April 17, 1956 O. D. GRANDSTAFF 2,742,538

ROTARY INTERRUPTER

Filed Oct. 10, 1952 3 Sheets-Sheet 1

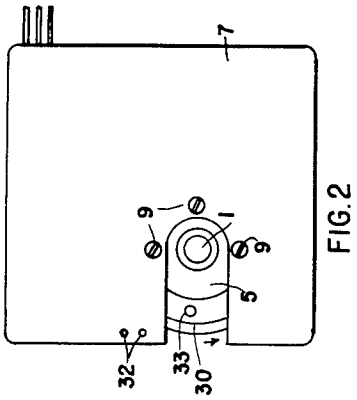


FIG. 2

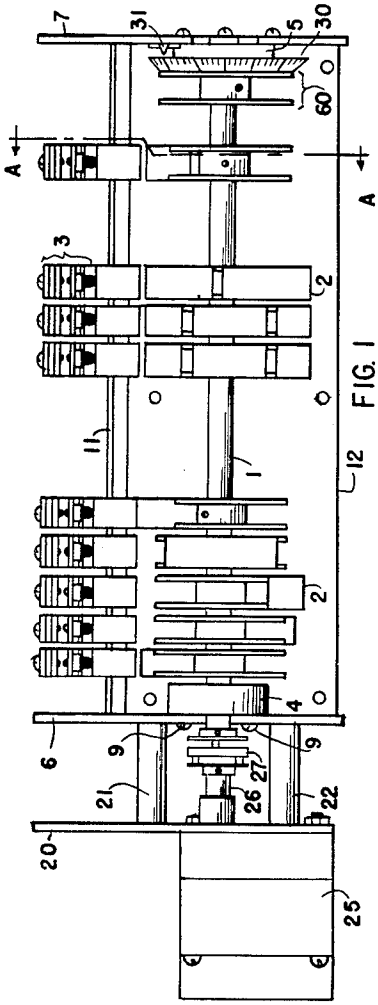


FIG. 1

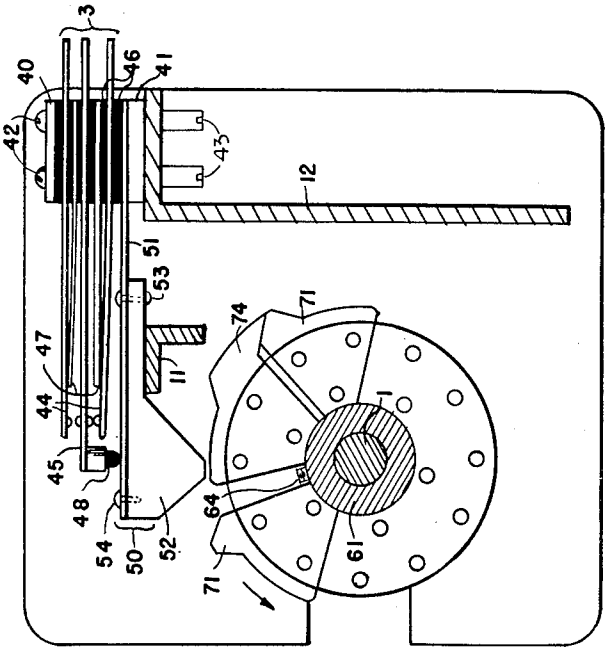


FIG. 3

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ROTARY INTERRUPTER

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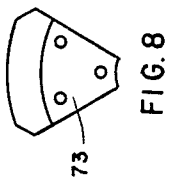


