March 10, 1942. F. MIESS 2,275,861

IGNITION APPARATUS

Filed Dec. 14, 1938 2 Sheets-Sheet 1

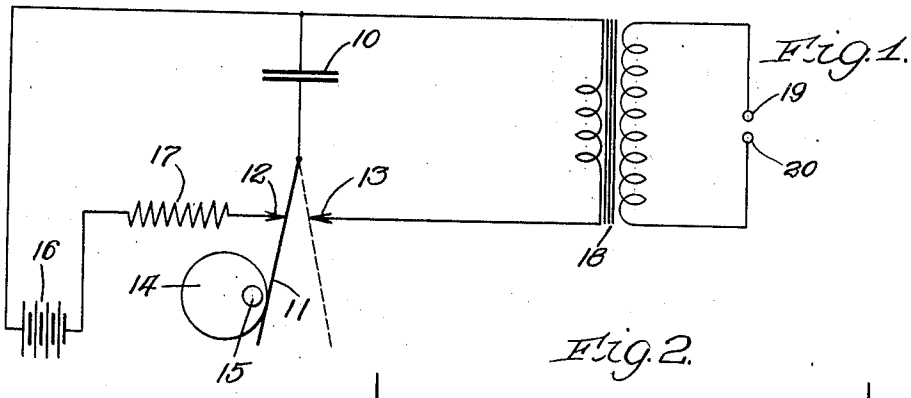
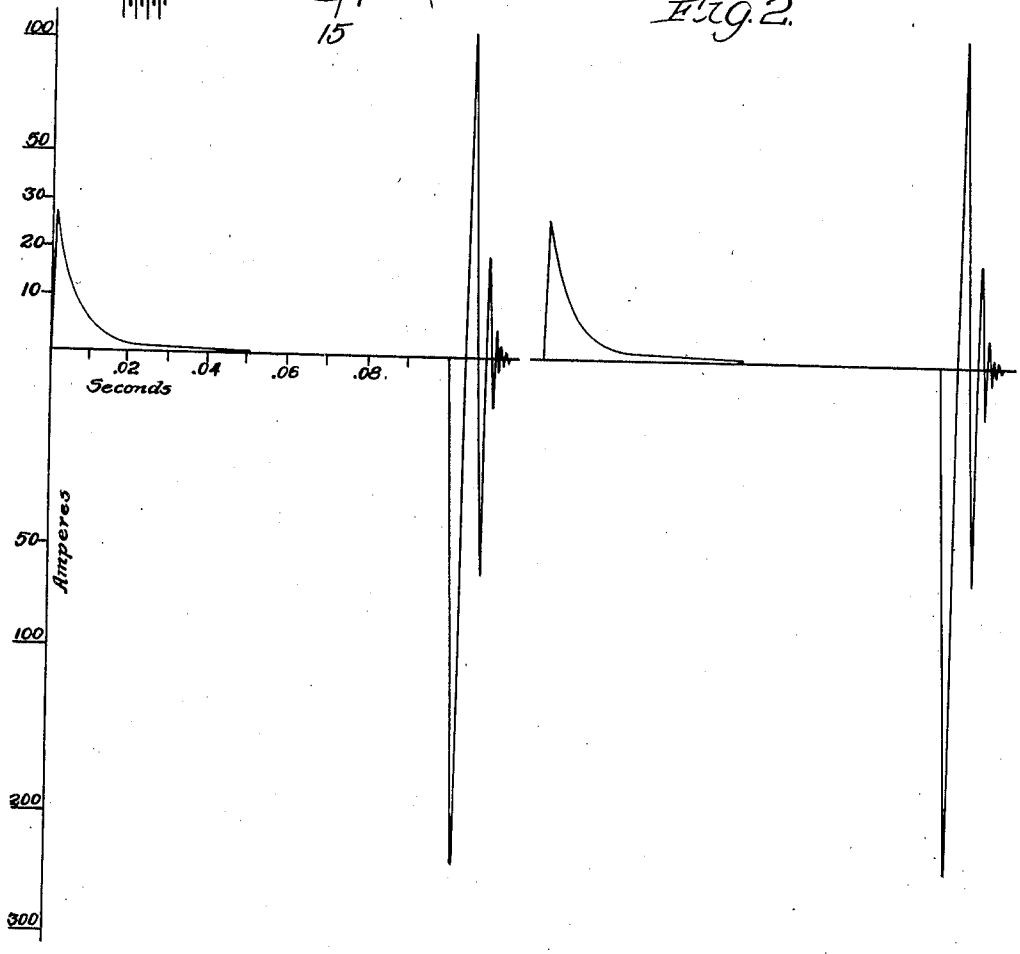


