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MAGNETIC BUCKET AND METHOD OF CONVEYING MATERIAL

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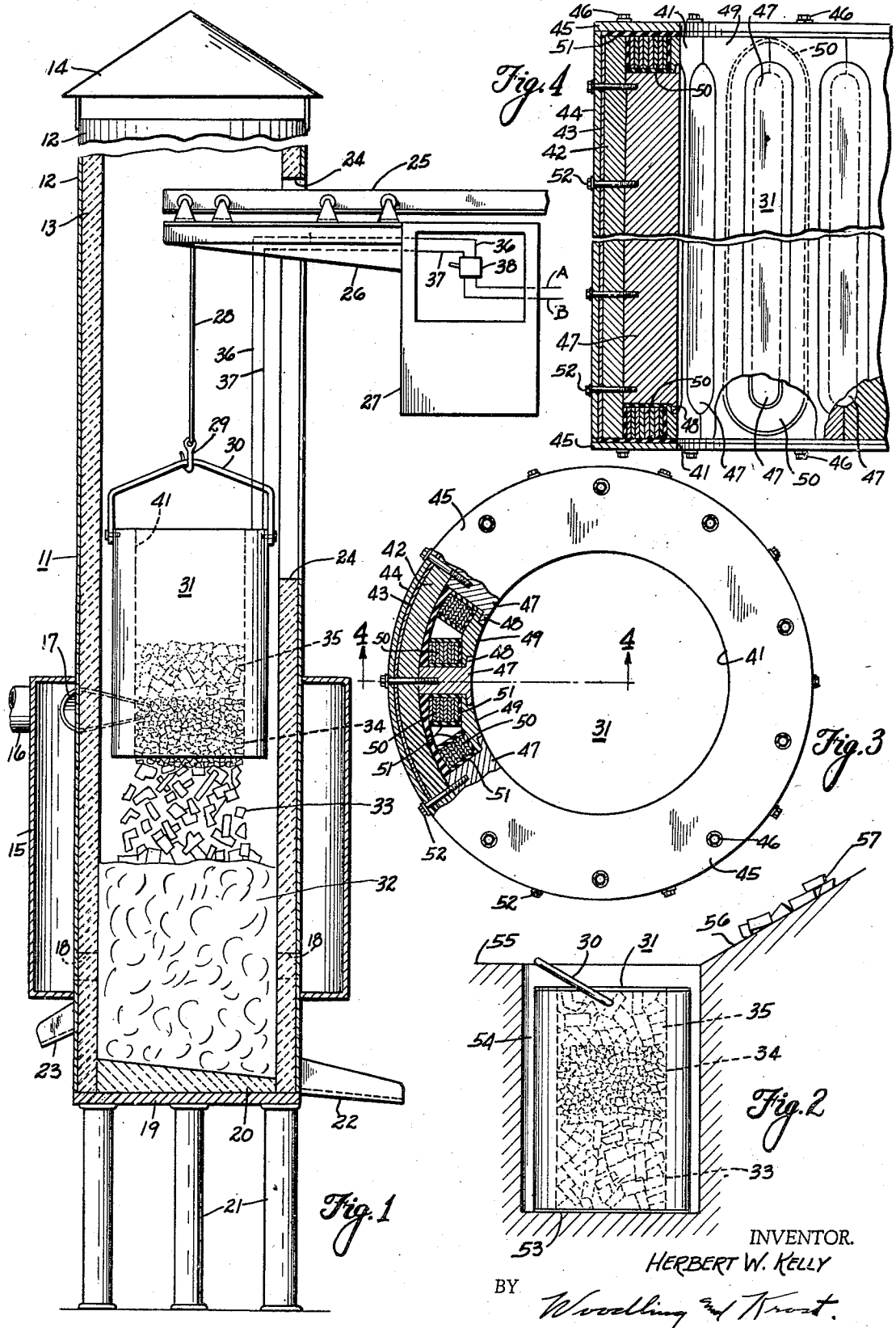


Fig. 1

Fig. 4

Fig. 3

Fig. 2

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MAGNETIC BUCKET AND METHOD OF CONVEYING MATERIAL

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My invention relates to apparatus for conveying material and more particularly to apparatus for charging metallurgical furnaces, cupolas, and the like and to an improved method of charging such a furnace or cupola.

