Nov. 10, 1959 H. NAIMER 2,912,527

CAM-CONTROLLED ELECTRICAL SWITCH CONSISTING OF AXIALLY ALIGNED UNITS

Filed April 19, 1957

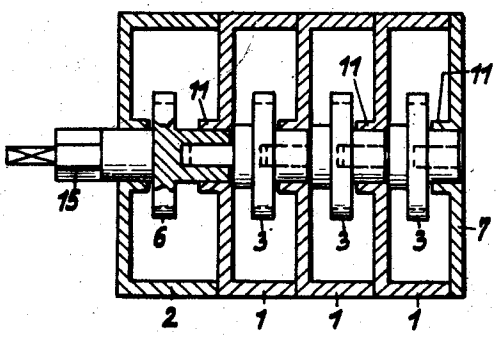


Fig.1

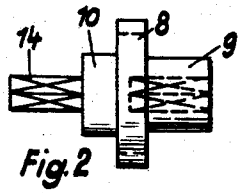


Fig.2

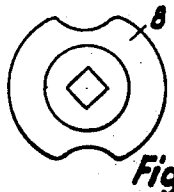
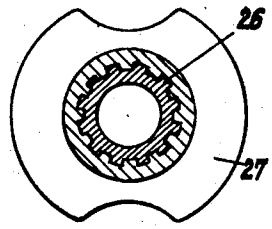


Fig.3

Fig.6



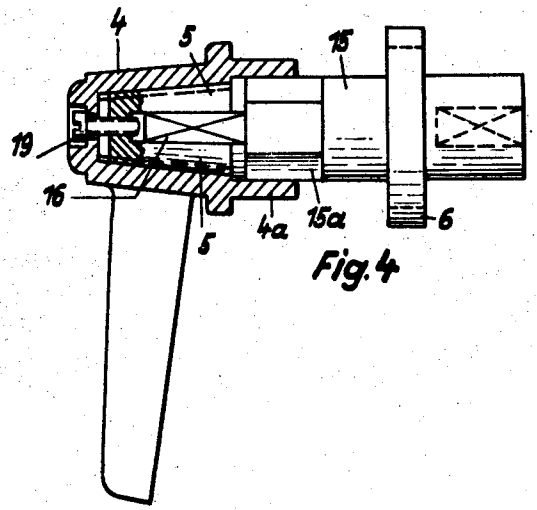


Fig.4

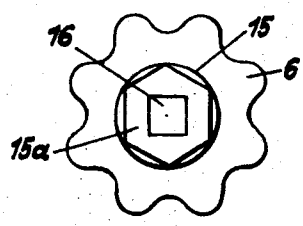


Fig.5

Inventor:
HUBERT NAIMER
by A. John Michel
ATTORNEY

United States Patent Office 2,912,527
Patented Nov. 10, 1959

2,912,527

CAM-CONTROLLED ELECTRICAL SWITCH CONSISTING OF AXIALLY ALIGNED UNITS

Hubert Naimer, Vienna, Austria

Application April 19, 1957, Serial No. 653,793

Claims priority, application Austria April 23, 1956

3 Claims. (Cl. 200—6)

This invention relates to cam-controlled electrical switches of the type which comprises a plurality of cam-actuated switch units arranged along a common axis of rotation. The usual type of these switches comprises an operating shaft which carries and couples the cams and which consists of metal and has usually a polygonal profile. This construction, which is generally used, involves a number of disadvantages, the most important of which are:

In selecting the profile of the shaft, standardized rolled sections must be employed, usually square or hexagonal sections, in order to avoid an expensive special manufacture, in spite of the fact such sections are not very favourable due to the play of the cams which results from the manufuacturing tolerances of the cam. Moreover, larger tolerances in the dimensions of said bar material must always be accepted, which is a disadvantage for the precise functioning of the switchgear.

