

United States Patent

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[54] **BRIQUETTING PRESS**
4 Claims, 4 Drawing Figs.

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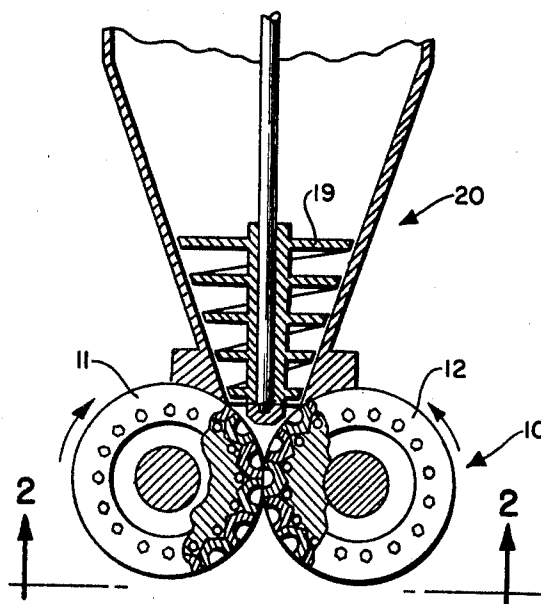
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ABSTRACT: A roll-type press for compressing particulate metal powders, especially ferrous metal powders such as produced in direct iron ore reduction processes, to provide series, or strings, of readily separable briquettes as articles of manufacture. The mold pockets in the faces of the two cooperating rolls are so arranged that they partially overlap as the pockets of one roll come into contact with the pockets of the other. The overlapping section, or junctures, of the compacted briquettes are less densely compacted than those conventionally produced so that the individual briquettes of the issuing series can be readily broken apart. Moreover, forces are generated which aid in the release of the briquettes from the mold pockets.



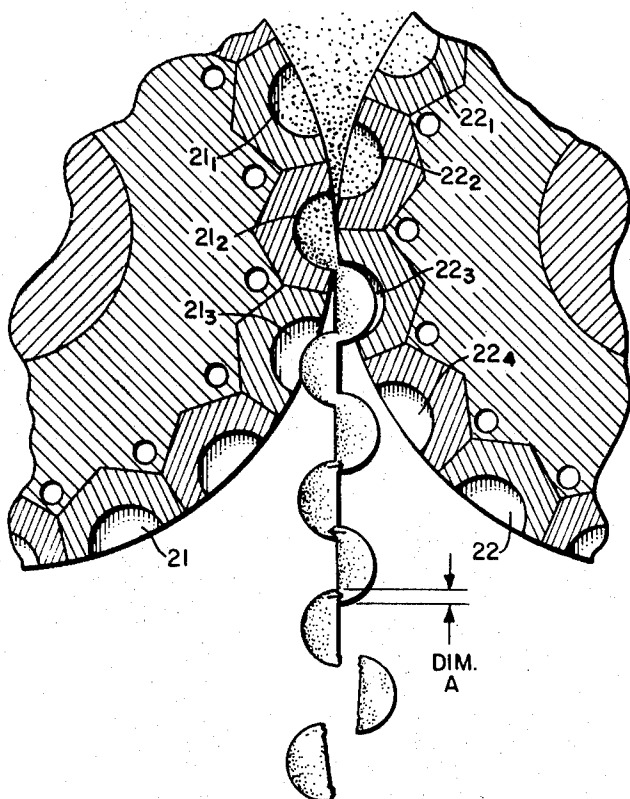


FIG. 3.

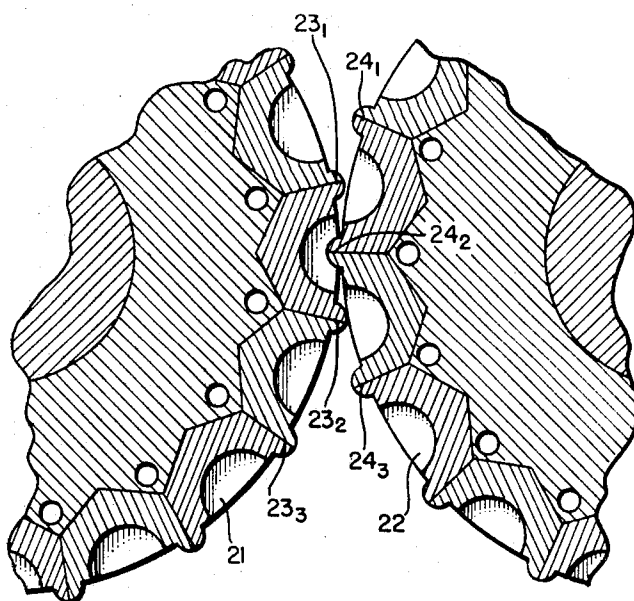


FIG. 4.