The present description will be given in connection with the operation of charging a cupola for the melting of iron or other magnetic material, although the invention is to be understood as also being directed to charging of other metallurgical furnaces and similar devices for processing metal of a magnetic nature and to other conveying of such magnetic material. The term magnetic material is to be understood as referring to metal capable of being magnetized such as iron and steel and as distinguished from metal substantially incapable of being magnetized, such as copper and the like.

In the operation of a cupola it is usual to charge the cupola with pig iron, iron or steel scrap, coke, fluxing material and such other material as may be desired. The different materials are positioned in appropriate layers in the bottom of the cupola to form the desired bed. Upon combustion of the coke and the melting of the metal, the layers of material progressively sink down in the shaft of the cupola. The melted iron and fluid slag are periodically drawn off in the usual manner. It is necessary to periodically recharge the cupola with additional material as the melting and the drawing off operations continue.

The initially charged material and the subsequently added charges of material are introduced into the interior of the furnace through a charging door or opening in the wall of the cupola and located near the top of the cupola shaft. The material is preferably charged in a manner as to be disposed in layers or strata of the respective types of material, such as superimposed layers of pig iron, coke, scrap, and limestone or other fluxing material. The relative positions of the layers in respect to each other and the thickness of each layer is dependent upon the operating conditions and requirements existing at a particular time. In any case, however, it is a desideratum to dispose the different types of material in even and distinct layers, horizontally disposed in the cupola rather than being generally commingled and haphazardly disposed.

The charges of material have been previously introduced into the interior of the cupola in several ways, none of which has been satisfactory from several points of view. Some cupolas have been charged by manually tossing pigs of iron, pieces of scrap, shovelfuls of coke and shovelfuls of limestone through the charging door and down onto the bed of the cupola. This method is laborious, time-taking and haphazard and does not assure the disposal of the different types of material in distinct and even layers within the cupola as is most desired. Moreover, several layers of the different types of material cannot be charged at once into the cupola but can only be progressively charged;—first one type of material, then another, and then another.

Another prior method of charging material into the cupola has been by means of a bucket which is loaded at the location removed from the cupola, conveyed by a crane or other means through the charging door into the cupola, and then dumped to discharge the material into the cupola. Some of these buckets have been provided with removable bottoms which upon being mechanically operated to open the bottom of the bucket permitted the material to fall out of the bucket and down onto the bed of the cupola. Such removable bottoms have included hinged plates on the bucket which swung down upon releasing a catch, thereby permitting the material to slide and fall past the hinged plates and down into the cupola. The structure and movement of the hinged bottom plates was such that the material was shunted sidewards, unevenly scattered, and deposited in the cupola in an arrangement other than in the even and distinct layers in which the material may have been loaded in the bucket. The releasing mechanism required, the defects and limitations in operation, the requirement for repositioning the hinged plates in closed position, the trouble with the swinging plates striking the inner wall of the cupola, in addition to the described uneven and poor distribution of the charge of material, are some of the reasons why such buckets have proved to be unsatisfactory in operation and maintenance.

Such removable bottoms have also included an inverted cone or bell-shaped closure which when mechanically moved downwardly, formed an annular opening between the closure and bottom edge of the bucket thereby permitting the material to slide radially outward and downward and to fall onto the bed of the cupola in a scattered, uneven and haphazard deposit, and not in even and distinct layers. The difficulties of operation, the limitations of the structure and the shortcomings in the results, are among the reasons why this type of bucket too was far from satisfactory in practice.

It is an object of my present invention to

obviate the difficulties, limitations and defects of the prior charging buckets and the prior methods of charging a cupola.

Another object is the provision of an improved charging apparatus and novel method of charging a cupola.

Another object is the provision of a charging bucket leaving both ends open, the material to be charged being loaded into the bucket through the upper end thereof and being discharged from the bucket through the lower end thereof, and having electro-magnetic means for retaining the material in the bucket after being loaded and until discharged therefrom.

Another object is the provision for efficiently charging a cupola with material in desired layers.

Another object is the provision for charging a cupola with several types of material at once, the several types of material being deposited in the cupola in substantially the same arrangement as loaded in the charging bucket.

Another object is the provision for charging a cupola with distinct layers of different types of material as predetermined and arranged exteriorly of the cupola.

Another object is the provision for charging a cupola without the use of mechanical discharging means within the cupola.

Another object is the provision for charging a cupola in a manner to minimize damage to the interior walls of the cupola.