For reasons of cost it is further necessary to use steel as material for the shaft so that an electroplating of the switch shaft is required for surface protection. In addition to the fact that it is not possible in mass production always to obtain a plating of the same thickness on all shafts, which gives rise to further variations in the final tolerances of the section bar, that surface protection is inadequate, even if it is very carefully made, if the switch is used in a room filled with a corrosive atmosphere, which is often inevitable.

The switch shafts must be cut to length in dependence on the overall length of the switch, i.e., on the number of units forming the switch. In addition to the manufacturing work required for this operation, this involves the need for a large stock of shafts of standardized lengths. A reshaping of such stocks, as is often necessary in the case of difficulties in the supply of bar material, causes losses of time and particularly of material.

For electrical reasons a metal shaft must be sufficiently spaced from the live parts of the switch to ensure that the inevitable creep paths are sufficiently long. This requirement alone gives rise to dimensions of the switch which are larger than would be required for mechanical reasons. In addition, where a metal shaft is provided it must either be effectively insulated from the actuating member or must be perfectly grounded, which involves certain structural difficulties.

In the desire to provide a construction which enables a switch which consists of several axially aligned switch units to be assembled from the fewest number of identical parts, a cam-controlled electrical switch has been proposed which consists of axially aligned units and in which cams which actuate the circuit breaking members are provided with shaft stubs on both sides, at least one of which shaft stubs of each cam serves for rotatably supporting the cam in a wall of a switch unit and each of which shaft stubs may also serve for coupling the cam to an axially adjacent similar cam or a drive member, preferably in such a manner that the shaft stubs of each cam form pin-shaped and bush-shaped coupling halves enabling the pin of one cam

to be plugged into the bush of an axially adjacent cam to couple both cams for joint rotation. The present invention relates to an important development of this structure.

The attempt to build this switch shows that the costs involved in the manufacture of suitable cams is very high. If applied to the practically important case in which the switch consists of a larger number, e.g., of six or more units, and if it is considered that to ensure safe electrical contacts the rotation of such a switch requires considerable accumulating counterforces to be overcome in the switch unit, it will be seen that the turning member consisting of several cams plugged together must have a torsion strength which can be provided only by high-grade materials of construction, particularly by metal. Metal cams, however, are expensive die-castings, which do not afford an improvement over the construction described hereinbefore also for electrical reasons. Whereas it is known that metal parts such as cams, gear wheels and the like which are subjected to high stresses may be made of high-grade plastics, such as laminated thermosetting plastics based on phenol-formaldehyde and with a textile reinforcement, such plastics are also too expensive in the present connection and would require special measures at the journals because they are entirely unsuitable in view of the switch casings, which consist of similar plastics and in which said parts are to be rotatably supported. In this connection it is of special importance that such cams having widely varying external shapes but equal internal parts must lend themselves to manufacture by a method which is suitable for inexpensive mass production. All these difficulties have previously prevented the practical realization of the proposal mentioned hereinbefore.

This problem is solved by the invention in a switch of the type mentioned initially hereinbefore by making the cams of a high-melting, electrically insulating thermoplastic resin, which has a high mechanical strength and toughness and a moderate elasticity and high resistance to abrasion, all in a degree which is obtained, e.g., in plastics based on polyamides or superpolyamides. It is surprising that it would be possible to make cams which fulfill all the requirements from a thermoplastic resin, in view of the previous belief that these requirements are partly inconsistent with each other and that thermoplastic resins are usually not taken into consideration for the present purposes owing to inadequate strength and heat-resisting qualities. More particularly, it is surprising that according to the invention even a relatively long switch shaft can be built up from several cam elements without causing intolerable torsion to be set up within the shaft itself. It is also surprising that plastics of the type just described have excellent sliding qualities relative to the casing parts in which they are rotatably supported and which consist in most cases of thermosetting materials. This is of decisive importance because the journals cannot be serviced throughout the life of the switch and the good sliding qualities must also be retained when the switch is exposed to a corrosive atmosphere.

