Sept. 17, 1940. E. MOSTHAF 2,215,333

APPARATUS FOR AND METHOD OF GAPPING SPARK PLUGS

Filed Oct. 19, 1937 3 Sheets-Sheet 1

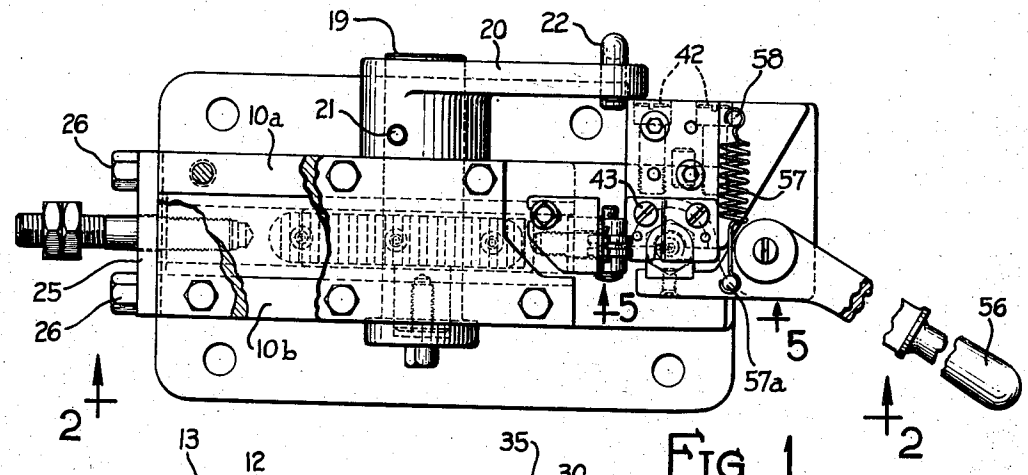


FIG. 1

