May 23, 1939. E. G. KELLY 2,159,330

ELECTRIC SPEEDOMETER

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Fig. 2

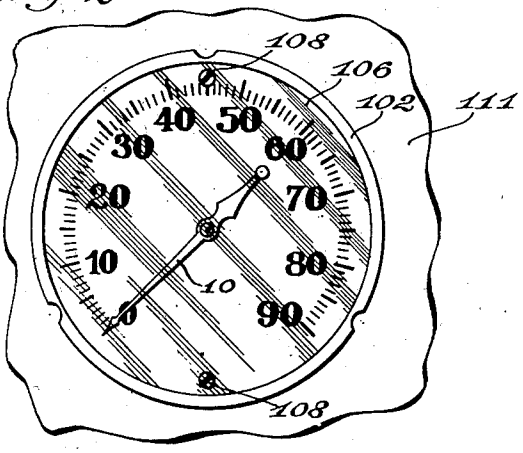


Fig. 8

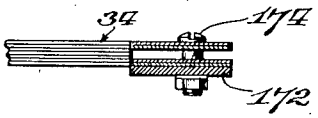
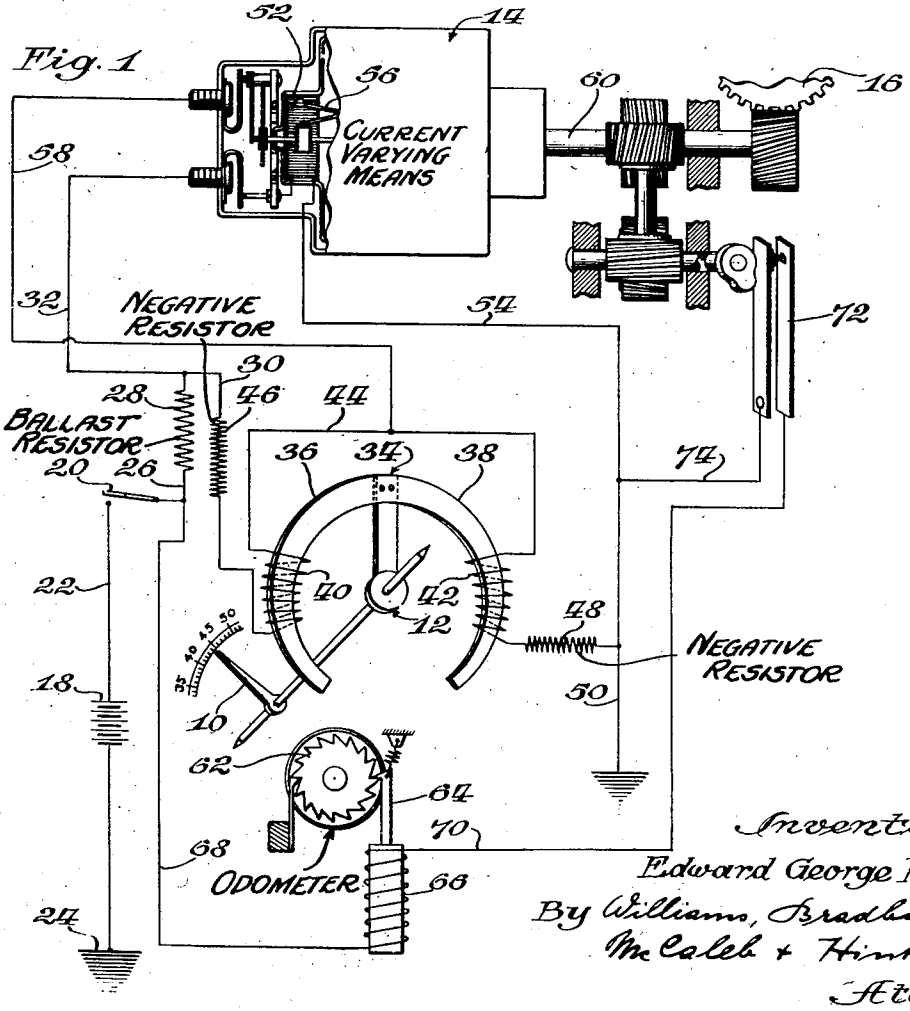


