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GB 1590368
Report of R. C. Barker and J. H. Liaw "Some Properties of Wiegand Wire Under Asymmetrical Sine Wave Drive" Dept. of Engineering and Applied Science Yale University 28th February 1977
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(54) Pulse Generator

(57) A pulse generator contains a Weigand wire 1 at the location of an alternating magnetic field, whereby its direction of magnetisation is changed abruptly and continuously. The abrupt change in magnetisation direction leads to an electrical pulse voltage between the extremities of the Weigand wire 1, which voltage is tapped galvanically at said extremities, and, where necessary, is amplified. Arrangements for producing alternating magnetic fields are described including those employed with the integrated amplifier circuits of Fig. 1, and Fig. 2, (not shown).

Fig. 1

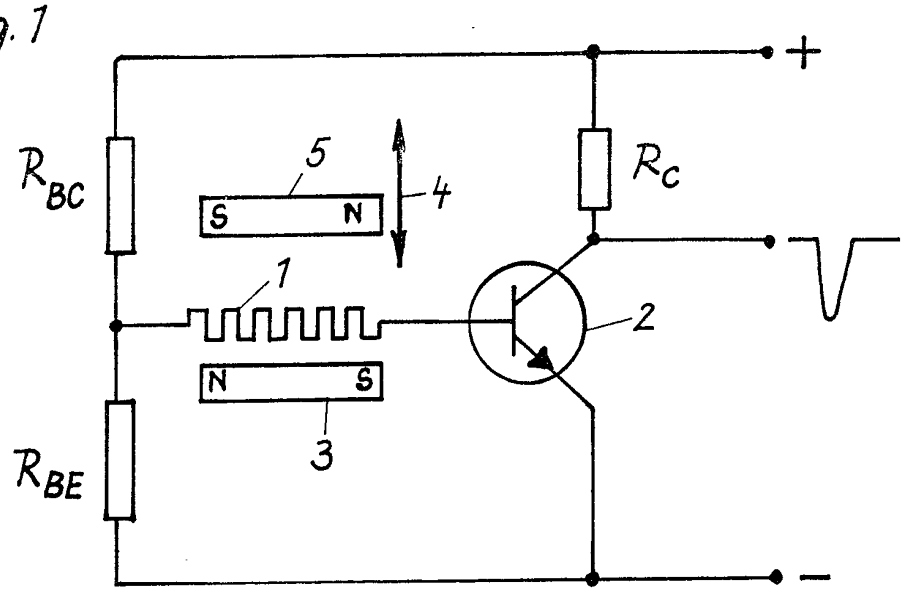

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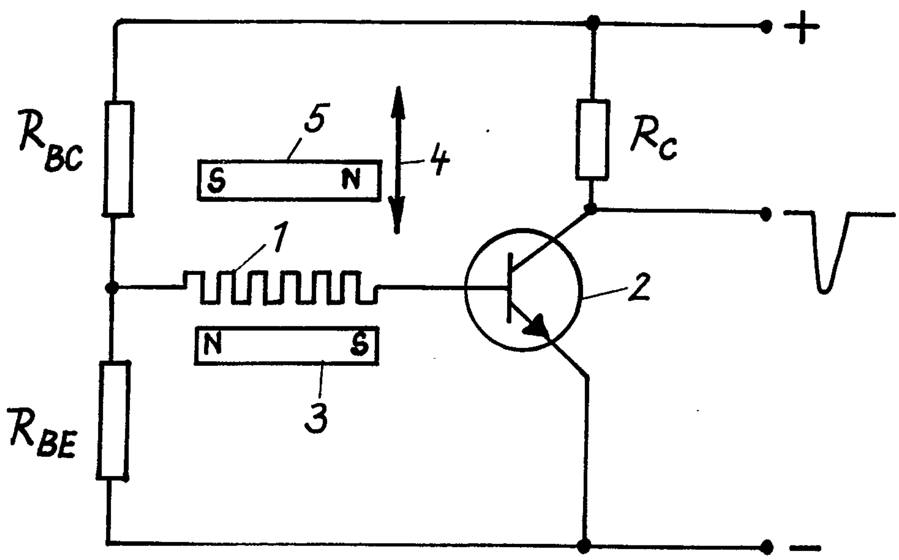
Fig. 1