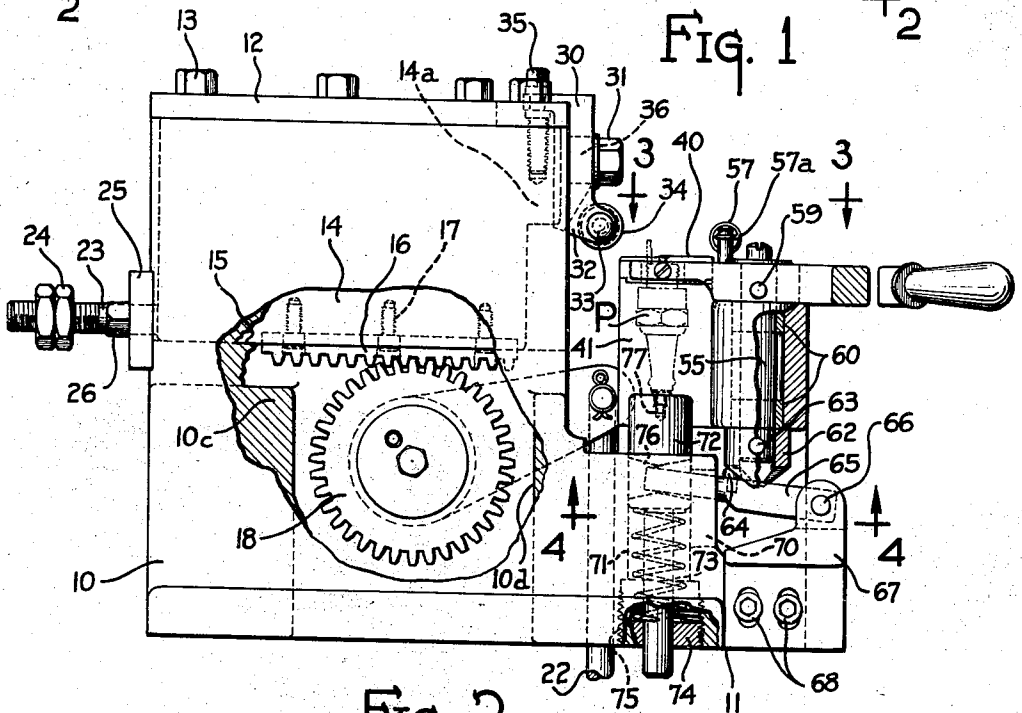


FIG. 2

INVENTOR
EDWIN MOSTHAF
BY Talbey & Stoltenberg
ATTORNEY

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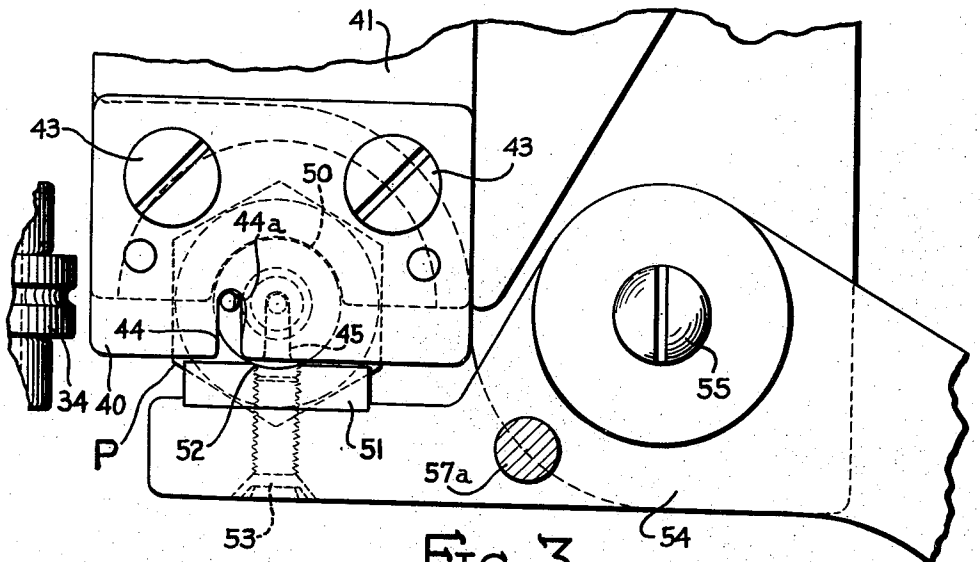


