Sept. 2, 1941. H. RABEZZANA 2,254,494

SPARK PLUG

Filed May 20, 1940 5 Sheets-Sheet 1

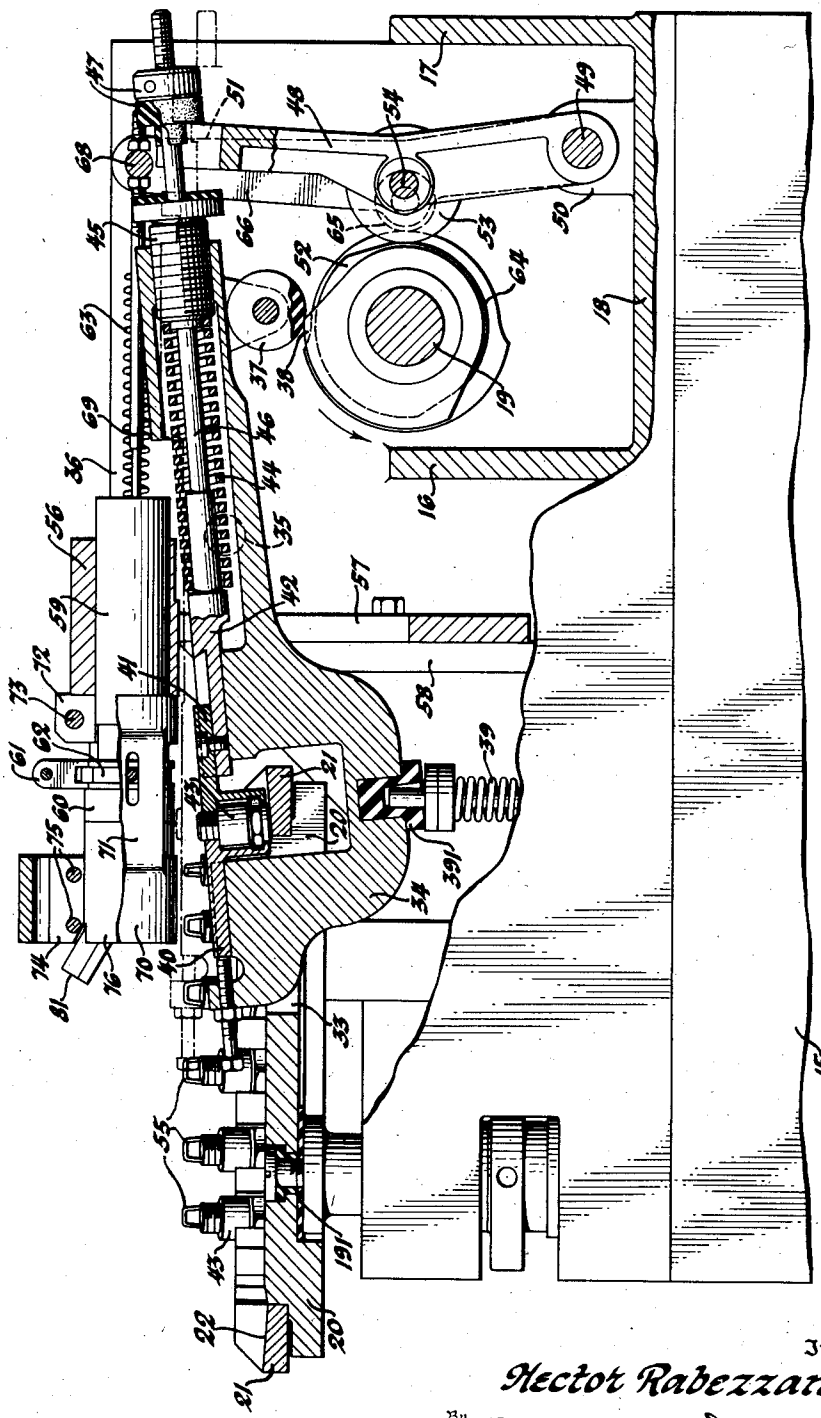


Fig. 1

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SPARK PLUG

