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APPARATUS FOR ROLLING METAL POWDER

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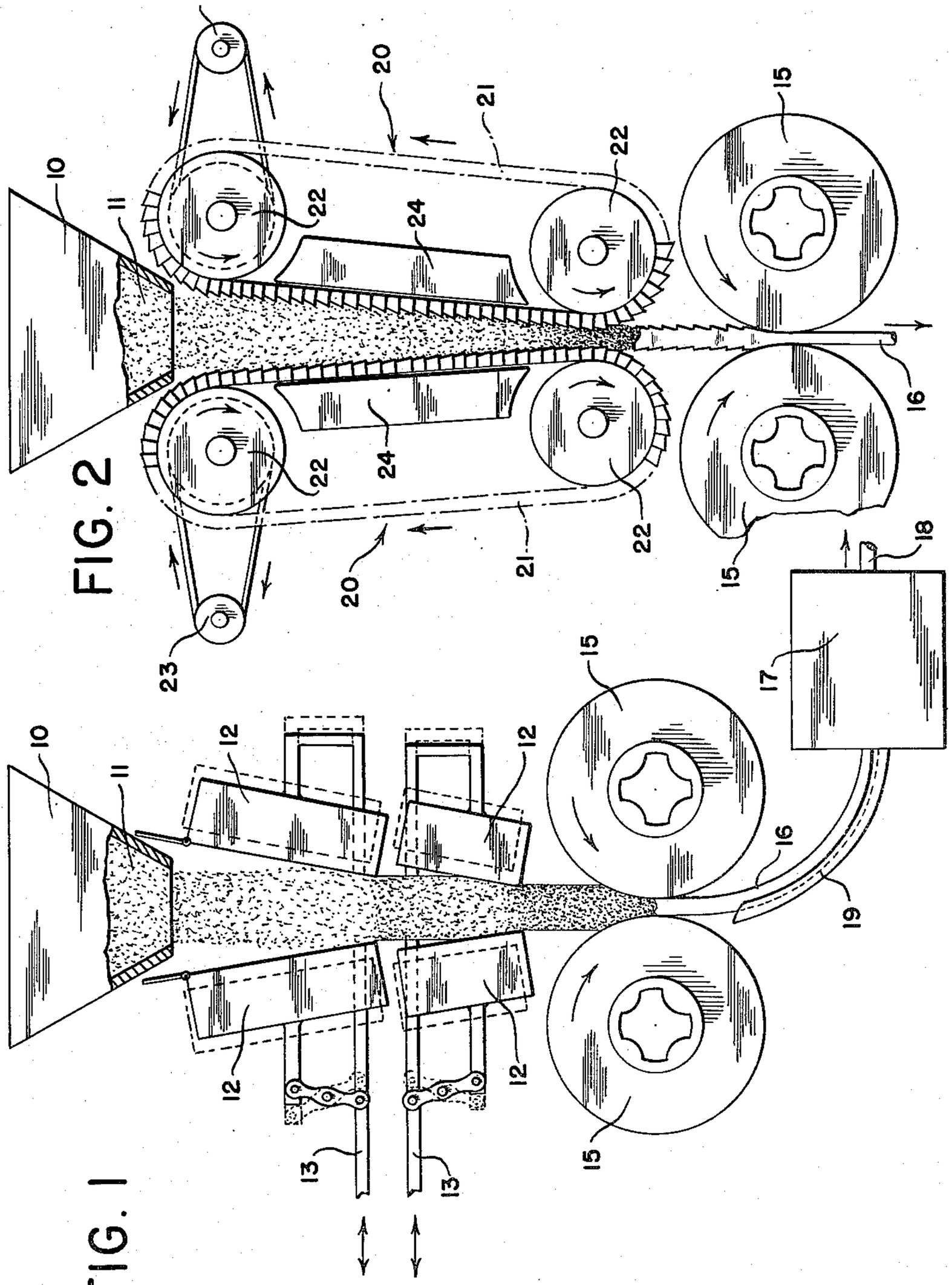

FIG. 2

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APPARATUS FOR ROLLING METAL POWDER

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This invention relates to an apparatus for converting metal powder into wrought metal shapes, such as metal sheets, strips, rods, wires and the like.

