

April 1, 1924.

1,488,975

P. BROWN

MAGNETO

Filed April 25, 1921

3 Sheets-Sheet 1

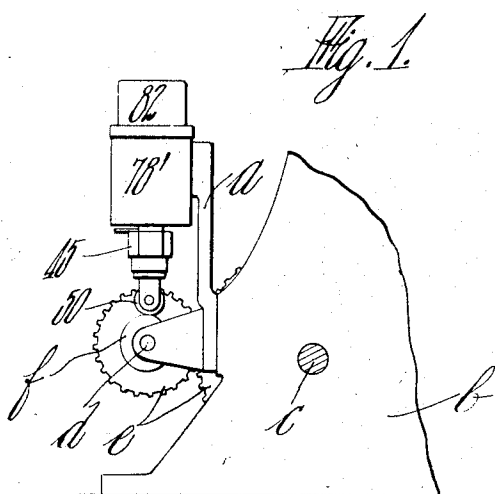


Fig. 2.

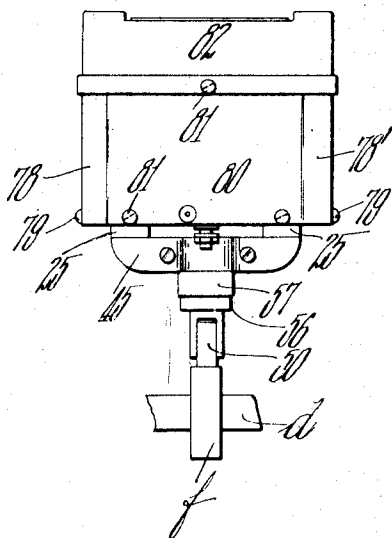
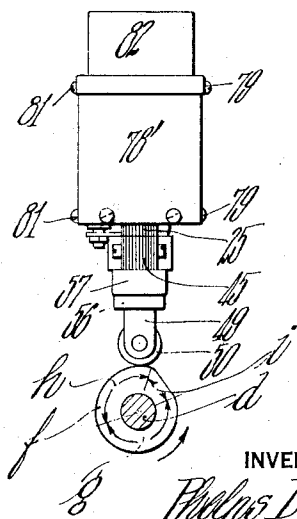


Fig. 3.



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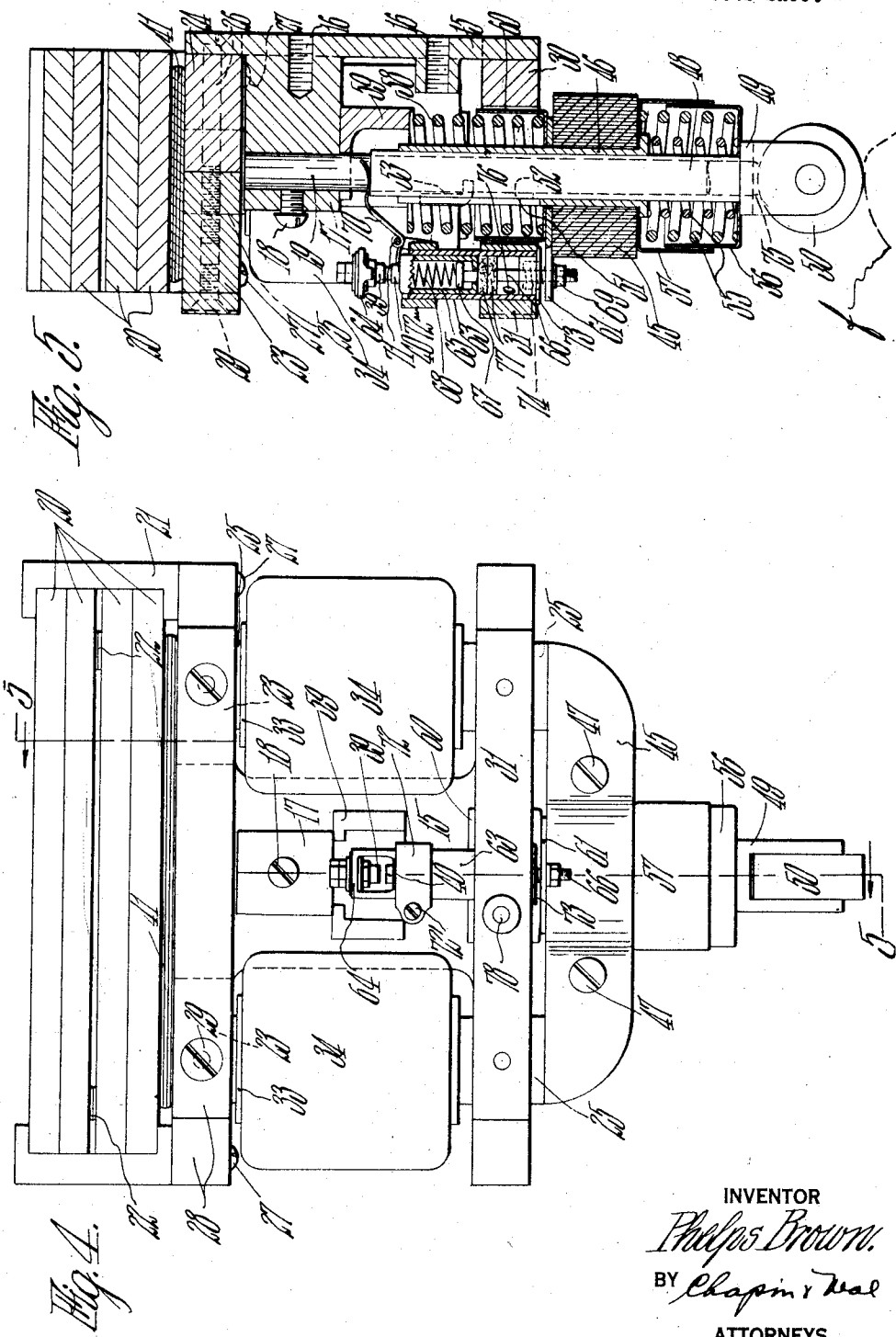
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3 Sheets-Sheet 2



