A. F. AND V. D. COLLINS.

SPARK PLUG.

APPLICATION FILED JUNE 17, 1919.

1,401,585. Patented Dec. 27, 1921.

Fig. 1.

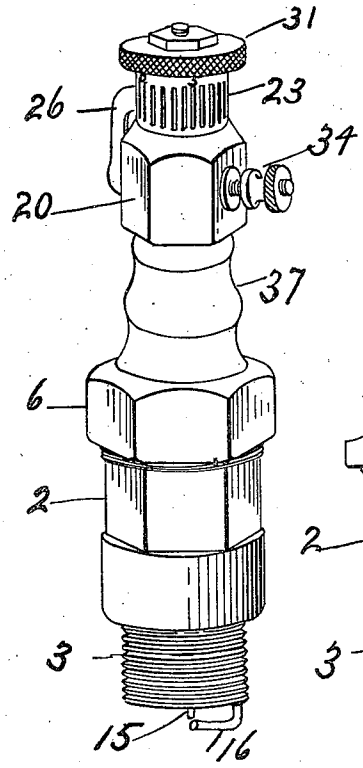


Fig. 2.

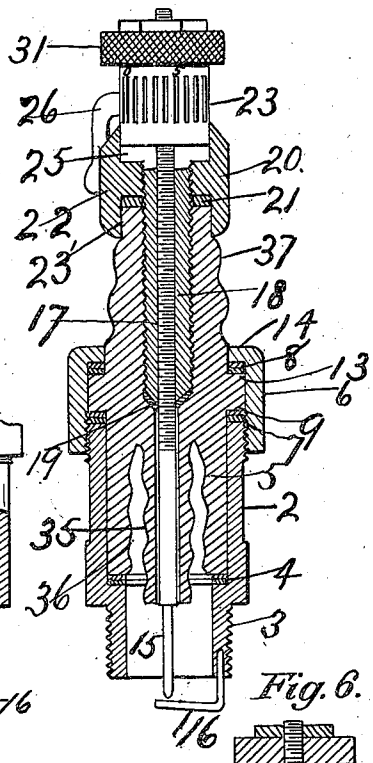


Fig. 3.

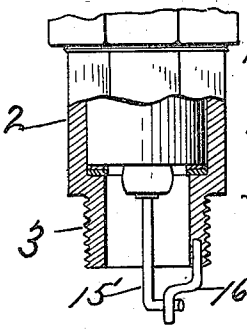


Fig. 4.

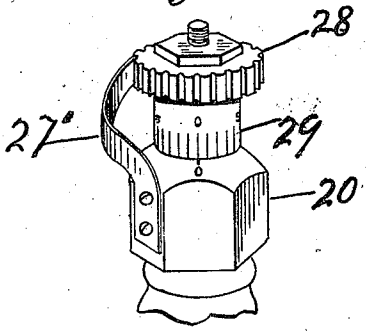


Fig. 5.

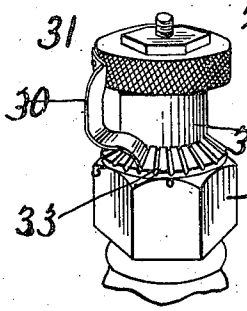


Fig. 6.

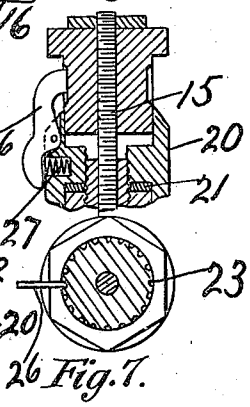


Fig. 7.

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UNITED STATES PATENT OFFICE.

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SPARK-PLUG.

1,401,585. Specification of Letters Patent. Patented Dec. 27, 1921.

Application filed June 17, 1919. Serial No. 304,845.

To all whom it may concern:

Be it known that we, ARCHIE FREDERICK COLLINS and VIRGIL D. COLLINS, citizens of the United States, residing at Congers, in the county of Rockland and State of New York, have invented certain new and useful Improvements in Spark-Plugs, of which the following is a specification.