Fig. 1.

Fig. 2.



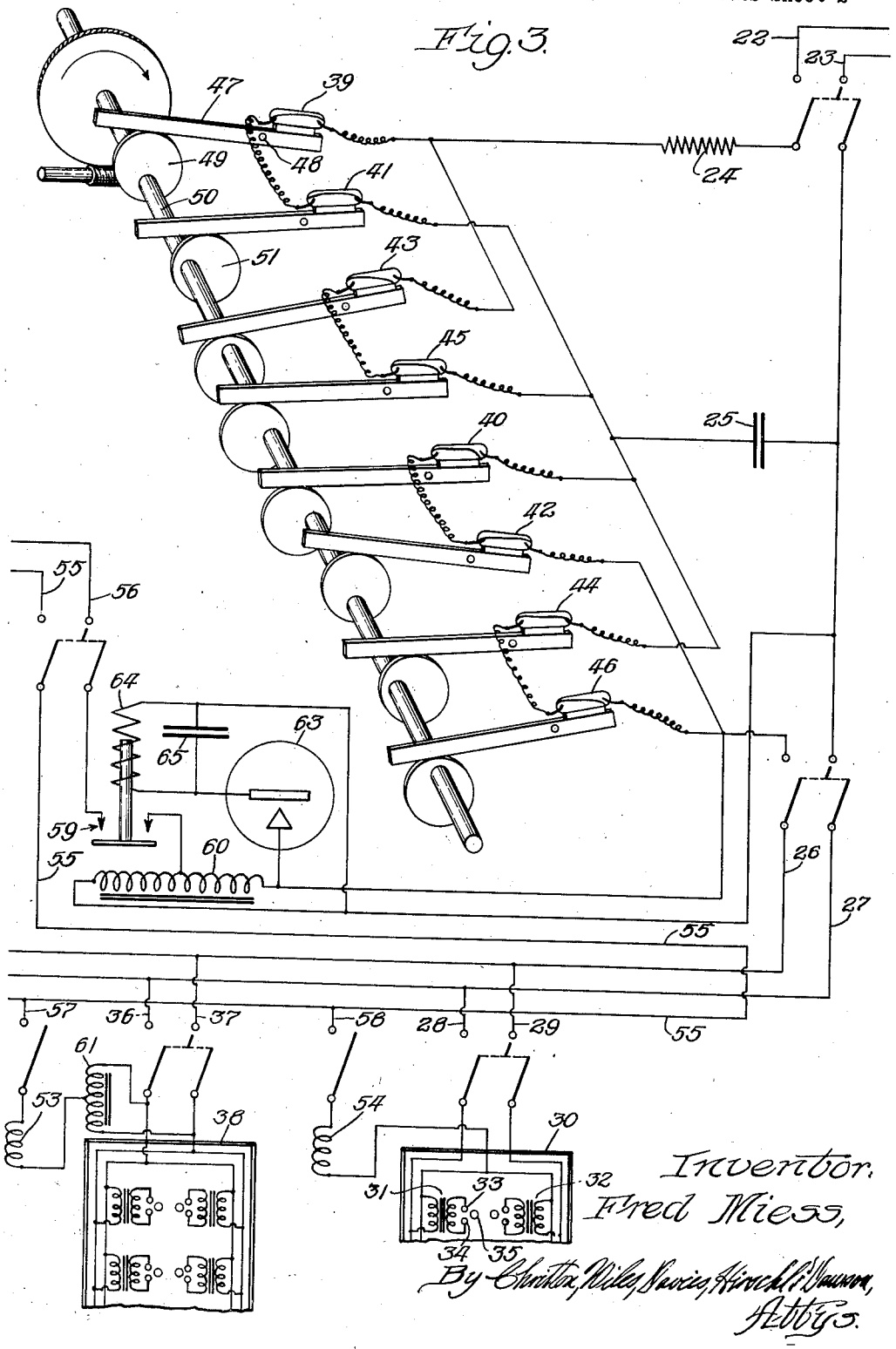
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IGNITION APPARATUS