FIG. 3

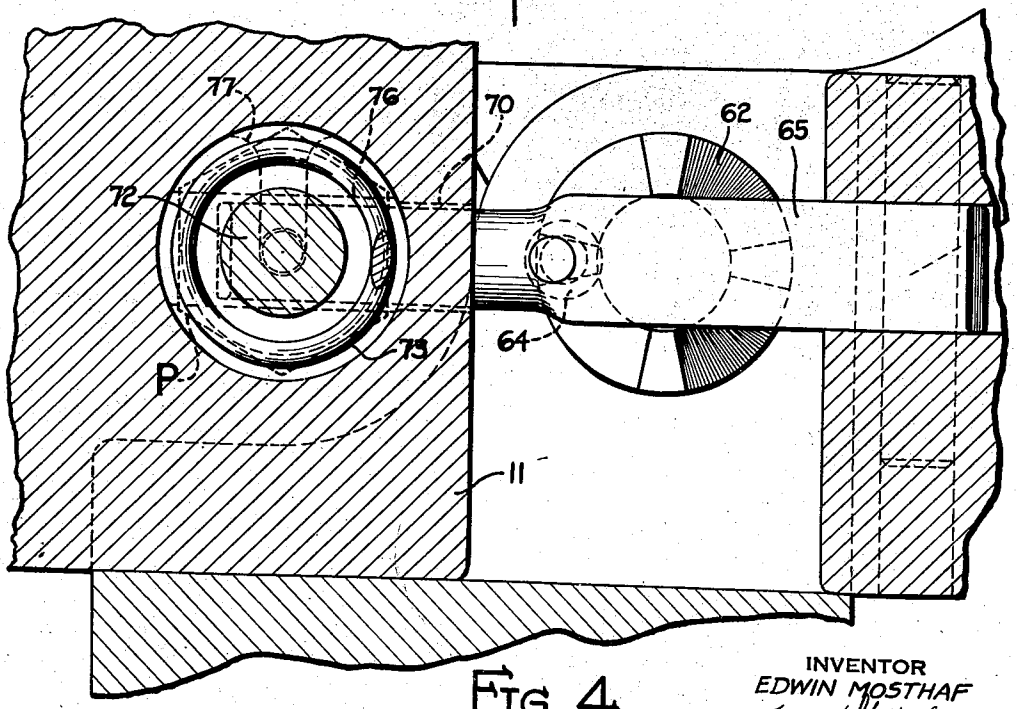


FIG. 4

INVENTOR
EDWIN MOSTHAF
BY Talbey & Stoltenberg
ATTORNEY

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APPARATUS FOR AND METHOD OF GAPPING SPARK PLUGS

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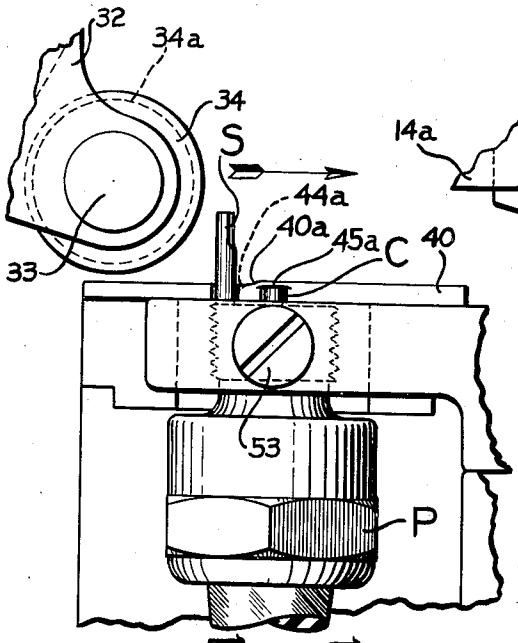