Fig. 1



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Fig. 3

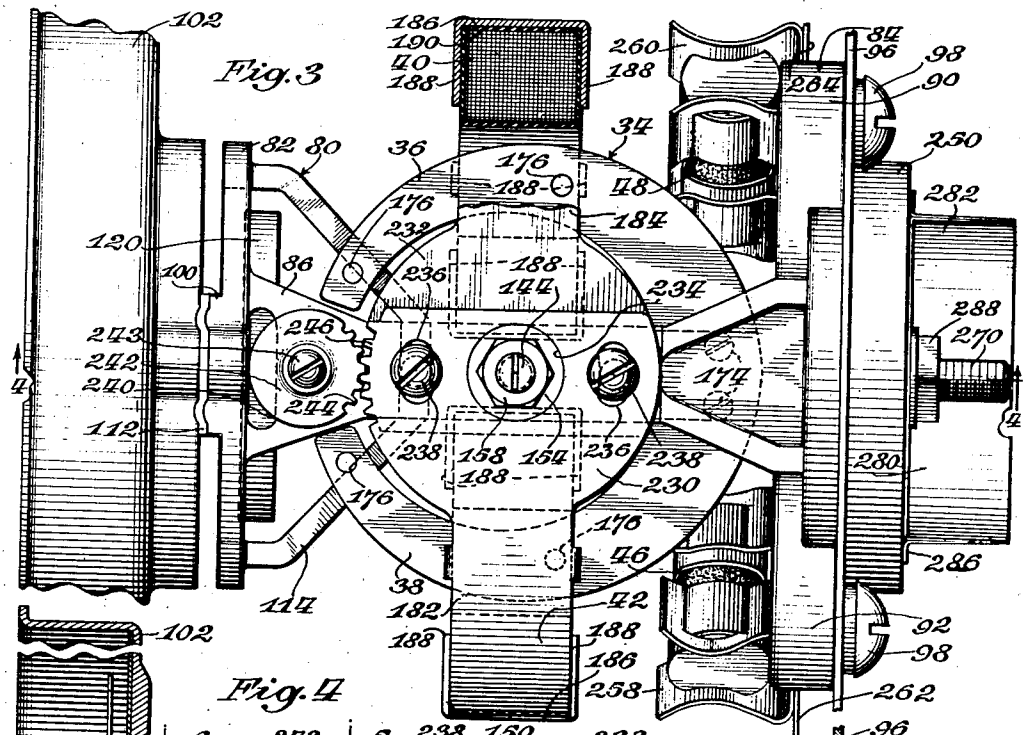


Fig. 4

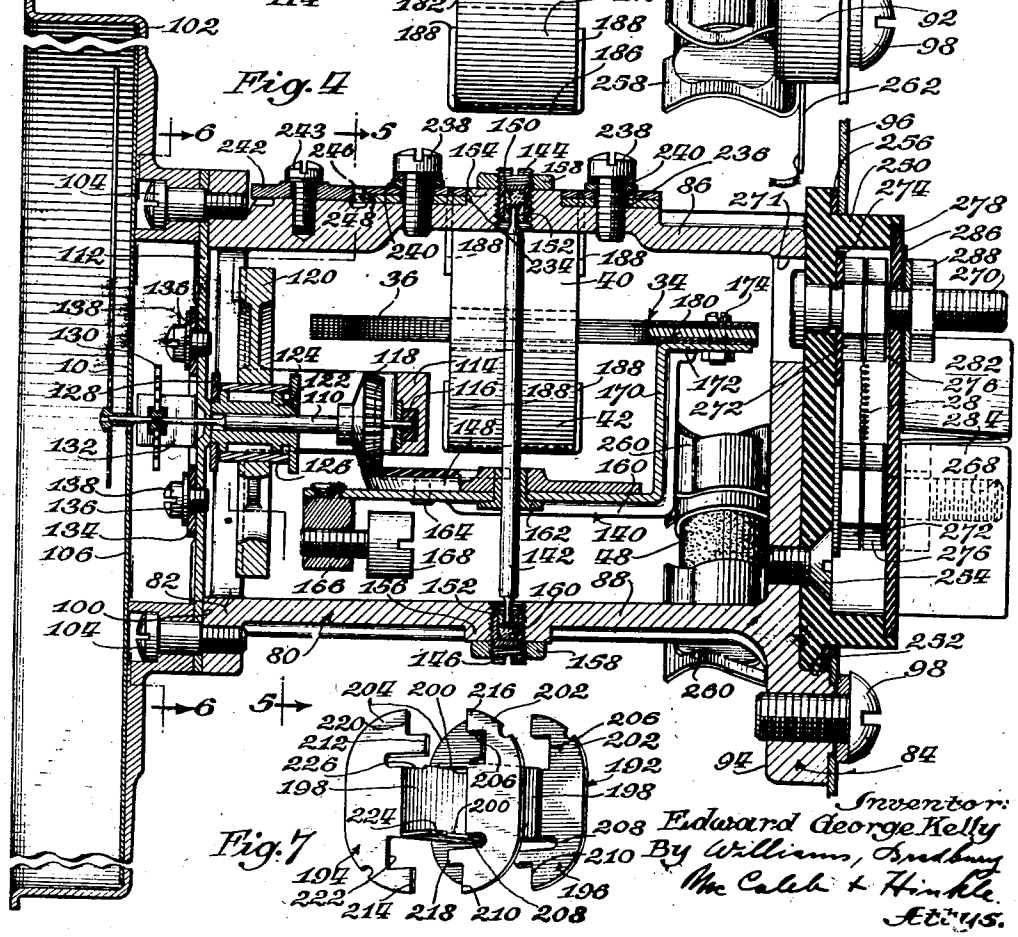


Fig. 7

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ELECTRIC SPEEDOMETER

Filed March 3, 1937 3 Sheets-Sheet 3

Fig. 5

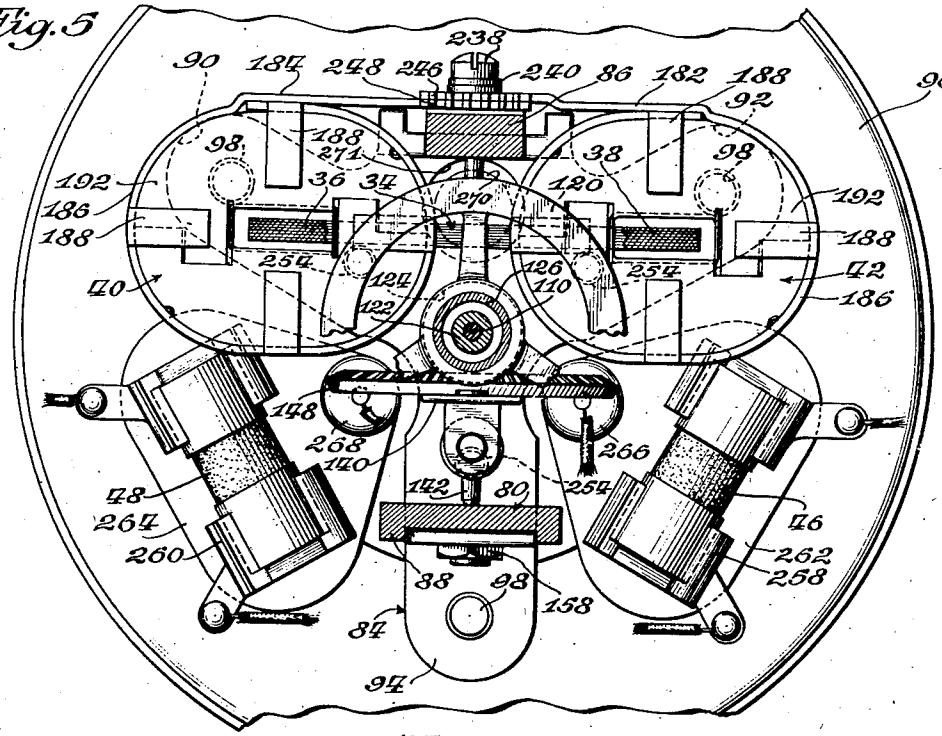
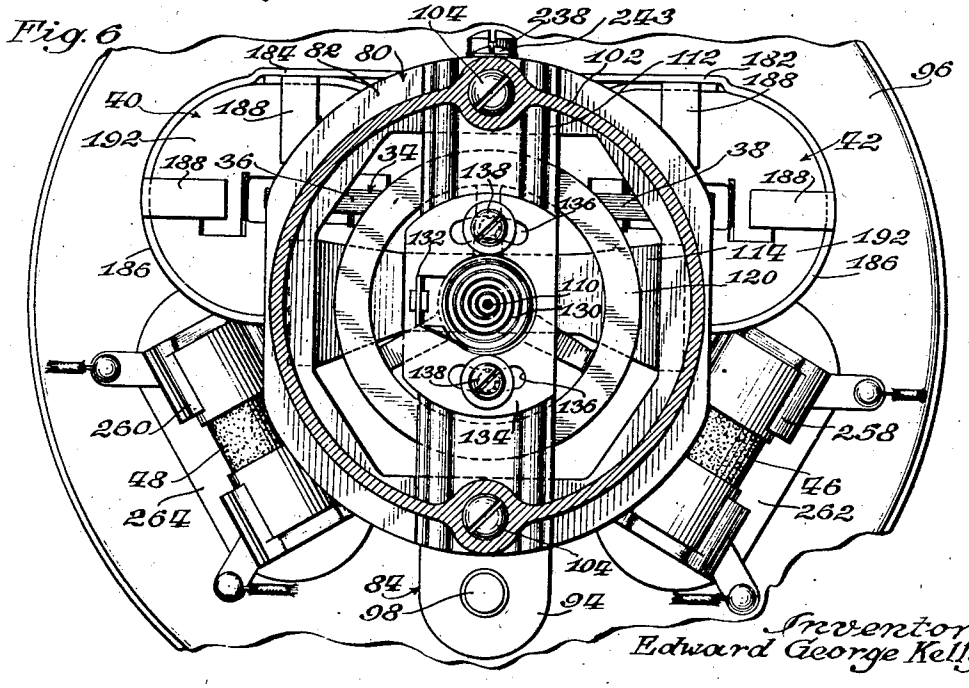


Fig. 6



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UNITED STATES PATENT OFFICE

2,159,330

ELECTRIC SPEEDOMETER

Edward George Kelly, Chicago, Ill., assignor to Stewart-Warner Corporation, Chicago, Ill., a corporation of Virginia

Application March 3, 1937, Serial No. 128,754

17 Claims. (Cl. 171—95)

The present invention relates to electric speedometers and particularly to improvements in the construction of the component parts thereof, whereby the speedometer unit may be manufactured cheaply and assembled in a simple, inexpensive manner. The invention is an improvement on the electric speedometer construction disclosed in application Serial No. 754,522, filed November 23, 1934.

The primary object of this invention is to provide a new and improved speed indicating mechanism that can be easily and cheaply manufactured.

A further object of the invention is to provide a new and improved speed indicating mechanism that is rugged and reliable in operation and one that can be readily calibrated and adjusted if it should get out of adjustment for any reason whatever.

A further object of the invention is to provide a new and improved speed indicator mechanism that can be assembled readily at the factory and one that can be just as readily disassembled in case repairs are necessary after use.

