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APPARATUS FOR LAYING OUT COMPLEMENTARY CAM CONTOURS

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2 Sheets-Sheet 2

FIG. 2.

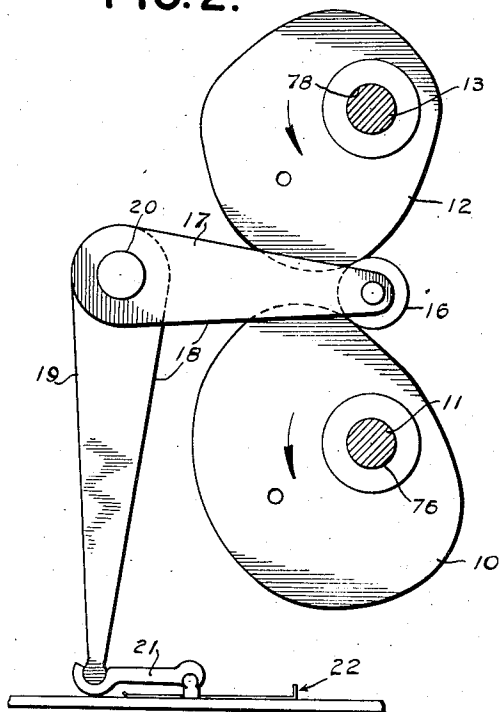


FIG. 4.

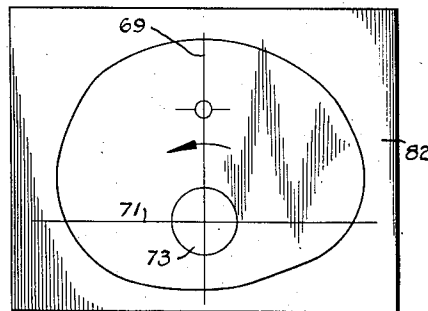


FIG. 3.

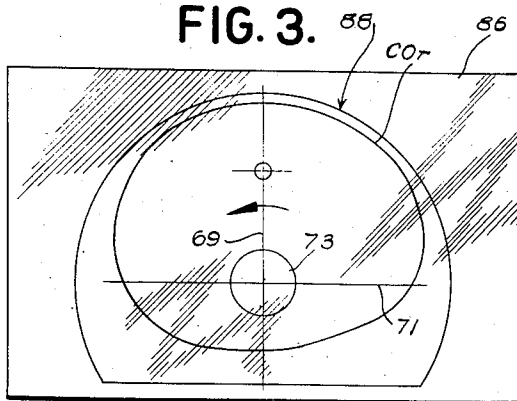
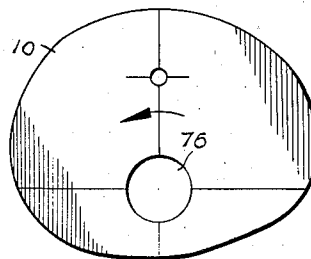


FIG. 5.



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APPARATUS FOR LAYING OUT COMPLEMENTARY CAM CONTOURS

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3 Claims. (Cl. 33—25)

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The improved method of and apparatus for laying out cam contours and producing cam elements therefrom is primarily adapted for use in connection with complementary cams of the type which are employed for the positive two-way driving motion of a cam follower. The invention, however, is capable of other uses and the same may, if desired, be employed in the laying out and production of either single or multiple cams of various types and designed for a variety of uses.

The principal object of the present invention is to provide a relatively simple and efficient method and apparatus whereby a large number of complementary or other associated cams may be produced at a comparatively great saving both in the time consumed for the cam layout operations and in the transfer of the cam layout contours to the metal or other material from which the cam elements are to be machined or otherwise constructed.

Another object of the invention is to provide such a method and apparatus which is equally well adapted for use in connection with cams having simple or compound contours, as for example, contours which are formed to produce positive two-way bail movements of a complex nature requiring initial analytical calculations of multiple tangential or intersecting parabolas, hyperbolas or other graphical curves.

A still further object of the invention is to provide a method and apparatus of the character set forth above wherein extreme accuracy in the production of the actual cam elements may be attained by the expedient of utilizing a substantial scale increase in the layout procedure for the cam contours and a corresponding photographic scale reduction in transferring the cam contours to the metal or other material from which the cams are to be machined or otherwise formed.

