Aug. 29, 1967 E. E. BEERS 3,339,093

ELECTRICAL CIRCUIT

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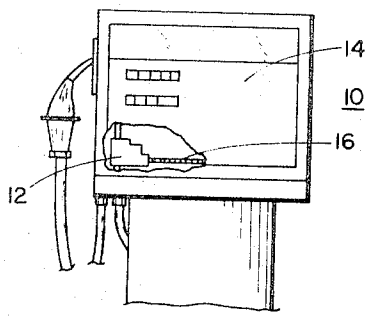


Fig. 1

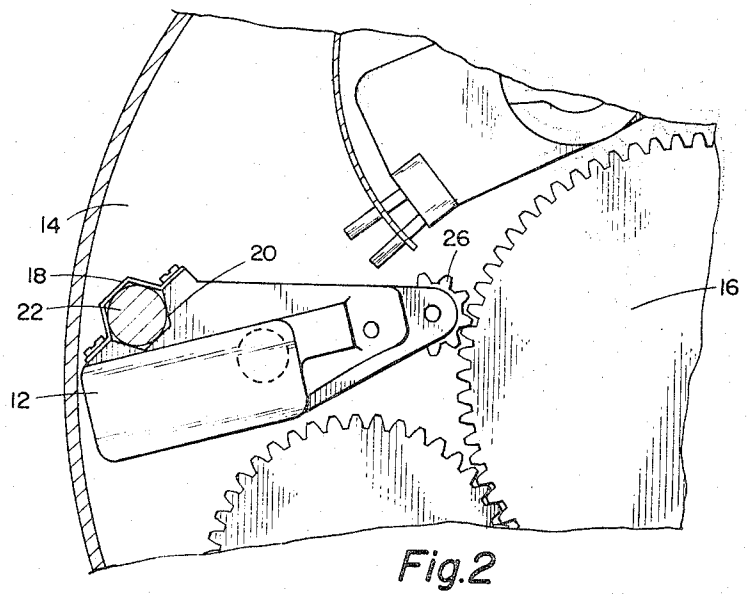


Fig. 2

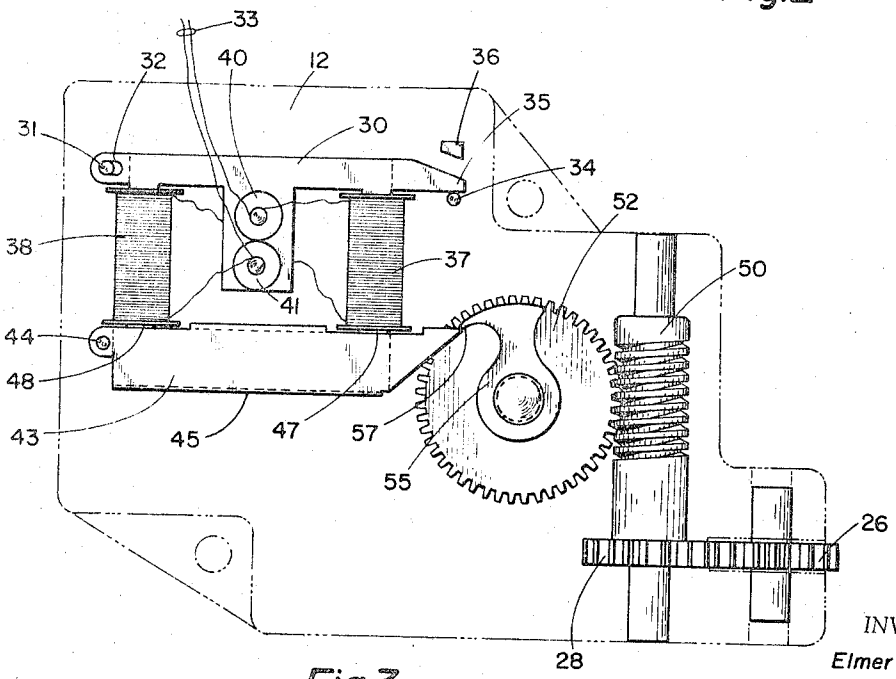


Fig. 3

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Fig.4

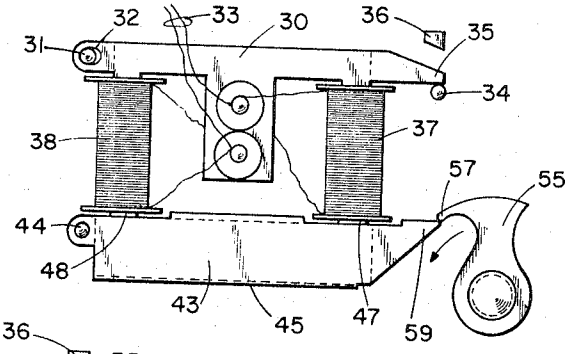


Fig.5

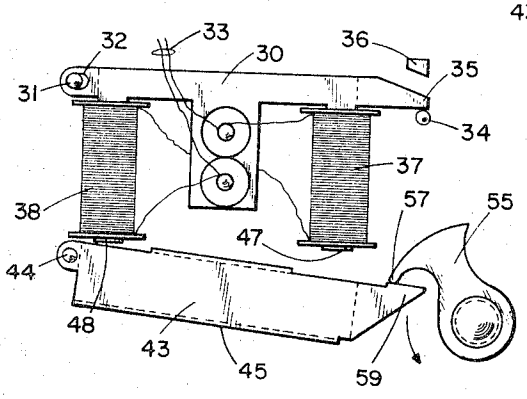


Fig.6

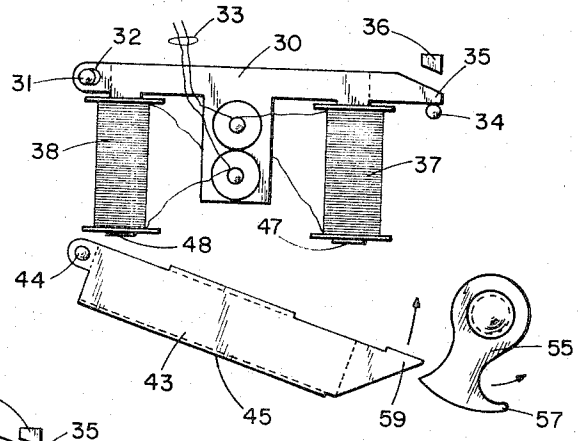
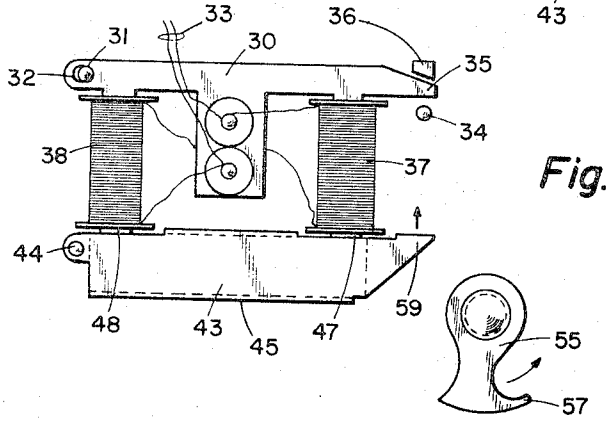


Fig.7



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ELECTRICAL CIRCUIT

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ABSTRACT OF THE DISCLOSURE

A pulse generator for converting a mechanical measurement to electrical impulses and which is particularly suitable for use in an explosive atmosphere. Pulses are generated by changing the reluctance of a magnetic path by moving an armature away from the remainder of the magnetic path and permitting the armature to return rapidly to its normal position. The magnetic structure is mounted so that it is free to pivot independently of the armature so that the kinetic energy of the armature is absorbed without vibration of the armature.

In order to transmit the output information of mechanical measuring devices it is desirable to convert the mechanical data into electrical pulses. The electrical pulses can then be transmitted over electrical circuits to data handling equipment located at a distance from the mechanical measuring device. For example, it may be desirable to measure the quantity of gasoline pumped by a service station gasoline pump and to transmit the measurements to a central station where the data thus transmitted can be processed. A pulse generator coupled to the gasoline pump computer may generate one pulse for each gallon of gasoline pumped. These pulses can be processed at the station and transmitted by electrical transmission means, such as a telephone line, to a central station for further processing.

A pulse generator for use in a gasoline pump must be designed to operate in an explosive atmosphere without danger. Circuits have been designed to produce electrical pulses by using mechanical motion to open and close electrical contacts. In opening, the contacts are subject to sparking and thus must be hermetically sealed to prevent the explosive atmosphere from being ignited by the sparks. The pulses produced must be narrow so that their energy content will be less than that required to ignite the explosive mixture if wire breakage causes sparking outside the sealed enclosure. The pulse shape must also be independent of the speed of the mechanical motion in order to accurately control electrical circuits. Magnetic pulse generators can be used to generate without sparking by opening and closing "magnetic contacts" to change the reluctance of a magnetic path. However, magnetic pulse generators have the disadvantage of producing relatively wide pulses with the pulse shape dependent upon the motion of the mechanical actuator, and/or the disadvantage of producing spurious pulses because of bouncing of the "magnetic contacts."