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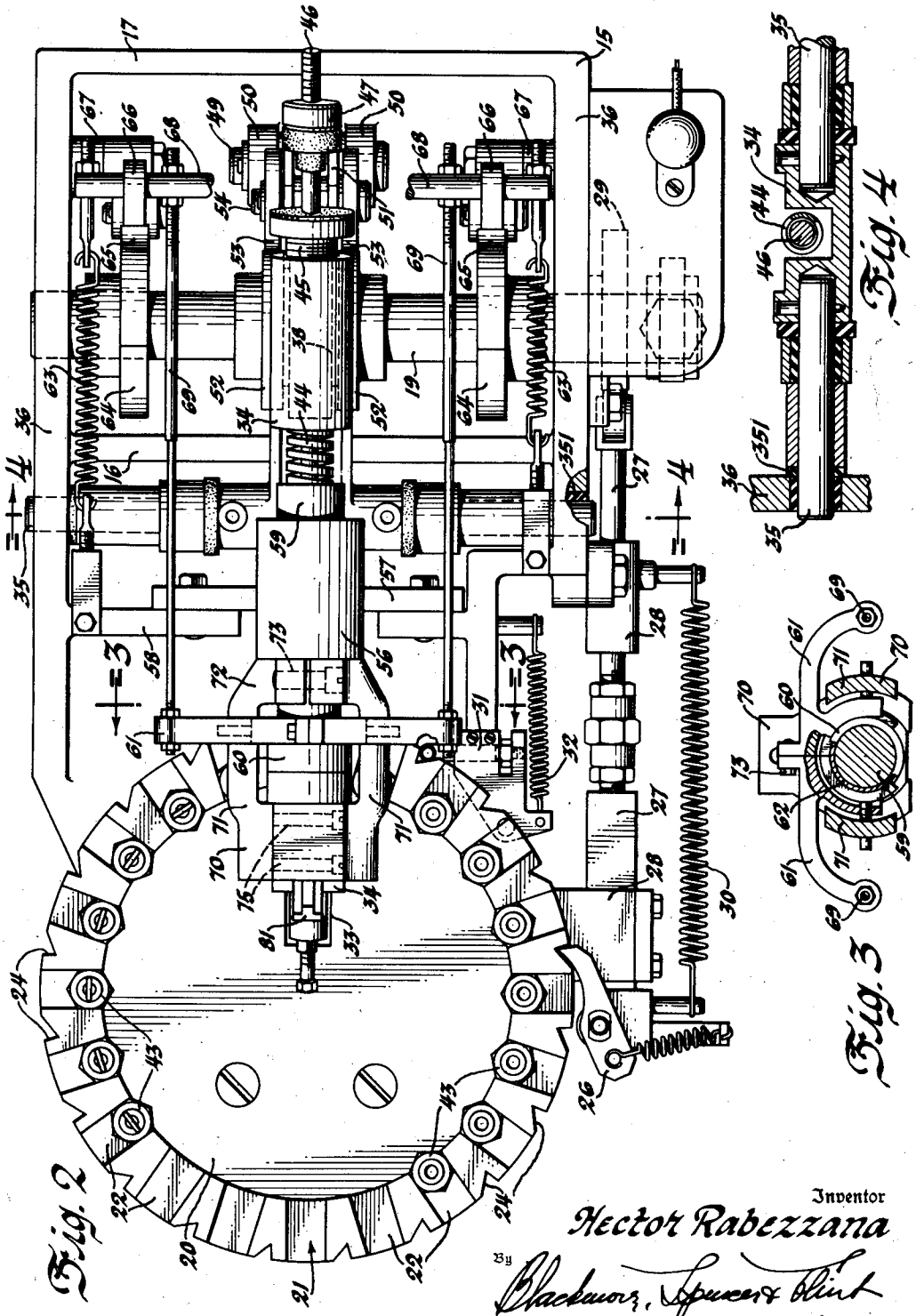


Fig. 2

Fig. 4

Fig. 3

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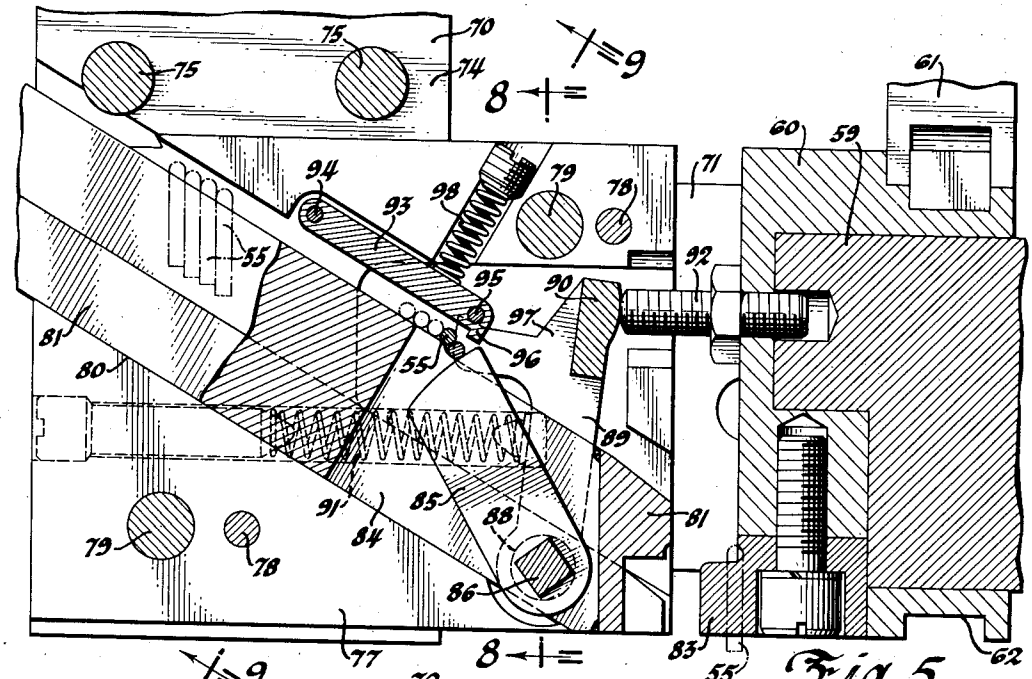