FIG. 5

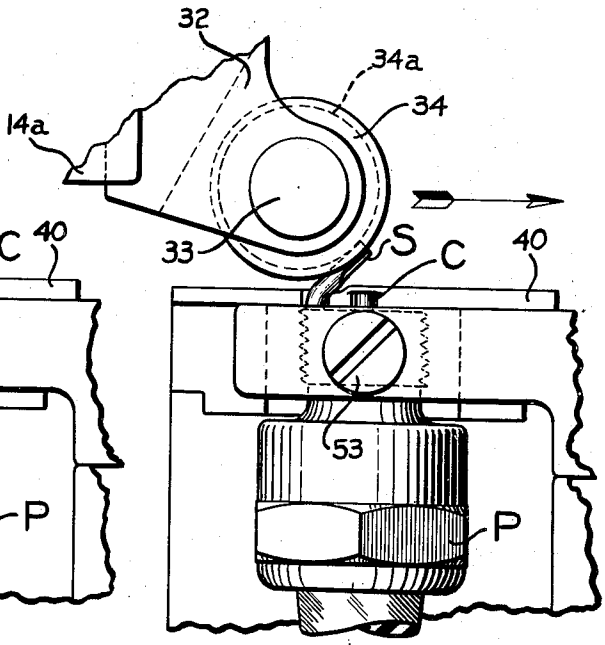


FIG. 6

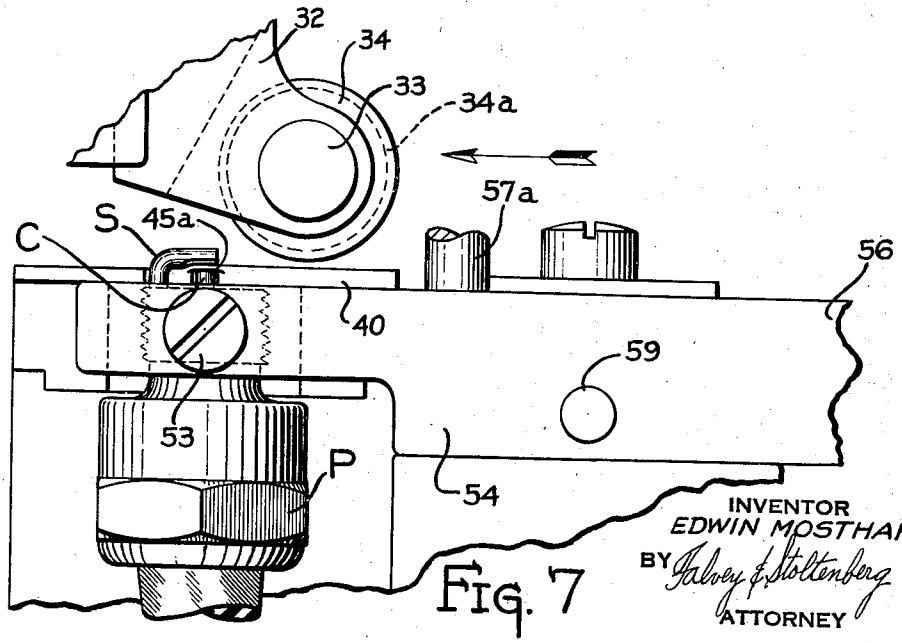


FIG. 7

INVENTOR
EDWIN MOSTHAF
BY Galvey & Stoltenberg
ATTORNEY

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2,215,333

UNITED STATES PATENT OFFICE

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APPARATUS FOR AND METHOD OF GAPPING SPARK PLUGS

Edwin Mosthaf, Fostoria, Ohio

Application October 19, 1937, Serial No. 169,837

8 Claims. (Cl. 153—21)

This invention relates to spark plugs, more particularly to the method of obtaining absolute uniformity in the gaps during mass production of the spark plugs.

In the past, the gaps of spark plugs have been formed by the use of manual tools and gauges. This process is expensive due to the time and care required on the part of the operator setting the gap, and, at the same time, is inefficient due to the error of the "personal equation" of the operator. With the limits of tolerance required in the usual manufacturing processes, the average operator had many "rejects" which were unacceptable as varying too far from the standard. The return of the "rejects" caused the cost of manufacturing to increase. Although the manual setting of gaps is very unsatisfactory and costly, it has been used in most of the spark plug manufacturing processes.

Electrical means have also been devised for this purpose which employ a photo-electric cell to control the oscillations of a magnetic hammer to bend the side electrodes of the spark plug by a quick succession of blows into proper relation with the center. The photo-electric tube was employed to control the length of the gap by stopping the blows of the hammer when the gap reached the required size. Although this system formed the gaps with a high degree of accuracy, it was found difficult to maintain the means in operation under average conditions in the manufacturing plant, the photo-electric cell being a very sensitive device and subject to frequent break-down.

Mechanical means have also been devised to gap the electrodes of the spark plug which have been found altogether unsatisfactory because the gaps formed on a long series of plugs could not be maintained within desired manufacturing tolerances.

The present invention contemplates the provision of a method of gapping the electrodes of a spark plug in which substantial uniformity of gaps may be maintained, and in which the stresses arising in the conformation of the electrodes are localized to a minimum section, the method being suitable for mass production in a manufacturing plant. At the same time, the speed with which the gaps can be set is sufficiently high to maintain the production costs at a minimum. The invention further contemplates the design of a machine incorporating the method which can be operated by a man of average intelligence and thereby allows the use of unskilled labor in the fabrication of the spark plug.

It is, therefore, an object of this invention to provide a method of forming gaps for the electrodes of the spark plug with absolute uniformity and with a speed sufficient to maintain the production costs of the spark plug at a minimum.

