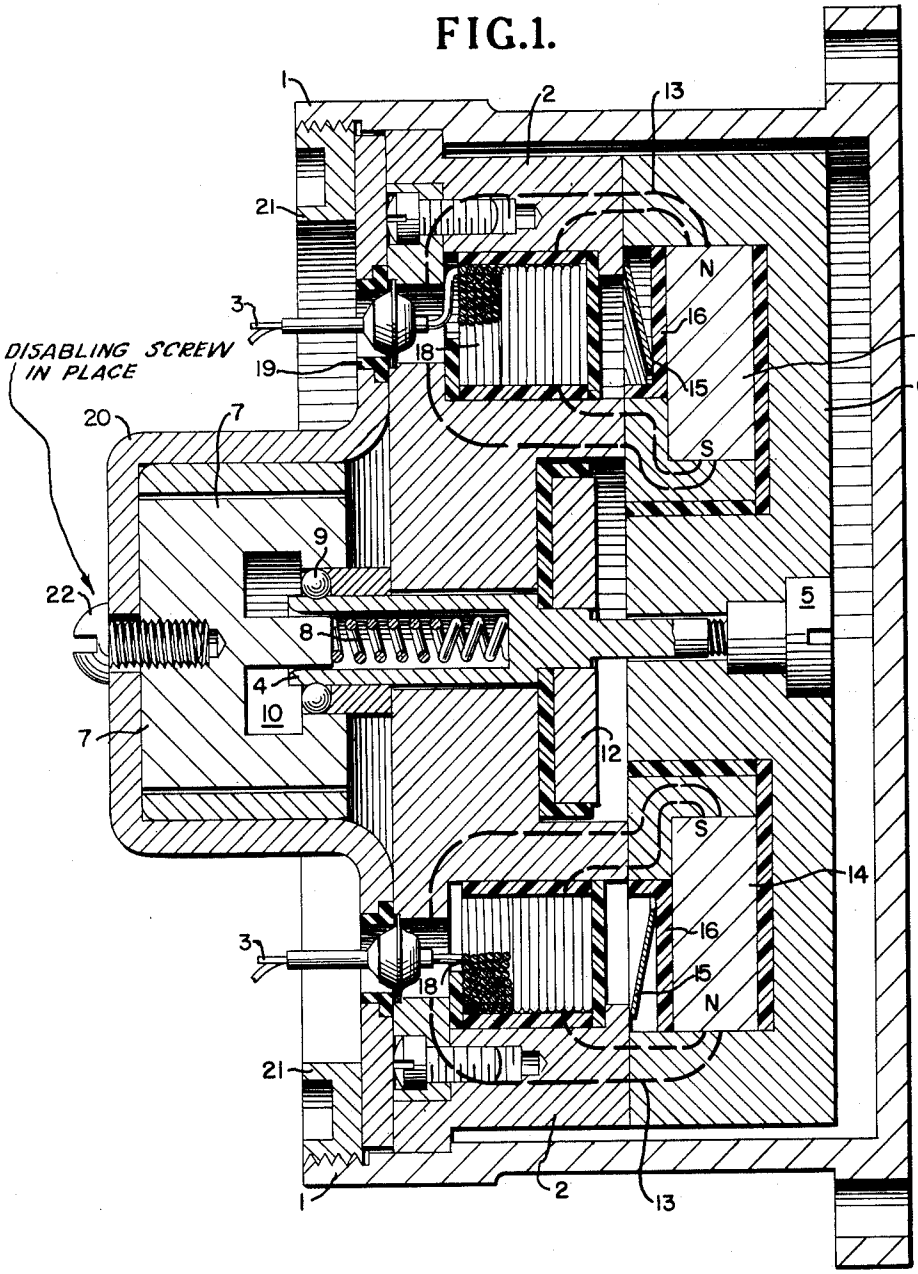
Oct. 20, 1964 E. F. BRANAGAN ETAL 3,153,735

INERTIA ELECTRO-MAGNETIC GENERATOR

Filed Dec. 14, 1959 3 Sheets-Sheet 1

FIG.1.



