Nov. 16, 1948. E. F. KOHL 2,454,067

CIRCUIT INTERRUPTING DEVICE

Filed May 7, 1945 5 Sheets-Sheet 1

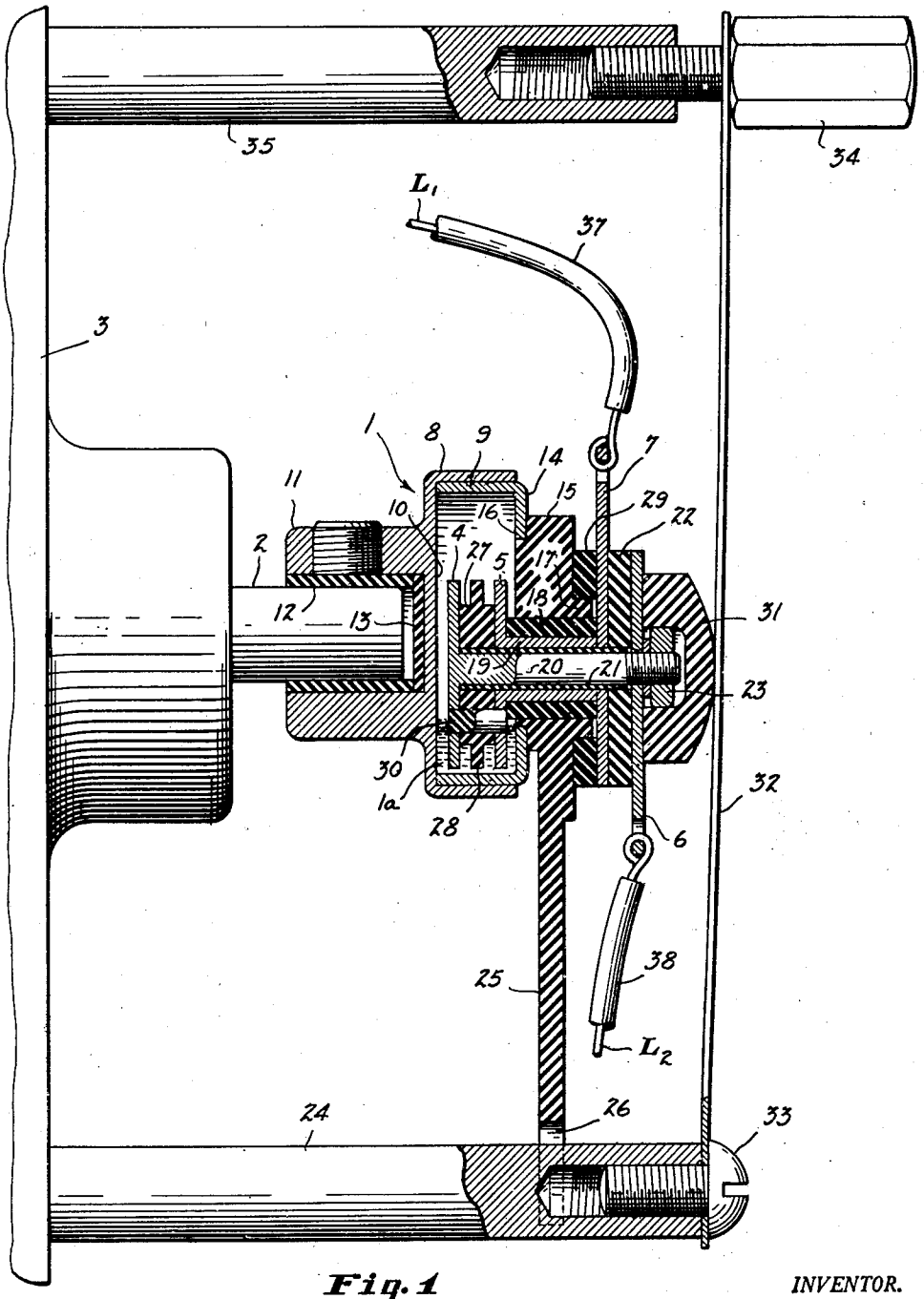

Fig. 1

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CIRCUIT INTERRUPTING DEVICE

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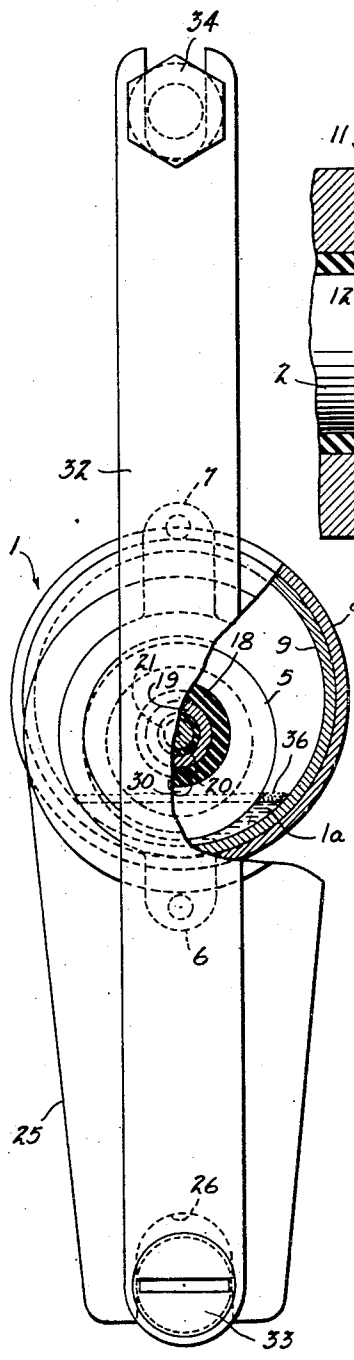

