G. HONOLD.

ELECTRIC CONTACT DEVICE.

APPLICATION FILED JULY 21, 1917.

1,264,797. Patented Apr. 30, 1918.

Fig. 1.

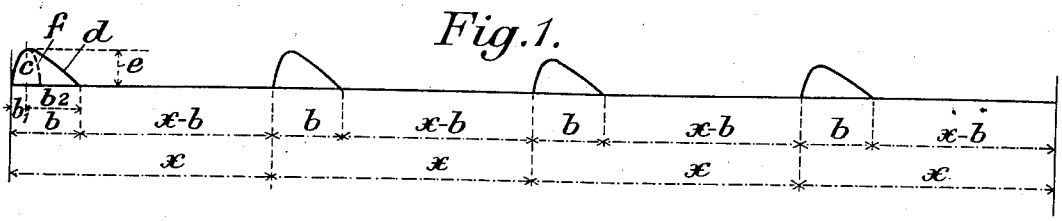


Fig. 2.

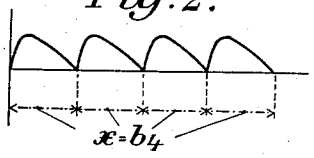


Fig. 3.

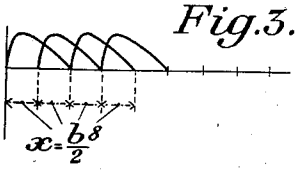


Fig. 4.

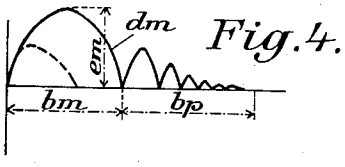


Fig. 5.

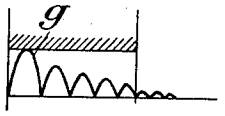


Fig. 6.

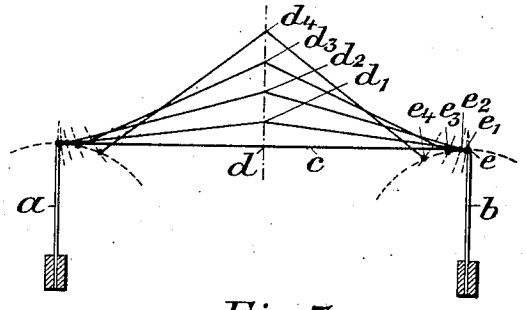


Fig. 7.

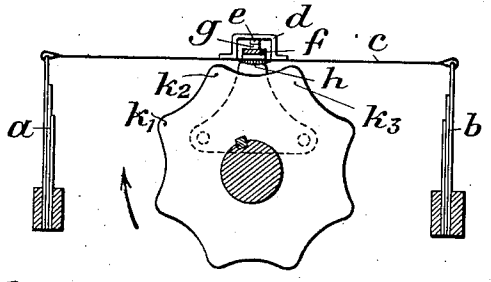


Fig. 11.



Fig. 10.

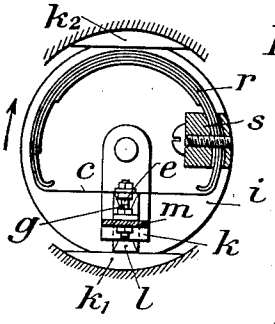


Fig. 8.

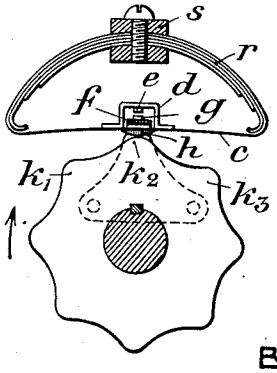
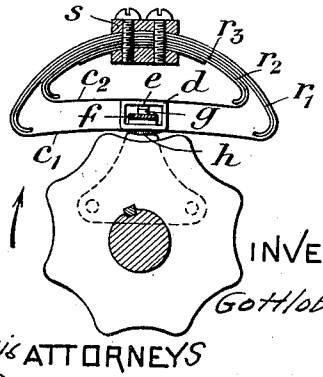


Fig. 9.



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Pennie Davis & Marvin

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ELECTRIC CONTACT DEVICE.

1,264,797. Specification of Letters Patent. Patented Apr. 30, 1918.

Application filed July 21, 1917. Serial No. 182,063.