FIG. 8



FIG. 14

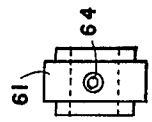


FIG. 13

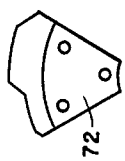


FIG. 7

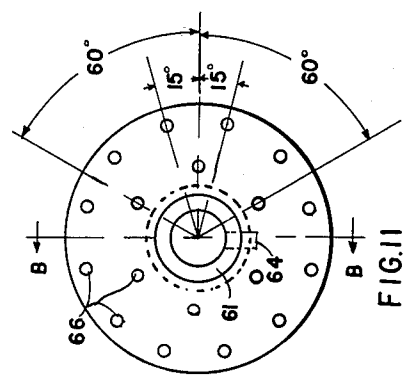


FIG. 11

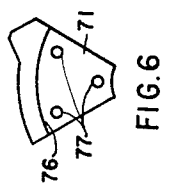


FIG. 6

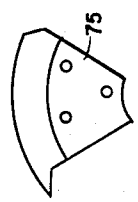


FIG. 10

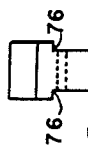


FIG. 5

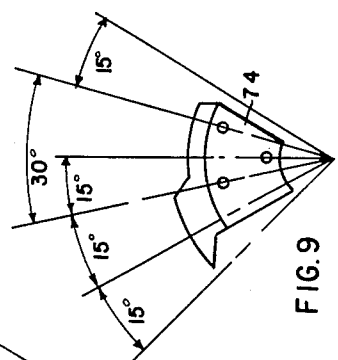


FIG. 9

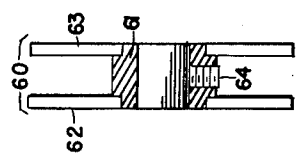


FIG. 12

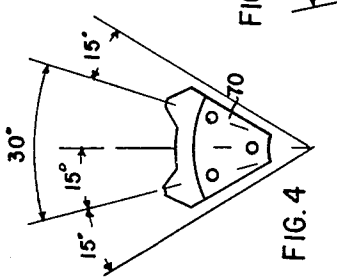


FIG. 4

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ROTARY INTERRUPTER

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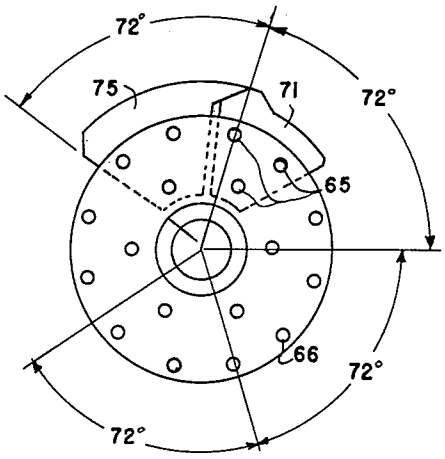


FIG. 15

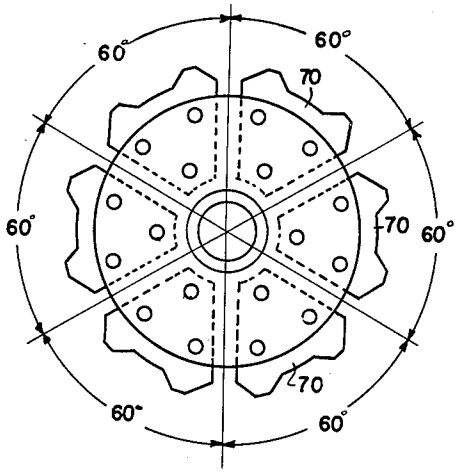


FIG. 16

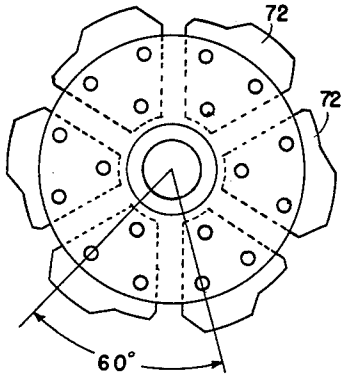


FIG. 17

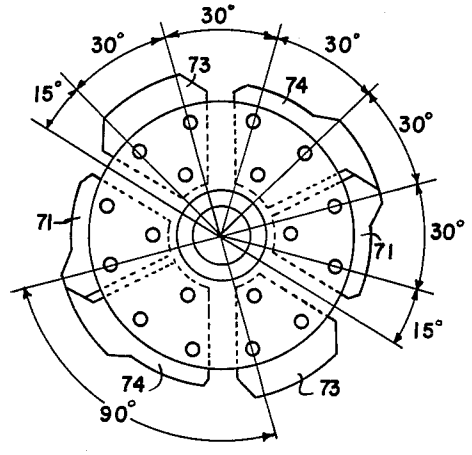


FIG. 18

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United States Patent Office

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Patented Apr. 17, 1956

2,742,538

ROTARY INTERRUPTER

Otho D. Grandstaff, Oak Park, Ill., assignor to Automatic Electric Laboratories, Inc., Chicago, Ill., a corporation of Delaware

Application October 10, 1952, Serial No. 314,060

9 Claims. (Cl. 200—30)

This invention relates to cyclic interrupters such as commonly employed in telephone exchanges for providing the characteristic interruptions in the various ringing and tone signals, and for providing electrical impulses of various lengths at various intervals, as may be required, for these and other signalling and timing operations. It relates particularly to what is known as a rotary interrupter, comprising a motor driven shaft carrying a plurality of cams for intermittently operating a corresponding number of contact assemblies at the required rates of speed. They are also called ringing interrupters, although most have other functions as well.