Metal powder has heretofore been rolled into wrought metal shapes by tightly compressing the powder between oppositely disposed, laterally spaced pressure rolls. The wrought metal shapes thus produced are invariably then sintered in a suitable furnace to produce metal products having a substantially coherent structure. The loose metal powder, which is introduced into the roll gap between the spaced rolls by means of a suitable hopper, is compacted by the rolls into a dense mass in which the individual particles of metal powder cling together with surprising tenacity. When metal powder is rolled in this manner, it is essential that the pressure rolls have a diameter many times larger than the thickness of the strip of compressed metal powder produced by the rolls. Because of the relationship between the diameter of the rolls and the thickness of the strip that can be compacted by such rolls, rolling apparatus adapted to produce a compressed metal strip lacks flexibility with regard to the thickness of the strip that can be produced thereby. Moreover, difficulty is experienced in producing a strip of compressed metal powder having uniform density and surface, due to the problems encountered in feeding loose metal powder directly to the rolls and having the rolls draw this loose powder uniformly and smoothly down into the roll gap to produce the compressed metal powder strip.

I have now found that, by precompacting loose metal powder into a lightly precompressed strip of metal powder prior to introducing the metal powder into the roll gap defined by the pressure rolls, I can produce a compressed powdered metal strip uniform in density and surface, and in a wider range of thickness of strip than has heretofore been produced by a pair of pressure rolls of a given diameter. Moreover, I have devised a novel apparatus for producing wrought metal shapes which includes means for lightly precompressing the loose metal powder into a strip unsuitable for sintering, and means for tightly compressing the strip thus produced into a strip suitable for sintering into a substantially coherent strip of metal. The apparatus of the present invention comprises compactor means for compacting loose metal powder into a lightly precompressed strip, and a pair of oppositely disposed laterally spaced pressure rolls defining a roll gap the width of which is less than the thickness of the lightly precompressed strip of metal powder prepared by the compactor means. The compactor means advantageously comprises at least one pair of convergent compactor elements each of which is disposed at an acute angle to the common axis of the pair of elements whereby the elements define between them a truncated V-shaped passageway adapted to compress loose metal powder fed into the wide end of the passageway into a lightly precompressed strip of powder that is discharged from the narrow end of the said V-shaped passageway.

For a more detailed description of the invention, reference may be had to the drawings in which:

FIGURE 1 is a schematic view of an embodiment of my invention in which the convergent compactor elements comprise oppositely disposed reciprocating plates; and

FIGURE 2 is a schematic view of another embodiment

of my invention in which the compactor elements comprise a pair of link belts mounted for convergent travel.

In the embodiment of my apparatus shown in FIGURE 1, a hopper **10** feeds loose metal powder **11** into the space between a pair of oppositely disposed laterally spaced convergent compactor elements **12**. In the apparatus shown, two pairs of compactor elements **12** in axial alignment comprise the compactor means of my invention. Each compactor element **12** is disposed at a slightly acute angle with respect to the common axis of the pair of elements so that the pair defines a truncated V-shaped passageway. The common axis of the pair of elements is the axis of symmetry lying between the pair.

The compactor elements **12** of each pair are movable laterally with respect to each other and means **13** are provided for moving these compactor elements in synchronization alternately toward and then away from each other. The amount of lateral movement of the compactor elements **12** is regulated so that the loose metal powder **11** introduced into the passageway between the compactor elements is lightly compressed by these compactor elements when they move toward each other. The compacting pressure exerted by the compactor elements on the loose metal powder necessary to form a lightly precompressed metal powder strip will depend upon the kind, the degree of subdivision and the cohesive properties of the metal powder employed as well as the thickness of the strip to be produced. The lightly precompressed strip of metal powder should have sufficient mechanical strength to retain its form while being introduced into the pressure rolls, but should not be so tightly compressed as to be suitable for direct sintering into a substantially coherent strip of metal.