It is therefore an object of this invention to provide an improved pulse generator to convert mechanical motion to electrical pulses and which can be used in an explosive atmosphere.

Another object of this invention is to provide a pulse generator for use with a gasoline pump and in which the number of pulses generated is a measure of the quantity of gasoline pumped.

Another object of this invention is to provide a pulse generator in which the amplitude of the pulses is independent of the rate at which they are generated.

Another object of this invention is to provide a pulse generator in which the generation of noise and false pulses is minimized.

Another object of this invention is to provide a pulse generator simple in design, economical to manufacture and install and which requires little or no maintenance.

A feature of this invention is the provision of a pulse generator in which a pulse is produced by changing the flux linking a coil.

Another feature of this invention is the provision of a pulse generator in which a magnet is positioned across a core of magnetic material to develop a flux in the core. Mechanical means moves the magnet slowly away from the core and releases the magnet, and the magnet rapidly returns to its position across the core causing a rapid change in the flux within the core thus generating a pulse in a coil linking the core.

Another feature of this invention is the provision of a pulse generator in which the core and magnet are so mounted that they are free to move so that the magnet will not bounce when it rapidly returns to its position across the core, thereby preventing the generation of noise pulses.

The invention is illustrated in the drawings in which:

FIG. 1 is a view of a gasoline pump showing the location of the pulse generator;

FIG. 2 is a view of a portion of the computer gearing of a gasoline pump showing the mechanical coupling of the pulse generator to the computer;

FIG. 3 is a view of the pulse generator; and

FIGS. 4 to 7 illustrate the operation of the pulse generator.

In practicing this invention a pulse generator is provided which may be mechanically coupled to a device which measures the flow of a product, as for example gasoline. Each time that a predetermined amount of gasoline is pumped, the pulse generator generates a single pulse. The shape of the pulse is independent of the rate at which the gasoline is pumped.

The pulse generator includes a core of magnetic material around which coils of wire are positioned. A permanent magnet is placed across the ends of the magnetic core developing a magnetic flux which links the coils of wire. A cam, adapted to move the magnet away from the magnetic core, is coupled mechanically to the gasoline pump computer. As the gasoline is pumped, the cam driven by computer gearing forces the permanent magnet away from the core causing the flux linking the coils to change. The rate at which the magnet is moved away from the core by the cam is such that the voltage developed in the coils is negligible.

When the magnet has been moved a predetermined distance from the core, the cam releases the permanent magnet allowing it to return to its position across the core. The magnetic attraction of the core for the magnet causes it to return to its position across the core very rapidly. The rapid return of the magnet to its position across the core causes the flux linking the coils to change rapidly thus developing a voltage pulse in the coil. Since the rate of flux change is greater during the last portion of the permanent magnet travel a very narrow pulse is generated. The narrow pulse thus generated will not have sufficient energy to ignite an explosive atmosphere.

In order to prevent the generation of noise pulses, the core and permanent magnet are mounted so that they are free to rotate when the magnet strikes the core. This rotation absorbs the kinetic energy of the moving permanent magnet to prevent the magnet from bouncing after striking the core and thus prevent the generation of spurious pulses or noise.

FIG. 1 illustrates a gasoline pump **10** incorporating the pulse generator of this invention. The pulse generator **12** is mounted inside the computer portion **14** of pump **10** and is mechanically coupled to gear **16**, the rotation of

which is a direct function of the number of gallons pumped by gasoline pump **10**.

FIG. 2 shows another view of pulse generator **12** mounted in computer **14** of the gasoline pump **10**. Clamp **18** cooperates with clamping portion **20** of the housing of pulse generator **12** whereby the pulse generator may be clamped to a mounting post within the computer. Clamp **18** and clamping portion **20** are hexagonally shaped so that they may be clamped around mounting post **22** which may be either cylindrical or hexagonal in shape. Pulse generator **12** is positioned so that gear **26** of the pulse generator meshes with gear **16** of the gasoline pump computer.

FIG. 3 shows the pulse generator mechanism. A magnetic core portion **30** is mounted within pulse generator **12** by pin **31** passing through elongated hole **32** and pin **34** which supports elongated arm portion **35** of core **30**. Elongated arm portion **35** is held against pin **34** by gravity. Elongated hole **32** is enlarged to permit pin **31** to slide within hole **32** as core **30** and magnet **43** are rotated about pin **44**.

