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[54] **AUTOMATIC ENGINE CRANKING SYSTEM**

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[52] **U.S. Cl.** .....**180/103,** 180/105 E, 123/179 K

[51] **Int. Cl.** **B60k 27/00**

[58] **Field of Search**.....123/179 R, 179 B, 179 K; 180/103, 105

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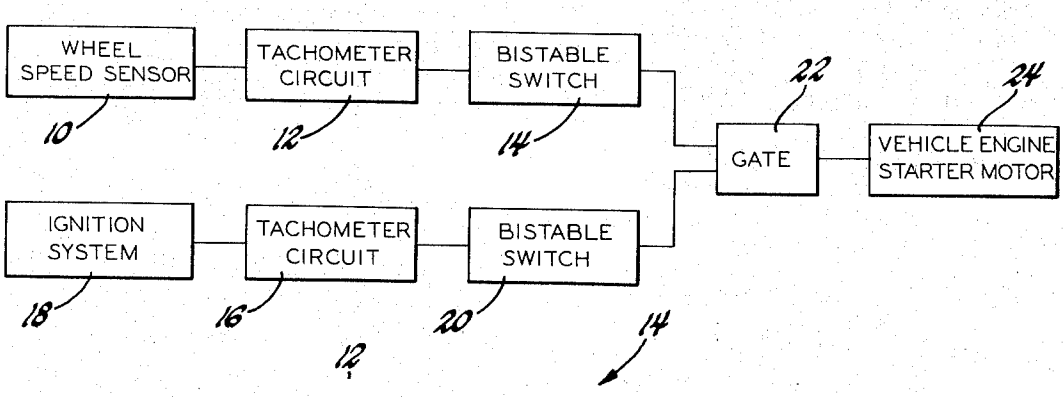
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[57] **ABSTRACT**

A system for energizing the vehicle engine starter motor when the vehicle engine stalls while the vehicle is at a speed greater than a predetermined minimum so as to maintain the operation of the vehicle driven accessories while the vehicle speed is greater than the predetermined minimum and to maintain the requirement of manual start while the vehicle is at rest.

