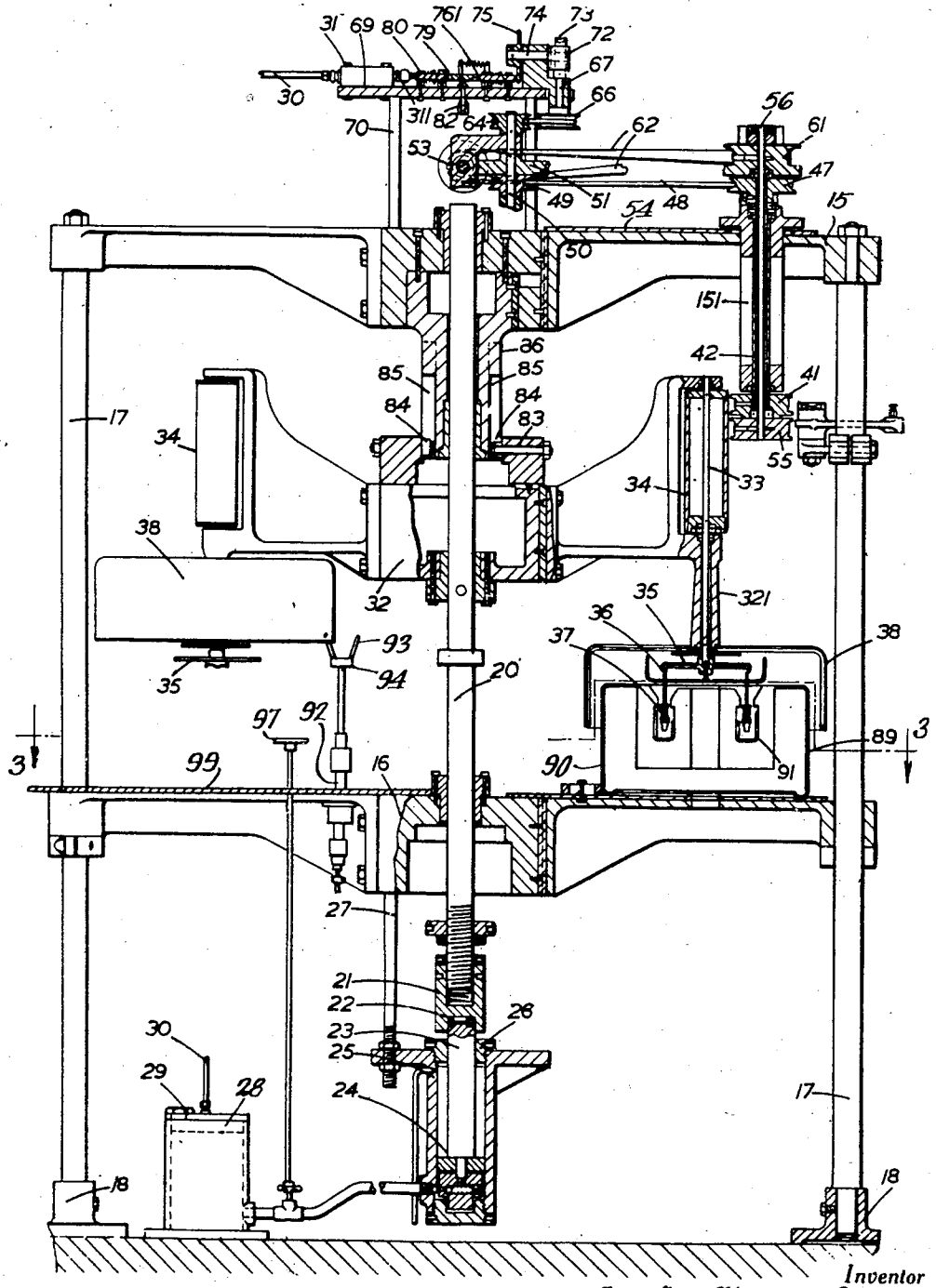
Aug. 10, 1948. D. H. CORBIN 2,446,908

SPARK PLUG MANUFACTURE

Filed Nov. 1, 1943 6 Sheets-Sheet 1

FIG. 1.



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SPARK PLUG MANUFACTURE

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FIG. 2.

