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FLUID-BLAST CIRCUIT INTERRUPTER WITH ARC TRANSFER TO ENERGIZE
ELECTRO-MAGNETIC PUMPING MEANS

Filed Sept. 1, 1966

2 Sheets-Sheet 1

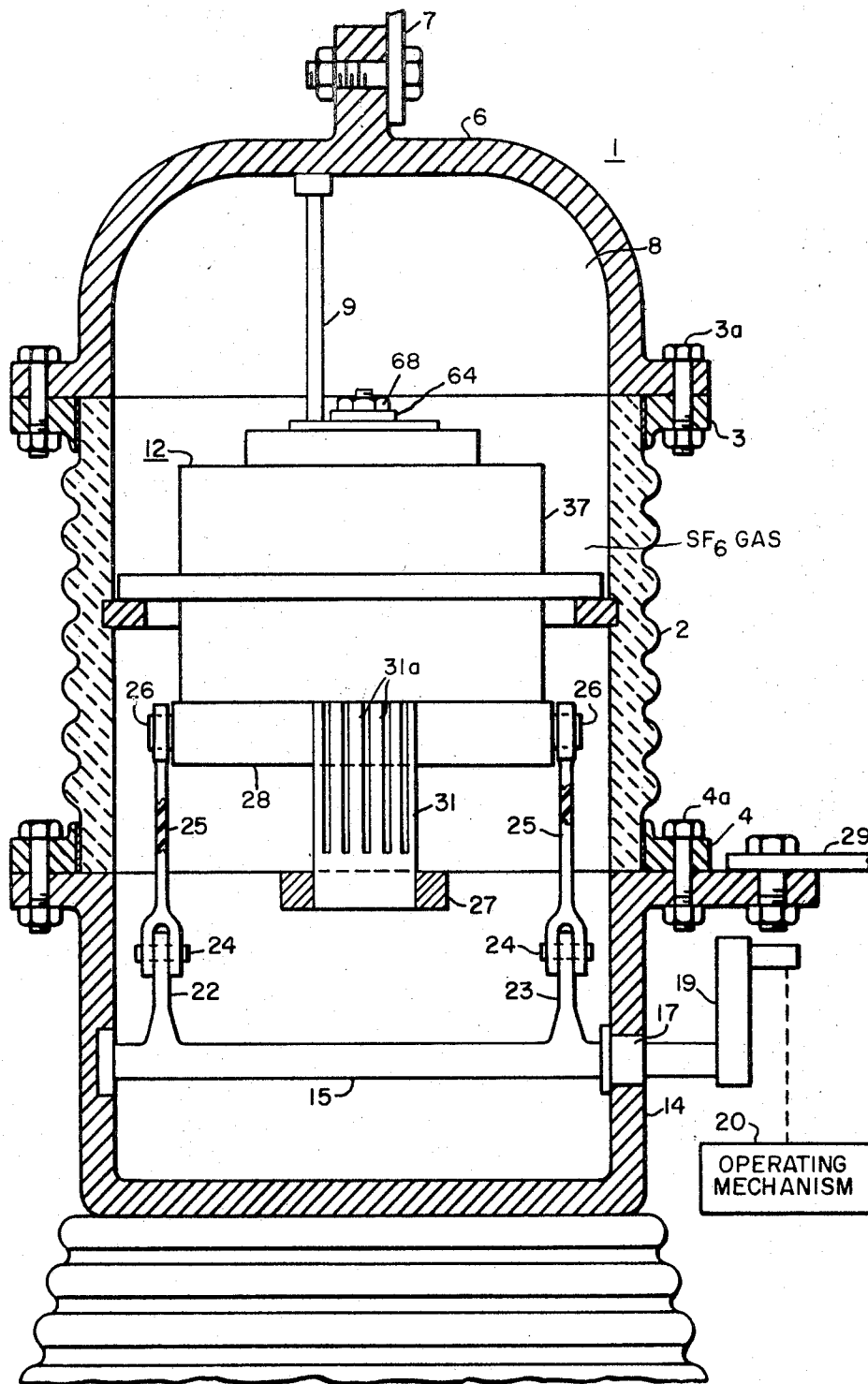


FIG. 1.

