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DIESEL ENGINE TACHOMETER

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FIG. 1.

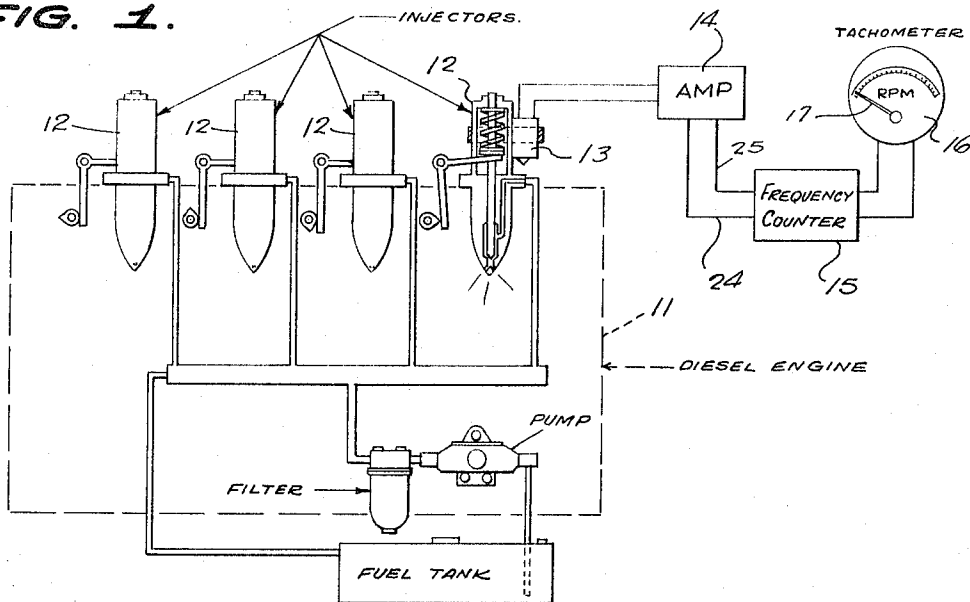


FIG. 2.

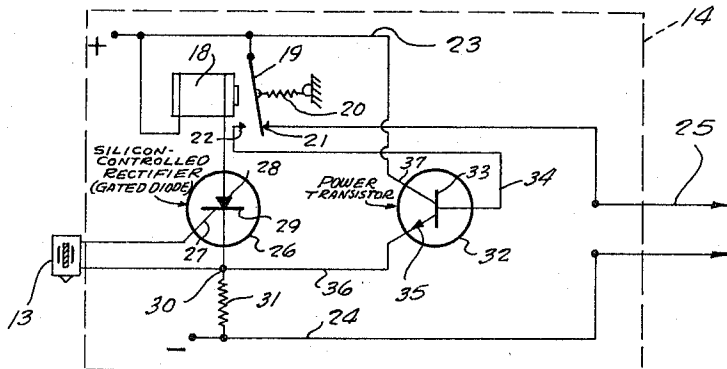
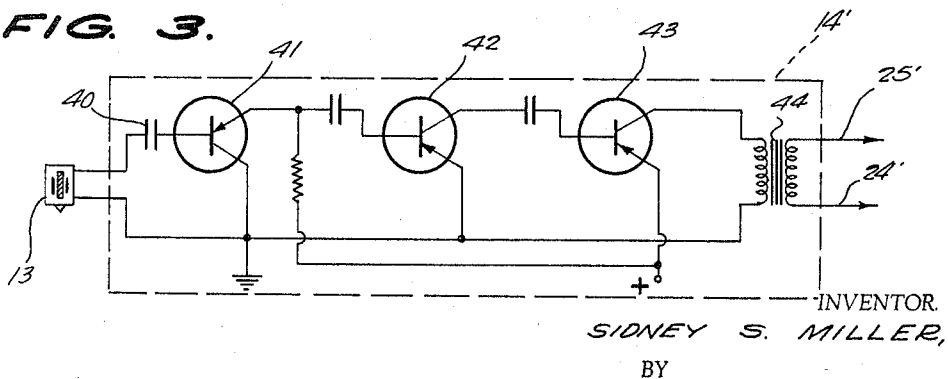


FIG. 3.



