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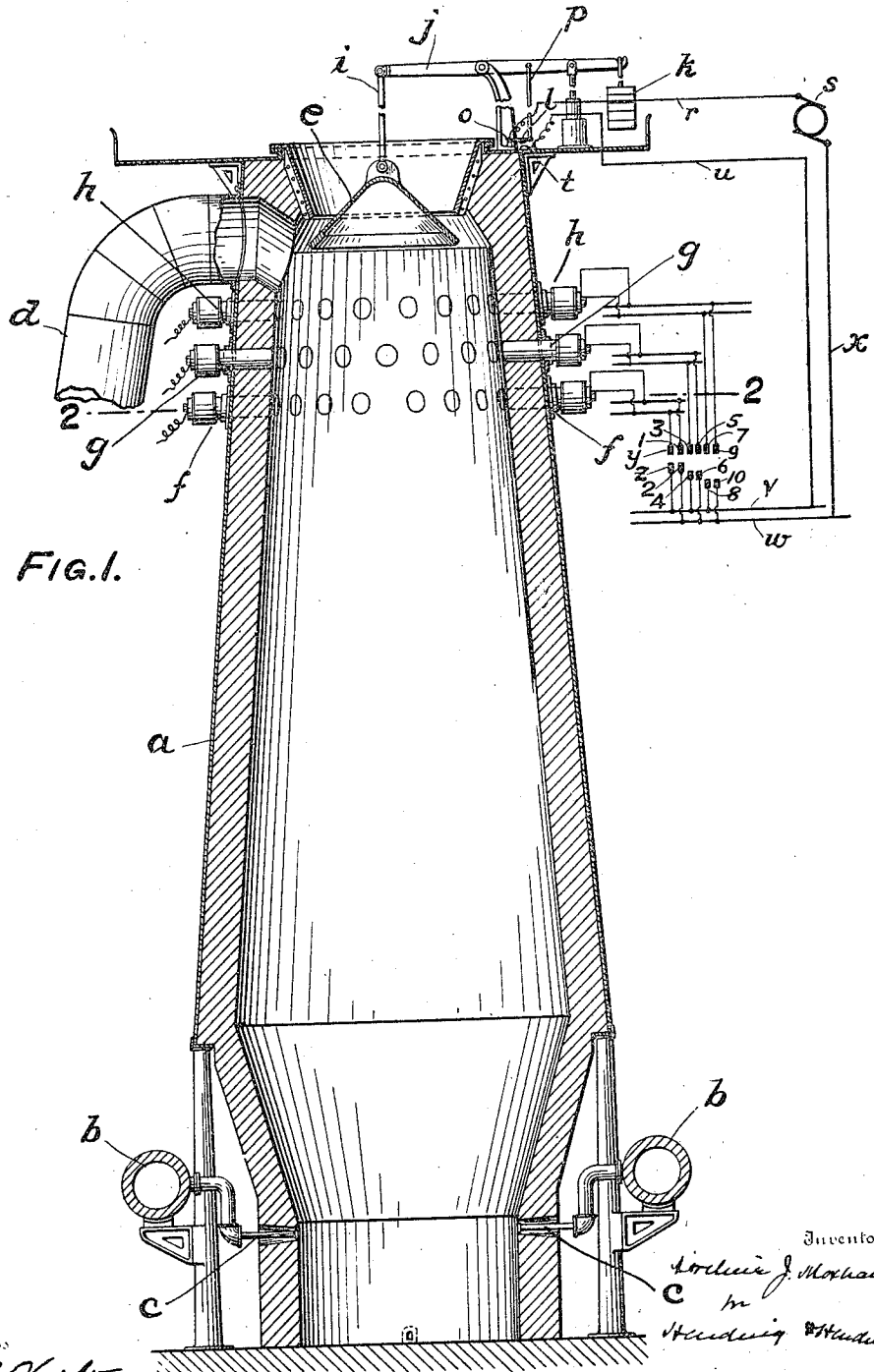


FIG. 1.

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BLAST FURNACE.
APPLICATION FILED SEPT. 25, 1911.

Patented Aug. 20, 1912.
2 SHEETS—SHEET 2.

1,036,137.

