Aug. 18, 1964 T. KRANTZ ETAL 3,144,681

APPARATUS FOR ROLL COMPACTING METAL AND METAL COATED PARTICLES

Filed May 14, 1962 2 Sheets-Sheet 1

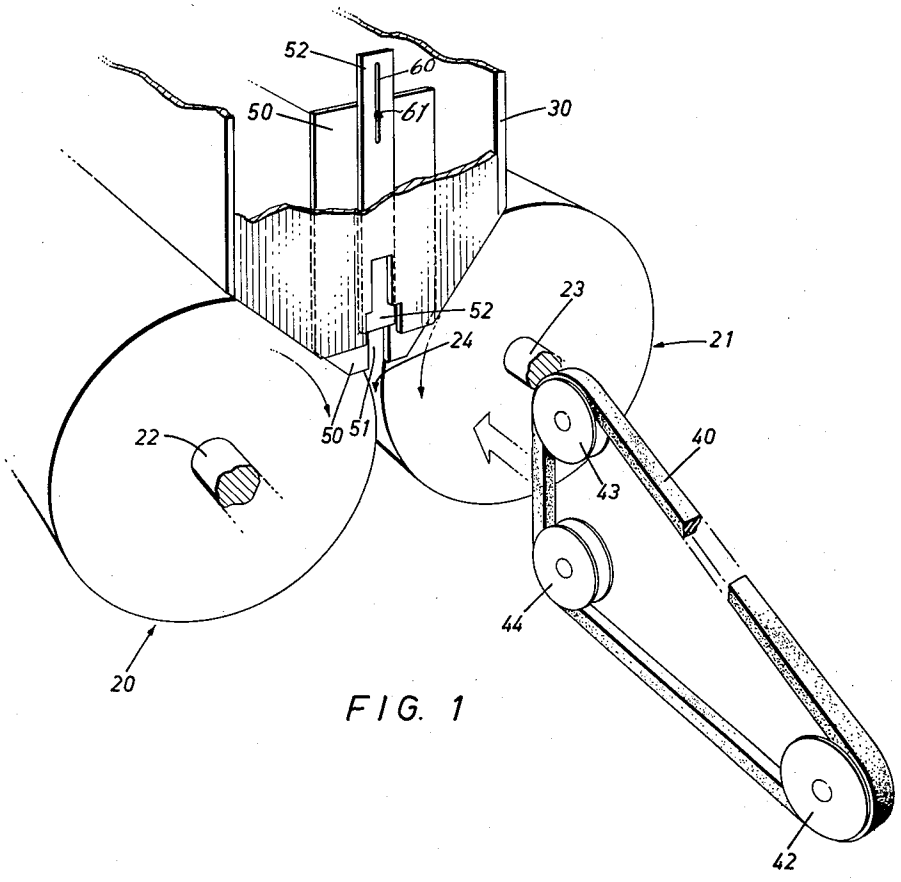


FIG. 1

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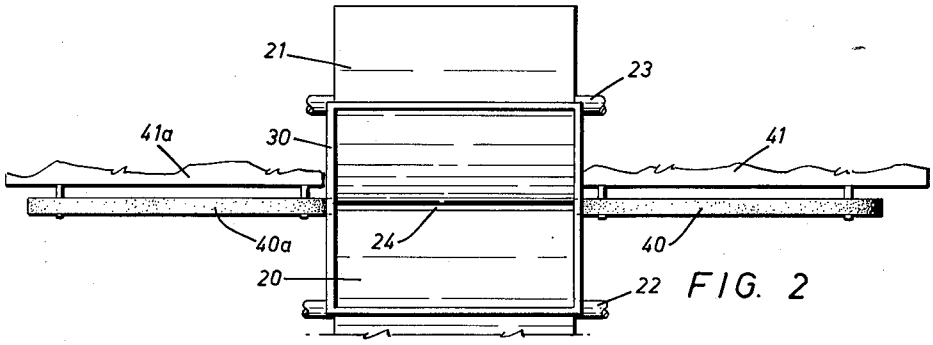