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2 Sheets-Sheet 2

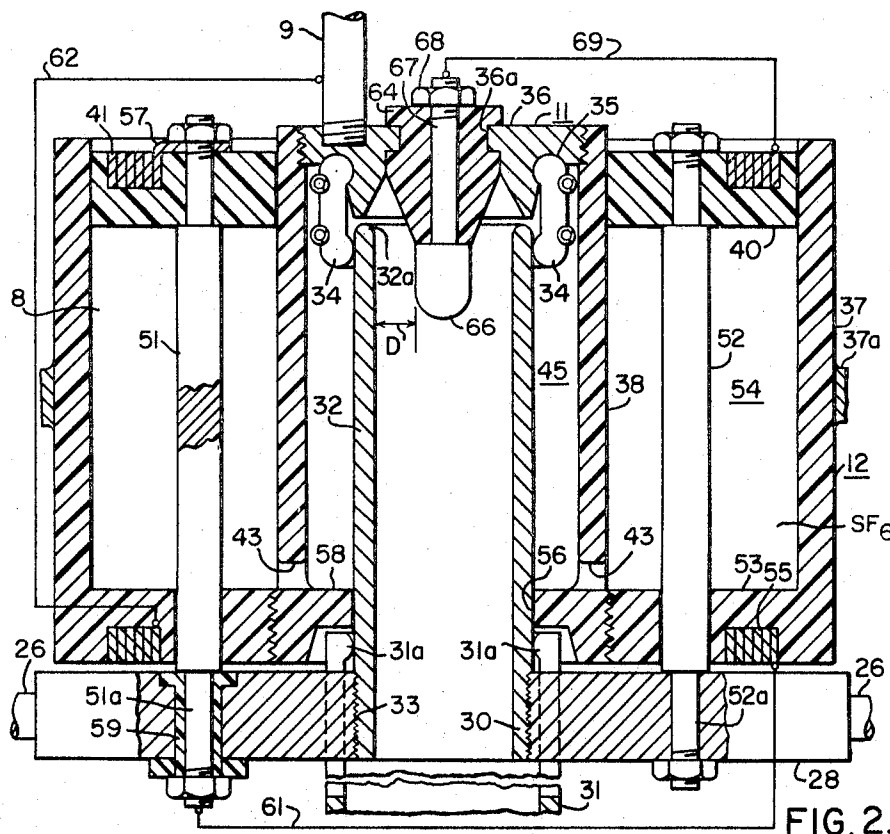


FIG. 2.

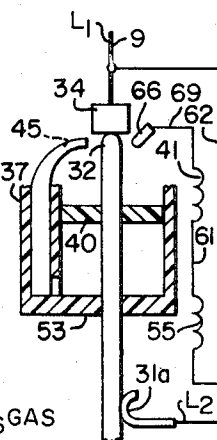


FIG. 4.