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Fig. 3.



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UNITED STATES PATENT OFFICE

2,275,861

IGNITION APPARATUS

Fred Miess, Gary, Ind.

Application December 14, 1938, Serial No. 245,765

6 Claims. (Cl. 175—115)

This invention relates to ignition apparatus, and more particularly to apparatus for periodically supplying strong electrical impulses of short duration, as to the ignition points adjacent the fuel nozzles of an industrial furnace.

One feature of this invention is that it provides periodical electrical impulses of short duration to any desired circuit; another feature of this invention is that it provides very effective ignition apparatus; a further feature of this invention is that it provides such an ignition with a very low electrical power consumption; a further feature is that the apparatus is very simple and rugged; yet another feature of the invention is that in certain embodiments means may be provided for actuating valve means or the like in accordance with the presence or absence of such intermittent impulses; other features and advantages of this invention will be apparent from the following specification and the drawings, in which:

Figure 1 is a schematic diagram of my invention in simple form; Figure 2 is a representation of the current flow; and Figure 3 is an illustration, partly schematic, of an industrial embodiment of my invention.

Ignition apparatus now in general use is of two main types. One is the make and break type found in automobile or other internal combustion engine ignition systems, where a primary circuit of a step-up transformer is opened and closed to effect periodic generation of energy in the secondary of the transformer. The other is the type more generally found in industrial applications, and consists of a step-up transformer directly connected to an alternating current line, so that there is a continuous arcing across the ignition points.

This latter type makes a very simple, rugged and reliable ignition system especially adapted to the supplying simultaneously of ignition impulses to a large number of gaps or pairs of points. This type, for example, is generally found on industrial furnaces having large numbers of fuel jets or burners as, for example, annealing furnaces in the steel industry. For reasons concerned with safety, such ignition apparatus is generally run continuously while fluid fuel is being supplied to the furnace; and this results in one of the principal objectionable features of such a system, a large energy consumption. An industrial annealing furnace with a large number of fuel jets will frequently draw three kilowatt-hours per hour.

My invention is equally rugged and reliable, is adapted to use the same transformers and points when used as ignition for an annealing furnace, for example, and will give equivalent ignition with only about five per cent of the power consumption. This invention comprises the use of a condenser to supply periodic strong impulses, the condenser being charged, between such impulses, from some primary source of current.

A simple embodiment of my invention is illustrated in Figure 1. A condenser 10 has one plate thereof connected to the movable element 11 of a single-pole double-throw switch or relay which is adapted to connect it to either of two circuits; and the other plate is connected, in common, to the returns of each of such circuits. The switch is here illustrated as having two contact points 12 and 13, and as being provided with means for periodically connecting the movable element 11 to one of said points and then to the other. This is here shown as a cam 14 mounted on a continuously rotating shaft 15 driven by any conventional means.

One of the circuits, which may be termed the charging circuit, includes a source of power such as the battery 16, a current limiting means such as the resistor 17, and the contact 12. When the movable switch element 11 is in the position shown in solid lines a charging circuit for the condenser is thus completed, and the condenser is charged to a desired voltage.