The lightly precompressed metal powder emerging from the discharge end of the V-shaped passageway defined by the compactor elements **12** is introduced into the roll gap defined by a pair of oppositely disposed, laterally spaced pressure rolls **15**. The diameter of each of these pressure rolls is many times larger than the width of the strip of metal powder introduced thereinto. The width of the roll gap defined by the pressure rolls **15** is appreciably less than the thickness of the lightly precompressed strip of powder which is, of course, determined by the lateral spacing of the compactor elements **12** at the discharge end of the passageway defined thereby. Thus, the lightly precompressed strip of metal powder produced by the convergent compactor elements **12** is tightly compressed by the pressure rolls **15** into a strip **16** suitable for sintering in a sintering furnace **17**.

The sintering furnace **17** sinters the tightly compressed strip of metal powder to form a substantially coherent strip of metal **18** suitable for many purposes, including subsequent cold rolling to reduce the sintered strip to a solid bar, rod, or wire of the parent metal. In the apparatus shown in FIG. 1, the sintering furnace **17** is offset to one side of the vertically aligned compactor means **12** and pressure rolls **15**, necessitating the use of a guide trough **19** having a relatively large radius of curvature to guide the tightly compressed strip of powder **16** into the furnace **17**.

In the embodiment of my invention shown in FIGURE 2, the compactor means comprises a pair of oppositely disposed laterally spaced compactor elements **20** each comprising a link belt **21** mounted to travel around a pair of supporting wheels **22**. The compactor elements **20** are disposed at a slight acute angle to the common axis of the pair of elements so that a truncated V-shaped passageway is defined by the adjacent outer surfaces of the links in the link belts **21**. The outer surfaces of the links in the link belt **21** form substantially continuous pressure surfaces adapted to compress loose metal powder received in the V-shaped passageway into a lightly precompacted

metal powder strip. Drive means **23** are provided for rotating the wheels **22** so that the adjacent surfaces of the link belts **21** will move downwardly toward the narrow end of the passageway defined by said adjacent surfaces at the same rate of speed, thus insuring uniform compaction of the powdered metal.

The wheels **22** on which the link belts **21** are mounted are advantageously laterally adjustable so that the width of the wide entrance and the narrow exit end of the convergent V-shaped passageway may be adjusted as circumstances warrant. The under sides of the link belts extending between the wheels **22** are provided with support members **24** adapted to support the pressure surfaces of the link belts employed in the compressing operation. The links of the link belts **21** advantageously overlap each other slightly to provide the pressure surfaces of the link belts with a saw-tooth configuration that facilitates the precompression of the metal powder by drawing the loose powder evenly downwardly into the converging passageway defined by the link belts of the compactor elements **20**.

The convergent compactor elements **20** of my apparatus lightly precompress the loose metal powder **11** into a strip having moderate mechanical strength and not sufficient density to be successfully sintered into a substantially coherent metal strip. The lightly compressed strip of metal powder discharged from the compactor elements **20** is introduced into the roll gap of a pair of oppositely disposed, laterally spaced pressure rolls **15**. The width of the roll gap defined by the pressure rolls **15** is appreciably less than the thickness of the lightly precompressed strip of metal powder introduced thereinto. The width of the precompressed strip of metal powder, of course, is determined by the lateral spacing of the convergent compactor elements at the narrow end of the V-shaped passageway defined thereby. The pressure rolls thus further compress the lightly precompressed strip of metal powder into a dense strip of tightly compressed powdered metal **16** suitable for sintering in a sintering furnace (not shown).

Advantageously, a strip of elastically deformable material is introduced between the pressure rolls **15** and the metal powder being compressed thereby in the manner described in the copending application of Gerhard Naeser, Serial No. 417,322, filed March 19, 1954, and now abandoned. By the use of such an elastically deformable material in rolling metal powders, undesirable sidewise spreading of the compressed metal strip is avoided as described in the aforesaid application.

The apparatus of the present invention may be used to compress many different metal powders, such as copper, iron, lead, nickel, cobalt, and the like, into wrought metal shapes. Various mixtures of metal powder may also be used to produce metal alloys.

Although various changes and modifications may be made in the particular constructions illustrated and described without departing from my invention, I presently prefer to employ the embodiment of my invention shown in FIGURE 2.

