

PATENT SPECIFICATION

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(54) INDIRECT EXTRUSION PROCESSES AND APPARATUS

(71) We, YOSHIDA KOGYO K.K., a corporation duly organized under the laws of Japan and existing at No. 1, Kanda Izumicho, Chiyoda-ku, Tokyo, Japan, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to indirect extrusion processes and apparatus.

As is well known in the art, the indirect extrusion process has advantages in that friction between the billet and the container wall defining a billet receiving bore is practically eliminated, and there is almost no turbulent metal flow in the billet, thereby reducing the extrusion force. Further, surface layers of the billet can be extruded, since there is no need of leaving in the container a thin sleeve of the billet which would otherwise be produced by a dummy block in the direct extrusion for preventing surface friction and entrainment of surface oxides into the extruded product.

A major problem with the indirect extrusion method is the accumulation of skull on the bore wall in the container. The skull comprises accumulations of unwanted materials on the container wall and may include a layer of unextruded metal, dirt, lubricant, metal particles produced when the outer periphery of a die holder is held in frictional contact with the bore wall, and metal oxides formed on the billet during homogeneous heat treatment before extrusion. These foreign impurities, deposited between the metal billet and the container wall, find their way into the products during extrusion and appear as flaws on the finished products, thereby lessening their quality and possibly rendering them defective.

Various attempts have been made in the past to remove such skull in order to assure an efficient indirect extrusion operation. One typical effort has been a skim block shown in U.S. Patent 3,184,944, issued May 25, 1965. The skim block has an outer surface shaped to provide a precisely

controlled sliding fit between the skim block and the container bore. The skim block is moved through the container for removal of the accumulated materials after an indirect extrusion process is completed. With this type of arrangement, the block itself must be carefully machined to avoid damage or excessive wear to the bore wall, and skull skimming through the container increases down time of the extrusion press.

Another form that has been suggested for preventing skull formation is described in U.S. Patent 3,522,721, issued August 4, 1970. The form comprises a separate die holder having an outer sealing surface that is configured also to provide a closely controlled sliding fit between the outer sealing surface and the container bore wall. The sealing surface involves careful machining. Further, the die holder allows the impurities to get into the extruded product as the billet is extruded.

The present invention seeks to provide a process of indirectly extruding a billet while collecting foreign impurities as an annular butt that can be ready for removal upon completion of an extrusion process.

The invention also seeks to provide a die assembly for use in an indirect extrusion press, which die assembly includes a die holder having near its front end an annular step portion that acts to collect foreign impurities and to prevent skull formation during an extrusion operation.

The invention further seeks to provide, in preferred embodiments thereof, an indirect extrusion process including the steps of removing butt portions of a billet from a container.

According to a first aspect of the invention, there is provided an indirect extrusion process comprising placing a billet to be extruded in the bore of a container from one end, inserting a die holder with a die in the other end of the bore in a close sliding fit therein, relatively moving the die holder and the container to extrude the billet through the die orifice and collecting impurities deposited between the inner surface of the

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bore and the billet as an annular ring about an annular recess adjacent the end of the die holder carrying the die.

Further according to this aspect of the invention, an indirect extrusion process comprises the steps of: providing a die holder fixed at one end to a support and a container having an inner surface which defines a concentric through bore, said die holder supporting at the other end a die having an orifice and having a peripheral surface shaped to provide a close sliding fit between said peripheral surface and said inner surface; loading a billet in said bore; inserting said die holder at said other end into said bore; moving said container to slide over said die holder so as to extrude said billet through said die orifice; and simultaneously collecting impurities deposited between said inner surface and said billet as an annular butt around an annular step portion formed adjacent to said other end of said die holder.

According to a second aspect of the invention, there is provided a die assembly comprising a hollow die holder for sliding engagement in a bore provided with a billet to be extruded; a die positioned in one end of the hollow die holder for engagement with the billet and an annular recess formed by a step in the hollow die holder at the end containing the die for collecting impurities or the like present between the billet and the bore wall.

Further in accordance with this aspect of the invention, there is provided a die assembly for use in an indirect extrusion press including a support and a container having an inner surface bounding a through bore in which a billet is to be loaded, said die assembly comprising: a hollow stem portion adapted to be fixed at one end to said support; and a die holder attached coaxially to the other end of said stem portion, said stem portion and die holder having peripheral surfaces shaped to provide a close sliding fit between the die assembly and said inner surface, said die holder having: an annular recess adjacent to but spaced from a free end thereof; an annular ring contiguous to said recess; and an annular step comprising a first wall defining in part said annular ring and a second wall tapered from said first wall to said free end, whereby there can be provided an annular space between said step and said inner surface when said die holder is in said bore.