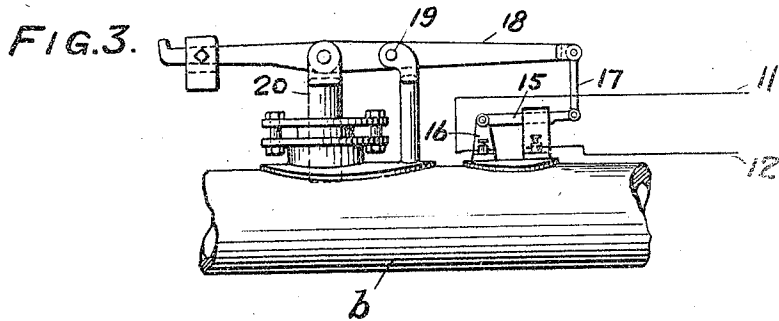
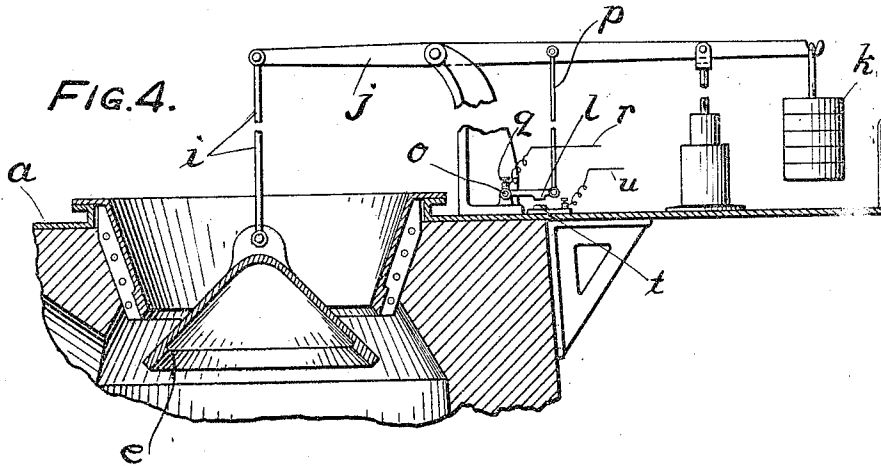
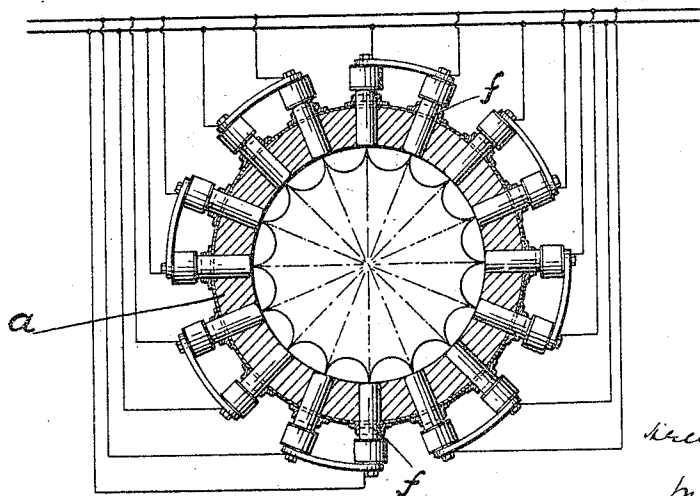


FIG. 2.



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UNITED STATES PATENT OFFICE.

ARTHUR J. MOXHAM, OF WILMINGTON, DELAWARE.

BLAST-FURNACE.

1,036,137.

Specification of Letters Patent.

Patented Aug. 20, 1912.

Application filed September 25, 1911. Serial No. 651,065.

To all whom it may concern:

Be it known that I, ARTHUR J. MOXHAM, a subject of the King of Great Britain, residing at Wilmington, county of Newcastle, and State of Delaware, have invented a new and useful Improvement in Blast-Furnaces, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, which form a part of this specification.

In the passage of ore through the blast furnace, attrition occurs and also the ore is fractured by the heat, thereby a certain proportion of the ore charge is reduced to an extremely fine dust. Fine ore is also often used, which requires a working pressure greater than using ores of larger size. Both of these conditions result in blowing away considerable of the ore in the forming of this dust. This ore is blown out through the downcomer. This entails considerable loss as well as a gathering of the dust on the boiler surfaces, and otherwise it adds to the difficulty and cost of manufacture.

