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E. VON LEPEL

1,776,172

ELECTRIC SINGLE STROKE RELAY ESPECIALLY FOR IGNITION CIRCUITS

Filed Dec. 14, 1926

2 Sheets-Sheet 1

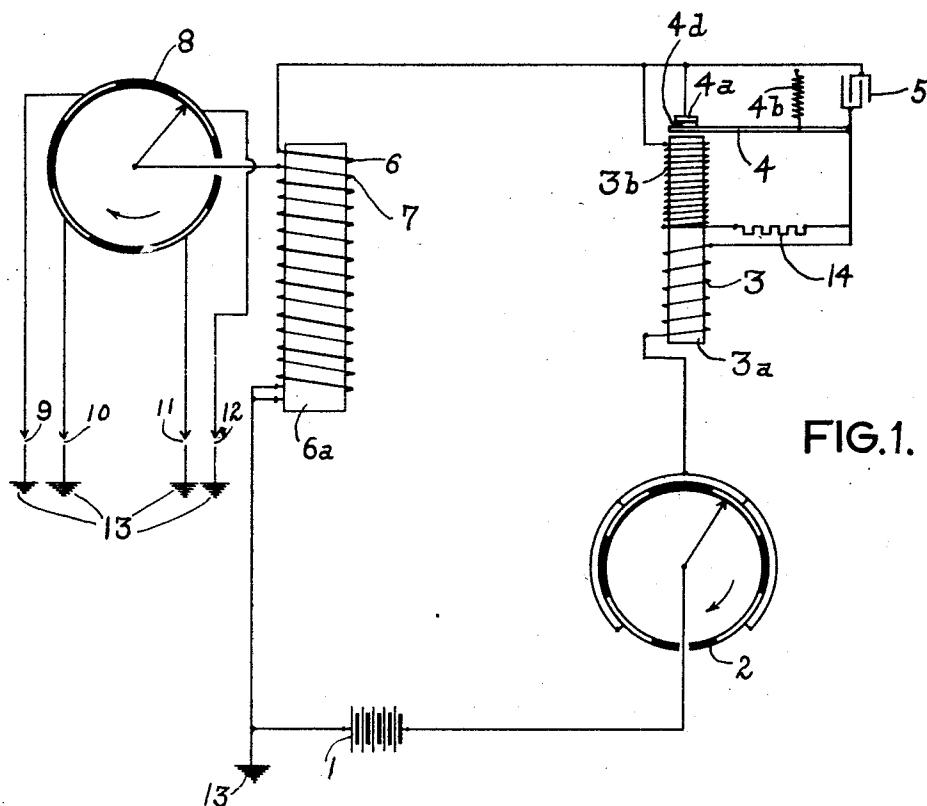


FIG. 1.