A stop **36** is built into the housing to limit rotation of core **30**. Pins **31**, **34** and **44** and stop **36** are mounted on the housing of pulse generator **12**. Coils **37** and **38** are positioned so that they surround magnetic core **30**. Thus flux passing through core **30** links coils **37** and **38**. Coils **37** and **38** are connected to terminals **40** and **41** from which connections may be made to external circuitry by leads **33**. A permanent magnet **43** is contained within a sleeve **45** which is positioned to rotate about pin **44**. The magnet is placed across end faces **47** and **48** of core **30**. Permanent magnet **43** develops a magnetic flux which passes through core **30** linking coils **37** and **38**.

Spur gear **26**, which is driven by computer gear **16** shown in FIG. 2, drives spur gear **28** which in turn causes rotation of worm gear **50**. Worm gear **50** meshes with worm wheel **52** causing it to rotate in a counter-clockwise direction. Cam **55** is mechanically coupled to worm wheel **52** and rotates with worm wheel **52**.

The operation of cam **55** in positioning permanent magnet **43** to generate a pulse is illustrated in FIGS. 4 to 7. Referring to FIG. 4, lip **57** of cam **55** engages a follower portion **59** of sleeve **45**. In FIG. 5 the rotation of cam **55** has continued and lip **57** has forced the follower portion **59** of sleeve **45** downward. Permanent magnet **43** rotates about pin **44** and is displaced from the end faces **47** and **48** of magnetic core **30**. The air gap thus developed between permanent magnet **43** and end faces **47** and **48** increases the reluctance of magnetic path thereby decreasing the flux linking coils **37** and **38**. When the flux linking a coil changes, a voltage is induced in the coil proportional to the rate of change of the flux. When cam **55** forces permanent magnet **43** away from the end faces **47** and **48** of core **30**, the rate of change is slow enough so that the voltage induced in coils **37** and **38** is negligible.

Referring to FIG. 6, cam **55** has rotated sufficiently far so that cam **55** releases permanent magnet **43** permitting the magnetic attraction between permanent magnet **43** and end faces **47** and **48** to cause the magnet to return to its position across these end faces. As permanent magnet **43** returns to its position across end faces **47** and **48**, the air gap between permanent magnet **43** and core **30** is reduced. This reduces the reluctance of the magnetic path causing the flux linking coils **37** and **38** to increase. Since permanent magnet **43** returns to its initial position much more rapidly than it was removed, the rate of flux change is considerably greater and thus the voltage induced in coils **37** and **38** is higher than that induced when the permanent magnet **43** was removed from its position across the end faces **47** and **48**. The reluctance of the air gap is considerably greater than that of the reluctance of the magnetic path in core **30** and thus has a more pronounced effect on the flux through the core **30** than the reluctance of the core itself. Thus, the greatest change in flux occurs during the last portion of the return travel of permanent magnet **43**. The pulse thus produced by the pulse generator can be made very narrow and in units produced for use in an explosive atmosphere of a gasoline pump, the pulse width has been of the order of 3 microseconds. Since there is no opening or closing of electrical contacts with the attendant sparking, the pulse generator need not be sealed hermetically from the explosive atmosphere in which it operates. Further, the energy of the pulse is sufficiently small so that sparking which may be produced by the pulse, as for example across a broken wire, is insufficient to ignite an explosive atmosphere.

The shock absorbing mechanism of the pulse generator is illustrated in FIG. 7. If core **30** were rigidly mounted, the rapid return of permanent magnet **43** against end faces **47** and **48** of magnetic core **30** could cause permanent magnet **43** to bounce. The bouncing of permanent magnet **43** would cause flux changes in core **30** thus generating spurious pulses. These spurious pulses could cause errors to develop in the equipment operated by the pulse generator. In order to prevent this bouncing, core **30** is not rigidly mounted but it is positioned by pin **31** inserted in elongated hole **32** and pin **34** supporting elongated arm portion **35**. Core **30** is so mounted that arm portion **35** is held against pin **34** by gravity. Thus core **30** and permanent magnet **43** are free to rotate about pin **44** as a single unit. As illustrated in FIG. 7 when permanent magnet **43** strikes core end faces **47** and **48**, the entire core magnet system rotates about pin **44**, with pin **31** sliding in elongated hole **32**. When the kinetic energy of magnet **43** has been dissipated, the core magnet system is returned to its rest position, as shown in FIG. 4, by gravity.

The rotation of magnet **43** and core **30** effectively dissipates the kinetic energy of permanent magnet **43** and prevents permanent magnet **43** from making a bouncing contact with end faces **47** and **48**. Thus only one pulse is generated upon the return of permanent magnet **43** to its position across end faces **47** and **48**. Gravity then returns core **30** and magnet **43** to the position shown in FIG. 4.