Another object is the provision for charging a cupola in a manner to minimize the distance that the charged material falls free within the cupola.

Another object is the provision of improved apparatus and method for conveying material from one location to another.

Another object is the provision of apparatus and methods for carrying out the foregoing.

Other objects and a fuller understanding of my invention may be had by referring to the following description and claims, taken in conjunction with the accompanying drawing, in which like parts are designated by like reference characters, and in which:

Figure 1 is a longitudinal cross-sectional view of a cupola showing my improved charging bucket positioned in the cupola;

Figure 2 is a longitudinal cross-sectional view of a novel loading floor arranged to accommodate my charging bucket while being loaded with material;

Figure 3 is an enlarged plan view looking down on the top of my improved bucket (without the bail showing) and having a portion removed to show the inner construction and arrangement of parts; and

Figure 4 is a longitudinal cross-sectional view of my improved bucket taken along the line 4—4 of Figure 3.

With reference to the several views of the drawing, and particularly with reference to Figure 1, there is shown a cupola denoted generally by the reference character 11. The cupola is in the form of a cylindrical shaft having the steel shell 12 lined by fire brick lining 13. The bottom of the shaft is closed by a refractory bottom 20 supported on the bottom plate 19. The upper end of the shaft has a roof 14 positioned a short distance above the top edge of the cylindrical shaft to permit gases to flow out the top of the cupola.

A wind box 15 of usual design is positioned adjacent, and surrounds, the lower portion of the cupola shaft to form a common distributing chamber for delivering an air blast from a blast main or pipe 16, through the inlet 17, to a plurality of tuyères 18 extending through the wall of the cupola at equal intervals around the circumferential extent of the cupola.

The legs 21 support the cupola in the usual manner as indicated in the drawing. A molten metal spout 22 on a side of the cupola is adapted to deliver molten metal from the cupola to a ladle or other receptacle upon tapping the furnace. The adjacent tap hole for out-flow of metal is plugged in the usual manner and is not shown in the drawing. A slag spout 23 on an opposite side of the cupola and somewhat above the spout 22 is adapted to guide the flow of slag withdrawn from the furnace upon opening a slag hole (not shown) in the wall of the cupola.

Extending through a wall of the cupola near the upper end of the shaft is an opening or port 24 commonly referred to as the charging door. Material to be introduced into the shaft of the cupola is charged into the cupola through the charging door 24 and deposited in the lower portion of the cupola to constitute the bed 32 of material. The material to be introduced into the cupola is stored at a storage space or loading yard at a distance from the cupola. My invention is particularly directed to the problem of efficiently conveying the material from the storage space and satisfactorily depositing the material in the cupola.

My improved charging bucket, denoted generally by the reference character 31, is carried by a crane 26 or other suitable carrying means back and forth between the cupola shown in Figure 1 and the storage space shown in Figure 2, the material being loaded in the bucket at the storage space and being deposited into the cupola from the bucket.

The crane 26 rides on a track or mono-rail 25 which extends into the cupola through the charging door 24 and outwardly away from the cupola to, and over, the storage space where the material to be charged is stored, such as over the storage space shown in Figure 2. A cable 28 suitably arranged over pulleys and connected to the crane motor is adapted to raise and lower the bucket 31, the cable 28 having a hook 29 detachably connected to a bail 30 secured to the bucket in the usual manner. The crane 26 has a cab 27 adapted to accommodate an operator and the controls of the crane. The crane has the usual operating parts to provide for its travel along the rail 25 and for the raising and lowering of the cable 28 and load carried thereby.

The construction of my improved bucket 31 is shown in detail in Figures 3 and 4. The bucket is in the general form of a cylinder having an open space 41 extending therethrough, both the upper and lower ends being open. The terms "cylinder" and "cylindrical" as used in the specification and claims are not to be considered as limited in meaning to a pure geometrical cylinder but is to be understood as including a hollow and open-ended body whether circular in cross-section, square in cross-section, polygonal in cross-section, or other shape. The preferred embodiment as here illustrated and described is circular in cross-section.

An iron magnetic shell 42 forms the principal part of the wall of the bucket. The shell 42 is preferably of highly magnetic material such as iron or other known material specially chosen for its ability to carry a magnetic flux. The shell 42 has a relatively large longitudinal dimension

to form a cylinder and may be formed in one piece, or may be made of a plurality of segments welded, bolted or otherwise firmly secured together in a good electrical connection, the segments being either a plurality of short rings or a plurality of longitudinal sections.

