J. M. WOODS & J. S. MAIMONE.

SPARK PLUG.

APPLICATION FILED MAR. 16, 1909.

961,057.

Patented June 7, 1910.

3 SHEETS—SHEET 1.

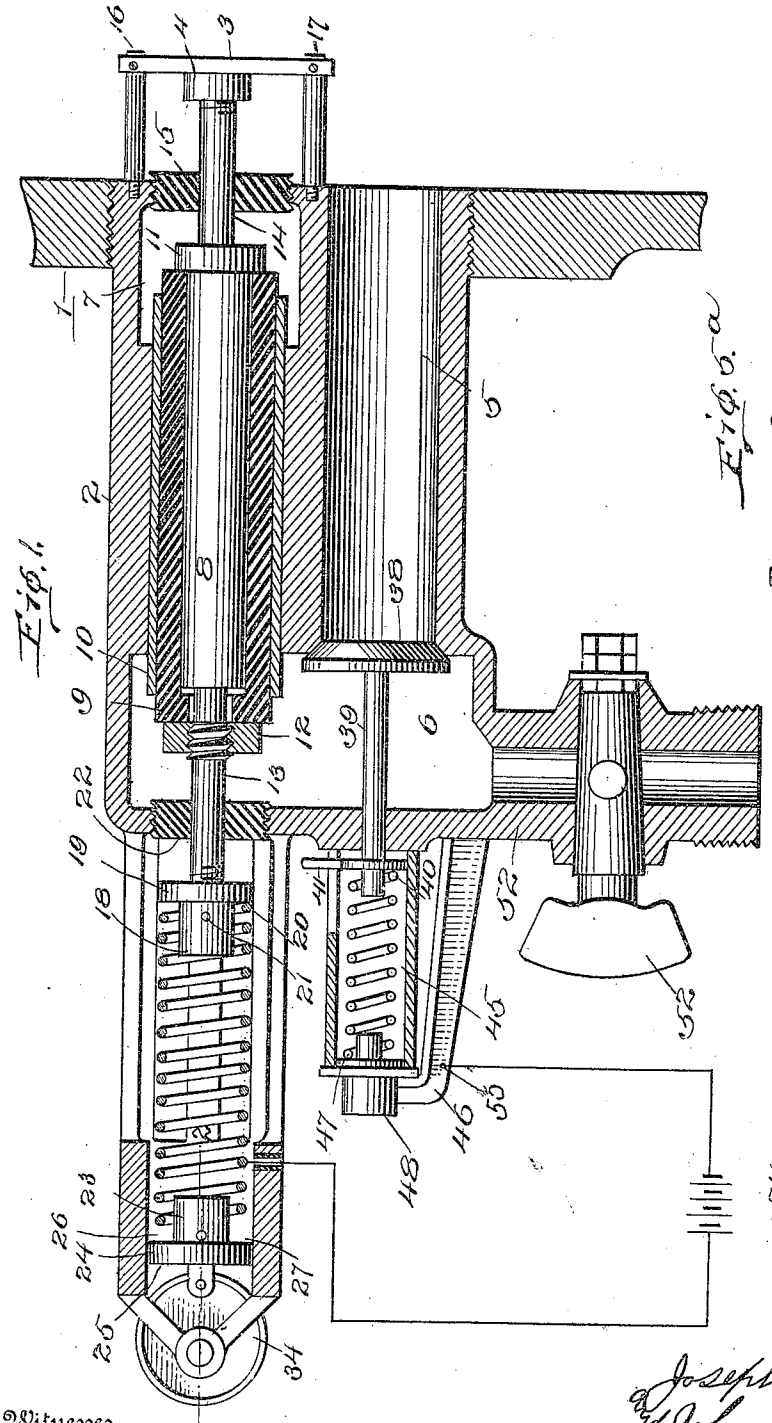

Fig. 1.