To all whom it may concern:

Be it known that I, GOTTLOB HONOLD, a subject of the German Emperor, residing at and whose post-office address is Stuttgart, Hauptmannsreute No. 93, Germany, have invented certain new and useful Improvements in Electric Contact Devices; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention refers to electric contact devices and more especially to mechanically controlled interrupters for use with the ignition devices of internal combustion motors. A certain type of this kind of interrupters is provided with a cam adapted to open a primary circuit under control in order to fix as far as possible the moment when the ignition takes place. However in such interrupters a closing of the contacts under control is impossible and a spring control action is substituted therefor. In such internal combustion motors, in which owing to their high speed or great number of cylinders the ignitions take place in rapid succession, the difficulty is encountered that the interrupter of the ignition device, after having opened its contacts, is not able to close them again with sufficient rapidity. This fact is illustrated by the diagrams shown in Figures 1 to 5 of the drawings affixed to this specification and forming part thereof, such diagrams illustrating the conditions of opening and closing of interrupters opened under mechanical control and closed under spring action. In these diagrams the time is represented by abscissæ, while the distances covered by the contacts are indicated by the ordinates.

In the accompanying drawings, Figs. 1 to 6, inclusive, represent diagrammatically the action of the deflectable element of mechanically controlled interrupters of various kinds; Figs. 7 to 10, inclusive, represent in front elevation several embodiments of interrupters according to the invention; and Fig. 11 is a detail view.

The diagram shown in Fig. 1 represents the case where the interruptions follow each other at relatively great intervals x. The cam lifts the movable part of the interrupter through the distance e. The controlled lift resulting in the placing under tension of the spring acting upon the movable part takes place in a steep curve c. After the cam has released the movable part of the interrupter, this part is free to move by itself; however as the spring requires a certain time for accelerating the moved mass in the inverse direction, the closing of the interrupter contact takes place according to the curve d. This curve is considerably flatter than the curve f which illustrates the return movement of the movable part of the interrupter in case that this movement (the closing of the contact) could be effected under control also. This shows that the time b^2 for closing the contact exceeds by far the time b^1 required for the opening, the movement mentioned in the first place being only controlled by a spring.

The whole time consumed in the movement of the interrupter is b seconds and until the interruption next following there is an interval of time of $x—b$ seconds during which the circuit of the primary winding is closed. As in the example illustrated in Fig. 1 this interval is three times as great as the interval in which the circuit is open, the current has ample time left for restoring the field so as to render possible at the interruption next following a considerable variation of the lines of force and the induction of a powerful igniting spark in the secondary winding.

With increasing speed of the interrupter the time of opening b^1 becomes shorter while the time of closing b^2 remains constant, it being independent of the cam. However as the time b^1 is relatively small, the time of opening b as a whole will be reduced only to a small degree, when the speed increases.

In the diagram shown in Fig. 2 the case is illustrated where the speed of the motor is increased by a little more than the fourfold. In consequence thereof the interval of time between the beginning of successive interruptions is one-fourth the interval indicated in Fig. 1, and is therefore equal to the time in which the primary circuit is open at each interruption, that is to say, at the moment of closing the circuit another lifting movement of the interrupter immediately begins. As can easily be seen therefrom, the interrupter cannot follow this in-

crease of speed which does not leave any time in which the circuit is closed and thus does not allow the primary coil to restore the field. No igniting sparks will be generated in this case. If one would try to still further increase the speed, as illustrated in Fig. 3, say to eight times the original speed, then the interval of time x left between each two interruptions would be only one half of the time in which the primary circuit is open. In this case the interrupter will always be open, for after it has started its descent from the uppermost position, the cam will lift it again, and no ignition whatever can take place.

In the cases spoken of above merely the influence of an increase of the time of interruption has been considered. In practice, however, whenever the speed is increased, some other influences will make themselves felt, and therefore the curves shown in Figs. 2 and 3 do not respond to the real working of the interrupter. An interrupter furnishing at low speed curves of opening as shown in Fig. 1, will not retain this curve when the speed is increased four or eight times. Owing to the high speed of the interrupter cams the mass of the movable part of the interrupter in being lifted is accelerated to such a degree that it will move far beyond the highest point e controlled by the cam and will pass for instance up to a point e_m (Fig. 4). It is clear that in order to return from this point the movable part of the interrupter will take more time than in returning from the point e (Fig. 1). Therefore the complete interruption requires a time b_m. The part d_m of this curve corresponding to the closing movement is much steeper than the corresponding part d of Fig. 1 for the reason that the greater lift also causes the spring to be placed under higher tension so as to increase the closing speed. In consequence of the high speed at which the movable contact meets the stationary contact, there results a recoil tending to throw the movable part up again. At the succeeding settling of this part another recoil of less force results, but as a rule the oscillations will continue during a considerable time as shown by the curves b_p. Owing to the oscillation of the masses therefore the closing of the contact is still far more retarded than is shown in Figs. 2 and 3 where merely the reduction of time between each two interruptions has been taken into account.

