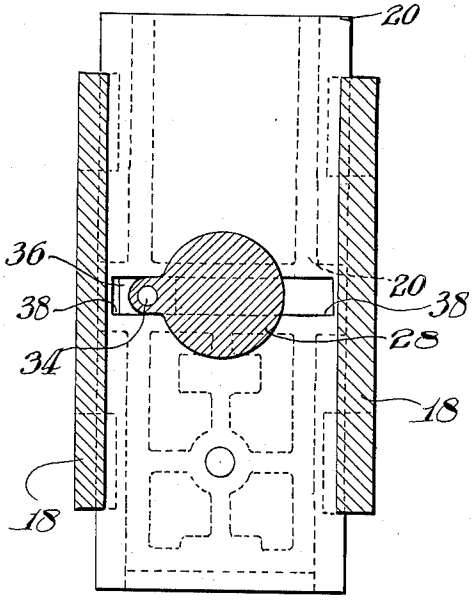


Fig. 7.



INVENTOR.
Edgar H. Schmidt
BY
Fred Sleroos
ATTORNEY.

Aug. 2, 1955 E. H. SCHMIDT 2,714,336

CAM GENERATING MACHINE

Filed Aug. 23, 1951 5 Sheets-Sheet 5

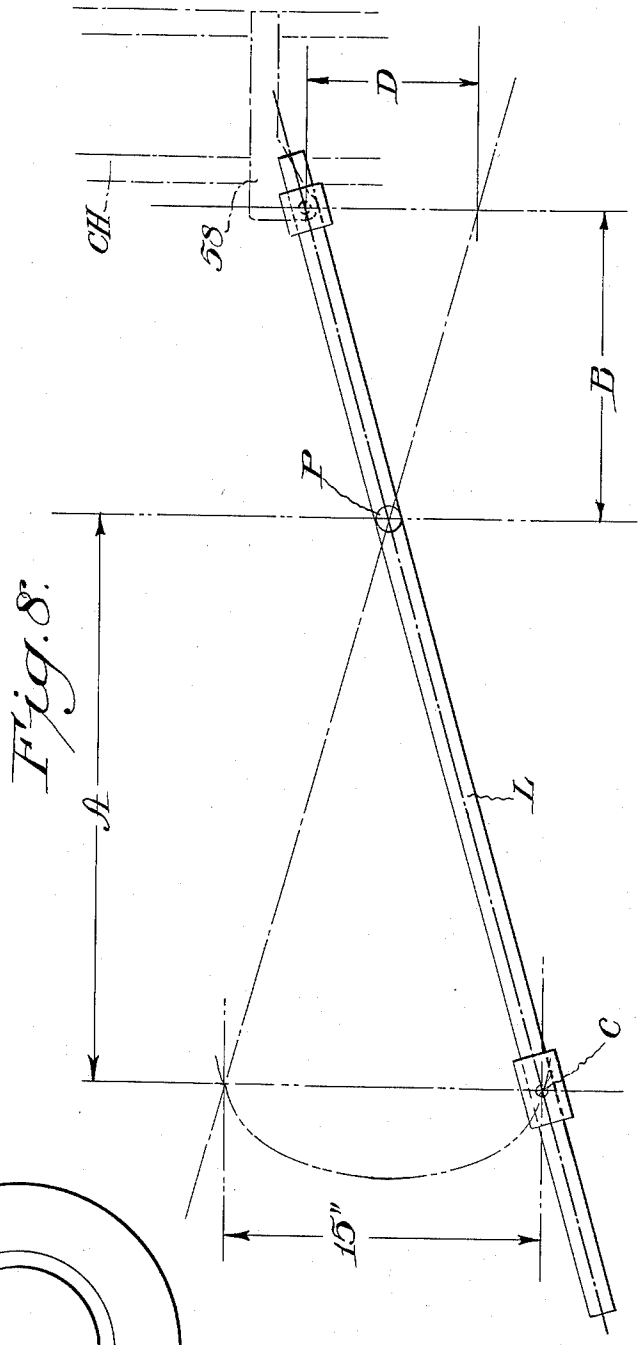


Fig. 8.

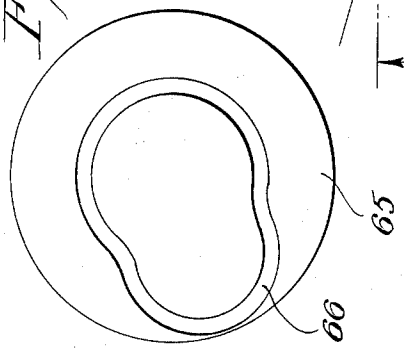


Fig. 9.

INVENTOR.
Edgar H. Schmidt
BY
Fred Sloan
ATTORNEY.

