May 8, 1923. 1,454,644

C. F. KETTERING

ELECTRIC SPEEDOMETER

Filed Aug. 28, 1918 3 Sheets-Sheet 1

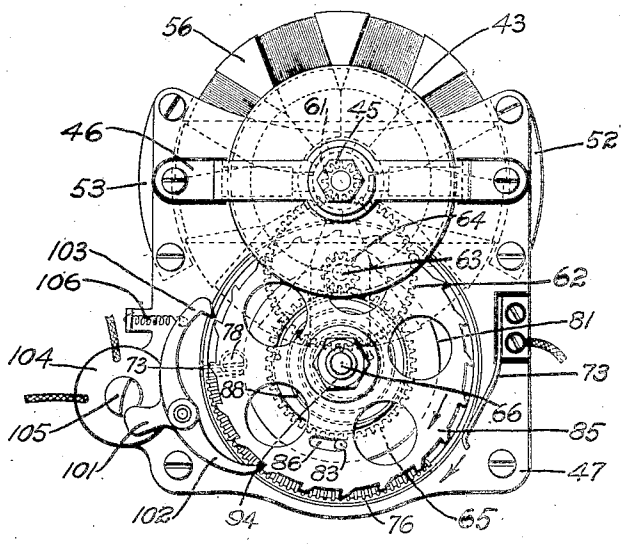


Fig. 1.

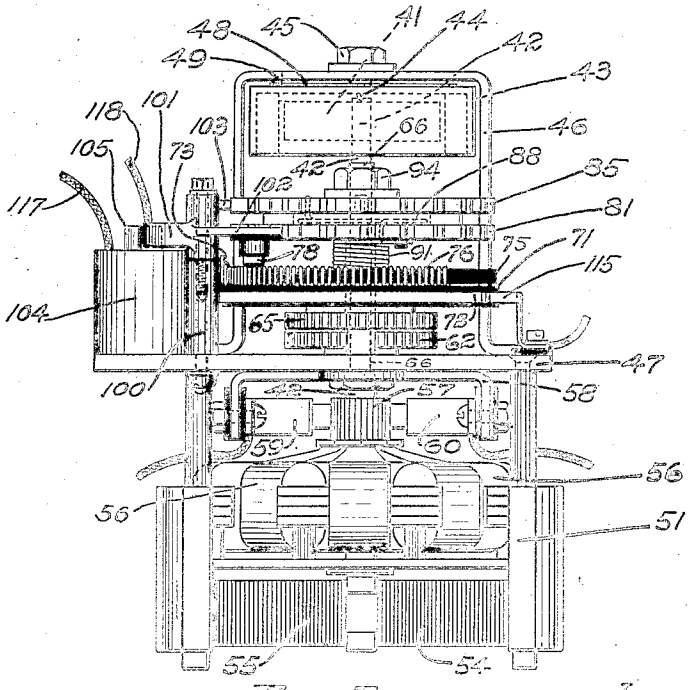


Fig. 2.

Witnesses
Walter M. Rusk
Edward E. Broad

Inventor
Charles F. Kettering
By Kerr, Page, Cooper & Hayward
Attorneys.

