BODY ELECTRICAL

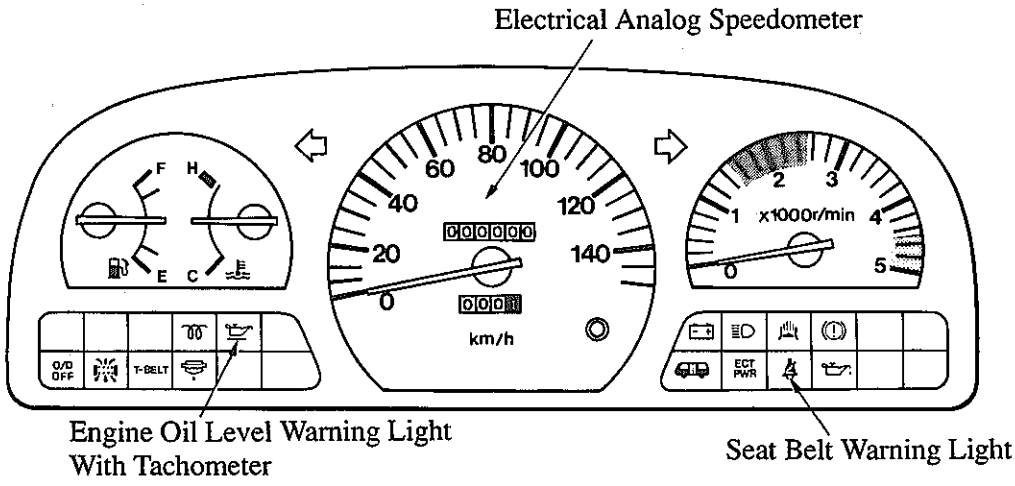
METER

■ COMBINATION METER

1. Description

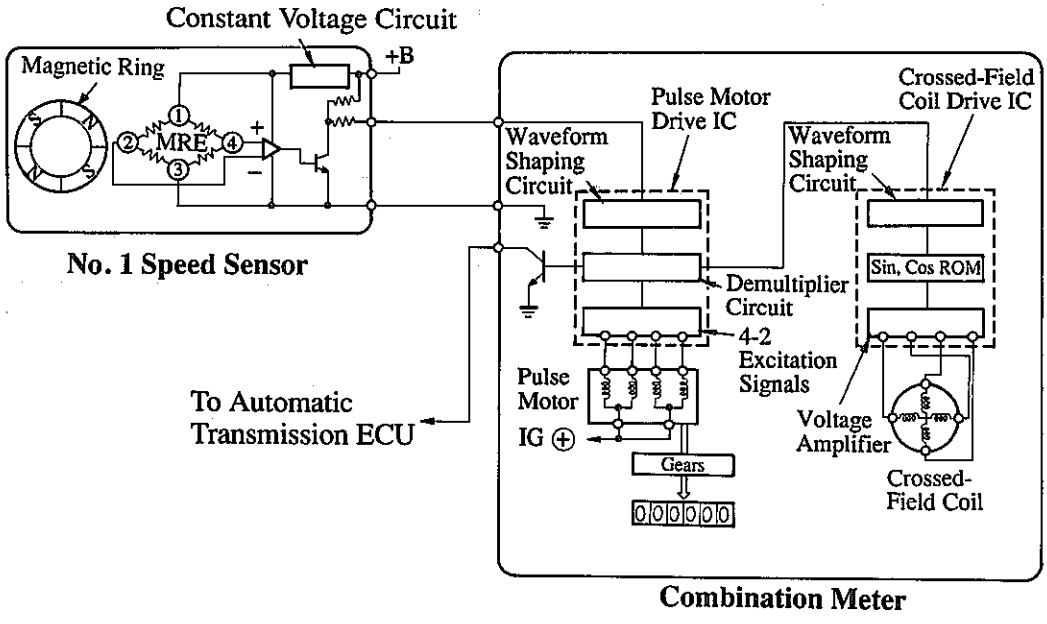
- The combination meter has a three-dial meter layout that enhances the speedometer's visibility (for with tachometer).
- An electrical analog meter is used in all models, eliminating the need for the speedometer cable. The speedometer indicates the vehicle speed based on the rotation speed of the output-shaft of the transmission as detected by the No. 1 speed sensor mounted on the transmission extension housing.
- A pulse motor-driven odometer is used.
- An engine oil level warning light is used. A seat belt warning light has been added to models for the Middle East.