Fig. 5

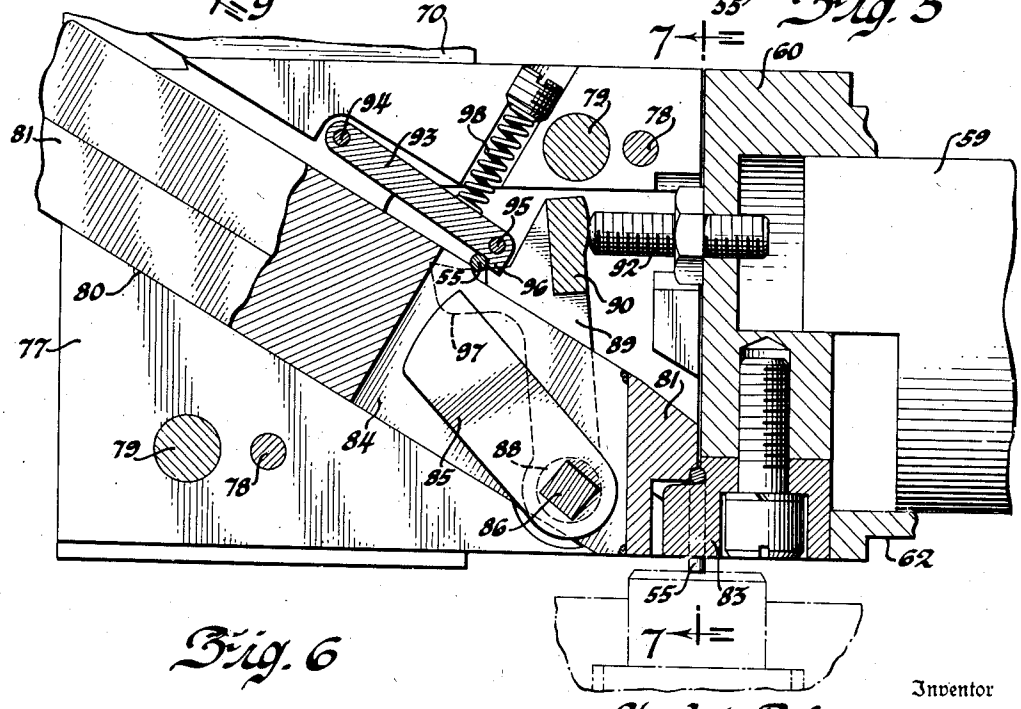


Fig. 6

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SPARK PLUG

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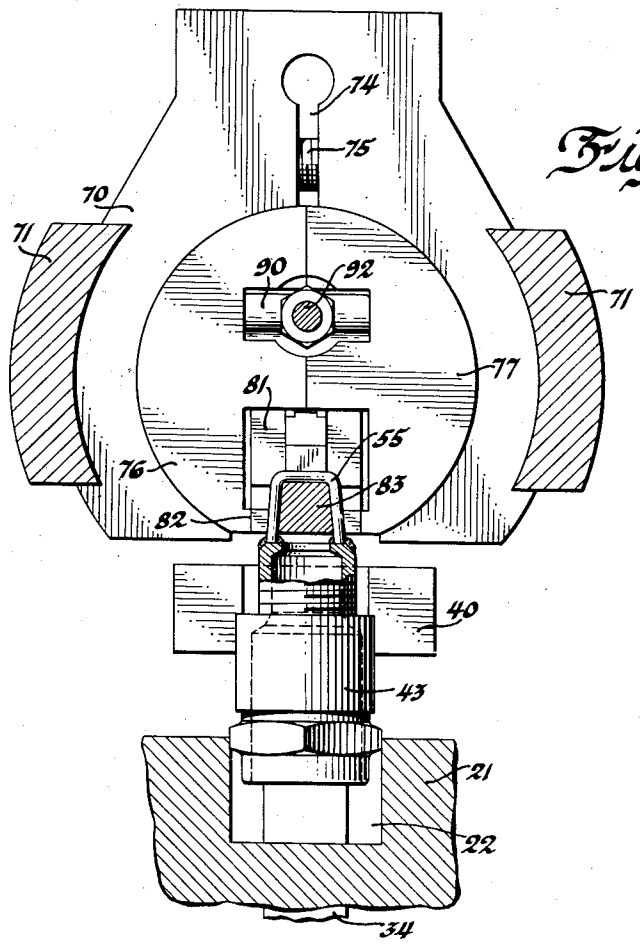