1 Claim, 2 Drawing Figures



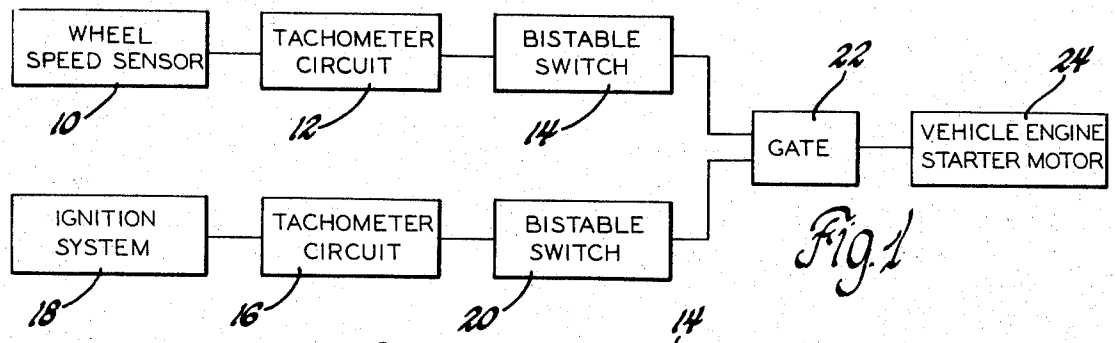


Fig. 1

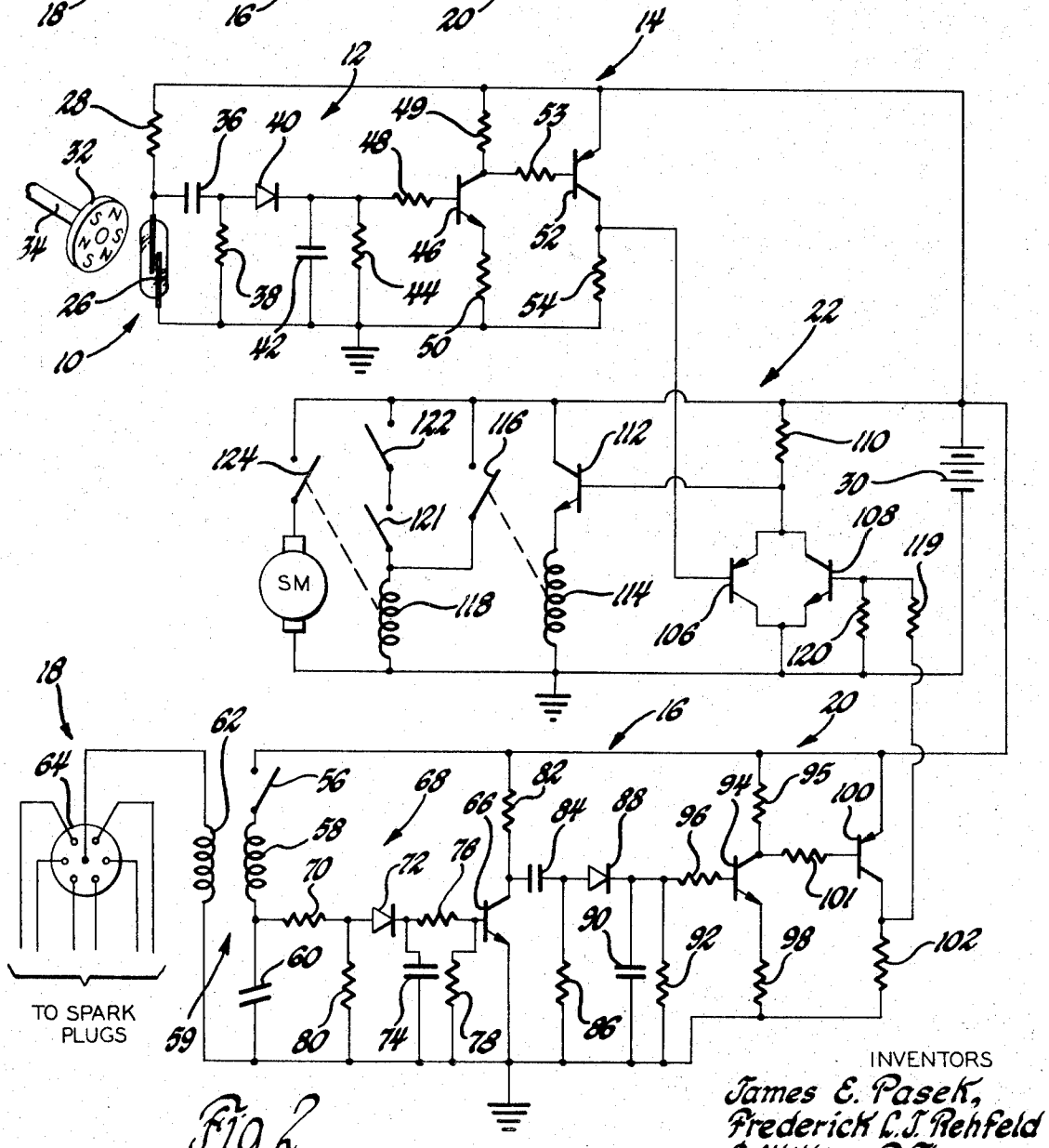


Fig. 2

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AUTOMATIC ENGINE CRANKING SYSTEM

This invention relates to an automatic cranking system for a vehicle engine and, more specifically, this invention relates to an automatic cranking system for maintaining the operation of vehicle engine powered accessories in the event of an engine stall while the vehicle is in motion.

Transmission fluid pumps for automatic transmissions of the type which are currently installed on automotive vehicles are driven by the vehicle engine. Consequently, when the vehicle engine stalls, the loss of transmission fluid pressure disables the transmission and prevents the engine from being driven by the drive wheels through the drive train while the vehicle is in motion even though the transmission selector lever is in a drive position. Therefore, in the event of an engine stall, the vehicle engine speed drops to zero which results in the loss of operation of the engine driven accessories, such as, for example, power steering assist. It is, therefore, one object of this invention to provide an automatic cranking system for energizing the vehicle starter motor upon the occurrence of an engine stall while the vehicle is in motion so as to maintain operation of the engine driven accessories.