To explain the invention, reference is made to the accompanying diagrammatic drawings, in which Fig. 1 is a longitudinal sectional view showing a cam-controlled switch which consists of three switch units and a stepping gear, whereas the jumper bridges and switch contacts, terminals, retaining springs and the like, which are of no interest in this connection, are omitted. Figs. 2 and 3 are an end view and a side view, partly in section, of a cam according to the invention. Fig. 4 shows the connection of the cam according to the invention with an operating handle and Fig. 5 is a side view of one of said cams, with the turning grip omitted. Fig. 6 shows that it is possible to fulfil several switching requirements with one plastic cam according to the invention by providing

cams selectively with control elevations or depressions disposed at different points.

In Fig. 1, numeral **1** denotes the casings of the switch units, **2** the casing of the stepping gear and **3** the three cams, before which a star-shaped stepping wheel **6** is arranged, which is also formed according to the invention. In Fig. 4, an operating handle is coupled by the jaws **5** in a manner which will be described hereinafter to the stepping wheel **6** belonging to the stepping gear. That stepping wheel is essentially a multiple cam. For this reason what will be said hereinafter of the switch cams applies analogously also to that stepping wheel. The casings **1** form chambers which accommodate in known manner the jumper bridges and the associated actuating means, consisting, e.g., of a roller which engages the cam and a plunger which operates the jumper bridge. The last casing **1** is closed by a cover **7**. All casings **1**, **2** and the cover **7** are held together by axially extending screws or other retaining means (not shown).

Each cam, Figs. 2, 3, consists of the actual cam disc **8**, which is provided on both sides with shaft stubs **9**, **10**, which are preferably integral with the cam. The shaft stubs serve in known manner for rotatably mounting the cams in the casings **1** or in the cover **7**; for this reason they have a cylindrical external shape whereas said casing parts form suitable bearings, e.g., in the form of flanges **11**. In order to preclude excessive mechanical strain on the bearings, each cam **3** is rotatably supported in a casing **1** or **2** only on one side, as is shown in Fig. 1. As is distinctly shown in Fig. 2, the shaft stub **10** has a coupling extension **14**, which takes here the form of a pin and has a suitable profile, e.g. a square profile, whereas the shaft stub **9** has a recess formed with a conforming profile of sufficient depth for fittingly receiving the pin-shaped shaft stub **14** of the adjacent cam. Thus the cams are simply fitted one in the other, as is shown in Fig. 1 and are thus coupled for joint rotation. On the other hand, they are held without axial play in the casing because they have no freedom of lateral movement therein.

The moderate elasticity of the plastic used here ensures in the case of an appropriate design that the cams can be plugged together practically without play. On the other hand, that elasticity surprisingly does not adversely affect an adequately precise transmission of the desired angle of rotation. Even in switches which are composed of a very large number of individual switches, the toughness of the plastic ensures an adequate resistance to fracture and permits also of a compensation of inevitable small manufacturing and assembling tolerances, which may result, e.g., in a slight misalignment of the journals. In conjunction with the favourable sliding properties of the plastics used here, this results in a sufficiently exact but reliably non-clamping bearing arrangement of the switch shaft consisting of the individual cams; this result is surprising for any of the known plastics. The favourable behaviour regarding abrasion resistance and sliding properties is also important for the cooperation of the cam with the plunger which actuates the contact bridge.

The cam **6** forming the stepping wheel may have shaft stubs somewhat different from those of the switch cams. One of its shaft stubs **15** has an outwardly protruding extension **15***a* of non-cylindrical shape, in the present embodiment of hexagonal section. That extension is continued by a square pin **16**. The operating handle contains in known manner jaws **5**, which are pulled by means of a screw **19** into the tapering grip part **4** so that they are forced against the square **16**. A sufficiently firm coupling between the grip **4** and the cam **6** and thus with all other cams **3** is ensured by the extension **4***a* of the grip **4** making connection with the hexagonal portion **15**.