May 8, 1923. 1,454,644

C. F. KETTERING

ELECTRIC SPEEDOMETER

Filed Aug. 28, 1918 3 Sheets-Sheet 2

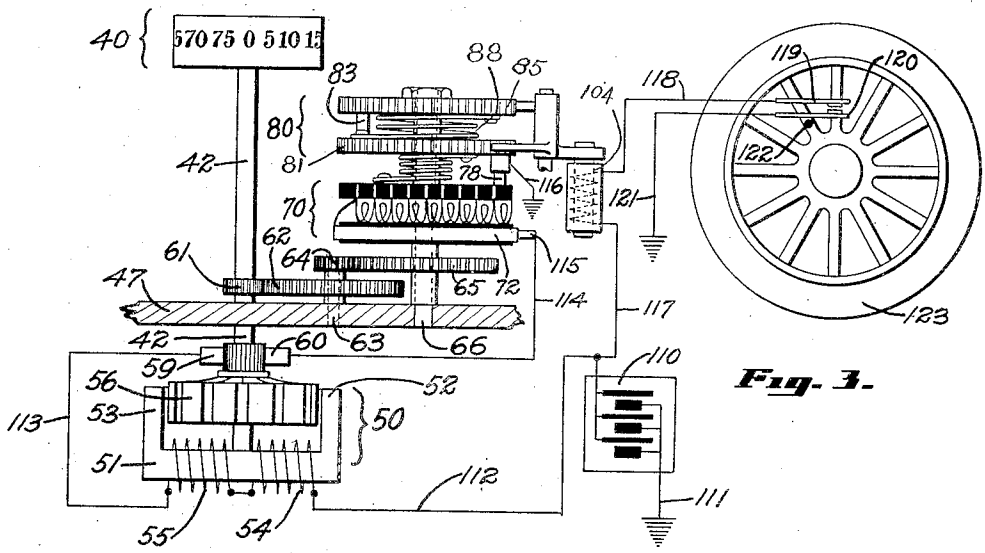


Fig. 3.

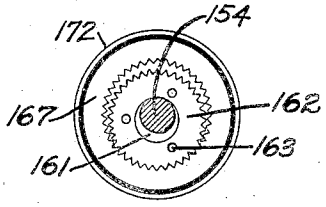


Fig. 5.

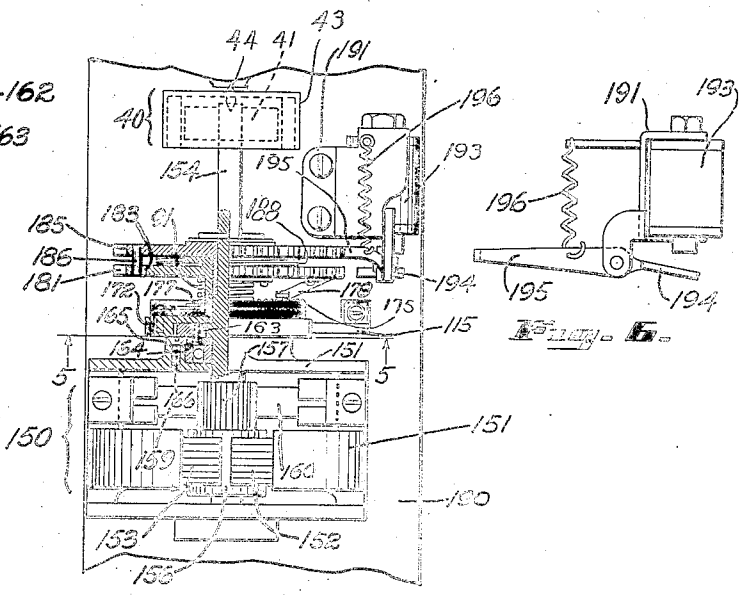


Fig. 4.

Fig. 6.