A still further object is to provide a new and improved supporting means for that member of the mechanism, in this case the armature, which is actuated to a position determined by the speed of the vehicle.

Another object of the invention is to provide a new and improved supporting means for the solenoids adapted to actuate the armature member of the mechanism.

Another object of the invention is to provide readily adjustable supporting means for these solenoids whereby they may be simultaneously adjusted from the outside of the casing adapted to house the mechanism.

Another object is to provide a compact unit containing the operative parts of the mechanism and the various electrical resistors forming part of the electrical system.

Other objects and advantages of the present invention will appear from the ensuing description of an embodiment of the invention in which reference is had to the accompanying drawings in which:

Fig. 1 is a diagrammatic layout of the speedometer indicating the various elements thereof and their electrical relationship;

Fig. 2 is a partial front plan view of the speedometer showing the face of the speed indicator;

Fig. 3 is a top plan view, partially in section, of the speed indicator operating mechanism;

Fig. 4 is a longitudinal vertical section taken on the line 4—4 of Fig. 3;

Fig. 5 is a partial irregular vertical section taken on the line 5—5 of Fig. 4;

Fig. 6 is a partial irregular vertical section taken on the line 6—6 of Fig. 4;

Fig. 7 is a perspective view of an insulating spacer used in the construction of the mechanism with parts thereof spaced apart for the purpose of better showing the construction; and

Fig. 8 is a partial cross sectional view of a modified form of armature construction.