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BRIQUETTING PRESS

Roll press briquetting of particulate metal powders, especially ferrous metal powders such as produced in direct iron ore reduction processes, has been long known to the art. Briquettes are thus formed by withdrawing particulate or finely divided reduced iron products from direct reduction processes and feeding same, generally while hot, into a hopper provided with a screw-type device for conveying the product into the nip of the pair of press rolls, at least one of which contains mold pockets so that the particulate iron is compacted therein into briquettes.

Briquettes are generally cast so that the cross sections thereof resemble "D's" or pillows (D's, back-to-back). In briquetting the particulate reduced iron product of direct reduction processes, despite the normally higher production achieved by casting pillow-shaped briquettes, it is often necessary or desirable to cast the briquettes as D's to achieve the necessary high density required to provide low porosity structures. Low porosity structures are necessary because this lessens moisture pickup and reoxidation, which is so acute in loosely packed agglomerated metals, especially active metals such as produced in a direct iron ore reduction process. Thus, with any given press, at similar conditions, D-shaped briquettes will be of greater density, and hence more impervious to moisture pickup and reoxidation than pillow-shaped briquettes.

For practical operation with conventional presses, it is necessary to maintain a running clearance between rolls which causes a connecting web to be formed between successive briquettes. As a result, briquettes issue from the rolls as a series joined together through narrow webbed sections. Such series or strings create problems in subsequent materials handling and therefore the individual briquettes must be separated one from another.

The webs are relatively thin sections, or junctures, between the joined briquettes wherein the particulate metal is more tightly compacted, or has a much greater density, than other portions of the briquettes. Ideally, the webbed sections should provide a juncture for easy separation of the briquettes, one from another. Unfortunately, however, this is not the case in briquetting many particulate metals, especially particulate reduced iron. Extreme pressures are required to produce the necessary high density agglomeration of the metal. The high pressure on the rolls at the webbed sections of the briquettes produces considerable wear. Binders, which normally reduce the need for the very high pressures, cannot be employed. A principal reason for this is that the binder material provides an undesirable contaminant, and hence interferes with the processes in which the briquettes are to be used. Consequently, separation of the briquettes from individual series constitutes a troublesome problem.

A string breaker, i.e., device constituted of a pair of sloped surfaces, is generally mounted immediately below the rolls to intercept the series of briquettes, and skew it from its path to twist and tear the webs to separate the individual briquettes. String breakers function fairly satisfactorily when the first briquettes of an unbroken series is properly intercepted. Unfortunately, the first briquette of a series, particularly D-shapes, frequently do not release cleanly from the pockets and is not properly intercepted. The malfunction locks or retains the briquette in a mold pocket and the protruding portion of the briquette strikes the string breaker. Repeated blows deform the string breakers to the extent that they rub and damage the rolls.

Briquette release from the mold pockets is another significant problem. Lubricants provide some help inasmuch as they promote briquette release. Unfortunately, however, lubricants reduce the roll grab necessary to ensure adequate feed rate. Thus, lubricity at the powder compact interface and within the powder are important features. On the one hand, minimum friction at the interface of a mold and within the powder is desired to ensure the necessary flow of the powder as it is

compacted. On the other hand, maximum friction between rolls and powder is required to ensure suitable feeding or grab by the pair of rolls. Hence, the amount of lubricant which can be employed is limited. The use of shallow pockets also aids in release. This, however, lowers the production capacity of the presses and, obviously, is generally undesirable.

It is accordingly the primary object of the present invention to obviate these and other difficulties. In particular, it is an object to provide a new and improved roll-type press for briquetting particulate metals, especially ferrous metals such as resultant from direct iron ore reduction processes. More particularly, it is an object to provide a press which gives improved roll life and superior performance, as well as one which is useful in high-temperature briquetting of products from direct iron ore reduction processes, especially fluidized iron ore reduction processes.

These and other objects are achieved in accordance with the present invention which contemplates a new and improved roll-type press wherein the rolls have mold pockets in alternate sides of the roll facings so that the pockets of one roll partially overlap the pockets of the other. Particulate metal powder introduced into the pockets is compressed as the pockets are rotated into contact to provide series or strings of briquettes, as articles of manufacture, while the overlapping sections provide junctures in the briquettes which are areas of less dense compaction than achieved in conventional operations, supra. The individual briquettes of the issuing series, or strings, as a result are more readily broken apart, one briquette from another. Moreover, forces are generated which aid in the release of the briquettes from the mold pockets.