United States Patent Office 2,714,336 Patented Aug. 2, 1955

2,714,336

CAM GENERATING MACHINE

Edgar H. Schmidt, Wilmington, Del., assignor to E. I. du Pont de Nemours & Company, Wilmington, Del., a corporation of Delaware

Application August 23, 1951, Serial No. 243,207

6 Claims. (Cl. 90—15)

This invention relates to the production of manufacture of cams, and particularly to a machine for generating cams with displacements according to a predetermined or prescribed form.

A main object of this invention is to provide means for directly producing a continuous cam surface in place of the scallops produced according to conventional step processes.

A further object of this invention is to provide sufficient flexibility so that any combination of rise and displacement angle can be obtained within the limits of a predetermined scope or design.

Another object of this invention is to provide a practical and efficient machine for the purpose set forth and one which may be adjusted quickly for the generation of cams directly without the use of a master cam.

By this invention the cam is generated according to a calculated displacement and the exact form is produced by combining a mechanism capable of generating the basic displacement curve in cooperation with an additional mechanism capable of proportioning this displacement in order to produce the desired cam rise for a given angular movement.

For the purpose of carrying out one specific embodiment, the basic displacement curve is a cycloid and is produced by a crank pin mounted on the pitch radius of a gear rolling on a rack. Only the component of the crank pin displacement in a direction parallel to the rack is transferred to a crosshead which is thereby caused to have a predetermined movement between two points of zero velocity. By means of an adjustable leverage this basic displacement can be proportioned to a cutting head so as to produce the calculated or required rise on the cam being cut.

In order that this invention may be more clearly understood and readily carried into effect, a specific embodiment thereof will now be fully described with reference to the accompanying drawings, in which:

Figure 1 is a front elevational view illustrating the relationship of essential elements of the combination, including the pivotally mounted lever between the cycloidal generating unit and the cutting head follower.

Figure 2 is a top plan view of the same.

Figure 3 is an enlarged detail view of the cycloidal generating unit and pair of crossheads, taken approximately on line 3—3 of Fig. 1.

Figure 4 is an end elevational view of Fig. 1 including the cycloidal generating unit and reduction unit.

Figure 5 is a sectional elevation taken on line 5—5 looking in the direction of the arrows of Fig. 1, including the position of the ball crank means operating the horizontal screw for adjusting the fulcrum of the lever.

Figure 6 is a detail view of the vertical driving screw, and rack bar driving the cycloidal gear, taken on line 6—6 of Fig. 3.

Figure 7 is a view taken on line 7—7 of Fig. 3, looking in the direction of the arrows, and showing the crank pin traversing a slot provided therefor.

Figure 8 is a diagrammatic illustration of the proportioning lever illustrating the method by which the desired rise is imparted to the cutting head; and

Figure 9 is an example of a contour surface that can be generated.

In general the invention comprises a cycloidal generator 16 (Figs. 3 and 4) including crossheads 18 and 20 mounted in a generally rectangular supporting structure 10. The movement of these crossheads controls the movement of lever bar 40 mounted on pivot plate 54 supported on adjustable slide block 48 mounted between the rectangular supporting structure 10 and the cam-cutting machine. The lever 40 has a groove 21 which engages block 23 on pin member 22 carried by crosshead 20 and at its opposite end bears against cutting-head follower 58 mounted on the cutting head of the cam-cutting machine. It will thus be seen that as the cycloidal generator moves upwardly on the guides 17—19 a calculated distance to produce a complete cycloid, this movement is proportioned to the cutting-head follower by means of the lever 40 to produce the desired cam rise.

It will be seen also by reference to the drawing (Fig. 1) that the supporting structure is mounted on a base section 12 enclosing a reduction unit 14 driven by D. C. motor 60. This motor may also be provided with potentiometer 61. This reduction unit operates the screw member 24 for moving the constant-velocity crosshead 18, and in turn the variable-velocity crosshead 20 of the cycloidal generator, through the action of rack bar 32, gear 28 and crank pin 34.

To exemplify the foregoing general description more fully, crossheads 18 and 20 move at different velocities. It will be seen from Figure 6 as previously stated that screw member 24 rides in a nut 26 positioned on the constant-velocity crosshead 18, and as gear 28, supported in bearings 29, of casing 30, rolls on rack bar 32, variable-velocity crosshead 20 is driven by means of lug or pin 34 carried by gear 28. Pin 34 is journaled in block 36 which rides in a horizontal slot or groove 38 provided in the rear face of variable-velocity crosshead 20 as shown in Figure 7, to move the latter as gear 28 is rotated. This movement of the variable-velocity cross head 20 is transmitted to lever bar 40 through pin or crank 22 and block 23 carried by the front face of the variable-velocity crosshead as shown. It is this movement of crank or lug 34 on gear 28 that produces the complete cycloid as represented by the diagrammatic illustration shown in Fig. 8, and transfers to the variable-velocity crosshead 20 the component of the pin or crank displacement in a direction parallel to the rack to produce a predetermined movement between two points of zero velocity. This basic displacement is thus proportioned through lever bar 40 to the cutting head follower 58 and in turn to the cutting head.