It is a further object of this invention to provide a machine for use in gapping electrodes of a spark plug which is simple to operate and foolproof, so that it may be manipulated by the average unskilled worker.

It is a further object of this invention to provide a method to gap the electrodes of a spark plug in which the initiating point from which the length of the gap is measured is a point on one of the electrodes which will give absolute uniformity of gap by the use of a template for measuring the length of gap.

It is a further object of this invention to provide a method of gapping spark plugs in which the bending stresses arising in the conformation of the electrodes will be localized in a minimum section so that relaxation of the conformed section of the electrode under operating conditions of high temperature will not substantially vary the gap dimension.

It is a further object of this invention to provide a machine which will allow the contour of the electrodes to be changed to a desirable design without interfering with the accuracy of the gap-setting process.

Other objects and advantages of this invention relating to the arrangement, operation and function of the related elements of the structure, to various details of construction, to combinations of parts and to economies of manufacture, will be apparent to those skilled in the art upon consideration of the following description and appended claims, reference being had to the accompanying drawings forming a part of this specification wherein like reference characters designate corresponding parts in the several views.

Figure 1 is a plan view, partly in section, incorporating the invention.

Figure 2 is an elevational view, partly in section, taken along the line 2—2 of Figure 1.

Figure 3 is an enlarged plan view, taken along the line 3—3 of Figure 2.

Figure 4 is an enlarged view, taken along the line 4—4 of Figure 2.

Figures 5, 6 and 7 are an elevational moving picture, taken along the line 5—5 of Figure 1.

Referring to the drawings, particularly to Fig-

ures 1 and 2, a supporting structure is supplied for a machine incorporating a modification of the invention which consists essentially of a base member 10 having two upright plates 10A and 10B connected integrally together by means of webs 10C and 10D which hold the plates in spaced relation. The upright plates 10A and 10B are provided with flanges at their bottoms to provide a convenient means for mounting the structure upon a table or the like. Forwardly of the web 10D, a jutting portion 11 is provided which is adapted to support mechanisms to be described hereinafter.

Adjacent the upper end of the upright plates 10A and 10B, a closure plate 12 is provided which is held in position upon the upright plates 10A and 10B by means of stud bolts 13 which are threaded into aligned openings in the upright plates. The space between the upright plates 10A and 10B is provided with a sliding block 14 which is adapted to move in a horizontal direction between the upright plates and is held in position therebetween the plate 12 and the ledge 15 but on the inner sides of the upright plates. A rack 16 is attached to the lower edge of the sliding block 14 by being fitted into a slot in the block and held in position by means of stud bolts 17. Cooperating with the rack 16, pinion 18 is provided which is mounted upon a jack shaft 19 suitably journaled in proper bearings in the upright plates 10A and 10B. The jack shaft 19, adjacent one of its outer ends, is provided with a bell-crank 20 attached thereto by means of pin 21. Adjacent the end of the bell-crank 20, a bent rod 22 is provided to connect the bell-crank with a suitable manual means (not shown) such as a foot lever.

By this structure, the movements of the sliding block 14 are under control of a foot lever which allows the block 14 to advance forwardly and to return at the will of an operator. The forward movement of the sliding block 14 is limited by a stud 23, upon which are positioned lock nuts 24 to allow adjustment of the forward movement of the sliding block 14. The stud 23 cooperates with an aperture in a plate 25 which is held in position on the upright plates 10A and 10B by means of stud bolts 26, the plate 25 acting as a stop for the lock nuts 24 to limit the movement of the sliding block. The rearward movement of the sliding block is controlled by the cooperation of the rear face of the sliding block 14 and the plate 25 as shown in Figure 2.