Automotive vehicles are also currently manufactured with a neutral and park safety switch which prevents the energization of the starter motor solenoid when the vehicle transmission selector lever is in drive or reverse positions. It is an object of this invention to provide an automatic cranking system for energizing the vehicle starter motor at all positions of the transmission selector lever when the vehicle engine stalls while the vehicle is moving at a predetermined minimum speed, which does not replace the function of manual start when the vehicle is at rest including the requirement that the vehicle selector lever be placed in neutral or park position prior to the manual start.

These and other objects of this invention are accomplished by monitoring the vehicle speed and the engine speed and energizing the vehicle starter solenoid when the vehicle speed is above a predetermined minimum speed and the engine speed is at a speed which represents a stalled condition. The starter motor cranks the vehicle engine to maintain the operation of the engine driven accessories until the vehicle engine restarts or until the vehicle speed decreases below the predetermined minimum.

The invention may be best understood by reference to the following description of a preferred embodiment and the figures in which:

FIG. **1** is a block diagram of the preferred embodiment of this invention; and

FIG. **2** is an electrical schematic of one means for accomplishing the functions of the block diagram of FIG. **1**.

Referring to FIG. **1**, a wheel speed sensor **10** is driven by a member of the vehicle drive train and supplies to a tachometer circuit **12** a signal having a frequency directly related to the speed of the vehicle. The output of the tachometer circuit **12** is a signal having a magnitude directly proportional to the speed of the vehicle. A bistable switch **14** is responsive to the output of the tachometer circuit **12** for switching from a first state to a second state when the output of the tachometer circuit **12** is at or above a value which represents a predetermined minimum speed of the vehicle and, conversely, switches from the second state to the first state when the output of the tachometer **12** is below a value which represents a speed less than the predetermined speed.

A tachometer circuit **16** is connected to the vehicle ignition system **18** and receives therefrom a waveform having a frequency directly proportional to the speed of the vehicle engine. The tachometer circuit **16** generates a signal in response to the frequency of the waveform at the input thereof having a magnitude directly proportional to the speed of the vehicle engine. A bistable switch **20** is responsive to the output of the tachometer circuit **16** for switching from a first state to a second state when the speed of the vehicle engine is greater than a speed which represents a stalled condition and, conversely, switches from the second state to the first state when the speed of the vehicle engine is below the minimum idle speed and at a speed which represents a stalled condition.

A gate **22** is connected to the bistable switches **14** and **20** and is responsive to the states thereof for energizing the vehicle engine starter motor **24** when the speed of the vehicle engine is at a speed which represents a stalled condition and the speed of the vehicle is above the predetermined minimum speed. The vehicle engine is cranked by the starter motor **24** so as to maintain the operation of the engine driven accessories. If the vehicle engine should start while the starter motor **24** was cranking the engine, the increase in speed thereof would result in an increase in the output of the tachometer circuit **16** to switch the bistable switch **20** from its first state to its second state at which time the gate **22** would deenergize the starter motor **24**. If the vehicle engine does not start and the speed of the vehicle decreases below the predetermined minimum, the output of the tachometer circuit **12** decreases and the bistable switch **14** switches from its second state to its first state. The gate **22** is responsive thereto for deenergizing the vehicle engine starter motor **24**. As the gate **22** will not energize the vehicle engine starter motor **24** while the vehicle speed is below the predetermined minimum speed, it is required that the vehicle engine be initially started in the conventional manner when the vehicle is at rest. Consequently, the requirement of a manual start is not altered by the foregoing described system including the requirement that the transmission selector lever be placed in park or neutral position.