In order to accomplish this movement of the crossheads, and produce the preferred displacement according to this invention, the gear 28 rotates over a prescribed path for a distance of 15 inches, since it has been determined that this distance in movement in combination with the proportioning lever 40 makes it possible to produce cams with a maximum rise of five inches (5").

It will of course be understood that the time required for displacing the variable-velocity crosshead 20 in 15 inches of movement, over the prescribed course provided for it between the two points of zero velocity, is adjustable, and this adjustment is preferably made by means of setting the speed of the D. C. motor 60 driving the reduction unit 14 and in turn the screw 24. This adjustment is made so that the cycloidal generator will go through its cycle in a given time, while the cam being cut is rotated at a constant angular velocity. This time selection is directly proportional to the angle through

which the cam rotates, and thereby the calculated rise in the desired angle on the cam is obtained.

The linkage supplied by lever **40** between the variable-velocity crosshead **20** and the cutting head is likewise adjustable, according to predetermined calculations, for varying the cutting stroke, and this may be done by varying the position of pivot point **52** by moving slide block **48** horizontally by means of horizontally positioned screw **50** thereon. This adjustment may be accomplished by operating ball crank **51**.

In this manner the movement of the variable-speed crosshead (i. e., in this case the vertical displacement as indicated by the completion of the cycloid) is proportioned through adjustable leverage action to the cutting head to produce the predetermined or calculated rise on the cam being cut.

It will be seen by reference to Fig. 1, that the lever bar **40** is so constructed that the center line of the slotted or grooved end engaging with the crank **22** beneath protective plate **42** of the cycloidal generator **16** (Figs. 3–4) passes through the center of the pivot point **52** of the pivot plate **54**, and also through the center of the angular extension of the cutting head follower **58**.

It will be seen also from the foregoing description and illustrations that when the desired combination of rise and displacement angle are once determined the exact form of cam may be produced directly according to the calculated displacement, and that this is done by generating the basic displacement curve described by crank pin **34** in a given time, translating the vertical component of the curve to crosshead **20** and lever bar **40** and adjusting the pivot point of the lever to increase or diminish the vertical movement of the cutting tool; the horizontal component of the cam profile being supplied by the rotation of the cam blank.

In short, the desired cam profile is produced on the rotating blank by timing the movement of the variable velocity crosshead to coordinate the rate of its vertical displacement with the angular velocity of the cam blank and adjusting the pivot point of the lever to control the extent of the vertical displacement of the cutting head.

Figure 8 illustrates one method of adjusting the machine for a predetermined displacement. According to this diagrammatic illustration, CH represents the cutting head controlled in its movements by the lever L, adjustably pivoted at P and operated by the cycloidal generator crank C as the generator moves over its course of travel, in this case 15 inches, while D represents the vertical distance the opposite end of lever L travels at the point of its contact with the cutting head, which is equivalent to the desired cam rise. The horizontal distance from this vertical line to the pivot point P is represented by B, while the horizontal distance from the point P to the line followed by the crank is represented by A, resulting in the formula

$$D=\frac{B}{A}15''$$

Applying the above illustrated principles to Figure 1, it will be understood also that once the adjustment of the pivot point **52** is made to produce a cam according to a predetermined or specific displacement or rise, the movement of crosshead **18** is constant during the generation of the cycloid for that cam rise, while at the same time the crosshead **20** and the lever **40** move at a variable speed as heretofore described. That is, the displacement of the cycloidal generator is always the same regardless of the shape being cut.

In actual operations involving the practice of this invention as described herein, continuous cam surfaces may be cut to produce cams of various forms. For example, in Figure 9, **66** illustrates one form of cam which may be cut from a cam blank **65**.

For this purpose, the cam generating mechanism of this invention may be applied to various cutting machines, to control the production of continuous cam surfaces in the generation of cams directly without the use of a master cam, and particularly to machines of the duplicating type, in which separate motors are provided for driving the cutting element **62** of the cutting head as designated by **56** (Fig. 1) and for the work (cam) being cut.

It will be understood that the speed of the generator is controlled so that the desired rise is obtained or displaced in the time required to rotate the work through the angle in which the rise is to occur.