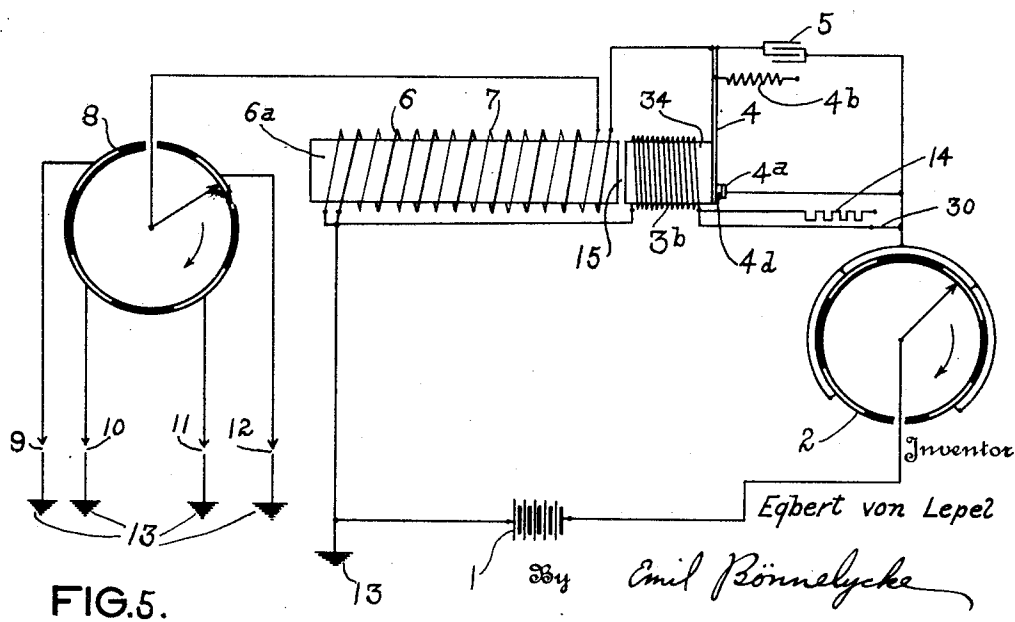


FIG. 5.

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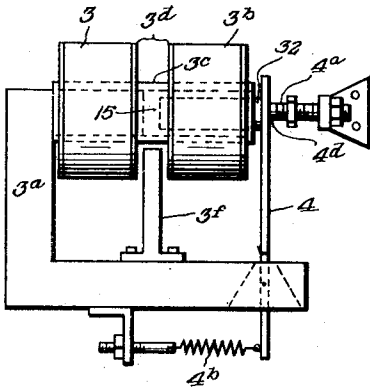


Fig. 2.

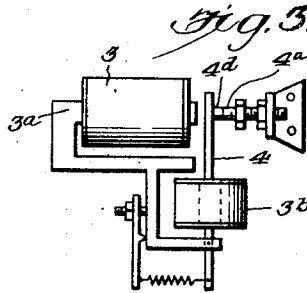


Fig. 3.

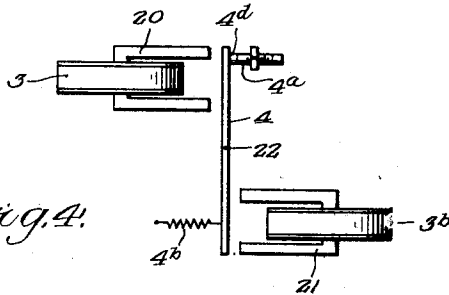


Fig. 4.

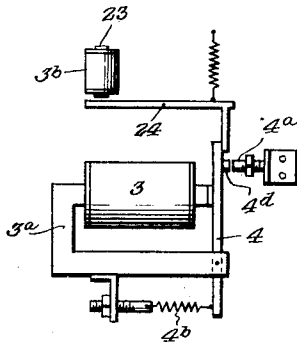


Fig. 6.

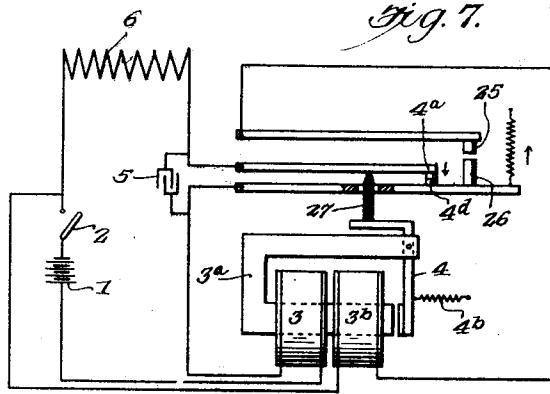


Fig. 7.

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UNITED STATES PATENT OFFICE

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ELECTRIC SINGLE-STROKE RELAY ESPECIALLY FOR IGNITION CIRCUITS

Application filed December 14, 1926. Serial No. 154,835.

While so called electric single stroke relays have been known in the United States in the art of motor ignition, at least since 1905 in U. S. Patent No. 800,625 of October 3, 1905, their operation is known to suffer a certain undesirable retard which hinders their general use where conditions require a high rate of very short makes and breaks and in circuits where alternately D. C. and A. C. current is supplied or where very pronounced fluctuations of the voltage may occur.