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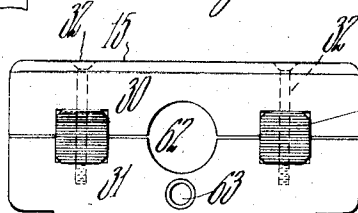
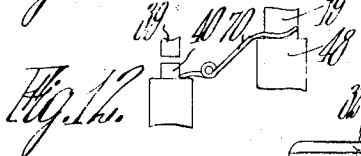
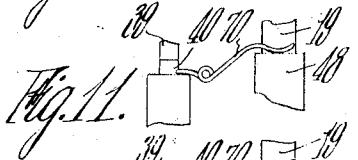
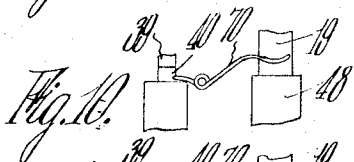
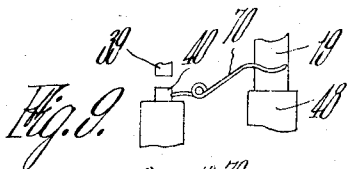
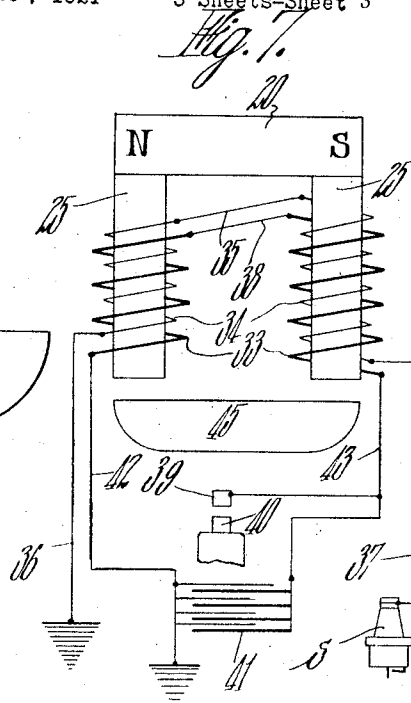
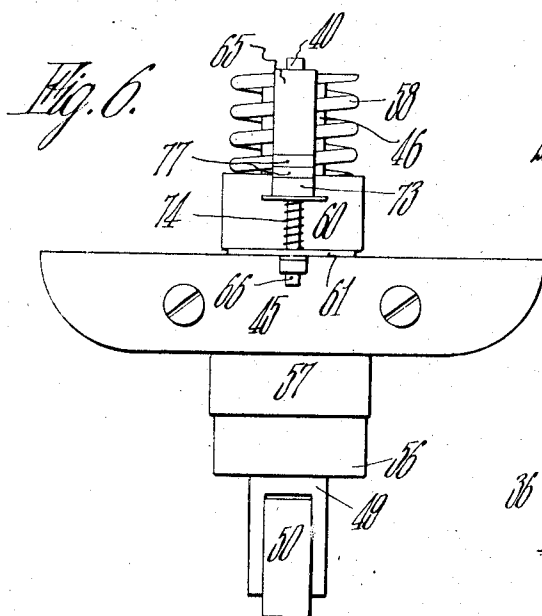
P. BROWN

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MAGNETO

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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE.

PHELPS BROWN, OF SPRINGFIELD, MASSACHUSETTS.

MAGNETO.

Application filed April 25, 1921. Serial No. 464,345.

To all whom it may concern:

Be it known that I, PHELPS BROWN, a citizen of the United States, residing at Springfield, in the county of Hampden and State of Massachusetts, have invented new and useful Improvements in Magnetos, of which the following is a specification.

This invention relates to improvements in magnetos and is especially directed to magnetos of the type wherein a reciprocating armature moves into and out of engagement with magnetic poles to vary the flux in a magnetic circuit and by such variation to cause the generation of electricity in a suitable winding.

The invention is particularly concerned with mechanism for actuating the armature in a novel manner. Heretofore, it has been thought essential, in magnetos of the type described, to apply to the armature very suddenly, if not practically instantaneously, a relatively high initial force to dislodge the armature from its poles and overcome the opposing force due to magnetic attraction. Hence, the use of the hammer which, when suddenly released, is driven toward the armature and, after acquiring considerable momentum, engages the latter with an impact which sets the armature suddenly in motion at high speed. Such actuation of the armature was considered necessary in order to provide for a rapid change in flux in the generating windings. Other prior art magnetos, of the type under consideration, while dispensing with the hammer, have nevertheless retained the sudden and practically instantaneous release of the armature to allow the sudden application of a considerable initial driving force.

The broad object of this invention is to provide, in a magneto of the type in which an armature is moved into and out of contact with magnetic poles, driving mechanism arranged to build up on the armature, while held to its poles, a differential of force to disengage it therefrom; such differential,—which, by reason of its infinitesimal initial value, is insufficient to move the armature at high speed,—increasing rapidly as soon as an air gap is established between the armature and poles and soon becoming effective to so move the armature by reason of the rapid weakening of the resistance, of which magnetic attraction is always an element.

According to this feature of the inven-

tion, as soon as the armature is separated by the least air gap from its poles, that opposing force due to magnetic attraction will be greatly lessened and, as the air gap widens, will progressively and very rapidly diminish (at the very least, in proportion to the square of the distance of separation). Accordingly, although only an infinitesimal initial differential of force existed to move the armature, such differential is rapidly increased by the rapid diminution of the force of magnetic attraction and, after the armature has moved a short distance away from its poles, it will acquire a sufficiently rapid speed. In order to render this mode of actuation of the armature most effective, choke-coils are associated with the magnetic circuit and, at the time that the armature leaves its poles, these coils are arranged in a closed electrical circuit, which is later broken after the armature has attained the requisite speed. The practical effect of this arrangement is to hold the flux in the magnetic circuit until the armature acquires a sufficient speed and has introduced a sufficient reluctance in the magnetic circuit, whereupon an opening of the choke-coil circuit will result in a desired rapid change of flux in the generating winding.

An important advantage of this mode of operation is that it renders available the use of far less violent motions than have heretofore been employed for actuating the armature and yet permits sparks of high intensity to be produced independent of engine speed. It eliminates the necessity for the use of cams which release the follower for a free fall. The principal advantage of this type of magneto is thus retained without the accompanying disadvantage incident to the use of relatively violent motions, which necessarily produce undesirable noise and cause more rapid wear of parts.

