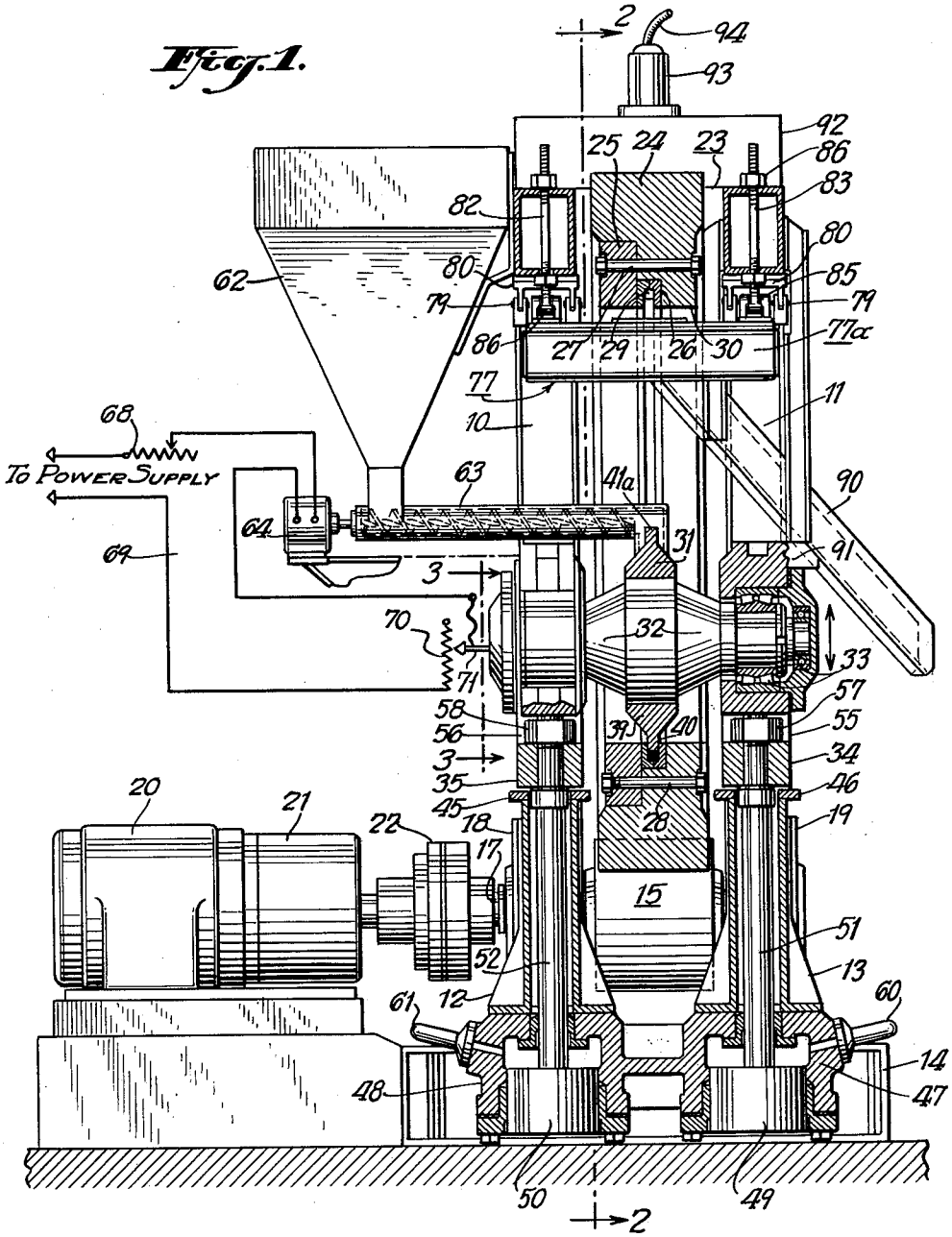
March 17, 1964 J. A. JACKSON ETAL 3,124,837

RING-ROLLER PRESSURE MOLDING OF METAL POWDERS AND THE LIKE

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Fig. 1.



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Fig. 4.

