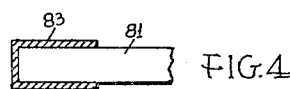
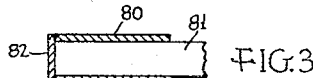
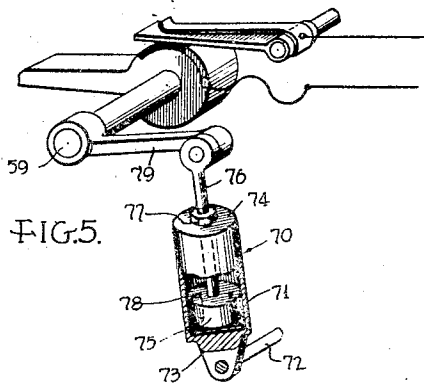
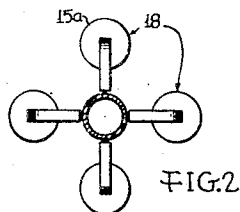
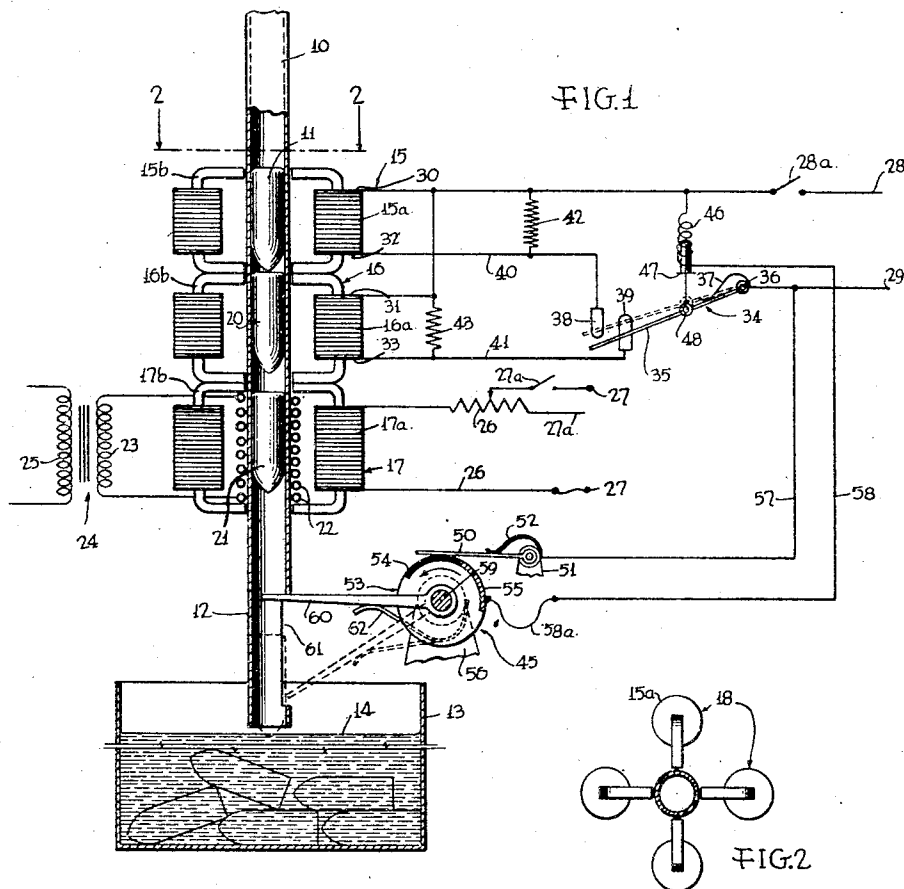


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H. A. STRICKLAND, JR
ELECTROMAGNETIC MEANS FOR FEEDING A
FERROMAGNETIC CHARGE TO A FURNACE
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INVENTOR
Harold A. Strickland, Jr.
BY *John P. Jarboe*
ATTORNEY

UNITED STATES PATENT OFFICE

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ELECTROMAGNETIC MEANS FOR FEEDING A
FERROMAGNETIC CHARGE TO A FUR-
NACE

Harold A. Strickland, Jr., Detroit, Mich., assignor,
by mesne assignments, to The Budd Company,
Philadelphia, Pa., a corporation of Pennsyl-
vania

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5 Claims. (Cl. 266—5)

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This invention relates to feeding apparatus for ferromagnetic articles with particular application to utilizing induction heating means.