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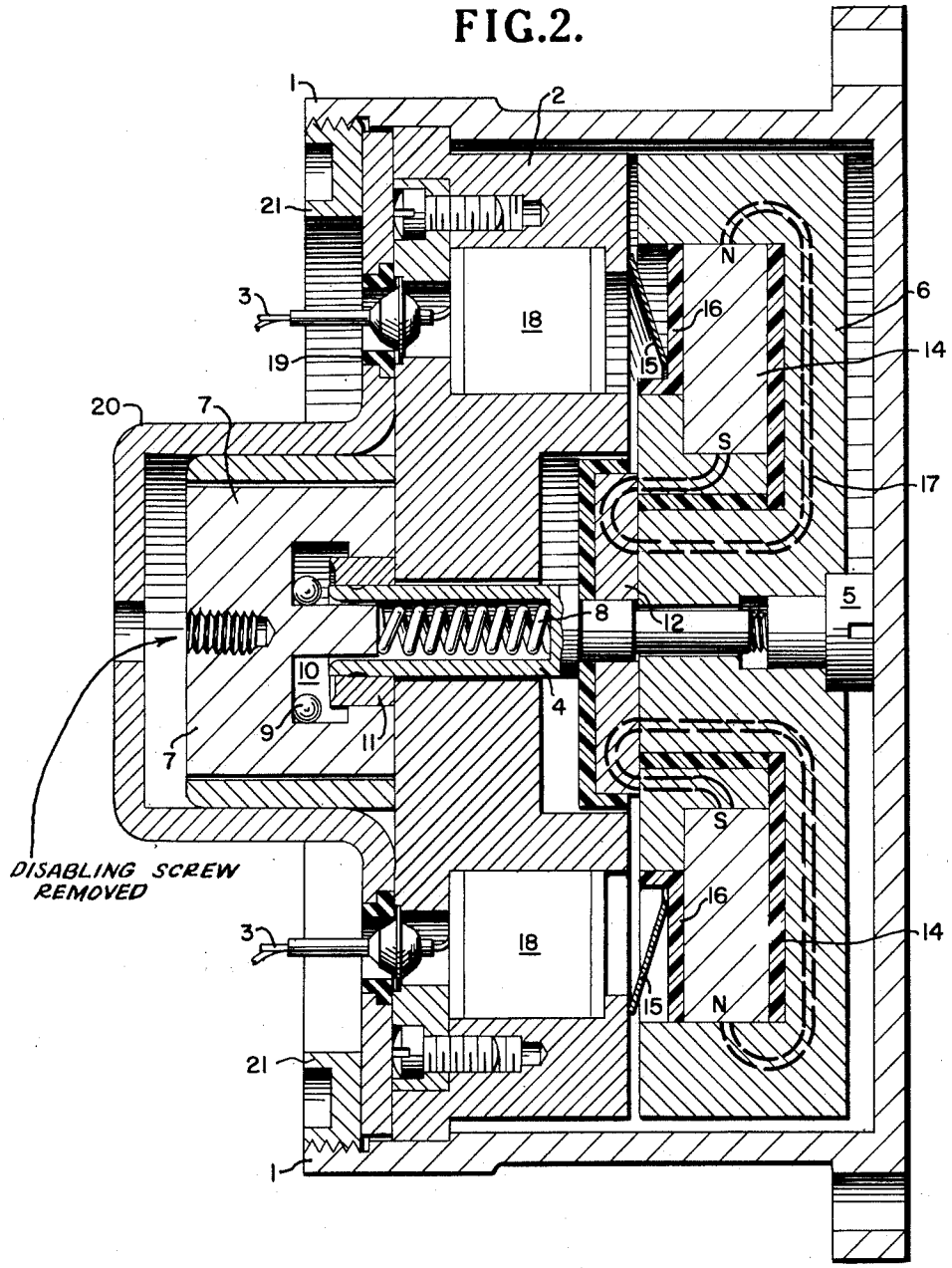
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INERTIA ELECTRO-MAGNETIC GENERATOR

Filed Dec. 14, 1959 3 Sheets-Sheet 2

FIG.2.