The other or discharge circuit includes the contact point 13 and the primary of step-up transformer 18. The secondary of this transformer is connected to any desired electrical apparatus, as a pair of separated ignition points 19 and 20. When the movable switch element 11 has been placed in the position shown in dotted lines by the rotation of the cam the discharge circuit is completed and the energy which was stored in the condenser is delivered in a brief strong electrical impulse to the ignition points.

Referring more particularly to Figure 2, the various current flows are illustrated. When the movable switch element 11 makes engagement with the switch contact 12, current is supplied from the battery 16 to charge the condenser 10. This current substantially immediately jumps to a value fixed by the resistor 17, here shown as about 27 amperes; and thereafter the current tapers down in substantially the manner illustrated in the first five-hundredths of a second on the curve. While the condenser is not theoretically fully charged, it is fully charged for all practical purposes; and the switch is so arranged that the charging circuit is disconnected at this time by separation of the switch element 11 from the switch point 12. It will be noted that the major portion of the energy input to the condenser was effected in the first one-hundredth of a second, and that there is substantially no drain upon the current supply source after that time.

It will thus be seen that the flow of current is practically terminated before the switches open in either the charging or discharging circuits, and it is this opening of switches under prac-

tically no current which is the chief factor in enabling very large currents to be handled without injury to switches, thus permitting a number of industrial furnaces to be supplied from one ignition unit. In the embodiment here being described it is assumed that at the end of one-tenth second after the switch element 11 engages the contact point 12 it engages contact point 13 in the discharge circuit. The condenser will then discharge through the transformer to provide a strong electrical impulse of brief duration, as indicated in Figure 2. While the maximum charging current was relatively low the condenser and transformer may be so arranged that the brief discharge current is of high amperage. In the assumed embodiment here being described this is shown as reaching a peak value between two and three hundred amperes. This, of course, effects a very hot spark of good igniting characteristics across the points 19 and 20. Inasmuch as the shaft 15 continuously rotates at a regular rate, at about one-tenth of a second after the discharge the condenser will again start to charge, and the cycle would be repeated.

A simplified commercial embodiment of my invention is illustrated in Figure 3. Here the wires 22 and 23 are connected to a source of direct current, as for example about 375 volts delivered by a motor generator set. This current acts through a resistor 24 and switches, which will be hereinafter more fully described, to periodically charge the condenser 25. Although here diagrammatically shown as a single pair of plates, in practice such condenser would usually comprise a number of electrolytic or paper condensers connected in parallel to provide the electrical effect of a single condenser of considerable capacity. The switch means periodically discharges the condenser through the wires 26 and 27. These wires are connected to a number of parallel ignition circuits. For example, wires 28 and 29 lead to an annealing furnace 30, and have connected thereto in series arrangement the primaries of transformers 31 and 32. The secondaries of these transformers are connected to separated ignition points, as 33 and 34, in igniting relationship to a stream of fluid fuel, as gas being delivered by the jet 35. Another pair of branch leads, as 36 and 37, may lead to the primaries of a plurality of ignition transformers (here shown, as a modification, in parallel arrangement) in another annealing furnace 38.

It has been found preferable to employ rockable mercury switches to effect the connecting and disconnecting, rather than a movable mechanical switch element of the type illustrated diagrammatically in Figure 1. To secure effective ignition, however, there must be several impulses per second, preferably about ten a second, delivered to the ignition points. This is so rapid that a single mercury switch would not be effective, since if an attempt were made to rock it at such a speed the mercury would splash and the action would be erratic. In order to solve this switch difficulty, therefore, each of the connecting and disconnecting means comprises a plurality of parallel circuits, each circuit including two mercury switches in series therein.

For example, I can employ a plurality of two-element mercury switches, here identified as 39 to 46. The switches indicated by odd reference numerals are the charging switches, 39 and 41 being in series in one charging circuit and 43 and 45 in a second parallel charging circuit. Switches 40 and 42 are in series in one discharging circuit adapted to connect the condenser 25 to the ignition supply lines 26 and 27; and switches 44 and 46 are in a second parallel condenser discharging circuit.