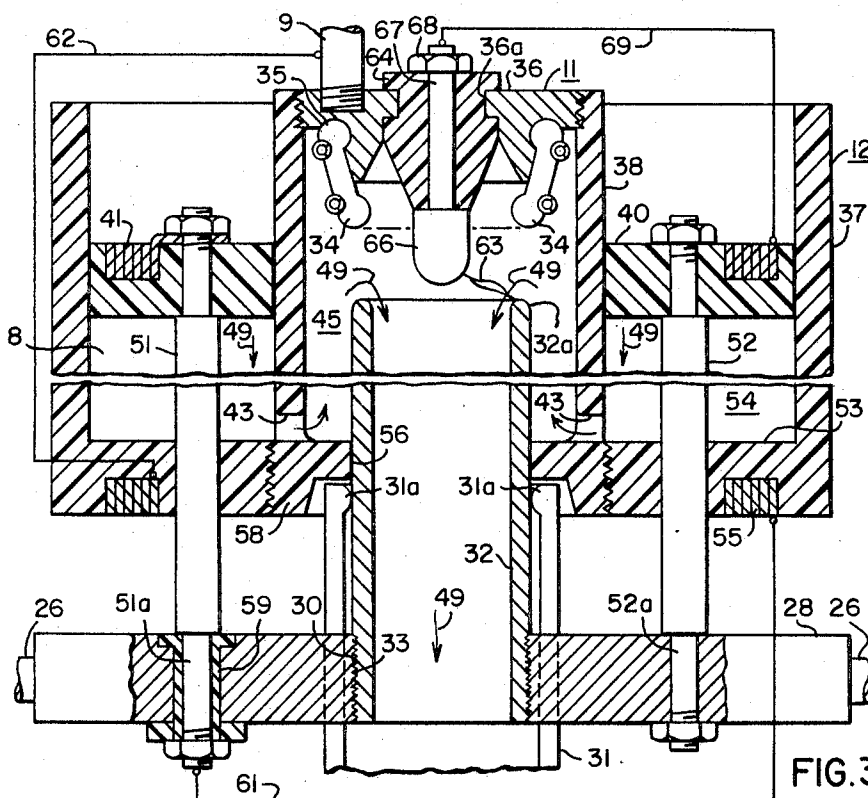


FIG. 3.

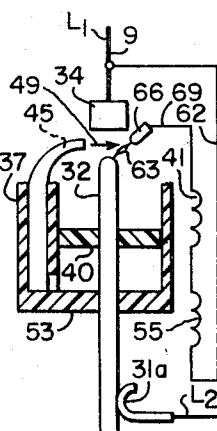


FIG. 5.

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FLUID-BLAST CIRCUIT INTERRUPTER WITH ARC TRANSFER TO ENERGIZE ELECTRO-MAGNETIC PUMPING MEANS

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10 Claims

ABSTRACT OF THE DISCLOSURE

A fluid-blast circuit interrupter is provided having a movable piston carrying an accelerating coil. Another accelerating coil is disposed at the lower end of the operating cylinder and is inserted serially into the circuit during the opening operation. The two accelerating coils are attracted magnetically to each other, and thereby assist the operating mechanism during the pumping action in the interruption of high-amperage currents.

This invention relates, generally, to fluid-blast circuit interrupters and, more particularly, to fluid-blast circuit interrupters having fluid-pumping means to force fluid under pressure toward the arc to effect the extinction thereof.

A general object of the present invention is to provide an improved electromagnetic pumping means for a fluid-blast circuit interrupter, so as to quickly effect the energization of the electromagnetic pumping means in a facilitated manner.

In United States patent application filed Sept. 1, 1966, Ser. No. 576,616, by Russell E. Frink, and assigned to the assignee of the instant application, there is illustrated and described a fluid-blast circuit interrupter utilizing an electromagnetic pumping means to force fluid toward the established arc. A further form of the same general concept is set forth and claimed in United States patent application filed Sept. 1, 1966, Ser. No. 576,615, by Russell E. Frink, and assigned to the same assignee as the instant application, involving improved transfer contact structure for inserting the accelerating coils into the circuit to energize the electromagnetic pumping means. It is a further object of the present invention to improve upon the electromagnetic pumping means of the aforesaid two patent applications rendering rapid energization of the electromagnetic pumping means by an improved method involving transfer of the established arc.

Still a further object of the present invention is the position of an improved fluid-blast circuit interrupter involving electromagnetic pumping means in which the several component parts are arranged in a compact manner with the pumping elements being so disposed as to efficiently direct the fluid flow in the proper manner to not only effect transfer of the arc to energize the accelerating coils, but, additionally, to rapidly effect extinction of the final residual current arc.

Further objects and advantages will readily become apparent upon reading the following specification, taken in conjunction with the drawings, in which:

FIG. 1 is a vertical sectional view taken through a circuit interrupter embodying the principles of the present invention, the contact structure being illustrated in the closed-circuit position;

FIG. 2 is a considerably enlarged vertical sectional view taken through the arc-extinguishing structure of the device of FIG. 1, again the contact structure being illustrated in the closed-circuit position;

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FIG. 3 is a view similar to that of FIG. 2, but the position of the several parts being taken at an intermediate point in the circuit-interrupting opening operation;

FIG. 4 is a diagrammatic view illustrating the coil connections and the general manner of pumping, the contact structure being illustrated in the closed-circuit position; and,

FIG. 5 is a diagrammatic view similar to that of FIG. 4, but illustrating the arc disposition with the accelerating coils inserted into the electrical circuit.