This improvement greatly reduces one of the major factors of roll damage, i.e., that caused during the separation or breaking apart of the individual briquettes of a series. It also aids in the separation, and the tendency of briquettes to stick in the mold pockets is also alleviated. Thus, the normal tendency of briquettes to stick within the mold pocket of one face of a roll is largely offset by the slight pulling effect of the next briquette of the series, which is in a mold pocket of the opposite roll thereby existing a tendency to follow in the path of the moving roll.

Partial overlap is provided between the alternating series of mold pockets. It has been found desirable to provide overlap ranging from about 1 to about 20 percent, and preferably from about 5 to about 15 percent, based on the sum total length of overlapped and nonoverlapped sections. The overlapped edges of the individual briquettes in an issuing series of briquettes, of course, reflects the same measurements. Thus, measurement along a cross section of the individual briquettes of a string, or series, would show that the overlapped edges also range from about 1 to about 20 percent, and preferably from about 5 to about 15 percent, based on the total length of the briquettes, this including the sum total of both the overlapped and nonoverlapped portions.

The invention will be better understood by reference to the following detailed description which makes further reference to the drawings which are partial section, or fragmentary, views illustrating the salient and necessary features.

In the drawings:

FIG. 1 depicts, in section, a general assembly side view of a press with a feed hopper mounted thereabove (string breaker not shown).

FIG. 2, which is a view along 2-2 of FIG. 1, depicts in plan a pair of cooperating press rolls,

FIG. 3 depicts an enlarged portion of the press rolls of FIG. 1, and a series, or string, of briquettes of D-shaped cross section, as would issue from a press such as described by reference to the preceding figures, and

FIG. 4 depicts a preferred roll design.

Referring to the figures, there is shown a roll-type press provided with a pair of cooperating rolls 11, 12. One face of a roll is in operative proximity with the other, and each roll is mounted for rotation in opposite directions about its respective axis, A, A'. The drive shaft 13, suitably coupled to a con-

venient power source (not shown), drives shafts 14,15 via suitable gear means 16.

A hopper 20, containing a vertically oriented drive shaft 21, forces particulate metal powder from the hopper into the nip, or grab, of the pair of rolls 11,12. Therein compression of the powder is initiated. The vertical shaft 21 is driven by any suitable motor, or motor- and drive-transmitting means (not shown).

The circumference of the pair of rolls 11,12 is provided with a continuous series of mold segments containing pockets (or voids) 21,22—viz., 21₁ to 21_n and 22₁ to 22_n, the subscript *n* representing any predetermined desired whole number of mold segment required to align the circumference of a roll. The mold segments per se, of course, are utilized so that after excessive wear the molds can be changed without the necessity of changing a whole roll. While in this instance the transverse distance (length) of a pocket 21,22 is shown as lesser than the longitudinal distance (width) of a pocket 21,22, the opposite could as well be true, or both distances could be equal. On the other hand, while only a single pocket 21,22 is aligned in the transverse direction on a roll, a plurality thereof could be so aligned without changing the nature of the present invention. It, of course, follows that the shape of the issuing briquettes is determined by the shape and positioning of the pockets 21,22.

The individual pockets 21,22 are arranged so that a pocket 21 overlaps the corners of a pair of pockets 22, as the pockets of one roll come into contact with the pockets of the other. Thus, in producing series of briquettes of alternating-D cross section, a pocket 21₁ overlaps, or will overlap, in part both of pockets 22₁, 22₂, a pocket 21₂ overlaps in part with both of pockets 22₂, 22₃, and a pocket 21₃ overlaps, or will have overlapped, in part both of pockets 22₃, 22₄ and so on ad infinitum, as the rolls 11,12 are rotated. The overlapping thus produces both areas of overlap and areas of nonoverlap. It has been found that the areas or edges of overlap in the series of briquettes are less compacted, and therefore less dense, than webs formed in conventional operations wherein webbed spaces are maintained between briquettes.

The pockets of D-shaped cross section are so arranged that the ends of the individual briquettes, upon discharge from the rolls 11,12, are pulled in alternately one direction and thence in the other. The direction of these alternately applied forces, as shown by the smaller arrows, tend to pull individual briquettes from the pockets 21,22 upon emergence. Release is thus assisted. String breaking is also aided by the alternating directions of pull. For these reasons it has been found that series of D-shaped briquettes are readily severed through the overlapped edges or segments. The break is in a narrow plane, the direction of which is transverse to that of the issuing series.

An analysis of conditions and forces at the time of briquette formation, and in the resultant product at the locations of overlap, is believed to explain these marked improvements. The partial overlap between the pockets relieves the excessive pressure conventionally generated at the pinched edges. This results in less dense compaction, this producing less cohesion of the individual particles, and consequently less mechanical strength at an overlap (Dim. A).