Yet another object of the invention is to provide a novel and efficient form of pantograph designed for use in effecting layout operations whereby a single cam contour may be outlined, or whereby plural complementary or otherwise related cam contours may simultaneously be outlined utilizing as a reference guide an initial predetermined bail movement timing chart.

Other objects and advantages of the invention not at this time enumerated will become more readily apparent as the nature of the invention is better understood.

In the accompanying two sheets of drawings forming part of this specification one embodi-

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ment of the invention is shown. In these drawings:

Fig. 1 is a plan view of a cam layout apparatus constructed in accordance with the principles of the present invention and showing purely for illustrative purposes the manner in which a pair of complementary cam contours may be inscribed on respective cam outline cards according to a predetermined bail movement represented on a graphic chart.

Fig. 2 is a side elevational view, diagrammatic in its representation, showing the pair of completed complementary cam elements and illustrating the manner in which they cooperate to produce the desired bail movement.

Fig. 3 is a plan view of a photographic plate employed in connection with the present invention and illustrating one step employed in producing a finished cam element.

Fig. 4 is a plan view of an etched blank employed in connection with the invention and illustrating a further step in the process.

Fig. 5 is a plan view of a completed or finished cam element.

The apparatus shown in Fig. 1 illustrates an apparatus which may be employed during the initial layout steps in the production of a pair of complementary cam elements of the type shown in Fig. 2 and designated at 10 and 12 respectively. The cam elements 10 and 12 possess arbitrary cam contours that have been selected purely for illustrative purposes in connection with the present invention. The contours of the cam elements 10 and 12 are predicated upon predetermined bail movements whose counterparts may be represented by several tangential parabolic curves, such as are designated at *a*, *b*, *c*, *d*, *e* and *f* in a bail movement timing chart of the type shown at 14 in Fig. 1. While the timing chart 14 and contours of the cams 10 and 12 resulting therefrom in the present instance are comprised of parabolic increments possessing six different points of tangency, it will be distinctly understood that by suitable modification the apparatus of Fig. 1 may be employed in the production of cams whose contours are comprised of a greater or lesser number of increments, whether these increments be parabolic in their nature or otherwise, and whether they be tangential or intersecting at their adjacent points of juncture. Regardless of the specific contours of the cam or cams which it is desired to construct, or of the bail movements from which they are derived, the essential features of the present invention are at all times preserved.

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The cams 10 and 12 of Fig. 2 are mounted upon rotary members 11 and 13 respectively for rotation in the same direction as indicated by the arrows and are said to be complementary to each other in that together they control the movement of a cam follower 16 which transmits motion to a bell crank lever 18, pivoted as at 20, which in turn imparts a predetermined character of motion to a reciprocable bail 22. Such complementary cams are well known in the art and are employed in order that the bail 22 may be driven in both directions by a positive driving action, as distinguished from the type of driving action that accrues from the use of a single cam and spring pressed follower wherein the bail is positively driven in one direction only.

The bell crank lever 18 includes a short arm 17 on which the cam follower 16 is mounted and a long arm 19 which is connected by a link 21 to the bail 22. The link 21 serves to convert the arcuate oscillatory motion of the free end of the arm 19 to linear reciprocal movement of the bail 22.

In carrying out the present invention the desired bail movement is plotted on transparent paper on a comparatively large scale, as for example, a scale of six to one using the various ordinates and abscissae required in the construction of the various tangential parabolas *a, b, c, d, e* and *f* in the graph of Fig. 1. A base line 24 of the chart is then divided into 360° by means of indicia 28 and a line 26 representing the mid-travel of the bail is drawn across the chart parallel to the base line.

The next step in the process resides in the construction of a pantograph, designated in its entirety at 30, from sheet metal or other suitable material and in its installation on a suitable drafting board 32 or the like.

The pantograph 30 is designed for operation at a commensurate scale of six to one and involves in its general organization a pair of relatively long, approximately parallel arms 34 and 36 which are pivoted as at 38 at spaced points to the surface of the board 32. A cross member 40 is pivoted as at 42 to points adjacent the free ends of the arms 34 and is provided with an extension 45 to which there is pivoted as at 44 at its free end a link 47 having a reference point 46 at its outer end. A cross piece 48 is pivoted at 50 medially of the arm 34 and is connected by an extension joint 52 to a follower 54 which is pivoted at 56 medially of the arm 36. The extension joint 52 is provided in order to permit slight adjustment of the pivotal points 38 on the board 32.

