

Oct. 22, 1963

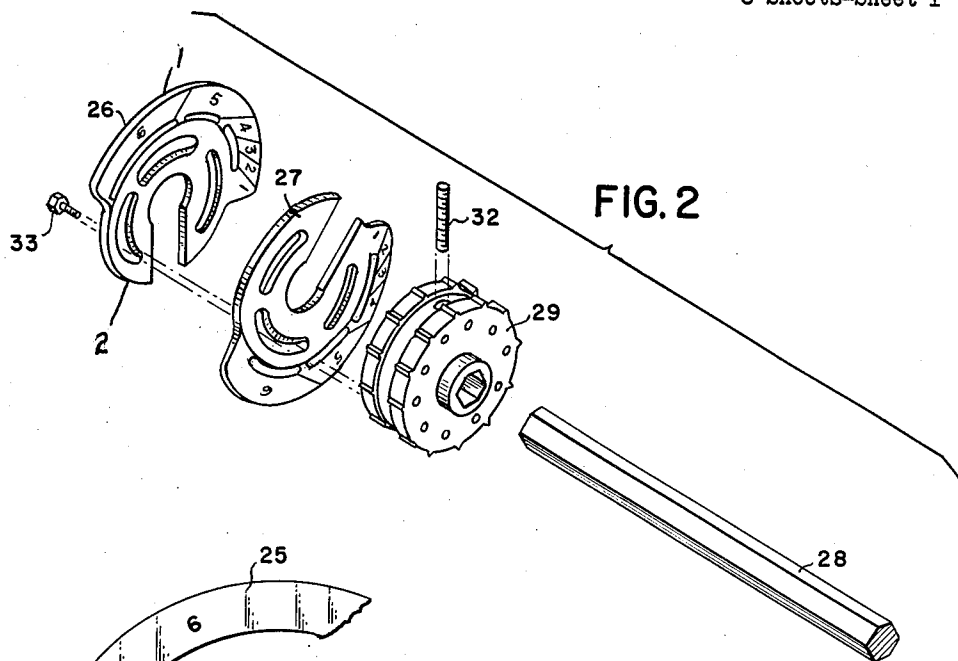
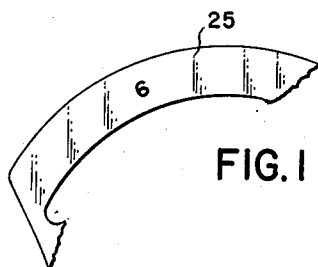
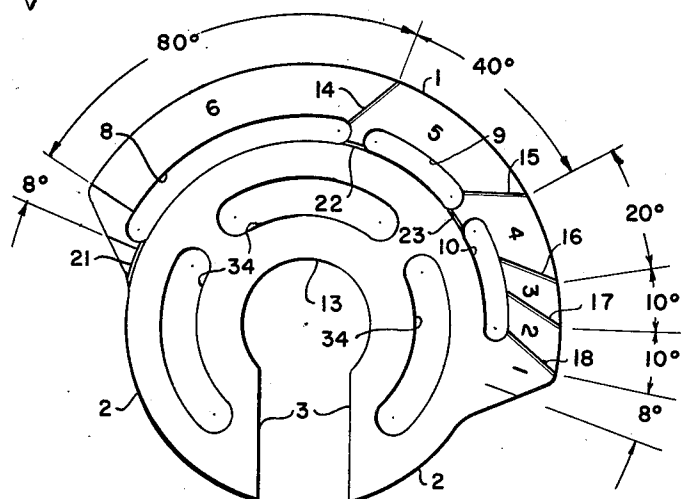
E. F. GOETZ ETAL