While the present arrangement herein described and illustrated was selected for the purpose of disclosing the fundamental and mechanical principles involved in the development of the present invention, it will be apparent from the detailed description herein that the machine need not of necessity follow the specific design here shown and described, and that this combination may be applied also to the production of any cam whose displacement can be generated or obtained from a master cam.

While a cam generating machine has been disclosed in specific detail in the foregoing description, it will be understood that various modifications within the spirit of the invention may occur to those skilled in the art. Therefore it is intended that no limitations be placed on the invention other than as defined by the scope of the appended patent claims.

What is claimed is:

1. A cam generating machine comprising in combination, a cycloidal generator including a pair of crossheads mounted to move at different velocities between two points of zero velocity, a rotating screw geared to the first of said crossheads to drive it at a constant velocity, a cam cutting head, a rack bar in spaced parallel relation with said screw, a rotating gear carried by the cycloidal generator and in engagement with said rack bar, a horizontal groove carried by the second of said crossheads, means riding in said groove and engaged by said gear to move the second crosshead at variable velocity, a crank pin carried on the face of said second crosshead, and a lever bar pivotally mounted in spaced relation to the cycloidal generator with one end engaging said cutting head and the other end engaging the crank pin on said variable velocity crosshead to proportion the basic displacement of the cycloidal generator to the cutting head to control the cutting of the cam.

2. In a cam generating machine, in combination with a cam cutting head, a cycloidal generator including a pair of crossheads mounted to move at different velocities between two points of zero velocity, means for driving one of the crossheads at a constant velocity, a rack bar in spaced parallel relation with said driving means, a gear supported in said cycloidal generator and positioned to mesh with and roll on said rack bar, a crank pin carried by said gear for driving the other crosshead at variable velocity while the movement of said pin produces a complete cycloid, a crank pin mounted on the variable velocity crosshead, and a lever bar pivotally mounted in spaced relation from said cycloidal generator with one end thereof controlling the movement of the cutting head and the other end engaging the crank on the variable velocity crosshead to proportion the displacement of the cycloidal generator to the cutting of the cam.

3. A cam generating machine, including a cutting head, and a mechanism for generating a basic displacement curve, in cooperation with a mechanism for proportioning this displacement to produce a cam according to a predetermined angular movement comprising a constant-velocity crosshead and a variable-velocity crosshead, control means for moving the crossheads to generate or describe a basic displacement curve to be proportioned to the cutting head comprising a rotating shaft and a fixed shaft in parallel relationship, power means for driving said rotating shaft to operate the constant-velocity crosshead, and means for producing a vertical component of

a cycloid in the direction of its motion comprising a rolling gear driven by said fixed shaft to cause a point on said gear to move a distance between two points of zero velocity and describe a cycloidal path, while also driving the variable-velocity crosshead to produce a cycloidal acceleration characteristic or basic displacement, a pivotally mounted lever bar having its fulcrum point intermediate the cutting head and the crossheads and in spaced relation from each, with one end operated by the variable-velocity crosshead while the other end proportions the basic displacement curve to the cutting head.

4. A cam generating machine, including a cutting head, and a mechanism for generating a basic displacement curve, in cooperation with a mechanism for proportioning this displacement to produce a cam according to a predetermined angular movement comprising a cycloidal generator, gear means mounted within said cycloidal generator and positioned to make one complete revolution in a direct course of travel, a lever bar pivotally mounted with its fulcrum point intermediate the cycloidal generator and the cutting head and connected on one side of said fulcrum point with said cycloidal generator and on the other side with said cutting head, to proportion the movement of elements of the cycloidal generator to the cutting head, power means for driving the cycloidal generator, and means for varying the speed of the power means according to the angle of rise desired on the cam being cut.

5. In a machine for cutting a cam, fixed guides for slideably supporting a crosshead, means for driving said crosshead along said guides at a predetermined constant velocity, a gear journaled on the said crosshead, a stationary rack fixed parallel to said guides and positioned to engage and rotate the gear upon movement of the said crosshead, a block journaled on a pin positioned on the pitch circle of the gear, a second crosshead mounted on and in slideable engagement with the first crosshead, a lateral slot in the second crosshead adapted to receive said block whereby upon rotation of said gear the second crosshead will be moved in a direction parallel to said rack but at a varying speed, a lever mounted on a fulcrum intermediate its ends, a pin carried by said second crosshead and engaging a slot at one end of said lever, and a cutting head mounted on the other end of the lever, whereby a movement proportional to the movement of the second crosshead will be imparted to the cutting head.

6. In the machine defined in claim 5, means for adjusting the fulcrum laterally to vary the extent of the displacement of the cutting head.

References Cited in the file of this patent

UNITED STATES PATENTS

1,780,211 Tornebohm ---------- Nov. 4, 1930