One of the objects of the invention is the provision of a machine of this type using cams made up of a small number of standard parts, which may be combined in various ways by a very simple assembly operation, into a very large number of similar yet different cam assemblies, for providing separate and individual types of interruptions or impulses, in a large number of possible combinations.

A feature of the invention is the use of pre-molded plastic cam segments or sectors arranged to mount at regular spaced intervals around a cam carrier and each arranged to occupy a fixed portion of the periphery evenly divisible into the total periphery, to provide uniform spacing.

Another feature of the invention is the use of molded plastic cams mounted on cam carriers in such a way as to reduce possible variations in dimension of the working parts of the cams, due to temperature and humidity changes, to a negligible minimum and also to reduce the effects of loosening due to cold flow, as may occur where plastic cams are secured directly to the shaft, or to the hub of a carrier.

Other objects and features of the invention will become apparent from a consideration of the following specification, when considered together with the appended drawings, comprising Figs. 1 to 18 inclusive, in which:

Fig. 1 is a front elevation of the machine, showing only a part of the cams and contact springs in place, in order to simplify the drawing.

Fig. 2 is a right end elevation of the machine of Fig. 1, showing the manner of mounting the shaft in the frame.

Fig. 3 is an enlarged cross sectional view of Fig. 1 taken along the line A—A.

Fig. 4 is a side view of one of the cam sectors, showing the angles involved.

Fig. 5 is a right end view of the cam sector of Fig. 4.

Figs 6 to 10 inclusive show side views of five additional cam sectors, which may be used separately and in combination, to give various lengths of pulses, or interruptions, in multiples of one quarter second.

Fig. 11 is a side view of one of the cam carriers.

Fig. 12 is a cross sectional view of Fig. 11, along the line B—B.

Fig. 13 is the hub used with the cam carrier of Fig. 11.

Fig. 14 shows one of the pins used for securing the cam sectors to the cam carrier.

Figs. 15 to 18 inclusive show side views of several different cam assemblies, out of the many possible combinations, with the hidden portions of the cam segments outlined by broken lines.

It will be noted that the Figs. 4 to 18 inclusive, are all drawn on the same enlarged scale as Fig. 3.

With particular reference to Figs. 1, 2 and 3, the machine of my invention may be seen to consist primarily of a motor driven cam shaft **1**, carrying a number of cam assemblies **2** side by side along its length, together with an equal number of contact assemblies **3** mounted above the cams for operation thereby. The shaft **1** is supported by end bearings **4** and **5** mounted on the inside face of end walls **6** and **7** respectively, by screws such as **9**. The end walls **6** and **7** are held rigidly in spaced-apart relation by two angle bars or structural members **11** and **12**, best seen in Fig. 3.

On the left end of the machine, a plate **20**, held in spaced relation with, and parallel to, the end plate **6**, by spacer posts such as **21** and **22**, serves as a mounting for a small A. C. synchronous motor **25** having a built in gear train for driving the motor shaft **26** in a clockwise direction as seen from the motor end, at a speed of ten revolutions per minute. The motor shaft **26** is coupled to the cam shaft **1** by a flexible metal coupler unit **27**, best seen in Fig. 1.

Mounted on the right hand outer face of the cam carrier on the extreme right hand end of the cam shaft is a dished scale **30** having the outer periphery marked off in degrees and multiples thereof, while a pointer **31** is mounted on the inner face of the end wall **7** adjacent to the scale **30**, so as to provide a ready and convenient means of quickly fixing the angular displacements of the cams on the shaft, where staggering of the cams is called for. The pointer **31** is fastened to the wall **7** by screws **32**, while the scale **30** is fastened to the cam carrier by three self-tapping screws such as **33** (Fig. 2), driven into the outer ring of holes in the right side plate of the carrier, at intervals of 120 degrees. This does not prevent the use of cam segments in this carrier, and does not interfere in any way with the operation of the cam or the contacts.