Upon the forward face of the sliding block 14, a projection 14A is provided, upon which is positioned a bracket 30 by means of stud bolt 31 positioned on the vertical portion of the bracket 30. A bifurcated portion 32 on the bracket 30 supports the journal shaft 33 of a roller 34. An adjustment is provided to control the vertical displacement of the roller 34 comprising an adjustment screw 35 cooperating with the horizontal portion of the bracket 30 and a slot 36 in the vertical portion cooperating with the stud bolt 31. The movement of the sliding block 14 forwardly advances the notched roller 34 in a horizontal direction with reference to a template 40 held in spaced relation with the roller by means of a bracket 41, which is preferably attached to the projection 11 of the base by means of stud bolts 42 (Figure 1). The template 40 is attached to the bracket 41 by means of screws 43 whose heads are preferably counter-sunk to be flush with the top surface of the template.

The template 40 is more clearly shown in Figure 3. A notch 44 is provided on the edge of the template opposite the screws 43 and channel 45 is cut on the lower side of the template in spaced relation with the notch 44, the distance between the channel and the notch being dependent upon the size of the spark plug which is to be manufactured. The notch 44 is designed to cooperate with the unbent side electrodes as shown in Figure 5, while the channel, which is parallel thereto, is designed to cooperate with the end of the center electrode C of a spark plug D. The width of the notch 44 and channel 45 is dependent upon the diameter of the electrodes of the spark plug; the length of the channel and notch, as measured from the vertical or narrow side of the template, is such that the center of the roller 34 which is provided with a peripheral notch 34A traverses a plane passing through the centers of both the side electrode and the center electrode in its lateral movement under the influence of the sliding block 14.

The side of the notch 44 adjacent the channel 45 is preferably provided with a chamfer 44A, so that the side wire will be bent in the form of a smooth curve rather than a sharp angle. In the case in which the side wire is given a peculiar conformation, such as shown in Figure 5, it is preferable to conform the upper surface of the template 40 to conform to the shape of the side wire. This is clearly shown in Figure 5, in which the template 40 is provided with a slightly raised portion 40A, so that it will fit, in the case illustrated, with the indentation on the side wire.

The channel 45, as pointed out before, does not pierce the template 40 but extends into it for a definite distance to provide a wall 45A of predetermined thickness between the bottom of the channel 45 and the top surface of the template 40. The thickness of the wall 45A determines the size of the gap which will be formed between the side and the center electrode of the spark plug after the gapping operation is complete. This operation will be described in further detail hereinafter.

In order to hold the spark plug in proper position during the process of gapping to obtain the greatest possible uniformity of gap, and at the same time assure convenience in positioning the spark plug in operable relation in the machine, and removing it after the operation is complete, a novel structure is provided which will accomplish these purposes. The holding means comprises generally of two interdependent structures, the first of which operates upon the threaded shank of the spark plug so as to prevent a lateral movement of the electrodes as the plug is held in operable position in the notch 44 and the channel 45; and the second holds the plug in operative relation with the template 40 by placing a force upon the plug in a longitudinal direction, that is, thrusting on the tip of the insulator to push the center electrode into close contactual relation with the wall 45A at the bottom of the channel 45. Through the agency of these two structures, the plug is securely held in position to prevent both lateral and longitudinal movement, so that the roller 34 may operate most effectually.

The first structure mentioned, which prevents the lateral movement of the plug, comprises a hemispherical notch 50 upon the forward edge of the bracket 41 immediately below the template 40, the notch being of the diametrical dimension of the threaded shank of the spark plug to be fitted therein. To hold the shank of the plug in

the notch 50, a locking member 51 is provided, having a shallow arcuate depression 52 similar to the notch 50 to contact the threaded shank of the plug on the diametrically opposed side from the notch 50 for holding the plug in position. The locking member 51 is positioned by means of screw 53 upon a bell-crank 54 which is pivoted for rotation on a spindle 55. The long arm of the bell-crank 54 is provided with a manual handle means 56 which will allow the displacement of the locking member 51 in the counter-clockwise direction against the action of a resilient means 57 which functions between a pin 57A on the bell-crank and an anchor pin 58 on the bracket 41. The bell-crank 54 is locked to the spindle 55 by means of pin 59, the spindle being journaled in proper bearings 60 within a bore in the bracket 41.

