Dec. 27, 1955 J. F. JORDAN 2,728,123

APPARATUS FOR FEEDING RAW MOLTEN IRON AT A CONSTANT RATE

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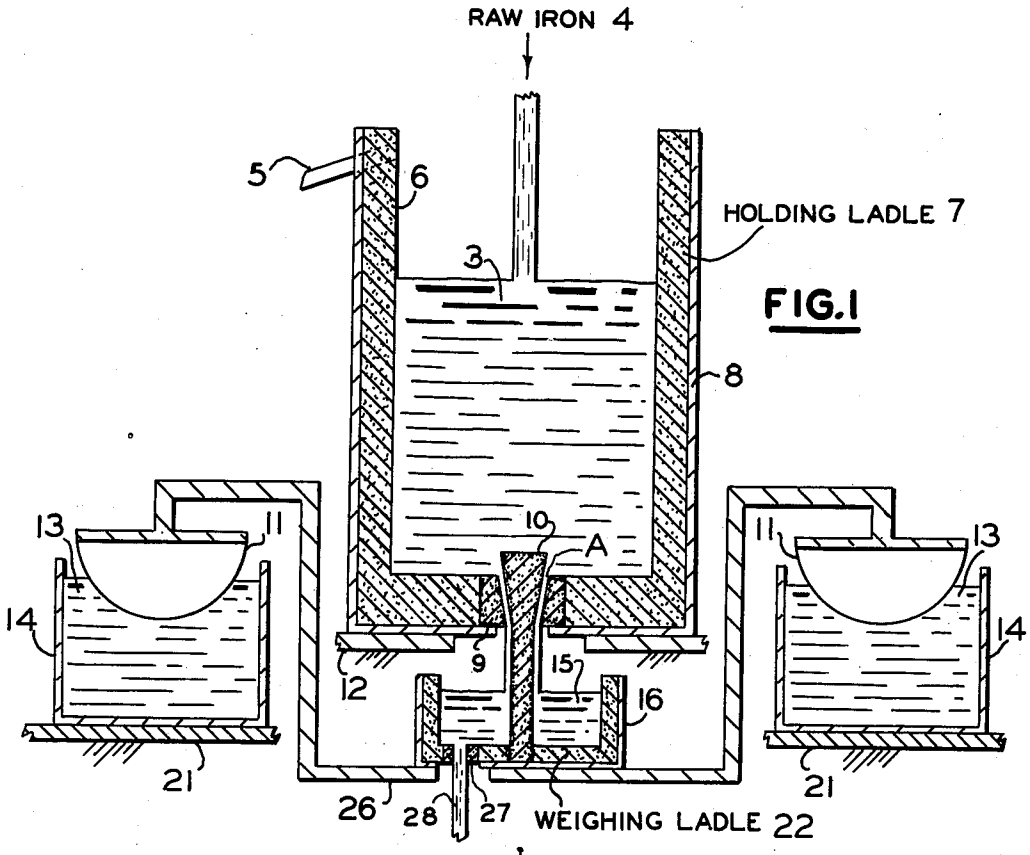


FIG. 1

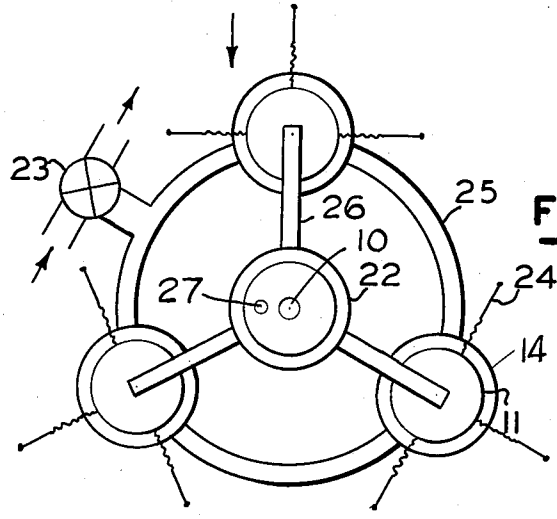


FIG. 2

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APPARATUS FOR FEEDING RAW MOLTEN IRON AT A CONSTANT RATE

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1 Claim. (Cl. 22—79)

My invention relates to metallurgy wherein a raw molten iron flows continuously into a continuous steel process.

The Kellogg concept of a continuous refining process involves the elimination of product storage between the various steps of the refining procedure, see Fortune, vol. XXXVIII, No. 5, November 1948, page 111, etc. This Kellogg achieves by integrating all of the refining steps so that the productive capacity of each step equals the productive capacity of each other step, so that the product from each step may be directly flowed to and thru the next step without storage therebetween. With this achieved, the process operator is in a position to develop and apply those methods of close control which are characteristic of all continuous refining processes. It has been repeatedly demonstrated in the chemical industries that this concept yields products whose quality and uniformity can never be approached by batch methods of refining.

