

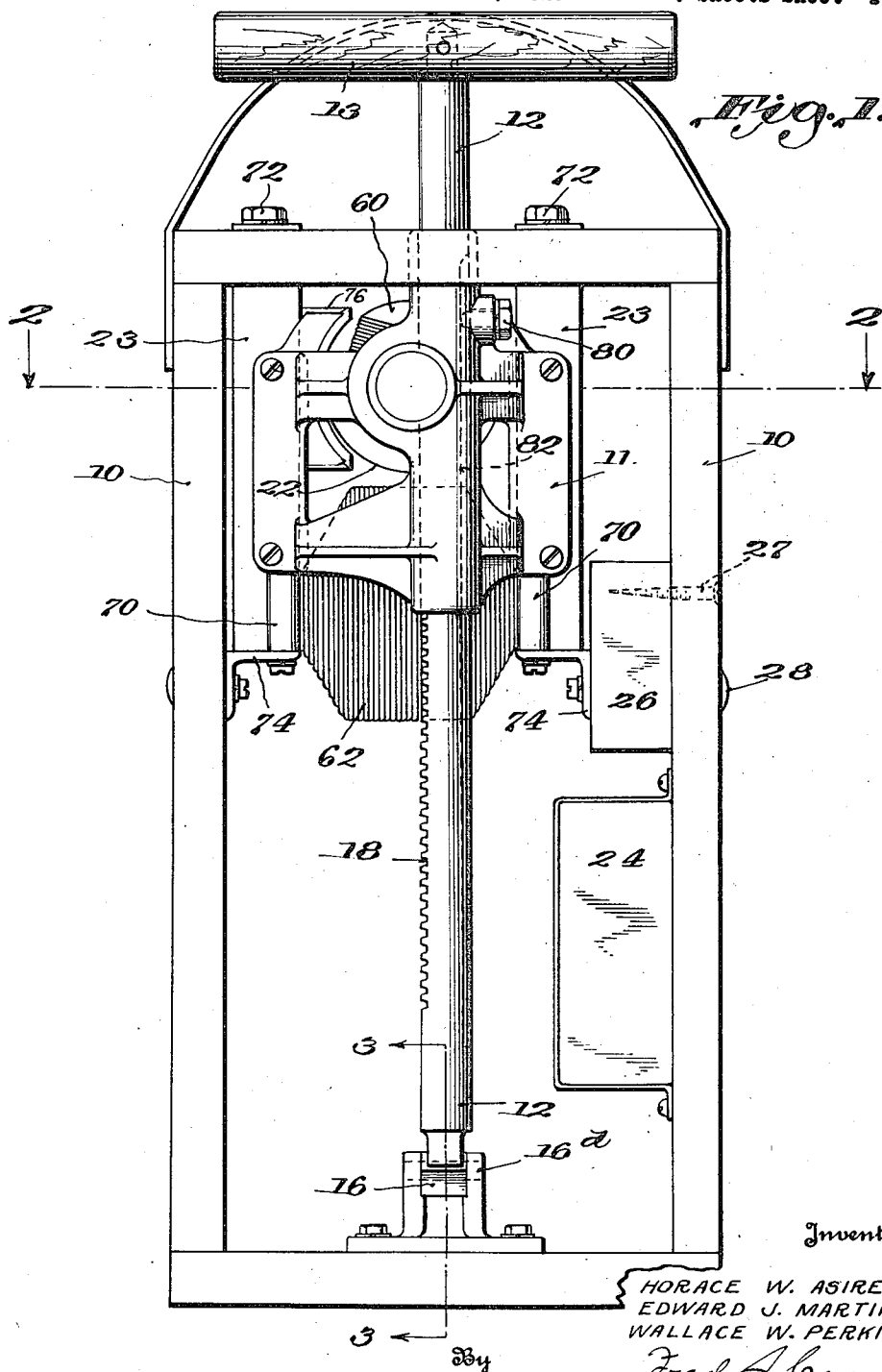
Dec. 13, 1932.

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ELECTRIC BLASTING MACHINE

1,890,445

Filed Oct. 8, 1929

3 Sheets-Sheet 1



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3 Sheets-Sheet 2

Fig. 2.