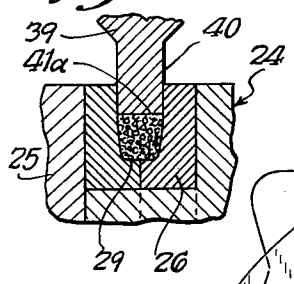


Fig. 2.

Fig. 3.

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RING-ROLLER PRESSURE MOLDING OF METAL POWDERS AND THE LIKE

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This invention pertains to methods and apparatus for rapidly compacting and molding finely comminuted, metal powders, metallic concentrates and the like, under high pressure and as a progressive and continuous operation, into relatively dense and strong molded sections, of a desired size convenient for handling and for minimizing oxidation and breakage in storage, shipment or handling.

The invention is especially adapted to the compacting of the finely divided metallic iron concentrates resulting from the low temperature reduction of iron ore and the like without fusion in the presence of hot combustible gases and a solid carbonaceous reductant, such as coke, char, etc., as described, for example, in U.S. Patent 2,829,042, to O. Moklebust, followed by concentration of the metallic iron values by conventional separating and concentrating operations, as by screening, grinding, magnetic separation, etc.

It has heretofore been the practice to compact the finely comminuted metallic iron concentrate thus obtained by pressing into briquettes by means of a plunger-actuated press. But this has the disadvantages of requiring intermittent weight feeding of the powdered concentrate into the press and batch type pressure molding therein, which is time consuming. Also the capacity of each press is limited by the size and weight of the briquettes formed which must be such as to permit ease of handling. This multiplies the number of presses required for high tonnage operations.

In accordance with the present invention, these drawbacks are eliminated by molding the powders as a progressive and continuous operation in a rotary mold into which the metallic powders are continuously fed and from which the molded sections are continuously discharged. The rate of powder feed and speed of the press may be varied in accordance with the tonnage to be handled.

In its essentials, the rotary powder molding press of the invention comprises in its preferred embodiment, a roll member having a medially disposed upstanding rib or flange of smooth surfaced, substantially cylindrical contour, extending peripherally thereabout, and a ring member of larger diameter having a medially disposed annular groove on its inner surface, formed substantially complementary to said roll flange for reception of the same. The roll and ring members are rotatably mounted on parallel axes with the roll member disposed within the ring member and with the roll flange extending into the ring groove and tracking therein during rotation.

The ring member is preferably rotatably supported with its axis horizontal, on a pair of spaced and horizontally disposed rolls, between which it is cradled, at least one of these rolls being motor driven, for frictionally driving and rotating the ring member, which in turn rotates the roll member.

During operation, the metal powders to be molded are fed continuously from a hopper, preferably by means of a motor driven, screw feeder into the ring groove adjacent the input side of the roll member for compression between these members within the groove, being thus molded to the shape of the groove by pressure of the roll flange exerted thereon. Mounted on the output side of the roll member is a stripper having a sharp-edged tongue which rides upon the base of the ring groove and thus

strips the densely molded material from the groove in the form of arcuate segments which are broken off in random fashion under the stripping action and discharged into a chute.

The roll member is journaled in bearing blocks which are vertically displaceable along upstanding frame guides, the frame being also provided with abutments on which the bearing blocks normally seat under gravity to provide maximum penetration of the roll flange into the ring groove. During the ring-roller molding of the powder, however, the roll member tends to be upwardly displaced thereby. In order to control the extent to which this occurs and also to maintain a preselected molding pressure on the powders, the bearing blocks for the roll member are held down by rod linkages to a pair of hydraulic pistons operating in cylinders located at the base of the apparatus into which hydraulic fluid is introduced under a preselected pressure atop the pistons. This pressure is adjusted to impart a desired degree of compression, density and sectional thickness to the molded powders.

In the event that the powder feed rate should become sufficiently great as to thrust the roll flange upwardly to too great an extent, or such as to cause the roll flange to ride out of the ring groove despite the hydraulic hold-down action referred to, or should an obstruction be encountered which causes this, there is mounted on one of the roll member bearing blocks, a contact arm of a variable resistance included in the power supply circuit of the screw feeder motor. The connections are such that elevation of the roll member progressively increases the amount of resistance thus included in the motor's power supply circuit, thereby progressively to decrease its speed and correspondingly the rate of powder feed. Additionally, if the roll member is thrust upwardly an excessive amount, the contact arm on the bearing block rides beyond the upper end of the resistance element and thereby opens the motor circuit to stop the motor. The motor circuit also includes a manual control for setting the motor speed as desired.