Referring first to Fig. 1 of the drawings, there is shown an electrically operated speed indicating system forming no part of the present invention, but disclosed and claimed in the copending application of Horace M. Norman, Serial No. 127,845, filed February 26, 1937.

The system comprises a speed indicating arm 10 adapted to be moved by an electromagnetically operated actuating means 12, the position of which is controlled by a magnetically operated current varying means 14 suitably driven from a gear 16 rotating in unison with a part, such as a rear wheel, of a vehicle.

The various elements of the apparatus are indicated as being connected in circuit with the ignition system of an automobile. Energy is supplied to the apparatus from the usual automobile battery 18 under the control of an ignition switch 20, shown in its open position, to which one terminal of the battery is connected by a conductor 22. The other terminal of the battery is grounded to the frame as indicated at 24.

The ignition switch 20 is connected by a conductor 26 to one end of a ballast resistance 28, the other end of which has connected thereto a pair of branch conductors 30 and 32, the former of which leads to the electromagnetically operated actuating means 12 and the latter to the magnetically operated current varying means 14.

The ballast resistance 28 is made of any suitable material having a high positive temperature coefficient of resistance. Thus when the battery voltage is low, the initial current flowing through the resistance is low and the resistance is relatively cool and permits a predetermined value of current to flow through the indicating apparatus. However, when the battery voltage is high, the initial current flow is relatively high and the resistance of the ballast resistance increases, thereby tending to maintain the current flow constant at said predetermined value.

The actuating means 12 comprises a unitary

crescent-shaped armature 34 having oppositely extending tapered portions 36 and 38 actuated by electromagnetic means, such as solenoids 40 and 42, respectively. The specific form of the armature, which will be described more fully hereinafter, forms no part of the present invention, but is the invention of Willard H. Farr and George E. Coxon, and forms the subject matter of a copending application Serial No. 128,734, filed March 3, 1937.

Solenoids 40 and 42 are connected in series with each other by a conductor 44 and have interposed in series therewith resistors 46 and 48, respectively. Resistors 46 and 48 have negative temperature coefficients of resistance and resistance values proportioned to compensate for changes in the resistance of solenoids 40 and 42 caused by changes in temperature of the solenoids resulting from variations in current flow therethrough. The circuit including the solenoids and compensating resistors in series is connected by the previously mentioned branch conductor 30 to the ballast resistance and through conductor 50 to ground.

The branch conductor 32 is connected to one end of a resistance 52, the other end of which is connected to ground through conductor 54 and the previously mentioned conductor 50. It is seen, therefore, that conductors 32 and 54 connect the resistance 52 in parallel with the series circuit including the solenoids 40 and 42 and the compensating resistors 46 and 48.

Associated with resistance 52 is a movable contact 56 connected by conductor 58 to conductor 44 and the position of which is controlled by the magnetically operated actuating means 14 in such manner that the position of the movable contact is dependent upon the rate of speed at which the vehicle is traveling.

The current varying means 14 is constructed after the manner described in the copending application of Arden W. Le Fevre et al., Serial No. 40,600, filed September 14, 1935. It comprises a permanent magnet (not shown) rotated by shaft 60 suitably geared to the gear 16 and a cup-shaped rotor (also not shown) adapted to actuate the movable contact 56. The rotor and contact 56 are magnetically dragged by the permanent magnet to positions dependent upon the rate of rotation of the magnet and, therefore, also dependent upon the speed of the vehicle.

The electric speedometer also comprises a mileage indicator 62 which may be of the usual drum type. This indicator is driven through a spring biased pawl 64 actuated by an electromagnet 66, one terminal of which is connected to the battery through conductor 68 and ignition switch 20. The other terminal of the electromagnet is connected by a conductor 70 to a normally open cam actuated switch 72 adapted to be closed at predetermined distance intervals by a suitable mechanism driven by the previously described gear 16 rotating in unison with a part of the vehicle. The switch 72 is connected to ground through a conductor 74 and the previously mentioned conductor 50, so that the magnet is connected in parallel with resistance 52 and the solenoids 40 and 42.

Before describing in detail the constructional features to which the present invention is directed, it may be well briefly to review the description of the operation of the above described electrical speedometer.

When the automobile is in motion, the switch 20 is normally closed, thereby establishing an electrical circuit through the three previously described parallel circuits, including the solenoids 40 and 42, the fixed resistance 52, and the magnet 66, respectively. The gear 16 rotates in unison with the vehicle wheels and drives the magnet shaft 60, which in turn rotates the magnet. The rotating field created by the magnet tends to rotate the rotor to which the movable contact 56 is connected in the same direction as the magnet, and the strength of this tendency is directly proportional to the speed of rotation of the magnet. Thus, the movable contact 56 assumes positions which at all times correspond to the speed of rotation of the magnet and, therefore, to the speed of travel of the vehicle.

When the movable contact 56 is located centrally of the resistance 52, no current passes through the bridge circuit consisting of the movable contact and conductor 58, and consequently the same current passes through both solenoids 40 and 42 and the resistances 46 and 48, which are in series with solenoids 40 and 42 respectively. Each of these solenoids attracts its associated portion of the armature with the same force, and the pointer 10 indicates a speed corresponding to approximately half the ultimate speed of the vehicle, or 44 miles an hour, as shown in the drawings.