On the lower end of the spindle 55, a cam member 62 is locked to the spindle by means of a pin 63, so that the movement of the cam member is under the control of the manual handle means 56. The cam member 62 cooperates with a cam button 64, positioned on a lever 65 whose one end is pivoted about a pin 66 for rotation thereabout. The pin 66 is held in position by means of a bifurcated bracket 67 which is adjustably positioned by means of screws 68 adjacent the bottom of the bracket 41. The opposite end of the lever 65 extends through a slot 70 into a vertical bore 71 in the projection 11 of the base member. A plunger 72 is provided to reciprocate within the bore 71 under the influence of the lever 65 against the action of a resilient means 73, acting between a shoulder on the plunger 72, and a threaded plug 74, screwed into a threaded counter-bore 75 on the lower end of the bore 71. Adjacent the slot 70 in the projection 11, a flared slot 76 is provided in the plunger 72 to cooperate with the end of the lever 65 projecting through the slot 70. By this structure, the bell-crank 54 is enabled to thrust the plunger 72 downwardly by means of a cam member 62 and the pivoted lever 65 against the action of the resilient means 73.

On the upper end of the plunger 72, an aperture 77 is provided to cooperate with the head of the insulator of the spark plug to be gapped, so that a non-slip grip is obtained between the plunger 72 and the spark plug. This enables the resilient means 73 to apply a longitudinal thrust to the spark plug to accomplish the purposes set out above.

From this structure, it is apparent that the holding means comprising the two structures which prevent lateral and longitudinal movement of the spark plug when it is in operable relation with the template 40, is under the control of one manual means, viz; the manual lever 56. When the manual lever 56 (Figure 1) is turned in a counter-clockwise direction against the action of the resilient means 57 and 73, it moves the locking block 51 from its contact with the threaded shank of the spark plug and simultaneously thrusts the plunger 72 downwardly by the action of the cam member 62 on the cam button 64 to remove the longitudinal thrust from the tip of the insulator. When the lever 56 is in its extreme counter-clockwise position, the plunger 72 will be depressed and the locking member 51 will be removed to a considerable distance from the template 40. When in this position, it is easy for an operator to remove a gapped plug from the machine and to place a new ungapped plug in operable position with the template 40. Then, with the release of the lever 56, the two resilient means 57 and 73 will return the lever 56 to its initial position shown in Figure 1, which locks the plug securely in position for the application of the gapping method.

Referring to Figures 5, 6 and 7, the interaction between the template, the spark plug, and the roller is clearly illustrated. Figure 5 illustrates the initial position in which the plug has been placed in operable relation with regard to the template, assuming that both holding means are in operative position. At this time, the operator actuates a manual means, for example, a foot lever acting on the bar 22 to thrust the roller 34 forwardly and bends the side electrode over the chamfered edge 44A of the slot 44 into final position. This action is clearly illustrated in Figure 6. The operator continues depressing the manual means until roller 34 has completely passed the electrodes of the spark plug, as illustrated in Figure 7. At this time, he releases the manual means which returns the roller to its initial position either by resilient means or through manual operation. The parts of the machine are returned to the initial position as shown in Figure 5 with the exception that the side electrode has been bent into position over the center electrode with the wall 45A which is of predetermined thickness to establish the proper gap size between the electrodes. The operator then moves the manual means 56 in a counter-clockwise direction and removes the plug from its operable relation with the template 40 by moving it in a lateral direction so as to disengage the side electrode and the center electrode from the notch 44 and the channel 45. He then places an ungapped plug in position with regard to the template 40 and the cycle begins again.

The formation of the gaps of spark plugs by this method gives greater uniformity in the dimension of the gaps and does not disturb the other elements of the plug so as to break the seal between the center electrode and the insulator or the insulator and the shell. The concentration or localization of the bending stresses of the electrodes into a small section, reduces the relaxation of the stressed metal to a minimum during the high temperatures to which it is subjected during use, the gap thereby remaining substantially the same until a stable condition is attained in the electrode metal. Should the electrode metal be especially difficult to conform, so that its resiliency will prevent the gap from being formed by the exact dimension of the template, an allowance can be made in the dimension of the template to compensate for the "spring-back."