The contact assemblies **3**, as shown in Figs. 1 and 3, are mounted at regular intervals along the top of the back angle bar **12**. In the drawings they are shown as simple break-make contacts, although other combinations, containing either more or less contacts, could be used. They are pre-assembled by clamping between upper and lower metal plates **40** and **41**, and held together by screws **42**, which thread into tapped holes in the lower plate **41**, and extend for some distance beyond, in the completed assembly. The extended ends of the screws are passed through clearance holes in the angle bar or mounting shelf **12**, and are secured by nuts **43** threaded on from the under side of the shelf. The contact set proper consists of the usual flexible flat metal springs such as **44** and **45**, equipped with precious metal contacts, and separated in the pile-up by insulating washers such as **46**. Back-stop springs **47** are also provided for the outside springs **44**, while the operating spring **45** is equipped with the usual insulated bushing **48** for communicating movement thereto.

Directly below the contact springs in the contact assembly, and insulated therefrom, is a cam follower **50**, comprising a flat spring **51** preferably of clock spring steel, carrying, on the under side of its tip, a molded plastic rider block **52** preferably of nylon, which is fastened to the spring **51** by any suitable means, as by the rivet **53** and the screw **54**. The rider **52** has a flat rearward extension which normally rests on the upper surface of the angle bar or support shelf **11**, at a height to hold the rubbing face of the riders **52** clear of the cams at all

times except when actually engaged by the humps or high spots, of the cams.

The cam assemblies **2**, shown in detail in Figs. 3 to 18, consist of one or more of the cam sectors of Figs. 4 to 10, mounted between two end plates on a cam carrier **60**. These cam carriers, shown without cams in Figs. 11 and 12 consist of a hub **61** preferably of steel, provided with a set screw **64** for securing it in place on the shaft, and supporting two spaced apart cam holder plates **62** and **63**, also preferably of steel, rigidly secured to the ends of the hub, as by a staking operation. Six groups of three holes **66**, each arranged in the form of an equilateral triangle with the apex inward, are distributed uniformly around the outer portion of the cam holder plates **62** and **63** for securing the cam sectors in place. The arrangement and angular distribution of these holes **66** is best seen in Fig. 11.

The six cam sectors **70**, **71**, **72**, **73**, **74** and **75**, shown in Figs. 4 to 10 are also molded from plastic, and are also, like the cam riders, preferably of nylon, molded to the exact dimensions required, to obviate any need for subsequent machining. These cam sectors all have the same basic outlines with equal heights, widths, and thicknesses. They are all provided with similar shoulders **76** which overhang the cam holder plates along their outer periphery, so that the working face of the cam occupies the full width of the carrier, thus reducing wear, and helping to support the cam sector. They are also all provided with three mounting holes **77**, corresponding to the groups of holes on the cam holder plates.

These truncated cam sectors are designed on the same centers as the cam carrier, and are provided with angular displacements as indicated in Figs. 4 and 9. Sectors **70**, **71**, **72** and **73** all have angular displacements as in Fig. 4, and differ only in the size and location of the humps on the working faces. They are intended to mount on sixty degree centers around the cam carriers, but the angular or radial sides have been cut back a small amount to allow for a small space between sectors, and have also been rectified to cause the juxtaposed edges of adjacent cam sectors to be parallel with each other, to permit insertion of a tool between the sectors, if required.

The sectors **74** and **75**, which are intended to be used in combination with any of the sectors **70** to **73** to alter the effective length of the hump thereof, have angular displacements as in Fig. 9. The layout of the right hand portion of these sectors corresponds to that of the sectors **70** to **73**, and the right edge is cut back in identical fashion. The upper part of the left edge however is extended to form an overhanging lip fitting against the edge of the hump of the adjacent cam, when the two are mounted side by side on the carrier. The lower part of the left edge is also extended to fill up the greater part of the normal inter-sector space, in order to strengthen the overhanging lip. Some space is left however, to aid in assuring a snug fit for the upper portions of the two sectors.