3,107,548

CAM STRUCTURES

Filed April 17, 1961

3 Sheets-Sheet 1



INVENTORS
ERNEST F. GOETZ
ALBERT W. ANDERSON
BY *Merton D. Moore*

ATTORNEY

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FIG. 3

INVENTORS
ERNEST F. GOETZ
ALBERT W. ANDERSON
BY *Merton D Mone*

ATTORNEY

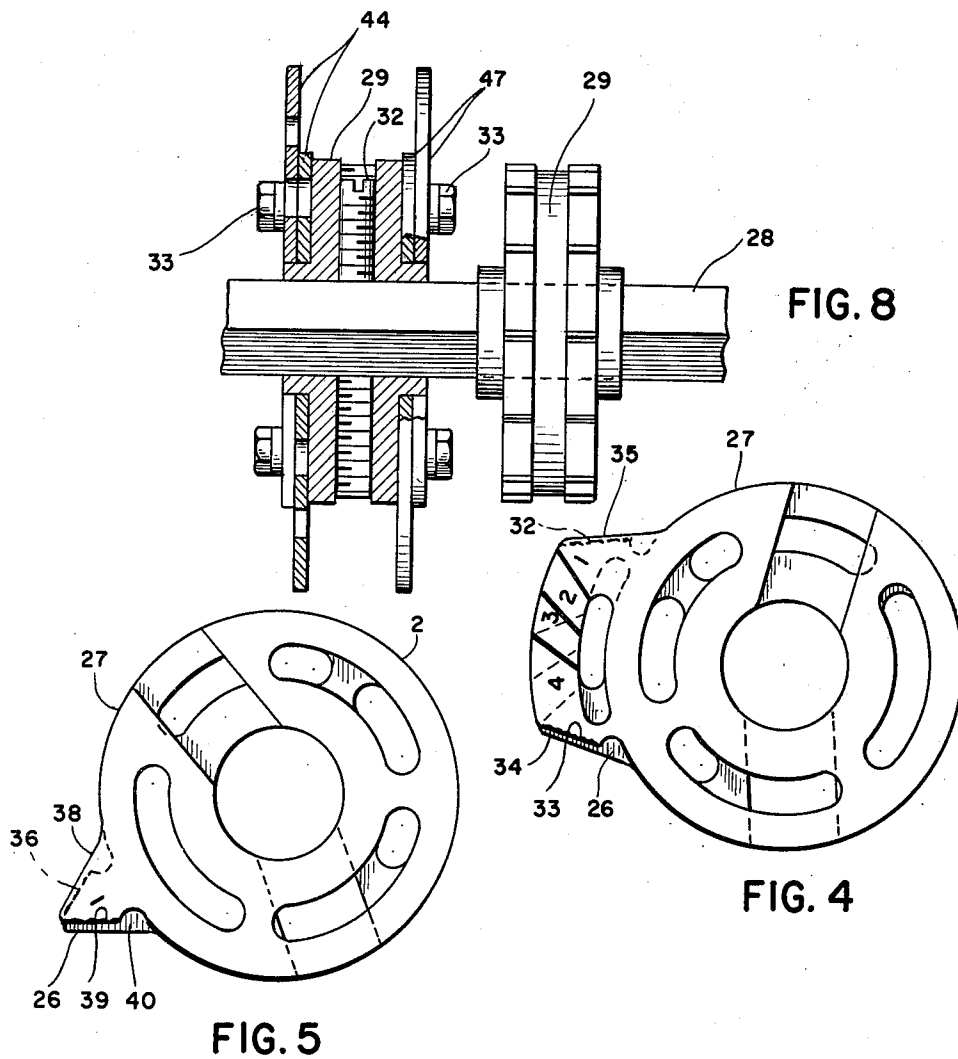
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INVENTORS
ERNEST F. GOETZ
ALBERT W. ANDERSON
BY *Merton D. Moore*
ATTORNEY

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CAM STRUCTURES

Ernest F. Goetz and Albert W. Anderson, Roanoke, Va.,
assignors to General Electric Company, a corporation
of New York

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Our invention relates to cam structures and particularly to such structures having variable cam surface lengths.

It has for one of its objects to provide a cam adapted for rotation and having two cam surfaces complementarily adjustable in length throughout substantially an entire circumference of the cam.

In electrical control systems, for example, need arises for operation of different switches of a switch assembly, in sequence, and in desired fixed angular relationships with respect to the rotation of a control shaft. An object of our invention is to provide a cam, and cam assemblies, which may be mounted upon such a control shaft, each cam, or cam assembly, being positioned and shaped to actuate an associated switch in desired relationship to the other switches and to provide desired "open" and "closed" periods of the switch which are readily adjustable over wide ranges.

A further object of our invention is to provide such operation by a cam structure that is economical to build and is highly practical in its application.

The novel features which we believe to be characteristic of our invention are set forth with particularity in the appended claims. Our invention, itself, however, may best be understood by reference to the following description taken in connection with the accompanying drawing in which FIG. 1 shows a cam constructed in accordance with our invention; FIG. 2 shows a pair of such cams arranged for assembly upon a shaft, but in exploded view; FIG. 3 shows two such cams arranged to comprise a single cam having maximum outer surface length; FIG. 4 shows the cams with the two longer segments of each cam broken away; FIG. 5 shows the cams with all of the break away segments removed; FIG. 6 shows two cams assembled together in a different relationship and with the longest segments removed; FIG. 7 shows a switch actuating assembly in which such cams find particular utility and FIG. 8 shows the manner of securing such cams to a shaft.