This invention relates to spark plugs for gas engines, the object thereof being to provide an improved spark plug in which the terminal electrodes or wires may not only be adjusted one relatively to the other whereby the spark gap may be varied and set to suit varying conditions not only with precision but such setting mathematically and accurately measured without the use of any independent means for this purpose and this when desired without the removal of the plug from the engine.

A further object of the invention is the provision of an improved spark plug having formed as a part thereof means for accurately measuring the spark gap during the setting thereof and which means is also effective to vary the spark gap as occasion requires.

A further object of the invention is the provision of an improved spark plug having embodied therein a micrometer for measuring the accuracy of the spark gap and also including means for accurately correcting such micrometer.

A further object of the invention is the provision of an improved spark plug having embodied therein not only means for accurately varying the spark gap as the conditions of the engine may require without the removal of the plug from the engine, but which means may also be utilized for determining whether the spark gap is varied during the running of the engine.

A further object of the invention is the provision of an improved spark plug so constructed that it may be readily taken apart for cleaning and quickly assembled, but which is so constructed that it affords increased protection against gas leakage.

A further object of the invention is the provision of an improved spark plug having the advantages herein set forth, which however, is simple in construction, comparatively inexpensive to manufacture and very durable and efficient in use.

A further object of the invention is the provision of an improved spark plug having an improved form of insulator.

A further object of the invention is the provision of an improved spark plug having improved means for preventing the breakage of the insulator on the slippage of the wrench.

In the drawings accompanying and forming a part of this specification, Figure 1 is a side view of one form of this improved spark plug; Fig. 2 is a vertical sectional view thereof; Fig. 3 is a partly vertically sectional view showing one way in which the terminal electrodes may be adjusted; Fig. 4 illustrates a somewhat different form of the measuring and adjusting means; Fig. 5 illustrates a still different form of the measuring and adjusting means; Fig. 6 is a vertical sectional view of the upper part of the plug shown in Figs. 1 and 2; and Fig. 7 is a cross sectional view of Fig. 2.

Similar characters of reference indicate corresponding parts in the several figures of the drawings.

As is well known to those versed in the art of automobile ignition, there are certain exacting conditions which must be met and therefore the spark plug must be designed and constructed in order to meet such conditions; for instance the spark gap length must be accurately varied to the thousandth of an inch as the compression is increased or decreased or as the speed of the engine increases or decreases, or as the richness of the fuel charge increases or decreases, or as the current strength and the electromotive force increases or decreases, or as the frequency of the oscillatory discharge increases or decreases.

Moreover the plug must be so constructed as to prevent any leakage of the compressed fuel charge through it and must be readily accessible for cleaning.

Further the plug must be so insulated as to prevent any leakage of the high tension current or short circuiting in the plug.

In addition, the electrodes must be so constructed or protected or both that they will not become heated to incandescence and preignite the fuel charge in high speed, high compression engines of small firing chamber volume.

And finally, it is also necessary that the insulating material projecting above the plug shell shall be so protected as to prevent

accidental breakage by the slipping of the wrench when screwing the plug into the cylinder or unscrewing the same. The present improvement provides an efficient spark plug which will meet the foregoing conditions.

For every make of engine built, for the different compressions that are employed, and for the varying sizes and proportions of the cylinders, and for the specific type of ignition system used, there is a critical spark gap length which is necessary. In other words, there is a spark gap length that is the most efficient.

As every automobile owner is aware, the ordinary plug in common use of whatever form or make must be taken out of the cylinder head and whatever adjustment that is made by the maker of the engine or by the owner thereof is usually guess work and must be made with a pair of pliers, and if any attempt is made to even approximately make the adjustment accurate a thickness gage must be used which is a method comparable to that of measuring the thickness of a sheet of paper with a carpenter's rule. Obviously this is a very laborious and impractical way of obtaining an accurate adjustment of a spark gap that must be limited to the variation of not more than .010 of an inch, *i. e.* between .020 to .030 of an inch.

While we are aware of the fact that patents have been granted for spark plugs in which the spark gap can be varied or adjusted without removing the plug from the cylinder, yet so far as we are aware, no patent has ever been issued in which means are provided for measuring the spark gap length. In order words, while the prior art discloses patents showing the plug fitted with an indicator by means of which the spark gap may be roughly gaged, they are of no practical value since the spark gap cannot be measured by such a construction of indicator as herein referred to.