The important objects of the present invention may be summarized as follows: to provide mag-
netic means for feeding the charge or work piece
to a furnace in stepped intervals; to provide feed-
ing means for moving articles to a furnace to be
heated in which the movement of the feeding
means is controlled by the movement of the
charge after expulsion from the furnace; to pro-
vide timing means for feeding apparatus which is
electrically controlled by delayed action mech-
anism; to provide in combination with step by
step feeding apparatus, heating means auto-
matically timed by the heating temperature of
the charge; to provide magnetic holding means
for a charge in a furnace which permits release
of the charge without external modification of the
magnetic action of the holding means when the
charge is heated to the degree desired; to provide
a gravitational feed for a furnace with charge
holding means and heating means which func-
tions automatically whenever charges are placed
in the feeding, holding and heating apparatus and
which can not properly function without the
proximity of the charge.

Other objects will appear on consideration of the specific embodiment of the invention which may be preferred as hereinafter described and as shown in the accompanying drawing in which Figure 1 is a diagrammatic showing partly in section of the feeding, holding and heating apparatus combined with the various controlling circuits and switches:

Figure 2 is a section of Figure 1 taken along line 2—2;

Figure 3 is a detail showing one mode of enclosing the end of the core yoke in copper or similar highly conducting metal;

Figure 4 shows another means of enclosing the holding core yoke; and

Figure 5 illustrates a modified delayed action type of circuit control switch.

Referring to the drawing, Figure 1 illustrates a non-magnetic chute 10 in which various articles to be heated 11 are fed by any appropriate means. These articles or work pieces, referred to generally as charges, may be of a miscellaneous type of articles, such as projectiles, formed of ferromagnetic substances such as iron, steel, nickel, cobalt or mixtures of these ferromagnetic substances with paramagnetic substances. The charges when placed in the upper end of chute 10 normally move by gravity to the base 12 of the chute, terminating in the quench tank 13 containing appropriate quenching fluid 14. Interposed between the upper end of the chute as shown and the lower end 12 are a series of electromagnet elements preferably in three units, the initial feed-

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ing unit 15, the final feeding unit 16 and the hold-
ing unit 17, these units being placed in the series
mentioned with the holding unit at the base. Each unit consists preferably of four electromagnet elements 18, indicated in Figure 2, of the drawing, spaced about the chute in generally parallel relationship thereto. These elements include the magnetizing coils 15a, 16a and 17a enclosing U-shaped magnet cores 15b, 16b and 17b. The terminals of the cores are positioned closely adjacent the chute 10 as illustrated in Figure 1. It thus appears that if charges 11, 20 and 21 are positioned as shown in Figure 1, the charge 11 being between the core terminals 15b, the charge 20 between the core terminals 16b and the charge 21 between core terminals 17b, these various charges complete with the adjacent cores a practically closed magnetic circuit so that as the various coils 15a, 16a and 17a are energized the magnetic action will hold the charges approximately in the position as shown, it being understood that the number of turns of the windings of the coils together with the dimensions of the cores and the amount of current flowing in the coils is such as to obtain the mentioned holding effects.

Within the chute area enclosed by electromagnet 17 a heating coil 22 is positioned exterior to but adjacent the chute surface, the circular section of the conductor indicating diagrammatically the tubular shape adapted for cooling fluids. The ends of this heating coil 22 are attached to the secondary 23 of a heating coil transformer 24 the primary 25 of which is connected to appropriate alternating or intermitting current of desired frequency. As is well known in this art, heating is produced by inductive action of the coil 22 on the charge 21. During the heating period the holding coil 17 magnetically retains the charge 21 in position to be heated by the heating coil 22. For this purpose direct current preferably is supplied the magnet 17 through variable control resistance 26 from source points 27.

Electromagnets 15 and 16 are connected in parallel with an appropriate power source 28 and 29 which may be direct or alternating current. As illustrated, points 30 and 31 of magnets 15 and 16 are connected directly to power source 28 while points 32 and 33 of these magnets are connected to power source 29 through a magnetically controlled switch hereafter referred to as the magnet switch 34. This switch consists of a movable arm 35 pivoted at 36 and normally held in the lowermost position as shown by a leaf spring 37, having the axis end fixed and the free end bearing on the upper surface of the arm 35. The end of the arm 35 is adapted for wiping contact with two terminal plates 38 and 39 the plate 38 forming the terminal of wire 40 connected to point 32 on transformer coil 15a and the terminal contact 39 having connection through wire 41 to point 33

of coil 16a. These contacts are elongated, as shown, and have rounded ends and are placed parallel and in relatively close proximity to each other with the ends reversed, and in such relation to the movable arm of the switch 34 that when the arm moves between its lower and upper limits it successively engages the contact 39, both contacts 38 and 39 as shown in dotted outline, and finally contact 38 only. It thus appears that when power is led into the feeding circuit from points 28 and 29 with the switch arm 35 in the position shown in full lines, only magnet 31 is energized; in the position of the arms shown in dotted outline, both coils 15a and 16a are energized; while in the uppermost position with the arm contacting the contact 38 only, the coil 15a only is energized. Resistance coils 42 and 43 preferably are utilized for bridging the magnet coils 15a and 16a, respectively, so as to limit the magnet discharge voltage to the desired amount.