Referring to FIG. **2** there is shown an example of a circuit which could be used in the mechanization of the system previously described with reference to FIG. **1**. The wheel speed sensor **10** includes a magnetically operated reed switch **26** in series with a current limiting resistor **28** across the vehicle battery **30**. The reed switch **26** is positioned adjacent the face of a disk **32** which is rotated by an input shaft **34** which in turn is rotated by a member of the vehicle drive train such as a vehicle rear wheel. Consequently, the rate of rotation of the disk **32** is directly proportional to the speed of the vehicle. The disk **32** is magnetized so as to have alternating north and south magnetic poles therearound. Upon rotation of the disk **32**, the reed switch **26** is alternately opened and closed thereby at a rate directly proportional to the speed of rotation of the input shaft **34** and, consequently, the speed of the vehicle. The

wheel speed sensor **10** supplies an output from between the reed switch **26** and the resistor **28** which is comprised of a series of current pulses supplied by the vehicle battery **30** through the resistor **28** when the reed switch **26** is periodically opened and closed. The output of the wheel speed sensor **10** is supplied to a differentiating capacitor **36** in the tachometer circuit **12**. The remaining side of the differentiating capacitor **36** is connected to ground through resistor **38** and to the anode of a diode **40**. The cathode of the diode **40** is connected to ground through a filtering circuit including a capacitor **42** and a resistor **44**. When the reed switch **26** is opened, a voltage pulse is developed across the resistor **38** while the capacitor **36** is charging, which pulse is coupled to the capacitor **42** and the resistor **44** through the diode **40**. When the reed switch **26** is closed, the capacitor **36** discharges through the reed switch **26** and the resistor **38**. The diode **40** prevents the capacitor **36** from discharging through the resistor **44** and the capacitor **42**. As the reed switch **26** is alternately opened and closed by the rotation of the disk **32**, the capacitor **42** is charged by the pulses coupled thereto through the diode **40** to a potential which is directly proportional to the rate of rotation of the disk **32** and, consequently, the speed of the vehicle.

The output of the tachometer circuit **12** is the charge on the capacitor **42** which is coupled to the base electrode of an NPN transistor **46** in the bistable switch **14** through a resistor **48**. The collector electrode of the transistor **46** is connected to the positive terminal of the vehicle battery **30** through a resistor **49** and the emitter electrode thereof is connected to ground through a resistor **50**. The bistable switch **14** also includes a PNP transistor **52** having its base electrode connected to the collector electrode of the transistor **46** through a resistor **53**, its collector electrode connected to ground through a resistor **54** and its emitter electrode connected to the positive terminal of the vehicle battery **30**. The bistable switch **14** supplies an output from the collector electrode of the transistor **52**, which output is the potential developed across the resistor **54**. When the speed of the vehicle is zero, the capacitor **42** in the tachometer circuit **12** is fully discharged. Consequently, the transistors **46** and **52** in the bistable switch **14** are biased into nonconduction. Therefore, the output of the bistable switch **14** at the collector electrode of the transistor **52** is ground potential. As the vehicle speed increases from zero, the capacitor **42** is charged to a potential directly related to the speed of the vehicle as previously described. The circuit parameters are chosen such that at a predetermined speed, the capacitor **42** is charged to a potential which biases the transistor **46** into conduction which in turn biases the transistor **52** into conduction. The output of the bistable switch **14** then switches from ground to the potential of the vehicle battery **30**. Conversely, when the speed of the vehicle decreases below the predetermined minimum speed, the transistors **46** and **52** are biased into nonconduction to again supply ground potential at the output of the speed switch **14**.

The tachometer circuit **16** receives an input from the vehicle ignition system **18** which includes a set of contacts **56** in the ignition switch, which are closed when the ignition switch is in an on position, in series with a primary winding **58** of the vehicle ignition coil **59** and the breaker contacts **60**, the foregoing series circuit being connected in parallel with the vehicle battery **30**. The ignition system **18** also includes a secondary winding **62** of the ignition coil **59** which supplies a high voltage pulse to the vehicle spark plugs through a distributor **64**. The ignition system **18** supplies an output to the tachometer circuit **16** from between the primary winding **58** and the breaker contacts **60**, which output is a series of pulses having a frequency directly proportional to the speed of the vehicle engine. This series of pulses is supplied to the base electrode of a transistor **66** through a signal conditioning circuit **68** which filters out the high frequency components. The signaling conditioning circuit **68** includes a resistor **70** connected between the output of the ignition system **18** and the anode of a diode **72** whose cathode is connected to ground through a filtering circuit including a capacitor **74** in parallel with the series combination of a resistor **76** and a resistor **78**. A resistor **80** is connected between the anode of the diode **72** and ground. The signaling conditioning circuit **68** supplies an output from between the resistors **76** and **78**, which output is applied to the base electrode of the transistor **66**. The amplitude of the pulse output of the ignition system **18** is reduced by the resistor **70**. The pulse developed across the resistor **80** is coupled through the diode **72** to the capacitor **74** and the resistors **76** and **78** which filters out the high frequency components and applies the resulting pulse to the base electrode of the transistor **66**.