In the present improvement the spark plug has embodied therein a micrometer, by means of which the spark gap length can be measured to the .001 of an inch and not only this, but the terminals are adjustable one relatively to the other whereby the spark gap length is variable and this without even removing the plug from the cylinder.

This improved spark plug in the various forms thereof shown, comprises a chambered shell 2, having an exteriorly threaded lower end 3 for insertion into the engine. Located within this shell and fitting on to a shoulder thereof is a suitable gasket 4. The shell carries suitable insulating material 5 shown in the form of a porcelain insulator, which is secured within the shell by means of a nut or sleeve 6, suitable gaskets 7 and 8 being located between the upper end of the shell and a shouldered portion 9 of the porcelain and between a similarly shouldered portion 13 of the porcelain and the inturned edge 14 of the sleeve thereby to provide gas-tight joints. The nut or sleeve 6 is threaded on to the upper end of the shell in a manner which will be readily understood. The porcelain shown is of the chambered or petticoat form and carries within the same the central electrode or terminal wire 15, the other terminal wire 16 being carried by the shell in the usual manner. The central terminal wire is provided with threads 17, fifty threads to the inch, and these threads mesh with a threaded stationary sleeve 18 set into or threaded into the insulator with a gas-tight joint at its lower end obtained by means of a suitable gasket 19. Mounted on the upper end of this threaded sleeve 18 is a rotatable thimble 20 provided with threads coöperating with the threads formed at the upper end of the sleeve, a suitable washer 21 being located between the upper end of the porcelain and the inturned portion 22 of this thimble. The thimble is chambered as at 23′ so that it overlaps the upper end of the porcelain. The upper threaded end of the central electrode rigidly carries a fluted micrometer sleeve 23 which is adapted on the rotation thereof to slide up and down in the thimble just described, which is chambered as at 25 for this purpose. To the thimble 20 in the forms shown in Figs. 1, 2 and 6 is secured a spring pointer or locking latch 26 shown in these views as a pivoted latch, the lower end of which is in engagement with a spring 27 seated in a recess in the thimble and the upper end of which latch is thus pressed into engagement with the grooves or flutes in the micrometer sleeve 23. In the form shown in Fig. 4 the pointer or latch is in the form of a leaf spring 27 riveted or otherwise secured to the thimble 20 and adapted to engage flutes or grooves 28 of the micrometer sleeve 29, while in the form shown in Fig. 5 the pointer or latch is also shown as a leaf spring 30 secured to a knurled nut 31 formed as a part of a rotatable sleeve 32. In this last form the micrometer grooves or recesses 33 are formed at the top of the thimble 20. In all forms it will be understood that the sleeve 23 or 29 or 32 is of course rigidly secured to the terminal electrode 15 so that the electrode will rotate with such sleeve. In any of the forms shown, the latch will readily slip into and out of the flutings, of which there are twenty on the micrometer sleeve, when the sleeve is rotated in the proper manner. In the form shown in Figs. 1, 2 and 6, the terminal post 34 and nut for the connection of the conduit wire is shown at the side of the thimble, but this could be otherwise located if desired.

When it is desired to set the spark gap to a certain micrometric length, it is merely

necessary to turn the sleeve 23 or 29 or 32 by means of its knurled or grooved nut, and as this sleeve is securely fixed to the central electrode, the latter will rotate with the sleeve until the points of the electrodes just touch each other. When they are in this position the locking latch or spring pointer will engage with the 0 or zero fluting of the micrometer scale on the sleeve.

As there are fifty threads to the inch on the central electrode, it is obvious that for every twentieth of a turn of the micrometer sleeve the length of the spark gap will be varied by one-thousandth of an inch, so that every time the micrometer sleeve is given a twentieth of a turn, the spring pointer or locking latch slips from its position in one fluting until it engages into the next, and hence as stated, the spark gap length is varied by one-thousandth of an inch. This micrometric measurement of the variation of the spark gap length is further facilitated by the scale numbers stamped on or in proximity to the fluted scale on the micrometer sleeve while the spring actuated latch serves to lock the micrometer sleeve in its proper adjusted position and prevents it from moving under the vibration of the engine.