The shape and size of the humps of the cam sectors is such, with due regard to the shape of the cam rider **52**, and the speed of the shaft **1**, as to cause the cam sector **70** to provide two ¼ second impulses (or interruptions) ¼ second apart, while the sector **71** will provide a single ¼ second impulse (or interruption), the sector **72** a single ½ second impulse (or interruption), and the sector **73** a single ¾ second impulse (or interruption). Adding the sector **74** to the sectors **71**, **72** or **73** will increase their operate times by ½ second, while adding the sector **75** will increase their operate times by one second. Thus, sectors **71** and **74** together will give a ¾ second impulse, **72** and **74** a one second impulse, and **73** and **74** a 1¼ second impulse. Similarly, sectors **71** and **75** together will give a 1¼ second impulse, **72** and **75** a 1½ second impulse, and **73** and **75** a 1¾ second impulse. Again, sectors **70** and **74** together will give a ¼ second impulse followed ¼ second later by a ¾ second impulse, while

sectors **70** and **75** together will give a ¼ second impulse followed ¼ second later by a 1¼ second impulse. Finally, it will be obvious that the various single and combined sectors may be arranged on the cam carriers in various combinations of like and unlike sectors to produce a multitude of different results.

For example, the combination shown in Fig. 3, wherein a sector **71** is followed by combined sectors **74** and **71**, will give a ¼ second impulse, followed ¾ second later by a ¾ second impulse, repeated every six seconds, while the combination of sectors **75** and **71** shown in Fig. 15 will give a 1¼ second impulse once each six seconds, it being remembered that the speed of the shaft is, as previously stated, 10 revolutions per minute. Similarly, the arrangement shown in Fig. 16, comprising six sectors **70** will give twelve ¼ second impulses at ¼ second intervals each six seconds, while the arrangement shown in Fig. 17, comprising six cams **72** will give six ½ second impulses at ½ second intervals in the same time, and the arrangement of Fig. 18, comprising two opposing sectors **73** and two opposing combinations of sectors **74** and **71** will give four ¾ second impulses at ¾ second intervals, each six seconds.

The arrangement of Fig. 15 is suitable for the application and interruption of ringing current on single party telephone lines or on harmonic ringing party lines. If for example, ringing current, or a ringing relay were connected to the upper make contacts of the corresponding cam follower contact assembly, the contacts would be closed and ringing current would be applied to called lines for 1¼ seconds out of each six seconds, while the contacts would be open and the ringing current removed for 4¾ seconds out of each six, corresponding to the usual ringing and silent periods of the ringing cycle. In practice, a number of such cams would be provided, having different circuit closing times, so as to distribute the ringing load by supplying ringing current to different parts of the exchange at different times. In the illustration of Fig. 1, it is assumed that five such cam assemblies are being used, spaced 72 degrees apart around the shaft **1**, which is readily accomplished with the aid of the graduated dial **30** and the pointer **31**. These cams are assumed to be the five on the left in Fig. 1.

The arrangements shown in Figs. 16, 17 and 18 are suitable for supplying a continuous series of impulses or interruptions at rates of 120, 60 and 40 per minute respectively, as required for providing characteristic interruptions of various tone or lamp signals, and the like. These are assumed to be the three cam assemblies in the approximate center of the shaft in Fig. 1.

In Fig. 16 for example, six cam sectors **70**, uniformly distributed around the cam carrier, are employed. By reference to Figs. 4 and 16, it will be obvious that the cam humps are uniformly spaced at intervals of 30 degrees. Each revolution of the cam carrier will therefore provide, as previously stated, twelve ¼ second impulses at ¼ second intervals. And since the speed of the shaft is ten revolutions per minute, there will, of course, be 120 such impulses per minute.

Similarly, in Fig. 17, six cam sectors **72** are employed, distributed uniformly around the shaft at 60 degree intervals like in Fig. 16. Here it will be apparent that the cam humps are also spaced 60 degrees apart. Since these sectors are designed to provide ½ second impulses it will be seen that this cam assembly will provide six such impulses at ½ second intervals for each revolution of the cam carrier, or 60 such impulses per minute.

In Fig. 18, two cam sectors **73** on opposite sides of the cam carrier are followed by two **74**—**71** combination sectors, to provide four ¾ second humps distributed uniformly around the carrier at 90 degree intervals. This cam assembly will accordingly provide four ¾ second impulses at ¾ second intervals for each revolution of the carrier, or 40 such impulses per minute.

