March 2, 1954 K. J. FLEMING 2,671,192

CIRCUIT BREAKING SWITCH FOR SMALL ELECTRIC MOTORS

Filed June 14, 1951

Fig. 1.

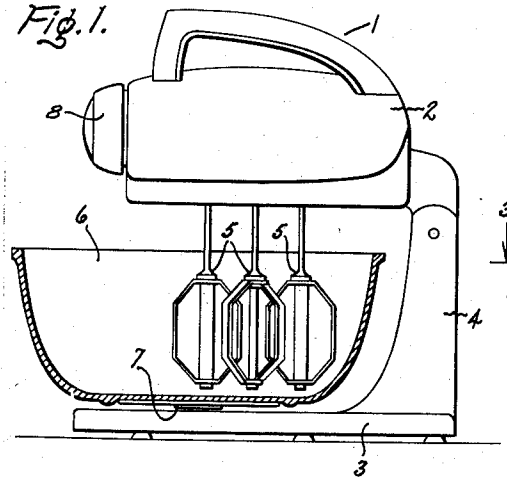


Fig. 2

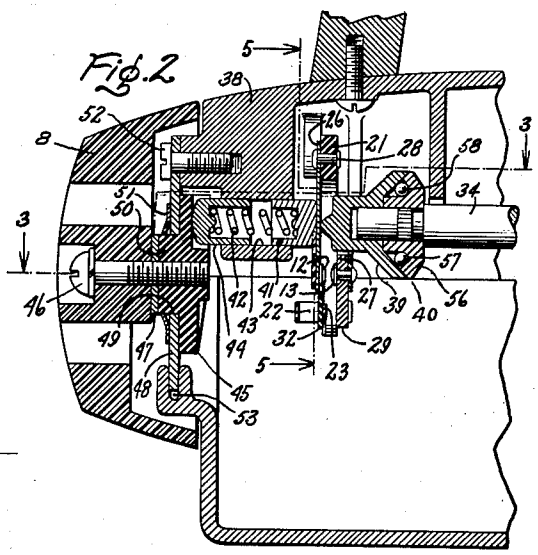


Fig. 6

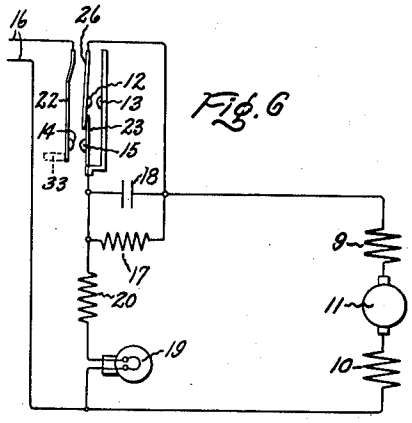


Fig. 3.

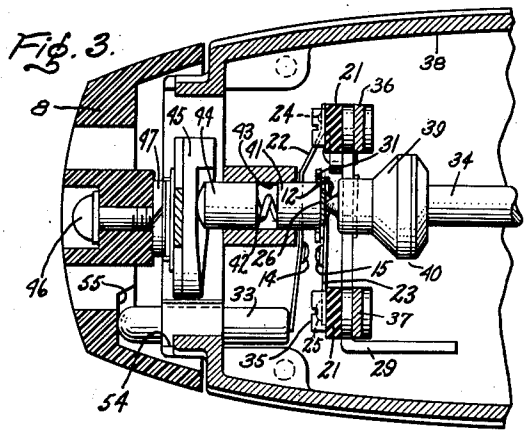


Fig. 4.

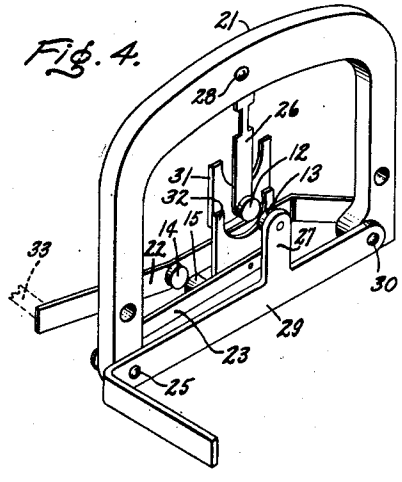
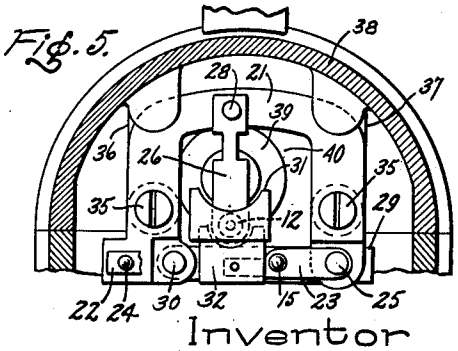


Fig. 5.