Witnesses
Walter Riedel
Edward Freed

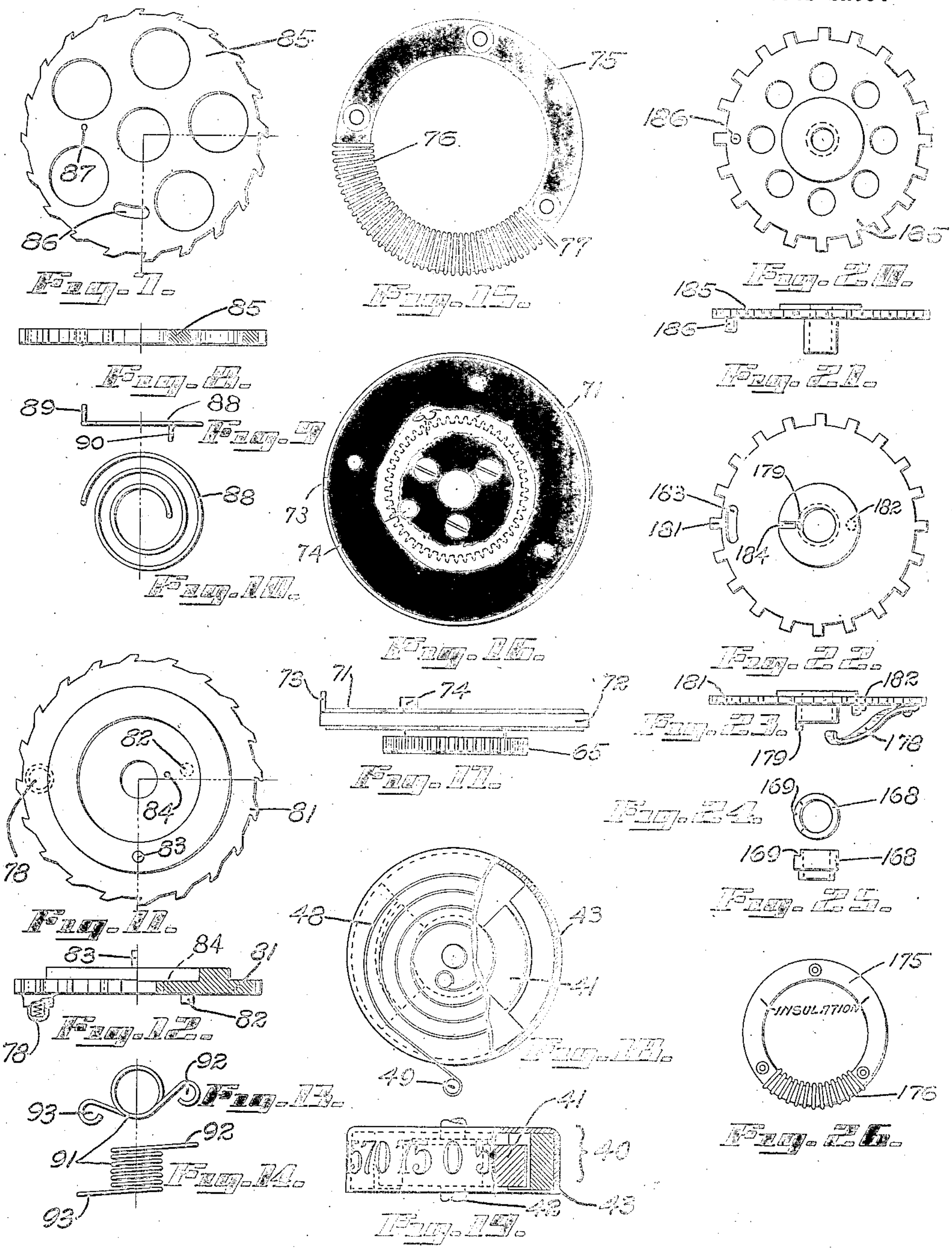
Inventor
Charles F. Kettering
By Kerr, Page, Cooper & Hayward
Attorneys

May 8, 1923. 1,454,644

C. F. KETTERING

ELECTRIC SPEEDOMETER

Filed Aug. 28, 1918 3 Sheets-Sheet 3



Witnesses
Walter W. Riedel
Elmer E. Frees

Inventor
Charles F. Kettering

By Lon, Page, Cooper & Hayward
Attorneys.

Patented May 8, 1923. 1,454,644

UNITED STATES PATENT OFFICE.

CHARLES F. KETTERING, OF DAYTON, OHIO, ASSIGNOR TO THE DAYTON ENGINEERING LABORATORIES COMPANY, A CORPORATION OF OHIO.

ELECTRIC SPEEDOMETER.

Application filed August 28, 1918. Serial No. 251,756.

To all whom it may concern:

Be it known that I, CHARLES F. KETTERING, a citizen of the United States of America, residing at Dayton, county of Montgomery, State of Ohio, have invented certain new and useful Improvements in Electric Speedometers, of which the following is a full, clear, and exact description.

This invention relates to speedometers for vehicles and the like and has for one of its objects the provision of a speedometer which is very sensitive to slight changes in speed and very reliable and accurate in operation.

More particularly it is an object of this invention to accomplish the purpose referred to by providing a speedometer in which the motion, which is imparted to the indicating member, is derived from a prime mover which is independent of the vehicle, instead of being driven directly by the vehicle itself, the quantity of motion which is delivered to the indicating device being determined by auxiliary devices which are controlled by the speed of the vehicle.