A plurality of magnetic poles 47, secured to the shell 42 in a good electrical connection by welding, or other suitable means, such as by the plurality of bolts 52, extend radially inward from the shell 42 at regular recording intervals around the annular extent of the bucket. These poles 47 therefore protrude inwardly from the shell 42 and are in good electrical connection therewith. The shell 42 and poles 47 together form a magnetic core.

Coils 50 of electrical conducting wire are wrapped around the poles 47, the coils 50 being wound in such manner that adjacent poles are of opposite polarity. There are an even number of poles of each of said opposite polarity. To electrically insulate and thermally protect the coils 50 suitable material 51 is disposed around the coils, the material being placed on the inner face of the shell 42 and on all sides of the coils 50 as shown in Figures 3 and 4. The material 51 is of a nature adapted to resist heat and to insulate electrically, such as asbestos board. The wires of the coils are enameled or japanned in the usual manner.

To further protect the coils and poles and to provide a smooth and even surface on the inner wall of the bucket, non-magnetic plates 49 are positioned between the inner radial ends, and above and below the longitudinal termini of the cores 50. To secure the plates 49 in place, shoulders 48 are provided on the inner edges of the poles 47 so as to over-lap and lock the plates 49 in place. Figures 3 and 4 illustrate the manner in which the plates 49 extend around, and intermediate, the poles 47, and the way in which the plates 49 are locked in place. All of the poles 47 have a coil 50 mounted thereon but in Figure 4 the coil 50 is not shown on all of the cores in order to simplify the illustration. In Figure 4 a coil 50 is shown in cross-section on one pole and is indicated in broken lines on another pole. To indicate the coils 50 on all of the poles in Figure 4 would confuse the lines of the drawing by reason of the concave annular disposition of the inner surface of the bucket illustrated.

The plates 49 are composed of a metal or material non-magnetic in nature, that is, substantially unable to conduct magnetic flux, such as copper, Babbitt metal, special alloys or other similar materials. By the use of non-magnetic plates 49, there is no opportunity for magnetic flux emanating from the coils and passing through the poles from being by-passed from one to the other through the plates 49.

The outer wall of the shell 42 is protected by a sheath 43 of suitable material capable of heat resistance and electrical insulation, such as asbestos board. A steel casing 44 surrounds and envelopes the shell 42 and sheath 43 to form a strong and tough outer wall for the bucket. The top and bottom of the assembled ring 42, cores 47, coils 50, and plates 49 are covered and protected, respectively, by annular steel plates 45 secured in place by bolts 46. The plates 45 have open spaces therein coinciding with the open space extending through the bucket and thus there is an open space 41 extending through the bucket from end to end.

The coils 50 of the bucket are connected to a source of electrical energy, preferably direct current, through wires or other electrical conductors 36 and 37 shown in Figure 1, the wires 36 and 37 being connected to the leads A and B which communicate with the source of current. The flow of current through the wires 36 and 37, and hence the coils 50, is controlled by the switch 38 or other control device in the cab 27 of the crane 26.

Figure 2 illustrates an improved arrangement for the loading of the bucket with material at the area where the material is stored and loaded in the bucket. A pit or recess 54 is formed in the floor or ground 55, the pit or recess 54 being slightly larger than the bucket so as to accommodate the bucket therein. The bottom of the pit 54 constitutes a supporting surface 53 which supports the bucket and closes the open lower end of the bucket when the bucket is placed within the pit by the crane to the position illustrated in Figure 2. When in the loading position of Figure 2, with its top open and its bottom closed, material may be placed within the bucket and the material is supported therein by the supporting surface 53 that also supports the bucket. The supporting surface 53 is thus a temporary closure closing the bottom end of the bucket when in the loading position of Figure 2.

Material to be loaded indicated by the reference character 57 may be conveniently introduced into the bucket by means of the inclined surface 56 sloping up from the edge of the pit 54. The material 57 may thus slide down the surface 56 and into the bucket.