Fig. 2

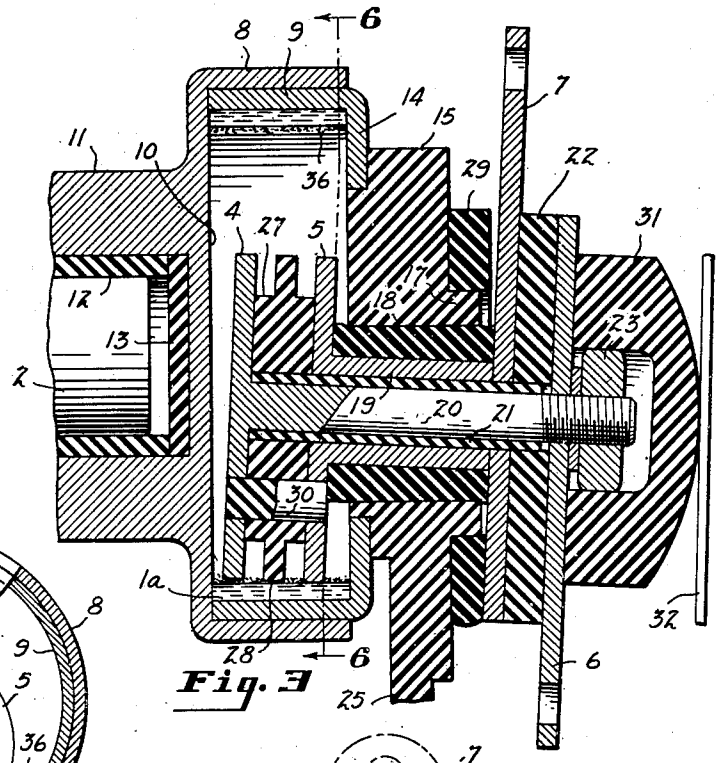

Fig. 3

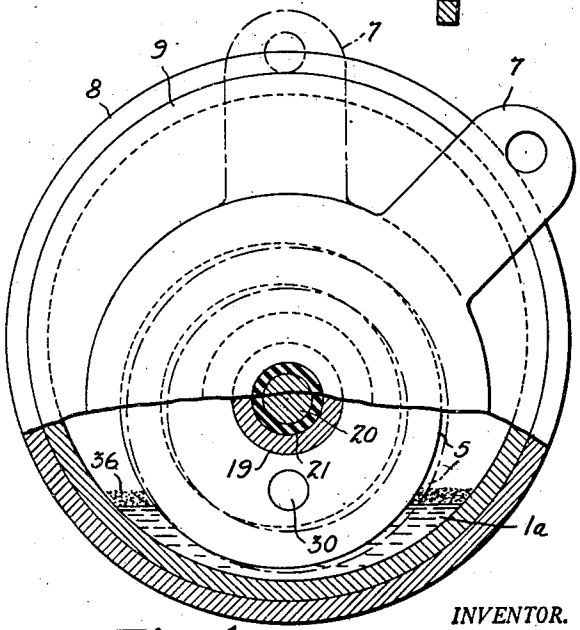

Fig. 4

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CIRCUIT INTERRUPTING DEVICE

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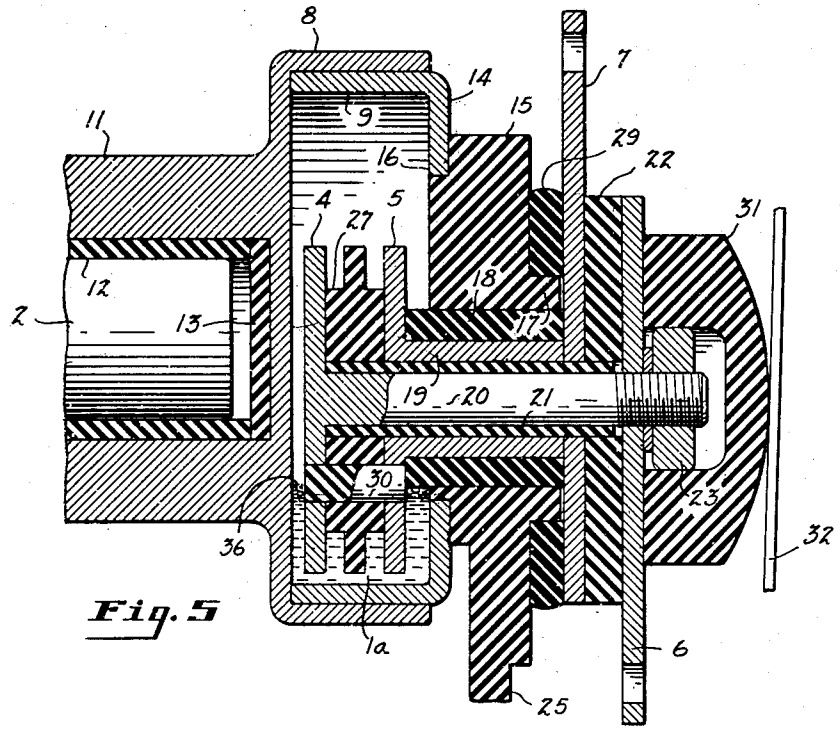