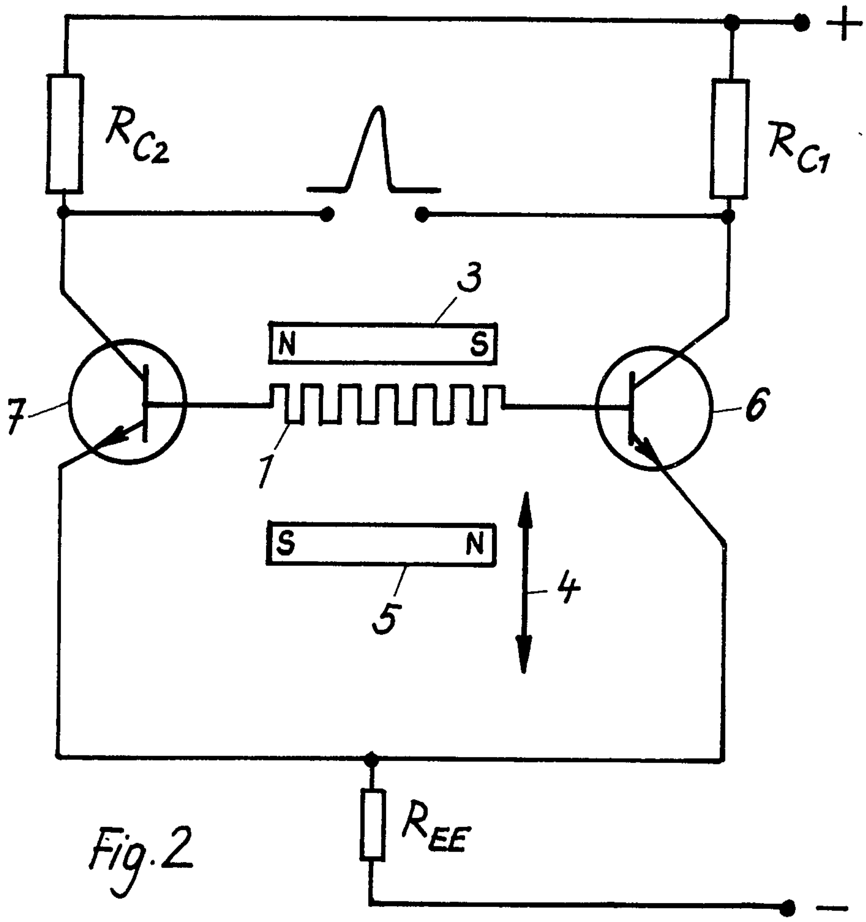


Fig. 2

SPECIFICATION

Pulse Generator

The invention relates to a pulse generator.

Wiegand wires are composed of homogeneous, ferromagnetic wires (e.g. of an alloy of iron and nickel, preferably 48% iron and 52% nickel, or of an alloy of iron and cobalt, or of an alloy of iron with cobalt and nickel, or of an alloy of cobalt with iron and vanadium, preferably 52% cobalt, 38% iron and 10% vanadium), which due to a particular kind of mechanical and heat treatment, possess a soft magnetic core and a hard magnetic shell, i.e. the shell possesses a higher coercive force than the core. The construction and manufacture of Wiegand wires are described in DE—OS 2, 143, 326. In the course of the process of manufacture, the wires are twisted, thus imparting to them their characteristic spiral texture, which is also revealed in the spiral course of their magnetisation. Typical Wiegand wires are 5mm to 50mm long, preferably between 20mm and 30mm. If a Wiegand wire, in which the direction of magnetisation of the soft magnetic core is the same as that of the hard magnetic shell, is introduced into an external magnetic field, the direction of which coincides with the direction of the wire-axis, but is opposite to the magnetisation direction of the Wiegand wire, on exceeding a field strength of appx. 16 A/cm, the magnetisation direction of the soft core of the Wiegand wire is reversed. This reversal is also referred to as "resetting". On further reversal of the direction of the external magnetic field, the direction of magnetisation of the core is again reversed when a critical field strength of the external magnetic field is exceeded, so that the magnetisation of the core and of the shell are again parallel. This reversal of the magnetisation direction occurs very rapidly and is accompanied by a correspondingly pronounced change in the magnetic flux per time-unit (Wiegand effect). This change in magnetic flux can induce in an induction coil a very short and very high voltage pulse (according to the number of turns and the load resistance of the induction coil, up to appx. 12v).

A pulse is also produced in an induction coil by resetting of the core, albeit of much lower amplitude and of reversed sign, as compared with the case of reversal from anti-parallel to parallel direction of magnetisation.

If an alternating field is selected as external magnetic field, which is capable of reversing the magnetisation, firstly of the core, and then of the shell, and of bringing these in each case to magnetic saturation, due to reversal of the magnetisation direction of the soft magnetic core, Wiegand pulses occur, with alternately positive and negative polarity, which is termed symmetrical excitation of the Wiegand wire. For this purpose, field strengths of appx. −(80 to 120 A/cm) to +(80 to 120 A/cm) are required. The reversal of magnetisation of the shell also occurs abruptly and likewise produces a pulse in the induction coil, but this pulse is much smaller than that induced by reversal of the core, so that it is generally not evaluated.