An examination of the various cam sectors and assem-

blies may indicate apparent discrepancies between the respective lengths of the humps and depressions in the cam faces and the time intervals given in the foregoing description. This is due to the shape of the rubbing face of the cam rider **52** as shown in Fig. 3, which has been made wide and comparatively heavy in cross section to reduce wear of this part as much as possible. Due to this fact, and the fact that the broad slopes of the sides of the rider cause the contact assemblies to be operated considerably before the rider has reached the top of a hump, and to be restored to normal some time after the rider has started down over the trailing edge of a hump. This has required a compensating reduction in the lengths of the high points on the cam sectors, and a proportionate increase in the length of the low points.

It will also be apparent that other cam combinations could be selected to provide the characteristic long and short coded ringing signals required with code ringing party lines. The machine illustrated will mount a total of 16 cam assemblies, but if more cams are needed, a longer shaft could be provided, or a second shaft could be coupled to the first by means of another shaft coupling like the coupling **27** in Fig. 1, or by a reducing gear assembly to operate the added unit at a different speed if desired. Many other combinations of the six cam sectors will suggest themselves. A plurality of cam sectors **75** for example, can be mounted one behind the other to extend any of the sectors **70** to **73** to give a single pulse each six seconds, ranging from 1¼ seconds to 5¾ seconds in length. The 1¼ second pulse, followed by a 4¾ interval, would be obtained by combining sectors **71** and **75**, while the 5¾ second pulse, followed by a ¼ second interval could be obtained by combining five sectors **75** with a sector **73**.

The cam sectors are mounted on the cam carriers by means of knurled pins **65**, one of which is shown in Fig. 14. Three pins are used for each cam sector, being simply driven or forced through the aligned holes **66** of the carrier (Fig. 11) and the corresponding holes **77** in the sector (Fig. 6). The holes in the sectors are slightly smaller than the holes in the carrier, to provide a good grip for the knurling. After insertion, the pins may be secured in place by any convenient means as by staking the ends in the holes **66** of the cam carrier end plates **62** and **63**, in order to prevent the pins from turning or loosening in the holes.

The set screw **64**, which is used to secure the cam assembly to the shaft, has a hexagonal center opening, to permit the use of a small-shank socket wrench for tightening it, through the opening between two cam sectors. In Figs. 3 and 11 it will be seen how the cam carrier end plates are mounted on the hub **61** in such a way that the set screw is located midway between two groups of cam sector location holes. In locating the cam sectors, care is also taken to so arrange them around the periphery of the carrier, that the set screw is opposite one of the openings between adjacent sectors. When the small cam sectors **70**, **71**, **72** and **73** are used exclusively, no difficulty presents itself, if the set screw is located between any two groups of holes. If combinations using the sectors **74** or **75** are employed, however, the number or extent of the open spaces between sectors may be reduced, as in Fig. 18. In such cases, care should be taken that the set screw is visible in one of the available openings before the sectors are locked in place, in the final assembly.

I have thus provided a cam assembly with a number of advantages over cams used heretofore. The use of solid cams for example, may require the use of mounting screws or set screws passing through the cam for securing it to the hub of a carrier or directly to a shaft. Where the cam is made of plastic material, as here, the pressure of the screw on the material may in time cause cold flow to occur in the plastic, with resultant loosening and unsatisfactory operation. The construction of independently mounted cam sectors and cam carriers employed here completely avoids this difficulty.

Another disadvantage in the use of plastic cams, is the possibility of dimensional variations in the cams due to the effects of heat and humidity on the plastic, with resultant variations in time. My construction also avoids this difficulty, through the use of small cam segments mounted independently between metal carrier plates, to which they are solidly secured by pins driven through them transversely in evenly distributed locations near their sides and near their outer peripheries. In this connection, it should be noted that the downward pressure of the cam riders on the cams is taken up entirely by the cam sector shoulders **76**, and is therefore not transmitted to the pins **65**, which are therefore subjected to little strain.

Another disadvantage of the use of solid cams, is the necessity for providing a separate cam for each purpose. In the arrangement of my invention, it is only necessary to provide a very limited number of cam shapes, which are combined as required, to form the different cam assemblies.

What is claimed is:

1. In a cam assembly for use on the shaft of a rotary circuit interrupter, a cam carrier comprising a central hub having two end discs rigidly secured on the opposite ends thereof, a plurality of spaced apart molded plastic cam segments held between and overlapping both said end discs, means for rigidly securing said cam segments to both said end discs independently of said hub, and means in said hub between said end discs for securing said carrier against rotary movement relative to said shaft independently of said cam segments.