▶ For G.C.C. Countries Models ◀



2. System Diagram

The driving circuit diagram for the speedometer and odometer is as follows.



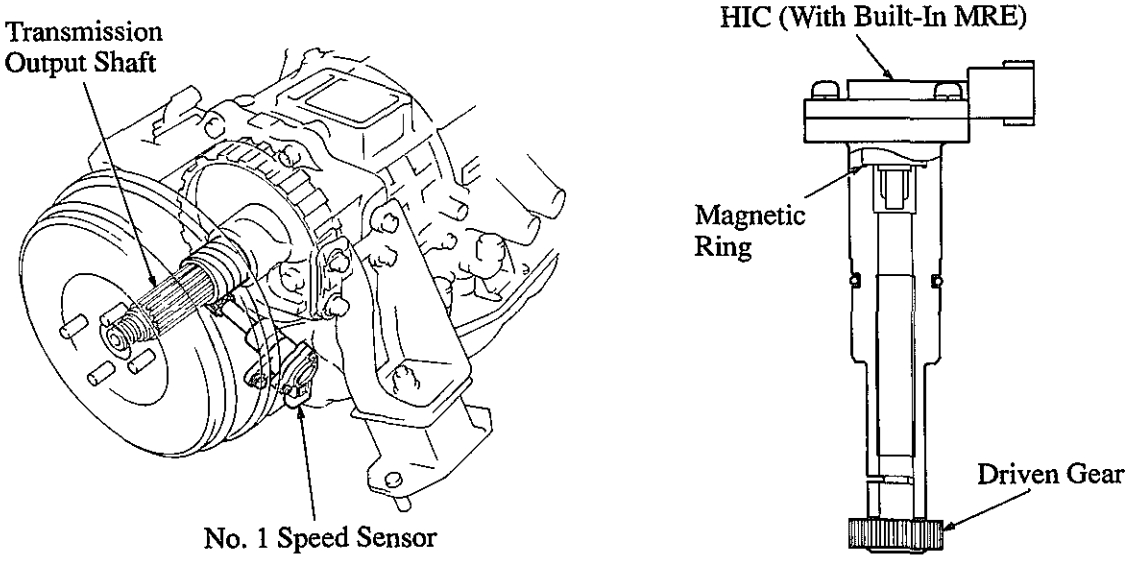
BE

3. Construction and Operation

No. 1 Speed Sensor

1) Construction

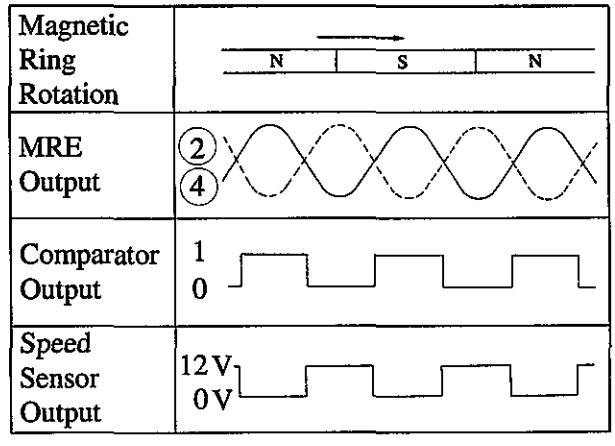
- The No. 1 speed sensor is fitted in the transmission extension housing. It has a sensor shaft and magnetic ring which are driven by the transmission output shaft drive gear by way of the speedometer driven gear.
- The No. 1 speed sensor consists of an HIC (Hybrid Integrated Circuit) with a built-in MRE (Magnetic Resistance Element) and a magnetic ring. The magnetic ring has four poles (two N and two S poles each).



No. 1 Speed Sensor

2) Operation

When the vehicle starts and the magnetic ring rotates, the MRE sends 4 cycles of alternating current to the comparator every rotation of the magnetic ring. The comparator changes the AC to a digital wave which is then inverted by transistor before being sent to the combination meter.