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UNITED STATES PATENT OFFICE

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CIRCUIT BREAKING SWITCH FOR SMALL ELECTRIC MOTORS

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Application June 14, 1951, Serial No. 231,522

5 Claims. (Cl. 318—325)

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This invention relates to circuit-breaking switches for use with small electric motors and more particularly to circuit-breaking switches for use with speed-governed motors such as are employed in electric kitchen mixers and the like.

In certain kitchen mixers means are provided whereby the speed of the beater drive motor may be varied in accordance with the density of the foodstuffs being mixed. Although this speed adjustment may be accomplished in various ways, one preferred manner has been to employ a centrifugal governor which opens a pair of normally closed, circuit-breaking contacts connected serially in the motor supply circuit upon the motor reaching the desired speed. The speed at which the governor operates may be varied by changing the amount of the force tending to keep the contacts closed, externally adjustable spring biasing means being included in the mixer structure for that purpose. Naturally, the greater is the force tending to keep the contacts closed, the greater is the speed at which the motor operates.

Besides these speed-regulating contacts, a two-position circuit-breaking switch, i. e., an "on-off" switch, is ordinarily included in the drive motor circuit. When this switch is closed, the motor is energized subject to the opening and closing of the speed regulating contacts, while when it is open, the motor is completely de-energized. Since in mixer applications space is very limited, the size and travel of the switch are also necessarily limited, and therefore, it has been extremely difficult to design a switch with as large an interrupting capacity as is necessary. Although switches have been designed which are quite satisfactory for opening the drive motor circuit under normal operating conditions of the mixer, these switches are not satisfactory for opening the circuit under the heavy current condition resulting when the motor stalls under an overload. With the motor stalled, the speed regulating contacts are, of course, closed so that the entire burden of opening the heavy current falls upon the switch. The result is such serious arcing and heating of the switch contacts that the life of the switch is appreciably shortened. Sometimes, the switch contacts even freeze closed due to the heating. The destruction of the switch contacts is particularly severe when the mixer is energized with direct current rather than alternating current, as may be done with mixers using universal motors.

It is a primary object of this invention, therefore, to provide new and improved circuit-breaking means for use with small electric motors.

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It is a further object of this invention to provide new and improved circuit-breaking means particularly adapted for use with the drive motors of electric kitchen mixers.

It is another object of this invention to provide a new and improved circuit-breaking switch for use with speed-governed motors in electric mixers.

It is a still further object to provide a new and improved circuit-breaking switch for use with speed governed motors, which automatically reduces the load current before breaking the circuit.

This invention also has as an object the provision of a switch structure and circuit for use in electric mixers whereby the speed-regulating contacts and the circuit-breaking contacts are both utilized in opening the drive motor circuit.

In accomplishment of the foregoing objectives, there is provided a new and improved switch structure mounting both a set of circuit-breaking or line switch contacts and a set of speed-regulating contacts. The structure mounts the two sets of contacts in cooperating relationship so that opening the line switch automatically opens the speed-regulating contacts; in fact, the speed-regulating contacts are separated slightly before the line switch actually opens. When the line switch is closed, the speed-regulating contacts are spring biased to the closed position, but are movable to the open position in response to a sufficient force being supplied against the bias. Both sets of contacts are connected serially in the supply circuit of the associated motor, such as a mixer drive motor, and a large electrical impedance is connected in parallel with the speed-regulating contacts.

A centrifugal governor is mounted on the motor shaft to supply a force for opening the speed-regulating contacts against their bias upon the motor reaching the desired speed. The opening of the regulating contacts places the impedance in series with the motor and thereby lowers the voltage across the motor. This causes the motor to slow down until the governor allows the contacts to reclose. The motor thus cycles narrowly around the desired speed, as in various conventional mixers.