In order to assure adequate contact pressure between the ring member and the motor driven roller on which it is supported, for frictionally driving the ring member, an hydraulic cylinder is mounted atop the frame, which actuates a plunger to which is journaled a hold-down roll which rides upon the ring member.

Having thus described the essentials of the invention in general terms, reference will now be had to the accompanying drawings for a more detailed description, wherein:

FIGURE 1 is a transverse sectional elevation of a preferred apparatus according to the invention as taken at 1—1 of FIG. 2; while FIGURE 2 is a sectional side elevation thereof as taken at 2—2 of FIGURE 1. FIGURE 3 is a fragmentary side elevation of the apparatus as taken at 3—3 of FIGURE 1, and FIGURE 4 is an enlarged fragmentary transverse sectional detail through the ring groove and roll flange assembly.

Referring to the drawings, the ring roller press of the invention comprises a pair of spaced, upstanding hollow frame members 10, 11, secured to a pair of correspondingly spaced lower frame members 12, 13, the latter mounted in a base 14. Between the lower frame members are disposed a pair of rollers, 15, 16, mounted on shafts 17, 17a, the opposite ends of which are journaled, as at 18, 19, FIG. 1, to the lower frame members 12, 13. An electrical motor 20, is coupled through suitable gearing, as at 21, and a conventional coupling device 22, to the shaft 17 of roll 15 for driving the same. Roll 16 functions as an idler roll.

Supported upon and cradled between the rolls 15, 16, is the above-mentioned ring member 23, which as shown

in FIG. 1, comprises an assemblage of three ring members 24, 25, 26, bolted together as at 27, 28. The largest ring member 24 is cut away as shown for assemblage therewith of the smaller ring members 25 and 26, the latter being substantially U-shaped in transverse section as shown, and being frictionally held in place between the larger ring 24 and the smaller insert ring 25, by means of the bolts 27, 28. As thus assembled as shown, the insert ring 26 provides a medially disposed annular groove, as at 29, which extends about the interior surface 30 of the ring assemblage 24, 25, 26, comprising the ring member 23.

Rotatably mounted within the ring member 23, on an axis parallel thereto, is a roll member 31 of considerably smaller diameter. The roll member 31 is secured to a shaft 32, which is journaled at its opposite ends through roller and ball bearings, as at 33, to bearing blocks, as at 34, 35. Referring to FIG. 3, these bearing blocks, one of which is shown at 35, have integral therewith, a pair of oppositely disposed guide members, as at 36, 37, which are substantially U-shaped in transverse section, and into which extend the inner edges, respectively, of a pair of upstanding and oppositely disposed frame members 38, 39, mounted on one of the frame members, as at 12, the opposite bearing block 34, being similarly supported on the opposite frame member 13. By reason of this construction, the entire roll member assembly 31–35, inc., may be displaced upwardly or downwardly within limits, by the sliding action of the guides, as at 36, 37, along the fixed frame members as at 38, 39.

Reverting to FIG. 1, the roll member 31, tapers to a medially disposed and peripherally extending flange 40, of smooth cylindrical outer contour, as at 41*a*, and which is of a configuration substantially complementary to that of the annular groove 29 of the ring member 23. The relative mounting of the roll and ring members is such as shown in FIGS. 1, 2 and 4, that the roll flange 40 penetrates the ring groove 29, over a lower segment of the former.