It is to be understood that the above detailed description of the present invention is intended to disclose an embodiment thereof to those skilled in the art, but that the invention is not to be construed as limited in its application to the details of construction and arrangement of parts illustrated in the accompanying drawings, since the invention is capable of being practiced and carried out in various ways without departing from the spirit of the invention. The language used in the specification relating to the operation and function of the elements of the invention is employed for purposes of description and not of limitation, and it is not intended to limit the scope of the following claims beyond the requirements of the prior art.

What is claimed:

1. In a device of the class described, a template having a channel to cooperate with the

center wire of the spark plug, the dimension of the template at the bottom of the channel being the same as the length of the gap desired between the electrodes, the template also having a chamfered slot to cooperate with the side electrode of the spark plug, means to hold the spark plug adjacent the template with the center electrode cooperating with the bottom of the channel, and reciprocating roller means to bend the side electrode into operable relation with the center electrode to place the template portion at the bottom of the channel between the electrodes.

2. In a device of the class described, a template having a slot to accommodate the side electrode and a channel to accommodate the center electrode of the spark plug, means to hold the plug in operable position with the template with the end of the center electrode in the base of the channel, and means to bend the side electrode into operable relation with the center electrode to place the template portion at the bottom of the channel between the end of the center electrode and the bent-over side electrode.

3. The method of gapping the electrodes of a spark plug, comprising, resiliently holding the center electrode of the plug against a template, locking the plug against lateral movement with respect to the template and bending the side electrode into operable relation with the center electrode having the template between the electrodes to assure the dimension of the gap between the electrodes.

4. In a device of the class described, a template adapted to cooperate with the center electrode of the spark plug, centering means to cooperate with the template and the spark plug to align the parts in proper operative relation, resilient holding means to thrust the center electrode against the template, a second holding means cooperating with the centering means to prevent lateral movement of the spark plug, means to bend the side electrode into operable relation with the center electrode, the gap between the side electrode and the center electrode being predetermined by the thickness of the template and manual means to control the holding means and the means to bend the side electrode.

5. In a device of the class described, a template adapted to cooperate with the center electrode of the spark plug and being of the same thickness as the length of the desired gap, resilient holding means to thrust the center electrode into operable relation with the template, a second holding means to prevent lateral movement of the spark plug, means to control both holding means, reciprocating means to bend the side electrode into operable relation with the center electrode over the template, adapted to bend the electrode sharply in a minimum longitudinal section, the gap between the electrodes being determined by the thickness of the template, and means to control the means to bend the side electrode.

6. The method of gapping a spark plug, comprising, completely assembling the spark plug with the electrodes in substantially parallel relation, positioning a template, having a predetermined thickness adjacent the center electrode to establish the dimension of the gap and a relatively sharp edge adjacent the side electrode, against the electrodes and then bending the side electrode over the relatively sharp edge of the template to concentrate the area of the bend formed in the electrode and to place the side electrode a predetermined distance from the center electrode as determined by thickness of the template.

7. The method of gapping a spark plug, comprising, completely assembling the spark plug, positioning a template firmly in relation with the electrodes, the template having a thickness of predetermined dimension to establish the length of the gap, and an upper surface formed to predetermine the shape and location of the conformed area of the side electrode and bending the side electrode over the template by a roller moving in a plane parallel to the upper surface of the template and substantially normal to the center electrode.

8. In a device of the class described, a template, means to hold a spark plug adjacent the template with the center electrode touching the template in substantially normal relation, and reciprocating means to bend a side electrode of the plug into cooperative relation with the center electrode, with the template positioned between them to determine the length of the gap between the center electrode and the bent-over side electrode.

EDWIN MOSTHAF.