The new and improved switch structure, together with its associated circuit, however, provides an improved circuit-breaking action which is able to interrupt even the high currents occurring when the motor stalls under load. Since the speed-regulating contacts are automatically opened slightly before the line switch contacts

are opened whenever the line switch is thrown from the closed to the open position, the aforesaid impedance is thus always introduced into the motor circuit before the line switch contacts open. This addition of the impedance to the circuit appreciably reduces the current therein so that the line switch contacts have to open only a fraction of the original stalled motor current. The line switch contacts thereupon may open the circuit with a minimum of arcing and heating.

The features of this invention which are believed to be novel are pointed out with particularity in the appended claims. The invention itself, however, both as to organization and mode of operation, together with additional objects and advantages thereof, may be best understood by reference to the following description to be taken in conjunction with the accompanying drawing in which:

Fig. 1 is a side elevation view of an electric kitchen mixer which is provided with improved circuit-breaking switch means embodying this invention;

Fig. 2 is an enlarged sectional view of a portion of the mixer shown in Fig. 1;

Fig. 3 is an enlarged fragmentary view in partial section taken on the line 3—3 of Fig. 2;

Fig. 4 is a perspective view of an improved switch structure embodying this invention;

Fig. 5 is an enlarged fragmentary section taken on the line 5—5 of Fig. 2, showing the switch structure of Fig. 4 as mounted in the mixer; and

Fig. 6 is a schematic diagram of a circuit for use with the improved switch means of this invention.

Referring to Fig. 1, therein is shown an electric kitchen mixer 1 comprising a power unit 2 mounted on a base 3 by a supporting arm 4. Power unit 2 includes an electric motor (not shown) which drives a plurality of beater elements 5 through suitable gearing means (not shown). The beater elements extend into a mixing bowl 6 which is positioned on a rotatable turntable 7 mounted on base 3. In order to regulate the operation of the beaters a rotatable knob 8 is provided which controls switch means for energizing and de-energizing the drive motor and for controlling its speed while in operation.

The drive motor is energized through a circuit such as is shown in Fig. 6, the motor being schematically illustrated therein as series field windings 9 and 10 and armature 11. Preferably the motor is of the universal type so that it may be used either with alternating or direct current. In the circuit it is connected serially with a pair of speed-regulating contacts 12 and 13 and a pair of line switch contacts 14 and 15 across a power supply 16. Although the opening of contacts 14 and 15 completely de-energizes the motor, an impedance, consisting of a resistor 17 and a capacitor 18 connected in parallel, is placed across contacts 12 and 13 so that their opening independently without the opening of contacts 14 and 15 does not completely de-energize the motor. However, the impedance is of a high enough value that the independent opening of contacts 12 and 13 does result in a voltage of considerably less than line voltage being applied to the motor. For example, for use with the conventional 110 volt domestic circuit resistor 17 would have a resistance of approximately 125 ohms and capacitor 18 would have a capacitance in the order of 0.001 mfd. so that the voltage across the motor would be considerably attenuated upon their being placed in the circuit. Besides the motor circuit an operating indicating branch comprising glow lamp 19 and current limiting resistor 20 is also connected to source 16 through contacts 14 and 15. As its name intimates, the branch is added merely to provide a means for indicating to the user whether or not the motor is energized.

As is shown in Figs. 4 and 5, a feature of this invention consists of providing a switch structure mounting both the speed-regulating contacts and the line switch contacts in a certain cooperating relationship, the contact arms for both sets of contacts being secured on a U-shaped insulating mounting member 21. Thus, line switch contacts 14 and 15 are mounted respectively on the movable portions of the electrically conducting resilient or spring contact arms 22 and 23 which are secured to opposite legs of member 21, arm 22 being secured to one leg by rivet 24 and arm 23 being secured to the other leg by rivet 25. Arm 23 is essentially a straight member and extends at a small angle to the principal plane of member 21, while contact arm 22 is crooked so that it first extends outwardly from member 21 at a substantial angle thereto and then turns to extend along behind arm 23. Contact 15 is positioned on arm 23 so that it lies in the path of contact 14 upon the bending of arm 22 toward arm 23.