Referring to the drawings, and more particularly to FIG. 1 thereof, the reference numeral 1 generally designates a fluid-blast circuit interrupter. A casing structure is provided including an upstanding insulating casing 2 of some suitable weatherproof material, such as porcelain, having annular metallic flange rings 3, 4 secured to its upper and lower ends. The upper flange ring 3 is bolted by bolts 3a to a top line terminal cap 6 having a line connection 7 associated therewith. Extending downwardly from the inner central portion of the cap 6 is a stationary contact rod 9, which is mechanically and electrically secured to the stationary contact structure 11 of an arc-extinguishing unit 12 of the fluid-blast type, to be described in detail more fully hereinafter. Preferably, an ambient of 60 p.s.i. gas pressure of sulfur-hexafluoride (SF₆) gas 8, for example, is provided interiorly of the casing structure 2. Other suitable arc-extinguishing gases may, of course, be used.

The lower flange ring 4 is secured by bolts 4a to a lower metallic mechanism housing 14 having a rotatable drive shaft 15 journaled therein and adapted for rotation. The drive shaft 15, as shown in FIG. 1, extends through a gas seal 17 and extends externally of the casing structure having a crank-arm 19 affixed to the outer extremity thereof. The crank-arm 19 may be actuated by a conventional operating mechanism designated by the reference numeral 20.

The rotatable drive shaft 15 has a pair of integrally-formed arm elements 22, 23, which are pivotally connected, as at 24, to a pair of insulating operating links 25, the upper ends of which are attached in a pivotal manner to trunnions 26 disposed at the ends of an actuating and operating bar 28.

Disposed generally centrally of the base casting 14 and having a supporting spider connection 27 therewith, is an upstanding tubular stationary contact tube 31. The stationary contact tube 31 has a plurality of circumferential contact fingers 31a at the upper extremity thereof, which bears on the external surface of a tubular movable vented contact tube 32, which is carried by the actuating and drive bar 28. In more detail, the movable vent tube 32 has a threaded connection, as at 33, within a hole 30 provided centrally within the actuating bar 28.

As shown more clearly in FIGS. 2 and 3 of the drawings, the movable tubular venting tube 32 make electrical contact with the plurality of circumferentially-disposed contact fingers 34, the upper ends of which seat within recesses 35 provided in an annular stationary contact ring 36, constituting a portion of the stationary contact structure 11. The stationary contact structure 11 and the movable contact 32 constitute a separable main contact means.

From the foregoing, it will be apparent that in the closed-circuit position of the device, as illustrated in FIG. 2 of the drawings, the electrical circuit extends from the line terminal 7 through the stationary contact rod 9, stationary contact structure 11 including the contact ring 36, stationary contact fingers 34, and movable contact tube 32 to fingers 31a of stationary contact tube 31. The circuit then extends through conducting spider 27 to the

conducting mechanism casting 14 to the lower line terminal 29 of the circuit interrupter 1.

With reference to FIGS. 2 and 3 of the drawings, it will be noted that the arc-extinguishing unit 12 includes a stationary operating cylinder 37 and an inner concentrically-arranged operating cylinder 38. Reciprocally movable within the annular space, defined by the operating cylinders 37, 38 is a movable piston 40, having an accelerating, or driving coil 41 embedded therein. As will be more fully brought out hereinafter, the accelerating or driving coil 41 assists the downward fluid-driving motion of the annular piston 40 to force fluid through the apertures 43 provided at the lower end of the inner operating cylinder 38 through the annular region 45, into the contact tube 32, to exhaust downwardly through the lower stationary contact tube 31 in a manner indicated by the arrows 49.

It will be observed that the annular piston 40 is provided with a pair of driving piston rods 51, 52, which are fixedly secured at their lower extremities 51a, 52a to the actuating drive bar 28.