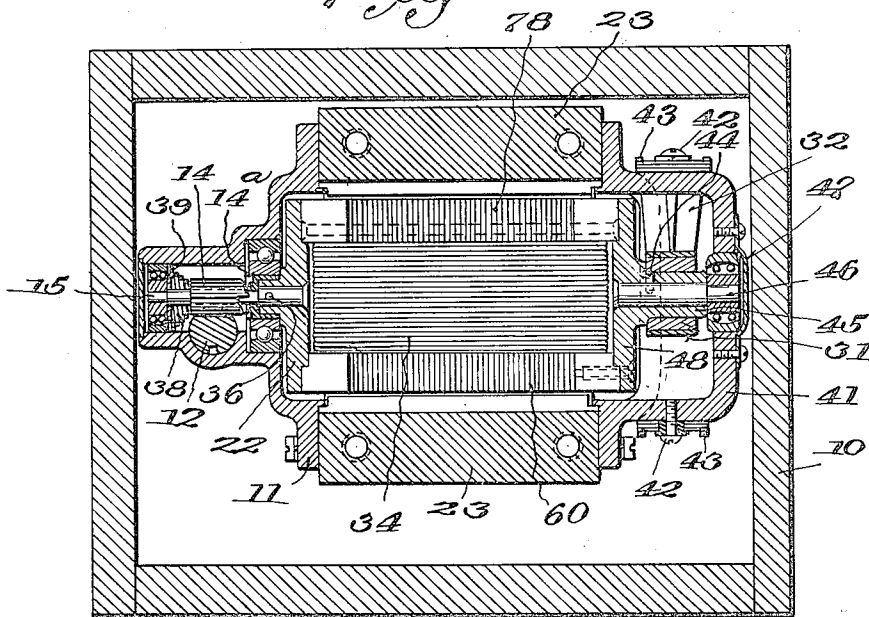


Fig. 3.

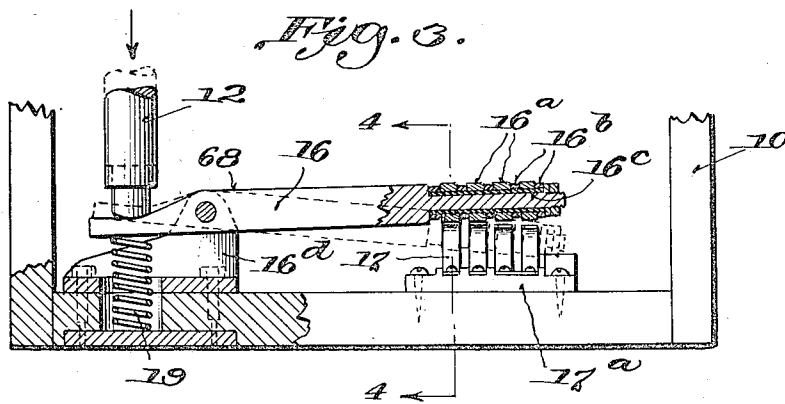
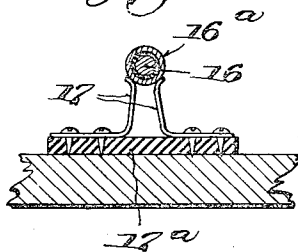


Fig. 4.



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3 Sheets-Sheet 3

Fig. 5.

ARMATURE POSITION AT
EACH TIME OF BREAK

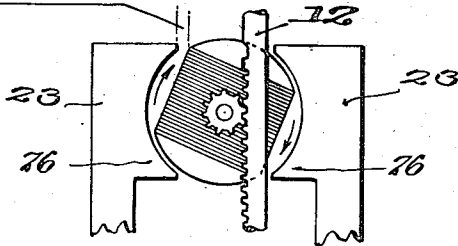


Fig. 6.