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DIESEL ENGINE TACHOMETER

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4 Claims. (Cl. 324-70)

This invention relates to tachometers for internal combustion engines, and more particularly to an electronic tachometer for use on an engine which does not have an ignition or electrical system, for example, for use on a diesel engine.

A main object of the invention is to provide a novel and improved electronic tachometer which provides an engine speed indication from the vibration or "clatter" produced by the operation of the fuel injector valve of a diesel engine, the tachometer being simple in construction, being reliable in operation, and being easy to install.

A further object of the invention is to provide an improved electronic tachometer for use on a diesel engine, the tachometer operating in response to vibration produced by the operation of the injector valve of the engine, the tachometer involving inexpensive components, being compact in size, and requiring substantially no modification of the existing structure of a diesel engine on which it is installed.

A still further object of the invention is to provide an improved electronic speed-indicating device for a diesel engine or similar machine, the device providing an accurate indication of the speed of the machine responsive to the opening and closing vibration produced by a valve of the machine, the device being particularly applicable for use with a diesel engine which does not have ignition or other electrical circuits which are tied in with the speed of operation of the machine, the apparatus being also suitable for use to operate a timing light to check the timing of the injection valve or other device whose vibration is employed to give the necessary speed indication.

A still further object of the invention is to provide an improved and relatively inexpensive electronic tachometer system for use on a diesel engine, the system operating in response to the clatter or vibration in the fuel injection valve of the diesel engine to provide a series of electrical pulses whose frequency may be counted, whereby the speed of operation of the engine will be indicated.

Further objects and advantages of the invention will become apparent from the following description and claims, and from the accompanying drawings, wherein:

FIGURE 1 is a schematic diagram showing the injection valve of a conventional diesel engine and showing the manner in which an improved electronic tachometer according to the present invention is installed on the engine, the electrical circuit being shown in the form of a block diagram.

FIGURE 2 is an electrical wiring diagram showing the circuit of one form of the electronic tachometer according to the present invention which may be employed in the system shown in FIGURE 1.

FIGURE 3 is an electrical wiring diagram showing the circuit connections of another form of electronic tachometer which may be employed in the system illustrated in FIGURE 1.

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Referring to the drawings, and more particularly to FIGURES 1 and 2, 11 generally designates a conventional diesel engine having the four fuel injection valves 12 which open and close at a rate of speed which is directly proportional to the speed of the engine. Thus, each valve 12 opens once during each revolution of the engine crank shaft, so that the rate of rotation of said crank shaft will be the same as the rate at which each valve 12 opens and closes.

In accordance with the present invention, a transducer 13 is mounted on one of the valves 12 in a position to receive the vibrations produced by the opening and closing of the valve, whereby to generate an electrical signal caused by such vibrations, the signal being amplified in a conventional amplifier 14 and being fed through a frequency counter 15 having an indicating meter 16 connected to its output, for example, similar to the arrangement shown in U.S. Patent No. 1,608,817 to H. O. Russell, et al., or in U.S. Patent No. 2,102,371 to B. Miller, the meter having a dial calibrated in revolutions per minute so that the pointer 17 of the meter will provide a visual indication corresponding to the frequency of operation of each valve 12, and therefore corresponding to the speed of rotation of the engine crank shaft.

The transducer 13 may be any suitable device which responds to mechanical vibrations and generates corresponding electrical signals, for example, may be a piezoelectric crystal device similar to that employed in a phonograph pick-up. In the arrangement of FIGURE 1 the transducer 13 is mounted so that the vibrations produced by the opening and closing of the associated fuel injection valve 12 will correspondingly stress the transducer in a manner to generate electrical voltage pulses or signals corresponding to the valve vibrations.