The object of my present invention is to remedy this weak point in the functioning of this type of electric relay so as to allow its general use for any speed, and any voltage within wide limits and without differences in its functioning whether D. C. or A. C. current is supplied to the circuit in which the relay has to function.

Referring to the drawing in which like reference characters indicate corresponding parts throughout:

Figure 1 is a circuit diagram of an ignition circuit,

Fig. 2 is a side view of a relay,

Fig. 3 is a side view of a modified form of relay,

Fig. 4 is a side view of a further modified form of relay,

Fig. 5 is a circuit diagram showing the application of loose coupling in an ignition circuit,

Fig. 6 is a side view of a still further modified form of relay, and

Fig. 7 is a side view of another form of relay.

To clearly illustrate what types of relays are referred to by the name of single stroke relays a general scheme of such device as is used in connection with motor ignition is represented in Fig. 1 with the exception of the resistance 14 in place of which an ordinary wire is used. In this circuit 1 represents the source of current, 2 a switch for instance a timer, 3 the main or pulling coil of a relay, 3^a the iron core of the relay, 4 a vibratory hammer or armature, 4^b a spring for the armature, 4^a and 4^d are the contact points actuated by the armature 4, 5 is a quenching condenser, and 3^b represents a coil,

the function of which is to maintain the magnetism created by the pulling coil 3 in the iron core 3^a and to thus hold the armature 4 after the pulling coil 3 has attracted it. This coil 3^b is therefore called the holding coil and it is connected to the contact points 4^a and 4^d. 6 represents the primary winding of a spark coil, 7 is its secondary winding, 8 indicates a high tension distributor, 9, 10, 11 and 12 are the spark plugs, and 13 are ground connections. As far as the relay is concerned, the holding coil and pulling coil may be referred to as a holding circuit and a pulling circuit.

While this device without the holding coil 3^b would act as a regular buzzer as long as the timer 2 closes the circuit, the coil 3^b prevents the armature 4 from vibrating more than once at each closing of the timer 2.

Such relays carrying two coils 3 and 3^b on the same iron core 3^a represent a small transformer and the coil 3^b being short circuited either through the contact points 4^a and 4^d or, when those are open, through the condenser 5, induced currents will flow in the coil 3^b at every variation of flux in the iron core. As the two coils 3 and 3^b are very closely coupled to one another and their inductance being large in respect to their resistance, these induced currents strongly retard the magnetic effect with respect to the magnetizing current. In fact, what upsets the general utility of such relays is nothing but the retarding effect of those induced currents upon the magnetism, and the closer the coils are coupled with one another, and the greater the proportion of inductance to ohmic resistance is made, the worse these relays will follow in high speed or under conditions where the voltage varies strongly or where alternately D. C. or A. C. voltage is supplied.

All the relays that have been used for instance in motor ignition in the past, show as a feature a common iron core on which both coils are wound either side by side or even less effectively, one covering the other. The number of turns on the pulling coil is made large to force the flux through the core against the retarding effect of the holding

coil. The holding coil will always be found to have a great self induction which is not at all counterbalanced by any sufficient ohmic resistance. Therefore it is no wonder that single stroke relays have disappeared from the market in motor ignition and have never been utilized, for instance, in Ford motors, where the required speed of functioning would not be prohibitive, but where battery and magneto feeding current are provided for alternate use and where the voltage of the flywheel magneto varies between less than 4 volts and more than 30 volts while the number of cycles per second varies between less than 30 and more than 500 while the battery furnishes 6 volts.

The disappearance of such single stroke relays from the market indicates that their weak points described have not heretofore been properly dealt with.

The means to render single stroke relays serviceable for all purposes according to my present application, consists of two steps which may be utilized each by itself or both jointly.

The one step is to increase the ohmic resistance of the holding circuit so far as to counterbalance the inductance of the holding coil by inserting the proper amount of ohmic resistance necessary to suppress completely or practically completely the wattless component of the induced current.