Fig. 7

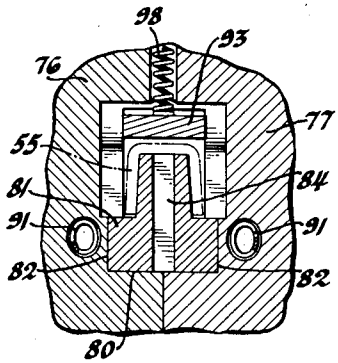


Fig. 9

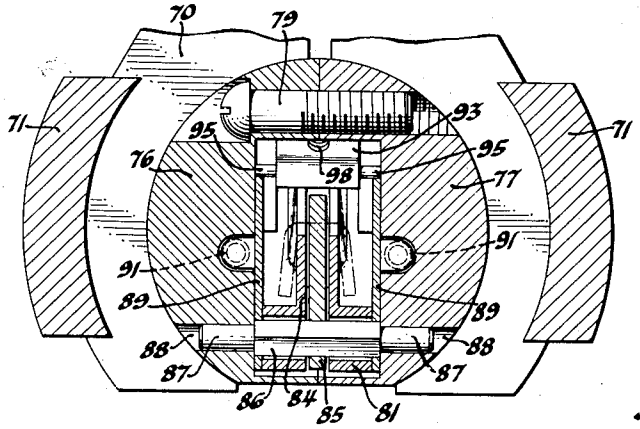


Fig. 8

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SPARK PLUG

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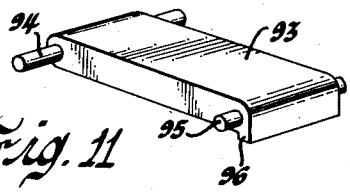


Fig. 11

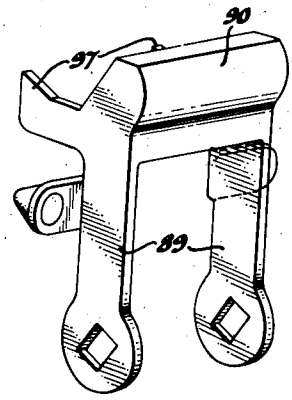


Fig. 10

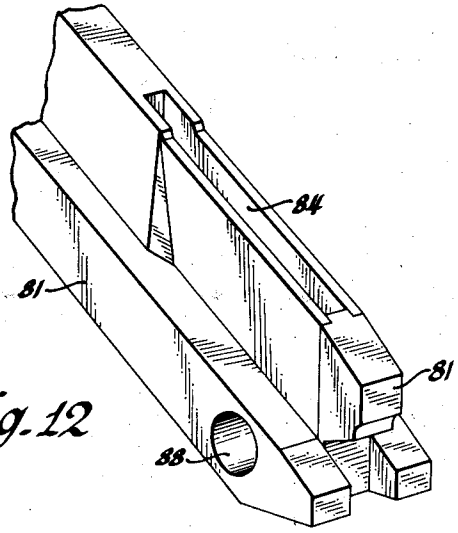


Fig. 12

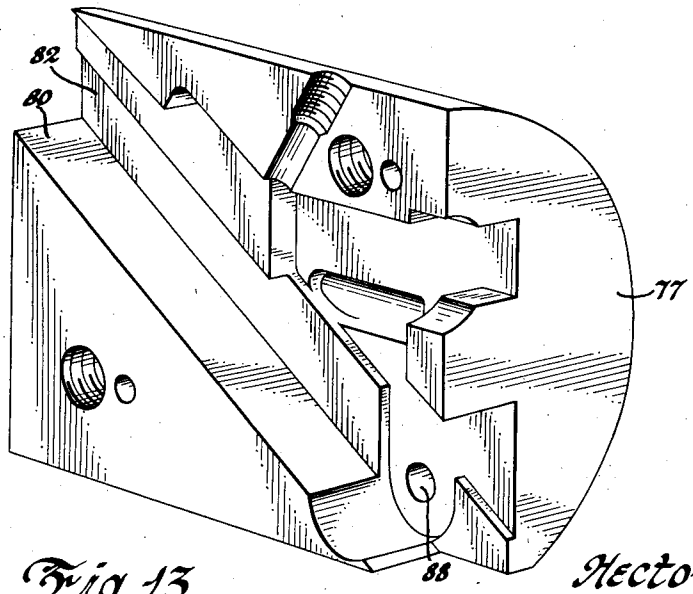


Fig. 13

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UNITED STATES PATENT OFFICE

2,254,494

SPARK PLUG

Hector Rabezzana, Flint, Mich., assignor to General Motors Corporation, Detroit, Mich., a corporation of Delaware

Application May 20, 1940, Serial No. 336,156

14 Claims. (Cl. 219—4)

My invention relates to spark plugs for internal combustion engines; and the same comprises a spark plug wherein the grounded or shell electrode is of loop or U-shaped form, with the free ends of both the sides or legs thereof electrically welded to the inner end of the shell or casing of the plug.

Grounded or shell electrodes of loop or U-shaped form have various features of advantage among which are that they are more sturdy, and less likely to become distorted under the high temperature conditions present in modern internal combustion engines, and are less likely to mechanical injury, than are shell electrodes which have one end only fastened to the shell; they operate at lower temperatures than prior electrodes wherein one end only is ordinarily fastened to the shell, because two paths for the flow of heat from the spark gap to the shell are provided instead of a single path; and, being stronger and more resistant to changes in form incident to inordinately high temperatures commonly present, and to mechanical injury due to handling, a more definite and constant length of spark gap is maintained than has usually been present in spark plugs wherein one end only of the shell electrode is fastened to the shell of the plug.

The advantages above enumerated and others are secured in my improved spark plug wherein both ends of the grounded or shell electrode are electrically welded to the spark plug shell. The advantage of strength has to be sure been heretofore secured to a degree in prior plugs having shell electrodes of loop or U-shape form, staked or otherwise mechanically fastened to the shell; and the advantage of better heat conduction from the spark gap to the shell, so far as that end may be secured by a single welded joint, has been sought by electrically welding one end of a shell electrode to the shell; but the simultaneous welding of both ends of such an electrode to the shell presents various and particular problems in the art of spark plug fabrication not heretofore solved according to my best information.