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INERTIA ELECTRO-MAGNETIC GENERATOR

Filed Dec. 14, 1959 3 Sheets-Sheet 3

FIG.3.

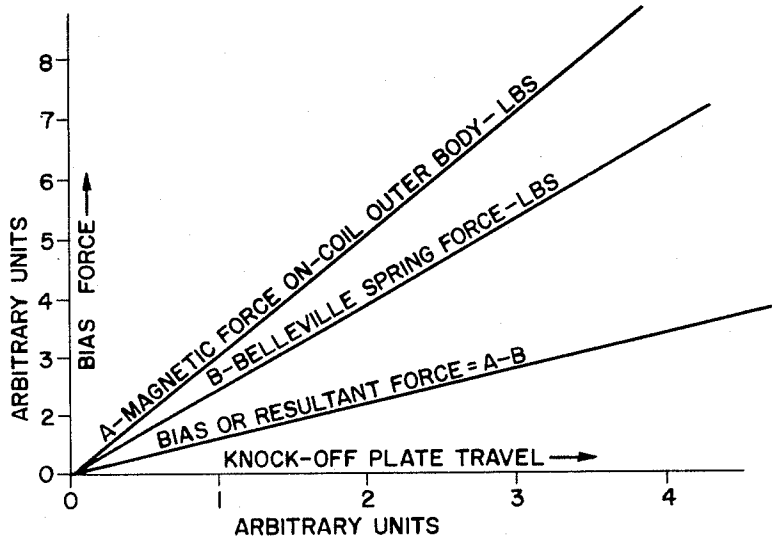
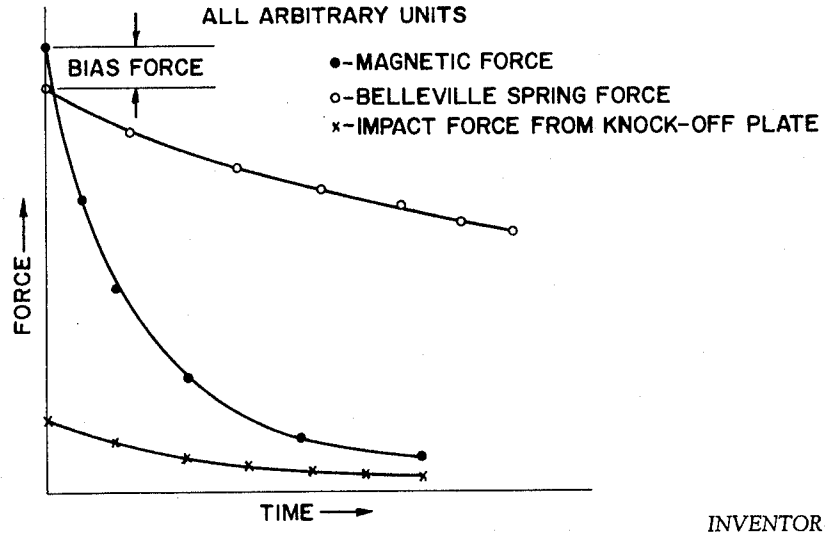


FIG.4.



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3,153,735

INERTIA ELECTRO-MAGNETIC GENERATOR

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5 Claims. (Cl. 310—15)
(Granted under Title 35, U.S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

This invention relates to a magnetic inertia actuated voltage generator. More particularly, to a magnetic inertia generator capable of delivering a large electrical voltage output due to a small mechanical force and in which the electrical output is independent of mechanical displacement of a magnetic keeper as a fuction of time.