Other and further objects of the present invention will be apparent from the following description thereof, reference being made to the accompanying drawings, in which preferred embodiments of the invention are shown.

In the drawings:

Fig. 1 is a plan view of one form of the invention;

Fig. 2 is a side elevation of the form of the invention shown in Fig. 1;

Fig. 3 is a diagrammatic showing together with a wiring diagram of electric devices included in the present invention;

Fig. 4 is an elevational view partly in section of a modified form of the invention;

Fig. 5 is a sectional view taken on the line 5—5 of Fig. 4 showing the hunting tooth gear included in this form of the invention;

Fig. 6 is a side view of an electro-magnet controlling device included in the form of the invention shown in Fig. 4.

Fig. 7 is a plan view of the upper escapement member of the form of the invention shown in Figs. 1 and 2;

Fig. 8 is an edge view thereof, partly in section;

Fig. 9 is a side elevation of the spring yieldingly connecting the upper and lower escapement members;

Fig. 10 is a plan view thereof;

Fig. 11 is a plan view of the lower escapement member included in the form of the invention shown in Fig. 1;

Fig. 12 is an edge view thereof partly in section;

Fig. 13 is a plan view of the energy storing spring;

Fig. 14 is a side view thereof;

Fig. 15 is a plan view of the resistor included in the form of the invention shown in Fig. 1;

Fig. 16 is a plan view of the collector disk included in the first form of the invention;

Fig. 17 is a side view thereof;

Fig. 18 is a top plan view partly in section of the indicator;

Fig. 19 is a side view thereof partly in section;

Fig. 20 is a plan view of the upper escapement wheel included in the second form of the invention shown in Fig. 4;

Fig. 21 is an edge view thereof;

Fig. 22 is a plan view of the lower escapement member included in the second form of the invention;

Fig. 23 is a side view thereof;

Fig. 24 is a top plan view of the hunting tooth rotating gear hub;

Fig. 25 is a side view thereof; and

Fig. 26 is a top plan view of the resistor included in the second form of the invention.

Referring to Fig. 3 which shows diagrammatically the first form of the invention shown in detail in Figs. 1 and 2, it will be seen that this form of the invention comprises in chief an indicating member 40 which depends for its action upon the motion transmitted to it from a prime mover 50 which in this form is a series motor. In

order to control the quantity of motion delivered to the indicator by the motor, the speed of the motor itself is controlled by means of a rheostat 70, and the devices indicated at 80 in Fig. 3 constitute provisions dependent upon the speed of the engine for actuating the rheostat so that the speed of the motor may be controlled in accordance with the speed of the engine.

Referring to Figs. 1, 2, and 4 and Figs. 7 to 19 of the drawings, the indicator 40 which is of the usual magnetic drag type, comprises a permanent magnet 41 mounted to rotate with the shaft 42 and to drag after it the index member 43 which is mounted by means of pivot pin 44 between the upper end of the shaft 42 and a screw 45 carried by the bracket 46. A spring 48 connected to the index 43 and to a pin 49 mounted on the bracket 46, serves to resist the movement of the index 43, due to the action of magnet 41. The bracket 46 rests upon a plate 47 which in turn is supported by the frame 51 of the motor 50.

The frame 51 is provided with pole pieces 52 and 53 which are energized by the field windings 54 and 55. The shaft 42 is journalled in the supporting plate 47 and in the motor frame 51 and carries the motor armature 56 which is connected with the motor commutator 57. A brush bracket 58 which is mounted on the plate 47 supports the brushes 59 and 60. Shaft 42 carries a pinion 61 which meshes with a gear 62 journalled on a stub shaft 63 mounted on the plate 47. Gear 62 carries a pinion 64 which meshes with a gear 65 mounted to rotate on the stub shaft 66 which is mounted upon plate 47.

Referring to Figs. 16 and 17, a collector disk 71 of insulating material is mounted upon the gear 65 and carries a collector ring 72 which is adapted to be engaged by a brush 115 mounted upon the plate 47 or insulated therefrom. Ring 72 is provided with an upstanding ear 73 for a purpose to be described. The disk 71 is provided with a pin 74 adapted to be engaged by a spring to be described. (The solid black used in Fig. 16 to indicate that the member 71 is made of insulated material, is broken away merely for the purpose of showing the plan view of the gear 65.)