The emitter electrode of the transistor **66** is connected to ground and the collector electrode thereof is connected to the positive terminal of the vehicle battery **30** through a resistor **82**. The pulses coupled to the base electrode of the transistor **66** bias the transistor **66** into conduction for the duration of each individual pulse.

The signal conditioner **68** supplies an output at the collector electrode of the transistor **66** which is comprised of a series of pulses supplied by the vehicle battery **30** through the resistor **82** when the transistor **66** is biased into nonconduction. The output of the signal conditioner **68** is supplied to a differentiating capacitor **84** in the tachometer circuit **16**. The remaining side of the differentiating capacitor **84** is connected to ground through a resistor **86** and to the anode of a diode **88**. The cathode of the diode **88** is connected to ground through a filtering circuit including a capacitor **90** and a resistor **92**. When the transistor **66** is biased into nonconduction, a voltage pulse is developed across the resistor **86** while the capacitor **84** is charging, which pulse is coupled to the capacitor **90** and the resistor **92** through the diode **88**. When the transistor **66** is biased into conduction, the capacitor **84** discharges through the transistor **66** and the resistor **86**. The diode **88** prevents the capacitor **84** from discharging through the resistor **92** and the capacitor **90**. As the transistor **66** is alternately biased into conduction and nonconduction by the opening and closing of the breaker contacts **60** in the ignition system **18**, the capacitor **90** is charged by the pulses coupled thereto through the diode **88** to a potential which is directly proportional to the rate of the opening and closing of the breaker contacts **60** and, consequently, the speed of the vehicle engine.

The output of the tachometer circuit **16** is the charge on the capacitor **90** which is coupled to the base electrode of an NPN transistor **94** in the bistable switch **20** through a resistor **96**. The collector electrode of the transistor **94** is connected to the positive terminal of the vehicle battery **30** through a resistor **95** and the emitter electrode thereof is connected to ground through a resistor **98**. The bistable switch **16** also includes a PNP transistor **100** having its base electrode connected to the collector electrode of the transistor **94** through a resistor **101**, its collector electrode connected to ground through a resistor **102** and its emitter electrode connected to the positive terminal of the vehicle battery **30**. The bistable switch **20** supplies an output from the collector electrode of the transistor **100**, which output is the potential developed across the resistor **102**. When the speed of the vehicle engine is zero, the capacitor **90** in the tachometer circuit **16** is fully discharged. Consequently, the transistors **94** and **100** in the bistable switch **20** are biased into nonconduction. Therefore, the output of the bistable switch **20** at the emitter electrode of the transistor **100** is ground potential. As the vehicle engine speed increases from zero, the capacitor **90** is charged to a potential directly related to the speed of the vehicle engine as previously described. The circuit parameters are chosen such that at a predetermined speed, the capacitor **90** is charged to a potential which biases the transistor **94** into conduction which in turn biases the transistor **100** into conduction. The output of the bistable switch **100** then switches from ground to the potential of the vehicle battery **30**. Conversely, when the speed of the vehicle engine decreases below the predetermined minimum speed, the transistors **94** and **100** are biased into nonconduction to again supply ground potential at the output of the bistable switch **20**.

The gate **22** includes a PNP transistor **106** and an NPN transistor **108**, the collector electrode of the transistor **106** being connected to the emitter electrode of the transistor **108** and the emitter electrode of the transistor **106** being connected to the collector electrode of the transistor **108**. The collector electrode of the transistor **106** and the emitter electrode of the transistor **108** are connected to ground. The emitter electrode of the transistor **106** and the collector electrode of the transistor **106** are connected to the positive terminal of the vehicle battery **30** through a resistor **110** and are connected to the base electrode of an NPN transistor **112**. The collector electrode of the transistor **112** is connected to the positive terminal of the vehicle battery **30** and the emitter electrode thereof is connected to ground through a relay coil **114**. The relay coil **114** controls a set of normally open relay contacts **116** which are connected in series with a starter motor solenoid **118** across the vehicle battery **30**. The output of the bistable switch **14**, at the collector electrode of the transistor **52** is connected to the base electrode of the transistor **106** and the output of the bistable switch **20** at the collector electrode of the transistor **102** is connected to the base electrode of the transistor **108** through resistor **119**. The base electrode of the transistor **108** is connected to ground through a resistor **120**. The output of the gate **22** is the potential of the vehicle battery **30** supplied to the starter motor solenoid **118** through the set of normally open relay contacts **116** when the relay coil **114** is energized.