I claim:

1. Apparatus for converting metal powder into wrought metal shapes comprising at least one pair of oppositely disposed laterally spaced convergent vertical compactor elements, each of said compactor elements comprising an endless link belt mounted to travel about a pair of supporting wheels, the adjacent outer surfaces of said link belts forming substantially continuous pressure surfaces inclined at an acute angle to the common axis of said pair of compactor elements whereby said adjacent pressure surfaces define a truncated V-shaped passageway, means for moving said link belts at the same rate of speed and in opposite directions so that said adjacent pressure surfaces travel uniformly toward the narrow end of the truncated V-shaped passageway defined by said compactor elements for compacting loose metal powder into a lightly precompressed strip of metal powder having sufficient mechanical strength to retain its form while being introduced into a pair of pressure rolls but not of a sufficient density to be successfully sintered into a substantially coherent metal strip, a metal power feed hopper adapted to introduce loose metal powder into the wide end of said truncated V-shaped passageway, and a pair of oppositely disposed laterally spaced pressure rolls having the axis of the rolls disposed in a horizontal plane defining a roll gap the width of which is appreciably less than the width of the narrow end of the passageway defined by said compactor elements for compacting the lightly precompressed strip of metal into a compressed strip of metal of a sufficient density to be successfully sintered into a substantially coherent metal strip, said pressure rolls being disposed adjacent the narrow end of said compactor elements with the roll gap in alignment with the truncated V-shaped passageway defined by said compactor elements.

2. Apparatus according to claim 1 in which one edge of each link in said link belt overlaps one of the adjoining links while the opposite edge of said link is overlapped by the other of the adjoining links in said link belt.

3. Apparatus according to claim 1 in which the pair of compactor elements are laterally adjustable with respect to each other whereby the width of the truncated V-shaped passageway defined by said compactor elements may be adjusted.

4. Apparatus for converting metal powder into wrought metal shapes comprising at least one pair of oppositely disposed laterally spaced vertical compactor elements, each of said compactor elements being inclined at an acute angle to the common axis of said pair of compactor elements whereby said pair of elements define a truncated V-shaped passageway, means for moving said pair of compactor elements in a reciprocating lateral path of travel alternately toward and away from each other for compacting loose metal powder into a lightly precompressed strip of metal powder having sufficient mechanical strength to retain its form while being introduced into a pair of pressure rolls but not of a sufficient density to be successfully sintered into a substantially coherent metal strip, a metal powder feed hopper adapted to introduce loose metal powder into the wide end of said truncated V-shaped passageway, and a pair of oppositely disposed laterally spaced pressure rolls having the axis of the rolls disposed in a horizontal plane defining a roll gap the width of which is appreciably less than the width of the narrow end of said truncated V-shaped passageway defined by said pair of compactor elements, said pressure rolls being disposed adjacent said narrow end of said pair of compactor elements with said roll gap in alignment with the truncated V-shaped passageway defined by said pair of compactor elements for compacting the lightly precompressed strip of metal into a compressed strip of metal of a sufficient density to be successfully sintered into a substantially coherent metal strip.

5. Apparatus for converting metal powder into wrought metal shape comprising at least one pair of oppositely disposed laterally spaced convergent vertical compactor elements defining a truncated V-shaped passageway for compacting loose metal powder into a lightly precompressed strip of metal powder having sufficient mechanical strength to retain its form while being introduced into a pair of pressure rolls but not of a sufficient density to be successfully sintered into a substantially coherent metal strip, a metal powder feed hopper adapted to introduce loose metal powder into the wide end of said truncated V-shaped passageway, and a pair of oppositely disposed laterally spaced pressure rolls having the axis of the rolls disposed in a horizontal plane defining a roll gap the width of which is appreciably less than the closest distance separating said convergent compactor elements disposed adjacent and in alignment with the narrow end of said truncated V-shaped passageway defined by said compactor elements for compacting the lightly precom-

pressed strip of metal into a compressed strip of metal of a sufficient density to be successfully sintered into a substantially coherent metal strip.

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