Fig. 5

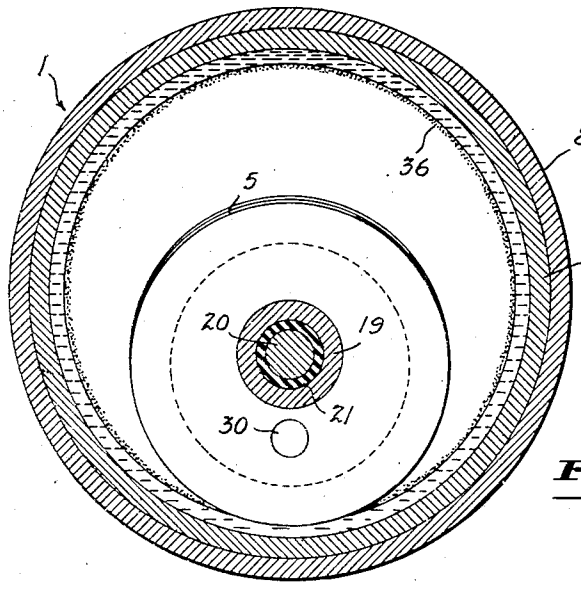

Fig. 6

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CIRCUIT INTERRUPTING DEVICE

Filed May 7, 1945 5 Sheets-Sheet 4

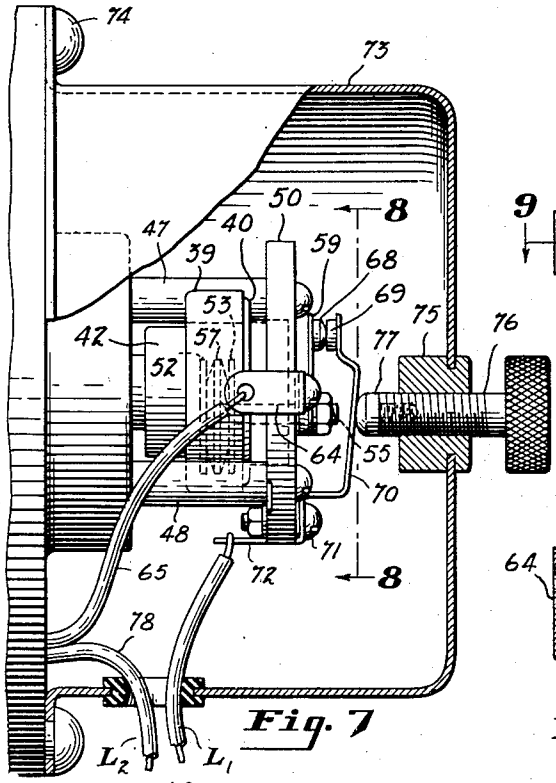

Fig. 7

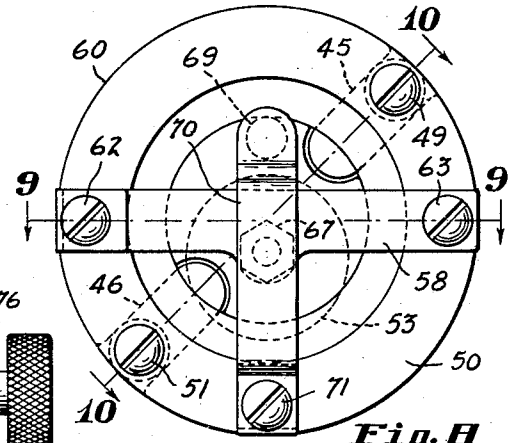

Fig. 8

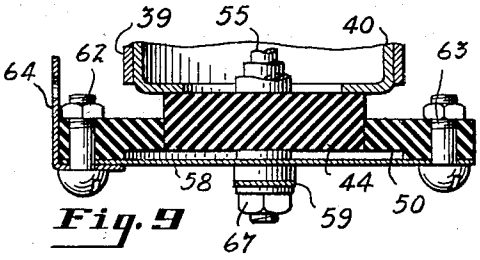

Fig. 9

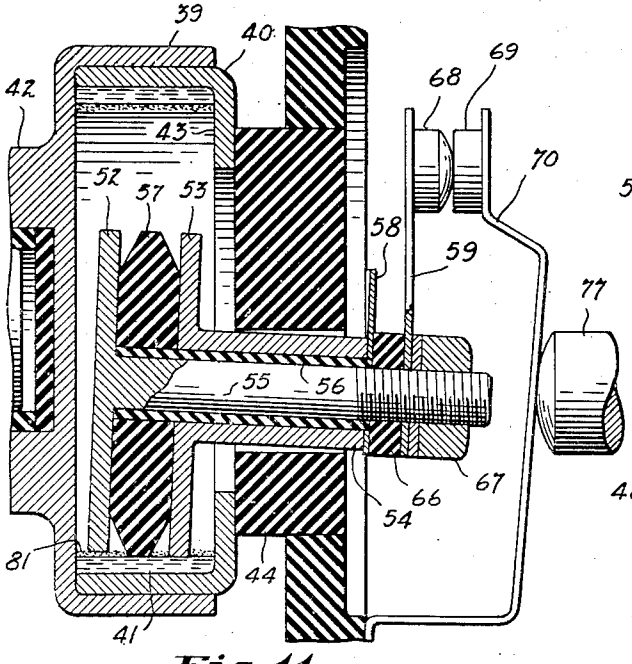

Fig. 11

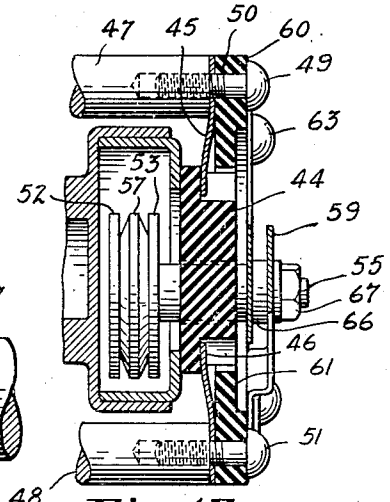

Fig. 10

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CIRCUIT INTERRUPTING DEVICE

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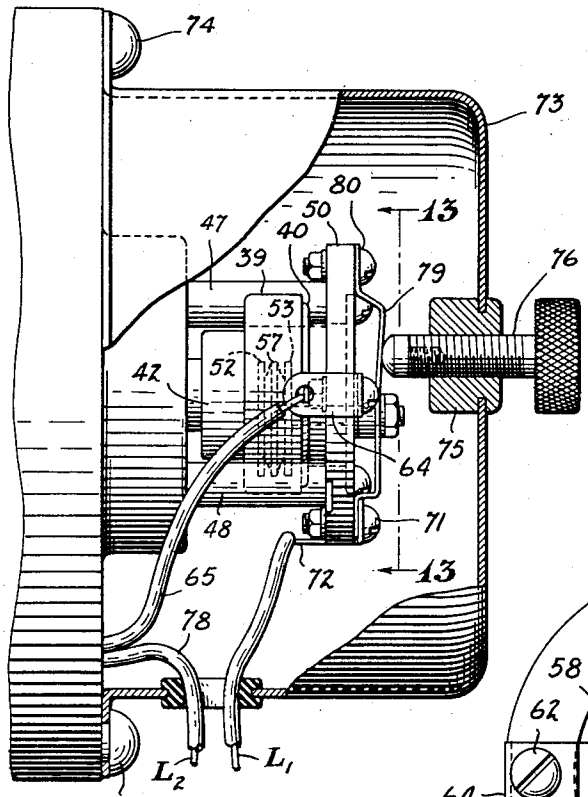