When the speed of the vehicle is such that the movable contact 56 is moved toward one end of the resistance 52, a greater current passes through one of the solenoids than through the other. The solenoid receiving the strongest current exerts the greatest force upon its associated armature and draws a larger cross sectional part thereof into the solenoid, at the same time withdrawing the other armature portion from its associated solenoid. This movement of the armature portions and the pointer shaft continues until the shifting compensates for the difference in solenoid currents, whereupon the pointer shaft and pointer come to rest and indicate the speed of the vehicle, which corresponds to the particular relationship of the solenoid currents then existing.

The negative temperature coefficient resistances 46 and 48 maintain the resistance of the respective branch circuits in which they are placed constant at all times, so that changes in temperature of the solenoids 40 and 42 are prevented from creating errors in the reading of the speedometer.

The construction of the speed indicating means about to be described is shown particularly in Figs. 3 to 6, inclusive. The indicating means comprises an integral supporting structure or frame 80 comprising a substantially annular front support 82 and a rear support 84 connected by a pair of longitudinal vertically spaced apart upper and lower arms 86 and 88, respectively. The rear support 84 comprises three radially extending arms 90, 92 and 94 provided with threaded openings whereby the rear support may be attached to a suitable part 96 of the vehicle by screw bolts 98. From Fig. 5 it may be seen that the upper horizontal arm 86 is formed integral with the upper junction of the radial arms 90 and 92, and that the lower horizontal arm 88 is formed integral with the lower and vertically extending radial arm 94.

The front support 82 is provided with a forward extending projection 100 upon which is mounted a cup-shaped member 102 secured thereto by bolts 104. In this cup-shaped member is located a dial plate 106 attached to the cup-shaped member by

bolts 108 and provided with suitable indicia, as shown in Fig. 2. The cup-shaped member is suitably secured to a portion, such as the dashboard 111, of the vehicle.

The pointer 10 cooperates with the indicia on dial plate 106 and is secured to a shaft 110 mounted for rotation on a horizontal axis. The shaft is journaled intermediate its ends in a relatively narrow vertically extending strip or web 112 secured to the projecting portion 100 of the front end of support 80, between the latter and cup-shaped member 102, by the previously mentioned screw bolts 104. The rear end of the shaft is journaled in a horizontally disposed V-shaped bracket 114 formed integrally with the front support and extending substantially midway between the upper and lower arms 86 and 88 to near the center of these arms. The bracket 114 is provided with a bearing 116 in which the end of the shaft rotates with a minimum of friction.

Movement is transmitted to the indicator shaft from actuating means to be described more fully hereinafter by a vertically disposed circular bevel gear 118 mounted on shaft 110 adjacent the bracket end thereof, and in order to prevent vibrations and road shocks from deleteriously affecting the indicating unit, an inertia wheel 120 is frictionally mounted on the shaft.

The inertia wheel is mounted adjacent the front bearing portion of the shaft 110 on an enlargement 122 fixedly secured to the shaft 110 and provided with an integral circular flange 124 against which abuts an annular sleeve 126 to which the inertia wheel is attached. The inertia wheel is held against longitudinal movement by a washer 128 secured in abutting relation to the sleeve 126 on the enlargement 122.

When the vehicle is at rest, the indicating shaft and the hereinafter to be described actuating unit are returned to their zero positions by a spiral spring 130 having one end suitably secured to shaft 110 intermediate the shaft support 112 and the indicating dial 106. The other end of the spring is secured to a forwardly extending flange 132 punched out of a plate 134 adjustably mounted on the vertical shaft support 112 by means of slots 136 formed thereon at opposite sides of the shaft and through which extend securing bolts 138.

The actuating unit, by means of which the indicator shaft 110 is rotated, comprises a pair of solenoids 40 and 42 through the central openings of which extend the tapered armature portions 36 and 38, respectively. The armature 34 is mounted substantially centrally thereof on a right-angled support 140 fixedly secured to a shaft 142 mounted for rotation on a vertical axis in removable bearing members 144 and 146 carried by the upper and lower horizontal arms 86 and 88, respectively. The right-angled support 140 also carries a substantially sector-shaped bevel gear 148 of small diameter adapted to engage the circular bevel gear 118 when the indicating unit is secured to the integral support 80 by screws 104.

The construction of the sector-shaped bevel gear 148 with a relatively small diameter and extending shaft 110 to near the center of the unit so that the gear 148 may engage gear 118, concentrates the weight of the actuating unit near the vertical shaft. This construction aids in preventing binding of shaft 142 in its bearings.

The bearing members 144 and 146, in which the vertical shaft 142 is mounted, comprise jeweled thrust bearing portions 150 and guide sleeves 152. The bearing members are firmly held in adjusted position on outwardly extending substantially circular bosses 154 and 156 by cap screws 158.

The armature support 140 comprises a horizontally extending relatively narrow strip 160 secured to a hub 162 attached to shaft 142 at a point below the V-shaped bracket 114 and the lower horizontal arm 88. The previously mentioned sector gear 148 is secured to the horizontal strip by suitable means, such as the rivet 164. A downwardly depending threaded weight 166 in which is rotatably mounted an adjusting screw 168 is also secured to the horizontal strip. The purpose of the weight and adjusting screw is to provide a means of balancing the weight of the armature member 34 so that no side thrust is imposed on the bearings supporting shaft 142. In this manner binding caused by uneven distribution of weight about the shaft 142 is avoided.

The vertically extending portion 170 of the right-angled support 140 extends upward to a point between the V-shaped bracket 114 and the upper horizontal arm 86. At its upper end it is provided with a horizontally extending flange 172 to which the central portion of the crescent-shaped armature 34 is secured by means of bolts 174.

In order to reduce eddy currents and hysteresis loss to a minimum, the armature 34 is constructed of a plurality of thin sheets of carefully selected soft iron. These sheets are held together by rivets 176 and the bolts 174.