FIG. 2

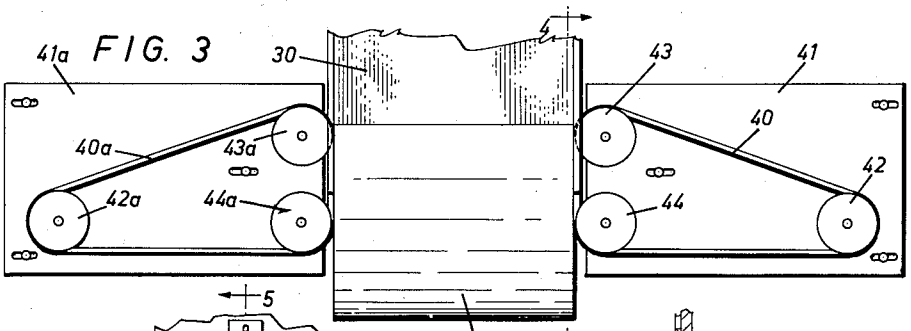


FIG. 3

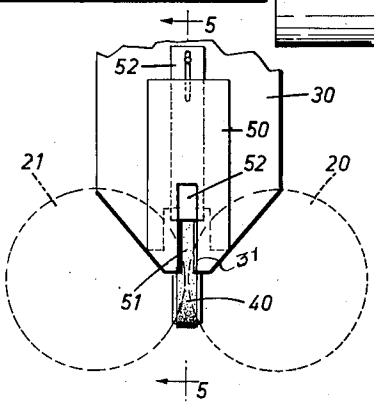


FIG. 4

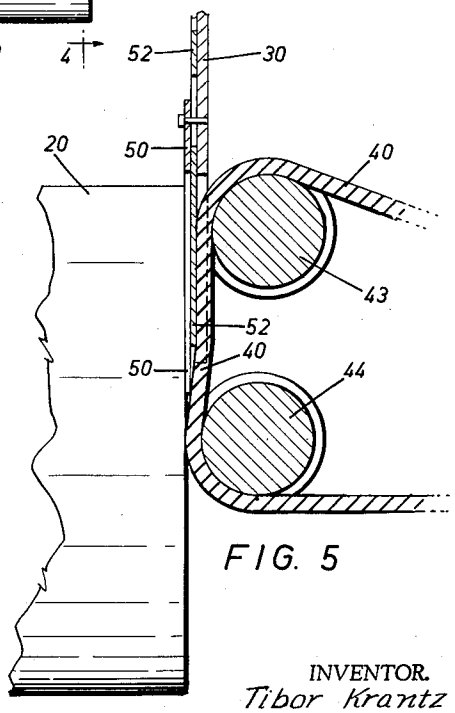


FIG. 5

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APPARATUS FOR ROLL COMPACTING METAL AND METAL COATED PARTICLES

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4 Claims. (Cl. 18—9)

This invention relates to improvements in a roll compacting unit of the type employed for roll compacting metal powder into sheets and strips. The invention is particularly directed to the provision of improved means for confining metal powder to the roll gap and for closely controlling the density and compactness across the width of the strip or sheet.

Metal powder is compacted initially into a "green" shape, such as in the form of sheet or strip, by feeding it, usually at a predetermined, uniform rate, into the roll gap of a pair of oppositely positioned, horizontally disposed, pressure rolls. The rolls are spaced such that a self-supporting, partially densified "green" shape of desired density and thickness is produced. It is essential to produce a "green" strip or sheet which is of substantially uniform thickness, of substantially uniform density between its longitudinal marginal edges, and with closely controlled weight of metal powder per unit area in the marginal edge zones.

There is a problem in rolling metal powder by this method if the metal powder, during compaction, is not confined along the outside edges of the rolls in that metal powder tends to flow or leak from the edges of the rolls with the result that the longitudinal edges of the sheet or strip are not compacted to the same density, coherence and thickness as is the central portion thereof. Thus, compacted shapes formed without some provision for confining the metal powder within the roll gap must be trimmed along the edges, thereby necessitating an additional step in the overall process and resulting in the production of an appreciable percentage of waste material in addition to non-uniformity of physical characteristics of the product across its width.

Devices are known and used for confining the metal powder within the roll gap during the compacting operation and thus preventing flow or leakage from the ends of the rolls. One known device involves the use of flexible discs or flanges mounted at each end of one of the rolls or at one end of one roll and at the opposite end of the other roll. The so-mounted discs or flanges have a radius greater than the roll on which they are mounted by at least the width of the roll gap. The discs or flanges are pressed against the opposing faces of the ends of the roll at the roll gap and confine the metal powder within the roll gap during compaction of the particles, thereby preventing leakage of metal powder from the ends of the rolls. In one known arrangement, slightly flexible discs are used which are pressed against the opposing faces of the ends of the rolls at the roll gap and pressed away from the opposing faces of the ends of the rolls at a point beyond the roll gap, thus facilitating discharge of the "green" strip or sheet from the roll gap without friction or binding.