An object of this invention is to provide a new and improved rugged but simple inertia generator that is responsive to a predeterminned force along a desired axis.

Another object of this invention is to provide an inertia generator capable of being adjustable to respond to a predetermined force.

Another object of this invention is to provide an inertia generator having a large output signal independent of the required type of impact over a wide force range.

Still another object of this invention is to provide an inertia generator having a large output voltage signal independent of mechanical displacement of the magnetic keeper as a function of time.

A further object of this invention is to provide a magnetic generator having a large output signal when the inertia weight is moved only a short distance.

A still further object of this invention is to provide a magnetic inertia generator of such a design that when the stabilizing weight responds to an initiating force suddenly applied thereto it is aided in its travel by the magnetic structure.

It is still another object of this invention to provide a simple locking mechanism to immobilize the inertia generator.

Further objects and the entire scope of the invention will be more clearly apparent from the following detailed description taken in connection with the accompanying drawings which display the general construction and operational principles of the invention. It is to be understood, however, that the drawings are furnished only by way of illustration and not in limitation thereof. It is to be further understood that like reference numerals refer to similar parts, and in which:

FIG. 1 is a sectional view of a preferred form or embodiment of this invention prior to impact with disabling screw in place;

FIG. 2 is a sectional view of the device of FIG. 1 after impact with disabling screw removed;

FIG. 3 is a graph showing the magnetic force and the Belleville spring force together with the resulting force necessary to operate the device;

FIG. 4 illustrates the operation of the several units in a graph of force versus time.

A common type magnetic inertia generator consists of a case containing a mass element movable supported by

a diaphragm of a spider so that it can move relative to the case in response to a force applied to the mass element, the extent of the movement being proportional to the magnitude of the force with regard to time. The mass element may include an armature element or pad constituting a portion of the magnetic circuit of a coil so that the inductance of the coil varies with the position of the mass element and hence with the acceleration. The coil constitutes a pick-up means, and by connecting the coil to a suitable electrical circuit the applied force can be measured. Other older methods require the mass element or a magnetic keeper to move an appreciable distance, thereby making the magnetic flux change as a function of displacement, time dependent.

The magnetic inertia generators of this variety were subject to many disadvantages. For example, it was necessary for the magnetic keeper or mass element to move a considerable distance before the magnetic flux changed appreciably. In addition, in the absence of a second magnetic path, a great number of flux lines remained around the coil and did not collapse. A further disadvantage occurred as a result of the inertia forces acting on the magnetic keeper which resulted in a flux decay which did not occur very rapidly. Since the energy from such a system is a function of time rate of decay of the magnetic field and also a function of the total number of decayed flux lines surrounding the field coil, it is apparent that a lot of energy is lost by this old technique.

Former magnetic inertia generators were also dependent upon the magnetic field to maintain the magnetic keeper in place. Vibration in the system where such designs were used often resulted in the generation of A.C. voltages which could cause serious problems in ordnance fusing systems. Either the magnetic inertia generator had to be shorted out until a few seconds before use or a mechanical locking mechanism had to be used. The first method complicated the design. The second added to the probability of failure.

The magnetic inertia generator of FIG. 1 is composed of an outside circular case 1, a circular magnetic keeper body 6 which is located in a circular raceway and moveable only along one axis. This keeper 6 is connected to rod and plate assembly 4 by a nut 5. The nut 5 is used to eliminate any free play in the plunger release mechanism after the magnetic keeper 6 is in place. This arrangement allows the keeper to be kept secure against accidental removal and vibration until the mechanism is intentionally armed by a force acting on inertia weight 7 for a required time. The time for actuation or movement of inertia weight 7 is directly dependent on the spring constant of member 8. The keeper is also magnetically held against the outer coil body 2 by a doughnut shaped permanent magnet 14 substantially as shown located in the body of the keeper. This magnet provides a flux path 13 initially around and through the coil winding 8 located in coil body 2. A Belleville washer 15 of nearly equal force as the force of attraction of the magnetic field 13, is insulated substantially as shown between the magnetic keeper 6 and the coil body 2, the purpose of which will be more clearly apparent as the description proceeds.