Substantially centrally of the crescent-shaped armature 34 there is provided a brass filler plate 180 for the purpose of increasing the reluctance of the magnetic power through the armature so that the armature will not be drawn beyond predetermined limits by either of the solenoids 40 or 42. As previously stated, a solenoid when supplied with increasing amounts of current draws a portion of the armature having a greater cross sectional area into the central portion of the solenoid. By providing the armature with a central portion having a greater reluctance, it is seen that the movement of the armature by either of the solenoids is limited, and the armature cannot be drawn into the solenoid past the portion of increased reluctance.

A modified form of construction of the arrangement for limiting movement of the armature is shown in Fig. 8, in which the brass filler strip has been entirely omitted and the increased reluctance obtained by merely decreasing the cross sectional area of the armature at the central part thereof. It is desirable also to make the cross section of the armature sufficiently large so that the magnetic saturation of the iron never rises above the rectilinear portion of the B—H curve. With armatures of such large cross sections, lag is eliminated and more accurate reading of instruments is obtained.

From Fig. 3, in particular, it may be seen that the armature 34 extends substantially around the vertically extending shaft 142. The tapered portions 36 and 38 thereof extend into the central openings of the solenoids 40 and 42. These solenoids are supported on opposite sides of the upper horizontal arm 86 by means of integral metallic strips 182 and 184 adjustably mounted on the upper arm 86. The supporting strips 182 and 184 are provided with similar bent end portions 186 substantially encircling the lateral sides

of the solenoids and supporting them in such manner that the armature is readily movable through the central hollow openings therein.

The bent portions 186 are also provided with relatively narrow fingers 188 adapted to be bent radially inward to hold securely the solenoids, as clearly illustrated in Fig. 5. The solenoid is insulated from the encircling supporting strips by an annular insulating strip 190 placed between the solenoid and the bent portions 186, and a novel insulating spool 192 constructed of two separate interfitting portions 194 and 196, as illustrated in Fig. 7. Each portion of the spool comprises a central longitudinal member 198 provided with a flanged portion 200 coextensive in length therewith and extending substantially at right angles therefrom. The ends of the spool are formed by substantially semi-circular flanges 202 and 204 extending at right angles to both the longitudinal portions 198 and flanges 200.

The end flanges 202 are provided with cutaway portions 206, 208 and 210 into which extend complementary projection 212, a portion of the longitudinal flange member 200 and projection 214, respectively, formed on flanges 204 when the two parts are brought into assembled relationship. The flanges 202 are also provided with extending projections 216 and 218 adapted to fit into opposite cutaway portions 220 and 222 formed on the flanges 204. The longitudinal flanges 200 are provided with opposite projections 224 adapted to fit into cutaway portions 226 formed on the longitudinal central portions 198, whereby the two portions are brought into predetermined spaced relationship when assembled.

It may be seen that the construction affords a very simple and economical arrangement for supporting the solenoids and insulating them from the surrounding supporting strips.

As previously stated, the solenoid supporting strips 182 and 184 are mounted adjustably upon the upper horizontal arm 86. The supporting strips 182 and 184 are provided with substantially semi-circular enlarged ends 230 and 232, respectively. These are provided with central openings 234 surrounding the boss 154 formed on the upper horizontal arm 86, and are provided with oppositely disposed arcuate slots 236 through which extend screw bolts 238, whereby the strips may be securely held in adjusted position. Lock washers 240 may be utilized to prevent any undesired rotation of the strips.

The solenoids are adapted to be simultaneously rotated in the same direction around boss 154 by means of a horizontally disposed toothed wheel 242 rotatably secured on the upper side of the horizontal arm 86 by a screw bolt 243. The wheel 242 is provided with teeth 244 adapted to engage coinciding teeth 246 and 248 formed on the semi-circular portions 230 and 232 of the solenoid mounting strips 182 and 184, respectively.

From Fig. 3 it may be noted that only a relatively few teeth are provided on the toothed portions of the respective members, but it is obvious that the number and size may be changed as desired in order to obtain proper movement of the solenoids. From Fig. 3 it is further evident that rotation of the toothed wheel 242 results in rotation of both the solenoids in the same direction, so that when adjustment of the solenoids is desired, it is necessary only to rotate the wheel 242.

The supporting structure 80, that has been described in detail above, is not only adapted to carry the described indicator and actuating units, but also to support a part of the electrical apparatus used in the system illustrated in Fig. 1. The electrical apparatus is supported on a cup-shaped insulating base 250 secured in a circular opening 252 on the rear side of the rear supporting member 84 by means of three screw bolts 254. The insulating cup 250 is separated from the portion 96 of the vehicle by an annular resilient spacer 256, whereby it is secured against movement and rubbing the supporting member 96.

The negative temperature coefficient resistances 46 and 48 are secured to the support side of the insulating cup 250 by means of spring clips 258 and 260 secured to substantially triangular insulating plates 262 and 264 mounted on the insulating cup by means of bolts 266 and 268, respectively. Bolts 266 and 268 extend through the base at points equally distant from the center of the support and near the points where the radially extending arms 90, 92 and 94 converge. This arrangement provides a very compact assembly by reason that the supporting means and the resistance units are located in a very narrow compass.

The bolts 266 and 268 also form terminals leading to parts of the electrical circuit illustrated in Fig. 1. The base plate 250 is provided also with a third terminal-bolt 270 leading to another part of the electrical circuit. Bolt 270 extends through the base plate into an opening 271 on the rear portion of the support and is, therefore, insulated from the latter. The bolts are secured to the base plate by nuts 272 spaced from the base plate by a circular insulating disc 274. The ballast resistance 28 is secured across terminal bolts 270 and 268 by means of nuts 276 and is located within the cup and separated from contact with other objects by an insulating cover 278.