In the chemical industries, the feeding of a continuous, uniform flow of raw material into the continuous refining process is no problem at all, due to the existence of suitable valves and metering devices. It is not enough for a continuous process to have available suitable valves, etc., they must be capable of operating in an essentially automatic manner. Such automatic feeding is available to all continuous chemical processes.

The development of continuous processes involving molten iron and/or steel is seriously handicapped by the lack of a suitable device for continuously and automatically feeding the raw metal. In those prior art processes which contemplate employing some form of the Kellogg concept in a metallurgical procedure, it has been the practice to dispose of this vital feeding problem by the casual statment that the raw metal must be fed into the refining process at a uniform rate. When such statements are dealing with ferrous metallurgy they are without substance, for the prior art contains no device capable of achieving this objective; that is, no device that is commercially feasible.

In a process involving the continuous conversion of raw molten iron into molten steel according to the Kellogg concept, it is not only necessary that the feeding device pass the raw iron to the refining process at a uniform rate but it is also necessary that this rate yield something approaching the desired production rate. A uniform rate of flow will permit the refining process to be closely controlled, however, a uniform production rate at the desired level is required in order to control the overall operation of the plant.

In addition to the aforementioned factors, it is of course also necessary that the incoming raw molten iron be reasonably uniform in composition and temperature, however, such uniformity is easily attained by passing each blast-furnace tap thru a hot-metal mixer on its way to the refining process.

I have devised an apparatus that will supply such a continuous steel process with a uniform flow of molten

iron at a controllable rate. In my apparatus, I employ a floating valve to automatically regulate the flow of molten iron out of a holding ladle.

Figure 1 shows a sectional view of my apparatus.

Figure 2 shows a plan view of one modification of my apparatus with holding ladle 7, support 12 and support 21 removed.

In Figure 1, holding ladle 7 consists of refractory lining 6 supported by shell 8. Raw iron 4 is added to pool 3 within ladle 7 either continuously or intermittently. In, and penetrating thru the bottom of ladle 7 is outlet A formed by refractory body 9, said body 9 acting as the seat of my valve by reason of the tapered opening formed by said body 9. Spout 5 may be employed to occasionally overflow molten slag that gathers on pool 3. Ladle 7 is shown supported by rigid support 12.

Passing down thru opening A is the tapered needle 10 of my valve, needle 10 being composed of a suitable refractory and being tapered so that it will seat in opening A of body 9. Needle 10 extends downward to its connection with the bottom of weighing ladle 22, ladle 22 being formed by lining shell 16 with a suitable refractory, being positioned beneath ladle 7 so that it receives the molten iron that passes thru the space between the seat in body 9 and needle 10.

Ladle 22 is supported by floats 11 thru the instrumentality of connecting arms 26. Floats 11 float on bodies of liquid 13 which are contained in vessels 14, vessels 14 being rigidly supported by supports 21. The function of ladle 22 is to weigh the body 15 of molten metal contained therein as said metal of pool 15 flows out of ladle 22 thru the opening in body 27 to form stream 28, stream 28 being thereupon passed to the refining process.

Ladle 22 must be supported by at least two floats 11, however, I prefer to employ three floats 11, as shown in Figure 2. In Figure 2, restraining members 24 are positioned so that they will restrain the lateral movement of floats 11, in my preferred embodiment members 24 are springs which maintain a lateral tension on floats 11. Valve 23 acts to control the level of liquid body 13 within vessels 14. While there must be at least two floats 11, such floats 11 may be floated in only one pool 13 or each float 11 may be supported by its own pool 13, it being presumed that pools 13 consist of water, however, pools 13 may be formed by other liquids, an oil, for example.

My appartus may be placed in operation in the following manner: Ladles 7 and 22 having been preheated, the level of pools 13 is lowered by valve(s) 23 until needle 10 seats in the tapered opening in body 9, so that the molten metal 4 will not pass thru opening A when it is introduced into ladle 7. Raw iron 4 is then introduced into ladle 7 to some selected height, say until ladle 7 is half full. The level of pool(s) 13 is now raised by means of valve 23 so as to lift ladle 22 and needle 10 to permit the molten metal of pool 3 to flow into ladle 22 and out thru the opening in body 27 to form stream 28. Opening A is gradually increased, by increasing the height of pool(s) 13 in vessel(s) 14, until the level of pool 15 within ladle 22 has raised to the desired position within ladle 22, whereupon the level of pool(s) 13 within veessel(s) 14 is stabilized by stopping the addition of the liquid of pool(s) 13 to said pool(s) 13. With the metal of pool 3 passing thru opening A and into pool 15, the flow of the metal of pool 15 thru the opening in body 27 to form stream 28 is controlled by the depth of pool 15, the dept of pool 15, on the other hand, being controlled automatically by my floating valve arrangement. For example, when raw iron 4 is introduced into pool 3 at a rate in excess of the rate at which the molten metal is passing thru opening A, the level of the