In FIGURE 2, the amplifier device 14 comprises a relay 18 having a pivoted armature 19 which is biased by a spring 20 into engagement with one stationary contact 21 of the relay, the armature 19 being attracted toward the core of the relay 18 when the relay becomes energized, and moving away from the contact 21 into engagement with another stationary contact 22. A pair of current supply wires 23 and 24 are connected respectively to the terminals of a suitable direct current supply source, such as a battery, or the like, the wire 23 being connected to the positive terminal of the supply source and the wire 24 being connected to the negative terminal thereof. The wire 24 constitutes one of the output leads from the amplifier 14, and another wire 25, extending from the relay contact 21, constitutes the other output wire. The wires 24 and 25 are connected to the input of the frequency counter 15, as shown in FIGURE 1.

Designated at 26 is a gated diode, for example, a gate-controlled silicon diode rectifier provided with the gate electrode 27. The diode 26 is further provided with the emitter electrode 28 and the base electrode 29. The piezoelectric transducer 13 has one terminal thereof connected to the gate electrode 27 and has the other terminal thereof connected to the base terminal 30. Base terminal 30 is connected to the supply wire 24 through a load-limiting resistor 31. One terminal of the winding of relay 18 is connected to the positive supply wire 23 and the opposite terminal of the relay winding is connected to the emitter electrode 28 of the gated diode 26.

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The armature 19 is likewise connected to the positive current supply wire 23. The arrangement is such that normally the respective power supply wires 23 and 24 are connected to the input circuit of the amplifier 14.

A transistor 32 has its base 33 connected by a wire 34 to the relay stationary contact 22 and has its emitter 35 connected by a wire 36 to the terminal 30. The power supply wire 23 is connected to the collector 37 of transistor 32. As shown in FIGURE 2, the base 33 is normally disconnected from the remaining portion of the circuit so that transistor 32 is normally nonconducting.

When the injector valve 12 on which the transducer 13 is mounted opens, the vibration is picked up by the transducer, which generates a corresponding electrical pulse, said pulse being transmitted to the gate 27 of the controlled silicon diode 26, being applied across the gate 27 and the junction point 30. This pulse triggers the controlled silicon diode 26, causing substantial current to flow through the winding of the relay 18, thereby energizing the relay and moving the pole 19 thereof from stationary contact 21 into engagement with stationary contact 22. This connects the base 33 of the transistor 32 to the positive supply wire 23, causing transistor 32 to conduct, whereby the transistor 32 acts as a shunt between wire 23 and junction point 30. This removes the load current from the diode 26 so that it no longer conducts, causing the relay 18 to become deenergized, so that its armature 19 moves from contact 22 into engagement with contact 21, producing a pulse between the wires 24 and 25 leading to the input of the frequency counter 15. The next vibration picked up by the transducer 13 initiates an identical cycle of operation of the circuit, so that a series of pulses are applied to the input of the frequency counter 15 from the wires 25 and 24 having the same frequency as the frequency of operation of the valve 12 on which transducer 13 is mounted. Thus, the calibrated dial of the meter 16 will provide an indication, according to the position of the pointer 17, showing the speed of operation of the engine 11.

Referring now to FIGURE 3, 14' designates an alternative amplifier circuit which may be employed in place of the amplifier 14 illustrated in FIGURES 1 and 2. The transducer 13 is connected through a coupling condenser 40 to the input of a conventional transistorized amplifier including the transistors 41, 42 and 43, which amplify the electrical pulse generated in the diesel electric transducer 13 and deliver the amplified pulse through an output transformer 44 to the output wires 25' and 24' leading to the input of the frequency counter 15. Thus, the amplifier 14' comprises a conventional transistorized amplifier which provides voltage amplification of the piezoelectrically generated vibration signal, finally delivering an amplified signal to the frequency counter 15. The circuit 14' involves the use of at least three transistors and an output transformer 44, and does not have the sensitivity of the circuit of FIGURE 2, wherein the output pulses are actually derived by keying the voltage supply source connected to the supply wires 23 and 24.