Automatic control means are employed for moving the arm 35 of magnet switch 34 the same being generally indicated by the numeral 45. This control switch operates in conjunction with a solenoid 46 positioned above the magnet switch arm 35, the core 47 being movable within the solenoid and having a lower end 48 pivotally secured to the arm intermediate its length so that upward movement of the core is accompanied by corresponding upward movement of the arm 35. This upward core movement is brought about by energization of the solenoid through action of the control switch 45.

The switch 45 includes two elements, the contact arm 50 pivoted on a fixed support 51 and spring held in downward position by a leaf spring 52, and a contact element 53, comprising a cylinder or disc having on its periphery an insulation sector 54 and a metallic conductor sector 55, the two sectors being contiguous and the insulator sector being normally in contact with the spring held arm 50. The contact element 53 is mounted for limited rotation on the support 56 so that rotation of the cylinder 53 in the direction indicated by the arrow causes contact to be made between the metallic sector 55 of the cylinder and the switch arm 50. Such contact will of course close the electric circuit through flexible connector 58a, wires 57 and 58, through solenoid 46 to the power source 28 and 29 thereby energizing the solenoid and causing the upward movement of the core 47. There is attached also to the pivot pin 59 of the cylinder 53 and movable with such cylinder a projecting contact pin 60 which extends from the pivot pin 59 to the interior of the chute 10 at the lower end 12 thereof, this lower end having a section on the side of the chute adjacent the control switch 45 cut away to form the opening 61. As illustrated the contact pin extends into the chute an amount sufficient to engage a falling charge so that the charge by its movement forces the contact pin downwardly against the action of the pin holding spring 62 until the pin end is clear of the moving charge, the pin thereupon swinging back into the full line position as shown. It is apparent that this forcing movement of the pin 60 by the moving charge causes limited rotation of the contact cylinder 53 and a consequent closure of the solenoid circuit by engagement of the switch arm 50 with the metallic sector 55.

In utilizing the combined heating, holding and feeding units as above described the chute 10 is positioned at an angle with the horizontal so that the charges tend to move downwardly to-

ward the quench tank through gravitational pull. If it now be assumed that through a conventional hopper or travelling belt arrangement charge 21 is carried down to the bank of magnets, power switch 28a being opened and power switch 27a and the heating circuit being closed, the charge moves to a point opposite the magnet 17 where it is inductively heated. As the temperature approaches the recalcrescence point the magnetic holding effect of magnet 17 rapidly diminishes toward zero and the charge is released and falls by gravity toward the quench tank 13. In the meantime while charge 21 is being heated switch 28a supplying power from source 28-29 is closed thus energizing magnet 16, and one or more additional charges are permitted to fall through the chute, the leading charge 20 being retained opposite the poles of energized magnet 16, thus holding charge 11 and other charges which may be behind this charge in a static position in the chute.

As soon as charge 21 is released from the holding coil 17 to fall downwardly in the chute, it engages the tip of control switch arm 60 causing the same to pivot downwardly and thus closing the circuit through the solenoid 46. Thereupon the arm 35 of the magnet switch 34 moves upwardly over the contact plates 38 and 39, at the limit of its movement the arm contacting only with plate 38. In the upward movement of the arm 35 it is observed that at the midpoint both plates 38 and 39 are engaged so that both coils 15 and 16 are simultaneously energized thus magnetizing not only magnet 16 but additionally magnet 15 so that the charge 11 is retained in position by magnet force effective prior to the opening of the circuit of magnet 16. Accordingly when the arm 35 moves clear of plate 39, permitting magnet 16 to be de-energized, charge 11 is retained in position by magnet 15 but charge 20 is free to fall into the magnetized region of magnet 17 where it is held for a heating treatment by coil 22.

Charge 11 is held in its position opposite magnet 15 for a brief interval only since the circuit of magnet 15 is closed only during the energization of solenoid 46 and this energization in turn is dependent upon the movement of control switch arm 60. Therefore, as soon as the charge 21 has moved past the arm 60, the same will, under the pressure of spring 62, move again upwardly to a horizontal position, as limited by the top edge of the gap 61. This of course breaks the solenoid circuit, de-energizing coil 15 and permitting charge 11 to fall until held by the magnet 16 re-energized by the downward movement of magnet switch arm 35. At the same time a new charge 11 moves into the space opposite the poles of magnet 15. It is evident that as soon as the above cycle of movement is once established it will continue automatically as long as additional charges are fed into the chute.