In addition to these advantages, roll wear is reduced. Moreover, indexing of the rolls is less critical and there is increased throughput for a fixed roll diameter as contrasted with one containing a fixed number of pockets of similar shape.

In an improved briquetting roll design the edges of the mold segments, between the voids or pockets of the pair of rolls, as shown by reference to FIG. 4, is provided with a raised surface 23,24—viz., 23₁ to 23_n and 24₁ to 24_n—which extends into a void or pocket on the opposite roll, as it revolves into position. A projection or protrusion 23,24 ranges generally from about ¼ to about ½ as high as the pockets are deep. Also, the protrusion ranges from about ¼ to about ½ as wide as the pockets, and from about ¼ to about ¾ as long. Preferably, the protrusion is symmetrical in shape to the concave pocket in the opposite roll and in operation to two rolls are aligned so that the

protrusion projects approximately into the center of the concave pocket of the opposite roll. The precise shape and location of the protrusion may be altered, but the effect is to improve the release of the molded briquettes from the rolls. The protrusions break bridges normally set up when pressing or molding the solids into shapes of concave cross section, thus giving a denser and faster melting briquette, especially when deep pockets are used. This also gives improved throughput without the problems associated with pillow briquettes. In addition, the grab characteristics of the pair of rolls is improved.

It is immaterial, in principle, whether the partial overlap is in longitudinal or transverse direction. Likewise, the overlap can be at the corners of briquettes produced by mold segments so arranged on the rolls to produce such an effect. Conventionally, however, the overlap is in the longitudinal direction along a whole edge, and in such configuration a conventional string breaker readily produces severance of the issuing series of briquettes.

In actual operation, particulate reduced iron powder (95+ percent metallized) from a fluidized iron ore reduction process, at 1300° F., was subjected to a roll force of 150 tons to produce series of alternating briquettes of D-shaped cross section, as described by reference to the preceding figures. Overlap between the individual briquettes was 13 percent. The resultant briquettes were readily released from the mold pockets using only a minimum of lubricant, and string breaking was quite effective.

A porosity of 15 percent (internal void volume relative to total volume) was achieved whereas under similar conditions pillow-shaped briquettes of 25 percent porosity were produced. The production rate in producing the D-shaped briquettes was 90 weight percent as great as in producing the pillow-shaped briquettes despite the greatly reduced porosity of the D-shaped briquettes.

It is apparent that various modifications and changes can be made without departing the spirit and scope of the present invention.

Until now the breaking of briquette strings has been a serious problem. This is particularly true with low porosity briquettes and briquettes having a relatively thick web between the briquettes. The thicker the web the harder it is to break the string. Conversely, mold wear is greater when the web is made thinner to ease the string breaking problem.

String breaking is not a problem when using the present alternating "D"-type rolls. Any slight interruption of the string flow causes the briquettes to separate. Increase in overlap thickness increases throughput and decreases roll wear along with the elimination of the web between the briquettes. The string of briquettes are readily broken into individual briquettes. This ease of string breaking is not affected even when the thickness of the overlap is quite high. The thickness of the overlap, however, aids greatly in reducing roll wear.

Having described the invention, What I claim is:

1. In roll press apparatus for serially compressing particulate metal into briquettes wherein is included
 - a pair of cooperating rolls, one face of which is in operative association with the other, mounted for rotation in opposite directions about their respective axes,
 - a plurality of circumferentially uniformly spaced mold pockets located in the face of each of the rolls,
 - drive means for rotating the rolls,
 - and feed means for charging the particulate metal into the nip of the pair of rolls,
 the improvement comprising
 - providing a series of mold pockets in each of the rolls, said mold pockets being uniformly spaced apart, one from the other, around the roll circumference so that on rotation of said pair of cooperating rolls, roll pockets of one roll partially overlap pairs of pockets on the opposite roll in the longitudinal direction of a roll, said overlap ranging from about 1 to about 20 percent of the total longitude of the overlapped and nonoverlapped segments.
2. The apparatus of claim 1 wherein the overlap ranges from about 5 to about 15 percent.

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3. The apparatus of claim 1 wherein the edges of the rolls, between the separated mold pockets, are provided with projecting surfaces which extend into the pockets of the opposite roll as the rolls are rotated.

4. The apparatus of claim 3 wherein the projections range in

height from about one-fourth to about one-half as high as the pockets of the opposite roll are deep, as wide as from about one-fourth to about one-half as wide as said pockets, and from about three-fourths to about seven-eighths as long.

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