The speed-regulating contacts are also mounted on electrically conducting contact arms, contact 12 being mounted on the movable portion of a resilient or spring contact arm 26 and contact 13 being mounted on a rigid arm 27. Resilient arm 26 is secured at its one end to the bight of U-shaped member 21 by a rivet 28 and extends downwardly therefrom; rigid arm 27 on the other hand constitutes an upwardly extending projection formed integrally on an otherwise approximately L-shaped member 29 which is secured to the legs of member 21 by rivets 25 and 30. Contact arms 22, 23 and 26 are all secured on one side or face of member 21, but member 29, i. e., arm 27, is secured on the opposite side. Contact arms 23 and 27 are, however, electrically connected through rivet 25, and contact 13 is so mounted on arm 27 that it lies in the path of contact 12 when the movable portion of arm 26 moves toward arm 27.

In addition to contact 12, resilient arm 26 also mounts a flat electrically conducting stop or plate 31, the front face of which engages the rear face of a flat electrically insulating stop or plate 32 mounted on arm 23, front and rear here referring to the switch as viewed in Fig. 4. Besides supplying the means for opening the speed-regulating contacts upon the opening of the line switch contacts, as will be more fully explained hereinafter, plate 31 also serves as a cooling fin to aid in cooling contact 12. Likewise, to aid in cooling contact 13 a similar plate may be mounted on arm 27 at contact 13.

Each of the resilient contact arms are self-biased, and in the "off" position of the line switch they assume a position shown in Fig. 4. Thus contact arm 22 moves contact 14 out of engagement with contact 15, and contact arm 23 moves contact 12 out of engagement with contact 13 due to the interaction between stops 31 and 32. Actually, contact arm 26 supplies a bias tending to move contact 12 toward contact 13, but arm 23 provides a greater bias in the opposite direction to keep the contacts apart.

Contacts 14 and 15 are closed through a force

being applied to the free end of arm 22 by a pin member 33 so that arm 22 bends toward arm 23. Once contacts 14 and 15 are closed, arm 23 begins to bend in the same direction, i. e., toward member 27, if the pressure from pin 33 is continued. Thus if pin 33 overtravels after the making of contacts 14 and 15, stop 32 tends to move away from stop 31. However, since arm 26 is biased to bend toward arm 27, stop 31 and, hence, contact 12 move right along with stop 32; and if arm 23 is bent far enough, contact 12 moves into engagement with contact 13. Assuming the overtravel of pin 33 to be a part of the normal travel of the line switch actuator, the throwing of the line switch from the open to the closed position thus closed contacts 12 and 13 are well as contacts 14 and 15. Moreover, when the switch returns to the open position, arm 23 initially moves with arm 22 due to its bias and thereby moves arm 26 sufficiently through the interaction of plates 31 and 32 to open contacts 12 and 13. Arm 22 then moves away from arm 23 to open contacts 14 and 15. In other words, with a circuit such as shown in Fig. 6, the parallel impedance of resistor 17 and capacitor 18 is always introduced automatically into the motor circuit before the line switch contacts open.

Contacts 12 and 13 may also be opened independently, while the line switch contacts 14 and 15 are closed, if a force is applied to contact arm 26 which is both larger than and in opposition to its bias. It is by the independent opening of contacts 12 and 13 through the action of a governing device that speed regulation of the motor may be obtained. A preferred manner of mounting the switch and an associated governing device with respect to the drive motor shaft 34 of kitchen mixer 1 is illustrated in Figs. 2, 3, and 5. As shown, the switch mounting U-shaped member 21 is secured by means of a pair of screws 35 to two oppositely disposed support members 36 and 37 which project from the top of the power unit housing 38 and lie in a plane essentially perpendicular to the longitudinal axis of drive shaft 34. Member 21 is so disposed that the front face of contact arm 26 (as viewed in Fig. 4) is engaged by the actuated member 39 of a governing device 40 which is preferably of the type disclosed and claimed in the copending application of Alastair D. Robertson, Serial No. 77,746, entitled "Speed Control Mechanism," filed February 23, 1949, now Patent No. 2,557,765 and assigned to the same assignee as the present invention; while the rear face of arm 26 is engaged by one section or member 41 of a cylindrically-shaped split housing which encloses a helical spring 42 and is slidably positioned in a slot 43 formed in housing 38. Actuated member 39 and housing section 41 are both formed of electrically non-conducting material so that they do not ground arm 26.