A further known arrangement for confining metal powder to the roll gap involves two rigid circular discs or flanges of a radius greater than the rolls by at least the width of the roll gap. A disc is mounted on the roll shaft at one end of one roll and a second disc is mounted on the roll shaft at the other end of the other roll. These discs or flanges are of a rigid type and are fitted against the opposing faces of the ends of the rolls.

The known arrangements are satisfactory insofar as confining the metal powder to the roll gap is concerned

but it is found that they create further problems. The discs or flanges are of a radius greater than that of the rolls on which they are mounted. Consequently, a disc mounted on the end of one roll overlaps the opposing end of the opposite roll. It is found in the operation of the roll compacting unit that the rolls tend to move relative to each other in the direction of their axes of rotation. This movement may only be very slight, of the order of, for example, from one to ten one-thousandths of an inch. However, it is sufficient for the discs to bind against the opposing faces of the ends of the rolls and wear grooves in the opposing faces of the discs. These grooves at least form defects in the longitudinal edges of the strip or sheet and may interfere with the smooth and unimpeded discharge of the compacted product from the roll gap. The unit must be shut down at frequent intervals to replace the flanges, which is costly and time consuming. Also, the flanges tend to draw more metal powder into the roll gap at the ends than flows by gravity into the gap between the ends, thus making it necessary to provide rather elaborate feeding devices to obtain a uniform flow of material from end to end of the roll gap.

We have found that problems of producing "green" strip or sheet from metal or metal coated particles of substantially uniform density and thickness between the longitudinal marginal edges can be overcome by providing a rotatable belt assembly at each end of the rolls, each belt having a flat surface pressed against opposing surfaces of the ends of the rolls from a point above the roll gap to the bottom of the roll gap. Each belt, preferably, is of the endless type and is extended over freely rotating pulleys, or sheaves, which are adjustably mounted to permit close adjustment of the belts against the opposing faces of the ends of the rolls with the axes of the lowermost pulleys mounted in the same horizontal plane, or slightly above, as the axes of the rolls.

The improved apparatus of this invention for compacting metal and metal coated particles comprises a pair of oppositely positioned rolls mounted on roll shafts for rotation in a horizontal plane, a roll gap between the rolls, and means for preventing leakage of metal particles from the ends of the roll gap which comprise a freely rotatable endless belt mounted at each end of the roll gap, each of said belts having a surface maintained in frictional engagement with the surfaces of the ends of opposing rolls from a point above to the bottom of the said roll gap, and means for maintaining the exposed surface of each of said belts in frictional engagement with the surfaces of the opposing ends of the rolls.

An understanding of the improved roll compacting unit of this invention can be obtained from the following description, reference being made to the accompanying drawing in which:

FIGURE 1 is a perspective view of an end of a pair of rolls of a roll compacting unit with the housing and frame removed showing the belt assembly shifted to the right to expose the roll gap and the lower part of the feed hopper assembly;

FIGURE 2 is a top plan view of the roll compacting unit with the belts in place;

FIGURE 3 is a front view showing the belts in their operative positions;

FIGURE 4 is a detail view taken along the line 4—4, FIGURE 3; and

FIGURE 5 is a detail view taken along the line 5—5, FIGURE 4.

Like reference characters refer to like parts throughout the description of the invention and the drawing.

As used herein, the term "metal particles" is intended to include, but is not necessarily limited to, particles of metal, metal alloy, composite metal and metal coated particles and compounds such as are produced by spray-

ing, mechanical attrition and precipitation from solutions by chemical reaction.

Referring to the drawing, the numerals **20–21** indicate rotatable rolls of the same length and diameter and of a conventional type used for roll compacting metal particles. In the modification illustrated, they are plain, or unprofiled, hard, ground steel rolls adapted to compact metal particles into sheet or strip. The rolls are mounted on shafts **22–23**, respectively, which are driven according to conventional practice, such as by an electric motor through a train of reducing gears. The rolls are formed of conventional material, such as steel and, conventionally, are adjustably mounted in exactly opposing relationship in a horizontal plane to apply a pressure on the particulate material fed into the space between the rolls, or the roll gap, indicated by the numeral **24**. Conventionally, provision is made to increase or decrease the width of the roll gap, thus to increase or reduce the thickness of the resulting strip or sheet, and to increase or reduce the pressure applied to the strip or sheet, thus to increase or reduce its "green" strength, adherency and density.

Metal particles are fed to the roll gap by gravity from a feed hopper **30** through the feed throat **31**. Provision can be made to increase or reduce the rate of flow of metal particles to the roll gap according to conventional practice.