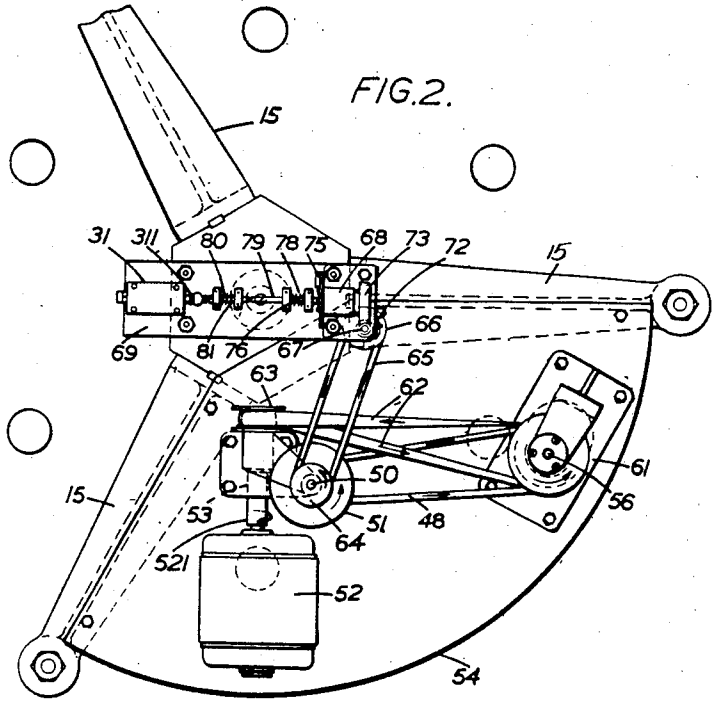
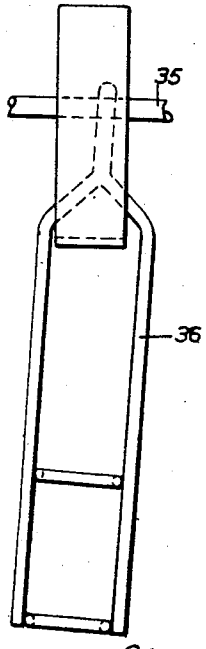


FIG. 8.



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SPARK PLUG MANUFACTURE

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FIG. 3.

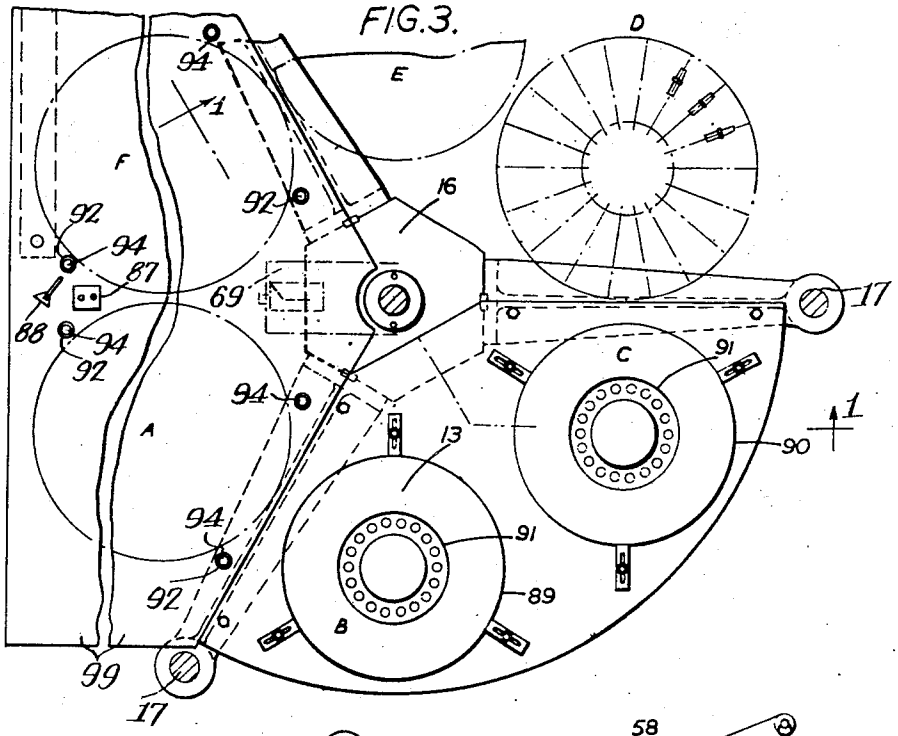
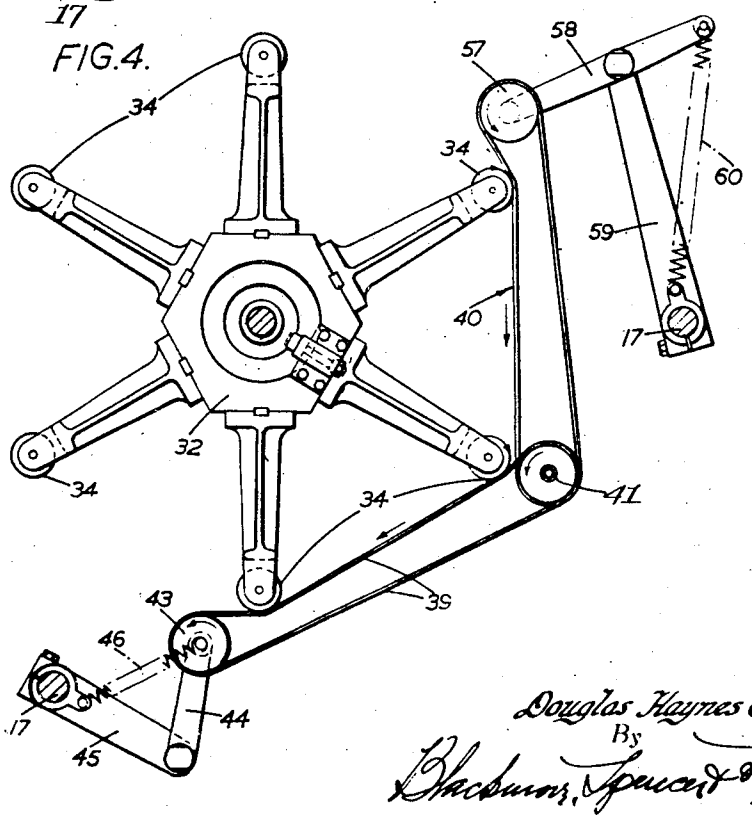