The other section 44 of the split housing rides on a cam 45 which is rigidly secured to the external adjusting knob 8 by a screw 46 and a lock washer 47 so as to rotate with the knob as a single piece. The cam rotates in frictional engagement with a support plate 48 which is provided with an aperture 49 to accommodate a hub portion 50 of the cam. A sheet metal speed nut 51 or other suitable means is utilized to hold the cam against plate 48. The plate itself is held firmly in place, its upper end being secured to the main housing 38 by a screw 52 and its lower edge being positioned in a groove 53 formed in the housing.

Spring 42 at all times supplies a bias against

switch arm 26 tending to close contacts 12 and 13. However, the bias of switch arm 23 opposes this bias and is sufficient to overcome it as well as the self-bias of arm 26 so that, as hereinbefore described, the regulating contacts cannot close until line switch contacts 14 and 15 are first closed. To provide means for opening and closing the line switch contacts, switch actuating pin 33 is extended through aperture 54 in main housing 38 into contact with the inner surface of knob 8. Formed in this inner surface is a recess 55 which accommodates pin 33 when the knob is turned to the "off" position, the pin being forced into the recess by the bias of contact arm 22. With the pin in recess 55, the switch is in the open position, as shown in Fig. 4, but as soon as knob 8 is rotated to the first speed setting, pin 33 is forced in a rearward direction to the right, as viewed in Fig. 3, and bends arm 22 sufficiently both to close contacts 14 and 15 and to allow the closing of contacts 12 and 13. Pin 33 remains in this rearward position throughout all the speed settings of the knob.

Once contacts 14 and 15 are closed, the speed at which the drive motor rotates is dependent upon the opening and closing of contacts 12 and 13. As knob 8 is moved from the "off" position to the lowest speed setting and then progressively to the higher speed settings, cam 45 moves split housing member 44 further and further toward contact arm 26. This compresses spring 42 more and more so that it applies an increasingly greater force to contact arm 26 tending to keep contacts 12 and 13 closed. As previously mentioned, contacts 12 and 13 are opened by the action of governing device 40, and the greater is the force required to open the contacts, the higher must be the shaft speed before the governor operates. Thus, the more spring 42 is compressed, the higher will be the speed setting of the motor.

Although, preferably, and as shown, governing device 40 is of the type disclosed and claimed in the aforesaid Robertson Patent 2,557,765, it should be understood that this invention is not restricted to that particular type of governor since various other type governors may be employed to open contacts 12 and 13. The Robertson governor is preferred, however, because its action is both speed and acceleration responsive, rather than strictly speed responsive as are most other governors.

As shown in Fig. 2, actuated member 39 of governor 40 is positioned slidably on the end of shaft 34 so that it may move toward contact arm 26. The rear face of member 39 mates with the front face of an actuating flange member 56, which is firmly secured to shaft 34. The mating faces are both frusto-conically-shaped and the front face of member 56 is provided with a plurality of circumferentially spaced recesses 57 in which are positioned weights or balls 58. These recesses are preferably declined from the front face of member 56 in the direction of rotation of the member and at an angle to drive shaft 34 so that the movement therein of balls 58 is responsive to both the speed and the acceleration of shaft 34.

The speed responsive movement of balls 58 is due to centrifugal forces, while the acceleration responsive action of the balls is due to inertia forces. Thus, when shaft 34 is rotated at a constant speed, balls 58 are centrifugally forced against the rear face of member 39 with a force proportional to the shaft speed; whereas, when shaft 34 is accelerated rapidly, the inertia of

balls 58 causes them to accelerate less rapidly than member 56 and thereby to move along tapered recesses 57 into contact with member 39 with a force proportional to the rate of shaft acceleration.