A freely rotatable endless belt **40–40***a* is pressed against opposing surfaces of the ends of the rolls from a point above to the bottom of the roll gap. A preferred arrangement comprises a frame **41–41***a* which is secured to the frame in which the rolls **20–21** are mounted. The belt **40–40***a* preferably is an endless V-belt extended over freely rotatable pulleys or sheaves **42–42***a*, **43–43***a* and **44–44***a* which are adjustably secured to the frame **41–41***a*, the forward pulleys **44–44***a* being mounted with their axes of rotation in the same horizontal plane as the axes of the rolls **20–21** or slightly above, and the forward pulleys **43–43***a* being mounted substantially vertically above the pulleys **44–44***a* in a position such that the flat surfaces of the belts **40–40***a* are pressed in frictional engagement against the opposing faces of the ends of the rolls. Tension of the belts can be adjusted readily by adjustment of the pulleys in their mounting slots, not shown, which are provided for that purpose in the frames. The V-shaped portion of each belt preferably is deeper than the grooves of the pulleys so that the flat portions extend beyond the peripheries of the pulleys and the pulleys **43–43***a* and **44–44***a* are mounted such that their peripheries are spaced from the opposing ends of the rolls a distance less than the thickness of the belt so that the flat surfaces are pressed firmly against the opposing ends of the rolls.

An important feature of the improved apparatus of this invention is that means can be provided to control the flow of metal particles to the ends of the roll gap, thus to control the profile of the strip or sheet emerging from the roll gap as described in detail hereinafter. A preferred arrangement for controlling the rate at which metal particles are permitted to flow into the ends of the roll gap is illustrated in FIGURES 1, 4 and 5. The ends of the feed throat **31** of the feed hopper are slotted in order to permit the belts to be pressed against the ends of the rolls. A relatively thin strip **50**, formed of rigid material such as steel, is secured to each of the lower ends of the feed hopper and overlies the slotted portions of the feed throat. This strip **50** also is formed with a slot **51** which overlies the slot in the feed throat but is of a width slightly less than the width of the flat surface of the belt. This allows the belt to be pressed firmly against the end of the rolls without danger of being jammed in the roll gap with excessive wear. Also, it prevents loss of metal powder through the space at the interface of the belt **40** and the strip **50**. A second, relatively thin strip **52** of rigid material is adjustably secured to the lower part of feed hopper and underlies the strip **50**. The strip **52** is adjustable in a vertical plane so that it can be raised or lowered as desired to increase or reduce contact of the flat surface of the belt with the metal powder contained in the hopper. The strip **52** can be provided with an elongated slot **60** and set screw **61** by means of which it can be adjustably secured relative to the belts **40–40***a*.

In the operation of the improved roll compacting unit of this invention, metal particles are fed into the hopper **30** and flow by gravity to the roll gap. The strips **52** are adjusted to provide the desired rate of flow of particles to the edge zone of the gap. The belts **40–40***a* are pressed firmly against the surfaces of the ends of the rolls from predetermined points above the roll gap to the bottom of the roll gap. The belts are driven by the rolls with a minimum of wear. It is found that the quality of the marginal edges of the strip or sheet is improved if the surfaces of the belts are pressed as firmly as possible against the ends of the rolls.

The downward motion of the belts in contact with the ends of the rolls combined with the flow characteristics of the metal particles causes metal particles to be drawn downwardly at the ends of the roll gap. As the belts are pressed firmly against the ends of the rolls at the point of compaction and for a short distance above, very little, if any, particles escape from the ends of the roll gap. As a result, the strip or sheet is formed with marginal edges which are of substantially uniform thickness and density with close control over the weight of metal particles per unit area in the edge zones. By means of the strips **52**, it is possible to control the amount of belt surface exposed to the particles in the hopper **30** and thus vary the amount of particles drawn into the ends of the roll gap. By withdrawing the belts from contact with the ends of the rolls at the bottom of the roll gap, there is no binding on the marginal edges of the strip or sheet which is permitted to discharge from the roll gap as it is formed without danger of deformation.