In the present example the stepping gear is disposed between the first switch unit and the actuating member **4**. It can be realized, however, that this arrangement is not essential because the cam of the first switch unit can easily be provided with an extension **15**, **15***a* and a pin **16** though this would eliminate the desirable uniformity of the switch cams.

Fig. 6 shows a cam which consists of a serrated core **26** and a profiled cam ring **27**, the contour of which is selected according to the switching requirements of each case. The cores **26** may be kept on stock.

The coupling portions should be given a tubular section with multiple teeth. An example is also shown in Fig. 6, wherein part **26** is the coupling pin of the adjacent cam. This ensures an optimum transmission of forces with the least expenditure of material. The multiple-tooth coupling profile enables each cam to be mounted relative to those of the adjacent switch chambers at an angle which is a multiple of the pitch angle of the teeth. This enables a considerable reduction in the number of cam profiles required for controlling the electrical contacts. The tubular section has also the advantage that a duct is formed which extends centrally throughout the switch and may be used for a number of special functions desired in switch construction (e.g., double shaft, push-button actuation through the switch, etc.).

The semielastic properties of the superpolyamides enable the virtual elimination of the radial play which is otherwise required. This ensures that even in switches having a large number of units the transmission of torsion corresponds to that of a steel shaft. Because the cam as such is injection-moulded, the time of manufacture is in no way prolonged by the simultaneous injection-moulding of the coupling profile on both sides. This applies also to the stepping wheel. Thus no time is required for the manufacture of the shaft. A finished switch can easily be extended or reduced by some switch chambers without requiring a replacement of the shaft, as was necessary before. Different switch types (for different current values) can easily be coupled by an adapter whereas previously special, now standardized, switch shafts were required for this purpose. From the electrical aspect difficulties due to creep paths are eliminated and absolute shockproofness for the operator is ensured without special design measures. In operation there is absolute safety against destructing influences by the humidity of the air, marine air (salt content) or other corrosive atmospheres. In the case of breakdown one or several switch chambers can be replaced on the spot without disassembly of the entire switch.

I claim:

1. A rotary cam-controlled electrical switch comprising, in combination a plurality of axially aligned housing units, each housing unit having two axially spaced end walls with axially aligned apertures in the end walls, a cam rotatably mounted in each housing unit for actuating at least one circuit breaking element with an actuating force perpendicular to the axis of rotation of the cam, and each cam comprising two axially extending tubular hubs, one of said hubs carrying a coupling having a serrated periphery while the other hub has a correspondingly serrated axial bushing engageable by said coupling of an adjacent one of said cams whereby adjacent cams may be coupled together against relative rotational movement to form a single rotary cam-unit for said switch, said cams consisting of a high-melting, electrically insulating thermo-plastic resin selected from the group consisting of polyamides, superpolyamides and resins substantially equivalent thereto in mechanical strength, tenacity, moderate elasticity and abrasion resistance, and axially aligned bearings being provided in said housing unit end walls to receive at least one of said hubs of each cam and to support the cams rotatably in said housing units.

2. The rotary cam-controlled electrical switch of claim 1, wherein each cam forms an integral element with its cam hubs and their coupling and bushing, respectively, each element having a central bore therethrough.

3. The rotary cam-controlled electrical switch of claim

1, comprising a switch actuating element adjacent an end one of said cams, the coupling of said end cam facing the actuating element and the actuating element gripping the periphery of the cam hub carrying said coupling.

References Cited in the file of this patent

UNITED STATES PATENTS

2,262,306	Thompson	Nov. 11, 1941
2,588,632	Jeffrey	Mar. 11, 1952
2,757,250	Brown	July 31, 1956
2,796,474	Glogau	June 18, 1957

FOREIGN PATENTS

103,183	Australia	Feb. 2, 1938

OTHER REFERENCES

"Product Engineering," September 1948, pp. 140 and 141 relied on.