The invention will now be described in greater detail, by way of example, with reference to the drawings, in which:—

Figure 1 is a schematic cross-sectional view of an indirect extrusion apparatus used for carrying out an indirect extrusion process of the present invention;

Figure 2 is an enlarged fragmentary perspective view of a die holder provided in accordance with the present invention, the die holder being used in the apparatus shown in Figure 1;

Figure 3 is an enlarged fragmentary sectional view of the die holder illustrated in Figure 2, the die holder containing a die through which is extruded a billet inserted in a container bore; and

Figures 4 through 8 are views similar to Figure 1, but showing successive steps of removing butt portions from within the container.

Figure 1 shows an indirect extrusion apparatus or press 10 having a container 11 with a bore 12 formed concentrically therethrough. The bore 12 is defined by a cylindrical inner wall or surface 13 and opens at the ends 14, 15 of the container 11. Within the bore 12 is disposed and confined a billet 16 of a material to be extruded by an extrusion die 17 (Figure 3) supported in a die assembly. The die assembly comprises a die holder 18 and a hollow stem portion 19 that is attached coaxially at its front end to the die holder 18 and supported at its rear end on a die stem support 21 fixed to a press frame 22. The die assembly has an outer peripheral surface 23 so shaped as to provide a close sliding fit between the peripheral surface 23 and the inner surface 13 bounding the bore 12. With the die holder 18 inserted partly in the bore 12, the container 11 can be pressed toward the support 21 by means of a main ram 24 having a small-diameter front end 25 retained in the bore 12 against displacement.

As shown in Figures 2 and 3, the die holder 18 has an annular recess 26 formed adjacent to but spaced from a front end 27 of the holder 18 to leave an annular ring portion 28 contiguous to the recess 26, the ring portion 28 having substantially the same outer diameter as that of the surface 23 of the die assembly. The ring portion 28 is defined partly by an annular step 29 which is composed of a steep wall 30 adjoining to the ring portion 28 and a gradual wall 31 tapered from the steep wall 30 toward the front end 27. Thus, there is formed an annular space 32 between the inner bore surface 13 and the step 29 of the die holder 18 disposed in the container 11.

The front end 27 of the die holder 18 has a radially inward flange 33 against which is held the die 17 having an orifice 34 through which the billet material 16 can be extruded. The die 17 is held in place by a die backer 35 having a through opening 36 larger in diameter than the die orifice 34 for the passage therethrough of an extrusion 37 being formed. The die backer 35 in turn is supported by a bolster 38 having a

larger-diameter opening 39 through which the extrusion 37 can pass while being formed.

For an extrusion operation, the billet 16 is inserted into the container 11 by a suitable billet loader (not shown) and the die holder 18 is placed partly in the container bore 12 at the end 14, with the die 17 being supported in position within the die holder 18. Then, the main ram 24 is actuated to push the billet-loaded container 11 toward the die stem support 21, when the bore surface 13 slides over the stationary die holder 18 to extrude the billet 16 through the die orifice 34.

As the container 11 moves relatively to the die holder 18, the bore surface 13 is held in frictional contact with the outer surfaces of the stem portion 19 and the annular ring 28, with the result that the outer surfaces are worn little by little to produce metal particles. Dirt and lubricant become deposited on the bore surface 13 as an extrusion cycle is repeated. Further, the billet 16 carried on its surface metal oxides produced during homogeneous heat treatment prior to and preparatory for extrusion. While the billet 16 is being extruded, these foreign impurities 40 accumulated between the bore surface 13 and the billet 16 are blocked by the steep wall 30 and prevented from getting past the annular ring 28. As an extrusion process proceeds, the blocked impurities 40 are trapped and compacted in the space 32, and are prevented by the gradual wall 31 from getting out even under the influence of metal flow in the billet 16 that concentrates in the vicinity of the die 17. Thus, an extruded product is substantially free from foreign materials such as dirt, lubricant, metal oxides, and the like. Further, since the annular ring 28 is closely fitted in the bore 12, the ring 28 serves as a barrier to hold skull formation at a minimum while an extrusion cycle is in progress. The die holder 18 thus constructed is advantageous in that it can be installed on existing indirect extrusion presses.