Normally the bearing blocks 34, 35, rest on the upper edges 45, 46, of the lower frame members 12, 13, to provide maximum entry of the roll flange 40 into the ring groove 29, in the manner illustrated in FIG. 4 below which the ring groove 29 has inwardly sloping side walls and rounded corners at the base, as shown, to facilitate stripping the molded material from the groove. In order to control the depth of penetration of the roll flange 40 into the ring groove 29, during the powder molding operation, and also to maintain a constant molding pressure on the powders, as above referred to, hydraulically actuated hold-down means are connected to the bearing blocks 34, 35. These comprise a pair of hydraulic cylinders 47, 48, mounted in the base 14, within which are enclosed pistons 49, 50, connected to piston rods 51, 52, which extend upwardly through the frame portions 12, 13 and through bores in the bases of the bearing blocks 34, 35. As shown in FIGS. 1 and 3, these bearing blocks have formed therein, transversely extending substantially rectangular slots, as at 55, 56, for reception of nuts, as at 57, 58, which are threaded into the upper ends of the piston rods 51, 52. The hold-down action is accomplished by the introduction of fluid under a preselected pressure into the cylinders 47, 48, through the conduit connections 60, 61, the fluid being thus introduced under pressure on the upper surfaces of the pistons 49, 50, and thereby tending to force them downwardly at all times.

The metal powders or powdered metallic iron concentrate to be ring-roller molded, is fed from a hopper 62 into a screw conveyor 63, driven by a motor 64, from whence it is discharged into a chute 65, and discharged thence into the ring groove 29, as at 66, on the input side of the roll member 31 as illustrated in FIG. 2. As above explained, the ring member 23 is driven through frictional engagement with roll 15 which in turn is driven by the motor 20. As the ring member is thus rotated in the direction shown in FIG. 2, carrying with it the metal powder 66 deposited in the ring groove 29, it is fed thus beneath the roll flange 40, thereby causing the roll member 31 to be rotated in the same direction as the ring member and thus mold the powder to the dense, compressed state shown at 67, conforming to the shape of the groove and frictionally adhering thereto as a result of the high molding pressure applied. Also as above explained, the molding pressure exerted stems from the hold-down action of the pistons 49, 50, due to the hydraulic pressure exerted thereon.

The thickness of the molded powder section 67 is dependent on the rate of powder feed at 66, also on the degree of hydraulic pressure exerted on the pistons 49, 50, and also on the speed of rotation at which the ring member 23 is driven. For any given set of these conditions, the roll member 31 will automatically be elevated against the hold-down action of the pistons sufficiently to handle the rate of powder feed. The rate of powder feed is determined by the speed of the motor 64, which is regulated by manual adjustment of a rheostat 68, connected in the motor power supply circuit 69. Should the feed rate be too great in relation to the other variables above mentioned, the roll member 31 may be elevated to such an extent as to cause its flange 40 to rise completely out of the ring groove 29, whereby the molding action would cease due to outflow of the powders. In order automatically and progressively to reduce the powder feed rate as the roll member is thus elevated and to disconnect the screw feeder motor if the upward displacement of the roll member exceeds a preselected safe upper limit, there is serially connected in the motor supply circuit 69, a variable resistance 70, adjustable by a contact arm 71, mounted on the bearing block 35. With the connections as shown, elevation of the bearing block will progressively increase the amount of resistance 70, included in the motor supply circuit 69, and thereby increasingly slow down the motor and the powder feed rate. If the roll member 31 is thrust upwardly beyond the preselected limit referred to, the contact arm 71, will ride off the upper end at resistance 70, and thus open the power supply circuit 69 to stop the motor and powder feed.

Referring to FIG. 2, during the powder molding and pressing operation, the roll flange 40 is continuously moistened with water fed at a dripping rate thereon from a supply pipe 75. This moistens the powder 66 and prevents it from squirting out between the roll flange and ring groove side walls during pressing, and thereby minimizes dusting and recycling of the powders otherwise required.

Also in order to minimize adherence of the molded material 67 to the base and sides of the ring groove 29, and thereby facilitate stripping of the molded material from the groove, a lubricant, such as a water and oil emulsion is sprayed into the rig groove over a pipe line 76, and at a point 76*a*, just in advance of the powder supply chute 65 as shown.

For segmentally stripping the molded section 67 from the ring groove, a stripping unit is provided. This consists of a stripping element 77, having a weighted terminus 77*a*, which extends between the frame members 10, 11 as shown in FIG. 1, and which has integral with its opposite ends, a pair of arms as at 78, the ends of which are pivotally secured, as at 79, to lugs, as at 80, mounted on the undersides of the frame members in the manner shown in FIG. 2. At their inner ends these arms are also pivotally secured, as at 81, to the lower ends, respectively, of a pair of rods 82, 83, which extend through the upper portions of the frame sections 10, 11, and which are secured thereto by upper and lower nuts, as at 85, 86.