This increased ohmic resistance may be inserted anywhere in the holding circuit as an additional resistance unit or an adjustable rheostat. Where the coil is wound with copper wire the amount of ohmic resistance necessary to obtain the desired result may vary between, for instance, a few ohms and 200 ohms according to the ratio of inductance and resistance present in the coil.

The resistance may be embodied in the coil itself by using a metal wire of higher resistance, for instance, brass instead of copper wire, or furthermore, by producing a winding which incorporates an unusual length of wire for the inductance required.

The more the wattless component is suppressed, the quicker will be the function of the relay with respect to the pulling or main current.

A very slight amount of retardation of the magnetic flux can however be useful in order to obtain a certain duration of contact time after the closing of the main switch or timer, thus making it unnecessary to use a spring setting for one of the contact points 4^a or 4^b.

The other step to eliminate the objectionable wattless component in accordance with my invention, consists in reducing the coupling of the pulling and holding coil to one another to zero or to the very small degree that may be useful. This latter degree of coupling will always be less than for instance a 50% coupling, and in most cases the degree

of coupling should be even below 25%, which means that not more than an amount of between 50% and zero of all flux lines generated by the one coil should be permitted to act inductively upon the other coil.

There are instances where the joint application of both the said means, that is ohmic resistance and loose coupling will give the best results.

In Fig. 1, according to this invention, the additional ohmic resistance 14 is inserted in the holding coil circuit. It is understood, of course, that this step of properly counterbalancing the inductance can be usefully applied to electric vibrators of any design having at least one pulling and one holding coil and being connected with any other type of main circuit.

Figs. 2, 3 and 4 show several modifications of many possible ways of designing a single stroke vibrator incorporating the principle of loose coupling according to the present application.

In Fig. 2 both the coils 3 and 3^b are wound side by side on a common support 3^c but spaced a certain distance 3^d away from one another. The pulling coil 3 covers only the stationary iron core 3^a while the armature 4 plunges into the holding coil 3^b by means of member 32. The air slot 15 between the stator and the armature iron 32 is large enough with respect to the two sectional areas of the cores to secure loose coupling and in addition a bridge of iron 3ⁱ may be used to aid in preventing most of the stator flux from penetrating to far into the plunger of the armature 4.

Fig. 3 shows substantially the same constructional principle. One of the coils for instance 3 magnetizes the stator 3^a and the other one 3^b the armature 4 but the flux common to both is still further reduced and the space between the coils is wider than illustrated in Fig. 3.

In Fig. 4 an arrangement is shown which incorporates two independent stationary electromagnets 20 and 21 the one carrying the holding coil 3^b and the other one the pulling coil 3. Both these electromagnets act upon the vibrating armature 4 which is supported on shaft 22.

It is obvious that a great number of various designs can be utilized for the application of my principle of loose coupling. In Fig. 5 for instance is shown a spark coil 6^a, 6 and 7 of the well known vibrator or buzzer type, adapted with a holding coil in reduced coupling. It will be noticed that the holding coil 3^b does not cover the core of the spark coil 6^a and that the armature 4 is equipped with a plunger upon which the holding coil 3^b acts. This iron plunger 34 is separated from the core 6^a by an air space 15. This circuit shows one of the many ways for combining a spark coil and a single stroke relay

with loose coupling into one unit thus substituting the pulling field by the field of the spark coil. An ohmic resistance 14 may also be inserted in the circuit of the holding circuit which may for instance be switched in by means of a switch 30.

It is a known fact that the greatest disadvantage adherent to electrical single stroke relays in motor ignition is that the lapse of time which occurs between the closing of the timer and the breaking of the circuit by the relay is not constantly the same at different motor speeds and at different voltages of the current supplied. While the retard angle increases with increasing motor speed it decreases with increasing voltage.

Therefore when a source of current, producing an increased voltage at increasing speed is used in combination with a relay designed in accordance with my present invention, the variation in the degree of the retard angle will be completely eliminated, it being immaterial whether the current supplied is of D. C. or A. C. voltage. This latter circumstance prevails for instance in Ford motors.