Referring to Figs. 2 and 15 a resistor ring 75 of insulating material is provided with a resistor 76, and is mounted upon the collector disk 71. The end 77 of the resistor 76 is soldered or otherwise permanently secured to the upstanding ear 73, and connection is thereby made with the collector ring 72.

The wiper 78 which cooperates with the resistor 76 is mounted upon the lower escapement wheel 81 which is mounted on the stub shaft 66 above the collector disk 71 and resistor 76. This escapement wheel 81 is shown in detail in Figs. 11 and 12. Said wheel 81 is provided with a downwardly projecting pin 82 and upwardly projecting pin 83 and a small hole 84.

The upper escapement wheel 85 is mounted upon the stub shaft 66 above the lower escapement wheel. Referring to Figs. 7 and 8 the wheel 85 is provided with a slotted hole 86 into which projects the pin 83 carried by the wheel 81. The wheel 85 is provided with a small hole 87.

Referring more particularly to Figs. 9 and 10, a flat spiral spring 88 is provided with upwardly projecting end 89 which fits into the hole 87, and a downwardly projecting end 90 which fits into the hole 84 provided in wheel 81. When the escapement wheels 81 and 85 and the spring 88 are in assembled relation, the pin 83 will be yieldingly held against the right hand end of the slot 86 as viewed in Fig. 1.

Referring to Figs. 13 and 14 and to Fig. 2, a coil spring 91 is provided with an eye 92 which engages the pin 82 carried by the escapement wheel 81, and with another eye 93 which engages the pin 74 carried by the collector disk 71.

The parts which are mounted on the stub shaft 66 are retained in position by means of a nut 94 which is threaded upon the upper end of said shaft 66.

The plate 47 carries a post 100 upon which is pivotally mounted an armature 101 which carries a pawl 102 adapted to cooperate with the lower escapement wheel 81 and a pawl 103 adapted to engage with the upper escapement wheel 85. An electro-magnet 104 is mounted on the plate 47 and is provided with a pole piece 105 arranged adjacent the armature 101. A spring 106 connected to the frame 47 and to the armature 101 serves to move the same away from the pole 105 when the magnet 104 is not energized.

Referring to Fig. 3 battery 110 is grounded at 111 and connected by wire 112 with the field windings 54 and 55 of the motor 50, which are connected by wire 113 with brush 59. Brush 60 is connected by wire 114 with the brush 115 which cooperates with the collector ring 72. The rheostat wiper 78 is grounded by wire 116. The battery 110 is connected by wire 117 with one terminal of the magnet 104, the other terminal of which is connected by wire 118 with contact member 119 which cooperates with contact member 120, 120 being grounded by wire 121. The contacts 119 and 120 are suitably mounted on the frame of the vehicle and are adapted to be closed intermittently by some moving part of the vehicle as a pin 122 mounted on the vehicle wheel 123.

The operation of the form of the inven-

tion described is as follows: It will be assumed first, that the speed of the vehicle has reached a maximum at which time the relation of the different elements of the speedometer will be as shown in Fig. 1, and the wiper 78 will be in engagement with the first turn on the left-hand end of the resistor 76; and then, that the vehicle has stopped. The motor 50 will continue to rotate at its maximum speed and cause the rotation of the resistor 76 in a clock-wise direction as viewed in Fig. 1. This motion will continue until the last turn of the resistor 76 on the right-hand end thereof as viewed in Fig. 1 has passed under the wiper 78. When this occurs the motor circuit will be broken and the motor will stop. This movement of the motor will cause the spring 91 to be wound up, and energy will be stored therein to effect the movement of the wiper 78 relative to the resistor 76.

When the vehicle is set in motion the contacts 119 and 120 will be intermittently closed. Each time the contacts are closed the magnet 104 will be energized causing the movement of the armature 101 in a clock-wise direction as viewed in Fig. 1. This movement of the armature 101 will release the lower escapement wheel 81 and cause the pawl 103 to move into engagement with the upper escapement wheel 85. After the pawl 102 has been moved out of engagement with the escapement wheel 81, the wheel 81 will move in a clock-wise direction viewed in Fig. 1, until the pin 83 moves to the left-hand end of the slot 86 as viewed in Fig. 1 when the movement of wheel 81 will cease. The angle of movement of wheel 81 is equal to the angle between adjacent tooth centers.