By means of the present improvement, it can be readily determined whether the spark gap length has been shortened due to the building up of the electrodes by the products of combustion on their opposed surfaces or by the electrolytic action of the current in carrying particles of metal from one electrode to the other or by the heat of combustion which melts the ends of the electrodes and forms beads of metal on them. The spark gap length is frequently lengthened also by the heat burning off the ends of the electrodes or by the warping thereof. Consequently the present improvement will tend to show when the piston rings permit the lubricating oil to leak past them into the combustion chamber or when too rich a fuel mixture is being used or when the electrodes are not being properly cooled and thus effect the terminal points. For instance, to ascertain whether the spark gap is too short or too long due to any of the conditions hereinbefore referred to, it is only necessary to bring the electrodes together as far as is possible by rotating the micrometer sleeve in the proper direction. If they are in proper condition, then the lock spring or pointer will engage with the flute marked "Zero" or "0," that is, if the electrodes are of normal length or in proper condition but if the length of the electrodes has been altered in any way during the running of the engine, the lock spring will not engage with the zero fluting of the scale, but with a fluting to one side or the other thereof, and since each fluting represents .001 of an inch it can be readily and exactly determined how much the gap has been altered by the building up or the burning off of the electrodes. In this condition of course the micrometer, if manipulated will not give the true spark gap length accurately, and hence this gap cannot now be effectively adjusted, but by means of the present improvement the calibration of the micrometer can be readily made, so that the spark plug gap can be again accurately adjusted. This calibration is effected by means of the rotatable thimble 20 hereinbefore described, which can be rotated in either direction, that is, clockwise or counter-clockwise, as the case may be, until the spring latch again engages with the zero fluting of the micrometer sleeve, and when so adjusted, in other words, when the micrometer has been calibrated in the manner described to accuracy then it is again ready for use.

In other words in order to calibrate, *i. e.* to correct or rectify the graduations of the micrometer or measuring instrumentality for ascertaining with mathematical accuracy the length of spark gap, it is merely necessary to rotate the sleeve 23, 29 or 32, as the case may be until the electrode 15 contacts with the electrode 16. When, therefore, as illustrated in Fig. 5, the pointer 30 engages the fluting as, for instance, at graduation No. 3, it will be necessary to reposition the thimble 20 so as to place the graduation reading zero of the thimble 20 opposite this fluting 3 wherein the pointer or indicator 30 now rests in its newly adjusted position. This is necessary in order to adjust thereafter the spark gap between the electrodes by measuring the same from a zero graduation on the thimble. As hereinbefore set forth, this calibration of the micrometer or, in other words, the rectifying of the graduations thereof is obtained by rotating the thimble 20 so that the zero graduation thereof will correspond to the new position of the pointer 30 on the fluting with electrode 15 at the same time in contact with electrode 16.

Having accomplished this correction or calibration of the measuring means, the sleeve 23, 29 or 32 may then be rotated to adjust anew the spark gap the proper amount.

It will of course be obvious that the various details may be more or less departed from without departing from the spirit or scope of the present improvement, and that instead of adjusting the central electrode lengthwise the central electrode 15′ may be rotated, for instance as in Fig. 3, to carry it toward and from its companion electrode or in place of the pivoted locking latch shown in Figs. 1 and 2 a leaf spring may be used, as shown in Figs. 4 and 5, and that instead of carrying the flutings on the micrometer sleeve as shown in Figs. 1, 2 and

6, they may be carried on the nut formed as a part of the sleeve 20 as shown in Fig. 4 or carried instead of on the nut on the upper edge of the rotatable thimble 29 as shown in Fig. 5, all of which forms of the device however, embody the micrometer principle in combination with a spark plug having an adjustable spark gap.

There are two forms of spark plugs well known upon the market,—one comprising the assembled plug in which the parts may be readily separated for cleaning, and the other the pressed plug. The present construction combines the best qualities of both types in that it offers protection against gas leakage and yet the parts of the plug may be readily separated and quickly assembled, and therefore the plug need not be thrown away when it becomes sooted.