As will be readily apparent, any suitable transducer may be employed as the vibration-sensitive means. Although the transducer 13 specifically illustrated and described above comprises a piezoelectric crystal cartridge, any other suitable transducer may be employed, for example, a carbon granule type of transducer connected in series with a suitable battery.

While certain specific embodiments of an improved diesel engine tachometer have been disclosed in the foregoing description, it will be understood that various modifications within the spirit of the invention may occur to those skilled in the art. Therefore, it is intended that no limitations be placed on the invention except as defined by the scope of the appended claims.

What is claimed is:

1. In a diesel engine having a fuel injector, a transducer

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mounted on said fuel injector so as to generate an electrical signal responsive to each vibration of the injector produced by the opening thereof, a source of current, a relay, a pair of output terminals, said relay, when deenergized completing a circuit between the source and the output terminals, a gated diode having a gate electrode, means connecting said gated diode and relay in a series circuit to said source of current, circuit means connecting said transducer to said gate electrode to trigger said diode responsive to each of said electrical signals, whereby to energize said relay, means to short circuit said series circuit responsive to energization of the relay, whereby to cut off the gated diode, and deenergize the relay, and means connected to the output terminals to count and indicate the frequency of said electrical signal pulses.

2. In a diesel engine having a fuel injector, a transducer mounted on said fuel injector so as to generate an electrical signal responsive to each vibration of the injector produced by the opening thereof, a source of current, a relay, a pair of output terminals, said relay, when deenergized completing a circuit between the source and the output terminals, a gated diode, means connecting said gated diode and relay in a series circuit to said source of current, means connecting said transducer between the gate electrode and the base electrode of the gated diode, whereby to trigger said diode responsive to each of said electrical signals and whereby to energize said relay, means to short circuit said series circuit responsive to energization of the relay, whereby to cut off the gated diode, and deenergize the relay, and means connected to the output terminals to count and indicate the frequency of said electrical signal pulses.

3. In a diesel engine having a fuel injector, a transducer mounted on said fuel injector and generating an electrical signal responsive to each vibration of the injector produced by the opening thereof, a source of current, a relay, a gated diode having an emitter electrode, a base electrode and a gate electrode, means connecting said gated diode and relay in a series circuit to said source of current, means connecting said transducer between the gate electrode and the base electrode of the gated diode, whereby to trigger the diode responsive to each of said electrical signals and whereby to energize said relay, a transistor having a base, a collector and an emitter, means connecting said collector and last-named emitter in circuit with said source of current, first contact means closing responsive to deenergization of said relay, a pair of output terminals connected to said source of current through said first contact means, second contact means closing responsive to energization of the relay, means connecting said second contact means across said series circuit through said last-named base and last-named emitter, whereby to shunt said series circuit and deenergize the relay when said second contact means closes, whereby an electrical pulse is generated at said output terminals with each of said first-named electrical signals, and frequency counting means connected to said output terminals.

4. In a diesel engine having a fuel injector, a transducer mounted in a position with respect to said fuel injector to receive vibrations therefrom and to generate an electrical signal responsive to each vibration of the injector produced by the opening thereof, a source of current, a relay, a gated diode having an emitter electrode, a base electrode, and a gate electrode, means connecting said gated diode and relay in a series circuit to said source of current, means connecting said transducer between the gate electrode and the base electrode of the gated diode, whereby to trigger the diode responsive to each of said electrical signals and whereby to energize said relays, a transistor having a base, a collector and an emitter, means connecting said collector and last-named emitter in circuit with said source of current, said relay having a pole

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and respective opposing contacts engageable by said pole, said pole engaging a first contact when the relay is energized and a second contact when the relay is deenergized, a pair of output terminals connected to said source of current through said pole and second contact, means connecting said pole and first contact across said series circuit through said base and last-named emitter, whereby to shunt said series circuit and deenergize the relay when said pole engages said first contact, whereby an electrical pulse is generated at said output terminals with each of

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said first-named electrical signals, and frequency counting means connected to said output terminals.

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