According to another feature of this invention, means are provided for opening, closing, re-opening and again closing, the choke-coil circuit of the magneto, during each cycle of movement of the armature, as distinguished from the usual arrangement of a single opening and closing during each cycle.

This feature of the invention may be made use of for various purposes, according to the time of the extra opening and closing. One way in which this feature may be used to

advantage, is to close the choke-coil circuit, as the armature approaches the poles and comes within the influence of magnetic attraction, and to hold the circuit closed until the armature is seated. This results in impeding the establishment of flux in the magnetic circuit and substantially reduces the magnetic attraction effect upon the armature, which otherwise tends to pull the armature against its poles rapidly with a sharp and undesired noise. By re-opening the choke-coil circuit after the armature is engaged with its cores, the flux is allowed to rapidly build up in the magnetic circuit, and after the flux has been built up, the circuit is closed, prior to disengagement of the armature, to hold the flux in the magnetic circuit until the armature has moved far enough away from the poles to attain the desired speed, whereupon the circuit is opened to permit a rapid decrease of flux for the generation of current. The advantage of reducing the effect of magnetic pull, as the armature nears its poles, is thus obtained without the disadvantage of later impeding the rapid building up of the flux by keeping the circuit closed after seating of the armature on its poles.

The two features, above set forth, are highly important in a magneto of the type described and are each independent of the other, although both contribute to quiet operation. As compared with the prior art, less violent motions are utilized, which permit operation at much higher speeds without undue noise and wear on parts. Particularly, as to the first feature, the necessary armature speed can be obtained by much more slowly acting means than have heretofore been used and still sparks of high intensity can be produced at lower motor speeds.

Other objects of the invention relate to improvements in the construction and arrangement of parts and will appear in the following description and in the illustrative embodiment of the invention in the accompanying drawings, in which,—

Fig. 1 is a fragmentary elevational view showing the mounting of the magneto on an engine;

Figs. 2 and 3 are somewhat enlarged front and side elevational views respectively of the magneto;

Fig. 4 is an enlarged front elevational view of the magneto with the casings removed to show its interior;

Fig. 5 is a cross-sectional view of the magneto;

Fig. 6 is an elevational view showing the group assembly of the moving parts of the magneto;

Fig. 7 is a diagrammatical view illustrative of the electrical connections of the magneto;

Fig. 8 is a bottom plan view of the magneto with the group of parts shown in Fig. 6 removed;

Figs. 9, 10, 11, and 12 are diagrammatical views illustrative of successive steps in the operation of the breaker points, which control the opening and closing of the choke-coil circuit; and

Figs. 9^a, 10^a, 11^a, and 12^a are diagrammatical views showing the relative positions of the armature and poles which obtain when the breaker points are in the respective position shown in Figs. 9, 10, 11 and 12.

In these drawings, there is shown, in full detail, an embodiment of the invention incorporating many desirable features relating to the particular construction and arrangement of various parts, which, although important and preferred, are not essential as far as the broader aspects of the invention, heretofore outlined, are concerned. As to each of the latter, the showing is to be taken merely as an illustrative example of one of many suitable types of magnetos, in which they may be embodied.

The magneto includes a group of stationary parts, such as the magnetic source, cores, and coils, which may be supported in any suitable manner, as by a bracket *a*, from the engine frame, as *b*, and a second group of movable parts, such as the armature and associated mechanism, which may be actuated from the engine by various means. One illustrative example of such means is shown in Fig. 1. Thus, the crankshaft of the engine, indicated at *c*, drives the camshaft *d*, as by gearing *e*, at the desired ratio of speed. The cam-shaft *d* has mounted thereon a cam *f*, which is here used also to support the group of moving parts. The contour of cam *f* is best shown in Fig. 3 and, as there shown, includes a gradual rise *g*, a dwell *h* and a drop *i*, which is gradual, as compared to the drop of cams heretofore used to permit a free fall and a practically instantaneous descent of the cam-follower. It will be seen, therefore, that the cam will permit a relatively gradual descent of the cam-follower, followed by a rise which usually, although not necessarily, is considerably more gradual than the descent thereof, and finally, by a dwell of the cam-follower.

The stationary group of parts includes a back frame 15, from which all the other parts of this group are supported. This member 15, which is of non-magnetic material, is provided with tapped holes 16 to permit its attachment to the bracket *a* described and also with a forwardly-extending boss 17. Mounted in and secured to the latter, as by the screw 18, is a rod 19, which extends downwardly below the lower edge of the frame and forms a guide for the moving parts of the magneto.

The source of magnetic flux, in this par-

particular instance, comprises a series of permanent bar magnets 20 arranged in superposed relation and grouped into a unit for convenient assembly in the general manner disclosed in U. S. Letters Patent No. 1,335,119 granted on an invention of T. G. Louis. That is, the ends of like polarity of all magnets are received within substantially U-shaped clips 21, to which they are firmly held, as by shims or wedges 22. The clips 21, although of magnetic material, are not hard, as are the magnets 20, and are readily drilled to receive the attaching devices, later to be described. Various other means may be employed for securing the magnets in place and the clips described are given merely as an illustration of one of many suitable means.

A magnetic pole-piece is provided for each pole of the magnetic source and each of these pole-pieces is made up of two rectangular blocks 23 and 24. The two blocks for each pole-piece, as shown in Fig. 5, are arranged side by side and are recessed to receive between them the upper end of a core 25. The latter, as indicated in Fig. 8, is built up of laminations which are drawn together by, and held to, the mating pair of blocks by a single screw 26 (Fig. 5). The latter passes through the back frame 15, through the block 24 and core 25 and threads into the block 23. The screw 26 serves to draw the blocks together, thereby clamping the laminations of core 25 and also securing these parts to the back frame 15. The clips 21, above described, are secured to their respective pole-pieces by screws 27 which pass upwardly through the latter and thread into the lower part of the clips, there being two screws for each clip, as indicated in Fig. 5. The two pole-pieces may be further tied together by a bar 28, of non-magnetic material, which connects the spaced blocks 23 and is secured thereto by screws 29. The two cores 25 extend downwardly from their pole-pieces in parallel relation, one on each side of the guide-rod 19, and terminate at a short distance below the lower edge of frame 15. Near their lower ends, the laminations of the cores are clamped together and connected to the frame 15 in a manner similar to that above described except that two members 30 and 31, of non-magnetic material, suffice for both cores. Two screws 32, passing through frame 15, member 30 and the cores 25, thread into member 31 and serve to draw the members together and hold them to the frame.