– REFERENCE –

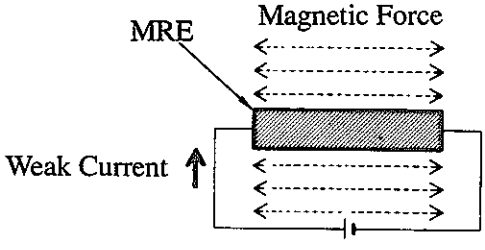
Theory of MRE Operation

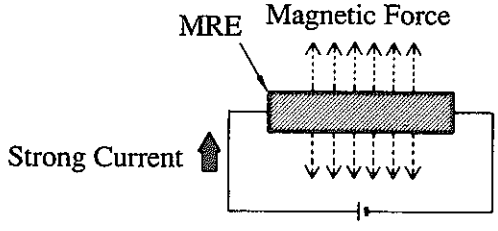
In the MRE, when the direction of the current flowing in the element is parallel to the direction of the magnetic lines of force, the resistance becomes great. Conversely, when the current direction and the direction of the magnetic lines of force cross each other, the resistance drops to the minimum level.

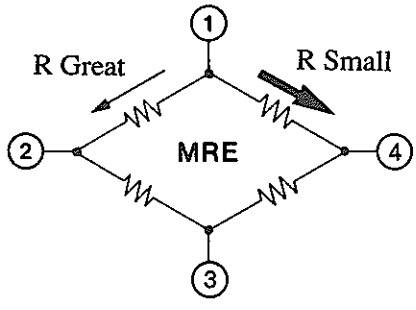
As shown below, if the power supply is connected to terminals (1) and (3) of the element and lines of magnetic force are caused to act in the horizontal direction in the figure, the resistance in A and C becomes great and the resistance in B and D becomes small. Therefore, a negative potential difference is generated at terminal (2) and a positive potential difference is generated at terminal (4).

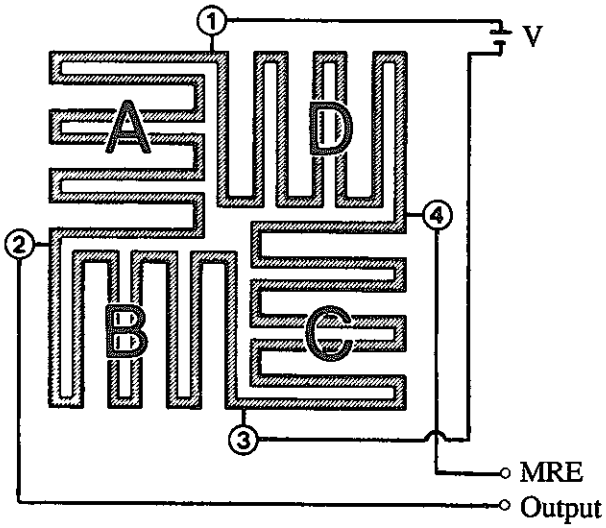
Conversely, if the lines of magnetic force are caused to act in the vertical direction, the resistance in B and D becomes great and the resistance in A and C becomes small , and a positive potential difference is generated at terminal (2) while a negative potential difference is generated at terminal (4).

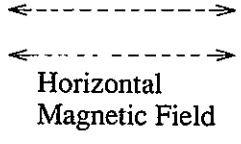
The direction of the lines of magnetic force is determined by magnetizing the magnetic ring and rotating the 4 pole magnet, with the result that the output of the element becomes an AC waveform 4 cycles per revolution of the magnetic ring.