When the contact 120 has been released by the pin 122 the magnet 104 will be deenergized, and the spring 106 will restore the armature 101 to the position shown in Fig. 1 thereby causing the pawl 102 to engage the ratchet wheel 81 and to cause the pawl 103 to be moved out of engagement with the wheel 85. This movement of the armature will cause the upper escapement wheel to move under the action of the spring 88 until the right-hand end of the slot 86 as viewed in Fig. 1 will engage the pin 83 carried by the ratchet wheel 81. This cycle of movements of the armature 101 and the escapement wheels 81 and 85, caused by the closing and opening of the contacts 119 and 120, will cause the wiper 78 to move relatively to the resistor 76 in such a manner as to cut resistance out of the motor circuit and to cause the motor to run faster. It is evident that the faster the vehicle travels the more frequently the cycle of movement referred to will take place, consequently the tendency to cut out resistance will be proportional to the speed of the vehicle. While these movements are occurring the motor is running all of the time tending to cut in resistance in the motor circuit, but a balance will be established between these two opposing forces resulting in the resistor and wiper moving in the same direction and at the same speed, and therefore with no relative movement between them. The motor will then be caused to rotate at a speed corresponding to the speed of the vehicle.

Referring now to Figs. 4, 5, 6 and Figs. 20 to 26 in which the second form of the invention is shown, 150 designates a prime mover which in this form is also an electric motor comprising a frame 151 including poles 152 and 153. A shaft 154 is journalled in the frame 151 and carries a motor armature 156 and commutator 157 with which cooperate the motor brushes 159 and 160 which are supported on the frame 151. Upon the upper end of the motor shaft 154 is mounted the indicator 40.

The shaft 154 is provided with an eccentric 161 shown in Fig. 5, which cooperates with the hunting tooth oscillating gear 162. Gear 162 is provided with pins 163 which cooperate with holes 164 provided in the hunting tooth oscillating gear retaining plate 165 which is secured to the frame 151 by means of screws 166. Hunting tooth rotating gear 167 is provided with a hub 168 shown in Figs. 24 and 25 by means of which the gear 167 is journalled upon the shaft 154. The hub 168 is provided with a notch 169 for a purpose to be described. The gear 167 is provided with a collector ring 172 associated with a brush 115 in a manner similar to the collector ring 72 of the first form. A resistor disk 175 carrying a resistor 176 is mounted upon the gear 167 but insulated therefrom, and one end of the resistor 176 is connected with the collector ring 172. The gear 167 carries a pin 177 which engages the eye 93 and the spring 91 shown in Figs. 13 and 14.

Referring to Figs. 22 and 23 the lower escapement wheel 181 is provided with a pin 182 which engages the other eye 92 of the spring 91. The wheel 181 is provided with a wiper 178 which contacts with the resistor 176. The hub of heel 181 is provided with a projection 179 which engages the notch 169 of the hub 168 of the hunting tooth gear 167. Escapement wheel 181 is provided with an arcuate slot 183 which is adapted to be engaged by a pin 186 carried by the upper escapement wheel 185. The wheels 185 and 181 are loosely journalled upon the shaft 154 and a flat spiral spring 188 occupies the space between adjacent faces of the escapement wheels 181 and 185 and has one end thereof connected with a notch 184 in the wheel 181, and the other end connected with the pin 186.

The motor frame 151 carrying the parts

described in the foregoing paragraphs is mounted upon a bracket 190. A magnet frame 191 is mounted upon the bracket 190 and supports an electro-magnet 193 and a pivotally mounted armature 194 which carries a pawl 195 which is adapted to cooperate alternately with the escapement wheels 185 and 181. The spring 196 connected between the armature 194 and the frame 191 serves to yieldingly maintain the armature 194 in the position as shown in Fig. 6.

The electrical connections between the battery 110, the motor, rheostat electro-magnet and contacts 119 and 120 are the same as the connections between the corresponding elements of the first form of the invention as shown in Fig. 3.