The material to be charged into the cupola is loaded into the bucket through its upper end and positioned in the layers desired when later deposited in the cupola. Inasmuch as coke is non-magnetic in nature, it cannot be made to constitute the lowest layer of material in the bucket as it would fall out of the lower end of the bucket upon the raising of the bucket by the crane from the supporting surface 53. Therefore the lower portion of the bucket is filled with the magnetic material, such as pig iron or scrap (iron or steel), that is to be charged into the cupola. When coke is also to be charged into the cupola it is loaded into the bucket as a layer above a layer of magnetic material.

In the example load of the bucket illustrated in Figures 1 and 2, the lower layer 33 is of a first magnetic material, such as pig iron or scrap, the intermediate layer 34 is of a non-magnetic material, such as coke or limestone, and the top layer 35 is of a magnetic material, such as pig iron or scrap. Other arrangements are of course at once suggested, as, for example, the entire load may be of magnetic material, or for example, non-magnetic material may be the upper-most layer.

In the operation of my apparatus, material to be charged is loaded into the bucket while it is in the loading position of Figure 2. The material loaded is all magnetic or at least the lower layer of material is magnetic, the lower layer always being of sufficient depth and mass that upon magnetization thereof, it may support its own weight as well as the weight of any non-magnetic material borne by it. The pieces of magnetic material, such as pigs of iron or chunks of scrap, are packed in together as closely as possible so as to afford the maximum of surface contact between the pieces and between the poles 47 and pieces of material.

After the bucket is loaded the electro-magnets

formed by the described assembly of parts are electrically energized to cause magnetic flux to flow out from the inner radial faces of the poles 47 and through the mass of magnetic material. Magnetic flux flowing from the outer radial faces of the poles passes through the shell 42 from one pole to another. The distance between the opposite inner pole faces, that is, the inner diameter of the bucket, and the distance between the adjacent pole faces is such that the magnetic flux flows through the magnetic material to attract the pieces of material toward the poles and to attract the pieces of material together and to thus retain them in place. The flow of magnetic flux, induced by the current in the coils 50 and preferably by direct current, is such that the pieces of magnetic material are magnetized and retained within the bucket. Upon the lifting of the bucket 31 from its loading position of Figure 2, the energization of the electro-magnets prevents the material from falling through the open lower end of the bucket and thus effectively closes the lower end of the bucket with magnetic material.

The crane 26 then carries the loaded bucket to the cupola 11 and through the charging door 24 into the interior of the shaft. To prevent the material from falling more than necessary and to retain it as much as possible in the form of the layers as placed in the bucket, the crane 26 lowers the bucket 31 in the cupola down near the top of the bed 32 in the cupola, as, for example, down to the position shown in Figure 1. When the bucket is in lowered position in the cupola the electro-magnets are deenergized, as by operation of the switch 38. Upon the stopping of the passage of current through the coils and of the flow of magnetic flux in the bucket, the magnetic material in the bucket is no longer retained in the bucket and falls by force of gravity onto the bed 32.

As the release of all the material in the bucket is simultaneous, and by reason of the absence of interfering swinging doors or a bell or cone or other mechanical parts, the material falls evenly and uniformly and is deposited in substantially the same layers on the bed 32 of the cupola. For example, in the illustration of Figure 1, the lower layer 33 of material will form a deposited layer of substantially uniform depth, the intermediate layer 34 will form a similarly uniform deposited layer on top of layer 33, and the top layer 35 will form a similarly uniform deposited layer on top of layer 34.

After releasing the material in the bucket and depositing it in the cupola, the bucket is raised by the crane to sufficient height to clear the charging door and is carried back to the material storage space where it is again loaded, as for example, by the arrangement shown in Figure 2. After being again loaded as described, the electro-magnets are again energized and the bucket repeats its journey to the cupola.

My invention includes the apparatus and method defined in the annexed claims as well as in the foregoing detailed description, which claims are made a part of this disclosure by reference thereto.

Although I have described my invention with a certain degree of particularity, it is understood that the present disclosure has been made only by way of example and that numerous changes in the details of construction and the combination and arrangement of parts may be resorted to without departing from the spirit and the scope of the invention as hereinafter claimed.