An analysis by sizing will show a large amount capable of passing through a 500 mesh sieve, and that very little of the dust fails to pass through a 100 mesh sieve. This ore dust is consequently easily carried by the blast, particularly when the increased pressure demanded by a charge of all fine ore, is used. This loss has heretofore been attempted to be met—1st, by reducing the percentage of fine ore carried in the charge, and therefore the amount of waste. 2nd, by gathering the accumulation from the dust catcher and the flues, and 3rd, subsequently briqueting the material so gathered to put it into proper form for once more being charged through the furnace. What is called the flue dust consists not only of fine ore but of more or less other material driven out by the blast together with the ore. An average content of iron in flue dust is frequently as low as thirty per cent. (30%), hence the briquets, which are costly to make, represent when made a low grade of material.

The object of my invention is to prevent this dust passing into the downcomer, accumulating it, and returning it to the charge.

Speaking generally, I surround the inner surface of the blast furnace above the charge

with electro magnets. Preferably I use a plurality of tiers of such magnets. The finer dust passing up with the blast is caught by these magnets and collected thereby. When a sufficient quantity has been thus collected, the current to the magnets is cut off, which deenergizes them. The dust will then tend to fall vertically into the charge, and the accumulated dust will be sufficient to overcome the blast and carry the dust in part or in whole into or on the charge.

As stated, I preferably use a plurality of tiers of magnets. The reason for this is that I may deenergize one set of magnets, allowing the collected dust to fall back into the charge, while the remaining tiers being still energized, will prevent the dust from the charge or any of the collected dust being blown out of the furnace by the blast. I can also so arrange the electric circuits to the tiers of magnets so that successively the tiers are deenergized and all the tiers are simultaneously deenergized when the blast is cut off or, the same time, when the bell is lifted.

I will now describe the embodiment of my invention shown in the accompanying drawings, and then point out the invention in the claims.

In the drawings: Figure 1 is a vertical section of a blast furnace embodying my invention. Fig. 2 is a section on the line 2—2, Fig. 1. Fig. 3 is a detail view of blast main and attachments for opening circuit to magnets when blast is cut off. Fig. 4 is a detail sectional view of the bell, its lever and the switch, controlling the circuit to the magnets, controlled by said lever.

a is the blast furnace, *b* the air pressure conduit, *c* the twyers, *d* the downcomer, *e* the bell.

f is a series of electro magnets, protruding through the walls of the blast furnace; the broken lines (Fig. 2) show the field of said magnets. In like manner *g* is another series of magnets protruding through the wall of the blast furnace above the magnets *f*, and *h* is a similar set of electro magnets above the electro magnets *g*.

i is a rod connecting the bell *e* and lever *j* having the weight *k*.

l is a switch point pivoted at *o* and having its free end connected to lever *j* by rod *p*.

q is a binding post to which a wire *r*, lead-

ing from one pole of a generator *s*, is connected, *t* is another switch point from which a wire *u* leads to wire *v*, and from wire *v* a wire *x* leads to the other pole of the generator.

When the switch points *l* and *t* are connected this circuit is completed. As may be seen, this takes place when the bell is elevated (which, as is well known, is when the blast is cut off), and the points are separated when the bell is depressed (which, as is well known, is when the blast is on). Interposed between the electro magnets *f*, *g* and *h* and wires *v* and *w* is a switch having contacts *y*, *z*, 1 and 2 from the magnets *f*, 3, 4, 5 and 6 from magnets *g*, and 7, 8, 9 and 10 from magnets *h*. As may be seen, if the switch is successively operated, the current connection to the magnets will be made first to magnets *f*, then to magnets *g* and finally to magnets *h*, and the breaking will be conversely. Thus with the three sets of magnets showing the making and breaking of the current, connection is successive, and moreover at all times at least one of the sets of magnets may be energized, and thus escape of the dust by the blast prevented.

In Fig. 2 I have shown in the full curved lines, connecting the pole pieces of the magnets, the accumulation of the dust.