FIG. 4.



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SPARK PLUG MANUFACTURE

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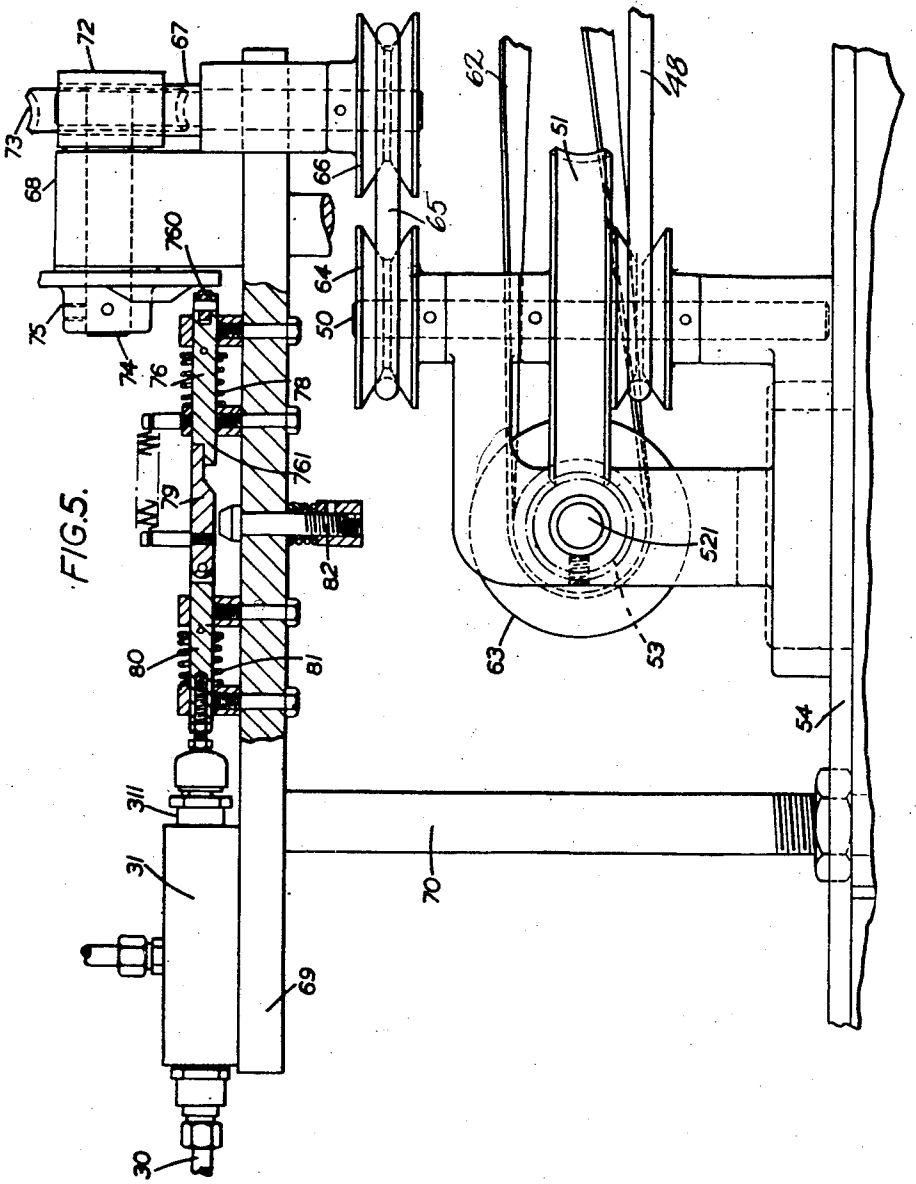


FIG.5.