If, However, as external magnetic field, a field is chosen which is capable of reversing the magnetisation direction only of the soft core but not of the hard shell, the high Wiegand pulses occur only with constant polarity, which is referred to as asymmetrical excitation of the Wiegand wire. For this purpose, a field strength is required in one direction of at least 16 A/cm (for the resetting of the Wiegand wire), and, in the reverse direction, a field strength of appx. 80 to 120 A/cm.

It is characteristic of the Wiegand effect that the pulses produced thereby are, in amplitude and width, largely independent of the speed of change of the external magnetic field, and show a high signal-to-noise ratio.

A pulse generator having the features of the pre-characterising portion of claim 1 is known from DE—OS 2,157,286. In the case of this previously proposed pulse generator, bare Wiegand wires are moved firstly, in cycles, past a resetting magnet which resets them magnetically, and then past a reading head in which is situated a magnet which is of opposite magnetisation to the resetting magnet and releases in the Wiegand wire the characteristic Wiegand pulse, which produces a voltage pulse in an electrical winding in the reading head.

It has also previously been proposed that the electrical winding, in which the electrical pulse is produced, is located, not near, but directly upon the Wiegand wire whereby a close magnetic coupling is obtained between the Wiegand wire and the winding, thus forming a very compact module. With such a module, comprising a Wiegand wire with a winding mounted thereon, a pulse generator can be constructed, in which cyclically one after the other, two magnets of opposite polarity are moved past the module and excite the Wiegand wire symmetrically or asymmetrically.

According to a proposal not previously made known, a pulse generator can be formed employing a Wiegand wire. For this purpose, two windings are mounted on a Wiegand wire, one of which is supplied with an alternating current which creates a magnetic alternating field which excites the Wiegand wire symmetrically or asymmetrically, whilst the second winding is intended to receive the Wiegand pulses.

A common feature of all three variants described is that the electrical voltage pulse is produced in an electrical winding. This has the advantage that, according to the number of turns and the load-resistance, the voltage pulse is of such a magnitude that it can be further employed in many arrangements without further amplification. In the case of DE—OS 2,157,286, there is however the disadvantage that the pulse generator is relative large; on the other hand, a module, in which one or even two windings are mounted on a Wiegand wire, is very difficult to manufacture. This is evident when one considers that a typical Wiegand module consists, for example, of a Wiegand wire 15mm long, on which a winding with six layers and 1300 turns is mounted, and that the external diameter of the complete module is only 1mm.

Accordingly, an object of the present invention is to provide a simplified and very compact pulse generator.

According to the present invention there is provided a pulse generator for the production of electrical voltage pulses which can be tapped galvanically at the output of the pulse generator, employing a Wiegand wire and with means for producing an alternating magnetic field at the position of the Wiegand wire, characterized in that the galvanic tapping point for the electrical voltage pulses is provided at the extremities of the Wiegand wire.

The present invention utilizes the discovery, proposed but hitherto not put into practice, that, due to the spiral shaped course of magnetisation in the Wiegand wire, when a Wiegand wire is excited, an electrical pulse voltage is produced between its extremities, which is admittedly very much smaller than the pulse voltage which can be obtained in a winding mounted on the Wiegand wire (Report of R. C. Barker and J. H. Liaw "Some properties of Wiegand wire under asymmetrical sine wave drive", Department of Engineering and Applied Science, Yale University, 28th February, 1977). In the present state of amplification technology, it is, however, in many cases simpler, more convenient and less expensive to amplify a signal of low amplitude electrically, than to employ other measures (here, the use of a winding to produce a pulse voltage) in order to obtain a high origin signal. In the present case, the winding on the Wiegand wire to receive the Wiegand pulses, which is so difficult to manufacture, can be dispensed with. It can be replaced, if required, by a pulse-amplifier circuit, which amplifies electronically the pulse voltage tapped at the extremities of the Wiegand wire. In this case, due to the smallness of the Wiegand wire, it would be possible to integrate it as a component into the pulse-amplifier circuit, e.g. solder it on to a conductor plate. The possibility also exist of producing the pulse-amplifier circuit as a module, with integrated structure, into which the Wiegand wire is integrated, e.g. attached to a silicon carrier. In this way, a vary compact and reliable module is obtained.

A module of this kind can be excited in a variety of ways for pulse-production. The excitation may be effected, for example, by moving two bar-magnets of opposite polarity, alternately and periodically, towards the module with the Wiegand wire. In order to do so, the module may be attached, for example, to the periphery of a rotor and moved past the two stationary bar-magnets in turn, or the two-bar-magnets may be attached to a rotor and move past the stationary module with Wiegand wire.