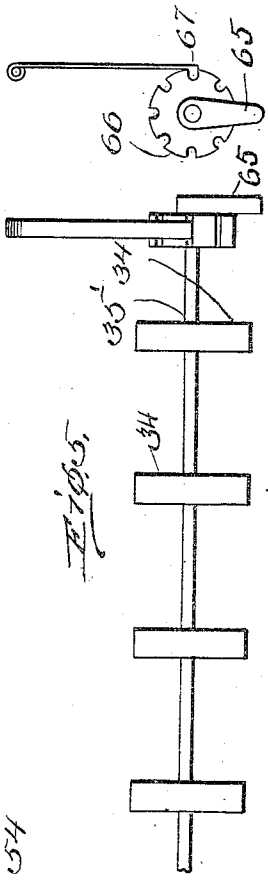

Fig. 5a.

Fig. 5.

Witnesses

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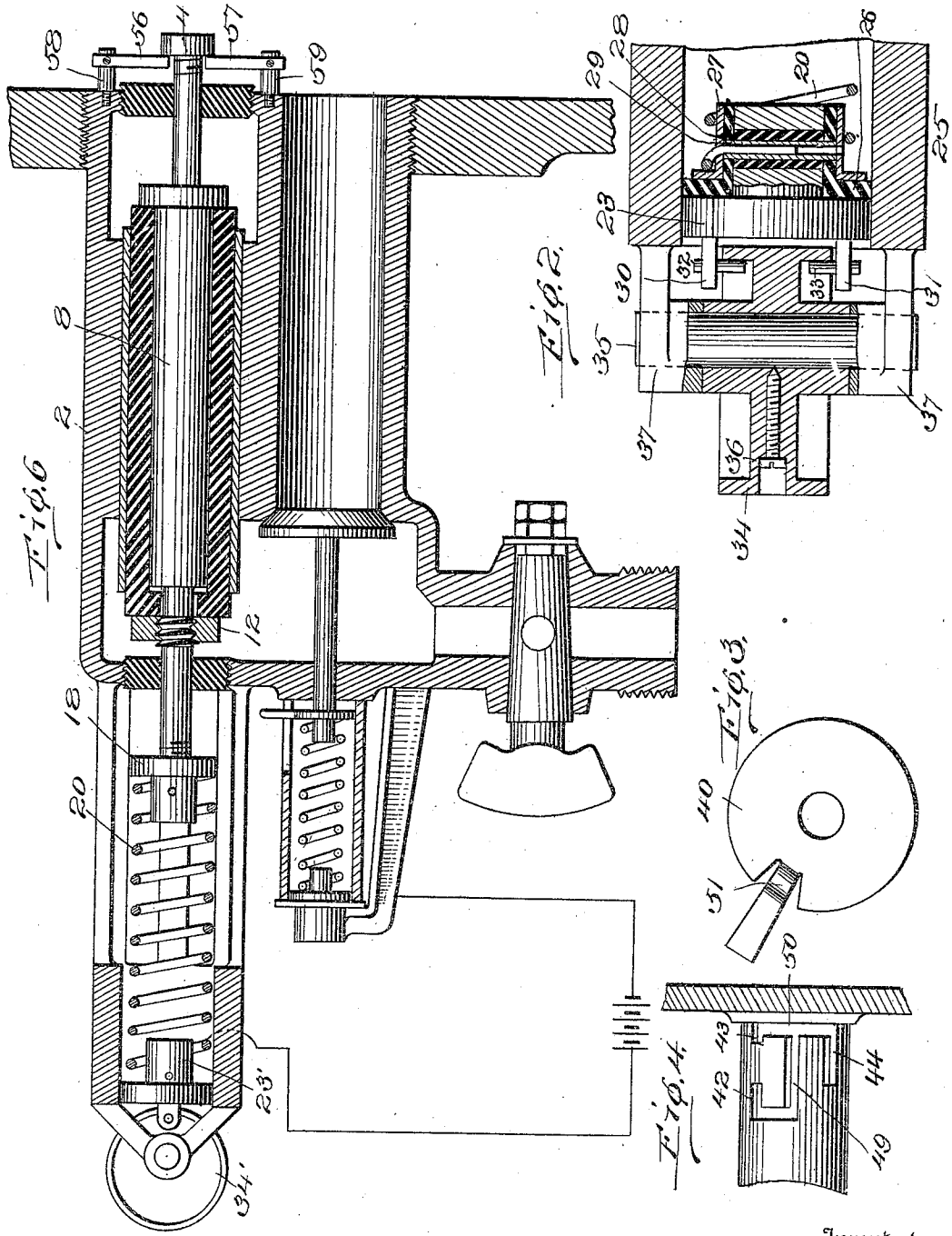
3 SHEETS—SHEET 2.