Upon each core 25, and between the points at which it is clamped, are provided two coils 33 and 34 arranged one upon the other. The inner coils 33 are provided for a choking function, either to retard the building up, or the diminution of, magnetic flux in cores 25. The outer coils 34 constitute the

generating winding. The electrical connections of these coils are shown in Fig. 7. The coils 34 are usually, although not necessarily, connected in series, as by a wire 35 joining one terminal of each coil. The other terminals of the generating winding, constituted by the connected coils, are the service terminals. Customarily, one terminal is grounded, as by a wire 36, to the frame of the magneto and the other extends to the ignition system, as indicated by the wire 37 extending to a spark-plug *s*.

The two coils 33 are also usually, although not necessarily, connected in series, as by a wire 38 joining one terminal of each coil. The other terminals of the choke-winding, afforded by the connected coils 34, are connected to relatively-movable breaker-points 39 and 40 and a condenser 41 is bridged across these terminals in the usual manner. Usually, as shown, one terminal of one coil 33 is connected, as by a wire 42, to one side of the condenser and grounded to the frame of the machine, whereby to conveniently connect with the movable breaker-point 40, which, as will appear, is in constant metallic connection with the frame. The corresponding terminal of the other coil 33 is connected, as by a wire 43, to the stationary breaker-point 39 and the other side of the condenser 41. The latter is conveniently located beneath the magnets 20 and between the clips 21, where it is supported by resting upon the blocks 23 and 24 (Fig. 1).

The magnetic circuit will be readily understood from Fig. 7. The poles of the magnetic source, extended by the cores 25 to admit the windings 33 and 34, are periodically connected and disconnected by an armature 45, thereby providing for a magnetic circuit of alternately low and high reluctance through the windings.

The armature 45, as best shown in Fig. 5, may be made up of laminations in the usual manner, although this is not necessarily essential. The armature is fixed to a guide sleeve 46, having a flanged lower end against which the lower face of the armature abuts, and the laminations are spread apart at the center of the armature to permit the sleeve to pass therethrough. Bolts 47, located on opposite sides of sleeve 46, pass through the armature and serve to clamp the laminations thereof together as well as to bind them to the sleeve. Slidable within sleeve 46, and upon the guide-rod 19, is a second sleeve 48 having a forked lower end 49 which receives a roll 50 to ride upon cam *f*. Both sleeves 46 and 48 have longitudinal slots 51 and 52, respectively, extending from their upper ends downwardly a substantial distance. These slots function as keyways, both being arranged to cooperate with a single key 53 in rod 19, which keys permits the desired vertical sliding movements of the two sleeves

and yet holds them in the desired angular relation to keep the armature 45 and roll 50 properly positioned with respect to cores 25 and cam f , respectively.

- 5 Preferably, although not necessarily according to all features of the invention, the armature 45 is not lifted directly by the cam-follower or lifting sleeve 48 but rather through the intermediary of resilient means.
- 10 As shown, such means takes the form of two coil-springs 55, which act together to provide the desired strength, although, of course, one spring of the desired strength may equally well be used. These springs 55
- 15 are preferably housed within two telescoping, cup-shaped housings 56 and 57. The housing 56 loosely slips over the sleeve 48 and rests upon the shoulder afforded by the intersection of the fork 49 therewith, also
- 20 forming a seat for the spring. The housing 57, as shown, is slipped over sleeve 46 previous to its attachment to armature 45 and, after such attachment, is held between the armature and the flanged end of the sleeve.
- 25 Although obviously it need not be so held. The two housings, even when the springs 50 are fully expanded, overlap and therefore under all conditions enclose the springs and prevent the ingress of dust and dirt which
- 30 might otherwise work their way between the two sleeves 46 and 48 to cause rapid wear on these relatively sliding parts.

- The armature is moved away from cores 25 by a driving-spring 58. The latter, as
- 35 shown, is a coil spring which encircles the sleeves 46 and 48 and acts between a spring-seat 59, which abuts the lower face of the boss 17 on frame 15, and a cup-shaped spring-seat 60 which slips over sleeve 46 and acts against the upper face of armature 45.
- 40 As shown, a plate 61, also loosely fitting on sleeve 46, is interposed between seat 60 and the armature and projects laterally therefrom for connection to the interrupter mechanism to be later described. As shown in
- 45 Fig. 8, the members 30 and 31 are recessed centrally at 62 to receive and closely fit the peripheral wall of the cup-shaped spring-seat 60, and such wall is of sufficient longitudinal extent so that its open upper end
- 50 never passes out of the lower end of opening 60, thus preventing the ingress of dust and dirt into the magneto through the bottom closure afforded by the members 30 and 31.

- 55 The interrupter mechanism includes a cylindrical casing 63, which is driven into an opening in the member 31 and thereby held stationarily to the frame structure already described. This casing extends upwardly in
- 60 parallelism with the line of travel of the armature and is located at the front of the magneto for convenient access and inspection. At the upper end of the casing 63 is a bridge 64 in which the stationary breaker-point
- 65 39 is adjustably mounted and from

which it is suitably insulated, all as indicated in Fig. 4. The movable breaker-point 40 is carried on the upper end of a relatively long cylinder 65 which closely fits in and is guided by the casing 63. The lower end of cylinder 65 is closed except for a central opening, to receive a rod 66 which passes loosely therethrough and into the casing. The upper end of rod 66 carries a head 67 and between this head and the closed upper end of casing 65 is a spring 68, through the intermediary of which the cylinder 65 is lifted from the rod 66. The latter, in its descending movement, lowers cylinder 65 by reason of the abutment of head 67 with the closed lower end of the cylinder. The lower end of rod 66 is threaded into, and thereby adjustably secured to, the projecting portion of the plate 61 above described. A screw-driver slot is provided in the lower end of rod 66, whereby it may be conveniently turned for adjustment and a lock-nut 69 is provided on the rod to prevent change of the adjustment.