Fig. 12

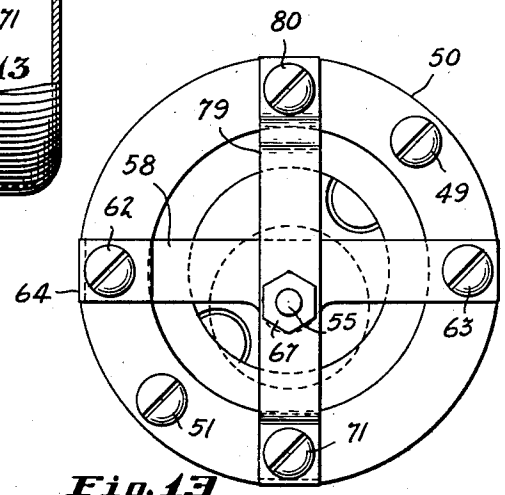

Fig. 13

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Patented Nov. 16, 1948 2,454,067

UNITED STATES PATENT OFFICE

2,454,067

CIRCUIT INTERRUPTING DEVICE

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Application May 7, 1945, Serial No. 592,491

16 Claims. (Cl. 200—80)

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My invention relates to circuit interrupting devices and more particularly to an improved circuit interrupting device or governor for controlling the speed of motors or the operation of switches, electromagnets, relays, solenoids and the like.

Governors which have heretofore been provided for controlling the speed of motors, and particularly motors of the series type, to prevent excessive speed under no load conditions and to permit the production of substantially increased power when load is applied, depend upon the making and breaking of mechanical contacts which separate under centrifugal force to control the speed of the motor by controlling the mean value of the load circuit. In such governors, however, it is not only necessary to maintain the springs controlling the contacts in proper adjustment to provide proper speed regulation but it is also necessary to utilize condensers or other valve means to prevent excessive arcing at the contacts. In such governors, it has also been necessary to utilize brushes for conducting electrical energy to and from the governor which not only increases the cost of the governor but since such brushes must be forced into engagement with slip rings on the governor, considerable power is required to overcome this friction during the operation of the motor.

It is the aim of the present invention to provide an improved circuit interrupting device or governor for controlling the speed of motors, or for establishing or interrupting circuits to auxiliary or associated devices when a rotatable member or shaft to which the governor is attached or with which it is associated attains a predetermined speed. My improved circuit interrupting device is characterized by the fact that an electrical circuit is established by a liquid to metal contact when the device is at rest or is rotated at low speed which circuit is interrupted when the device is rotated above a predetermined speed. The electrically conductive liquid which is utilized is also preferably heat conductive and consequently heat developed by the flow of electrical current when an electrical circuit is established or by back electromotive force when the circuit is interrupted is conducted to the outside atmosphere. Because of the manner in which my improved governor is constructed and associated with the motor, no brushes are required and consequently no power is required to overcome their friction.

My improved circuit interrupting device or governor is also characterized by the fact that an electrical resistance material is provided which

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floats upon the surface of the liquid and which prevents or minimizes arcing between one of the metal contacts and the liquid when the circuit is interrupted and consequently it is particularly adapted to be utilized in combination with an electrical motor to regulate the speed of the motor. It is to be distinctly understood, however, that this particular feature of my invention is not limited to the apparatus shown and described in the present application but may be utilized in any apparatus in which an electrical contact is utilized to establish an electrical circuit between a conductive liquid and a metal and which may be interrupted by any means, such as the revolution, rotation or other movement of the apparatus containing the liquid.

It is therefore an object of my invention to provide an improved circuit interrupting device or governor including means for interrupting an electrical circuit when a rotatable member with which the device is associated attains a predetermined speed.

Another object of my invention is to provide an improved circuit interrupting device associated with a rotatable shaft in which an electrical circuit including a metal to liquid contact is established when the shaft is at rest or is being rotated at low speed and which circuit is interrupted when the device is rotated at high speeds, including electrical resistance material which floats upon the surface of the liquid and which is effective in preventing or minimizing arcing when the circuit is interrupted.

Other objects and advantages of my invention will be apparent as the specification proceeds.

My invention will be better understood by reference to the accompanying drawings in which:

Fig. 1 is a fragmentary portion of a motor, showing my improved circuit interrupting device or governor affixed to the shaft and showing means, partly in elevation and partly in section, associated with the governor and motor for adjusting the speed at which the circuit is interrupted;

Fig. 2 is an end view of the governor and speed adjusting means with parts broken away to show adjacent structure;

Fig. 3 is an enlarged view of the circuit interrupting device shown in Fig. 1 with the parts in circuit interrupting position;

Fig. 4 is an enlarged view of a portion of the circuit interrupting device with parts in section and parts broken away to show adjacent structure and with the discs and terminal bars shown

in dotted lines in one position and in full lines when moved to a different position;

Fig. 5 is an enlarged view of a portion of the apparatus shown in Fig. 1 with the parts in a different position;

Fig. 6 is a cross sectional view on the line 6—6 of Fig. 3, showing the form the liquid assumes when the governor is rotating with the electrical resistance material buoyed inwardly and floating upon the surface of the liquid;

Fig. 7 is an elevational view of a modified form of my improved circuit interrupting device arranged within a housing attached to the motor, with the housing shown partly broken away and partly in section;

Fig. 8 is an end view of the governor shown in Fig. 7 as viewed from a plane taken through the line 8—8 of Fig. 7;

Fig. 9 is a cross sectional view on the line 9—9 of Fig. 8;

Fig. 10 is a cross sectional view on the line 10—10 of Fig. 8;

Fig. 11 is a central cross sectional view of the circuit interrupting device shown in Fig. 7 with parts in circuit interrupting position;

Fig. 12 is a view similar to that shown in Fig. 7 of a modified form of my improved circuit interrupting device; and

Fig. 13 is an end view of the circuit interrupting device shown in Fig. 12 taken on the line 13—13 of Fig. 12 looking in the direction of the arrows.

While my improved circuit interrupting device may be associated with any suitable driven member, such as a driven shaft, and may be utilized to establish and interrupt a circuit to any suitable device, such as a relay, solenoid, electromagnetic coil, switch, or motor, or may be associated with a driving shaft, such as a motor shaft and utilized for like purposes, as illustrated in the drawings, it is shown associated with a motor for regulating the speed of the motor.