All of the mercury switches are of similar construction, and are of the conventional two-element type wherein a pair of separated elements are sealed in a small glass tube having a small quantity of mercury therein. Referring to one of the switches, as 39, it will be seen that it is mounted upon an arm 47 adapted to be rocked about the pivot point 48. Rocking of this arm is effected by cam 49 mounted on continuously rotating shaft 50 driven by any conventional means. The other switches are similarly mounted and driven, switch 41, for example, being driven by the cam 51.

The particular arrangement shown is employed to enable relatively small movement of the switches to effect the desired making and breaking of the various circuits with great rapidity. The switches in series in each particular circuit are arranged to be rocked out of step with each other, with a predetermined time relationship therebetween. Considering first switches 39 and 41, it will be seen that as the shaft 50 rotates cam 51 first closes switch 41 while switch 39 is still open; and the latter switch 39 was closed to complete a charging circuit to the condenser 25. The cam 51 has continued to rotate, however, and therefore very shortly after switch 39 is closed to complete the charging circuit switch 41 opens to break it. It will be seen that the time relationship between the cams can thus be arranged to hold this closed circuit interval to a very brief one, a matter of hundredths of a second when desired. It will be noted that the slight further rotation of the shaft 50 which breaks switch 41 closes switch 40; and that switch 42 is already in closed position. Thus in a very brief interval after the charging circuit has been disconnected from the condenser 25 the condenser is connected, through the switches 40 and 42, to the ignition lines 26 and 27 to deliver its desired ignition impulse thereto. Switch 42, however, is already rocking in the opening direction; and again, very shortly after switch 40 has completed connection of one of the discharge circuits, switch 42 opens it. The cycle is then repeated in a pair of parallel charging and discharging circuits; that is, shortly after switch 42 breaks or opens, switch 43 closes to charge the condenser through itself and switch 45; and as soon as 45 opens the condenser is discharged through a circuit completed by switches 44 and 46. Such a switching arrangement enables any desired number of ignition impulses to be delivered per second, with a relatively slow rocking of the mercury switches which is a factor of their number. That is, in the embodiment illustrated two ignition impulses per second would be delivered with only one rocking cycle per second of the mercury switches; with ten sets of parallel circuits on both the charge and discharge side, rather than two as shown, ten impulses per second can be delivered with only one rocking cycle per second of each switch.

In order to prevent any danger of an explosion as a result of flame failure, each furnace is here shown as provided with electrical actuating means here identified as 53 and 54, which means are adapted to actuate any conventional type of electric valve to shut off the stream of fluid fuel being supplied to the furnace. Such a failure

of ignition impulses might be occasioned by opening the switches at any particular furnace, or by complete failure of the entire system for some reason, as burning out of the motor generator. The actuating means here shown as solenoids **53** and **54** are adapted to be supplied with current from a separate source of any type connected to the lines **55** and **56**. One of these lines, here shown as **55**, is connected to one side of each of the solenoids **53** and **54**, as by the branch leads **57** and **58**. The other lead, as **56**, is connected through a relay **59** to the center point of an impedance **60** having the ends thereof connected to the ignition supply lines **26** and **27**. The other end of each of the solenoids **53** and **54** is connected, through balanced or centering means, to the branch ignition circuits at each furnace. In furnace **38** this connection is shown as made to the center point of a separate impedance element **61** having its ends connected to the branch ignition supply lines **36** and **37** furnishing ignition impulses to that particular furnace. The arrangement shown in furnace **30** is a modified form achieving the same result, by using the primaries of the transformers **31** and **32**, rather than a separate impedance, to complete the circuit from the solenoid **54**.