It is to be noted that the movable breaker-point 40 can yield relatively to its actuating rod 66. Such yield is desirable for several reasons. First, the travel of rod 66 need not be the same as the travel of point 40. Second, it is desirable that the latter be less than that of rod 66 to compress the spring 68 after engagement of the points 39 and 40, so that the latter will be held firmly pressed together even after considerable wear. Third, it is desired, according to one feature of the invention, to be able to open the breaker-points after they have been closed by upward movement of the armature and while the latter is seated on its cores. For this purpose, a lever 70 is pivoted intermediate its ends at 71 to a split collar 72 secured to casing 63 by the clamping-screw 72' shown in Fig. 4. One end of this lever bears on the upper face of cylinder 65, and the other end is forked to straddle guide-rod 19 and lie in the path of the sleeve 48. This sleeve has a greater travel than the armature and after the latter has been seated, continues to move upwardly and in such movement engages and lifts the inner end of lever 70, thereby depressing its outer end and lowering cylinder 65 with the breaker-point 40 carried thereby. On a reverse movement, the sleeve 48 moves downwardly sufficiently to release lever 70 and allow the breaker-points to close previous to disengagement of the armature from its poles.

The time of this extra opening and closing of the breaker-points may be varied as desired, as by adjusting the collar 72 axially on casing 63, whereby the engagement of lever 70 by sleeve 48 may be made to occur earlier or later than above described. While the described arrangement is preferred, in

so far as it permits a substantial reduction of the magnetic pull on the upthrow of the armature, the utility of the extra opening and closing of the breaker-points is not confined to this one feature.

The magnet assembly is encased by a top casing section 82 which overlaps the upper portions of the side casings and is secured in place by some of the screws 79 and 81 used to hold the latter.

For the purpose of preventing ingress of dust and dirt to the guide cylinder 63, its otherwise open lower end is closed by a dust-cap 73, which fits over rod 66 and is held in place by a spring 74 acting between cap 73 and plate 61.

The particular details of the construction and arrangement of parts, as above set forth, are especially advantageous from the point of view of quantity production manufacture. The entire magneto is subdivided into units, the parts of each of which may be separately assembled, and then the assembled units mounted in their proper working relation with one another by simple means. The frame, pole-pieces, cores, and associated parts constitute one unit to which prior to complete assembly, are applied the coils 33 and 34 previously made up as another unit to slip over the cores 25. The magnets 20 are separately assembled in their clips 21 as a distinct unit and are readily applied to the frame unit by the screws 27. The armature, and all its associated reciprocating parts, constitute another unit which is applied in correct working relation to the other units by simply slipping the sleeves 46 and 48 over the guide-rod 19, the key 53 by its engagement in slots 51 and 52 positioning these parts in proper angular relation, as above set forth. The armature unit is held in place by the roll 50 resting on cam *f*. Associated with the armature unit is a unit consisting of the reciprocable parts of the interrupter mechanism, and this unit requires merely to be slipped in place in casing 63, which is previously applied to member 31 during the assembly of the frame unit. All the reciprocating parts of the magneto are readily applied or removed by the one simple operation of pushing or pulling the sleeve 48 over or from the guide-rod. This assembly of reciprocating parts is clearly shown in Fig. 6 and the only operation connected with the assembly of these parts, requiring any appreciable amount of time, is the assembly of the laminations of the armature and the clamping of them to sleeve 46, to which the spring-housing 57 is previously applied. Thereafter, the housing 56 is slipped in place on sleeve 48 and the springs 55 dropped over the latter, after which sleeve 48 is inserted in sleeve 46. The plate 61, carrying all the reciprocating parts of the interrupter mechanism, is then slipped over sleeve 48, followed by seat 60 and spring 58, which completes the assembly.

The lubrication of the various moving parts of the magneto is effected in the following manner. A plug 75 of felt, or other suitable material, is inserted in the lower end of sleeve 48 and arranged to bear on roll 50. The working face of cam *f* is lubricated and some of this lubricant is picked up by roll 50 and transferred to the plug 75, which absorbs it. On each reciprocation of the armature, the sleeve 48 and rod 19, having a relative movement, function like a pump and draw up the lubricant from plug 75 and squeeze it out between their engaging surfaces, which are thereby lubricated. Such lubricant eventually leaves by way of the upper end of sleeve 48 and falls onto the outer surface thereof, upon which sleeve 46 slides, thereby lubricating these sliding surfaces. The latter action is assisted by the pumping action due to the telescoping casings 56 and 57.

The lubrication of the interrupter mechanism is effected by one or more rings of felt 77, or like absorbent material, which are placed on rod 66 and pick up oil supplied into casing 63 through a passage 76, which at its outer end is yieldably closed by the usual closure, indicated conventionally at 78. The felt rings 77 distribute the oil over the lower portion of the inner surface of casing 63, from which it is worked upwardly by the sliding guide cylinder 65.

The housing of the magneto comprises a plurality of bent or pressed sections of non-magnetic material, which completely enclose all parts above the bottom closure members 30 and 31, and prevent the ingress of dust and dirt as well as protecting the parts from mechanical injury. The outer contour of the assembled units, comprising parts 15, 30 and 31, shown in Fig. 8, is the same as that of the assembled unit comprising parts 15, 23, 24 and 28, and the space between these two units is closed by side casings shaped to conform to such contour.

As shown, one side casing section 78 encompasses the back, both ends, and overlaps the ends of the front of the magneto and is held in place by screws 79 threading into the units just described. This leaves an opening in front, through which access may be had to the interrupter mechanism, such opening being closed by a second casing section 80 similarly held in place by screws 81.

The operation of the magneto, and more especially the movements of the armature with which the broad features of the invention are concerned, will now be described. Assuming that the cam-follower is positioned on the low point of cam *f* and that the latter is rotating in the direction of the arrow (Fig. 3), the cam-follower will be

gradually raised by the portion *g* of cam *f*. The raising of the armature, however, is preferably not directly accomplished thereby for it is usually desired to seat the armature upon the magnetic poles (comprising the lower ends of cores 25) as gently and as quietly as possible. Therefore, the cam-follower transmits its lifting force to armature 45 through the intermediary of the spring or springs 55. Opposing the action of the latter is the drive-spring 58, and the armature is thus carried upward between two forces, which naturally seek a balance. The upward movement of the armature is therefore not directly proportional to the movement of the cam-follower for the latter encounters increasing resistance as it moves upwardly by the compression of spring 58, and as the latter compresses the spring 55 must compress to balance it. Therefore, the upward movement of the armature, which may be initially nearly as fast as the cam-follower, soon becomes slower and slower as it approaches the poles. This particular mode of lifting the armature, although desirable and preferred because it permits a gentle seating of the armature on its poles, is not essential to the broad features of the invention.