The movement of balls 58 against the rear face of member 39, of course, creates a force tending to move it toward contact arm 26; and when this force is great enough to overcome the combined bias of arm 26 and spring 42, member 39 moves bending arm 26 and separating contact 12 from contact 13. This removes the short from resistor 17 and capacitor 18 and greatly attenuates the voltage across the drive motor. The motor and its connected load including shaft 34 then begin to slow down. When the speed of shaft 34 has decreased to a lower level, the spring bias tending to return contact arm 26 to the closed position again becomes greater than the force from member 39 tending to keep it in the open position. The contact arm then recloses contacts 12 and 13 and the drive motor is once again energized. The motor again begins to accelerate and continues to do so until the level of rotation is reached where member 39 moves to operate arm 26. Thus, the speed control of the motor is accomplished by causing it to accelerate and decelerate in a narrow band between two predetermined levels of rotation. The mean or average speed of the motor is, of course, dependent upon the amount of bias applied to arm 26 by spring 42.

Naturally, the more dense is the mixture being stirred, the heavier is the load on the motor and the greater percentage of the time must contacts 12 and 13 remain closed for any given speed. If the load is so heavy as to stall the motor, contacts 12 and 13 remain closed and a great inrush of current occurs in the motor circuit. However, as soon as knob 8 is turned to the "off" position contacts 12 and 13 open due to the force supplied from arm 23 through plates 31 and 32. This removes the short from resistance 17 and capacitor 18 and increases the circuit impedance appreciably so as to reduce the current to a value which may be safely interrupted by the subsequent opening of contacts 14 and 15.

As previously pointed out, it is in this cooperating action of the two sets of contacts that the great advantage of this invention lies. By utilizing the speed regulating contacts to reduce the circuit current before the circuit is broken by the line switch contacts, arcing and heating at the line switch contacts are substantially avoided. This permits the use of small contacts and switch arms of short travel even though the stalled motor currents may be quite large. The combination of an increased interrupting capacity with little or no increase in physical size over conventional switches makes the circuit breaking means of this invention particularly desirable for use in kitchen mixers and like devices where only a limited space is available to house the line switch.

While in accordance with the patent statutes there has been described what at present is considered to be the preferred embodiment of this invention, it will be obvious to those skilled in the art that numerous changes and modifications may be made therein without departing from the invention, and it is, therefore, aimed in the appended claims to cover all such changes and modications as fall within the true spirit and scope of this invention.

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

1. In an electric kitchen mixer including a drive motor and a circuit for energizing said motor, a circuit controlling switch comprising first and second pairs of cooperating contacts connected serially with said motor in said circuit on one side of the line to the motor, an impedance connected in said motor circuit in parallel with said second pair of contacts but in series with said first pair of contacts, said first pair of contacts being biased to the open position and manually movable against said bias to the closed position, said second pair of contacts being biased to tend to move to the closed position, one of the contacts of said second pair being biased toward the other contact of said second pair, one of the contacts of the first pair being biased in a direction opposite to that of said one contact of said second pair, a mechanical connection between the two oppositely biased contacts that normally prevents movement of said one contact of said second pair toward the other contact of said second pair, such movement being permitted only after said one contact of said first pair is forced to move in a direction opposite to that in which it is normally biased, such forced movement occurring only after the closing of said first pair of contacts, said mechanical connection causing a prior opening of said second pair of contacts upon the opening of said first pair of contacts whereby said impedance is always introduced into said motor circuit before said circuit is broken by said first pair of contacts.

2. In an electric kitchen mixer including a drive motor and a circuit for energizing said motor, a circuit controlling switch comprising a pair of cooperating speed-regulating contacts and a pair of cooperating circuit-breaking contacts connected serially with said motor in said circuit on one side of the line to the motor, an impedance connected in said motor circuit in parallel with said speed-regulating contacts but in series with said circuit breaking contacts, said circuit-breaking contacts being biased to the open position and manually movable against said bias to the closed position, said speed-regulating contacts being biased to tend to move to a closed position, a mechanical connection between said circuit-breaking contacts and said speed-regulating contacts allowing said speed-regulating contacts to close only after the closing of said circuit-breaking contacts and causing a prior opening of said speed-regulating contacts upon the opening of said circuit-breaking contacts, and a centrifugal governing device driven by said motor and disposed to open said regulating contacts upon said motor reaching a predetermined level of rotation after the closing of both pairs of contacts, the opening of said regulating contacts by said governing device being effective to reduce the speed of said motor by introducing said empedance into said circuit, said impedance also being introduced into said circuit by said prior opening of said regulating contacts upon the opening of said circuit-breaking contacts whereby said impedance is always introduced into the motor circuit before said circuit is opened by said circuit breaking contacts.