The lower end of the pumping region 54, defined by the outer and inner operating cylinders 37, 38, is closed by a plate portion 53, having embedded therein a stationary accelerating coil 55. The base portion 58 of the inner operating cylinder 38 has a central opening 56 provided therethrough, through which reciprocally moves the movable contact tube 32.

It will be observed that the driving piston rod 51 is composed of conducting material and has an electrical connection at the upper end thereof, as at 57, to one terminal of the upper movable driving coil 41. In addition, the lower end of the conducting driving rod 51 is insulated, by means of an insulating sleeve 59, from the actuating bar 28. A flexible connection 61 electrically connects the lower end of the conducting piston rod 51 with one terminal of the lower stationary accelerating coil 55. The other end of the lower stationary accelerating coil 55 is electrically connected by a conductor 62 to the upper stationary contact rod 9.

An apertured insulating plate 64 is fixedly secured within the opening 36a of the upper stationary contact ring 36, and serves to support a stationary arcing contact or stationary probe means 66. As shown, the arcing contact or probe means 66 has a stud portion 67, which, together with a nut 68, firmly secured the arcing contact 66 in a stationary manner, as shown. A flexible connection 69 electrically interconnects the arcing contact 66 with one terminal end of the upper movable accelerating or driving coil 41.

OPENING OPERATION

To effect an opening operation of the interrupter 1, the operating mechanism 20 is energized, either by manual operation, or in response to the tripping of an overload relay, as well understood by those skilled in the art, to effect rotative opening motion of the external crank-arm 19. This motion is translated into opening rotative motion of the main crank-shaft 15, which through the arms 22, 23 actuates the two insulating links 25 to effect downward opening movement of the actuating or driving bar 28. Since the movable vented contact tube 32 is affixed to the driving bar 28, it will also move downwardly to draw an arc (not shown) between the upper end 32a of the contact tube 32 and the stationary contact fingers 34. Since the piston rods 51, 52 move downwardly with the actuating bar 28, the annular piston 40 will also move downwardly to force fluid upwardly within the region 45 interiorly of the inner operating cylinder 38 to force the established arc across the gap between the stationary contacts 34 and the arcing contact or probe 66, thereby effecting arc transfer to the latter, as illustrated in FIG. 3 of the drawings.

By so effecting arc transfer, the two accelerating or driving coils 41, 55, constituting an electromagnetic driv-

ing means, are inserted serially into the electrical circuit, thereby utilizing the electrical energy passing through the electrical circuit L_1 - L_2 , controlled by the circuit interrupter 1, to assist in downward pumping motion of the annular piston 40. In more detail, the electrical circuit now includes contact rod 9, connection 62 to one terminal of the lower accelerating coil 55. The electrical circuit extends from the other terminal of the accelerating coil 55 through the flexible connector 61 to the conducting piston rod 51 and through the connector 57 to one terminal of the upper moving accelerating coil 41. The electrical circuit then extends from the other terminal of the upper movable driving coil 41 to the flexible connector 69 to the arcing contact 66 and through the arc 63 to the movable contact tube 32. The circuit then extends through the contact fingers 31a and through the stationary contact tube 31 and support 27 to the other line connection 29 of the interrupter.

The accelerating coils 41, 55 are so wound as to attract each other, and so assist in the downward fluid-driving motion of the annular piston member 40. As a result, during heavy fault-current interruption, the electrical energy of the circuit L_1 - L_2 is utilized to provide increased driving effort exerted upon the fluid 8 to force the latter downwardly through the vented contact tube 32 in the manner shown by the arrows 49, and so effect a rapid extinction of the transfer, or residual current arc 63. Upon interruption of this arc 63, further movement of the actuating bar 28 and movable contact structure 32 will effect an isolating gap in the circuit.

It will be noted that during low-current interruption, or normal load-current interruption, the mechanical energy supplied by the operating mechanism 20 will in itself be adequate to supply the required fluid-driving force. However, during heavy fault-current interruptions, to avoid the use of a much heavier operating mechanism 20, it is desirable to utilize the energy in the electrical circuit controlled by the interrupter 1 to assist in an increased downward driving piston effort. This is provided by the force of magnetic attraction between the two relatively movable accelerating coils 41, 55.