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FIG. 6.

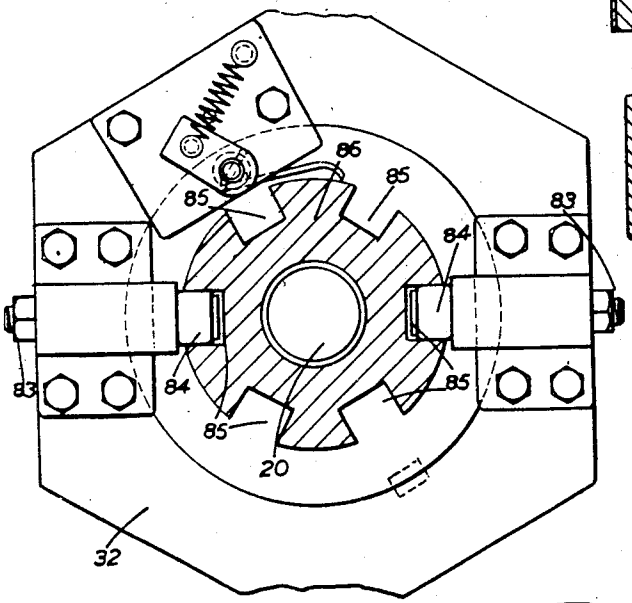
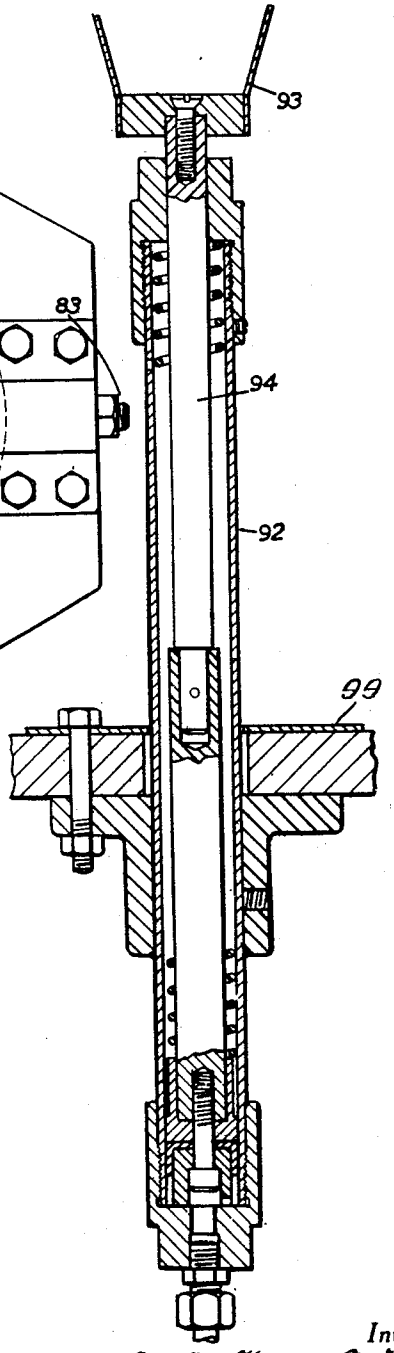


FIG. 9.