The starter motor solenoid **118** is connected in series with a park and neutral safety switch **121** which is closed when the vehicle transmission selector lever is in neutral or park position and a set of contacts **122** which are closed when the vehicle ignition switch is in the start position. This series combination is connected across the vehicle battery **30**, the switch **121** and the contacts **122** being in parallel with the set of normally open relay contacts **116**. The starter motor solenoid **118** controls a set of normally open relay contacts **124** which are connected in series with the starter motor **24** across the vehicle battery **30**. When either the set of normally open relay contacts **116** are closed or the switch **121** and the contacts **122** are closed, the starter motor solenoid **118** is energized to close the set of normally open contacts **124** and connect the vehicle battery **30** across the starter motor **24** which is energized to crank the vehicle engine.

When the speed of the vehicle is below the predetermined minimum speed, the base electrode of the transistor **106** is grounded through the resistor **54** in the bistable switch **14**. Consequently, the transistor **106** is biased into conduction to bias the transistor **112** into nonconduction and maintain the relay coil **114** deenergized. Therefore, when the vehicle engine is not running while the vehicle speed is below the predetermined minimum speed, the starter solenoid **118** can be energized to start the vehicle engine only by positioning the transmission selector lever into park or neutral position to close the contacts **121** and rotating the ignition switch to start position to close the contacts **122**.

When the vehicle engine is running, the output of the bistable switch **20** is the battery potential. Consequently, the transistor **108** is biased into conduction to bias the transistor **112** into nonconduction and maintain the relay coil **114** deenergized. From the foregoing it can be seen that the set of normally open relay contacts **116** are maintained open when either the vehicle speed is below the predetermined minimum or the speed of the vehicle engine is above the speed which represents a stalled condition. The transistor **112** is biased into conduction only when both the transistors **106** and **108** are biased into nonconduction, which condition exists only when the vehicle speed is above the predetermined minimum speed and the vehicle engine has stalled. When this condition exists, the relay coil **114** is energized to close the set of normally open relay contacts **116** to energize the starter motor solenoid **118** and connect the battery **30** across the starter motor **24**. The starter motor **24** will be energized to crank the vehicle engine so as to maintain operation of the engine driven accessories until the vehicle speed decreases below the predetermined minimum speed or until the vehicle engine restarts.

In the foregoing manner the engine driven accessories are operated during engine stall only during the period when such operation is required.

The detailed description of the preferred embodiment of the invention for the purpose of explaining the principles thereof is not to be considered as limiting or restricting the invention, since many modifications may be made by the exercise of skill in the art without departing from the scope of the invention.

We claim:

1. An apparatus for automatically maintaining the operation of motor vehicle engine driven accessories

when the vehicle engine stalls while the vehicle is in motion and the normal start circuit is disabled, the motor vehicle including a starter motor for cranking the vehicle engine, comprising engine speed tachometer means responsive to the speed of the engine for generating an output signal related to the engine speed; vehicle speed tachometer means responsive to the speed of the vehicle for generating an output signal related to the vehicle speed; and circuit means independent of the normal start circuit connected to the engine speed tachometer means, the vehicle speed tachometer means and the starter motor and responsive to the output signals of the engine speed tachometer means and the vehicle speed tachometer means for energizing the starter motor without operator action when the output of the engine speed tachometer means represents an engine speed less than the minimum idle speed of said engine and the output of the vehicle speed tachometer means represents a vehicle speed above a predetermined minimum speed, said energizing circuit being maintained until the engine exceeds the minimum idle speed so as momentarily to provide accessory operation even though the engine does not start.

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