A further advantage of the improved apparatus is that a "green" strip or sheet can be produced which has a predetermined unit weight profile across its width which conforms to that profile which is found to produce the best results in subsequent treatment, such as in hot or cold rolling. For example, it is found when the belt exposure is set to provide a slightly higher density along the marginal edges, improved results are obtained in a following hot working treatment of the strip or sheet. Cross-section profiles are obtained by plotting the weight of metal powder per unit area against the width of the strip or sheet. For example, we have produced strips in which the unit weight of the strip between the marginal edges was substantially constant at 7.6 grams, rising uniformly at the marginal edges to 8 grams. Heretofore, a desired profile could be obtained only by the distribution of the particles across the roll gap to produce a predetermined configuration by relatively complicated metal particle distributing devices or by shaping the surfaces of the rolls to produce the desired profile.

The improved roll compacting apparatus of this invention possesses a number of important advantages. The rate of flow of metal particles to the ends of the roll gap can be positively controlled, without leakage from the ends of the roll gap, to produce a strip or sheet having a desired profile. The marginal edges are clearly cut and are free from cracks. The strip or sheet is discharged freely from the roll gap without binding along its marginal edges. The belts are readily available and inexpensive and can be changed when worn with a shut-down of only several minutes.

It will be understood, of course, that modifications can be made in the preferred embodiment of the invention described and illustrated herein without departing from the scope of the invention defined by the appended claims.

What we claim as new and desire to protect by Letters Patent of the United States is:

1. Apparatus for compacting metal and metal coated particles which comprises a pair of oppositely positioned rolls mounted on roll shafts for rotation in a horizontal plane, a roll gap between the rolls, and means for preventing leakage of metal particles from the ends of the roll gap which comprises a freely rotatable endless belt mounted at each end of the roll gap; each belt having a surface maintained in frictional engagement with surfaces of the ends of opposing rolls from a point above to the bottom of the said roll gap; means for feeding metal particles to said roll gap; means for regulating the effective surface area of said belts in contact with the metal particles contained in said feeding means whereby the rate of feed of particles to the ends of said roll gap is controlled independently of the rate of feed of particles to the roll gap between the ends; and means for maintaining the exposed surface of each belt in frictional engagement with the surfaces of the opposing ends of said rolls.

2. Apparatus for compacting metal and metal coated particles which comprises: a pair of oppositely positioned rolls mounted on roll shafts for rotation in a horizontal plane and defining a roll gap therebetween; means for preventing leakage of metal particles from the ends of the roll gap which comprises a freely rotatable endless belt mounted at each end of the roll gap, each belt having a surface maintained in frictional engagement with surfaces of the ends of opposing rolls from a point above to the bottom of the roll gap; a feed hopper positioned above said rolls having a feed throat extending into said roll gap, means adjustable in a vertical plane between said feed throat and the portion of the belt above the roll gap for controlling the surface area of each belt exposed to the metal particles contained in said feed throat whereby the rate of flow of metal particles into the ends of said roll gap can be regulated; and means for maintaining the exposed surface of each belt in frictional engagement with exposed surfaces of the opposing rolls.

3. Apparatus for compacting metal and metal coated particles which comprises: a pair of oppositely positioned rolls mounted on roll shafts for rotation in a horizontal plane and defining a roll gap therebetween; means for preventing leakage of metal particles from the ends of the roll gap which comprises a pair of belt and pulley assemblies freely rotatable on axes perpendicular to the axes of rotation of said rolls, the periphery of one pulley being positioned at each end of one roll above the roll gap and the periphery of the other pulley being positioned at the bottom of the roll gap, each pair of pulleys being vertically aligned and spaced from the ends of the rolls a distance slightly less than the thickness of an endless belt extended thereover, the axis of rotation of each of the pulleys positioned at the bottom of the roll gap being in the same horizontal plane as the axes of rotation of the said rolls, a feed hopper communicated with the roll gap defined by said rolls and adapted to provide gravity feeding of metal particles to said roll gap, the end walls of said hopper being disposed at either end of said roll gap and having openings formed therein for entry of said belts; and means for varying the size of said openings in the end walls whereby the rate of flow of particles into the ends of said roll gap can be regulated.

4. A rolling mill for compacting metal particles comprising, in combination: a pair of compacting rolls horizontally disposed in parallel, spaced-apart relationship and defining a roll gap therebetween; a belt and pulley assembly disposed at each end of said roll gap with the belts in frictional engagement with the ends of said rolls and providing belt contact with said rolls from a point above said roll gap to the bottom of said roll gap; a feed hopper in communication with said rolls and adapted to feed metal particles to said roll gap, the end walls of said hopper being disposed at either end of said roll gap and having openings formed therein for entry of said belts for contact with the ends of said rolls; and adjustable means for regulating the surface area of the belts exposed to the metal particles contained in said feed hopper whereby the rate of flow of said particles to the ends of the roll gap can be regulated.

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