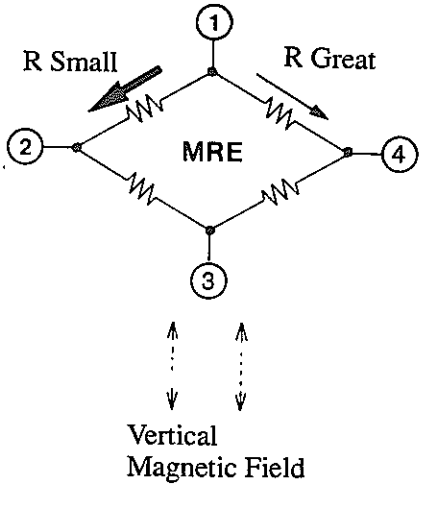










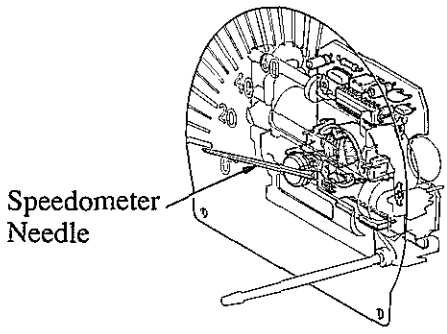


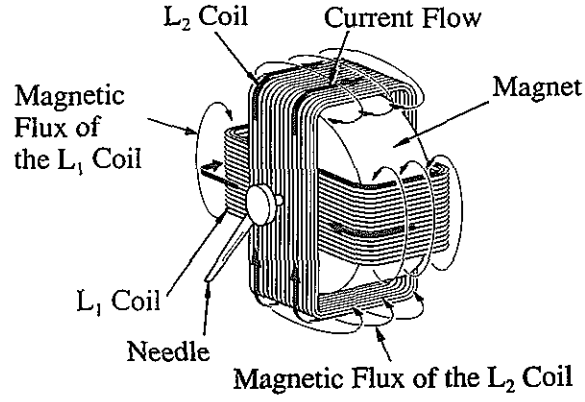
BE

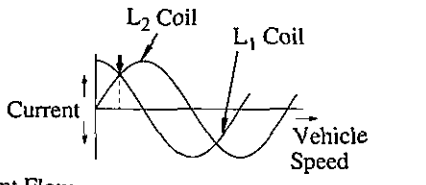
Speedometer

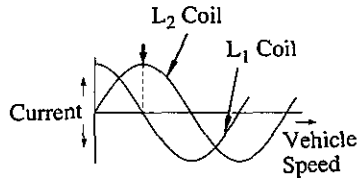
1) Construction and Theory

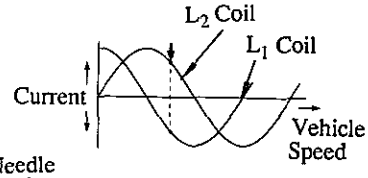
The indicator needle is driven by a crossed-field coil. The crossed-field coil meter consists of a magnetic rotor with 2 coils wound around it at an angle of 90° to each other. By changing the strength and direction of the current flowing in the coils, the magnetic flux excited in the coils is changed and a combined force which causes the rotor to move can thus be created. The currents flowing in coils L_1 and L_2 are out of phase by 90°. By introducing an alternating current with a logical sine waveform, linear indicator characteristics are obtained around the entire 360°.

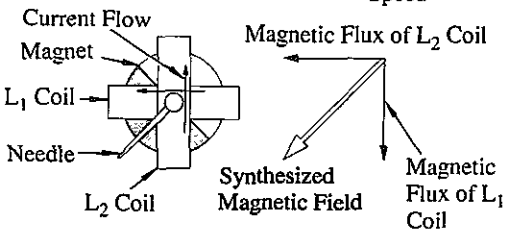


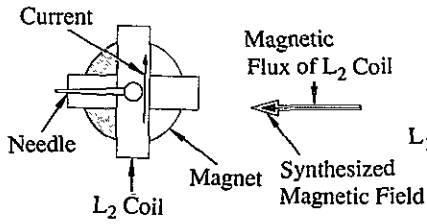


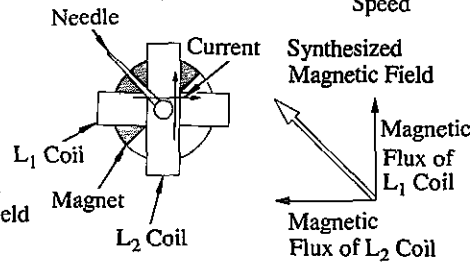












2) Operation

Vehicle speed signals (4 pulses/revolution) from the No. 1 speed sensor are input to the logic IC in the combination meter as input signals. The logic IC calculates the speed from the period of time the speed signal pluses are on and off, then, in accordance with the result, draws from the crossed-field coil driver signal memory the directional signal and strength of the current flowing to each coil and outputs them to the crossed-field coil drive IC.