In Fig. 3 I have shown an arrangement whereby the circuit to the magnets is broken when the blast is cut off. In this drawing, *b* is the blast main. In this Fig. 3, 20 is the plunger maintained in position shown by pressure of the blast within the main. 19 the fulcrum for lever 18. 15 and 16 an ordinary electric switch, 11 and 12 representing the wires therefrom. 17, link connecting the lever 18 with the switch. The figure as shown shows the switch thrown in, the pressure operating to force the plunger 20 upward to position shown for this purpose. When the blast is cut off the pressure in the blast main falls, consequently plunger 20 drops and by means of link 17, pulls switch 15 open and thereby cuts off the current, so that when the blast is off, the current is also off and vice versa.

From what has been described, the operation is apparent, with the bell elevated and all the sets of magnets in circuit. The dust carried off by the blast is collected and held by the magnets. By breaking the circuit to any one of the sets of magnets, retaining the circuit to the other sets, the accumulated dust will by gravity tend to fall back into the charge, and if the accumulation be sufficient, the greater portion will so fall. The remaining magnets prevent any escape of the small proportion of the dust that may tend upward. By a corresponding operation with respect to the other sets of magnets their accumulated dust may be removed and carried back to the charge. While fresh

charges of material are entered into the furnace, the bell is depressed. Such charges, by impact, tend to carry down the ore dust accumulated on the magnets, but as the blast is kept on during this time, there will be a tendency for some of the accumulation to be blown out. By keeping one of the zones magnetized this can be largely checked or reduced. Preferably the upper zone is retained by the magnets.

I am not claiming as my invention the broad idea of collecting metal or even ore dust by means of electro-magnets, but I believe it to be novel with me to provide the electro magnets in the blast furnace to catch the ore dust which would otherwise be blown out of the furnace and which are in vertical alinement with the charge so that by gravity, when the magnets are deenergized, the dust will fall back into the charge. I also believe it to be novel with me to provide the plurality of tiers of magnets which enables one set to be deenergized to discharge its accumulated ore dust, while the other set or sets are still energized and stand guard to prevent any dust being blown out by the air blast. Finally, I believe it to be novel with me to simultaneously discharge the accumulation of all the magnets by deenergizing them when the blast is cut off.

Many ores utilized in the blast furnace, such as limonites and hematites, are non-magnetic ores, hence the question may occur as to how my invention is operative in this event. It is a fact, however, that the first effect that occurs when such ores meet the ascending gases in the upper part of the blast furnace in connection with the carbon in the coke, that the ore is converted quickly into a magnetic condition. The operation commences at once and is practically complete in the first ten feet or thereabout, the exact distance depending upon minor conditions, but in any event it is the first effect of the admission of the ore into the furnace.

Having now fully described my invention, what I claim and desire to protect by Letters Patent is:

1. The improvement for preventing the escape of ore dust in blast furnaces and returning it to charge, comprising in combination with the blast furnace and its air supply and twyers electro magnets, the fields of which act upon the inner portion of the upper part of the blast furnace, a source of current supply, electrical connection between said source of current supply and the electro magnets.

2. The improvement for preventing the escape of ore dust in blast furnaces and returning it to the charge, comprising in combination with the blast furnace and its air supply and twyers electro magnets the fields of which act upon the inner portion of the upper part of the blast furnace, a source of

current supply, electrical connection between said source of current supply and the electro magnets, and a switch for controlling said circuit.

5 3. The improvement for preventing the escape of ore dust in blast furnaces and returning it to the charge, comprising in combination with the blast furnace and its air supply and twyers, a plurality of tiers of
10 superposed electro-magnets, the fields of which act upon the inner portion of the upper part of the blast furnace, a source of current supply, electrical connection between said source of current supply and
15 each tier of magnets.

4. The improvement for preventing the escape of ore dust in blast furnaces and returning it to the charge, comprising in combination with the blast furnace and its air
20 supply and twyers, a plurality of tiers of superposed electro-magnets, the field of which act upon the inner portion of the upper part of the blast furnace, a source of current supply, electrical connection between
25 said source of current supply and each tier of magnets, and a switch controlling the circuit to each of the tiers of magnets.