The various terminals are separated one from another by three radially diverging reverse bent portions 280, 282 and 284, respectively. These upstanding portions are formed integral parts of an insulating member 286 secured to the insulating cover 278 by means of a plurality of nuts 288 which also serve to hold the cover in place.

From a comparison of the construction of Fig. 4 with the electrical system of Fig. 1, it may be seen that the terminal 270 is connected to conductor 26, terminal 268 to the branch conductors 32 and 30, while the remaining terminal 266 is connected to conductor 58. Thus, the speed indicating means is a complete unit in itself and may be mounted in a desirable location in the vehicle at a considerable distance from the magnetically operated current varying means 14.

In the assembly of the described unit, the supporting structure 80 is first preferably cast and machined; then the base plate 250 and the actuating unit secured thereto. Thereafter the indicating unit comprising the cup-shaped member 102 is mounted on the supporting means, and the unit is complete for use wherever desired.

Each of the above sub-units may be manufactured independently and thereafter assembled to form a complete speed indicating unit as described above.

If it is found necessary to repair the speed indicating unit, the various parts thereof are all readily accessible from the outside thereof. For instance, the dial plate 106 need only to be removed to permit the removal of bolts 104 and the horizontally disposed indicator actuating shaft 110. Furthermore, the removal of the dial plate

permits adjustment of the spring carrying plate 134.

The electrical apparatus included in the unit is likewise easily removable. The solenoids may be removed simply by loosening bolts 238 and manually rotating armature 34 to a position where the coils may be slipped between the ends thereof. The resistances are all separately removable.

I claim:

1. In apparatus of the type described, the combination including an actuating unit and an indicating unit detachably secured thereto, said actuating unit comprising a pair of horizontally disposed supporting arms and a shaft mounted between said arms for rotation on a vertical axis, said indicating unit comprising supporting means and a shaft mounted thereon for rotation on a horizontal axis, and movement transmitting means mounted on each shaft adapted to interengage when the units are secured in place, said transmitting means being so constructed and arranged that the weight thereof is concentrated near the axis of said first mentioned shaft.

2. In apparatus of the type described, the combination including an actuating unit and an indicating unit detachably secured thereto, said actuating unit comprising a pair of horizontally disposed supporting arms and a shaft mounted between said arms for rotation on a vertical axis, said indicating unit comprising supporting means and a shaft mounted thereon for rotation on a horizontal axis, and movement transmitting means mounted on each shaft adapted to interengage when the units are secured in place, said transmitting means comprising a small diameter sector gear secured for rotation with said first mentioned shaft and a cooperatively associated gear mounted on said second mentioned shaft.

3. In apparatus of the type described, the combination including indicating means, a shaft mounted for rotation on a horizontal axis for actuating said means, a shaft mounted for rotation on a vertical axis, means including an electromagnetically actuated armature for imparting rotation to said second mentioned shaft, said armature substantially surrounding said shaft and being secured thereto by a support providing a space substantially centrally of the shaft between the armature and support, and gear means located in said space and mounted on said shafts for transmitting movement from one shaft to the other.

4. In apparatus of the type described, the combination including indicating means, a shaft mounted for rotation on a horizontal axis for actuating said means, a shaft mounted for rotation on a vertical axis, means including an electromagnetically actuated armature for imparting rotation to said second mentioned shaft, said armature substantially surrounding said shaft and being secured thereto by a right angle support, the portion of the support secured to the shaft being substantially parallel to and spaced from the armature by the portion of the support extending at right angles therefrom parallel to the axis of rotation of the shaft, gear means located between the armature and support carried by said support, and cooperatively associated gear means mounted on said first mentioned shaft adapted to be rotated by said first mentioned gear means when the second mentioned shaft is rotated.

5. In apparatus of the type described, the combination including a supporting structure comprising a pair of horizontal oppositely disposed arms and a horizontally disposed substantially V-shaped bracket located between said arms and extending from one end of said structure to near the center of said arms, an indicating unit detachably secured to said structure comprising a horizontally disposed shaft supported by a portion of said unit and by the bracket, an actuating unit comprising a shaft mounted centrally of and between said arms for rotation on a vertical axis, an electromagnetically actuated armature substantially surrounding said shaft and located between said bracket and the upper one of said arms, supporting means for said armature secured to said shaft between said bracket and the lower one of said arms, and means for transmitting movement from one shaft to the other.

6. In apparatus of the type described, the combination including a supporting structure comprising a pair of horizontal oppositely disposed arms and a horizontally disposed substantially V-shaped bracket located between said arms and extending from one end of said structure to near the center of said arms, an indicating unit detachably secured to said structure comprising a horizontally disposed shaft supported by a portion of said unit and by the bracket, an actuating unit comprising a shaft mounted centrally of and between said arms for rotation on a vertical axis, an electromagnetically actuated armature substantially surrounding said shaft and located between said bracket and the upper one of said arms, horizontally disposed supporting means for said armature secured to said shaft between said bracket and the lower one of said arms and means for transmitting movement from one shaft to the other, said means including a sector gear mounted on the upper side of said supporting means and a gear secured to the horizontally disposed shaft adjacent the bracket end thereof adapted to be engaged by said sector gear when the indicating unit is secured to said structure.