In the present improvement, the sleeve 18 carrying the central electrode is pressed into the insulator, which makes it gas-tight, and this insulator is also made gas-tight in the plug shell 2 by means of the removable hexagonal ring nut or sleeve 6, which enables the plug to be readily taken apart and cleaned.

It is well known to those versed in high frequency and high potential electricity that the best shape for an insulator is one having a corrugated surface; this is because the corrugations provide a larger surface per unit of area than a flat surface and hence it offers a greater resistance to the high tension currents, which may leak through, and which tend to travel on the surface.

It is further well known that spark plug insulators of the petticoat type provide a better protection against the leakage of the high tension currents when they become sooted by reason of the additional surface area they offer. From the construction of the insulator shown in the present improvement, it will be observed that the corrugated petticoat type shown provides nearly one-third more surface area and hence resistance than any others of which we are aware, since both opposing walls 35 and 36 of the chambered porcelain around the central electrode are corrugated as well as that portion thereof as 37 which projects beyond the metal body portions of the plug.

It is also known to designers and manufacturers of high compression, high speed engines having small combustion chambers, that the ordinary petticoat insulator is undesirable for its leaves the central electrode unprotected and the intense heat developed causes the electrode to become incandescent, when of course pre-ignition occurs, and therefore these designers and manufacturers recommend solid insulators in preference to those of the petticoat type. Now, as solid insulators provide but small surface resistance to short circuiting due to soot, it will be readily seen that the present improved insulator which is a combination of the solid and petticoat type, is a great improvement over either of the above named types of insulators, when used separately, since it protects the electrode and at the same time offers a high resistance to the high tension currents. Moreover, it will be observed that in the present improved plug that part of the insulator which projects above the plug shell is protected from breakage when a wrench is used to screw or unscrew the plug in place, since the hexagonal ring nut or sleeve 6 takes the place of the small internal bushing usually found in the ordinary plug, and as this ring nut is above and extends outwardly beyond the shell 2 which is provided with the usual wrench receiving surface, it follows that when the wrench is applied to the shell the wrench cannot slip off and up and so strike the insulator and break it. Thus the present improvement provides a long life plug.

We claim as our invention:

1. A spark plug having a pair of electrodes, one adjustable relatively to the other thereby to vary the spark gap, said plug embodying means for adjusting said electrode, means for accurately measuring the spark gap, and means for correcting the setting of such measuring means.

2. A spark plug having a pair of electrodes, one adjustable relatively to the other thereby to vary the spark gap, said plug embodying means for adjusting said electrode, means for accurately adjusting the spark gap, and means for calibrating said measuring means while the plug is in its operative position.

3. A spark plug having a pair of electrodes, one adjustable relatively to the other thereby to vary the spark gap, said plug embodying means for adjusting said electrode, a micrometer for accurately measuring the spark gap, and means for calibrating said micrometer while the plug is in its operative position.

4. A spark plug having a pair of electrodes, one adjustable lengthwise relatively to the other thereby to vary the spark gap, said plug embodying means for adjusting said adjustable electrode lengthwise, means for accurately measuring the spark gap, and means for calibrating such measuring means while the plug is in its operative position.

5. A spark plug having a pair of electrodes including a centrally located one adjustable relatively to its companion electrode thereby to vary the spark gap, said plug embodying means for adjusting said electrode, means for accurately measuring the spark gap, and means for correcting the setting of such measuring means while the plug is in its operative position.

6. A spark plug having a pair of elec-

trodes including a centrally located one adjustable relatively to its companion electrode thereby to vary the spark gap, micrometer means for adjusting said central electrode and accurately measuring the spark gap, and means for calibrating said micrometer while the plug is in its operative position.

7. A spark plug having a pair of electrodes, one comprising a centrally located electrode adjustable relatively to its companion electrode thereby to vary the spark gap, means for adjusting and accurately measuring such gap without removing the plug from the cylinder and including a micrometer measuring instrumentality, and means for calibrating it.

8. A spark plug having a pair of electrodes, one comprising a movable electrode shiftable toward and from its companion electrode, measuring and calibrating means comprising a pair of rotary elements, one adapted to control the movement of said movable electrode and the other movable independently thereof whereby the spark gap may be accurately measured and said measuring means may be rectified.