The main ram 24 is continuously advanced until the billet 16 is substantially completely extruded so that a butt end 41 of the billet 16 remains within the container as illustrated in Figure 4. The butt end 41 is joined to the extruded product and to an annular butt 42 formed by accumulation of the impurities 40 in the space 32. To remove these butt portions 41 and 42 there are provided a gate 43 on the side of the die stem support 21, a shear 44 on the side of the main ram 24, and a suitable hydraulic cylinder 45 having a piston rod 46 attached to the container 11. The gate 43 is in the form of an inverted U and is vertically movable between a lower position in which it straddles the die stem portion 19 adjacent

to the die stem support 21 and an upper portion above the container 11. When the gate 43 is in the lower position and is sandwiched between the support 21 and the container 11, the shear 44 can slide over the end 15 of the container 11 that faces the main ram 24. The gate 43 has a thickness such that when it is interposed between the support 21 and the container 11, the front end 27 of the die holder 18 is substantially in line with or slightly held back from the end 15 of the container 11.

In operation, the main ram 24 is retracted upon completion of an extruding process, and the gate 43 is lowered to its lower position. Then, the piston rod 46 is actuated to move the container 11 toward the support 21 until the container 11 is held against the support 21 with the gate 43 sandwiched therebetween. At this time, the butt end 41 projects beyond the container end 15 as shown in Figure 5. The shear 44 is moved downwardly to cut off the butt 41, when the extrusion can be taken out of the extrusion press 10. Upon shearing of the butt 41, the shear 44 is withdrawn (Figure 6), and the gate 43 is raised to the upper position (Figure 7). The piston rod 46 is further actuated to shift the container 11 toward the support 21 until the annular butt 42 around the step 29 projects beyond the container end 15 as illustrated in Figure 7. Then, the piston rod 46 is moved in the opposite direction to return the container 11 away from the support 21. As the container 11 is moved back, the step 29 of the die holder 18 leaves the annular butt 42 on the container end 15 because the butt 42 becomes deformed when exposed to air and is retained against reinsertion into the container bore 12. The motion of the container 11 is stopped when the front end 27 of the die holder 18 is withdrawn into the bore 12 (Figure 8). The shear 44 is lowered again to remove the butt 42 from the container end 15.

WHAT WE CLAIM IS:—

1. An indirect extrusion process, comprising the steps of: providing a die holder fixed at one end to a support and a container having an inner surface which defines a concentric through bore, said die holder supporting at the other end a die having an orifice and having a peripheral surface shaped to provide a close sliding fit between said peripheral surface and said inner surface; loading a billet in said bore; inserting said die holder at said other end into said bore; moving said container to slide over said die holder so as to extrude said billet through said die orifice; and simultaneously collecting impurities deposited between said inner surface and



larger-diameter opening 39 through which the extrusion 37 can pass while being formed.

For an extrusion operation, the billet 16 is inserted into the container 11 by a suitable billet loader (not shown) and the die holder 18 is placed partly in the container bore 12 at the end 14, with the die 17 being supported in position within the die holder 18. Then, the main ram 24 is actuated to push the billet-loaded container 11 toward the die stem support 21, when the bore surface 13 slides over the stationary die holder 18 to extrude the billet 16 through the die orifice 34.

As the container 11 moves relatively to the die holder 18, the bore surface 13 is held in frictional contact with the outer surfaces of the stem portion 19 and the annular ring 28, with the result that the outer surfaces are worn little by little to produce metal particles. Dirt and lubricant become deposited on the bore surface 13 as an extrusion cycle is repeated. Further, the billet 16 carried on its surface metal oxides produced during homogeneous heat treatment prior to and preparatory for extrusion. While the billet 16 is being extruded, these foreign impurities 40 accumulated between the bore surface 13 and the billet 16 are blocked by the steep wall 30 and prevented from getting past the annular ring 28. As an extrusion process proceeds, the blocked impurities 40 are trapped and compacted in the space 32, and are prevented by the gradual wall 31 from getting out even under the influence of metal flow in the billet 16 that concentrates in the vicinity of the die 17. Thus, an extruded product is substantially free from foreign materials such as dirt, lubricant, metal oxides, and the like. Further, since the annular ring 28 is closely fitted in the bore 12, the ring 28 serves as a barrier to hold skull formation at a minimum while an extrusion cycle is in progress. The die holder 18 thus constructed is advantageous in that it can be installed on existing indirect extrusion presses.