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3 SHEETS—SHEET 3.

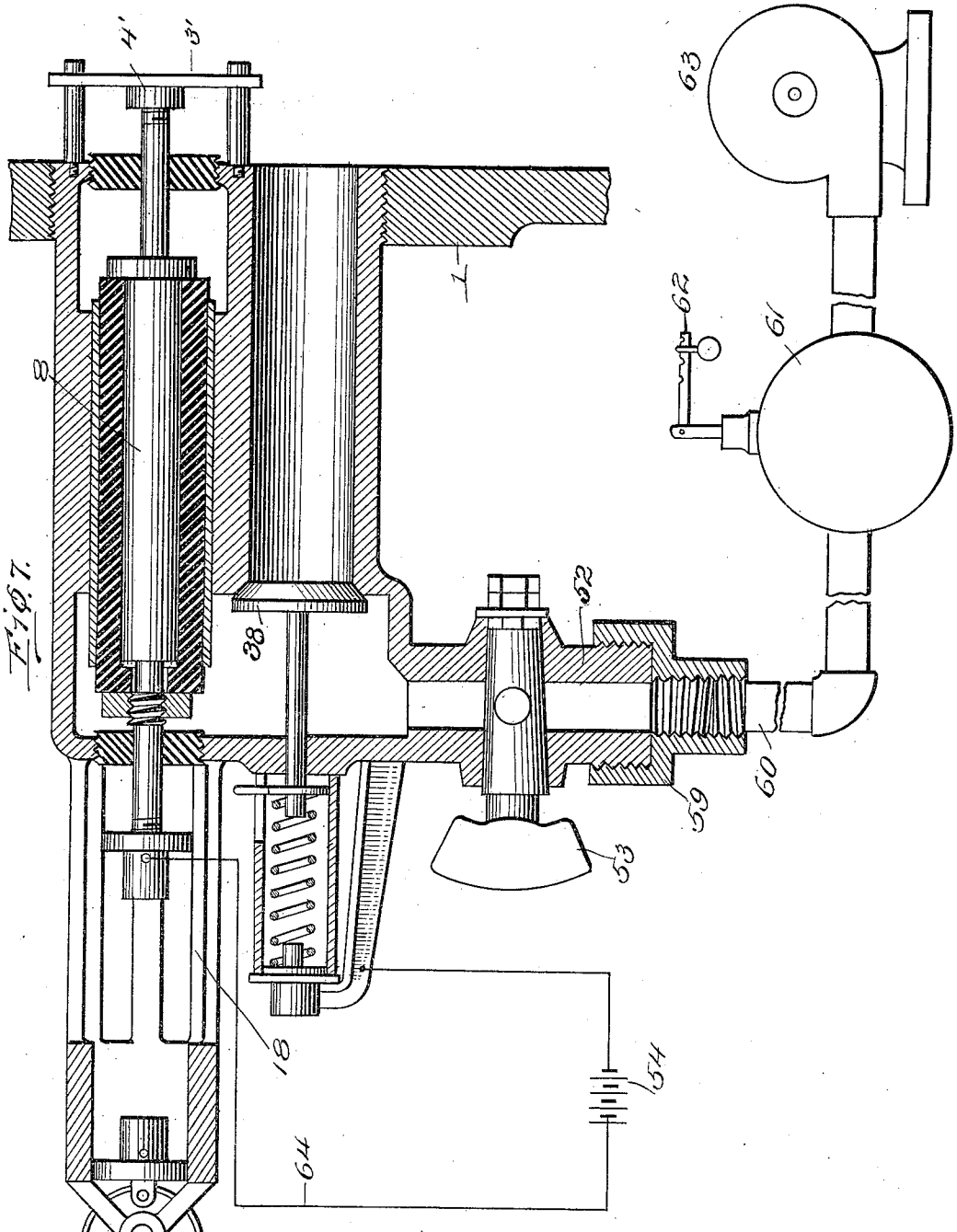

Fig. 7.