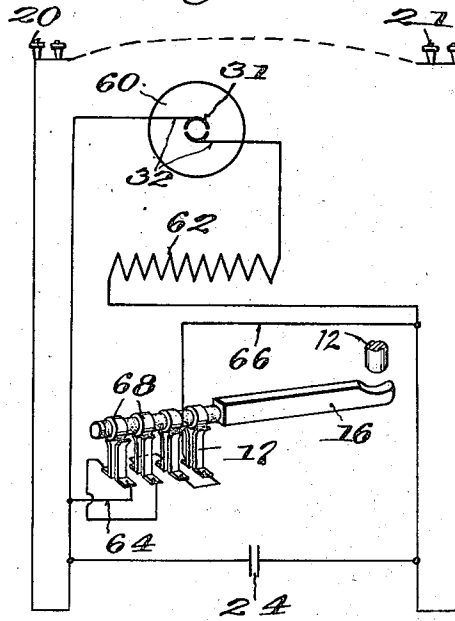


Fig. 7.

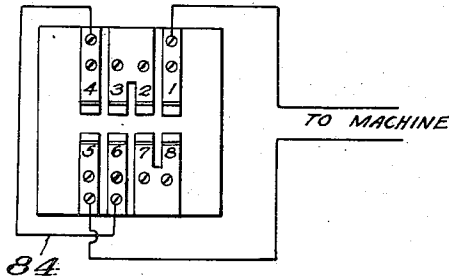


Fig. 8. Fig. 9.

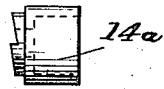
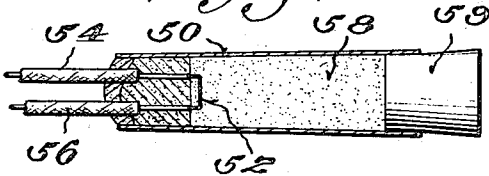


Fig. 10.



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ELECTRIC BLASTING MACHINE

Application filed October 8, 1929. Serial No. 398,132.

This invention has to do with blasting equipment of the type in which the charge contained in an electrical blasting cap or "squib" is ignited by an electric current generated by a dynamo operated by the workman. Such equipment is customarily so designed that the dynamo and all of the operating parts are compactly assembled so that they may be readily transported as a unit and connected to the squib or squibs by suitable wiring. The dynamo is designed for hand operation.

The problem is presented of securing the maximum electrical discharge from the slight amount of power available, and to keep the apparatus within convenient size and weight.

The prior apparatus of this type with which we are familiar has consisted essentially of a manually operated series or shunt wound direct current generator. The series machine is normally short circuited and connected to the squibs so that, upon breaking the short circuit, an electric current passes through the resistance unit in the squibs, producing the heat that fires the charge. The efficiency of these devices was comparatively low and the energy delivered at the squib was correspondingly small in amount so that it was necessary to provide a range of machines differing in size and power depending upon the number of squibs to be fired at one time.

It has been our object to improve the efficiency and power output of this type of blasting equipment so that one generator will provide sufficient energy to fire a large number of squibs and will be sufficiently compact so that it may be readily transported. By applying to this equipment the inventions herein set forth we have succeeded in developing a blasting machine which will fire as many as 550 squibs in series as compared with prior machines of practically the same size that had a capacity of 120 squibs. The details of the invention are set forth in the following specification wherein:

Figure 1 is a side elevation of our improved blasting machine.

Figure 2 is a section on line 2—2 of Figure 1.

Figure 3 is a view on line 3—3 of Figure 1 with parts in section.

Figure 4 is a section on line 4—4 of Figure 3.

Figure 5 is a somewhat diagrammatic view of the end of the generator to which the operating mechanism is applied.

Figure 6 illustrates the circuit employed, while Figure 7 shows the arrangement of contacts of the multi-point breaker switch.

Figures 8 and 9 are detail views of the clutch collar secured to the shaft of the generator.

Figure 10 shows one of the electrical blasting caps or squibs as it appears in section.