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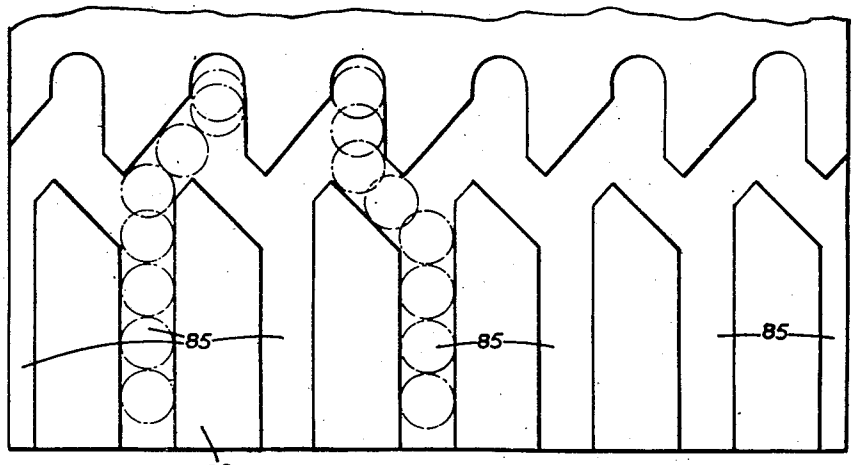
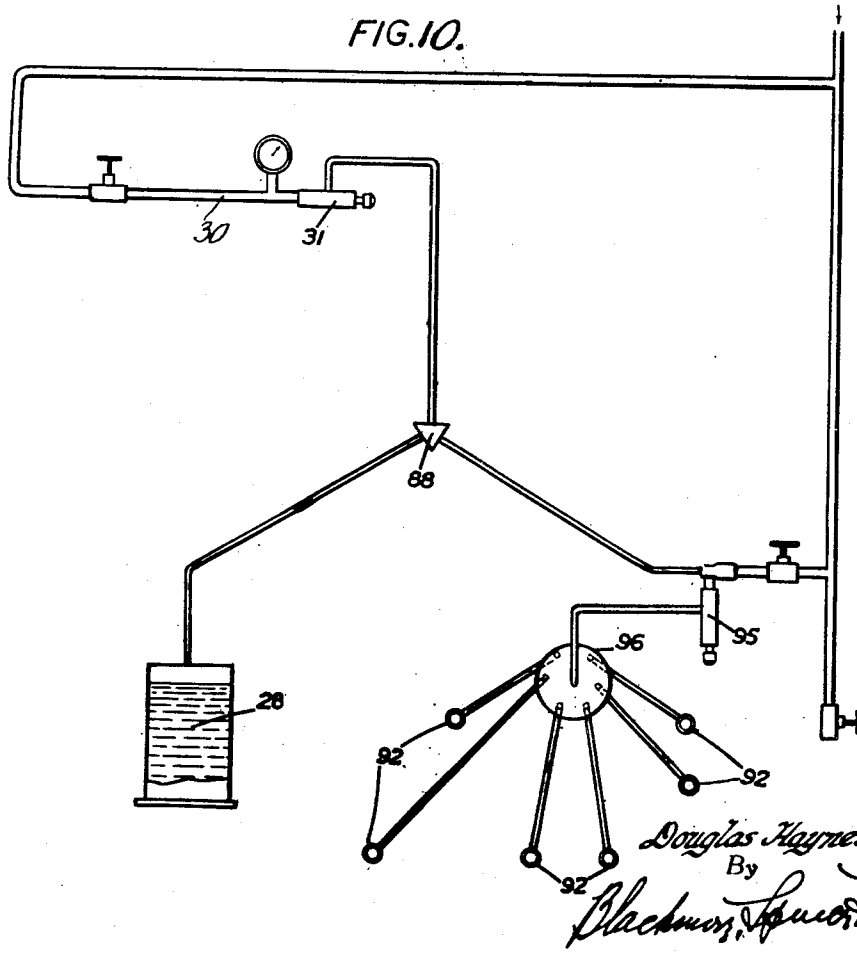


FIG. 7.

FIG. 10.



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UNITED STATES PATENT OFFICE

2,446,908

SPARK PLUG MANUFACTURE

Douglas Haynes Corbin, Dunstable, England, assignor to General Motors Corporation, Detroit, Mich., a corporation of Delaware

Application November 1, 1943, Serial No. 508,549
In Great Britain November 6, 1942

1 Claim. (Cl. 22—58)

1

This invention relates to the manufacture of spark plugs for internal combustion engines.

In general such spark plugs are of various constructions; and furthermore the form of and manner of forming the central electrode within the insulator vary considerably according to the requirements that have to be fulfilled.

One form of central electrode, with which the present invention is concerned, has the lower part consisting of a metallic core moulded in position in the bore of the insulator. One manner of forming such an electrode part is by heating and pressing a mass of metal in the insulator bore, such that by plastic deformation it is moulded to the bore. The metal can be of powdered or solid form. Another manner of forming such an electrode part is by heating a mass of metal to a molten condition within the insulator bore, so that it will mould itself to the bore.

The metals of greatest utility in such methods are silver and copper, with silver the preferred. Their heat, electrical and physical properties render them the most suitable known at the present time.

The object of the present invention is to improve the manufacture of spark plugs by moulding part of the central electrode in the insulator bore under centrifugal pressure.

This is effected by subjecting the insulator assembly to rotation about a centre on the insulator axis, with the metallic mass in at least a plastic but preferably in a molten condition. By effecting the rotation whilst the metal is molten the need for any weight to compress the metal in a powdered or plastic condition is avoided. Whilst the insulator is rotating it is cooled and thus the metal sets whilst it is held compressed against the inner wall of the insulator. The cooling, however, can be effected after rotation.