With certain masses of charges the time interval of action control switch 45 is too short and hence it may be desirable to slow down the return movement of the arm 60 of this switch. Figure 5 illustrates a slow motion device for accomplishing this result and shown in substitution for spring 62. This unit 70 includes a closed cylinder 71 pivotally supported on the support rod 72 by means of the base bracket 73. The upper end 74 of the cylinder 75 is removable to permit insertion of a piston 75 with this attached piston rod 76 the latter being movable through a central opening enclosed by the boss 77 in the top plate

74. The piston head contains axial openings 76 of diminished diameter so that rapid movement of the piston which contains air or other gas is delayed unless the piston is moved with considerable force. The free end of the piston rod 76 has a pivot connection with end of arm 78, the other end of which is fixed to the shaft 59 movable with a cylinder 58 of the control switch. With this construction when the charge 24 moves past the arm tip of arm 60 the piston is suddenly forced upwardly, the weight of the charge being sufficient to overcome the resistance of the air moving through apertures 70 of the piston 75. On release of the arm 60 however the only pressure being exerted in the cylinder 71 is the weight of the piston and associated parts which compresses the gas beneath the piston, causing it to flow upwardly through apertures 70 until the piston is at the downward end of the cylinder and arm 60 is at its normal upward level. Accordingly the time period of contact of control arm 50 and metallic sector 55 is increased thus increasing the holding period of magnet 15.

It is pointed out that the heating coil 32 produces flux which includes the pole tips of the core 17b and possibly also 16b. Consequently these poles will be subjected to the heating action of the inductive circuit. Since this would be undesirable means are provided as illustrated in Figures 3 and 4 for short circuiting eddy currents formed in the pole tips by means of a shell of copper or other metal which encloses the pole tips or the whole core. In the form of attachment shown in Figure 3 the copper shell 80 is either electrically applied to the core throughout its entire length or is closely fixed to the steel or iron core 81 and the ends closed by copper disks 82 attached by silver solder as indicated. In the alternative arrangement of Figure 4, a cap tube 83 is applied to the ends only of the yoke of the core 81 and secured thereto by any appropriate means.

In describing the heating, holding and feeding unit adherence has been made to specified elements for ease in description. Obviously substitutions or modifications may be made in these elements without interfering with the accomplishment of the objects of the invention. For example while inductive heating means are described and illustrated, other types of heating means may be used, the operation being dependent not upon the method of heating but upon the temperature of heating. Also while there is shown automatic means dependent upon the movement of the charge for timing the movement of the feed apparatus in its broader aspects manual or other means may be employed for the feeding operation. While I have indicated direct current as desirable for the holding unit 17 it may be possible under certain circumstances to employ alternating current. The time delay means of Figure 5 is of course merely illustrative as in substitution any of the well known types of time delaying mechanism may be employed. Other modifications will be apparent to those skilled in this particular art and hence no limitations are implied other than those required by the scope of the claims hereto appended.

What is claimed is:

1. In charge feeding apparatus, a non-magnetic chute, heating means for a ferromagnetic charge in said chute, independent retention means for holding the charge at the heating means, and feeding means for supplying a charge intermittently to said heating means, said feeding means

including electro-magnets spaced along the chute at points displaced from the heating means, switch means for energizing said magnets in succession toward said heating means, and actuating means for operating said switch means.

2. In charge feeding apparatus, a non-magnetic chute, heating means for a ferromagnetic charge, retention means for holding the charge at the heating means, and feeding means for supplying a charge intermittently to said heating means, said feeding means including electro-magnets spaced along the chute at points displaced from the heating means, switch means for energizing said magnets in succession toward said heating means, and actuating means for operating said switch means, said actuating means being operated by a charge subsequent to release after being heated to recalcence by said heating means.

3. In charge feeding apparatus, a non-magnetic chute, heating means for a ferromagnetic charge in said chute, retention means for holding the charge at the heating means, and feeding means for supplying a charge intermittently to said heating means, said feeding means including electro-magnets spaced along the chute at points displaced from the heating means, switch means for energizing said magnets in succession toward said heating means and charge actuated means for operating said switch means.

4. In charge feeding apparatus, a non-magnetic chute, heating means for a ferromagnetic charge in said chute, retention means for holding the charge at the heating means, and feeding means for supplying a charge intermittently to said heating means, said feeding means including electro-magnets spaced along the chute at points displaced from the heating means, switch means for energizing said magnets in succession and charge actuated means for operating said switch means, said charge actuated means including a time delay mechanism.

5. In charge feeding apparatus, a non-magnetic chute, heating means for a ferromagnetic charge in said chute, retention means for holding the charge at the heating means, and feeding means for supplying a charge intermittently to said heating means, said feeding means including electro-magnets spaced along the chute at points displaced from the heating means, switch means for energizing said magnets in succession, and actuating means for operating said switch means, said actuating means including normally open make and break electrical contacts and an arm extending into said chute whereby movement of a charge through the chute moves the arm to close said contacts.

HAROLD A. STRICKLAND, JR.

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