The follower 54 is formed of flat sheet metal stock and is provided with substantially semi-circular ends 58 and 60, which ends afford guiding edges for a draftsman's pencil or other scribing tool in the successive placement of circular arcs in the outlining of the cam contours, as will be described presently.

The pantograph 30 is designed for use in laying out the complementary cam contours, which in Fig. 1 are designated at CO and CO_c respectively, and which, in addition, have been correspondingly labeled. The laying out operations are performed on a pair of circular cam outline cards 62 and 64 respectively.

Each of the cam outline cards 62 and 64 is provided with indicia 66 around its periphery representing degrees of angular movement and corresponding to the indicia 28 of the bail movement chart 14. Indicia reference markers 68

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are affixed to the drafting board 32 for cooperation with the indicia 66 of the two cam outline cards 62 and 64 and occupy fixed positions on the board which are ascertained after determination of the two rotational centers for the circular cards.

In order to establish a center on the drawing board for the cam outline cards, the card 64, upon which the outline CO_c of the complementary cam 12 is to be drawn, is placed in a position approximating its true position. A line is then drawn on the card utilizing one edge of the cross piece 48 as a guide. The card is rotated throughout an angle of 60° and another line is drawn on the card in a similar manner. This process is repeated until a closed hexagon, shown at 67 in dotted lines, has been described on the card and its true center *c* is determined by well known geometrical expedients and the established center of the hexagon is transferred to the drafting board 32 and is utilized as the rotational center of the cam outline card 64. Reference lines 69 and 71 are drawn on the card 64 through the established cam center for the purpose of checking the scale of a subsequent photographic reduction process which is resorted to for the purpose of etching the true complementary cam outline on the stock preparatory to machining operations, as will be set forth presently.

The center *c'* for the cam outline card 62, upon which the cam outline CO of the cam 10 is to be drawn, lies on a line normal to the edge of the cam outline chart 14 and passing through the center *c*. The distance between the two centers *c* and *c'* is dependent upon the center to center distance between the respective centers of the semi-circular ends 58 and 60 of the follower 54.

The drafting procedure employed in producing the cam outlines CO and CO_c on the cam outline cards 62 and 64 respectively consists in positioning the transparent bail movement chart 14 on the drafting board 32 in such a manner that the line 26 representing the mid-travel of the bail is superimposed upon a previously inscribed reference line 27 on the board 32. The 0° designation of the scale 28 is brought into superimposed alignment with a transverse line 29 on the board 32 which constitutes a time reference line for subsequent drafting operations. The 0° designations of the peripheral indicia 66 on both of the cam outline cards 62 and 64 are brought into register with their respective reference markers, while at the same time the reference point 46 on the link 47 of the pantograph 30 is brought into register with the plotted bail movement curve on the chart 14 at the 0° position. With the apparatus thus set up, small arcs are described in pencil as at 70 and 72 on the cards 62 and 64 utilizing the semicircular ends 58 and 60 of the follower 54 as guides.

After the arcs 70 and 72 have been described on the two cam outline cards 62 and 64, the transparent bail movement chart 14 is moved upwardly so as to bring the 1° indicia on the scale 28 into register with the reference line 27 and thereafter the cam outline cards 62 and 64 are indexed one degree. During the movement of the chart 14, the lines 26 and 27 are maintained in register so that the angular position of the chart remains undisturbed. Additional arcs 70 and 72 are described on the outline cards 62 and 64.

The above described procedure is repeated degree-for-degree until continuous cam outlines are

indicated on the two cards. Where the nature of the cams 10 and 12 warrant it, as for example, where the cams have straightaway portions, it is obvious that indexing of the bail movement chart and cam outline discs may be effected utilizing larger steps at the discretion of the operator.