3. In an electric kitchen mixer having an electric motor and a circuit for energizing said motor, circuit-breaking and speed controlling means for said motor comprising a pair of cooperating circuit-breaking line contacts and a pair of cooperating speed-regulating contacts

connected serially with said motor and said circuit on one side of the line to the motor, an impedance connected in said motor circuit in parallel with said regulating contacts but serially with said line contacts, first and second movable contact arms each mounting one of said line contacts and a third movable contact arm mounting one of said regulating contacts, the other of said regulating contacts being fixed in position, each of said first and second arms being biased to a normal position to open said line contacts, means for manually moving said first and second arms against their bias in a predetermined direction, said third arm being biased to tend to move said one regulating contact in said predetermined direction to engage said fixed regulating contact, a stop engaging said third contact arm and one of said first and second arms and secured to one of the engaged arms, said stop limiting the movement of said third arm in said predetermined direction, the bias of said one of said first and second arms being greater than the bias of said third arm to keep said one arm in its normal position with said stop engaging said regulating arm, said third arm thereupon being held in a position with said one regulating contact not engaging said other regulating contact, said line contacts being closed by movement of said first arm in said predetermined direction, additional movement of said first arm in said predetermined direction after the engagement of said line contacts moving said stop sufficiently to allow said third arm to close said regulating contacts, and a centrifugal governor mounted on said shaft and engaging said third arm to apply a force thereto in opposition to the bias of said third arm, said force being proportional to the level of rotation of said motor and being effective to cause movement of said third arm to open said regulating contacts at a predetermined level of rotation to introduce said impedance into said circuit, said regulating contacts also being opened by the action of said stop before the opening of said line contacts upon the movement of said first arm back toward its normal position whereby said impedance is placed in said circuit before said line contacts are opened.

4. In a kitchen mixer having an electric motor and a circuit for energizing said motor, circuit-breaking means for said motor comprising a pair of cooperating circuit-breaking line contacts and a second pair of cooperating speed governing contacts connected serially with said motor in said circuit, an impedance connected in said motor circuit in parallel with said second pair of contacts but serially with said line contacts, first and second contact arms each mounting one of said line contacts and a third movable contact arm mounting one of said second contacts, the other of said second contacts being fixed in position, each of said first and second arms being biased to a normal position to open said line contacts and manually movable against its bias

in a predetermined direction, said third arm being biased to tend to move said one of said second contacts in said predetermined direction to close said second contacts, a stop engaging said third contact arm and one of said first and second arms and secured to one of the engaged arms, said stop limiting the movement of said third arm in said predetermined direction, the bias of said one of said first and second arms being greater than the bias of said third arm to keep said one arm in its normal position with said stop engaging said third arm, said third arm thereupon being held in a position with said one of said second contacts not engaging said other of said second contacts, said line contacts being closed by the movement of said first arm in said predetermined direction, additional movement of said first arm in said predetermined direction after the engagement of said line contacts moving said stop sufficiently to allow said third arm to close said second contacts, whereby said second contacts may be closed only after said line contacts are closed and whereby said line contacts may be opened only after said second contacts are opened.

5. In a rotation controlled electric motor driven device of the type having an electric motor, an electrical circut to the motor, a rotation responsive governor driven by the motor, a set of normally closed governing contacts in the circuit leading to the motor, said contacts being separated by said governor upon the attainment of a predetermined level of rotation by said motor and closed below said level of rotation, and a voltage reducing impedance in the circuit leading to the motor connected in parallel with the governing contacts to be in the circuit to the motor when said governing contacts are separated, that improvement comprising a disconnect switch with cooperating contacts in said motor circuit, connected in series only both with said set of governing contacts and with said impedance, manual means for opening and closing said disconnect switch contacts and a mechanical connection between said disconnect switch and said governing contacts such that upon manual movement toward opening of said disconnect switch contacts said governing contacts are separated before said switch contacts are opened, whereby upon operation of said disconnect switch, said impedance is always placed in the circuit leading to the motor before said disconnect switch breaks the motor circuit.

KARL J. FLEMING.

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