Referring to FIG. 1 the cam illustrated comprises a generally circular platen member having an outer peripheral cam surface 1 having the larger of two radii and an inner peripheral cam surface 2 having the smaller of the two radii.

The surface 1 from the middle of the cam rise at one end to the middle of the cam fall at the other, subtends 176° and the surface 2 subtends the balance of the circumference except for an area 3 cut away for the purpose of permitting the cam to be assembled on a shaft.

The surface 1 comprises the outer peripheral surface of a partial annulus made up of segments 6, 5, 4, 3, 2 and 1, each preferably having the lengths indicated in degrees on FIG. 1. These segments are partially severed from the cam body, which is illustrated as circular, by elongated circumferential openings 8, 9 and 10 extending circularly about the shaft opening 13 and lying outside of the circumference defined in part by surface 2. All of the cam segments 6, 5, 4, 3, 2 and 1 are connecting together end to end, but only by break away sections 14, 15, 16, 17 and 18.

Segment 1 is integral with the body of the cam. Segment 6 is connected to the body of the cam only by the break away section 21. Segment 5 is connected to the body of the cam only by break away section 22.

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Segment 4 is connected to the body of the cam only by break away section 23, and segments 3 and 2 are connected to the body of the cam only through their attachment to each other and to segment 1 by break away sections 17 and 18.

These break away sections are merely sections at which a segment, such as the segment 6, for instance, may be readily broken free from the rest of the cam as shown at 25 in FIG. 1. This breaking away may be done either by hand or with a pair of pliers or wrench, the section having been prepared for such breaking by an appropriate groove in the surface, such as might be produced by a saw, or chisel, cut, or a molded groove.

The surface left at the break away sections 14, 15, 16, 17 and 18 may be somewhat irregular and unsuitable as the cam rise or cam fall of a cam follower but, as we contemplate the use of the cam, this is unobjectionable because, as will presently appear, these break away edges are not engaged by the cam follower. The break away sections 21, 22 and 23 are unobjectionable because of clean breaks that may be had with hardened and tempered materials, although occasionally a file, or abrasive means may be used to remove burrs.

Of course as many of these segments may be broken away as desired dependent upon the cam length desired.

FIG. 2 shows two cams, 26 and 27, arranged for assembly upon a shaft 28, which may project through a hub 29, which may be secured thereto by means of a set screw 32. The cams may both be secured to one side of the hub having desired angular relationship to each other by means of a number of screws, one of which is shown at 33 and which may project through the elongated openings 34 in the body of the cam.

The two cams 26 and 27 taken together form a single cam having a cam surface of the larger radius, which may be made as long as desired by properly positioning the two cams in rotation with respect to each other. This outer larger radius surface may also be made as short as desired by proper positioning the cams in rotation with respect to each other and by breaking away some or all of the break away cam segments. In the same way the surface 2 of shorter radius is complementarily varied in length.

FIG. 3 shows two cams 26 and 27, such as those of FIG. 2, positioned with respect to each other to form the largest possible cam surface 1 of the larger radius and the shortest possible cam surface 2 of the shorter radius. Of course these cam surfaces may be rotated about the shaft to overlap to a desired degree to form a surface 1 of large radius of any desired shorter length down to a length of approximately 180°. If it be desired to have an outer surface 1 shorter than 180°, both of the two segments 6, and as many of the other segments as desired, may be broken away.

FIG. 4, for example, shows the two cams 26 and 27 arranged together with the segments 6 and 5 broken away. The segment 5 of cam 26 is broken away along the line 32, and the segment 5 of cam 27 is broken away along the line 33. These areas where segments are broken away, as previously mentioned, may be somewhat irregular, but this is unobjectionable because the cam follower rides up the finished surface 34 of the cam 26 and it rides down the finished surface 35 of the cam 27, or vice versa, dependent on the relative directions of rotations of the cam and cam follower. Slight filing, or abrading, of these surfaces removes objectionable burrs.