Broadly stated, my improved circuit interrupting device includes a casing 1 containing a suitable conductive liquid 1*a*, such as mercury, which casing is adapted to be attached to the shaft 2 of a motor 3 and arranged within the casing are a plurality of spaced disc-shaped contacts 4 and 5 provided with terminals 6 and 7 arranged outside of the casing. While the casing 1 may be of any suitable shape and construction, as illustrated, it is formed of telescoping cylindrical outer and inner parts 8 and 9 which may be pressed, shrunk, welded or otherwise secured together and the outer cylindrical part is formed integral with one of the end walls 10 of the casing and terminates in a hub 11 which may be electrically insulated from and secured to shaft 2 of motor 3 in any suitable manner. As shown, a sleeve 12 formed of a molded insulating material is mounted upon shaft 2 and a disk 13 of a like material is interposed between the sleeve 12 and the end 10 of the casing.

The portion 9 of the housing is provided with an inwardly turned flange 14 which provides an opening at the opposite end of the casing to receive a stationary bearing 15 which also acts as a seal. The bearing 15 may be formed of any suitable material, such as a molded phenolic condensation product containing graphite, or other suitable lubricating material. As illustrated, bearing 15 is shouldered to form an annular recess to receive the free edge of flange 14 and to provide an annular rim 16 upon which the

housing rotates. Stationary bearing 15 is also provided with an outwardly extending hub 17 and an eccentrically arranged opening provided with a bushing 18 formed of a suitable resilient material, such as soft rubber, and arranged within the bushing are shafts 19 and 20 which are secured to contacts 5 and 4, respectively, in any suitable manner. As illustrated, shaft 19 which is tubular and engages bushing 18 is formed integral with contact disc 5 and shaft 20 which is formed integral with contact disc 4 extends through the bore of shaft 19 and a sleeve 21 formed of an electrically insulating material, such as a molded condensation product, is interposed between the two shafts.

Shaft 19 and bushing 18 extend outwardly beyond hub 17 and abut against terminal 7 which may be secured to shaft 19 in any suitable manner, such as by welding. Terminal 6 is in electrical contact with shaft 20 but is slidable thereon and a disk 22 formed of electrical insulating material, such as a molded composition, is interposed between terminals 6 and 7 and the assembly is maintained in position by means of a nut 23 threaded upon shaft 20.

To prevent rotation of bearing 15 with the governor, a post 24 is secured to the lower portion of the motor frame and bearing 15 is provided with an extension 25 terminating in a bifurcated end providing a recess 26 to receive post 24.

When the casing is at rest an electrical circuit is established between terminal 7, shaft 19, contact 5, the mercury in the casing, contact 4, shaft 20, and terminal 6, and to permit the interruption of this circuit by the centrifugally-developed buoyant force of the liquid when the casing attains a predetermined speed, a spacer 27 formed of an electrical insulating material and provided with a rib 28 is interposed between discs 4 and 5 and a collar 29 formed of resilient material, such as rubber, which engages hub 17, is interposed between terminal 7 and bearing 15. With the parts arranged in this manner, it will be apparent that when the casing is rotated the mercury will be picked up by the inner periphery of the casing and will exert a centrifugally-developed inward buoyant force on the outer peripheries of discs 4 and 5 and rib 28 which increases as the square of the speed of the casing and consequently when the casing attains a predetermined speed, the upper portion of shaft 19 will be forced against the resilient bushing 18 and the lower portion of terminal 7 against the resilient collar 29 to incline shafts 19 and 20 in the manner indicated in Fig. 3 of the drawing and since shaft 20 is considerably longer than shaft 19, when the casing attains the predetermined speed, disc 4 will be buoyed inwardly from the conductive liquid while contact 5 is still immersed in the liquid at which time the electrical circuit is interrupted.

When the circuit is interrupted there is a tendency for arcing to occur due to back electromotive force. To minimize this arcing, I have found that when a material having a comparatively high electrical resistance, such as powdered carbon, is placed upon the surface of the mercury, it will be buoyed inwardly toward the surface of the liquid and when the circuit is interrupted, the resistance material prevents or minimizes arcing. This particular feature of providing a material having a comparatively high electrical resistance which floats upon the annulus of conductive liquid formed during the rotation of the

casing and which prevents or minimizes arcing when an electrical circuit is interrupted between a conductive liquid and a metal, is one of the essential features of my invention and, as previously stated, is not limited to the apparatus shown in the present drawings. It may, for instance, be utilized in the apparatus shown in my copending application, Serial No. 443,205, filed on May 16, 1942, which has matured into Patent No. 2,410,663.

Means are also provided to vary the speed at which the circuit is interrupted. For this purpose, disc 4 is mounted eccentrically on shaft 20 and in a like manner disc 5 is mounted eccentrically on shaft 17 and means are provided to connect discs 4 and 5 so that they may be rotated together to vary the extent of their immersion in the liquid and while any suitable means may be provided for this purpose, as illustrated in the drawings, a pin 30 formed of an electrical insulating material is inserted in aligned openings in discs 4 and 5 and in spacer 27 and shaft 19 is welded or otherwise secured to terminal 7. The depth to which discs 4 and 5 may be immersed in the conductive liquid when the casing is at rest or is being rotated at low speed may therefore be regulated by rotating terminal 7. For instance, by rotating terminal 7 from its dotted line position as shown in Fig. 4 to its full line position, contact discs 4 and 5 may be immersed in the liquid to a less extent than when they are in the position shown in Fig. 1 and the electrical circuit may therefore be interrupted at a lower rotative speed of the shaft and the casing.