I claim:

1. In a metallurgical furnace having a charging door through which material having magnetic characteristics is charged into the furnace for processing therein, the improvement of a charging bucket having upright walls disposed around an open space for accommodating said material in the said open space intermediate of the said walls, said bucket having an open upper end through which said material enters in being loaded into the bucket and having an open lower end through which said material exits in being discharged from the bucket, a plurality of electro-magnets mounted in said walls on opposite sides of said open space and disposed at intervals around the circumferential extent of the bucket, and electrical circuit means adapted to communicate with a source of electrical energy for energizing said magnets, the said material, upon being placed in appropriate layers in said bucket through the open upper end thereof while the bucket is positioned over a supporting surface exteriorly of the furnace, being retained in the position of said layers within the open space of the bucket by the magnetic force of the said magnets upon energization thereof during movement of the bucket from said supporting surface through the said charging down into the furnace, and being released from the bucket through the open lower end thereof upon de-energization of said magnets while the bucket is within said furnace to fall in said layers to the lower portion of the furnace for processing.

2. In a charging apparatus for a metallurgical furnace having a charging door in an upper portion thereof through which a bucket of magnetic material is moved, a loading floor over which said bucket is placed during loading of the bucket, and carrying means for carrying said bucket from the loading floor, through the said charging door into the interior of the furnace and return, the improvement of a bucket having side walls defining an open space for accommodating said material therebetween and having upper and lower open ends, a plurality of electro-magnets carried by said walls and positioned at intervals around said open space to generate magnetic flux within said space, and electrical circuit means adapted to communicate with a source of electric energy for energizing said electro-magnets, the arrangement of said side walls, open ends, electro-magnets and circuit means providing for the loading of the bucket with said material through the said upper open end and the support of the material in the bucket by said loading floor when the bucket is placed over the loading floor, for the retention of the material in the bucket by the force of the magnetic flux generated by said electro-magnets upon energization by said circuit means when the bucket is being carried by said carrying means from the loading floor, through the charging door and into said furnace, and for the releasing of said material from the bucket through said lower open end upon de-energization of said electro-magnets after the bucket is in said furnace to place the charge of material in the furnace for processing.

3. A bucket for conveying magnetic material from a loading floor through the charging door of a cupola to the interior of the cupola, said bucket having vertical walls disposed around an

open space for accommodating said material and having upper and lower open ends to permit passage of said material therethrough, electro-magnetic means carried by said walls for magnetically retaining said material within said walls, said electro-magnetic means including a plurality of magnetic poles which extend toward said open space and between which magnetic flux passes in said open space to magnetize said material, and means for energizing and de-energizing said electro-magnetic means, said material being loadable in said bucket through said upper open end thereof upon closing of the lower open end by said loading floor, being retainable in the bucket by the magnetic force of said electro-magnetic means upon energization thereof upon removal of the bucket from the loading floor and transfer to the interior of the cupola through said charging door, and being dischargeable from the bucket by force of gravity through said lower open end upon de-energization of said electro-magnets to charge the cupola.

4. A bucket for charging a cupola with material through an opening in an upper portion thereof by a carrier moving the bucket from a loading surface located exteriorly of the cupola to the interior of the cupola through said opening, said material being, at least in part, of a magnetic nature, said bucket comprising, in combination, a wall member having an open space extending therethrough from the upper to the lower end to accommodate said material therein, electro-magnetic means mounted in said wall member around said open space for establishing a magnetic flux in said open space, said electro-magnetic means including a plurality of spaced magnetic poles directed inwardly of said bucket to provide magnetic paths to the magnetic material in said open space for the flow of magnetic lines of force through the said magnetic material, and means for energizing and de-energizing said electro-magnetic means, the said bucket accommodating said material within the open space in the wall member upon loading the material through the upper end of the bucket and upon closing the lower end thereof with said loading surface, retaining said material within the open space in the wall member upon the opening of said lower end by energization of said electro-magnets to magnetize said material, and dropping the said material therefrom through said lower end into the lower portion of the cupola by de-energizing said electro-magnets upon the moving of the bucket by said carrier through said opening of the cupola to the interior thereof.

5. A bucket for charging magnetic material into a cupola comprising, in combination, a hollow member having side walls for confining said material against lateral movement, the hollow member being open at the top to permit introduction of said material thereto and being open at the bottom to permit exit of said material therefrom by force of gravity, and electro-magnetic means disposed around a substantial portion of said side walls for magnetically holding said material in the hollow member in opposition to said force of gravity, the combination of the hollow member and electro-magnetic means providing for the retention in the hollow member of said material introduced through said open top thereof upon loading of the bucket and for the release of said material from the hollow member through the open bottom thereof upon discharging the bucket.