It will be noticed from FIG. 1 that if the length of the outer cam surface be measured from the middle of the rise at one end to the middle of the fall at the other end it amounts to about half of the circumference, the balance of the circumference being of shorter radius. The outer surfaces of segments 6, 5, 4, 3 and 2 are respectively

80°, 40°, 20°, 10° and 10° in length, or $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$, etc., of the total length of the outer surface. Thus each time that the longest segment of the cam is broken away it shortens the outer surface by one half. This is desirable since with such proportioning, without breaking away any segments, the outer cam length may be varied by varying the overlap from about 320° in FIG. 3 to about 160°. Then by breaking away segments 6 the cam length may be varied by overlapping, and without further breaking, from 160° to about 80°. Then by breaking away segments 5 the cam length may be varied from 80° to 40° etc., on down to the situation illustrated in FIG. 5 where enough overlapping still exists to provide a smooth outer cam surface over the tip of the somewhat pointed cam. Of course a single cam segment of one cam may be broken away without breaking any segment from the other cam. Usually when the outer cam surface is to be less than 180° cam segments are broken from both cams.

FIG. 5 shows the two cams arranged for the smallest possible surface area of large radius and the largest possible surface of small radius. Here again the irregular break away surfaces such as the surface 36 is not engaged by the cam follower which rides up the finished surface 38 of the cam 27. Similarly, the irregular surface 39 is not engaged by the cam follower which rides up the finished surface 40.

FIG. 6 shows cams 26 and 27 arranged with the longer segments overlapping whereas in FIG. 4 the shorter segments overlap. It also shows the segment 6 broken away to form irregular surfaces at 42 and 43. These are unobjectionable, however, because they are not engaged by the cam follower.

It will be noticed that the outer cam surface may be varied all the way from a minimum point as in FIG. 5 to almost a complete circumference as shown in FIG. 3, and that the inner shorter radius surface is varied complementarily therewith.

FIG. 7 shows a switch actuating assembly utilizing such pairs of cams. It comprises a shaft 28 provided with a hub 29 to one side of which may be bolted a pair of cams 44 for actuating a cam follower 45 which serves to reciprocate a lever mechanism 46 for controlling a switch not shown. Similarly, a pair of cams 47 may be bolted to the opposite side of the hub to actuate a corresponding cam follower which reciprocates a lever 48 to operate a desired switch not shown. A number of other such pairs of cams may be mounted upon the shaft 28 to operate different switches of any desired angular relationship with respect to the rotation of the shaft.

FIG. 8 shows two such hubs 29 mounted on a shaft 26, shaft 28, the left-hand hub carrying two pairs of cams 44 and 47 and being bolted to the hub by means of bolts 33. The hubs may be secured to the shaft by set screw 32.

It will be noticed from the various figures that the cams can always be placed together in overlapping relationship to produce any desired continuous cam length of both radii and without any discontinuity caused by the slot 3 for admission of the shaft.

While we have shown a particular embodiment of our invention it will, of course, be understood that various modifications may be made therein and we contemplate

by the appended claims to cover any such modifications as fall within the true spirit and scope of our invention.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. For use in a cam mechanism, a cam having two cam follower surfaces of different radii from a common center, the surface of larger radius comprising the outer periphery of a partial annulus, said partial annulus comprising segments attached together end to end and to the inner portion of the cam by break away sections so positioned at the ends of the segments that the length of said cam follower surface of greater radii may be shortened by breaking away a break away section, said segments between break away sections from one end of the partial annulus to the other having successive lengths related to each other substantially as $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$ of the cam surface length of larger radius.

2. For use in a cam mechanism, a pair of cams each having two cam surfaces of different radii, the surface of larger radius comprising a partial annulus, said partial annulus comprising segments of successive shorter lengths from one end to the other, the segments being attached together end to end by break away sections, said break away sections and one end of the partial annulus being sloped at an angle to the radius from the inner surface to the outer surface toward the shorter segments, the other end of the partial annulus being sloped toward the longer segments, whereby said longer segments may be broken away and the cams placed together with areas toward the shorter segments overlapping to form a single path for a cam follower comprising parts of each cam and free of any broken away area.

3. For use in a cam mechanism, a pair of cams each having two cam surfaces of different radii, the surface of larger radius comprising a partial annulus, said partial annulus comprising segments of successively graded lengths attached together end to end and to the inner portion of the cam by break away sections, said sections between segments being generally slanted to the radius similar with one end surface of the partial annulus, said end surface being sloped at an angle to a radius to provide a continuous surface for the cam follower from the surface of smaller radius to the surface of larger radius, and said pair of cams being positioned together to constitute a single cam surface, with the segments of greater length overlapping, whereby any segment of greatest length may be broken away to shorten the cam and the cams overlapped to cover the broken away surface.

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