After the continuous cam outlines have been indicated on the cards 62 and 64 by the more or less close succession of arcs 70 and 72 thereon, the indicated cam outlines are traced and inked with the aid of a suitable French curve, utilizing a line approximately .02 inch wide so as to produce a line of about .003 inch during the subsequent photographic reduction process, as will be set forth hereinafter. While the thickness of the tracing line has been stated above as being preferably .02 inch wide, it is obvious that lines of greater or lesser thickness may be employed, depending upon the drafting and photographic exigencies encountered in the production of the cam elements.

It is obvious that the rotation centers of the two cam outlines CO and CO_c will coincide with the rotation centers of the two cards 62 and 64. Circles 73 and 74 are described about these centers for subsequent production of cam mounting openings 76 and 78 on the finished cam elements.

Because of the fact that the link 21 associated with the arm 19 and bail 22 of Fig. 2 serves to convert the oscillating movement of the arm 19 into straight line reciprocal movement of the bail 22, a similar compensating device must be employed in the pantograph 36. The link 47, which is pivoted as at 44 to the extension 45, accomplishes this purpose.

The pencilled arcs 70 and 72 are erased from the cam outline charts and the remaining cam outlines CO and CO_c are then photographed by a conventional photographing operation at a commensurate reduction which is on a scale of six to one in the present instance so as to obtain an exact size reproduction CO_r on a glass plate 82 as shown in Fig. 4. The lines 69 and 71 which appear in the negative reproduction are used for checking the accuracy of scale reduction.

The next step in the process of producing the cam elements 10 and 12 consists in making an etching 88 on a selected cam stock 90 to a depth of approximately from one to two thousandths of an inch. Any suitable negative emulsion which permits those portions thereof which are not exposed to light to be washed away preparatory to application of the etching acid or solution may be employed in the etching process.

During machining operations, wherein the cam elements 10 and 12 are produced in final form, the elements are finished to the outside of the cam contour lines CO and CO_c which, as previously stated, are preferably about .003 inch in thickness.

It has been found that by the above procedure cam elements which are extremely accurate may be produced with a great saving in both time and labor and at a comparatively low cost as compared to the production of these cams by present day standard methods.

The invention is not to be limited to the exact arrangement of parts shown in the accompany-

ing drawings or described in this specification as various changes in the details of construction may be resorted to without departing from the spirit of the invention. Only insofar as the invention has been particularly pointed out in the accompanying claims is the same to be limited.

What is claimed is:

1. A pantograph for producing complementary cam outlines comprising a pair of pantograph arms mounted for pivotal swinging movement about spaced axes, a pair of cross members pivotally connected adjacent their opposite ends to said arms to form a closed parallelogram-like structure, a link pivotally connected to one of said cross members, a tracing point on said link, and a follower mounted on the other cross member and having a pair of arcuate guide surfaces thereon serving as guide lines for manual scribing purposes.

2. A pantograph for producing complementary cam outlines comprising a pair of pantograph arms mounted for pivotal swinging movement about a pair of spaced axes, a cross member pivotally connected adjacent its ends to a medial point on each of said swinging arms and of an extent whereby said swinging arms are maintained substantially in parallelism, a second cross member pivotally connected to said swinging arms adjacent the free ends of the latter, an extension on said second cross member, a link pivotally connected to said extension, a tracing point on said link, and a follower carried by said first mentioned cross member and having a pair of oppositely disposed convex arcuate guide surfaces thereon serving as guide lines for manual scribing purposes.

3. A pantograph for facilitating the laying out of complementary cam contours comprising two pantograph arms of substantially equal length, each of said arms being pivoted adjacent one end thereof for swinging movement about a fixed center, a cross member pivoted to the other ends of said pantograph arms and serving to maintain the arms in substantial parallelism, said arms and cross member thus forming a quadrilateral structure, said cross member including a follower having a pair of arcuate guide surfaces adapted to serve as guide lines for manual scribing purposes, one of said guide surfaces being disposed wholly within the quadrilateral structure and the other thereof being disposed wholly outside of the structure, a second cross member pivotally connected to the free ends of said arms, an extension on said latter cross member exteriorly of the quadrilateral structure, a link pivotally connected to said extension adjacent one end of the former, and a tracing point formed on said link adjacent the other end thereof, said tracing point being designed for register with a bail movement chart.

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REFERENCES CITED

The following references are of record in the file of this patent:

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