7. In apparatus of the type described, the combination including a supporting structure comprising a pair of horizontal oppositely disposed arms and a horizontally disposed substantially V-shaped bracket located between said arms and extending from one end of said structure to near the center of said arms, an indicating unit detachably secured to said structure at the bracket supporting end comprising a horizontally disposed shaft supported by a portion of said unit and the bracket, an actuating unit comprising a shaft mounted centrally of and between said arms for rotation on a vertical axis, an electromagnetically actuated armature substantially surrounding said shaft and located between said bracket and the upper one of said arms, supporting means for said armature secured to said shaft between said bracket and the lower one of said arms, means for transmitting motion from one shaft to the other, and inertia means frictionally mounted on said first mentioned shaft between said bracket and the supporting portion of the indicating unit.

8. In apparatus of the type described, the combination including a supporting structure comprising a pair of horizontal oppositely disposed arms and a horizontally disposed substantially V-shaped bracket located between said arms and extending from one end of said structure to near the center of said arms, an indicating unit detachably secured to said structure at the bracket supporting end comprising a horizontally dis-

posed shaft supported by a portion of said unit and the bracket, an actuating unit comprising a shaft mounted centrally of and between said arms for rotation on a vertical axis, an electromagnetically actuated armature substantially surrounding said shaft and located between said bracket and the upper one of said arms, supporting means for said armature comprising a horizontal portion secured to said shaft between said bracket and the lower one of said arms, means for transmitting motion from one shaft to the other, said means including a sector gear mounted on the upper side of the horizontal portion of said supporting means, and a circular gear secured to the horizontally disposed shaft adjacent the bracket end thereof adapted to be engaged by said sector gear when the indicating gear is secured to said structure, and inertia means frictionally mounted on said horizontally disposed shaft between said circular gear and the supporting portion of said indicating unit.

9. In apparatus of the type described, the combination including a supporting structure comprising a pair of horizontal oppositely disposed arms and a horizontally disposed substantially V-shaped bracket located between said arms and extending from one end of said structure to near the center of said arms, an indicating unit detachably secured to said structure at the bracket supporting end comprising a vertically extending support and a horizontally disposed indicator operating shaft supported thereby and by the bracket, an actuating unit comprising a shaft mounted centrally of and between said arms for rotation on a vertical axis, an electromagnetically actuated armature substantially surrounding said shaft and located between said bracket and the upper one of said arms, supporting means for said armature secured to said shaft between said bracket and the lower one of said arms, means for transmitting motion from one shaft to the other, and spring means secured at one end to said horizontally disposed shaft and at the other end to said vertically extending support for biasing said shafts to a zero position.

10. In apparatus of the type described, the combination including a supporting structure comprising a pair of horizontal oppositely disposed arms and a horizontally disposed substantially V-shaped bracket located between said arms and extending from one end of said structure to near the center of said arms, an indicating unit detachably secured to said structure at the bracket supporting end comprising a vertically extending support and a horizontally disposed indicator operating shaft supported thereby and by the bracket, an actuating unit comprising a shaft mounted centrally of and between said arms for rotation on a vertical axis, an electromagnetically actuated armature substantially surrounding said shaft and located between said bracket and the upper one of said arms, supporting means for said armature having a horizontal portion secured to said shaft between said bracket and the lower one of said arms, means for transmitting motion from one shaft to the other, said means including a sector gear mounted on the upper side of the horizontal portion of said supporting means, and a circular gear secured to the horizontally disposed shaft adjacent the bracket end thereof adapted to be engaged by said sector gear when the indicating unit is secured to said structure, inertia means frictionally mounted on said horizontally disposed shaft between said circular gear and the vertically extending portion, and means including a plate adjustably mounted on said vertically extending portion, and a spiral spring having one end secured to said plate and the other to said horizontally disposed shaft for biasing both said shafts to a predetermined zero position.

11. In electric apparatus of the type utilizing an armature and a solenoid for actuating said armature, the combination including a support and a substantially rigid strip of metallic material secured to said support for supporting said solenoid, said strip being provided with an end portion bent substantially to encircle said solenoid.

12. In electric apparatus utilizing an armature and a pair of solenoids for actuating said armature, the combination including a support, a pair of substantially rigid oppositely disposed metallic strips for securing said solenoids to said support, said strips being provided with end portions bent substantially to encircle said solenoids, and projections adapted to be bent at an angle to said encircling portions for further securing said solenoids.

13. In electric apparatus utilizing an armature and a pair of solenoids for actuating said armature, the combination including a support, a pair of oppositely disposed rotatably mounted arms for securing said solenoids to said support, said arms being provided with coinciding toothed portions, and means engaging said toothed portions for simultaneously rotating said arms.

14. In electric apparatus utilizing an armature and a pair of solenoids for actuating said armature, the combination including a support, a pair of oppositely disposed rotatably mounted arms for securing said solenoids to said support, said arms being provided with coinciding toothed portions, a toothed wheel mounted on said support in cooperative relation to said toothed portions, and means permitting rotation of said wheel for simultaneously rotating both arms.

15. In electrical indicating apparatus of the type described including electromagnetic actuating means and resistors in circuit therewith, a unitary support for said actuating means and resistors, including in combination, a substantially circular support of insulating material, a support for said electromagnetic actuating means and circular support comprising a structure provided with three radially extending arms, and substantially triangular supports fitting between said radially extending arms for securing said resistors to said circular support.

16. An insulating spool for a solenoid including a pair of complementary sections, each including a longitudinal portion provided with a right angled flange extending the length thereof forming the body of the spool and ends for said spool comprising substantially semi-circular flanges extending at right angles to said body portion.

17. An insulating spool for a solenoid including a pair of complementary interfitting sections, each comprising a longitudinal portion, a flanged portion coextensive in length therewith, said flanged portions having fingers extending into grooves formed on said longitudinal portions, and ends for said spool comprising end flanges extending at right angles to said longitudinal and first mentioned flanged portions, each of said end flanges being provided with projecting portions fitting into similar cut-away portions on the other.

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