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UNITED STATES PATENT OFFICE.

JOSEPH M. WOODS AND JOHN S. MAIMONE, OF DENVER, COLORADO.

SPARK-PLUG.

961,057. Specification of Letters Patent. **Patented June 7, 1910.**

Application filed March 16, 1909. Serial No. 483,783.

To all whom it may concern:

Be it known that we, JOSEPH M. WOODS and JOHN S. MAIMONE, citizens of the United States, residing at Denver, in the county of Denver and State of Colorado, have invented certain new and useful Improvements in Spark-Plugs; and we 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.

This invention relates to improvements in spark plugs, and particularly to that variety of spark plugs having a movable contact member, and has for an object the provision of improved operating means for the movable contact.

Another object in view is the arrangement of a reciprocating contact controlled by a spring in combination with the pressure of the explosive mixture in the engine cylinder, and improved means for varying the action of the spring.

A further object of the invention is the arrangement of a movable contact in a spark plug, which has connected therewith a spring for resisting any movement of the spark plug and a cam for varying the action of the spring, the spring being so arranged in connection with the movable contact as to be overcome by the pressure of the explosive mixture in the cylinder, whereby the movable contact will be caused to move and a spark created.

A still further object of the invention is the arrangement in a spark plug of a movable contact which is so arranged as to use a spring for causing the movable contact to resist pressure exerted thereon, or pressure from any desired source, in lieu of the spring, upon proper adjusting and re-arranging of various parts of the plug.

With these and other objects in view the invention comprises certain novel constructions, combinations and arrangement of parts as will be hereinafter more fully described and claimed.

In the accompanying drawings: Figure 1 is a longitudinal sectional view of the spark plug embodying the invention. Fig. 2 is an enlarged detail fragmentary sectional view approximately on line 2—2 of Fig. 1. Fig. 3 is an enlarged detail view of the valve controlling member embodying certain features of the invention. Fig. 4 is a fragmentary top plan view of a cylinder showing catches for engaging the lever shown in Fig. 3. Fig. 5 is a top plan view of a series of cams and a controlling ratchet, the same embodying certain features of the invention in a slightly modified form. Fig. 5[a] is an end view of the structure shown in Fig. 5. Fig. 6 is a longitudinal vertical section through a slightly modified form of spark plug to that shown in Fig. 1. Fig. 7 is a still further slightly modified form of the plug shown in Fig. 1.

In the construction of a spark plug embodying the invention one of the controlling objects in view is the arrangement of means whereby the pressure of the explosive mixture in the cylinder will cause the movable member of the plug to break contact and thus form a spark. In connection with a structure for accomplishing these objects means are arranged for varying the resistance of the movable member of the plug, whereby a greater or less amount of pressure is required for causing the same to break contact, and in this way the strength of the mixture may be regulated as occasion may require. In forming a structure of this character the same is preferably constructed as shown in the accompanying drawings in which—

1 indicates a cylinder, and 2 a body portion or housing threaded into cylinder 1. The housing 2 may be otherwise secured to cylinder 1 as may be desired, the essential part being that the same is to be secured in such a manner as to permit a stationary contact bar 3 and a movable contact 4 to be positioned in or in free communication with the interior of cylinder 1. The body portion 2 is arranged with a cylindrical opening or chamber 5 that is in free communication with cylinder 1, and a chamber 6 so that pressure from cylinder 1 may act on shaft 8 to force it into chamber 7 when valve 38 has been unseated.

Positioned in the passage way between chambers 6 and 7 is a reciprocating shaft 8 that is surrounded by insulation 9 and a wearing and bearing strip 10. The insulation 9 may be passed over shaft 5 until the same engages stop 11 and is held in place by a nut 12 that is threaded onto the reduced portion 13 of shaft 8. The metallic cylinder 10 is preferably simply forced over the insulation 9 and held thereon by fric-