In order to insure cessation of fuel flow if the whole ignition circuit becomes inoperative, the relay **59** is arranged to open. In the particular form here shown a rectifying tube **63** is adapted to transform the oscillating ignition impulses into unidirectional charging impulses to condenser **65**. Condenser **65** supplies holding current for relay **59** through its winding **64** to keep the relay closed as long as charging impulses to condenser **65** continue at regular intervals. Current from condenser **65** through winding **64** bridges the period when there is no current flow through the rectifying tube.

While I have described and claimed certain embodiments of my invention it is to be understood that it is capable of many modifications. Changes, therefore, in the construction and arrangement may be made without departing from the spirit and scope of the invention as disclosed in the appended claims, in which it is my intention to claim all novelty inherent in my invention as broadly as permissible in view of the prior art.

I claim:

1. Apparatus of the character described for periodically supplying a strong electrical impulse of short duration from a source of electrical energy, including: a condenser; a source of current adapted to charge said condenser; means for limiting the charging flow of current; and means for periodically connecting said condenser to the circuit to which said strong impulse is to be delivered, the second named means comprising a pair of mercury switches in series rocked, with a predetermined time relationship therebetween, by a continuously rotating shaft.

2. Apparatus of the character described for periodically supplying a strong electrical impulse of short duration from a source of electrical energy, including: a condenser; a source of current adapted to charge said condenser; means for limiting the charging flow of current; and means for periodically connecting said condenser to the circuit to which said strong impulse is to be delivered, said connecting means comprising a plurality of parallel circuits, each circuit including in series therein a switch.

3. Apparatus of the character described for periodically supplying a strong electrical impulse of short duration from a source of electrical energy, including: a condenser; a source of current adapted to charge said condenser; means for limiting the charging flow of current; and means for periodically disconnecting said condenser from said source and connecting it to the circuit to which said strong impulse is to be delivered, said connecting and disconnecting means each comprising a plurality of parallel circuits, each circuit including in series therein a pair of switches, all of said switches being operated, with a predetermined time relationship therebetween, by a continuously rotating shaft.

4. Apparatus for simultaneously energizing a relatively large number of spark gaps with sparking current, including a circuit interconnecting all said gaps for simultaneously energizing the same, a condenser, a resistance, a source of direct electric current, means for alternately connecting and disconnecting said source in series with said condenser and said resistance, and means for charging said circuit from said condenser when said source is disconnected therefrom, the first named means including switches working at a speed proportioned respecting the electrical characteristics of said resistance to permit the initial current flowing through said switches when said source is connected to said condenser and said resistance, to practically terminate prior to said switches disconnecting said source from said condenser and said resistance.

5. Apparatus for simultaneously energizing a relatively large number of spark gaps with sparking current, including a circuit interconnecting all said gaps for simultaneously energizing the same, a condenser, a resistance, a source of direct electric current, means for alternately connecting and disconnecting said source in series with said condenser and said resistance, and means for charging said circuit from said condenser when said source is disconnected therefrom, the first named means including switches working at a speed proportioned respecting the electrical characteristics of said resistance to permit the initial current flowing through said switches when said source is connected to said condenser and said resistance, to practically terminate prior to said switches disconnecting said source from said condenser and said resistance, said switches being mercury switches provided with means for rocking them sufficiently slowly to prevent splashing of their mercury.

6. Apparatus for simultaneously energizing a relatively large number of spark gaps with sparking current, including a circuit interconnecting all said gaps for simultaneously energizing the same, a condenser, a resistance, a source of direct electric current, means for alternately connecting and disconnecting said source in series with said condenser and said resistance, and means for charging said circuit from said condenser when said source is disconnected therefrom, the first named means including switches working at a speed proportioned respecting the electrical characteristics of said resistance to permit the initial current flowing through said switches when said source is connected to said condenser and said resistance, to practically terminate prior to said switches disconnecting said source from said condenser and said resistance, said resistance having an electrical value limiting the flow of said initial current to a value safely within the capacity of said switches.

FRED MIESS.