The main ram 24 is continuously advanced until the billet 16 is substantially completely extruded so that a butt end 41 of the billet 16 remains within the container as illustrated in Figure 4. The butt end 41 is joined to the extruded product and to an annular butt 42 formed by accumulation of the impurities 40 in the space 32. To remove these butt portions 41 and 42 there are provided a gate 43 on the side of the die stem support 21, a shear 44 on the side of the main ram 24, and a suitable hydraulic cylinder 45 having a piston rod 46 attached to the container 11. The gate 43 is in the form of an inverted U and is vertically movable between a lower position in which it straddles the die stem portion 19 adjacent

to the die stem support 21 and an upper portion above the container 11. When the gate 43 is in the lower position and is sandwiched between the support 21 and the container 11, the shear 44 can slide over the end 15 of the container 11 that faces the main ram 24. The gate 43 has a thickness such that when it is interposed between the support 21 and the container 11, the front end 27 of the die holder 18 is substantially in line with or slightly held back from the end 15 of the container 11.

In operation, the main ram 24 is retracted upon completion of an extruding process, and the gate 43 is lowered to its lower position. Then, the piston rod 46 is actuated to move the container 11 toward the support 21 until the container 11 is held against the support 21 with the gate 43 sandwiched therebetween. At this time, the butt end 41 projects beyond the container end 15 as shown in Figure 5. The shear 44 is moved downwardly to cut off the butt 41, when the extrusion can be taken out of the extrusion press 10. Upon shearing of the butt 41, the shear 44 is withdrawn (Figure 6), and the gate 43 is raised to the upper position (Figure 7). The piston rod 46 is further actuated to shift the container 11 toward the support 21 until the annular butt 42 around the step 29 projects beyond the container end 15 as illustrated in Figure 7. Then, the piston rod 46 is moved in the opposite direction to return the container 11 away from the support 21. As the container 11 is moved back, the step 29 of the die holder 18 leaves the annular butt 42 on the container end 15 because the butt 42 becomes deformed when exposed to air and is retained against reinsertion into the container bore 12. The motion of the container 11 is stopped when the front end 27 of the die holder 18 is withdrawn into the bore 12 (Figure 8). The shear 44 is lowered again to remove the butt 42 from the container end 15.

WHAT WE CLAIM IS:—

1. An indirect extrusion process, comprising the steps of: providing a die holder fixed at one end to a support and a container having an inner surface which defines a concentric through bore, said die holder supporting at the other end a die having an orifice and having a peripheral surface shaped to provide a close sliding fit between said peripheral surface and said inner surface; loading a billet in said bore; inserting said die holder at said other end into said bore; moving said container to slide over said die holder so as to extrude said billet through said die orifice; and simultaneously collecting impurities deposited between said inner surface and

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said billet as an annular butt around an annular step portion formed adjacent to said other end of said die holder.

5 2. An indirect extrusion process according to claim 1, further including steps of moving said container toward said support upon completion of an extrusion process until a butt end of said billet projects beyond an end of said container, said butt end being joined to an extruded product and said annular butt, cutting off said butt end; moving said container further toward said support until said annular butt projects beyond said container end; 10 returning said container away from said support to leave said annular butt on said container end; and removing said annular butt from said container.

20 3. A die assembly for use in an indirect extrusion press including a support and a container having an inner surface bounding a through bore in which a billet is to be loaded, said die assembly comprising: a hollow stem portion adapted to be fixed at 25 one end to said support; and a die holder attached coaxially to the other end of said stem portion, said stem portion and die holder having peripheral surfaces shaped to provide a close sliding fit between the die assembly and said inner surface, said die holder having: an annular recess adjacent to but spaced from a free end thereof; an annular ring contiguous to said recess; and 30 an annular step comprising a first wall defining in part said annular ring and a second wall tapered from said first wall to

said free end, whereby there can be provided an annular space between said step and said inner surface when said die holder is in said bore.

40 4. An indirect extrusion process substantially as herein described with reference to the drawings.

45 5. A die assembly substantially as herein described with reference to the drawings.

6. An indirect extrusion process comprising placing a billet to be extruded in the bore of a container from one end, inserting a die holder with a die in the other end of the bore in a close sliding fit therein, relatively 50 moving the die holder and the container to extrude the billet through the die orifice and collecting impurities deposited between the inner surface of the bore and the billet as an annular ring about an annular recess adjacent the end of the die holder carrying the die. 55

7. A die assembly comprising a hollow die holder for sliding engagement in a bore provided with a billet to be extruded, a die positioned in one end of the hollow die holder for engagement with the billet and an annular recess formed by a step in the hollow die holder at the end containing the die for collecting impurities or the like 60 present between the billet and the bore wall. 65

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