In carrying out this improved process in a preferred manner, an insulator of dense refractory oxide or oxides has a small spark tip of platinum or like metal positioned at the lower end of its bore. The tip is prevented from dropping out by having its head enlarged or distorted with respect to the lower end of the bore. A small stick of silver is then inserted on the top of the tip. The whole assembly is then heated

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at least up to the melting point of silver, and then while the silver is molten, the whole assembly is rapidly rotated about a centre above the top of the insulator, with the tip outward. The rotation is continued until the silver is solidified. When sufficiently cool, the remainder of the insulator assembly and of the whole plug assembly are completed in the usual way.

Apparatus for carrying out the process aforesaid can take various forms, and a convenient construction of machine for the said purpose will now be described with particular reference to the accomanying sheets of drawings.

In the drawings:

Figure 1 is a side elevational view of the machine taken along the line 1—1 of Figure 3;

Figure 2 is a fragmentary view in plan of the upper portion of the machine illustrated in Figure 1;

Figure 3 is a fragmentary view of the machine in plan section taken along the line 3—3 of Figure 1;

Figure 4 is a detail view mainly in plan of part of the driving mechanism;

Figure 5 is an expanded fragmentary view in side elevation of the compressed air valve control mechanism utilized in Figure 1;

Figure 6 is a cross sectional view illustrating the indexing cam employed in the machine;

Figure 7 is a developed view of the indexing cam illustrated in Figure 6;

Figure 8 is a detail view in front elevation of a holder for an insulator during its treatment in the machine showing also the method of suspending the said holder in the machine;

Figure 9 is a detail view in vertical section of a compressed air cylinder for raising the hoods utilised in the machine illustrated; and

Figure 10 is a diagrammatic representation of the compressed air lay-out as incorporated in the aforesaid machine.

In the drawings like numerals of reference indicate similar parts in the several views.

As illustrated in the drawings, the machine incorporates an upper triangulated frame member 15 and a lower triangulated frame member 16 which are interconnected by uprights 17, said uprights 17 being supported at their lower ends upon feet 18. Slidably mounted within bearings situated at the hubs of the frame members

15 and 16 is a vertically disposed rod 20 hereinafter termed "the lifting rod 20." Adjacent to its lower end the lifting rod 20 has screwed thereto an adjustable boss 21 which is supported upon a ball bearing mounting 22. This ball bearing mounting 22 in turn is supported on the upper end of a piston rod 23 which is associated with a piston 24 mounted in a hydraulic cylinder 25, said piston rod 23 passing through a gland 26. The hydraulic cylinder 25 is suspended from the underside of the frame member 16 by means of rods 27.

The hydraulic cylinder 25 has valve controlled communication with a vessel 28 containing oil. The cover plate 29 for the said oil vessel 28 is provided with an aperture which is in communication with a pipe line 30 associated with a compressed air control valve 31 to be referred to hereinafter.

Fixed to the lifting rod 20 intermediate the frame members 15 and 16 is a six armed spider 32. The outer end of each arm of the spider 32 is forked and the limbs of each forked portion are furnished with bearings for a vertically disposed spindle 33. The portion of a spindle 33 intermediate the limbs of a forked portion has fixed thereto an elongated pulley 34 and the lower ends of each of the said spindles 33 support a carrier disc 35 from which is pivotally suspended a plurality of wire holders 36 for the insulators 37 (see also Figure 8). As shown, each carrier disc 35 is adapted to accommodate eighteen insulator holders 36. Slidably mounted on a downward extension 321 of each arm of the spider 32 is an annular hood 38 the internal diameter of which slightly exceeds the sum of the diameter of a carrier disc 35 and the length of the insulator holders 36.

It should be noted that when suspended from a carrier disc 35 the holders 36 are caused to hang as shown in Figure 8 with one limb in contact with an adjacent edge of the carrier disc 35 for a purpose to be described hereinafter.

The elongated pulleys 34 when in certain positions cooperate with a pair of endless driving belts 39 and 40, the belt 39 hereinafter being termed the "slow speed belt" 39 and the belt 40 the "fast speed belt 40." The slow speed belt 39 passes around a pulley 41 secured on the lower end of a sleeve 42 rotatably mounted in bearings in a guide 151 carried by the frame member 15 and a pulley 43 carried at one end of an arm 44 which is pivoted to a bracket 45 clamped to an upright 17, a spring 46 anchored to the arm 44 and bracket 45 serving to tension the said slow speed belt 39. At its upper end the sleeve 42 carries a pulley 47 which is adapted to be driven by an endless belt 48 from a pulley 49 fixed to a spindle 50 to which is pinned a wormwheel 51 which is adapted to be driven by an electric motor 52 through the medium of a worm 53 secured to the driving shaft 521 of the said motor 52. The electric motor 52 is mounted on the upper side of a platform 54 bolted to two of the arms of the frame member 15.