The operation of this form of the invention is as follows: Assuming that the vehicle has come to rest with all of the resistance in the motor circuit cut out, the motor will continue to operate until, through the hunting tooth gearing, motion is transmitted to the resistor 176 causing it to gradually cut in resistance in the motor circuit until the resistor moves entirely from under the wiper 178 and the motor circuit is broken. While this motion takes place, the upper escapement wheel 185 will be held stationary by reason of the engagement therewith of the pawl 195. The escapement wheel 181 will be held stationary under the yielding pressure of the spring 188. After the motor circuit has been broken the motor will continue to rotate, due to its momentum, and cause the hunting tooth gear 167 to rotate until one end of the notch 169 of the hub 168 contacts with the projection 179 of the wheel 181. When this occurs the motor armature will be stopped under the yielding pressure of the spring 188. This operation of the motor will cause the winding up of the spring 91 as in the case of the first form of the invention.

Whenever, due to the movement of the vehicle, causing contacts 119 and 120 to close, the magnet 193 is energized, the armature 194 will be attracted and the pawl 195 will be caused to move downwardly, thereby releasing the upper escapement wheel 185 and engaging the lower escapement wheel 181. When this occurs the upper escapement wheel 185 will be actuated due to the action of the spring 188 relative to the wheel 181. When the circuit through the magnet 193 is broken the spring 196 will cause the armature 194 to return to the position shown in Fig. 6, at which time the pawl 195 will move out of engagement with the escapement wheel 181 and into engagement with the escapement wheel 185, thereby causing the lower escapement wheel 181 to move in a clock-wise direction under the action of the spring 188 as viewed in Fig. 22. This movement of wheel 181 will continue until the lower end of the slot 183 as viewed in Fig. 22, moves into engagement with the pin 186 carried by the upper wheel 185. The wheel 181 will then have travelled the distance between adjacent tooth centers. The clock-wise movement of the wheel is such as to cause the wiper 178 to cut resistance out of the motor circuit. As in the first form of the invention the faster the vehicle operates the more frequently the electro-magnet 193 will operate the pawl 195 in order to release the escapement wheels 181 and 185, whereby to cut resistance out of the motor circuit. The action of the vehicle in cutting out resistance will be opposed by the action of the motor tending to cut in resistance. When these opposing forces reach a balance no relative motion between the resistor 176 and the wiper 178 will occur, and the motor will operate at a speed corresponding to the speed of the vehicle.

While the forms of mechanisms herein shown and described constitute preferred forms of embodiments of the invention, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow:

1. In a synchronizing system for electric motors, the combination with a motor; of a rheostat in the motor circuit including as elements, a resistor and a wiper; means actuated by the operation of the motor tending to move the resistor relatively to the wiper; a spring which is wound up by the movement of the motor; and means controlled by the movable part with which the motor is to be synchronized for releasing the spring whereby the wiper will be moved under the action of the spring relatively to the resistor in order to counteract the effect of the first named means, thereby tending to increase the amount of current delivered to the motor.

2. In a synchronizing system for electric motors, the combination with a motor; of a rheostat in the motor circuit including as elements a resistor and a wiper; means actuated by the operation of the motor for moving one of the rheostat elements relatively to the other tending to reduce the current delivery to the motor to a minimum; a spring adapted to be wound up by the motion of the motor; and means controlled by the movable part with which the motor is to be synchronized for releasing the spring by step by step motion controlled by the speed of the said part for moving one of the rheostat elements relatively to the other in order to counteract the effect of the first named means, thereby tending to increase the amount of current delivered to the motor.

3. In a synchronizing system for electric motors, the combination with a motor; of a rheostat in the motor circuit including a resistor and a wiper; means actuated by the operation of the motor for moving the re-

sistor relatively to the wiper tending to reduce the current delivered to the motor to a minimum; a spring adapted to be wound up by the motion of the motor; and means controlled by the movable part with which the motor is to be synchronized for permitting the release of the spring by step by step motion, whereby the wiper is moved relatively to the resistor thereby cutting resistance out of the motor circuit and tending to increase the amount of current delivered to the motor.