Means associated with the motor may also be provided for varying the speed at which the circuit is interrupted. For this purpose, a thrust cap 31 formed of an electrically insulating material, such as a phenolic condensation product, is provided. As illustrated, cap 31 has a recess to receive nut 23 and its inner portion bears against terminal 6 while its outer surface is convex in shape and means are provided to apply pressure to the outer surface of the cap to force terminal 6, washer 22 and terminal 7 inwardly to cause terminal 7 to engage and compress resilient washer 29. For this purpose, a spring 32 is provided, one end of which has an aperture to receive a bolt 33 which is threaded into a bore formed in post 24 and the other end of which has an aperture to receive the threaded portion of a bolt 34 which is adapted to be threaded into a bore formed in a post 35 which is affixed to the upper frame of the motor. When bolt 34 is threaded into the bore of post 35, resilient washer 29 will be compressed as shown in Fig. 5 of the drawings and since a portion of this washer must be compressed still further when discs 4 and 5 are buoyed inwardly, it will be apparent that the pressure exerted by the spring 32 on cap 31 will determine the speed of the casing at which the circuit to the motor is interrupted.

Since bearing 15 is stationary in my improved circuit interrupting device and neither the contacts nor the terminal bars rotate with the casing, no brushes are required to conduct electrical energy to or from the governor and when an electrical resistance material, such as powdered carbon, is placed upon the mercury, it will be buoyed inwardly by the mercury as indicated by the numeral 36 in Fig. 6 to form a thin layer of carbon upon the inner surface of the mercury and the carbon will minimize the formation of arcs due to the back electromotive force when the circuit is interrupted and my improved circuit interrupting device is therefore particularly adapted for use in regulating the speed of motors.

In utilizing the governor to regulate the speed of a motor, the governor may be attached to the shaft of the motor as illustrated in the drawings and electrical energy from line L_1 is conducted to terminal 7 through a conductor 37 and from thence to contact 5 and through the conductive liquid to contact 4 and shaft 20 to terminal 6 from which terminal the current may be conducted to the inlet brush of a motor through a conductor 38 and from the outlet brush of the motor to the other line terminal.

In operation, when the motor is rotated above a predetermined speed, the circuit to the motor is automatically interrupted and when the motor falls below the predetermined speed, the circuit to the motor is reestablished, thus maintaining the motor at the desired speed. I do not desire, however, to limit the use of my improved circuit interrupting device to regulate the speed of motors as it may obviously be employed to interrupt and establish a circuit to an auxiliary device, such as an electromagnetic coil, a solenoid, switch, relay, or the like, when the motor shaft or a driven shaft to which the device is attached or with which it is associated is rotated above or falls below a predetermined speed.

Another modification of my invention is shown in Figs. 7 to 11 of the drawing in which the casing of my improved circuit interrupting device is formed of telescopic cylindrical outer and inner members 39 and 40 and contains mercury 41. Cylindrical member 39 is formed integral with one end of the casing and terminates in a hub 42 attached to the shaft of the motor in a manner similar to that shown in Fig. 1 and cylindrical member 40 terminates in a flange 43 providing an opening which is sealed by means of a bearing 44 formed of an electrical insulating material. The margins of bearing 44 are forced against flange 43 by suitable means, such as springs 45 and 46 supported by a pair of oppositely disposed posts 47 and 48 attached to and extending outwardly from the motor casing and while the springs may be attached to the posts in any desirable manner, as illustrated the free end of each post is provided with a threaded bore and spring 45 is maintained in position by means of a bolt 49 which extends through an annular ring 50 of insulating material and an aperture in spring 45, and is threaded into post 47 and bolt 51 extends through the ring of insulating material and an aperture in spring 46, and is threaded into post 48.

As in previous modifications, a pair of contact discs 52 and 53 is arranged in the casing, the contact disc 53 being formed integral with a tubular shaft 54 and contact disc 52 being formed integral with a shaft 55 which extends through tubular shaft 54 and is electrically insulated therefrom by means of a sleeve 56. As shown contacts 52 and 53 are spaced from each other by an electrical insulating disc 57 formed of a suitable material, such as calcium aluminosilicate, and the opening in the bearing is of sufficient size to permit tilting movement of the shafts when the casing is rotated at a predetermined speed.

To provide a circuit between contact discs 52 and 53 when the casing is at rest or is being rotated at low speeds, a pair of flexible, resilient metallic strips 58 and 59 are arranged outside of the casing, strip 58 being in electrical con-

tact with shaft 54 and strip 59 being in electrical contact with shaft 55.

Resilient strips 58 and 59 are arranged, however, so that their resilient properties are utilized to maintain contacts 52 and 53 immersed in the mercury when the casing is at rest or is being rotated at low speed and to permit the separation of contact 52 from the mercury when the casing is rotated at a predetermined speed. For this purpose ring 50 is provided with an outer rim 60 and a recessed portion 61 and resilient strip 58 extends across the recessed portion and has its opposite ends attached to rim 60 by suitable means, such as bolts 62 and 63, and a terminal 64 is interposed between the resilient strip 58 and the head of bolt 62 to which a suitable outlet lead 65 may be attached.

Resilient strip 59 is insulated from resilient strip 58 by suitable means, such as a collar 66, and the parts are maintained in assembled position by means of a nut 67 which is threaded on shaft 55. Resilient strip 59 is also provided with a contact 68 which is adapted to be engaged by a contact 69 affixed to a resilient spring 70 having one end affixed to rim 60 of insulating ring 50 by a bolt 71 and an apertured terminal 72 is interposed between the head of bolt 70 and the rim of the insulating ring to receive lead L_1.

My improved circuit interrupting device is adapted to be arranged within a housing 73 which may be attached to the motor casing in any desirable manner, such as by bolts 74 and is provided centrally with a threaded bushing 75 to receive a threaded bolt or actuator 76 having a tip 77 formed of insulating material for engaging spring 70. Spring 70 is biased outwardly and when actuator 76 is threaded outwardly contact 69 is disengaged from contact 68 to interrupt the circuit and when actuator 76 is threaded inwardly contact 69 engages contact 68 to establish a circuit between contacts 68 and 69. When actuator 76 is forced inwardly, it will also be apparent that contacts 52 and 53 will be immersed in mercury 43 and a circuit will be established from line L_1 to contacts 69 and 68 and through shaft 55, disc 52, mercury 41, contact 53 and resilient strip 58 to conductor 65 which is connected to the inlet brush of the motor, the outlet brush of the motor being connected through conductor 78 to terminal L_2. When the casing is rotated at a predetermined speed, however, the centrifugally-developed buoyant force of the mercury buoys contacts 52 and 53 inwardly inclining shafts 54 and 55 against the resilient force of spring arms 59 and 70 and as shaft 55 is longer than shaft 54, it will be apparent that when the casing attains a predetermined speed, disc 52 will be buoyed inwardly out of contact with the mercury while disc 53 is still immersed in the mercury at which time the circuit will be interrupted and when the casing slows down the resilient force of arms 59 and 70 will again force contacts 52 and 53 to again immerse them in the mercury at which time the circuit will again be established.