The fast speed belt 40 passes around a pulley 55 fixed to the lower end of a spindle 56 which is rotatably mounted in the sleeve 42 and a pulley 57 carried by an arm of a lever 58 fulcrumed on a bracket 59 clamped to an upright 17, the lever 58 and bracket 59 being anchored to the ends of a spring 60 which tends constantly to tension the high speed belt 40. Fixed to the upper end of the spindle 56 is a pulley 61 which is adapted to be driven by an endless belt 62 from a pulley 63 fixed to the end of the motor driving shaft 521.

The spindle 50 has secured thereto also a pulley 64 which is adapted to drive by endless belt 65 a pulley 66 fixed to the end of a vertical shaft 67 mounted in bearings formed in a pedestal 68 carried by a platform 69 supported by means of upstanding rods 70 from the frame member 15. This said shaft 67 carries a worm 72 which meshes with a wormwheel 73 fixed on one end of a horizontally disposed shaft 74. The other end of the horizontal shaft 74 carries a cam disc 75.

Adapted to abut the cam face of the cam disc 75 is a roller 760 located at one end of a plunger 76 which is slidably mounted in brackets supported from the platform 69. A spring 78 tends to maintain abutment between the roller 760 and the presented cam face. The other end of the plunger 76 is formed with a shoulder 761 which cooperates with the free end of a gravity operated catch link 79. This link 79 is pivoted to one end of a second slidable plunger 80 which in turn is associated with the piston rod 311 of the air control valve 31. The piston rod 311, plunger 80, link 79 and plunger 76 are arranged axially and a spring 81 tends to move the plunger 80 towards the cam disc 75.

Disposed below the central portion of the link 79 is the head of a tappet 82 the lower end of which is located above the upper end of the lifting rod 20.

The spider 32 is provided with a pair of oppositely disposed axles 83 having mounted thereon rollers 84 said rollers 84 engaging within the grooves 85 of an indexing cam 86 associated with the underside of the hub of the frame member 15.

The plane containing upper surface of the frame member 16 is laid out with six equidistantly spaced stations marked—A, B, C, D, E, F.

The station A is termed the idle station, the station B the pre-heating station, the station C the final heating station, the station D the centrifuging station, the station E the cooling station and the station F the unloading and loading station.

The stations F and A are presented to the operator who effects the loading and unloading by hand and controls the machine by means of a push button control 87 for the electric motor 52 and a three-way valve 88 for the compressed air control, see Fig. 3, from a table 99 supported by two of the arms of the frame member 16. The pre-heating and final heating are effected by electric furnaces 89, 90 mounted on a platform supported by two other arms of the frame member 16. The said furnaces 89, 90 are annular and generally similar in construction and each embodies an electrically heated annular chamber 91 which is situated and dimensioned so that the insulators 37 can depend thereinto when a loaded carrier disc 35 is located at the stations B or C, see Fig. 1.

During the time when a carrier disc 35 is at stations B or C the respective elongated pulleys 34 are in engagement with the adjacent length of the slow speed belt 39 so that the carrier discs 35 are rotated slowly whilst at the said station. Meanwhile the elongated pulley 34 of the carrier disc 35 which is located at the centrifuging station D is in engagement with the fast speed belt 40 whereby the insulators 37 concerned are rotated rapidly and swung out by centrifugal force into a substantially horizontal position. At stations F and A the table 99 supports six pneumatic

cylinders 92 which are symmetrically arranged at each station so that jawed portions 93 at the upper ends of the piston rods 94 are located below the rims of the hoods 38 when disposed at the said stations F and A. The supply of compressed air to the cylinders 92 is controlled by the three-way valve 88 already referred to in conjunction with a valve 95 and distributor 96, see Fig. 10.

Adjacent to the operator is located a screw down valve 97 for cutting off communication between the hydraulic cylinder 25 and the oil vessel 28 when required, see Fig. 1.

The operation of the machine is as follows:

At the loading station F the holders 36 are filled with insulators 37 in the central holes in which have been inserted the lengths of silver rod which are to constitute the metallic cores of the central electrodes.

When the loading operation is complete the motor 52 is put into action and after a predetermined period of time the lifting rod 20 and parts fixed thereto are raised so that the carrier disc 35 is indexed one step to station A and lowered in a manner determined by the movement of the rollers 84 in the grooves 85 of the indexing cam 86. The succeeding carrier disc 35 which arrives at station F is then unloaded if the machine has been previously in operation and the cooled insulators 37 removed and new insulators 37 and their fillings inserted. In due course the carrier disc 35 from station A is indexed a further stage whereby the said carrier disc 35 is brought to station B at which is located preheating furnace 89. In a like manner the carrier discs 35 are passed progressively to each station where they remain for a definite and constant period of time.