My invention therefore comprises the machine hereinafter described and claimed for electrically welding both ends of loop or U-shaped electrodes to shells or casings of spark plugs whereby the advantages of better heat conduction, enhanced strength, and less liability to change of form under the high temperature conditions commonly present are secured than has heretofore commonly been secured in spark plugs.

The drawings accompanying and forming a part of this specification illustrate the preferred form of my invention, and therein:

Figure 1 is a view showing various elements and features of my invention in side elevation, and others in section.

Figure 2 is a view showing the machine wherein my invention consists in plan.

Figure 3 is a sectional view taken upon a vertical transverse plane indicated by the line 3—3, Figure 2, and showing certain details of my invention.

Figure 4 is a fragmentary view showing details of a trunnion shaft of my invention, taken upon a vertical transverse plane indicated by the line 4—4, Figure 2.

Figure 5 is a fragmentary sectional view upon a much larger scale than the scale of Figures 1 to 4, showing certain U-shaped shell electrode feeding mechanism, and welding mechanism cooperating therewith.

Figure 6 is a view like Figure 5 but showing the parts in different positions than they are shown in Figure 5.

Figure 7 is a fragmentary view showing a section upon a transversely extending vertical plane indicated by the line 7—7, Figure 6.

Figure 8 is a fragmentary view showing a section upon a transversely extending vertical plane indicated by the line 8—8, Figure 5.

Figure 9 is a fragmentary view showing a section upon a transversely extending inclined plane indicated by the line 9—9, Figure 5.

Figure 10 is a view showing an escapement operating member associated with the U-shaped shell electrode feeding mechanism shown in Figures 5 and 6, in perspective.

Figure 11 is a view likewise in perspective, showing one of two escapement members of my device.

Figure 12 is a perspective view showing the lower end of a loop electrode feeding bar of my device, down which U-shaped shell electrodes slide.

Figure 13 is a perspective view showing one of two semi-circular members which house various elements of the shell electrode feeding mechanism of my invention.

Referring now to the drawings, the numeral 15 designates a base of general box-like construction and having transverse partition and end walls 16, 17 and a bottom wall 18, whereby an oil reservoir is provided whereby cams upon a rotatable shaft 19, the ends of which are supported in bearings in the side walls of the base, are kept supplied with oil. Cams carried by this

single transverse camshaft operate all the mechanisms involved in the operation of the machine wherein my invention consists, through oscillating levers and other elements operated by said cams as will hereinafter appear.

Supported from the base and insulated therefrom as indicated by the numeral 191 is a non-rotatable circular supporting member 20, and the numeral 21 designates an annular spark plug shell carrier carried by, and which is rotatable relative to said member 20. This shell carrier member has a series of radially arranged seats 22 adapted to receive spark plug shells 43, as shown, and a series of peripheral notches 24 arranged in alternation with said seats with which the free end of a spring-pressed pawl 26 engages to impart a step-by-step rotary movement to said carrier. This pawl is carried by the left hand end, Figure 2, of a slide 27 which reciprocates in guides 28 carried by the base 15; movement of said slide and pawl toward the left being produced by a cam 29 upon the shaft 19, and return movement thereof being produced by a tension spring 30. Reverse or backward movement of the carrier member 21 is prevented by a pivotally supported pawl 31 which is acted upon by a tension spring 32.

The supporting member 20 is provided with a radial slot 33; and the numeral 34 designates a reciprocating spark plug shell lifting member shown as carried by trunnions 35, supported in bearings 351 of insulating material provided in the side walls 36 of the base 15, which walls also support bearings for the ends of the cam shaft 19. The left hand end of this shell lifting member moves up and down in the slot 33, see Figure 1; and the same has a gap, as shown, so that it will not interfere with rotary movement of the carrier member 21. The right hand end of the shell lifting member 34 carries a roller 37 of insulating material as shown in Figure 1, which is acted upon by a cam 38 upon the shaft 19 to move the left hand end of said member downward against the action of a compression spring 39 and into its lowermost position shown; which spring returns said member into its uppermost position when the cam 38 moves out of engagement with the roller 37. A buffer 391 of insulating material is interposed between the lifting member 34 and the upper end of the spring 39, as shown.

The shell lifting member 34 has a pair of shell grasping jaws 40, 41 which grasp and hold the spark plug shells 43 during the welding of grounded shell electrodes 55 to them, and which jaws are commonly made adjustable so as to adapt the machine for operation upon shells of different diameters; and replaceable by other jaws to adapt the machine for use with types of shells differing from the particular type shown. The right hand one 41 of these jaws is carried by a reciprocating slide 42 which is urged toward the left to grasp a shell and hold it during the welding of a shell electrode 55 thereto, by a stiff compression spring 44 acting against an adjustable abutment 45 within the right hand tubular end of the shell lifting member 34, as shown; and a rod 46 extends from the slide 42 through the abutment, and has a collar 47 of insulating material at its free right hand end, whereby the slide 42 may be moved against the action of the spring 44 to release the shell 43 from the holding action of the jaws 40, 41.