The crossed-field coil drive IC amplifies the signals from the logic IC and sends them as current to each coil, exciting the indicator needle (magnetic rotor) in the direction of the magnetic field synthesized from these currents.

The cross coil driver signal memory contains logical sine curves and 2 AC waveforms. These waveforms are 90° out of phase.

The movement time of the indicator needles is nearly the same as that of a mechanical indicator needle.

NOTE: The logic IC inside the combination meter outputs the vehicle speed signal to the automatic transmission ECU.

– REFERENCE –

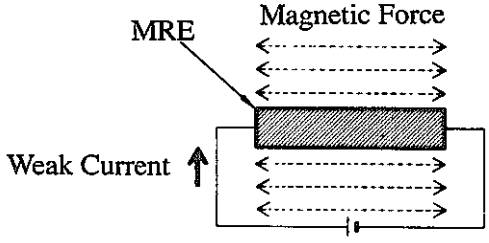
Theory of MRE Operation

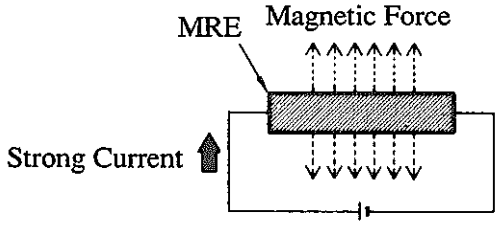
In the MRE, when the direction of the current flowing in the element is parallel to the direction of the magnetic lines of force, the resistance becomes great. Conversely, when the current direction and the direction of the magnetic lines of force cross each other, the resistance drops to the minimum level.

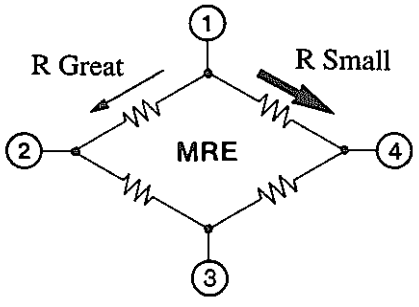
As shown below, if the power supply is connected to terminals (1) and (3) of the element and lines of magnetic force are caused to act in the horizontal direction in the figure, the resistance in A and C becomes great and the resistance in B and D becomes small. Therefore, a negative potential difference is generated at terminal (2) and a positive potential difference is generated at terminal (4).

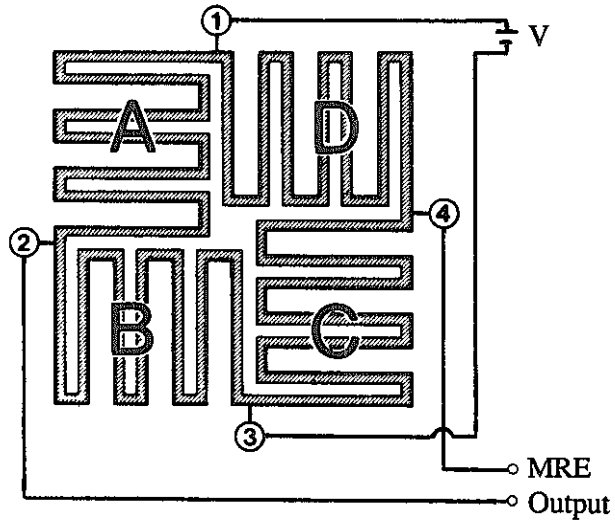
Conversely, if the lines of magnetic force are caused to act in the vertical direction, the resistance in B and D becomes great and the resistance in A and C becomes small , and a positive potential difference is generated at terminal (2) while a negative potential difference is generated at terminal (4).

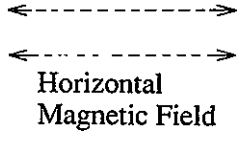
The direction of the lines of magnetic force is determined by magnetizing the magnetic ring and rotating the 4 pole magnet, with the result that the output of the element becomes an AC waveform 4 cycles per revolution of the magnetic ring.