tion and forms a substantial bearing for the insulation and shaft 8 as the same reciprocate, the sleeve 10 reciprocating therewith. Shaft 8 is reduced at 14 and extends through a nut 15 of any desired or preferably insulating material, as for instance, some good quality of fiber. The nut 15 is designed to make a tight joint with reduced portion 14, and is preferably threaded into housing 2 so as to be easily removed and replaced as desired, and also to firmly hold the same in position. The reduced portion 14 carries at its outer end the contact point or block 4 which is preferably threaded thereon. Contact point or block 4 is designed to normally rest against contact bar 3 which is connected with uprights or supports 16 and 17 by any suitable means, as for instance screws. The uprights 16 and 17 are preferably threaded into housing 2 so as to be easily removable whenever desired. Threaded upon the reduced portion 14 at the opposite end of shaft 8 to contact point 4 is a cap 18 that is formed with a flange 19 against which spring 20 impinges. One end of the spring 20 may be passed through an opening 21 in cap 18 if desired for holding the spring in proper position.

Positioned between flange 19 and chamber 6 is a nut 22 of any desired kind of insulating material, as for instance fiber. This nut is preferably threaded into position, and also forms a tight joint or bearing for reduced portion 13 of shaft 8 so as to prevent the escape of any pressure from chamber 6 at this point. Spring 20 extends from cap 18 to a second cap 23 formed with a flange 24 which is adapted to be reciprocated in a bearing 25 and to be guided thereby. Surrounding the cap 23 is an insulating cap 26 Fig. 2 which in turn is surrounded by a metallic cap 27 that acts as a friction member for spring 20. Spring 20 is designed to press against cap 27 by which motion is conveyed to cap 23 through cap 26. The end of spring 20 if desired may be passed through an opening in cap 23 so as to positively hold the same in position. An insulating sleeve 28 is placed in an aperture formed in cap 23 and has a bearing sleeve 29 of metal mounted therein to present a bearing surface for the end of the spring. In this way the spring 20 is connected firmly to cap 23 and yet is thoroughly insulated therefrom. Projecting from flange 24 are a pair of ears or lugs 30 and 31. The lugs or ears 30 and 31 carry pins 32 and 33 respectively which engage the under surface of the flange of cam 34. Cam 34 is mounted upon a shaft 35 and is adjustably secured thereto by a pointed set screw 36. Shaft 35 is supported by brackets 37—37 which extend from bearing or guide 25. By this arrangement of cam cap 23 may be reciprocated or adjusted, and consequently the tension or compression of spring 20 varied so as to cause a greater or less amount of pressure against contact point or block 4 to move shaft 8 and to separate contact members 3 and 4.

Positioned at one end of chamber 5 is a valve 38 which is provided with a stem 39 arranged to pass through housing 2 and to form a tight joint therewith. Positioned on the end of shaft or stem 39 that projects beyond housing 2 is a stop 40 provided with a controlling lever 41 which is adapted to engage any of the notches 42, 43 or 44 as may be desired. The outer end of housing 45 is supported or braced by a bracket 46 extending from housing 2. Arranged in housing 2 is a spring 47 which presses against stop 40 and against a cap 48 which is placed in housing 45 in order to hold the spring 47 properly in position. Spring 47 normally tends to force stop 40 to the position shown in Fig. 1, and valve 38 into engagement with its seat. As stop 40 is rigidly secured to shaft 39 whenever the same is locked against movement valve 38 will be locked against movement, and in order to lock stop 40 against movement housing 45 is arranged with slots 42, 43 and 44 in which the lever 41 is adapted to be positioned for regulating the position of the stop, and consequently the position of valve 38. When it is desired to hold valve 38 positively in engagement with its seat lever 41 is moved over into engagement with notch 43. When it is desired to lock valve 38 positively in an open position the same is moved to the desired position by moving lever 31 through slot 49, and from thence to slot or socket 42 where the same is held under the action of spring 47. If it should be desired to permit a free reciprocation of spring 47 lever 41 is brought over so as to play back and forth in slot 44. In order that lever 41 may be moved over into a cross slot or opening 50 for moving the lever to notch 43 or slot 44 the lever is weakened or made thinner at 51 so as to permit the lever to spring sufficiently to permit such movement.