CLOSING OPERATION

During the closing operation of the circuit interrupter 1, again the mechanism 20 effects rotative closing travel of the externally-disposed crank-arm 19. This effects corresponding closing rotative travel of the main operating crankshaft 15, which, together with the arms 22, 23, effects closing upward travel of the insulating operating links 25. The links 25 will force the actuating bar 28 and the movable contact tube 32 upwardly into contacting engagement with the stationary contact fingers 34, thus bypassing the circuit through the two accelerating coils 41, 55, and directly contacting the stationary contact structure 11. As a result, in the closed-circuit position of the device, the accelerating coils 41, 55 are not in the electrical circuit. Additionally, it will be noted that during the closing upward travel of the movable venting contact tube 32, there is no tendency whatsoever to have pre-striking occur between the upper extremity 32a of the contact tube and the stationary arcing contact or probe 66. As will be obvious, if this were to occur, the accelerating coils 41, 55 would be inserted into the circuit to oppose the closing motion. However, because of the gap spacing D (FIG. 2), there is no tendency whatsoever for this to occur, and any pre-striking during the closing stroke will occur between the upper extremity 32a of the contact tube 32 and the stationary contacts 34 bypassing the coils 41, 55. The net result is an avoidance of insertion of the accelerating coils 41, 55 into the circuit during the closing operation, and direct engagement between the stationary contacts 34 and the movable contact tube 32 during such a closing operation.

From the foregoing description of the invention it will be apparent that there has been provided an improved

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fluid-blast circuit interrupter 1 having arc-transfer means 34, 66 to insert the accelerating or driving coils 41, 55 into the series electrical circuit. Consequently, there is no need to provide separable auxiliary contacts for this purpose, and it will be observed that the same fluid blast, which effects arc transfer, and consequent insertion of the series coils 41, 55 into the electrical circuit, additionally effects extinction of the residual current arc 63 following arc transfer to the stationary arcing contact 66.

Calculations show that with reasonable parameters, forces in excess of 10,000 lbs. are easily obtained under short-circuit conditions. However, this force is proportional to the square of the current, and the mechanism itself must supply practically all of the power for load-switching operation.

Although there has been illustrated and described a specific structure, it is to be clearly understood that the same was merely for the purpose of illustration, and that changes and modifications may readily be made therein by those skilled in the art, without departing from the spirit and scope of the invention.

I claim as my invention:

1. A fluid-blast circuit interrupter including separable main contact means for establishing a main current arc, piston means for generating fluid under pressure and forcing the same against the main current arc, electromagnetic means including a pair of accelerating coils for assisting the piston means in rapidly generating fluid under pressure, probe means (66) insulated from the separable main contact means electrically connected to said two accelerating coils, and means utilizing said generated pressure from the movement of the piston means for effecting arc transfer from the separable main contact means to the probe means (66) to thereby insert said two accelerating coils serially into the electrical circuit, whereby piston operation is mechanically assisted.

2. The combination according to claim 1, wherein at least one of the separable main contact means is a hollow contact (32) and has the fluid flow passing therethrough.

3. The combination according to claim 1, wherein the probe means (66) is centrally located with respect to the stationary contact means (11).

4. The combination according to claim 1, wherein the

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probe means is stationary and centrally located with respect to the stationary contact means.

5. The combination according to claim 1, wherein the probe means is stationary.

6. The combination of claim 1, wherein the piston means comprises a stationary operating cylinder (37) and an inner concentrically-arranged operating cylinder (38) with an annularly-shaped piston (40) operable therebetween.

7. The combination of claim 6, wherein the inner operating cylinder (38) has apertures (43) provided adjacent one end thereof so that a reverse flow of fluid occurs.

8. The combination of claim 6, wherein the separable main contact means is located interiorly of the inner concentrically-arranged operating cylinder (38).

9. The combination of claim 1, wherein the piston means comprises at least one conducting piston rod which forms part of the connecting means for the pair of accelerating coils.

10. The combination of claim 1, wherein the separable main contact means comprises a movable contact, and an actuating member (28) is provided and fixedly attached to both said movable contact (32) and also to the movable piston (40).

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U.S. Cl. X.R.

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