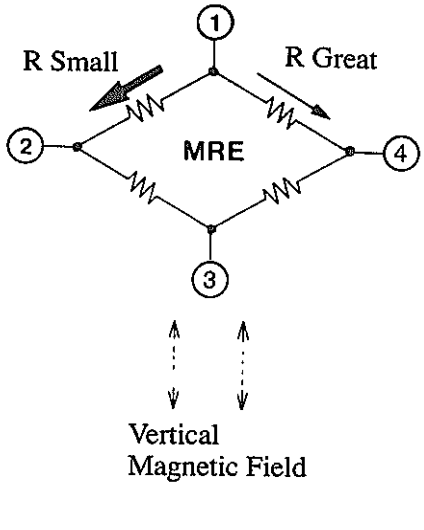






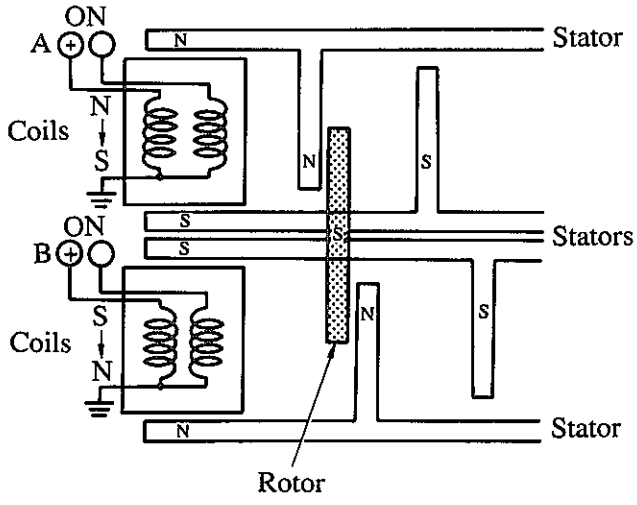




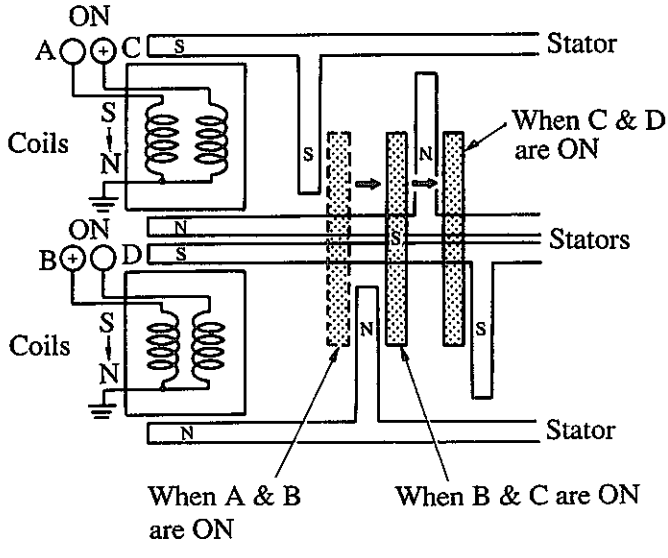


BE

If current flows to coil A, a magnetic field is generated with the top of the coil as the N pole and the bottom of the coil as the S pole. In this way, a magnetic field is induced in the top and bottom stators. If current also flows to coil B, a magnetic field is induced as in the case of coil A, but since the winding directions of coil A and coil B are different, the top stators become the S pole and the bottom stators become the N pole. In this condition, the rotor's S pole takes a fixed position between the N pole of the coil A side and the N pole of the coil B side. By switching the flow of current from coil A to coil C, the top of the coil becomes the S pole and the bottom of the coil becomes the N pole, thus changing the magnetic poles of the stators. This causes the S poles to repel each other, pushing the rotor. The rotor then becomes fixed at a position between the stator N pole of the coil C side and the stator N pole of the coil B side. In this way, by switching the flow of current in sequence to coils A B, B C, C D, D A, A B, etc., the pulse motor is turned 15° (1/24 turn) each time.



Operation I



Operation II