Thus a simple mechanism for generating pulses in response to mechanical motion has been shown. The pulse shape is independent of the pulse rate and the mechanism is mounted to prevent the generation of spurious pulses. The pulse generator can be used in an explosive atmosphere and can be economically manufactured, installed, and maintained.

I claim:

1. An electrical pulse generator including in combination, a magnetic structure forming a closed magnetic path and including a permanent magnet whereby a magnetic flux is caused to flow through said magnetic path, coil means surrounding said magnetic path and linking said magnetic flux, said magnetic structure having a movable portion, first mounting means for supporting said magnetic structure and second mounting means for pivotally supporting said movable portion, moving means engaging said movable portion to rotate the same about said second mounting means thereby introducing an air gap in said magnetic path to cause said magnetic flux to decrease, said moving means acting to disengage said movable portion at a predetermined position whereby said magnetic flux causes said movable portion to move to rapidly close said air gap and said flux increases rapidly thereby generating a voltage pulse in said coil means, said first mounting means being adapted to permit rotation of said magnetic structure about said second mounting means whereby the kinetic energy of said movable portion is dissipated.

2. A pulse generator, including in combination, a core of magnetic material having end faces thereon, first mounting means for positioning said core, coil means surrounding said core and adapted to be coupled to an external circuit, permanent magnet means, second mounting means pivotally supporting said magnet means across said end faces whereby said magnet means acts to produce a magnetic flux through said core and linking said coil there-

by attracting said magnet means to said core, said magnet means further being adapted to rotate about said second mounting means whereby said magnet means is moved away from said end faces, a cam positioned to engage said magnet means, means coupled to said cam for rotating the same whereby said magnet means is rotated about said second mounting means to move said magnet means away from said core, said cam acting to disengage said magnet means after a predetermined amount of rotation whereby said disengaged magnet means rapidly returns to said position across said end faces in response to said magnetic attraction, said rapid return causing a change in the magnetic flux through said core whereby a voltage pulse is induced in said coil means, said first mounting means being further adapted to permit rotation of said core about said second mounting means whereby the kinetic energy of said magnet means is dissipated.

3. A pulse generator for generating electrical impulses in response to the amount of gasoline pumped by a gasoline pump, the pump including a computer having a gear therein which rotates at a speed proportional to the amount of gasoline pumped, the pulse generator including in combination, a core of magnetic material having end faces thereon, first mounting means for positioning said core, a coil means surrounding said core and adapted to be coupled to an external circuit, permanent magnet means, second mounting means positioning said magnet means across said end faces whereby said magnet means acts to produce a magnetic flux through said core and linking said coil thereby attracting said magnet means to said core, said magnet means further being adapted to rotate about said second mounting means whereby said magnet means is moved away from said end faces, a cam positioned to engage said magnet means, means coupling said cam to the computer gear to cause said cam to rotate at a speed proportional to the amount of gasoline pumped, said rotation of said cam acting to rotate said magnet means about said second mounting means to move said magnet means away from said core, said cam acting to disengage said magnet means after a predetermined amount of rotation whereby said disengaged magnet means rapidly returns to said position across said end faces in response to said magnetic attraction, said rapid return causing a change in the magnetic flux through said core whereby a voltage pulse is induced in said coil means, said first mounting means being further adapted to permit rotation of said core about said second mounting means whereby the kinetic energy of said magnetic means is dissipated.

4. A pulse generator, including in combination, a core of magnetic material having a first side and a second side opposite said first side, said core further having a third side with end faces thereon, said first side having an elongated hole adjacent thereto and said second side having an arm extending therefrom, housing means, a first pin coupled to said housing means and passing through said elongated hole, a second pin coupled to said housing means, said arm extending over said second pin whereby said core is positioned in said housing means by said first and second pins, coil means surrounding said core and adapted to be coupled to an external circuit, permanent magnet means having a hole therein, a third pin coupled to said housing means and passing through said magnet means hole to position said magnet means across said end faces whereby said magnet means acts to produce a magnetic flux through said core and linking said coil thereby attracting said magnet means to said core, said magnet means further being adapted to rotate about said third pin whereby said magnet means is moved away from said end faces, a cam positioned to engage said magnet means, means coupled to said cam for rotating the same whereby said magnet means is rotated about said third pin to move said magnet away from said end faces, said cam acting to disengage said magnet means after a predetermined amount of rotation whereby said disengaged magnet means rapidly returns to said position across said end faces in response to said magnetic attraction, said rapid return causing a change in the magnetic flux linking, said coil means whereby a voltage pulse is induced therein, said first pin and said elongated hole cooperating to permit rotation of said core and said magnet means about said third pin whereby the kinetic energy of said magnet means is dissipated.

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