The coil body 2 and cover 20 are rigidly connected inside the case 1 by a cover ring 21.

The coil body has a doughnut shaped coil 18 recessed therein. The coil connector leads 3 extend through the cover and are protected by a feed through insulator 19. The rod assembly extends through the center of the coil body with the knock off plate 12 recessed in the body near the magnetic keeper. The rod 4 extends thru the coil body 2 to the cover side of coil body where the inertia weight 7 and rod 4 are held in position by a spring 8 and locking balls 9. Screw 22 attaches the inertia weight to cover 20 so that the generator will be unable to operate until the screw is removed.

The operation of the generator will now be described with particular reference to FIGS. 1 and 2.

As a force is applied to the rear of case 1, shown to the right of the drawings, the weight 7 starts to move to the rear of the casing compressing spring member 8. As the weight continues to move rearwardly, the locking balls 9, which are held in place by bushing 11, weight 7 and rod 4 are released into the recessed portion of weight 10 thereby releasing and forcing the rod 4 and the insulated knockoff plate 12 assembly to the rear making contact with the magnetic keeper 6. The magnetic keeper 6 is magnetically held in place against the outer body 2 by the magnetic field 13 of the doughnut shaped permanent magnet 14. The force of the magnetic field is somewhat offset by the Belleville washers 15. As the knockoff plate 12 hits the magnetic keeper the lines of flux immediately are switched to path 17 of FIG. 2 because it presents a path of least reluctance. Therefore, as the knockoff plate and magnetic keeper make contact, the magnetic force between keeper 6 and coil body 2 rapidly decreases thereby allowing the Belleville washers to snap to their original position and suddenly impart an additional thrust rearwardly to the magnetic keeper.

As the flux lines and flux path 13 collapse from maximum to 0, a high voltage is induced in the coils 18 which is fed into a load device, not shown by the coil connectors 3 disposed within insulators 19 in the cover plate 20.

In order to insure that the inertia generator will not operate prematurely a locking screw 22 is utilized to hold the initial weight 7 to the cover member 20. Removal of the screw will arm the generator for immediate use.

From the foregoing it will be clearly apparent that this inertia magnetic generator provides a unique mechanism for obtaining a high voltage signal from a small initiating force.

In order to actuate this inertia generator the system must experience the arming force for the required time and direction. The energy obtained from the arming force is used to trigger or remove the magnetic keeper 6 from the coil outer body 2.

The knock off plate assembly approaches the base of the magnetic keeper 6 in such a manner as to obtain a considerable kinetic energy from the magnetic field upon being established through paths 17 as shown in FIG. 2. This means that even though the blocking mechanism were designed to operate on small accelerating or decelerating forces it would have more than sufficient energy to remove the magnetic keeper, which requires an arbitrary bias force as shown in FIG. 3. This feature allows a wide range in designing of the spring mass system which is used by the unlocking mechanism, as well as the wide range and force characteristics of the Belleville washer.

The magnetic keeper is removed by an impact, or a rapidly applied force, from knock off plate 12 at the instant the maximum flux is established in path 17 at the time of impact as more fully shown in FIG. 2, the relative force characteristics being disclosed in FIG. 4. This allows the flux lines 13, of FIG. 1, to collapse rapidly from around coil 18 and to be reestablished as flux lines 17, of FIG. 2, at the instant of impact of the knock off plate against the magnetic keeper. This means that the voltage generated by the coil 18 is substantially a function of the electrical and magnetic parameters.

The permanent magnet 14 for holding the magnetic keeper against the coil outer body may be of any well-known types such as Alnico V, Bismanol, as is well known in the art.