The rod 46 is moved as aforesaid by an oscillating lever 48 the lower end of which is supported by a short shaft 49 which in turn is supported by bearings 50 upon the bottom wall 18; and the upper end 51 of this lever is bifurcated to clear the rod 46, and engages the collar 47. The lever 48 itself is swung about the shaft 49 at its lower end by duplicate cams 52 upon the shaft 19 which act upon roller 53 carried by a short shaft 54 carried by the lever 48.

A spark plug shell 43 is carried by the rotary carrying member 21 into a position between the jaws 40, 41 while the jaws are separated by the cams 52 acting through the lever 48 as above explained to compress the spring 44, and while the left hand end of the lifting member 34 is down as shown in Figure 1; the cams 52 next release the lever 48 and permit the spring 44 to close the jaws upon the shell and grasp it firmly, due to the action of said spring; and following this last action the cam 38 runs beyond the roller 37 and permits the spring 39 to move the left hand end of the lifting member 34 and the shell held between the jaws 40, 41 upward and into the position necessary to accomplish the welding of the grounded or shell electrode to the shell, heating necessary to accomplish the welding being due to a current of electricity supplied through leads connected one to the grounded frame of the machine and the other to the lifting member 34 as will be understood.

Figure 7 shows a spark plug shell 43 having a U-shaped grounded or shell electrode 55 the two ends of which are butt welded to the shell by the machine wherein my invention consists, heating of the two to accomplish the welding being by a current of electricity made to flow between the shell and the electrode; and this figure and Figures 5 and 6, and 8 to 13, show various features of mechanism for feeding electrodes into position to be welded to the shell and for electrically welding their free ends to the upper end of the shell, that is to the inner end of the spark plug regarded as in use in an internal combustion engine.

The numeral 56, see Figures 1 and 2, designates a tubular supporting member shown as cylindrical in form, the same being supported from the base 15 by supports 57 and 58; and 59 designates a bearing member secured in place within said sleeve and which serves as a support for a hollow reciprocating welding member 60 which slides upon the left hand end of said bearing member 59, see Figures 5 and 6. Said welding member 60 is operated by a yoke 61 which engages within a circumferentially extending groove 62 therein; and said yoke is moved toward the right against the resistance of two tension springs 63, 63 by two cams 64 carried by the shaft 19, and which cams act upon two rollers 65 carried by two vertically arranged oscillating levers 66 the lower ends of which are pivotally supported by pivotal supports 67 adjacent the side walls 36 of the base. The upper ends of these levers are connected by a cross bar or rod 68 with the ends of which the right hand ends of the springs 63 are connected so as to move said cross rod toward the left; and longitudinally extending tie rods 69, 69 extend between said rod and the yoke 61 as shown in Figure 2. It therefore follows that the cams 64 act through the levers 66, cross rod 68 and tie rods 69 to move the welding member 60 from the position in which it is shown in Figures 1, 2 and 6 toward the right against the resistance of the tension springs 63; and that said springs move said member from the position in which it is shown in Figure 5 to-

ward the left and return it to the position in which it is shown in Figure 6 when the cans 64 release the rollers 65 so that the springs 63 may contract.

The numeral 70 designates a second tubular supporting member preferably cylindrical in form, and having two arms 71 which merge therewith; and having also a split clamping ring 72 which surrounds the left hand end of the bearing member 59 and is secured thereupon by a cross-screw 73. This member 70 has an internal seat which receives and holds electrode feeding means whereby U-shaped grounded or shell electrodes 55 are supplied to the shells 43 preparatory to being welded thereto, as appears in Figures 6 and 7, said member 70 being split at 74 and the electrode feeding means being clamped in place within said seat, which is preferably cylindrical in form, by cross screws 75; the electrode feeding means being located adjacent the reciprocating welding member 60 as will be appreciated.

The electrode feeding means comprises two semi-cylindrical housing members 76, 77 which are identical with one another except that they are made rights-and-lefts, and which housing members are definitely positioned relative to one another by dowel pins 78, and are secured together by screws 79; and the meeting longitudinal surfaces of these members in contact with one another and in which the axis of said electrode feeding means lies are provided with registering recesses within which are housed various elements which cooperate to accomplish the feeding of the electrodes 55 as next appears.

Extending longitudinally of the housing members 76 and 77 and disposed half in one and half in the other is an inclined ledge 80; and the numeral 81 designates an inclined loop electrode feeding bar of inverted T-shaped form in cross section which rests upon said ledge and is held between vertical side walls 82 of said members 76, 77, and which bar extends from beyond the left hand end of said members to a position adjacent an anvil 83 carried by the reciprocating welding member 60, as see Figures 5 and 6. This anvil, although it is a unitary part of the welding member 60, is commonly made separate therefrom, of hard steel so as to withstand the severe service required of it. The electrodes slide down this bar 81 and come to rest upon the anvil 83, and are caught between the welding member and the lower end of the bar 81 as the welding member moves from the position shown in Figure 5 to the position shown in Figure 6; and are held between said parts while the shell 43 is moved upward and into contact with the depending sides of an electrode 55, and while current flows through the shell and electrode to accomplish the welding of the electrode to the shell as hereinbefore explained.