2. In a cam assembly for use in a rotary interrupter, in combination, a metal hub for mounting on a shaft of said interrupter, a rigid metallic circular carrier plate secured to each end of said hub, a non-metallic cam sector mounted between said plates, said cam sector formed with arcuate shoulders that engage the peripheral edges of both said carrier plates, a group of aligned and corresponding transverse holes in said carrier plates and said cam sector, pins inserted through said holes in both said plates and said cam sector for rigidly securing said sector to said plates independently of said hub, and a set screw in said hub between said plates and out of line with said cam sector for securing and loosening said assembly on said shaft independently of said cam sector.

3. In a cam assembly as in claim 2, other similar groups of transverse holes distributed uniformly around said carrier plates, other cam sectors of identical shape mounted similarly between said plates opposite said other groups of holes and similarly secured thereto, and radially disposed spaces between said cam sectors to provide access to said set screw through one of said spaces.

4. In a cam assembly for use in a cyclic motor driven circuit interrupter, a cam carrier comprising a metallic hub for mounting on a shaft of said interrupter and a circular metallic cam-holder plate on each end of said hub, a plurality of groups of identically disposed transverse holes in aligned and corresponding locations in both said plates and distributed uniformly at equal angular spacings around the complete circumference of said carrier, a plurality of cam sectors of similar basic form but having variously shaped working faces mounted between said holder plates opposite said respective groups of holes, said cam sectors overlapping both said cam holder plates, identically disposed transverse holes in each of said cam sectors corresponding to the holes in said plates, pins inserted through said holes in said plates and said cam sectors for securing said cam sectors to both said plates independently of said hub, a set screw in said hub between two of said groups of holes in said plates, and spaces be the adjacent radial edges of said cam sectors to provide access to said set screw through one of said spaces.

5. A cam assembly as in claim 4, including arcuate

shoulders on the flate sides of said cam sectors in the upper portions thereof, and said arcuate shoulders engaging and overlaying the respective peripheral edges of both said holder plates to provide a point of support and thrust-absorption for said cam sectors independent of said pins.

6. A cam assembly as in claim 4 including at least one cam sector of such a form as to close only the upper part of the space between it and an adjacent cam sector, for changing the effective timing of such adjacent cam sector.

7. A cam assembly for use on the shaft of a motor driven cyclic interrupter comprising, in combination, a cam carrier having two circular cam holder plates in spaced apart relation on a central hub, a plurality of cam sectors distributed uniformly on equal centers around the circumference of said carrier in the space between said holder plates, high points on said sectors each having sloping sides, a fastening means in said hub in the space between said holder plates for securing said hub to said shaft, radial spaces between said cam sectors to provide access to said fastening means through one of said spaces for securing said hub and said assembly on said shaft, and at least one of said cam sectors so shaped as to have a projection overlying the sloping side of the adjacent sector for prolonging the high point of said adjacent sector.

8. A cam assembly as in claim 7 in which there are a plurality of cam sectors having said projection, said plurality of sectors identical with each other but different from another of said sectors, said plurality of sectors so constructed as to mount uniformly around the carrier on the usual centers, each of said plurality of sectors also so constructed as to overlie the sloping surface of the adjacent sector and bridge the space between said sectors when so mounted, thereby extending the high point of said adjacent sector in a continuous line through said cam sectors, and enabling the build up of various shaped cam surfaces with a minimum number of different shaped sectors.

9. In a cyclic circuit interrupter comprising, in combination, a housing, a plurality of cam followers and contact sets mounted on said housing, and a motor driven cam shaft mounted on said housing, a plurality of cams mounted on said shaft for operating said cam followers and said contact sets at timed intervals in response to the rotation of said shaft, each said cam including a pair of cam-holder plates on a central hub and one or more cam sectors mounted between said plates at the outer periphery thereof, a row of transverse holes in said plates near said periphery, pins inserted in at least some of said holes opposite said cam sectors for securing said sectors to said plates, means comprising a pointer mounted on said housing and a graduated scale mounted on the outer side wall of the outside holder plate of the last cam on the shaft through unused ones of said holes in said outside holder plate to facilitate staggering the angular settings of said cams around said shaft, and means for securing said cams in place on said shaft in said staggered settings.

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