The mechanical bias which is used to offset the magnetic force of the permanent magnets, is a Belleville washer. The Belleville washer allows a maximum force-to-distance ratio at the time of impact by the knock off plate 12. At the instant of impact the magnetic force holding the magnetic keeper against the face of the outer coil body is shunted from path 13 to path 17 giving a resultant force characteristic as shown in FIG. 4.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. A magnetic inertia actuated voltage generator comprising a casing means for completely housing the inertia generator, a coil body means fixedly positioned in said casing means for providing a first low reluctance flux path, a coil winding recessed in said coil body means in the low reluctance path, a movable rod means passing medially through said coil body means, said rod having an inertia weight on one end for actuating said rod means upon a first impact and a knock off plate on the other end for providing a second impact force and simultaneously creating a second low reluctance magnetic path after the first impact, a magnetic means normally attached to said coil body means for generating a magnetic force including the lines of flux passing through the first low reluctance path in said coil body means whereby in response to a predetermined first impact force the inertia weight of said rod means moves the knock off plate against the magnetic means to complete the second low reluctance magnetic path and shunt the flux lines of the magnetic force from said first path causing the magnetic means to be released and moved into a spaced relation with said body means and a high voltage signal induced in the coil winding.

2. A magnetic inertia actuated voltage generator comprising a casing means for enclosing the generator, a coil body means located in said casing for providing a low reluctance path for lines of flux, a coil winding means located in said body means in the path of the flux lines and responsive to a change of the flux lines, a magnetic means normally attached to said body means for generating a magnetic field with lines of flux having a first path through said coil body means, a rod means medially passing through said coil body means having an inertia responsive locking device on one end for unlocking the rod means for movement upon impact and a knock off plate on the other end for making contact with said magnetic means and moving it in a space relation with said coil body means and completing a second low reluctance path for the lines of flux whereby the flux lines normally passing through the coil winding means is suddenly reduced to zero and a large voltage signal is induced into said coil winding.

3. In a magnetic inertia actuated voltage generator as recited in claim 2 wherein the coil body means comprises a cylindrical steel core having a medially located aperture and recess therein, a doughnut shaped coil winding means recessed in said core, said coil winding means having connecting means for establishing an external electrical connection to a load device, said coil winding means being responsive to a change of the flux of said field thereby energizing said load device.

4. A magnetic inertia generator according to claim 2 wherein the magnetic means comprises a cylindrical steel core with a doughnut shape permanent magnet assembly recessed in a magnetic keeper, the said permanent magnet assembly having non-magnetic material on two sides

so that the magnetic field has a high reluctance path except when shunted by said coil body means or knock off plate means, insulated biasing means including a Belleville washer located in the recess with the said permanent magnet and having a biasing force of slightly less magnitude than said magnetic field such that when the knock off plate makes contact with the magnetic keeper thereby shunting the magnetic force between said magnetic keeper means and said coil body means below the biasing force of said biasing means the magnetic keeper is accelerated to a spaced relationship with said coil body means.

5. A magnetic inertia actuated voltage generator comprising a first member and a second member, coil means carried by said first member, magnet means carried by said second member, said second member initially being in contact with said first member for causing most of the lines of magnetic flux from said magnetic means to pass through said coil means, spring means urging said members apart, said magnet means being magnetically

attracted to said first member for holding said first and second members in contact, said second member being responsive to an impact force for moving out of contact from said first member, plate means initially spaced from said second member and responsive to an impact force for moving into contact therewith for causing most of said lines of magnetic flux to pass through said second member and thereby by-pass said coil means; whereby a suitable impact force in concert with the urging of said spring means and plate means overcomes said magnetic attraction and moves said members out of contact, movement of said plate means into contact with said second member causing the number of lines of magnetic flux passing through said coil means to change rapidly for generating a voltage therein.

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