The advantages on the other hand obtained by the use of my single stroke breaker instead of a buzzer type are that the contact points will be much less abused and that no breaking spark will occur at the rotary sliding timer, while it is impossible to obtain this result with a single stroke relay of any other of the known types.

Figs. 6 and 7 represent two additional ways for incorporating the principle of avoiding induction between the pulling and holding coils into a high speed single stroke relay, the performance of which will be unaffected by the type of voltage supplied.

In Fig. 6 the pulling coil 3 and the holding coil 3^b are wound on independent iron cores 3^a and 23 and the holding coil actuates its own armature 24 the function of which is to lock the swinging of the armature 4 after the contacts 4^d and 4^a is broken until the timer opens the circuit.

Fig. 7 shows a different way for avoiding the induction effect between the two coils 3 and 3^b although both are wound on the common iron core 3^a. The desired effect according to this diagram is obtained by the specific combination of the contacts 4^d, 4^a and 25, 26. When the magnetic flux in core 3^a is built up by coil 3, the armature 4 will break the contacts 4^d, 4^a with which it is connected by the insulated member 27 and at this moment the holding coil circuit is completed by the contact 25, 26. Therefore no retarding reaction of the holding coil can take place because no current is induced in the holding circuit which is made only after the flux is built up in core 3^a.

I claim as my invention:—

1. A relay for single stroke operation having a holding circuit and a pulling circuit

both actuated by the same source of current, the breaker of the pulling coil acting when closed as a shunt to the holding coil, including an ohmic resistance included in the holding circuit, such ohmic resistance having the quality of counter-balancing the effect of the inductance of the holding circuit to a degree which approximately eliminates the wattless current component in the holding circuit to reduce the retarding effect which the wattless current component has upon the magnetic flux of the relay.

2. A relay for single stroke operation having a holding circuit and a pulling circuit both actuated by the same source of current, the breaker of the pulling coil acting when closed as a shunt to the holding coil, including an ohmic resistance in series in the holding circuit, such ohmic resistance having the quality of counter-balancing the effect of the inductance of the holding circuit to a degree which approximately eliminates the wattless current component in the holding circuit to reduce the retarding effect which the wattless current component has upon the magnetic flux of the relay.

3. A relay for single stroke operation having a holding circuit and a pulling circuit both actuated by the same source of current, the breaker of the pulling coil acting when closed as a shunt to the holding coil, including an adjustable ohmic resistance in series in the holding circuit, such ohmic resistance having the quality of counter-balancing the effect of the inductance of the holding circuit to a degree which approximately eliminates the wattless current component in the holding circuit to reduce the retarding effect which the wattless current component has upon the magnetic flux of the relay.

4. A relay for single stroke operation having a holding circuit and a pulling circuit both actuated by the same source of current, the breaker of the pulling coil acting when closed as a shunt to the holding coil, including means for suppressing the retardation between the magnetizing current and its influence upon the armature of the relay, said means acting to suppress the electromagnetic coupling between the pulling circuit and the holding circuit.

5. A relay for single stroke operation having a holding circuit and a pulling circuit both actuated by the same source of current, the breaker of the pulling coil acting when closed as a shunt to the holding coil, including means for suppressing the retardation between the magnetizing current and its influence upon the armature of the relay, said means acting to reduce the electromagnetic coupling between the pulling circuit and the holding circuit so that less than approximately 50% of the flux lines generated by the pulling circuit will act inductively upon the holding circuit.

6. A relay for single stroke operation having a holding circuit and a pulling circuit both actuated by the same source of current, the breaker of the pulling coil acting when
5 closed as a shunt to the holding coil, including means for suppressing the retardation between the magnetizing current and its influence upon the armature of the relay, said
10 means acting to reduce the electromagnetic coupling between the pulling circuit and the holding circuit so that less than approximately 50% of the flux lines generated by the pulling circuit will act inductively upon the holding
15 circuit; and an ohmic resistance in the holding circuit to eliminate the wattless current component in the holding circuit to completely further reduce the retarding effect between the magnetizing current and its influence upon the armature.

20 In testimony whereof I affix my signature.
 EGBERT VON LEPEL.

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