An obvious remedy against this unfavorable action seemingly presents itself in an increase of the original tension imparted to the contact spring. Such an increased tension will cause the excessive lift beyond the point e to be reduced and the settling down of the movable contact to be accelerated, the oscillations b_p being reduced in number at the same time. However the increase of tension of the spring also carries with it the drawback of causing the interrupter to jolt. The cam cannot lift the movable part of the interrupter free of jerks, the strong spring tension offering a considerable resistance to the lifting of this part. A still stronger shock however results from the settling down upon the contact. This results in a rapid wear of the cam and its point of impact as well as of the interrupter contacts. Moreover the noise resulting from the jolting of the interrupters is rather disagreeable.

It has been tried to remedy these defects by providing a stop in the path of the movable part of the interrupter, the impact of this part against the said stop causing it to be quickly carried back to the stationary contact; however, as mentioned above, the recoil resulting from a rapid meeting of the contacts gives rise to oscillations tending to retard the final closing of the circuit.

As has been shown, the movable part of the interrupter tends to execute oscillations of its own imparted to it during the lifting movement by the cam and during the closing movement by the spring. These oscillations now are greater, the greater the mass and the weaker the spring. As an increase of the tension of the spring is limited by the shocks resulting therefrom, the most effective means for obviating these drawbacks is the greatest possible reduction of the oscillating mass. This reduction however is again limited by the requirements of strength of the movable part as well as the spring itself. As therefore it is not possible to make the mass so small nor the tension of the spring so great that at a high speed of interruptions the drawbacks mentioned above will be done away with entirely, the only way left is a damping of the oscillations. The more perfect this damping is rendered, the more the speed of interruptions can be increased with a certain mass and spring tension. In consequence thereof there result the following three conditions for the most efficient working of the interrupters:

The lowest possible mass of the movable part,

A high spring tension,

The most perfect damping of the oscillations.

In the interrupter according to the present invention these three conditions are combined and in consequence thereof it allows of obtaining extraordinarily high speeds of interruption. According to the invention the movable part of the interrupter contact being opened under control by a cam and closed under the action of a spring is arranged on a flexible band held under tension at both ends by springs and acted upon

by the cam in a direction vertical to its direction of tension. The band being under strain of tension may be very thin although the springs are placed under a high tension. The movable part of the interrupter also fulfills the second condition, as in view of the small mass the high tension of the spring cannot give rise to violent shocks. The best results however are obtained with the new interrupter regarding the third condition, *i. e.* the damping of the oscillations. As illustrated by the diagram shown in Fig. 6, *c* is a band placed under tension by means of two springs *a* and *b*. The center *d* of the band is designed to be lifted to the points d^1, d^2, d^3, d^4, the distances between these points being equal in all cases. The points of connection *e* of the band and springs will move to the positions e^1, e^2, e^3, e^4, respectively. As shown in the diagram, the distances between these successive points increase although the distances between the points d^1, d^2, d^3, d^4 are equal. Therefore the springs *a* and *b* will offer to the lift of the point *d* of the band a resistance increasing to such an extent that the oscillations of the band are damped vigorously.

As shown in this diagram, the oscillations of the movable part of the new interrupter are either suppressed altogether or reduced so far that they do not any more exceed the lifting movement controlled by the cam and do not therefore exert any influence. Experiments have shown that with a frequency of more than 20,000 interruptions per minute the oscillations still remain within the path controlled by the cam so that at this extraordinarily high speed of interruptions no disturbance in the passage of the sparks could be observed. In practice I prefer replacing the springs holding the band under tension by a bow spring, the band encircling the bow and forming the string. In some cases I insert two or more bows provided with strings within each other so as to place the strings in parallel. In order to keep the strings in a parallel position, I prefer connecting them rigidly, preferably at the point carrying the contact. I hereby obtain a parallel movement of the movable contact, as a system of parallel springs as mentioned above results in a sort of parallelogram guide which is very useful in the lifting of the contacts.