In the above description of the forces acting on armature 45 during its upward travel no consideration was given to the upward force which would normally tend to draw the armature to its poles with a sharp noise. For as the armature nears the latter the magnetic pull would ordinarily increase very rapidly, and this rapidly-increasing force added to that of spring 56 would tend to defeat the object sought for, viz, the depositing of the armature on the cores as quietly as possible. However, the effect of magnetic pull is substantially reduced so as to be a practically negligible factor in the described operation. This is accomplished by the closing of the choke-coil circuit during the latter part of the upward flight of the armature. The breaker-points, controlling the opening and closing of this choke-coil circuit, are, when the armature is in its lowest position (Fig. 9^a), open as shown in Fig. 9. As the armature nears its poles to a position such, for example, as is indicated in Fig. 10^a, it has moved sufficiently to carry the breaker-point 40 into engagement with the fixed breaker-point 39, thus closing the circuit in which the choke-coils are located. On continued movement of the armature, spring 58 compresses to take care of the over-travel of rod 66, and the points remain closed until after the armature has been seated on its poles. These coils, when in a closed electrical circuit, oppose a change of flux in the magnetic circuit, and in this instance they oppose the building up of the flux in cores 25 and consequently there will not

be immediately a magnetic pull on the armature of anything like the usual strength. The force, due to magnetic pull, is substantially reduced over that which would otherwise exist if the choke-coil circuit were left open.

After the armature has been seated on its poles, the cam-follower continues its upward travel, the spring 55 by its further compression, permitting this action. This "over-travel" of the cam-follower is important since it insures that the armature will continue to be seated on its poles even after extended wear. It is also important as it affords a means for opening the breaker-points after the armature has come to rest on its poles and is no longer available to actuate them. Continued travel of the cam-follower opens the breaker-points as illustrated in Fig. 2, thus allowing the flux to build up rapidly in the now closed magnetic circuit and the follower may, as shown, dwell in its upper position for an interval to insure this result, although such dwell is not necessarily essential.

As the cam-follower rides onto the portion *i* of the cam *f*, the supporting forces acting on armature 45 are progressively diminished. In addition to the supporting force of spring 55, there is now a substantial force of magnetic attraction acting in conjunction with it, which additional force is, until the armature leaves its poles, substantially constant. The first result is a progressive, instead of an instantaneous, expansion of spring 55 and a lowering of sleeve 48, unaccompanied by any movement of armature 45. Thus, the breaker-points are closed before the armature leaves its poles, the relative positions of these elements being shown in Figs. 11 and 11^a. Thus, the choke-coils are again brought into play on the magnetic circuit, but for a different purpose, viz, to oppose any sudden change in magnetic flux when the armature leaves its poles.

The disengagement of the armature from its poles is not accomplished by the sudden application of a substantial initial force. On the contrary, when in the descent of the cam-follower, the force opposing the driving action of spring 58,—in this instance that due to spring 55 and that due to magnetic attraction,—become just slightly less than that of spring 58, the armature will begin to move but naturally slowly in its initial infinitesimal step of downward movement because the driving force is infinitesimal. Practically, spring 55 becomes almost entirely released before the armature begins to move, and the major force left to oppose spring 58 is that due to magnetic attraction. The instant, however, that the least air gap is created between the armature and its poles, this opposing force is very much di-

minated and on doubling the air gap this force is at least quartered, and so on. Thus, once the armature is started from its poles, no matter how slowly, by the very smallest differential of force, its subsequent movement is rapidly accelerated on account of the exceedingly rapid diminution of the resisting force. The practical result is that a high armature speed is obtained after the armature has moved away from its poles a certain distance, and at the point of maximum speed, or as nearly thereto as it can be arranged, the breaker-points open. The choking effect on the magnetic circuit, having been thus done away with, there results a very rapid change of flux in this circuit, thereby inducing a high voltage in the generating winding. Thus, by the expedient of the breaker-points and choke-coil winding, which may be likened to a valve for controlling the flux in the magnetic circuit, it is possible to hold the flux in the latter until the armature gets under way and attains a sufficient speed. Otherwise, the change in flux would be relatively gradual because it would depend entirely on the speed of the armature in the initial stages of its downward flight.

To complete the description of operation, it should be noted that the spring 55 has still another function which is to yieldingly and quietly arrest the armature in its downward flight. After the breaker-points have opened for the purpose of releasing the flux in the magnetic circuit, the driving force of spring 58, by its expansion, weakens and in addition encounters increasing opposition by reason of spring 55 and the forces due to these two elements seek and find their balance and thus arrest the armature in the desired quiet manner.

While in the foregoing description the driving spring 58 has been considered as stronger than the force due to magnetic attraction, under the conditions illustrated in Fig. 5, it is not necessarily essential to the success of this mode of actuating the armature, for it is simply necessary to supply the deficiency in force necessary to unseat the armature by other means and the unseating, once accomplished, the initially insufficient force of the driving spring becomes sufficient, due to the rapidly waning influence of magnetic pull. Moreover, under such conditions, of course, magnetic attraction may be utilized to maintain the armature seated, once it is deposited on its poles, and consequently the supporting springs 55 are not necessarily essential to the success of the mode of actuating the armature in its downward flight.

The closing of the breaker-points and the holding of them closed until the armature is seated, while important and preferred for the reasons outlined, are obviously not con-

cerned in any way with the downward flight of the armature. Even on the upward flight of the armature, the timing of the extra closing and opening may be changed as occasion requires to effect other results. For example, if the rise g of cam f is so abrupt as to move the armature rapidly enough to cause an upthrow spark, the closing of the choke-coil circuit will tend to "kill" this spark, even if this opening and closing are not timed exactly as described.