The speed of the casing at which the circuit is interrupted may be regulated by adjusting the position of actuator 76 as will be apparent to those skilled in the art.

Another modification of my invention is shown in Figs. 12 and 13 of the drawing. This modification is similar to that shown in Figs. 7 to 11 with the exception that contacts 68 and 69 and spring arm 70 have been omitted and arm 59 has been replaced by a resilient strip 79 which ex-

tends across recess 61 and is attached to rim 60 at its upper end by a bolt 80 and at its lower end by the bolt 71 which was utilized in the former modification to connect arm 70 to the rim. The other parts are similar to those shown in Figs. 7 to 11 and consequently have been designated by the same reference numerals.

The operation of the circuit interrupting device shown in this modification is similar to that shown in Figs. 7 to 11 with the exception that actuator 76 serves merely to regulate the speed of the casing at which the circuit between contact discs 52 and 53 is interrupted.

In the modifications shown in Figs. 7 to 11, inclusive, and Figs. 12 and 13, powdered carbon is preferably arranged upon the surface of the liquid as indicated by the numeral 81 to prevent or minimize arcing when the circuit is interrupted. This feature is of particular importance when my improved circuit interrupting device is utilized in combination with a motor to regulate its speed.

What I claim is:

1. Apparatus of the class described comprising a rotatable casing containing an electrically conductive liquid, a contact arranged in said casing which is in electrical contact with said liquid and which is stationary or substantially stationary when the casing is at rest or is being rotated at low speed, and said contact being movable inwardly by the centrifugally-developed buoyant force of said liquid to cause it to emerge from said liquid when the casing is rotated above a predetermined speed to break said electrical contact.

2. Apparatus of the class described comprising a movable casing containing an electrically conductive liquid, a contact arranged in said casing which is in electrical contact with said liquid when said casing is at rest, means whereby said casing may be moved to separate said contact from said liquid to break said electrical contact, and an electrical resistance material of less specific gravity than said liquid arranged upon the surface of the liquid to minimize arcing when said contact is separated from said liquid.

3. Apparatus of the class described comprising a rotatable casing containing an electrically conductive liquid, a pair of spaced contacts arranged in said casing, resilient means for maintaining said contacts in electrical contact with said liquid during the rotation of said casing at low speed, and means associated with said contacts and resilient means which is responsive to the centrifugally-developed inward buoyant force of said liquid on said contacts for inclining said contacts as they are buoyed inwardly to cause one of said contacts to emerge from said liquid to break its electrical contact with said liquid when said casing attains a predetermined speed.

4. Apparatus of the class described comprising a rotatable casing containing an electrically conductive liquid, a pair of spaced contacts arranged in said casing which are in electrical contact with said liquid during the rotation of said casing at low speed, resilient means for maintaining said contacts in electrical contact with said liquid during the rotation of said casing at low speed, means associated with said contacts and resilient means which is responsive to the centrifugally-developed inward buoyant force of said liquid on said contacts for inclining said contacts as they are buoyed inwardly to cause one of said contacts to emerge from

said liquid to break its electrical contact with said liquid when said casing attains a predetermined speed, and an electrical resisting material of less specific gravity than said liquid which is buoyed inwardly to the surface of the liquid during rotation of the casing for minimizing arcing when said electrical contact is broken.

5. Apparatus of the class described comprising a rotatable casing containing an electrically conductive liquid and provided at one end with an opening, a stationary bearing for sealing a portion of said opening and upon which a portion of said casing rotates and said bearing being also provided with an opening, a pair of spaced contacts arranged in said casing, each of which is provided with a shaft extending through the opening in said bearing and said shafts being insulated from each other and arranged in telescopic relation, resilient means interposed between the outer shaft and said bearing for maintaining said contacts emerged in said liquid, and the centrifugally-developed buoyant force of said liquid to establish electrical contact between said contacts and said liquid upon said contacts being effective in inclining said shafts against the force of said resilient means to cause one of said contacts to emerge from said liquid to break electrical contact between the emerged contact and said liquid when said casing attains a predetermined speed, and an electrical resistance material supported upon the surface of said liquid to minimize arcing when said electrical contact is broken.

6. Apparatus of the class described comprising a rotatable casing containing an electrically conductive liquid, a pair of spaced contacts arranged in said casing, resilient means for maintaining said contacts in electrical contact with said liquid during the rotation of said casing at low speed, means associated with said contacts and resilient means which is responsive to the centrifugally-developed inward buoyant force of said liquid on said contacts for inclining said contacts as they are buoyed inwardly to cause one of said contacts to emerge from said liquid to break the electrical contact between the emerged contact and said liquid when said casing attains a predetermined speed, and means for adjusting the position of said contacts in said casing to cause one of the contacts to emerge from said liquid to break electrical contact therewith at various speeds of said casing.

7. Apparatus of the class described comprising a rotatable casing containing an electrically conductive liquid, a pair of spaced contacts arranged in said casing, resilient means for maintaining said contacts in electrical contact with said liquid during the rotation of said casing at low speed, means associated with said contacts and resilient means which is responsive to the centrifugally-developed inward buoyant force of said liquid on said contacts for inclining said contacts as they are buoyed inwardly to cause one of said contacts to emerge from said liquid to break the electrical contact between the emerged contact and said liquid when said casing attains a predetermined speed, and means for adjusting the position of said contacts in said casing to very their depth of immersion in said liquid to thereby cause one of said contacts to emerge from said liquid at various speeds of said casing.

8. Apparatus of the class described comprising a rotatable casing containing an electrically conductive liquid, a pair of spaced contacts arranged in said casing, resilient means for maintaining said contacts in electrical contact with said liquid during the rotation of said casing at low speed, means associated with said contacts and resilient means which is responsive to the centrifugally-developed inward buoyant force of said liquid on said contacts for inclining said contacts as they are buoyed inwardly to cause one of said contacts to emerge from said liquid to break electrical contact between the emerged contact and said liquid when said casing attains a predetermined speed, and means for adjusting the position of said contacts to vary their distance from one end of said casing to thereby cause one of said contacts to emerge from the liquid at various speeds of said casing.