The electrode feeding bar 81 has a slot 84 adjacent its lower end; and 85 designates one of two cooperating escapement members, the same being carried by an oscillating shaft 86 the ends 87 of which are supported in bearings 88 adjacent the lower ends of the housing members 76, 77. Said shaft carries also two arms 89, the upper ends of which are connected by a cross bar 90; and which arms are acted upon by two compression springs 91, Figures 5 and 9, to hold the escapement member 85 in the uppermost position in which it is shown in Figure 5, in which it acts to prevent the loop electrodes from sliding down the electrode feeding bar. The reciprocating welding member 60 carries a tappet 92 adapted to engage the cross bar 90 as said member moves from the position shown in Figure 5 into that shown in Figure 6 to thereby release the lowermost shell electrode 55 and permit it to slide down the bar 81 from the position in which it is shown in Figure 5, and to come to rest upon the anvil 83 as shown in Figure 6.

The U-shaped shell electrode feeding means includes also a second escapement member 93 which is supported within a chamber within the semi-cylindrical members 76, 77 by a pivot 94 at one of its ends, and the other end of said member has a transverse pin 95 whereby the free end 96 thereof may be lifted. When the two escapement members are in the position shown in Figure 5 downward sliding of the column of electrodes is prevented by the first described escapement member 85 as hereinbefore appears, the free hooked end 96 of the second escapement member 93 being held up above the column by arms 97 extending from the arms 89, and having inclined ends which lie beneath the transverse lifting pin 95. When, however, the welding member 60 is moved toward the left the tappet 92 engages the cross-bar 90, and the arms 97 release the pin 95 and permit a spring 98 to swing the free end of the escapement member 93 downward, thus arresting downward sliding movement of the column of shell electrodes as indicated in Figure 6. This permits the electrode 55 downward movement of which was arrested by the first escapement member 85, as aforesaid, to slide down the bar 81 and come to rest upon the anvil 83 as hereinbefore explained; whereupon and as the welding member reaches its extreme left hand position said electrode is grasped between the welding member 60 and the lower end of said bar as shown in Figure 6.

Having thus descried and explained my invention, I claim and desire to secure by Letters Patent:

1. In a machine for welding loop electrodes to spark plug shells, an inclined bar adapted to receive a loop electrode and down which said electrode may slide; a reciprocating welding member having an anvil portion arranged adjacent the lower end of said bar and adapted to receive a loop electrode fed thereto by said bar; means for operating said welding member to grasp a loop electrode supported by said anvil portion between said member and the lower extremity of said inclined bar; a reciprocating lifting member; and means for moving said member to cause a spark plug shell carried thereby to engage both the free ends of said electrode.

2. In a machine for welding loop electrodes to spark plug shells, an inclined bar adapted to support a series of loop electrodes and down which said electrodes may slide; a reciprocating welding member having an anvil portion arranged adjacent the lower end of said bar and adapted to receive a loop electrode fed thereto by said bar; escapement mechanism for controlling the supply of electrodes one at a time to said anvil; means for operating said escapement mechanism; means for operating said welding member to grasp a loop electrode supported by said anvil portion between said member and the lower extremity of said supporting bar; a reciprocating lifting member; and means for moving said member to cause a spark plug shell

carried thereby to engage both the free ends of said electrode.

3. In a machine for welding loop electrodes to spark plug shells, an inclined bar adapted to support a series of loop electrodes and down which said electrodes may slide; a reciprocating welding member having an anvil portion arranged adjacent the lower end of said bar and adapted to receive a loop electrode fed thereto by said bar; escapement mechanism for controlling the supply of electrodes one at a time to said anvil; means whereby and through which said escapement mechanism is operated by said welding member; means for operating said welding member to grasp a loop electrode supported by said anvil portion between said member and the lower extremity of said supporting bar; a reciprocating lifting member; and means for moving said member to cause a spark plug shell carried thereby to engage both the free ends of said electrode.

4. In a machine for welding loop electrodes to spark plug shells, an inclined bar adapted to support a loop electrode and down which said electrode may slide; a reciprocating welding member arranged adjacent the lower end of said bar and to which a loop electrode is fed by said bar; means for operating said welding member to grasp a loop electrode between said member and the lower extremity of said supporting bar; a reciprocating lifting member; and means for moving said member to cause a spark plug shell carried thereby to engage both the free ends of said electrode.

5. In a machine for welding loop electrodes to spark plug shells, an inclined bar adapted to support a series of loop electrodes and down which said electrodes may slide; a reciprocating welding member arranged adjacent the lower end of said bar and to which a loop electrode is fed by said bar; escapement mechanism for controlling the supply of electrodes one at a time to said welding member; means for operating said welding member to grasp a loop electrode between said member and the lower extremity of said supporting bar; a rotatable spark plug shell carrier adapted to support a series of spark plug shells and to supply them one at a time to a lifting member; means for operating said carrier; a reciproacting lifting member adapted to receive a spark plug shell from said carrier and to move it into engagement with both the free ends of said loop electrode; and means for operating said lifting member.