In conclusion, it may be pointed out that the necessary speed of the armature is really obtained by fully utilizing the factor of the rapidly diminishing force of magnetic pull by the creation and the increase of an air gap. This factor may be termed "magnetic retraction" as distinguished from "magnetic attraction" and is the factor relied upon here to obtain armature speed, as distinguished from the hammer blow or the substantial, and instantaneously applied, initial force heretofore used to produce an initial high speed. Inasmuch as the flux can be held by the choke-coils for an interval sufficient to accelerate the armature to the desired speed, initial speed becomes unnecessary.

Although the invention has been described here with considerable particularity in order to make clear to those skilled in the art a preferred means of making use of it, it is to be understood that the invention is not limited to the details illustrated and described except as they are included in the following claims.

What I claim is—

1. In a magneto, of the type wherein an armature is periodically moved into position to complete a magnetic circuit entirely through magnetic material, means including the force of magnetic attraction for exerting a force tending to hold the armature in said position, means for exerting a force tending to move the armature away from said position, and means for progressively changing the relation of the opposing forces acting on the latter until a differential of force is created for the purpose of moving the armature away from said position, such differential of force increasing rapidly as the armature moves away from said position due to the rapid diminishing of the opposing force of magnetic attraction by the creation of an air gap in said circuit.

2. In a magneto, of the type wherein an armature is periodically moved into position to complete a magnetic circuit entirely through magnetic material and is subsequently moved out of said position to vary the reluctance of said circuit and a generating winding is associated with said circuit in which currents are induced by the variation of flux therein; resilient means progressively brought into action and cooperat-

ing with the rapidly diminishing resisting force of magnetic attraction to produce a rapid movement of the armature away from said position, a closed circuit choke winding associated with the magnetic circuit, and means for opening the choke winding circuit after the armature has moved away from said position.

3. In a magneto, of the type wherein magnetic members are connected to the poles of a magnetic source and an armature moves into and out of engagement with said members to connect and disconnect the same and vary the reluctance of the magnetic circuit and a generating winding is associated with said circuit in which currents are induced by the variation of flux therein; driving means tending to move the armature away from said members but periodically exerting a force less than the total of opposing forces, means acting relatively gradually to change the relation of the opposing forces until a differential of force exists to start the armature away from said members, such differential becoming rapidly greater after disengagement of the armature by the creation of an air gap between it and said members, whereby the opposing force of magnetic pull is rapidly weakened.

4. In a magneto, of the type wherein an armature moves into engagement with magnetic poles to complete a magnetic circuit entirely through magnetic material and subsequently moves out of such engagement to vary the reluctance of said circuit and a generating winding is associated with said circuit in which currents are induced by the variation of flux therein; mechanism for disengaging the armature and moving it away from its poles against the opposing force of magnetic attraction, said mechanism including means for exerting upon the armature a force which increases progressively from zero until the opposing force is overcome, whereby the armature at the instant of leaving its poles moves slowly under a differential of force, the latter by reason of the rapidly diminishing opposing force of magnetic attraction being effective to move the armature at rapidly increasing speed, a closed circuit choke-winding associated with the magnetic circuit, and means to open said winding after the armature has moved away from the poles sufficiently to acquire the requisite speed.

5. In a magneto, of the type wherein an armature moves into engagement with magnetic poles to complete a magnetic circuit entirely through magnetic material and subsequently moves out of such engagement to vary the reluctance of said circuit and a generating winding is associated with said circuit in which currents are induced by the variation of flux therein; mechanism for disengaging the armature and moving it

away from its poles against the opposing force of magnetic attraction, said mechanism including means for building up a force until it just overbalances the opposing forces, whereby the armature will move away from its poles slowly under a small initial force and the latter, due to the rapidly diminishing resistance of the opposing force of magnetic attraction on separation of the armature from its poles, becomes effective to move the armature at rapidly increasing speed, and a choking winding associated with the magnetic circuit to hold the flux therein until the armature has moved away from its poles sufficiently to acquire the requisite speed.

6. In a magneto, of the type wherein magnetic members are connected to the poles of a magnetic source to act as cores and pole pieces and an armature is moved into and out of contact with said members to connect and disconnect the same, means for depositing the armature on said members, driving means arranged to act on the armature in opposition to the force of magnetic attraction, said first-named means arranged to withdraw relatively gradually from the armature and until the driving means can move the armature.

7. In a magneto, of the type wherein an armature is moved into and out of contact with magnetic poles, means including the force of magnetic attraction between the poles and armature for exerting a force tending to hold the latter to the former, means for exerting a force tending to move the armature away from its poles, and means adapted to be driven from the engine in definite timed relation therewith and periodically effective to gradually change the relation of the opposing forces until that exerted by the second named means becomes just sufficient to overpower that exerted by the first named means and start the armature away from its poles, whereby as the armature continues to move the initially small differential of force effective to move it increases rapidly due to the rapid diminishing of the opposing force of magnetic attraction.

8. In a magneto, of the type wherein an armature moves into engagement with magnetic poles to complete a magnetic circuit entirely through magnetic material and subsequently moves out of such engagement to vary the reluctance of said circuit and a generating winding is associated with said circuit in which currents are induced by the variation of flux therein; driving means tending to move the armature away from its poles, means for gradually diminishing the forces opposing said means until the latter become effective to start the armature from its poles, the armature rapidly increasing in speed after separation from its

poles due to the rapid diminution in the opposing force of magnetic attraction, and a choking winding associated with the magnetic circuit to hold the flux therein until the armature has attained the desired speed.

9. In a magneto, of the type wherein an armature moves into engagement with magnetic poles to complete a magnetic circuit entirely through magnetic material and subsequently moves out of such engagement to vary the reluctance of said circuit and a generating winding is associated with said circuit in which currents are induced by the variation of flux therein; mechanism for moving the armature, including compressible devices acting in opposition thereon, and means for compressing said devices until one overbalances the other and the armature is moved into engagement with its poles, and later progressively releasing said devices until the second just overbalances the combined force due to the first device and magnetic attraction, whereby the armature at the instant of leaving its poles moves at a slow rate which is rapidly increased due to the rapidly diminishing force of magnetic attraction, and a choking winding associated with the magnetic circuit to hold the flux therein until the armature has moved away from its poles a sufficient distance to acquire the requisite speed.