Valve 38 is designed to regulate the pressure of explosive mixture from cylinder 1 for controlling the action of contact 4 in that the same by its position determines which way shaft 8 will be moved for making a spark. When the stationary contact 3 is used, as shown in Fig. 1, valve 38 is locked against its seat so as to compel the explosive mixture to press against contact 4 and move the same away from contact 3 against the action of spring 20. When it is desired to use a stationary contact, as shown in Fig. 6, valve 38 is unlocked and permitted to become unseated upon the pressure of explosive mixture impinging against the same, so as to permit the pressure to be exerted

against nut 12 and surrounding parts for forcing contact 4 away from stationary contacts 56 and 57.

Connected with housing 2 is a projection 52 provided with a valve 53. The projection 52 is adapted to receive pressure from various sources as hereinafter more fully described.

In order that current may be properly supplied to contact points or members 3 and 4 a source of current of any desired kind, as for instance battery 54, is provided which has one side thereof connected at 55 to bracket 46. Bracket 46 is in electrical communication through housing 2 with chamber 1 and as the posts or uprights 16 and 17 are secured to cylinder 1 the same are in free electrical connection with one side of battery 54. The uprights or posts 16 and 17, as heretofore set forth, have secured thereto contact member 3 so that contact member 3 is grounded upon the cylinder 1 so that it is necessary to have the contact point 4 insulated therefrom as heretofore set forth. Battery 54 is connected to spring 20 but is insulated from housing 2 or any parts in electrical connection therewith, and as spring 20 and parts connected therewith are insulated battery 54 cannot become short-circuited. The current from battery 54 will pass onto spring 20, and from thence to guiding member 19, shaft 8, contact 4, contact 3, housing 2, bracket 46, and from thence back to battery 54. Spring 20 is insulated from member 24 by cap 26, and also by insulating sleeve 28 so that no current can escape therefrom to housing 2. The inner end of spring 20 which engages cap 18 does not contact with anything except cap 18, which in turn does not contact with anything except the reduced portion 13 of shaft 8. The shaft 8 is insulated by nuts or threaded sleeves 22 and 15, and also by a sleeve 9.

When the mechanism of the spark plug is in the position shown in Fig. 1 current is flowing, but immediately upon a sufficient pressure being provided in cylinder 1 to overcome the action of spring 20 contact 4 will break with contact 3, and a spark will result for igniting the compressed explosive mixture. After the mixture has been exploded the pressure will be relieved and spring 20 will be permitted to move shaft 8 and force contact member 4 against contact member 3 for closing the circuit. Immediately upon the compression of a second charge of explosive mixture to a sufficient degree to overcome spring 20 the same action is repeated as above set forth.

In starting the engine the cylinder is turned over in any desired manner for compressing the initial charge of explosive matter. Immediately upon the explosive mixture reaching a predetermined pressure the same will act upon contact 4, and force the same in against the action of spring 20, valve 38 being locked against its seat. When it is desired to change or vary the degree of pressure necessary in which to move contact member 4 cam 34 is partially rotated for moving cap 23 toward or from nut 22 and for consequently compressing or relieving the pressure of spring 20 so that the same will act more strongly or not quite so strong against shaft 8, and thereby either require an increased or decreased pressure in the explosive mixture before the same will move contact member 4. As the cam is set in Fig. 1 of the drawing the spring 20 is compressed to its extreme limit so as to require an extreme amount of compression of the explosive mixture to cause contact member 4 to break contact with member 3. By this construction and arrangement a greater or less amount of power will be provided and a greater or less amount of speed produced in the engine by the proper manipulation of cam 34. When the cam is set as shown in Fig. 1 the engine is running comparatively slow and producing maximum power, but if turned to substantially the opposite position comparatively little power will be generated but a comparatively high speed.

In Fig. 6 is seen a slightly modified form of the invention in which like reference numerals will be used for corresponding parts and the modified parts designated by additional numerals. Referring more particularly to this form of invention it will be observed that a spring 20′ is used which is a retractile spring, that is, a spring that is normally contracted so that any power applied thereto for stretching the same will be resisted. Spring 20′ is connected with cap 23′ which is formed similar to cap 23, and will therefore need no additional description. Cap 23′ is associated with a cam 34′ similar to cam 34 but arranged to cause a greater or less stretching or tension of spring 20′, while cam 34 of the preferred form is designed to create a greater or less compression. Spring 20′ is connected at one end with cap 23′ and at the other end to cap 18 for causing cap 18 to have a continuous tendency to move toward cap 23′. This will cause contact 4 at the inner end of shaft 8 to normally rest against contact members 56 and 57 which are supported by uprights 58 and 59 which in turn are threaded into housing or casing 2. By this arrangement a greater or less tension may be brought to bear upon contact member 4 for causing the same to engage contact members 56 and 57 for varying the amount of pressure required to move the same for breaking the contact.