6. In a machine for welding loop electrodes to spark plug shells, an inclined bar adapted to support a series of loop electrodes and down which said electrodes may slide; a reciprocating welding member arranged adjacent the lower end of said bar and to which a loop electrode is fed by said bar; escapement mechanism for controlling the supply of electrodes one at a time to said welding member; means for operating said welding member to grasp a loop electrode between said member and the lower extremity of said supporting bar; a non-rotatable supporting member circular in form and having a radially extending slot; an annular spark plug shell carrier supported by and rotatable relative to said supporting member, and adapted to support a series of spark plug shells and to supply them one at a time to a lifting member; means for operating said carrier; a reciprocating lifting member movable up and down in the slot aforesaid, and which member is adapted to receive a spark plug shell from said carrier and to move it into engagement with both the free ends of said loop electrode; and means for operating said lifting member.

7. In a machine for welding loop electrodes to spark plug shells, means for supplying a loop electrode to be welded to said shell; a reciprocating welding member arranged adjacent said electrode supplying means; means for operating said welding member to grasp a loop electrode between said member and said electrode supplying means; a reciprocating lifting member; means for moving said member to cause a spark plug shell carried thereby to engage both the free ends of said electrode; shell grasping mechanism carried by said lifting member and adapted to grasp and hold said spark plug shell; and means for operating said shell grasping mechanism.

8. In a machine for welding loop electrodes to spark plug shells, an inclined bar adapted to support a loop electrode and down which said electrode may slide; a reciprocating welding member arranged adjacent the lower end of said bar and to which a loop electrode is fed by said bar; means for operating said welding member to grasp a loop electrode between said member and the lower extremity of said supporting bar; a reciprocating lifting member; means for moving said member to cause a spark plug shell carried thereby to engage both the free ends of said electrode; shell grasping mechanism carried by said lifting member and adapted to grasp and hold said spark plug shell; and means for operating said shell grasping mechanism.

9. In a machine for welding loop electrodes to spark plug shells, a suitable base; a supporting member supported by said base; a bearing member supported by said supporting member; a reciprocating welding member slidable upon said bearing member; means for operating said welding member; a second supporting member arranged adjacent said welding member; means carried by said second supporting member for feeding a loop electrode to said welding member; and means for moving a spark plug shell into contact with both the free ends of a loop electrode grasped between said welding member and said electrode feeding means.

10. In a machine for welding loop electrodes to spark plug shells, a suitable base; a tubular supporting member supported by said base; a bearing member within said supporting member and extending therefrom; a reciprocating welding member slidable upon the end of said bearing member; means for operating said welding member; a second member also tubular in form arranged in line with and adjacent to said welding member, and which second member is supported by said bearing member; means housed within said second tubular member for feeding a loop electrode to said welding member; and means for moving a spark plug shell into contact with both the free ends of a loop electrode grasped between said welding member and said electrode feeding means.

11. In a machine for welding loop electrodes to spark plug shells, a suitable base; a supporting member supported by said base; a bearing member supported by said supporting member; a reciprocating welding member supported by said bearing member and slidable thereupon; means for operating said welding member; a second member tubular in form, and means for supporting said second member adjacent said first mentioned supporting member; means housed within said second tubular member for feeding a loop electrode to said welding member; and means for

moving a spark plug shell into contact with both the free ends of a loop electrode grasped between said welding member and said electrode feeding means.

12. In a machine for welding loop electrodes to spark plug shells, a suitable base; a supporting member supported by said base; a bearing member supported by said supporting member; a reciprocating welding member supported by said bearing member and slidable thereupon; means for operating said welding member; a second member tubular in form, and means for supporting said second member adjacent said first mentioned supporting member; two housing members within and extending longitudinally of said second tubular member; an inclined bar grasped between said housing members and adapted to receive a loop electrode, and down which said electrode may slide to said welding member; and means for moving a spark plug shell into contact with both the free ends of a loop electrode grasped between said welding member and the lower extremity of said inclined bar.

13. In a machine for welding loop electrodes to spark plug shells, a suitable base; a supporting member supported by said base; a bearing member supported by said supporting member; a reciprocating welding member supported by said bearing member and slidable thereupon; means for operating said welding member; a second member tubular in form, and means for supporting said second member adjacent said first mentioned supporting member; two housing members within and extending longitudinally of said second tubular member; an inclined bar grasped between said housing members and adapted to support a series of loop electrodes, and down which bar said electrodes may slide to said welding member; escapement mechanism for controlling the supply of loop electrodes one at a time to said welding member; means for operating said escapement mechanism; and means for moving a spark plug shell into contact with both the free ends of a loop electrode grasped between said welding member and the lower extremity of said inclined bar.

14. In a machine for welding loop electrodes to spark plug shells, a suitable base; a tubular supporting member supported by said base; a bearing member within said supporting member and extending therefrom; a reciprocating welding member slidable upon the end of said bearing member; means for operating said welding member; a second member also tubular in form arranged in line with and adjacent to said welding member; two housing members within and extending longitudinally of said second tubular member; an inclined bar grasped between said housing members and adapted to support a series of loop electrodes, and down which bar said electrodes may slide to said welding member; escapement mechanism located within said housing members and adapted to control the supply of loop electrodes one at a time to said welding member; means whereby and through which said escapement mechanism is operated by said welding member; and means for moving a spark plug shell into contact with both the free ends of a loop electrode grasped between said welding member and the lower extremity of said inclined bar.

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