10. In a magneto, of the type wherein an armature moves into and out of connecting engagement with magnetic members connected to the poles of a magnetic source to vary the reluctance of a magnetic circuit and a generating winding is associated with said circuit in which currents are induced by the variation of flux therein; resilient means arranged to act in opposition on said armature, and actuating means transmitting its force through one of said resilient means for moving the armature into engagement with said members, said means arranged to progressively release one of said resilient means until the other is enabled to disengage the armature from said members.

11. In a magneto, of the type wherein an armature moves into and out of engagement with magnetic poles to vary the reluctance of a magnetic circuit and a generating winding is associated with said circuit in which currents are induced by the variation of flux therein; a choke-winding associated with the magnetic circuit and arranged in an electric circuit which can be opened and closed, and means for closing said electric circuit before the armature engages its poles and for later opening it after the armature has engaged said poles.

12. In a magneto, of the type wherein an armature moves into and out of engagement with magnetic poles to vary the reluctance of a magnetic circuit and a generating winding is associated with said circuit in which

currents are induced by the variation of flux therein; a choke-winding associated with the magnetic circuit and arranged in an electric circuit which can be opened and closed, and means for closing said electric circuit before the armature engages its poles and for later opening it after the armature has engaged said poles and again closing it before the armature leaves its poles.

13. In a magneto, of the type wherein an armature moves into and out of engagement with magnetic poles to vary the reluctance of a magnetic circuit and generating and choking windings are associated with said circuit; an electrical circuit including the choking winding, and means for closing, opening, again closing, and again opening said electrical circuit on each reciprocation of the armature.

14. In a magneto, of the type wherein an armature moves in a straight line path toward and away from magnetic poles secured to a frame, a guide sleeve passing through the armature, a driving sleeve telescoping within the first sleeve and having a shoulder, a spring encompassing the driving sleeve and acting between said shoulder and one side of the armature, a guide-rod mounted in the frame to slidably receive the driving sleeve, and a spring encompassing the guide sleeve and acting between the opposite face of the armature and said frame.

15. In a magneto, of the type wherein an armature moves in a straight line path toward and away from magnetic poles secured to a frame, a guide sleeve passing through and secured to the armature, a driving sleeve telescoping within the first sleeve and having a shoulder, a spring encompassing the driving sleeve and acting between said shoulder and one side of the armature, a guide-rod mounted in the frame to slidably receive the driving sleeve, a key in said guide-rod, slots provided in said sleeves in which said key engages, and a spring encompassing the guide sleeve and acting between the opposite face of the armature and said frame.

16. In a magneto, of the type wherein an armature moves in a straight line path toward and away from magnetic poles secured to a frame, a guide sleeve passing through the armature, a driving sleeve telescoping within the first sleeve and having a shoulder, a spring encompassing the driving sleeve and acting between said shoulder and one side of the armature, telescoping cup-shaped members to enclose said spring and arranged one on each of said sleeves, a guide-rod mounted in the frame to slidably receive the driving sleeve, and a spring encompassing the guide sleeve and acting between the opposite face of the armature and said frame.

17. In a magneto, a frame including spaced members, cores extending between said members, coils on said cores, a source of magnetic flux superposed on one of said members and connecting said cores at one end, interrupter mechanism located between said members and between said cores, a casing enclosing said source and removably secured to the last-named member, means enclosing the space between said members to house said coils and interrupter mechanism, and including a separately removable section to permit access to the interrupter mechanism, an armature to connect said cores at their other ends, and actuating mechanism for the armature.

18. In a magneto, a source of magnetic flux, cores connected therewith, coils on the cores, means encasing said source, coils and cores except for short extensions of the latter which pass through and closely fit one wall of said encasing means, an opening provided in said wall between the cores, an armature to periodically connect said extensions of the cores, and reciprocating mechanism associated with the armature and including parts movable through said opening, and a member carried by said mechanism to closely fit and close said opening at all times during the travel of the armature.

19. In a magneto, of the type in which an armature moves into and out of engagement with magnetic poles to vary the reluctance of a magnetic circuit and generating and choking windings are associated with said circuit: interrupter mechanism including an element movable to open or close the choking winding, mechanism for actuating the armature including a part having a travel greater than the latter, means movable by the armature for moving said element, and means movable by said part for actuating said element in a direction opposite to that in which it is actuated by the armature when moving in the same direction as said part.

20. In a magneto, of the type in which an armature moves into and out of engagement with magnetic poles to vary the reluctance of a magnetic circuit and generating and choking windings are associated with said circuit, cooperating and relatively-movable breaker-points to control the choking winding, actuating mechanism for the armature including a member movable in the same di-

rection as the armature but having a greater range of travel, means movable by the armature on one stroke for moving the movable breaker-point in one direction, and means movable by said member on the same stroke for moving the movable breaker-point in an opposite direction after it has ceased to be moved by the armature.

21. In a magneto, of the type in which an armature moves into and out of engagement with magnetic poles to vary the reluctance of a magnetic circuit and generating and choking windings are associated with said circuit, cooperating and relatively-movable breaker-points to control the choking-winding, actuating mechanism for the armature including a member movable in the same direction as the armature but having a greater range of travel, means movable by the armature on one stroke for moving the movable breaker-point in one direction, means movable by said member on the same stroke for moving the movable breaker-point in an opposite direction after it has ceased to be moved by the armature, and yieldable means through which one of said means transmits its force to the movable breaker-point.

22. In a magneto, having a magnetic source, cores, and a generating winding together with a casing enclosing them except for one end of each core, a reciprocable armature to periodically connect the cores at said end, actuating mechanism for the armature including reciprocating parts associated with the latter, the armature and all said parts capable of being withdrawn without opening the casing.

23. In a magneto, having a magnetic source, cores, generating and choking windings and interrupter mechanism associated with the choking winding and including relatively movable breaker-points, a casing to enclose all said elements except for one end of each core, a reciprocable armature to periodically connect the cores at said end, actuating mechanism for the armature including reciprocating parts associated with the latter, the armature, movable breaker-point and all said parts capable of being withdrawn without opening the casing.

In testimony whereof I have affixed my signature.

PHELPS BROWN.