In order to cause contact member 4 to move away from contact members 56 and 57 against the action of spring 20′ pressure from cylinder 1 will pass into chamber 6,

and press against nut 12 and the associated parts, including insulation 9 and sleeve 10. When the pressure in the cylinder, and consequently in chamber 6, has reached a sufficient degree the same will force shaft 8 inward and cause contact member 4 to break contact with members 56 and 57 which will result in a spark. The construction and operation of this form of the invention is identical with that shown in Fig. 1, except the arrangement of contact members 56 and 57 and surrounding parts, and also the provision of a spring that resists stretching or expansion, and the use of means for varying the amount of resistance thereof.

A still further modified form of the invention is shown in Fig. 7 in which the same parts or structures are used principally, but the spring that acts upon shaft 8 is removed and gaseous pressure used in place thereof. In this embodiment of the invention the valve 38 is positively locked closed, and instead of having a spring to actuate shaft 8 pressure is supplied through valve 53 for acting on shaft 8 near its inner end for normally holding the same in an outer position. Connected to the extension 52 is a nipple 59 which has in turn connected thereto a pipe 60 that is in free communication with a storage tank 61. The storage tank 61 has a safety and regulating device 62 connected therewith for maintaining the pressure in tank 61 at any desired degree. A compression pump or fan 63 is provided for supplying pressure to tank 61. The fan 63 may be driven by any desired means for maintaining the desired pressure in tank 61. When it is desired to start the engine to which the plug is attached valve 53 is opened or turned for permitting a free communication between tank 61 and chamber 6. This will cause the pressure in tank 61 to act against shaft 8 and force the same inward against contact member 3′. The pressure is maintained continuously in chamber 6, and against shaft 8 so as to act as a continuous yielding resistance thereto somewhat on the order of spring 20 of the preferred structure.

When it is desired to start the engine the same is turned over or the piston is caused to move in any desired manner for compressing the charge of explosive mixture. Immediately upon the pressure in cylinder 1 reaching a sufficient tension to overcome the pressure in chamber 6 and cylinder 61 contact member 4′ will move outward or away from contact member 3′, and consequently a spark will be the result. In connection with the electrical circuit for causing the sparking it will be noted that battery 54 is connected to bracket 46 and to cap 18, and from such respective connections to the contact members 3′ and 4′. In compressing the explosive mixture in cylinder 1 it will be also noted that the same must be compressed to a greater degree than the pressure in chamber 6 as the inner end of shaft 8 is smaller than the outer end. If it is desired to cause the engine to provide a considerable amount of power but comparatively slow speed a comparatively large pressure is maintained in tank 61, and consequently in chamber 6, so that it will require the explosive mixture to be compressed to a considerable extent before explosion thereof. If less power is desired, and for instance a greater speed, pressure in tank 61 is lowered by properly operating the regulator 62. This will cause the pressure against the outer end of shaft 8 to be less, and consequently to require a less amount of pressure in the explosive mixture to move contact member 4′. By this construction and arrangement the power and speed of the engine may be varied as occasion may require by simply regulating the pressure in tank 61.

If desired the reduced extension 13 of shaft 8 might be cut off substantially even at nut 12, and the insulating nut 22 made solid or made from metal as may be desired, and wire 64 passed through the metal and secured to shaft 8 in chamber 6, the wire of course being insulated. However, the mere removal of spring 20 and the connecting of wire 64 to cap 18 is preferable, as the same structure shown in Fig. 1 could be used with the addition of the pressure mechanism and the use of valve 53.