As the blasting machine is especially designed for use with the conventional electrical blasting cap or squib shown in Figure 10, this will first be described. The squib comprises a paper cartridge 50 containing a short length of platinum wire 52 of small diameter and correspondingly high resistance. In actual practice the wire employed is .0015" in diameter and about 1/8" long. This wire is connected to the two lead-in wires 54 and 56, sealed in the end of the cartridge by any suitable material. The wire 52 is surrounded by the priming charge 58 consisting of any suitable explosive. A stopper 59 closes the end of the cartridge. The squib is fired by passing current through it and bringing the platinum wire to a temperature sufficiently high to explode the priming charge. Usually the wire fuses in the process. Obviously, the squib presents a considerable resistance to the flow of current so that to fire a number of squibs in series, quite a high voltage is necessary to produce a flow of current of the required magnitude.

Our blasting machine consists of a series wound direct current generator normally short circuited and provided with a squib circuit in parallel with the short circuit. Upon breaking of the short circuit the energy stored in the machine and the generated current flows through the squibs heating the resistance wires 52 and igniting the charges.

Referring now to the wiring diagram, shown in Figure 6, 60 indicates the armature of the generator preferably provided with the

two-segment commutator shown at 31. The brushes are indicated by the numeral 32 and one of them is directly connected to the series field 62. The armature and the series field
 5 are normally short circuited by leads 64 and 66 connected by multi-point switch 68. The multi-point switch, which will be described in detail later is designed to provide, when
 10 open a series of gaps in parallel so as to reduce sparking. In parallel with the short circuit path is the condenser 24. The path containing the squibs 21 in series is arranged in parallel with the short circuit path and with the condenser.

15 In the operation of the device the multi-point switch 68 is normally closed, and rotation of the armature builds up a heavy current through the armature 60, the series field 62, and the short circuit path. This circuit is
 20 then broken by opening of the multi-point switch. This is accompanied by a certain amount of arcing at the switch contacts which, however, is minimized by the special type of switch employed, and at the same time
 25 a considerable amount of energy is momentarily stored in the condenser 24, but this together with the electrical energy generated by continued rotation of the armature is almost immediately discharged through the
 30 squib circuit heating the platinum wires to incandescence and igniting the charges.

We have illustrated our generator in Figures 1 and 2 wherein 23 indicates the field pieces, preferably of soft iron, secured to the
 35 frame 10 by means of bolts 72 and brackets 74. Between one of the brackets 74 and the frame a block of wood 26 is interposed in this particular design. The field pieces 23 are provided with separately formed or integral
 40 pole pieces 76 conforming to the curvature of the armature. The field pieces 23 are connected by member 70, serving as the core upon which the series field 62 is wound. To the ends of the field pieces 23 are secured brass
 45 castings 11 and 41 in which are provided bearings for the ends 15 and 46 of the armature shaft. The armature itself consists of a laminated core 78 clamped between end pieces 22 and 48 to which the shafts 14 and 46 are
 50 respectively secured. The end piece 48 is extended in the form of a sleeve 45 surrounding the shaft 46 and to the sleeve are secured the commutator segments 31 as best shown in Figure 2. The segments are, of course, insulated from the shaft and from each other.
 55 The brushes 32, one of which is clearly shown in Fig. 2, are secured to but insulated from end member 41 by means of suitable bolts 42 and insulating washers and bushings 43.

60 To the shaft 15 there is secured by means of pin 36 a clutch collar 14a provided with diametrically opposite teeth adapted to mesh with corresponding teeth on gear 14 loosely carried on shaft 15. Coil spring 38 bears at
 65 one end against washer 39 abutting against

the adjacent bearing, and at the other end against the gear 14, tending to yieldingly urge it into engagement with the clutch member 14a. With the gear 14 meshes the rack
 70 12 slidably mounted in suitable bearings provided in the end member 11, and prevented from rotation in the bearings by any suitable means such as stud 80 and slot 82 (Fig. 1). The upper end of the rack 12 is provided with
 75 a handle 13.

As previously stated the generator is of a simple series wound type. We have found it very important to employ a laminated armature core, as shown at 78, for the reason
 80 that this greatly reduces the hysteresis and eddy current losses resulting from the reversal of magnetism of the core incident to its rotation. As a matter of fact, we have found by simply laminating the armature we obtained an increase in output in one design of
 85 as much as 70%.