9. Apparatus of the class described comprising a rotatable casing containing an electrically conductive liquid, a pair of spaced contacts arranged in said casing, resilient means for maintaining said contacts in electrical contact with said liquid during the rotation of said casing at low speed, means associated with said contacts and resilient means which is responsive to the centrifugally-developed inward buoyant force of said liquid on said contacts for inclining said contacts as they are buoyed inwardly to cause one of said contacts to emerge from said liquid to break electrical contact between the emerged contact and said liquid when said casing attains a predetermined speed, and a pair of substantially stationary terminals arranged outside of said casing, one of which is electrically connected to one of said contacts and the other of which is electrically connected to the other contact.

10. Apparatus of the class described comprising a rotatable casing provided with an opening and containing a conductive liquid, a stationary bearing arranged in said opening upon which a portion of said casing rotates, said bearing having an opening provided with a resilient bushing, a pair of contacts arranged in said casing and being insulated from each other, one of which engages and the other of which is spaced inwardly from said bushing, and each of said contacts being provided with a shaft extending through said bushing which shafts are movable in unison and are insulated from each other, said contacts being in electrical contact with said liquid when said casing is at rest or is being rotated at low speed and being movable inwardly by the centrifugally-developed buoyant force of said liquid against said resilient bushing to incline said shafts and move the contact which is spaced from said bushing from said liquid to break the electrical contact therewith when the casing attains a predetermined speed.

11. Apparatus of the class described comprising a rotatable casing provided with an opening and containing a conductive liquid, a stationary bearing arranged in said opening upon which a portion of said casing rotates, said bearing having an opening provided with a resilient bushing, a pair of contacts arranged in said casing and being insulated from each other, one of which is spaced inwardly from said bushing and each of said contacts being provided with a shaft extending through said bushing which shafts are movable in unison and are insulated from each other, said contacts being in electrical contact with said liquid when said casing is at rest or is being rotated at low speed and being movable inwardly by the centrifugally-developed buoyant force of said liquid against said resilient bushing to incline the shafts and move the contact which is spaced from said bushing from said liquid to

break its electrical contact with said liquid when the casing attains a predetermined speed, and each of said shafts being electrically connected with a terminal arranged outside of said casing.

12. Apparatus of the class described comprising a rotatable casing provided with an opening and containing a conductive liquid, a pair of spaced contacts arranged in electrical contact with said liquid, each of which contacts is provided with a shaft, said shaft being insulated from each other, one of said shafts being longer than the other, and both of which shafts extend through said opening and are movable in unison with each other, and the centrifugally-developed buoyant force of said liquid upon said contacts being adapted to incline said shafts to cause one of said contacts to emerge from said liquid to break its electrical contact with said liquid when said casing is rotated at a predetermined speed, and resilient means arranged outside of the casing for preventing the emergence of one of said contacts from said liquid until the casing has attained a predetermined speed.

13. Apparatus of the class described comprising a rotatable casing provided with an opening and containing a conductive liquid, a pair of spaced contacts arranged in said casing, a stationary bearing partially closing said opening, said bearing having an opening and a pair of shafts arranged in the opening in said bearing which shafts are insulated from each other, one of said shafts being longer than the other and being connected to the contact which is more remote from said opening and the other shaft being connected to the other contact, and the opening in said bearing being of sufficient size to permit inclination of said shafts, resilient means for maintaining said contacts immersed in said liquid to provide electrical contact therewith when said casing is at rest or is being rotated at low speed and the inward centrifugally-developed buoyant force of said liquid upon said contacts being effective in inclining said shafts against the force of said resilient means to cause one of said contacts to emerge from said liquid to break its electrical contact with said liquid when the casing is rotated above a predetermined speed.

14. Apparatus of the class described comprising a rotatable casing provided with an opening, a pair of spaced contacts arranged in said casing, a pair of spring strips, each provided with a contact arranged outside of the casing, one of said strips being normally biased from the other, means whereby the contacts on said strips may be forced into engagement with each other, and means associated with said contacts in the casing and the contacts outside of the casing for maintaining the contacts inside the casing in electrical contact with said liquid when the casing is at rest or is rotating at low speed, and the centrifugally-developed buoyant force of said liquid being adapted to force the contacts within the casing inwardly against the action of the strips outside the casing to cause one of said contacts within the casing to emerge from the liquid to break its electrical contact with said liquid when the casing attains a predetermined speed.

15. Apparatus of the class described comprising a rotatable casing containing an electrically conductive liquid and provided at one end with a stationary bearing for sealing a portion of said opening and upon which a portion of said casing rotates and said bearing being also provided with an opening, a pair of spaced contacts arranged in said casing, each of which is provided with a shaft, said shafts being insulated from each other and arranged in telescopic relation, resilient means interposed between the outer shaft and said bushing for maintaining said contacts emerged in said liquid to establish an electrical contact between said contacts and said liquid, and the centrifugally-developed buoyant force of said liquid upon said contacts being effective in inclining said shafts against the force of said resilient means to cause one of said contacts to emerge from said liquid to break the electrical contact between the emerged contact and said liquid when said casing attains a predetermined speed.

16. Apparatus of the class described comprising a rotatable casing provided with an opening and containing a conductive liquid, a stationary bearing partially closing said opening and being itself provided with an opening, a pair of contacts arranged in said casing, each having a shaft extending through the opening in said bearing which shafts are electrically insulated from each other, resilient means for maintaining said contacts in electrical contact with said liquid during rotation of said casing at low speed, and said contacts being movable inwardly by the centrifugally-developed buoyant force of said liquid against the force of said resilient means to incline said shafts to cause one of said contacts to emerge from said liquid to break its electrical contact with said liquid when said casing attains a predetermined speed, and a pair of stationary terminals arranged outside of said casing, one of which is electrically connected to one of said shafts and the other of which is electrically connected to the other shaft.

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REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
2,301,217	Lambert	Nov. 10, 1942