If desired any desired number of engines having spark plugs, as shown in Figs. 1 and 6, can be connected to by a shaft 35′ similar to shaft 35, except that the same is arranged to extend from one plug to another and to carry the respective cams 34 of the various plugs. A lever or handle 65 is connected to shaft 35′ for presenting means by which the shaft may be rocked or rotated as desired for varying the position of the various cams at the same time. A ratchet wheel 66 is secured to shaft 35′ and is normally held against movement by a spring pressed catch 67. The respective cams 34 on the respective plugs are adjusted as may be desired for causing the engines to run fast or slow as preferable, and then secured to shaft 35′ by set screws 36. By this means a plurality of engines may be coupled together that run at various speeds and the action of all of the same may be varied at the same time by merely turning shaft 35′ a short distance. By this arrangement the pressure or tension of the respective springs may be varied in relation to each other, and through them the pressures in the respective cylinders may be varied so that one cylinder may run at high speed, another at low speed, and others at various speeds as desired, and the speed and power of all together may be changed by simply turning one shaft 35′.

It will of course be evident that not only may the engines coupled together by shaft 35′ be run at various speeds and produce varying power, but engines arranged to produce the same speed or power may be connected up and have the action thereof varied at the same time by the operation of a single shaft.

What we claim is:

1. In a spark plug, stationary and movable contacts arranged to be in free communication with the cylinder to which said plug is attached, a reciprocating shaft secured to said movable contact, a spring for normally holding said contacts together, a rotatable cam connected with said spring for varying the action thereof, means for locking said cam in various positions, and means for supplying current to the contacts.

2. In a spark plug, a casing, a stationary contact, a movable contact, means for yieldingly holding the movable contact against the stationary contact, means for varying the pressure of said yielding means, and a cam for controlling said last mentioned means.

3. In a spark plug, a casing, a stationary contact, a movable contact, a reciprocating shaft carrying said movable contact, an insulating sleeve surrounding said reciprocating shaft, a reciprocating bearing member surrounding said insulating sleeve, resilient and yielding means for normally holding said contacts together, and means for supplying current to said contacts.

4. In a spark plug, a stationary contact member, a movable contact member normally in engagement with said stationary contact member, said movable contact member being in free communication with the cylinder to which the plug is attached for permitting the pressure of the explosive mixture to act thereon for separating the same from said stationary contact member, a reciprocating shaft connected with said movable contact members, a spring for normally holding said contact members together, and a cam for varying the action of said spring.

5. In a spark plug, stationary and movable contacts arranged to be in free communication with the cylinder to which said plug is attached, a movable shaft secured to said contact movable member, a spring for acting on said shaft for normally holding said contact members together, a cam for varying the action of said spring on said shaft, means for holding said cam in various positions for causing the same to act variously upon said spring, and means for supplying current to said contact members.

6. In a spark plug, a housing, a stationary contact, a movable contact, a shaft connected to the movable contact arranged to be forced in one direction by the pressure of the explosive mixture in the cylinder to which the plug is attached for moving the movable contact from the stationary contact, a spring for normally resisting movement of said shaft, a sliding member carried by the spring at one end, ears projecting from said sliding member, a cam, pins projecting from said ears and engaging said cam whereby when said cam is moved, said sliding member will be moved and the action of said spring varied, and means for supplying said contact members with current.

7. In a spark plug, the combination with a cylinder, of a housing, a stationary contact connected to said housing and projecting into the cylinder to which said housing is secured, a movable contact member normally in engagement with said stationary member, a reciprocating shaft carrying said movable contact member, an insulating sleeve surrounding said shaft, a bearing sleeve surrounding said insulating sleeve, a spring connected with said reciprocating shaft and acting upon the same for causing the shaft to normally hold said movable contact member against said stationary contact member, a sliding support for the opposite end of said spring to that secured to said reciprocating shaft, a guide for said sliding support, and insulating means for preventing said spring from coming into electrical contact with said guide, a cam, means for connecting said sliding support and said cam whereby when said cam is moved said sliding support will be moved and the action of said spring varied, means for locking said cam in various positions, and means for supplying current to said contact members.

In testimony whereof we affix our signatures in presence of two witnesses.

JOSEPH M. WOODS.
JOHN S. MAIMONE.

Witnesses:
EARLE WHITEHEAD,
ISABEL M. STRONG.