5. The improvement for preventing the escape of ore dust in blast furnaces and returning it to the charge, comprising in combination with the blast furnace and its air
30 supply and twyers, a plurality of tiers of superposed electro-magnets, the fields of which act upon the inner portion of the upper part of the blast furnace, a source of current supply to each tier of magnets, and
35 a switch controlling the circuits to all the tiers of magnets, and means to operate said switch to open when the blast is cut off and
40 to close when the blast is on.

6. The improvement for preventing the escape of ore dust in blast furnaces and returning it to the charge, comprising in combination with the blast furnace and its air
45 supply and twyers, a plurality of tiers of superposed electro-magnets, the fields of which act upon the inner portion of the upper part of the blast furnace, a source of current supply to each tier of magnets, and
50 a switch or switches controlling the circuits to all the tiers of magnets, a bell, means connecting said bell and switches to close said switches when the bell is lifted and open the switches when the bell is depressed.

7. The improvement for preventing the escape of ore dust in blast furnaces and returning it to the charge, comprising in combination with the blast furnace and its air
55 supply and twyers, a plurality of tiers of superposed electro-magnets, the fields of which act upon the inner portion of the upper part of the blast furnace, a source of current supply to each tier of magnets, and
60 a switch controlling the circuits to a tier of magnets, a bell, means connecting said bell

and said switch to close said switch when the bell is lifted and open the switch when the bell is depressed.

8. The improvement for preventing the escape of ore dust in blast furnaces and returning it to the charge, comprising in combination with the blast furnace and its air
70 supply and twyers, electro magnets the fields of which act upon the inner portion of the upper part of the blast furnace, a source of current supply, electrical connection between said source of current supply
75 and the electro magnets, and a switch for controlling said circuit, and means to operate said switch to open when the blast is cut off and to close when the blast is on.
80

9. The improvement for preventing the escape of ore dust in blast furnaces and returning it to the charge, comprising in combination with the blast furnace and its air
85 supply and twyers, electro magnets the fields of which act upon the inner portion of the upper part of the blast furnace, a source of current supply, electrical connection between said source of current supply and the
90 electro magnets, and a switch for controlling said circuit, a bell, means connecting said bell and switch to close said switch when the bell is lifted and open the switch when the bell is depressed.
95

10. The improvement for preventing the escape of ore dust in blast furnaces and returning it to the charge, comprising in combination with the blast furnace and its air
100 supply and twyers, electro magnets in tiers, the fields of which act upon the inner portion of the upper part of the blast furnace, a source of current supply, electrical connection between said source of current supply and the electro magnets, and a switch for
105 controlling the current connection with one of said tiers of magnets.

11. The improvement for preventing the escape of ore dust in blast furnaces and returning it to the charge, comprising in combination with the blast furnace and its air
110 supply and twyers, a plurality of tiers of superposed electro-magnets, the fields of which act upon the inner portion of the upper part of the blast furnace, a source of current supply, electrical connections between
115 said source of current supply and each tier of magnets, and a switch for the circuit to each tier of electro magnets.

12. The improvement for preventing the escape of ore dust in blast furnaces and returning it to the charge, comprising in combination with the blast furnace and its air
120 supply and twyers, a plurality of tiers of superposed electro-magnets, the fields of which act upon the inner portion of the upper part of the blast furnace, a source of current supply, electrical connections between
125 said source of current supply and each tier of magnets, and a switch for the circuit
130

to each tier of electro magnets, said switches being arranged to operate in a predetermined sequence.

13. The improvement for preventing the
5 escape of ore dust in blast furnaces and returning it to the charge, comprising in combination with the blast furnace and its air supply and twyers, a plurality of tiers
10 of superposed electro magnets, the fields of which act upon the inner portion of the upper part of the blast furnace, a source of current supply, electrical connections between said source of current supply and each tier

of magnets, a switch for the circuit to each
15 tier of electro magnets, and interconnection between said switches whereby one of said switches may be opened without opening the other or others of said switches.

In testimony of which invention, I have
20 hereunto set my hand, at Wilmington, Delaware, on this 22nd day of September, 1911.

ARTHUR J. MOXHAM.

Witnesses:

M. M. HAMILTON,
E. E. WALL.