Medially disposed along the weighted element 77*a*, is a prong-like member 87, provided with a sharp outer edge which projects against the base of the ring groove 29, and thus strips the molded section 67 out of the groove in segments of random lengths in the manner illustrated at 88. The pressure with which the prong member 87 engages the base of the ring groove is adjusted by appro-

priate adjustment of the upper and lower nuts, as at 85, 86, along the rods, as at 83, thus to swing the stripping element 77 about the outer pivot points of the arms, as at 79. The molded segments 88 fall down a chute 90 and are discharged thence to the exterior.

Since the weight of the ring member 23 may not be sufficient under all molding conditions of the powder, to avoid slippage between the ring member and its driving roll 15, a hydraulically actuated hold-down roll for the ring member is provided. Thus mounted on top of the frame members 10, 11, and spanning the same, is a frame section 92, on which is mounted an hydraulic cylinder 93, supplied with hydraulic fluid under pressure over line 94, and which thereby actuated a plunger 95, to which is pivoted a hold-down roll 96, which rides upon the ring member 23 as shown. Also rotatably mounted on the frame members 10, 11, are side guide rolls for the ring member as at 97, 98.

As above stated the outer periphery 41*a* of the roll flange 40 is of smooth cylindrical contour to assure that the molded section 67 is molded substantially to uniform density and strength throughout. It has been found that this facilitates stripping of the molded section into segments, as at 88, of reasonably uniform lengths, as applied to molded metal powders. It has been found that if the outer surface of the flange is provided with transversely extending ribs, for example, a greater compacting and welding of the metal powders occurs in the portions compressed by these ribs than in the intermediate portions, such that even though the rib-compressed portions are thinner, they are nevertheless stronger and hence breakage in stripping does not occur in these portions as would be anticipated. The reverse is the case where powders of brittle materials, such as coal or the like are molded. In the molding of such materials the strength of the molded sections is weakest in the rib depressed areas so that breakage in stripping occurs at these points.

What is claimed is:

1. Apparatus for pressure molding metal powders and the like, comprising: a peripherally flanged roll member and an interiorly grooved ring member of larger diameter, means rotatably mounting said members on parallel axes for adjustable axial spacing and with said roll flange penetrating said groove, said means including spaced rolls on which said ring member is rotatably supported, and vertically displaceable bearings for said roll member, hydraulic pressure actuated hold-down means urging said roll flange to maximum penetration in said groove under a preselected hydraulic pressure, means for concurrently rotating said members, means for continuously feeding said powders into said groove for compression therein between said members at said preselected pressure, and means for thereafter progressively stripping said compacted powder from said groove in self-sustaining arcuate segments, said powder feeding means including a variable speed motor for varying the rate of feed, a power supply circuit for said motor including a speed control for said motor, and an actuating arm for said control mounted on one of said bearings for actuating said control to reduce the motor speed as said bearing is raised, and for opening said supply circuit to stop said motor at a preselected elevation of said bearing.

2. Apparatus for pressure molding metal powders and the like, comprising: a peripherally flanged roll member and an interiorly grooved ring member of larger diameter, means rotatably mounting said members on parallel axes, for adjustable axial spacing and with said roll flange penetrating said groove, said means including spaced rolls on which said ring member is rotatably supported, and a pair of vertically displaceable bearings for said roll member, a first hydraulic pressure actuated hold-down means linked to one of said bearings, a second hydraulic pressure actuated hold-down means linked to the other one of said bearings, said actuated hold-down means being individually controlled for urging said roll flange to maximum penetration in said groove, means for concurrently rotating said members, means for continuously feeding said powders into said groove for compression therein between said members, and means for thereafter progressively stripping said compacted powder from said groove in self-sustaining, arcuate segments.

3. Apparatus for pressure molding metal powders and the like according to claim 2 wherein said powder feeding means comprises a variable speed motor for varying the rate of feed, a power supply circuit for said motor including a speed control for said motor, and an actuating arm for said control mounted on one of said bearings for varying said motor speed in accordance with the vertical displacement of said bearings.

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