9. A spark plug having a pair of electrodes, one comprising a centrally located adjustable electrode having a predetermined number of threads to the inch, a rotary sleeve rigidly secured to said adjustable electrode and having a predetermined number of graduations whereby the spark gap may be varied and measured, and means for calibrating said measuring instrumentality while the plug is in an operative position.

10. A spark plug having a pair of electrodes, one comprising a centrally located adjustable electrode having a predetermined number of threads to the inch, a rotary sleeve secured to said adjustable electrode and effective to rotate the same and having a predetermined number of graduations whereby the spark gap may be varied and measured, means for calibrating said measuring instrumentality, and means for holding said sleeve in its adjusted position.

11. A spark plug having a pair of electrodes, one comprising a centrally located adjustable electrode having a predetermined number of threads to the inch, a rotary sleeve rigidly secured to said adjustable electrode and having a predetermined number of graduations whereby the spark gap may be varied and measured, means for calibrating said measuring instrumentality when the plug is in the cylinder, and means for holding said sleeve in its adjusted position and comprising a spring actuated latch, said sleeve having its graduations in the form of flutes adapted to coöperate with said latch.

12. A spark plug having a pair of electrodes, one comprising a centrally located adjustable electrode having a predetermined number of threads to the inch, a micrometer sleeve carried by said adjustable electrode and effective to rotate the central electrode thereby to vary the spark gap, means for holding said micrometer sleeve in its adjusted position and comprising a spring actuated latch, the graduations on the micrometer sleeve comprising grooves adapted to coöperate with said latch, and means for calibrating said micrometer sleeve when the plug is in the cylinder.

13. A spark plug having a pair of electrodes, one comprising a centrally located adjustable electrode having a predetermined number of threads to the inch, a micrometer sleeve carried by said adjustable electrode and effective to rotate the central electrode thereby to vary the spark gap, means for holding said micrometer sleeve in its adjusted position and comprising a spring actuated latch, and means for calibrating said micrometer sleeve without removing the plug from the cylinder and comprising a rotary sleeve with which said latch coöperates.

14. A spark plug having a pair of electrodes, one adjustable relatively to the other thereby to vary the spark gap, said plug embodying a micrometer for accurately measuring the spark gap length and comprising a graduated sleeve secured to and rotatable with said adjustable electrode whose displacement is such that the ratio of the angular movement of the electrode to the length to which the spark gap is varied may be accurately determined, and means carried by the plug for accurately rectifying the graduations of said micrometer.

15. A spark plug having a pair of electrodes, one comprising a centrally adjustable electrode, a micrometer for accurately measuring the spark gap length and consisting of a sleeve rigidly secured to said adjustable electrode and having equi-distant flutes around its circumference, said electrode having a predetermined number of threads to the inch and coöperating with a threaded stationary sleeve carried by the plug, a spring pointer adapted to engage the flutes of the sleeve, and a rotary thimble carrying said spring pointer.

16. A spark plug having a pair of electrodes, one adjustable relatively to the other thereby to vary the spark gap, said adjustable electrode having a predetermined number of threads to the inch, an interiorly threaded member coöperating with said adjustable electrode and having an exteriorly threaded end, a threaded member coöperating with said threaded end and rotatable relatively thereto, a micrometer sleeve rigidly secured to said adjustable electrode, and indicating means carried by said last

threaded member and coöperating with said micrometer sleeve whereby the spark gap may not only be varied and measured but the micrometer calibrated.

17. A spark plug having a pair of electrodes, one adjustable relatively to the other thereby to vary the spark gap, micrometer means carried by said plug for accurately measuring the spark gap, and means also carried by the plug for calibrating said micrometer means.

18. A spark plug having calibrating means operable while the plug is in its effective position.

19. A spark plug having measuring means, and means for calibrating said measuring means in an operative as well as an inoperative position of said plug.

Signed at Congers, county of Rockland and State of New York, this 11th day of June, 1919.

ARCHIE FREDERICK COLLINS.
VIRGIL DEWEY COLLINS.