In the interrupter shown in Fig. 7 the band *c* is attached at its ends to flat vertical leaf-springs *a b* and carries a stirrup-shaped support *d* for the movable contact *e*. The stationary contact *g* is arranged on a support *f* projecting into the carrier *d*. A cam face *h* is fixed to the band opposite the cams k^1, k^2, k^3 . . . forming part of a rotary disk and hitting against face *h* one after the other, when the disk is rotating, thus lifting contact *e* off contact *g*. The cams k^1, k^2, k^3 . . . are preferably lined with Vulcan fiber or a like material in order to work smoothly without requiring any lubrication.

In the interrupter shown in Fig. 8 the band *c* is placed around a spring bow *r* rigidly fixed to a stationary block *s* and consisting of a number of leaf-springs. The band *c* is formed of thin spring steel. The free ends of the bow spring are bent so as to preserve the free part of the band from breaking at these points.

The interrupter shown in Fig. 9 differs from the one shown in Fig. 8 in that two bands c^1 c^2 are provided, the band c^1 encircling the outer bow r^1, the band c^2 the middle bow r^2, while an inner bow spring r^3 serves to reinforce the whole. In the middle between the two parallel parts of the bands c^1 c^2 a rectangular carrier *d* is arranged, this carrier carrying the movable contact *e*, while the stationary contact *g* is fixed to a stationary support *f*.

In the interrupter shown in Fig. 10 the bow *r* is fixed near one of its ends to a block *s* forming part of the interrupter disk *i*. Opposite the straight part of the band *c* a lug *k* is fastened to the disk *i*, said lug serving as a guide for the deviating block *l*, while the stationary contact *g* is fastened to the upper projection *m* of the lug. The band *c* carries on its upper side a projection *n* carrying the movable contact *e* (Fig. 11). Outside the disk *i* the cam faces k^1 k^2 are arranged in such a position as to press the block *l* against the string *c* and to open the contact each time the block *l* passes one of said cams.

In a like manner the spring system might be made rotary and the cam disk stationary in the modifications shown in Figs. 8 and 9 of the drawings. The band itself may be either elastic or substantially inelastic and may consist in the latter case of annealed copper, of a strong tissue or the like.

I claim:

1. In a mechanical interrupter for electric ignition systems, a flexible band, means for keeping said band under high elastic tension, a contact piece carried by said band, another contact piece coöperative with the first, and a mechanically driven device for periodically flexing said band to thereby alter the relative position of the contact pieces at the successive ignition periods.

2. In a mechanical interrupter for electric ignition systems, a flexible band provided with a contact piece, yieldable means on opposite sides of the contact piece for keeping said band under high elastic tension, a stationary contact piece coöperative with the first, and mechanical means for periodically flexing said band to thereby alter the relative position of the contact pieces at the successive ignition periods.

3. In a mechanical interrupter for electric ignition systems, a flexible band, a bow spring arranged to keep said band under elastic tension, a contact piece carried by said band intermediate the ends of the spring, a stationary contact piece coöperative with the first, and mechanical means for periodically flexing said band to thereby alter the relative position of the contact pieces at the successive ignition periods.

4. In an electric contact device in combination, at least one bow spring, a flexible band stretched out between and in operative connection with the ends of said bow spring, a movable contact piece fixed to a part of said band intermediate between said spring ends, a stationary contact piece in face of said movable contact piece and means for imparting motion to said part of the band in a direction vertical to the line of tension of said band.

5. In an electric contact device in combination, a plurality of bow springs of different length, a flexible band between and in operative connection with the ends of each bow spring, the shorter spring arranged between the shanks of the longer one so as to keep their bands in parallel, a rigid connection between said bands, a movable contact piece fixed to one of said bands at a point intermediate between its points of contact with the bow spring, a stationary contact piece opposite said movable piece and means for imparting motion to said part of the band in a direction vertical to the line of tension of said band.

6. In an electric contact device in combination, at least one bow spring, a flexible band extending between the ends of and adapted to be kept under tension by said bow spring, a movable contact piece fixed substantially to the middle of said band, a stationary contact and a rotary cam disk in face of said movable contact and band, said disk being adapted to move said band and movable contact in a direction substantially vertical to the line of tension of said band.

7. In a mechanical interrupter for electric ignition systems, a flexible band, a contact carried by said band, a coöperative contact, a spring extending at an angle to the band and arranged to subject the band to high elastic tension, and a mechanically driven device for periodically deflecting the band to thereby alter the relative position of the coöperative contacts.

In testimony whereof I affix my signature, in presence of two witnesses.

GOTTLOB HONOLD.

Witnesses:
PAUL WOLFART,
ADOLF LEBHERS.