4. In a synchronizing system for electric motors, the combination with a motor; of a rheostat in the motor circuit including a resistor and a wiper; means actuated by the operation of the motor for moving the resistor relatively to the wiper tending to reduce the current delivered to the motor to a minimum; a spring connected to the wiper and adapted to be wound up by the motor; an escapement wheel connected to the spring; a pawl co-operating with the escapement wheel; and means controlled by the movable part with which the motor is to be synchronized for actuating the pawl to release the spring and thereby cause the wiper to move relatively to the resistor.

5. In a synchronizing system for electric motors, the combination with a motor; of a rheostat in the motor circuit including a resistor and a wiper; means actuated by the operation of the motor for moving the resistor relatively to the wiper tending to reduce the current delivered to the motor to a minimum; a spring connected to the wiper and adapted to be wound up by the motor; an escapement wheel connected to the spring; a pawl co-operating with the escapement wheel; an electro-magnetic means controlled by the motion of the part with which the motor is to be synchronized for actuating the pawl to release the spring and thereby cause the wiper to move relatively to the resistor.

6. In a synchronizing system for electric motors, the combination with a motor; of a rheostat in the motor circuit including a resistor and a wiper; means actuated by the operation of the motor for moving the resistor relatively to the wiper tending to reduce the current delivered to the motor to a minimum; a spring connected to the wiper and adapted to be wound up by the motor; an escapement wheel connected to the spring; a pawl co-operating with the escapement wheel; an electro-magnet for operating the pawl; co-operating switch contacts connected in the magnet circuit; and means carried by a moving part with which the motor is to be synchronized for intermittently closing the contacts, whereby to intermittently release the spring and to cause the wiper to move relatively to the resistor.

7. In a synchronizing system for electric motors, the combination with a motor; of a rheostat in the motor circuit including a resistor and a wiper; means actuated by the operation of the motor for moving the resistor relatively to the wiper to reduce the current delivered to the motor to a minimum; a spring connected to the wiper and adapted to be wound up by the motor; yieldably connected escapement wheels connected with the spring, said escapement wheels including co-operating stops for limiting the motion between the wheels; pawls adapted to co-operate with the escapement wheels; and means controlled by the movement of a part with which the motor is to be synchronized for operating the pawls whereby the pawls will alternately engage the escapement wheels to release the spring, whereby the wiper is moved relatively to the resistor in order to oppose the first named means and to tend to increase the amount of current delivered to the motor.

8. In a synchronizing system for electric motors, the combination with a motor; of a rheostat in the motor circuit including a resistor and a wiper; means actuated by the operation of the motor for moving the resistor relatively to the wiper to reduce the current delivered to the motor to a minimum; a spring connected to the wiper and adapted to be wound up by the motor; yieldably connected escapement wheels in different planes connected with the spring, said escapement wheels provided with co-operating stops for limiting the motion between the escapement wheels; a pivotally mounted armature provided with pawls located in the planes of the escapement wheels, said pawls adapted to alternately engage the escapement wheels; an electro-magnet for operating the armature in one direction; a spring co-operating with the armature for moving the same in the opposite direction; and means controlled by the movement of a part with which the motor is to be synchronized for intermittently permitting current to flow to the magnet.

9. In a synchronizing system for electric motors, the combination with a motor; of means operated by the motor tending to reduce the motion of the motor and to store energy in an energy storing device; means adapted to be actuated upon the release of the energy storing device and thereby tending to increase the motion of the motor; and means controlled by the movement of a part with which the motor is to be synchronized to effect the release of the energy storing device.

10. In a synchronizing system for electric motors, the combination with a motor; of a device for controlling the speed of the motor including a first and a second member movable relatively to each other; means actuated continuously by the motor tending to move

the first member relatively to the second whereby to decrease the motion of the motor; means independent of driving connection with a movable part with which the motor is to be synchronized for causing the second member to tend to move relatively to the first member whereby to increase motion of the motor and means controlled by said movable part periodically to release said second means, the co-operation of said second means with the first means resulting in the establishment of a fixed relation between the first and second members corresponding to the speed of said movable part.

In testimony whereof I affix my signature.

CHARLES F. KETTERING.

Witnesses:
J. W. McDONALD,
M. A. PEARE.