When a carrier disc 35 is correctly located at station B or C the lowering movement locates the insulators within the respcetive annular furnace chambers 91 with the furnaces partially enveloped by the hoods 38 as seen in Fig. 1. As stated hereinbefore the insulators 37 when at station B are preheated and acquire a final heating when indexed to station C, the division of the heating into two parts reducing the time at which a carrier disc 35 would otherwise be required to remain at a single heating station. The final heating melts the silver rods so that when station D is reached where the carrier discs 35 are rotated at high speed the insulators 37 are swung into a horizontal position under the influence of centrifugal force whereby the molten silver in the central bores of the respective insulators 37 is caused to accommodate itself under centrifugal force to the bore of the said insulators 37 and in so doing to expel air and other trapped gases from the bore of the insulators 37, and from the mass of molten silver.

After centrifuging, indexing to station E obtains where cooling takes place with the insulators 37 at rest and ultimately progress is made to station F where unloading and loading is carried out.

When at stations F and A the hoods 38 are lifted by the jawed portions 93 of the piston rods 94 of the pneumatic cylinders 92 by admitting compressed air to the said cylinders 92.

The control of the air valve 31 is determined as follows. During periods between stations the plunger 76, link 79 and plunger 80 are rigid so that when a peak of the cam disc 75 traverses the roller 760 an axial thrust is exerted whereby the valve 31 is operated to cause compressed air to flow into the oil vessel 28. The oil displaced by the air passes into the hydraulic cylinder 25 and raises the lifting rod 20 and thus causes the

rollers 84 to traverse the grooves of the cam 86. As the lifting rod 20 approaches the top of its stroke the upper end of the said rod strikes the tappet 82 which in turn lifts the catch and frees the link 79 thus permitting the spring 81 to move the plunger 80 so that the valve 31 is caused to cut off the supply of compressed air to the oil vessel 28. Consequently the lifting rod 20 falls under the influence of gravity and indexing takes place by virtue of the movement of the rollers 84 in the cam grooves 85. The lowering of the lifting rod 20 in conjunction with the movement of the cam disc 75 permits the catch link 79 to fall and reseat itself on the shoulder 761 of the plunger 76.

In an emergency the motor 52 can be stopped and the three-way valve 88 manipulated to cause the lifting rod 20 to be raised likewise the hoods 38 at stations F and A, the said rod 20 being maintained in a raised position by retaining a head in the hydraulic cylinder 25 by manipulating the valve control 97 to shut off communication between the said hydraulic cyliner 25 and the oil vessel 28.

By causing the holders 36 to hang as shown in Figure 10 it is found that the friction engendered by one limb of the holder contacting an edge of the carrier disc 35 exerts a restraint on the swinging movement permitted to the holders so that insertion in and removal from the heating chambers 91 is facilitated.

A machine constructed as hereinbefore described admits of an improved process being carried out continuously and substantially automatically.

"Molten" is used in the following claim to designate a condition of the electrode material which permits it to flow or be deformed by the action of centrifugal force as disclosed herein.

I claim:

A machine for use in the manufacture of spark plugs embodying a frame structure, a rotatable and vertically displaceable lifting member mounted on said frame structure adapted to be moved step by step from station to station, a plurality of shafts rotatably supported by said lifting member, carrier members fixedly attached to each of said shafts for rotation therewith, means for pivotally suspending from the carrier members a plurality of insulators the bores of which have been already loaded with the metal required to form the core of the central electrode, said means permitting the insulators to swing outwardly under centrifugal force with the spark tip ends of the insulators directed outwardly, a pair of furnaces located at successive stations for heating the loaded insulators so that the metal becomes plastic or molten, means for slowly rotating the carriers while at said stations to produce even heating, means at a succeeding station for imparting a fast rotation to the carrier so that the loaded insulators are subjected to centrifugal force and the plastic or molten metal caused to fill the spaces to be occupied by the metallic core of a central electrode, and so that air and any trapped gases are expelled, cooling and unloading stations, means for intermittently moving said lifting member from station to station comprising an indexing cam, means associated with the lifting member and which cooperates with the indexing cam for effecting an indexing of the said lifting member and the carrier means supported thereby as determined by a raising and lowering of the aforesaid lifting member, a hydraulic means for effecting the raising of the said lifting

member, pneumatic means for controlling the actuation of said hydraulic mechanism, and trip mechanism for governing the operation of the pneumatic means according to a prescribed time cycle.

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