It is also possible to have one of two bar-magnets of opposite polarity stationary with the Wiegand wire, e.g. in the module, whilst the other is displaceable relative to the Wiegand wire. In this case, the displaceable magnet must be of such a strength that, when it is moved towards the Wiegand wire, it dominates the magnetic field of the stationary magnet so strongly that the resulting magnetic field has at least sufficient power to reset the Wiegand wire magnetically (It must therefore have a field strength, at the position of the Wiegand wire, of at least appx. 16 A/cm).

Instead of a movable arrangement of permanent magnets, it is possible, of course, for the permanent magnets to be stationary relative to the Wiegand wire, and instead to vary the field strength at the position of the Wiegand wire by moving ferromagnetic components towards or away from the permanent magnet(s), whereby the magnetic field of one or other permanent magnet is either strengthened or weakened at the position of the Wiegand wire.

Instead of employing permanent magnets, the Wiegand wire may also be excited by electro-magnets. The simplest arrangement is a winding supplied with alternating current, which is coupled with the Wiegand wire magnetically and produces at the position of the Wiegand wire, a magnetic alternating field which is able to excite the Wiegand wire symmetrically or asymmetrically. An exciter winding of this kind is placed with advantage near the Wiegand wire and may also be integrated into the module of a pulse-amplifier circuit. It may also be placed around the Wiegand wire; in this case, as compared with the known arrangement of two windings on the Wiegand wire, i.e. and exciter winding and a receiver winding, there is also the advantage that the difficult receiver winding is not longer required.

The switch according to the invention may be employed in all cases where pulses are required with a half-value width of appx. 20μs, for example in keyboards, as a magnetic proximity switch, for the firing of thyristors, etc.

Embodiments of the present invention will now be described, by way of example with reference to the accompanying diagrammatic drawings in which:—

Figure 1 illustrates a first embodiment of the present invention; and

Figure 2 illustrates a second embodiment of the present invention.

In Figure 1, a Wiegand wire 1 is shown in place of an ohmic resistance and is integrated into a transistor amplifier comprising a n-p-n transistor 2 in emitter basic circuit, a collector resistance R_c, a resistance R_{BC} in the base collector circuit, and a resistance R_{BE} in the base emitter circuit. The Wiegand wire 1 is placed before the base of the transistor 2. Parallel to and in proximity to the Wiegand wire 1 lies a stationary permanent bar-magnet 3, and a second stationary permanent bar-magnet 5 which is displaceable to-and-fro in the direction of the arrow 4, but which is of opposite magnetisation. As the magnet 5 is moved away from the Wiegand wire 1, the magnet 4 resets the Wiegand wire 1, and when the magnet 5 is moved back again towards the Wiegand wire 1, within a predetermined distance, the magnetic field of the magnet 5, at the position of the Wiegand wire 1, dominates that of the magnet 4 to such an extent that the direction of magnetisation of the soft core of the Wiegand wire 1 is reversed, whereby a characteristic Wiegand pulse is produced which is manifested in a voltage pulse at the extremities of the Wiegand wire 1. This voltage pulse reaches the base of the transistor 2 as an input signal. The amplified output signal appears at the collector.

Figure 2 shows a Wiegand wire 1, which, as in the embodiment of Figure 1, is excited asymmetrically by a stationary and a movable bar-magnet 3 and 5 respectively. The Wiegand wire 1 is integrated into an amplifier circuit comprising two transistors 6 and 7 coupled in emitter basic circuit, the base of each of which is connected by the Wiegand wire 1 and which possess the common emitter resistance R_{EE} and the collector resistances R_{C1} and R_{C2}. The impulse voltage produced by the Wiegand pulse at the extremities of the Wiegand wire 1, reaches the base of the two transistors 6 and 7 as in input signal. The amplified output signal can be tapped at the collectors.

Claims

1. A pulse generator for the production of electrical voltage pulses which can be tapped galvanically at the output of the pulse generator, employing a Wiegand wire and with means for producing an alternating magnetic field at the position of the Wiegand wire, in which the galvanic tapping point for the electrical voltage pulses is provided at the extremities of the Wiegand wire.

2. A pulse generator according to claim 1, in which the extremities of the Wiegand wire are connected to the input of an electronic pulse-amplifier circuit.

3. A pulse generator according to claim 2 in which the Wiegand wire is integrated into the pulse-amplifier circuit.

4. A pulse generator according to claim 3, in which the pulse-amplifier circuit is a module produced with integrated structure.

5. A pulse generator according to any one of the foregoing claims, in which a permanent magnet or magnets displaceable relative to the Wiegand wire, are provided for excitation of said Wiegand wire.

6. A pulse generator according to any one of claims 1 to 4, in which, for excitation of the Wiegand wire, a winding is provided which is connectable to a source of alternating current.

7. A pulse generator according to claim 6, in which the winding is positioned in proximity to the Wiegand wire.

8. A pulse generator substantially as hereinbefore described with reference to Figure 1 or Figure 2 of the accompanying drawing.

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