6. In a cupola charging apparatus, the combination of a movable wall member defining an open spaced wherein magnetic material may be confined, the wall member being open at its upper end for introduction of said material into said open space and being open at the lower end for gravity discharge of said material therethrough from said open space, a fixed surface member for supporting said material within said open space during introduction of said material through said open upper end at a fixed loading location, and electro-magnetic means carried by said wall member for magnetically retaining said material within said wall member during separation of the movable wall member from the fixed surface member, energization of said electro-magnetic means retaining said material within the wall member during movement of the wall member away from said surface member and into the cupola and de-energization of said electro-magnetic means releasing said material to permit the material to fall from the wall member through said open lower end into said cupola.

7. In a cupola charging apparatus, the combination of a bottomless and topless bucket and electro-magnetic means including a plurality of magnets of opposite polarity spatially disposed in, and carried by, the bucket for magnetizing magnetic material loaded in said bucket to retain in the bucket, upon energization of the electro-magnetic means, material loaded in the bucket through the upper end thereof, and to release from the bucket through the lower end thereof, upon de-energization of the electro-magnetic means, the said retained material in charging said cupola.

8. In a cupola charging apparatus, a bucket adapted to be positioned in said cupola to discharge magnetic material from the bucket into said cupola and to be positioned in juxtaposition to a loading floor to receive said material therein, said bucket being open at the top to permit the material to be loaded into the bucket through the said open top and being open at the bottom to permit the material to be discharged from the bucket through the said open bottom, electro-magnetic means mounted in the wall of said bucket to establish magnetic flux within said bucket for retaining said material in the bucket, and electric circuit means for the selective energization and de-energization of said electro-magnetic means, the energization of the electro-magnetic means retaining the said material loaded in the bucket during change of position of the bucket from the said loading floor to within said cupola and the de-energization of the electro-magnetic means discharging the said material loaded in the bucket within said cupola.

9. An improved bucket for conveying material of a magnetic nature comprising a wall member having an open space extending therethrough from top to bottom and electro-magnetic means carried within said wall member and arranged to magnetize said material in said open space, the arrangement of the open space extending through the bucket and the electro-magnetic means providing for the loading of the said material into said open space through the top thereof, for the retention of said material in said open space by the magnetic force of said electro-magnetic means, and for the release of said material from said open space through the bottom thereof by force of gravity.

10. An improved charging bucket comprising, in combination, a magnetic shell disposed around an open space, said shell being open at the top and at the bottom, a plurality of magnetic poles extending from said shell toward said open space and disposed at intervals around said shell, electrical coils mounted on each of said poles to induce a flow of magnetic flux out into said open space from one pole to another, and electrical circuit means adapted to communicate with a source of electrical energy for energizing said coils, said bucket magnetically retaining magnetic material introduced into said open space through the top thereof upon energization of said coils and discharging said material from said open space through the bottom thereof upon de-energization of said coils.

11. The method of conveying magnetic material from one place to another place, comprising the steps of positioning an open-ended cylinder upon a supporting surface at said one place to close the bottom end thereof, placing said material in the cylinder through the upper end thereof while on said supporting surface, magnetically attracting said material to the cylinder to retain the material therein, carrying said cylinder and retained load to above said another place where the material is to be discharged, and discontinuing the magnetic attraction of the material to discharge the material from the lower end of said cylinder to said another place by force of gravity.

12. The method of charging a metallurgical furnace through a charging door thereof with magnetic material from a loading floor, comprising: positioning an open ended cylinder on the said loading floor to close the lower end thereof, placing said material in the cylinder through the upper end thereof, magnetically attracting the material to the inner wall of said cylinder to retain the material in the cylinder, carrying the cylinder through said charging door to the interior of the furnace, and discontinuing said magnetic attraction of the material to permit it to fall by force of gravity through the bottom end of the cylinder into said furnace.

13. An improved charging bucket comprising, in combination, magnetic shell means disposed around an open space, said shell means being open at the top and at the bottom, a plurality of magnetic poles extending from said shell means toward said open space and disposed at spaced relationship to each other, electrical coils mounted on each of said poles to induce a flow of magnetic flux out into said open space from one pole to another, and electrical circuit means adapted to communicate with a source of electrical energy for energizing said coils, said bucket magnetically retaining magnetic material introduced into said open space through the top thereof upon energization of said coils and discharging said material from said open space through the bottom thereof upon de-energization of said coils.

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