The generator is also characterized by a solid soft iron field. In the field, of course, there is no reversal of magnetism so that it is desirable to have a field which will retain
 90 enough residual magnetism to cause the machine to build up rapidly.

We have also found that the output of the generator is very sensitive to the ratio of turns in the field and armature. Thus with
 95 a ratio of field to armature turns of approximately 2 to 1 we have found that the generator output is much greater than with any other ratio. In the specific machine illustrated we have employed 846 turns on the
 100 field and 400 turns on the armature.

The breaker switch 68 is best shown in Figs. 3 and 4. The movable member of the switch consists of a lever 16 pivoted to
 105 bracket 16d and normally urged into switch closing position by coil spring 19. The other end of the lever is encircled by an insulating bushing 16c on which are mounted contacts 16a separated by insulating bushings 16b. Each of the members 16a, when in its lower-
 110 most position, closes a pair of contacts 17 as best shown in Figure 4. The specific arrangement of contacts 17 is shown more clearly in Figure 7. Thus contact No. 1 is
 115 connected to one side of the generator while contact No. 5 is connected to the other side of the generator. Contacts 2 and 3 are integrally formed as are also contacts 7 and 8, while contacts 4 and 6 are connected by lead
 120 84.

When the contact carrying end of lever 16 is raised it is apparent that at each pair of contacts 17 the circuit is simultaneously broken at two points. As shown in Figure 3 the contact members 17 are so graded in size,
 125 and so designed that upon the raising of the contact carrying end of the switch 16, the circuit is substantially simultaneously broken at each of the pairs of contacts 17. Since there are four pairs of contacts and the cir- 130

cuit is broken in two places at each pair, it is apparent that eight gaps in the circuit are almost simultaneously created. This, of course, results in a reduction in the sparking voltage available at each gap with the result that sparking is greatly minimized and the effect of a single gap of very long dimensions is obtained. The corresponding single gap would, of course, be many times as long as the combined total of the eight gaps, since it is well known that the resistance to sparking across a gap does not increase in direct proportion to the length of the gap but at a much slower rate.

The blasting machine described in this application is capable of generating a maximum of approximately 2300 volts on open circuit while with a squib circuit the maximum voltage will be less than this value depending upon the number of squibs in the circuit. With so high a voltage there is necessarily some sparking at the breaker switch contacts, but this is minimized by the employment of the series gap type switch. If desired, instead of, or in addition to this type of switch, a magnetic blow-out may be employed, this consisting either of an electromagnet supplied with current from the generator or a portion of the magnetized field iron arranged in proximity to the gap. However, we have found that the multi-point switch takes care of arcing in a satisfactory manner.

We call attention to the fact that a lead 84 is extended between contacts 4 and 6. The effect of this arrangement is to provide one terminal of the switch in one row of contacts 17 and the other terminal in the other row. The advantage of this is that any short circuiting of the switch can only take place by arcing across the adjacent switch segments on one side of the switch and across the gap between two opposed contacts. In other words, four gaps in series must be jumped by the current to short circuit the switch. We have found this design to be much preferable to the normal construction in which the terminals of the switch are at opposite ends of one row of contacts since in this case there are but two gaps to be jumped by the current in short circuiting the switch.

We have shown the condenser 24 mounted on the side of the frame in Figure 1 merely for convenience in design. We have likewise not indicated the wiring in this figure to avoid complication and for the wiring diagram refer the reader to Figure 6.

In the operation of the blasting machine with the circuit arranged as shown in Figure 6 and the squibs arranged in series between the terminals of the machine, the rack 12 is raised to uppermost position, this having no effect on the armature because of the provision of the one way clutch at 14a-14. The operator then shoves handle 12 downwardly

at a rapid rate, this through clutch 14-14a producing rapid rotation of the armature 60 and building up a heavy current in the short circuiting path through the breaker switch.