molten iron of pool 3 begins to rise. As the level of pool 3 begins to rise, the static head on opening A increases, resulting in an increased flow of molten iron thru opening A. As an increased flow thru opening A begins, the level of pool 15 begins to rise, thus increasing the overall weight of the floating valve system, and resulting in floats 11 sinking further into pool(s) 13 in proportion to the increased valve weight and in relationship to the buoyancy of the floating system. In the event that needle 10 is flat on top, as in Figure 1, an increase in the depth of pool 3 acts to lower needle 10 into opening A as the greater head of liquid 3 acts on needle 10. The pressure exerted by variations in the depth of pool 3 acts with, not against, the response of the overall float system.

If the flow of raw iron 4 into pool 3 is stopped, the reaction of the part of the controlling valve system is opposite to the case just described; for, the outflow of metal thru opening A lowers the head of metal over needle 10 and opening A, resulting in an opposing reaction on the part of the valve system.

Depending upon the variables present in such a system—for example, on the buoyancy of the floating system, the ratio of the depth of pool 15 to the width of pool 15, the ratio of the depth of pool 3 to the width of pool 3, the cross section shape and width of the top of needle 10, etc., the lag between action within ladle 7 and reaction on the part of the valve system will vary, and such variation will result in a variation in the rate of flow of stream 28.

The expression "rate" is always employed herein to reflect the weight of metal flowing per unit of time.

The swing of the system around the norm or average rate of flow must be nominal. I have found that such swings become too pronounced when the width of pool 15 becomes less than 2½ times the depth of pool 15. This relationship between the depth and width of pool 15 causes pool 15 to act as a surge vessel that effectively prevents the rate of flow from swinging too far from the norm. In other words, with a shallow pool 15, the lag between action and reaction in the system is effectively prevented from causing serious swings in the rate at which the system is feeding the molten iron. Pool 15 must, therefore, be at least 2½ times as wide as it is deep.

Junghans, in French Patent No. 905,660 of December 11, 1945, disclosed a system for feeding molten ferrous metal. In Junghans' system, the flow is balanced against a selected weight by a lever system. While the lever action of Junghans may be employed with my invention, I prefer my floating valve, due to the essentially straight movement of the needle of my valve.

I prefer the bottom orifice of body 27 for flowing the metal of pool 15 out of ladle 22, however, if desired, said metal may be flowed out of pool 15 by an overflow lip (not shown), such as was disclosed by Junghans.

Refractory bodies 9 and 27 and needle 10 are preferably made of high-density graphite/carbon, for this material will stand up indefinitely against the erosive action of molten raw iron. Other non-metallic refractories may of course be used.

As shown in Figure 2, vessels 14 are connected with connecting pipes 25 that causes the level of all pools 13 to be the same.

By maintaining the depth of pool 15 below 20% of the width of pool 15, I have been able to minimize the swing in the feeding system to limits which meet most requirements. When it is necessary to lower these rate-of-feed swings to the absolute minimum, I have found it necessary to maintain pool 3 at a depth that lies below 40% of the width of pool 3.

Having now shown and described several forms of my invention, I wish it to be understood that my invention is not to be limited to the specific form or arrangement of parts hereinbefore shown and described, except insofar as such limitations are imposed by my claim.

I claim as my invention:

In a continuous weighing apparatus having a refractory-lined ladle that is rigidly supported and adapted to hold a pool of molten iron, a tapered outlet positioned in the bottom of said ladle and adapted to seat with a tapered refractory needle that is centered within and passes through said outlet, said needle being supported by and in fixed junction with the bottom of a refractory-lined weighing ladle that is positioned beneath said outlet, said weighing ladle being supported by balancing means, and means for removing molten iron from said weighing ladle, in combination therewith: balancing means consisting of at least two floats which are rigidly connected to said weighing ladle, and a valve for controlling the level of the liquid upon which said floats are floating.

References Cited in the file of this patent

UNITED STATES PATENTS

2,040,157 Story et al. ---------- May 12, 1936

FOREIGN PATENTS

905,660 France ---------- Apr. 23, 1945