There is likewise a considerable storing of energy in the condenser 24. Toward the end of its movement the lower end of rack 12 engages the breaker switch 16, and practically simultaneously opens the short circuiting path 64-66 at the eight contact points provided on the breaker switch. While there is some slight amount of arcing at the points of the breaker switch, this is minimized by the provision of the condenser 24, and shortly thereafter discharge of current takes place through the high resistance squib circuit. In this discharge the energy stored up in the condenser and in the inductances constituted by the armature and field windings is supplemented by the electrical energy created by the continued movement of the armature which is permitted to freely rotate even after the rack reaches its lowermost position by virtue of the overrunning connection at 14-14a.

In actual test we have found that the provision of the condenser at 24 not only reduces arcing at the breaker switch but increased the output of the machine by as much as 46%.

We call attention to the fact that our improved machine is so designed that the breaker switch is opened at the point in the rotation of the armature where the maximum current is being generated. This is accomplished by the use of a two jawed clutch at 14-14a and gearing the rack 12 and pinion 14 together so that when the rack is at the bottom of its stroke the armature is either in the position shown in Figure 5 or in a position removed 180° therefrom. In either of these positions the armature winding is in the position in which the maximum flux is being cut so that the generated voltage is a maximum.

We have described a number of improvements in blasting machines, each of which adds materially to the efficiency and capacity of the machine. It is obvious that some or all of these improvements may be used as desired in particular designs and that, as pointed out in the following claims, the invention herein described is of corresponding scope.

We claim:

1. In a blasting machine the combination of a closed igniting circuit, including a charge igniting device, a generator in the igniting circuit, means for normally short circuiting the generator including a normally closed multi-point switch, means for operating the generator, and means for thereafter opening the switch to produce discharge of generated current through the igniting circuit, said switch, when opened, providing a series of gaps in series to minimize arcing.

2. In a blasting machine the combination of a closed igniting circuit including a charge igniting device, a generator in the igniting

- circuit, means for short circuiting the generator including a normally closed multi-point switch, and means for operating the generator and thereafter opening the switch to produce electrical discharge through the igniting device, said last named means being connected to the generator and switch so that the switch is opened when the generator is in position for generating its maximum current.
3. In a blasting machine, the combination of a closed igniting circuit including a charge igniting device, a two-pole series wound direct current generator in the igniting circuit, means for short circuiting the generator including a normally closed switch, means for operating the generator including a two position clutch, and a common operating means for the generator operating means and the switch adapted to first operate the generator and thereafter open the switch to produce discharge of generated current through the igniting circuit, said common operating means being so synchronized with respect to the generator operating means that the generator is generating maximum current when the switch is opened.
4. In a blasting machine, the combination of a closed igniting circuit including a charge igniting device, a series wound direct current generator in the igniting circuit comprising a stationary field structure, and a rotatable armature, said field structure being provided with a solid core, of soft iron, the core of said armature being laminated, means for normally short-circuiting the generator including a normally closed multi-point switch, means for operating the generator and means including a circuit breaker for thereafter opening the short-circuit path to cause electrical discharge through the igniting circuit.
5. In a blasting machine, the combination of a closed igniting circuit including a charge igniting device, a series wound direct current generator in the igniting circuit, means for short-circuiting the generator including a normally closed multi-point switch, means for operating the generator and means for thereafter opening the switch to permit electrical discharge through the igniting circuit, the ratio of field to armature turns in the generator being approximately two to one.
6. In a blasting machine, the combination of a closed igniting circuit, including a charge igniting device, a generator in the igniting circuit, means for short circuiting the generator including a normally closed multi-point switch, means for operating the generator, means for thereafter opening the switch to produce discharge of generated current through the igniting circuit, and a condenser in parallel with the switch for storing energy to reduce arcing and for use in effecting discharge through the igniting circuit.
7. In a blasting machine the combination of a closed igniting circuit, including a charge igniting device, a generator in the igniting circuit, means for normally short-circuiting the generator including a normally closed multi-point switch, means for operating the generator, and means for thereafter opening the switch to produce discharge of generated current through the igniting circuit, and a condenser in parallel with the switch for storing energy to reduce arcing, said switch, when opened, providing a series of gaps in series to minimize arcing.
- In testimony whereof we affix our signatures.
- HORACE W. ASIRE.
EDWARD J. MARTIN.
WALLACE W. PERKINS.

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