



CONTINUOUS EXTRUSION OF METALS
TECHNICAL FIELD

5 This invention relates to an apparatus for
effecting continuous extrusion of metal from a
feedstock in particulate, comminuted or solid form,
which apparatus includes:-

10 (a) a rotatable wheel member arranged for
rotation when in operation by a driving means, said
wheel member having formed peripherally thereon a
continuous circumferential groove;

15 (b) a cooperating shoe member which extends
circumferentially around a substantial part of the
periphery of said wheel member and which has a
portion which projects in a radial direction partly
into said groove with small working clearance from
the side walls of said groove, said shoe member
portion defining with the walls of said groove an
enclosed passageway extending circumferentially of
said wheel member;

20 (c) feedstock inlet means disposed at an
inlet end of said passageway for enabling feedstock
to enter said passageway at said inlet end whereby to
be engaged and carried frictionally by said wheel
member, when rotating, towards the opposite, outlet
25 end of said passageway;

(d) an abutment member carried on said shoe
member and projecting radially into said passageway
at said outlet end thereof so as to substantially
close said passageway at that end and thereby impede
30 the passage of feedstock frictionally carried in said
groove by said wheel member, thus creating an
extrusion pressure in said passageway at said outlet
end thereof; and

35 (e) a die member carried on said shoe
member and having a die orifice opening from said

passageway at said outlet end thereof, through which orifice feedstock carried in said groove and frictionally compressed by rotation of said wheel member, when driven, is compressed and extruded in continuous form, to exit from said shoe member via an outlet aperture.

The invention is particularly concerned with a method of producing a said rotatable wheel member for use in such a rotary, friction-type, continuous extrusion apparatus.

BACKGROUND ART

In operating such an extrusion apparatus, the parts defining said passageway adjacent said outlet end thereof suffer very great working loads and very high operating temperatures. Of such highly stressed (mechanically and thermally) parts, those that suffer greatest wear or damage are the stationary, feedstock-engaging parts of, or associated with, said stationary shoe member, particularly on said abutment member, said die member and the stationary parts that support those items.

For the convenience of readily making good worn or damaged surfaces or parts, the abutment member, and the die member and its supporting parts are made as separate replaceable items which are rigidly but removably secured in the stationary shoe member.

In order to reduce the temperatures at which those replaceable items operate, such items have been provided with internal cooling passages through which cooling water has been circulated. However, such cooling measures have not been very effective, for the reasons that

(a) the small sizes of those items and the high mechanical loads to which they are subjected

have severely restricted both the sizes of the internal cooling passages and their proximity to the source of heat, so that the cooling water has been unable to extract heat at an adequate rate, and

5 (b) the materials used for such small items (e.g. high-speed tool steels) have relatively poor heat transmission properties.

As a consequence of the low dissipation of heat by the cooling water, plastic flow of the tip of the abutment member, at its free end adjoining the
10 bottom of the groove in the wheel member, has been experienced, due to the excessive tip temperatures reached. This has severely limited the life of the abutment member, and the running time of the
15 apparatus between successive occasions when the abutment member has to be replaced. This in turn has led to a reduction in the quantity of the output extrusion product produced, due to the down-time during which the apparatus cannot be operated.

20 Also, with prolonged use, there has been the risk that the extrusion die may overheat to a temperature at which its mechanical strength is impaired, with the consequent risk of deformation and/or increased wear of the die.

25 After experimentation with various different arrangements of internal cooling passages, particularly in the abutment member, highly satisfactory results have now been achieved by means of an entirely different arrangement for cooling the
30 abutment member. Such different arrangement, and various modifications thereof, have been described and claimed in the copending, parent patent application No. 8309836/^(SERIAL NO. 213428) filed 12th April, 1983, from which application this present application has been
35 divided.

The use of the invention of that parent application enables such a rotary, friction-type, continuous extrusion apparatus to operate at lower temperatures, for longer periods of time, and with longer operating lives for those parts of the apparatus that are subjected to high mechanical and thermal stresses.

The beneficial results obtained by the use of that invention can be enhanced by the use in conjunction therewith of the invention of this divisional application.

By way of introduction to the present invention, reference should be made to the passage in the specification of that parent application, which begins - "It is believed that the highly beneficial ..." and ends - "... at which heat will be conveyed to the cooling zone by the wheel member."

That passage appears later in this specification, since the description given later with reference to the drawing figures is the same as that given in said parent application.

DISCLOSURE OF INVENTION

According to the present invention, a method of producing a rotary wheel member adapted for use, in a rotary, friction type, continuous extrusion apparatus comprises the steps of:

(a) producing a rotary wheel having formed in its cylindrical peripheral parts a continuous, radially-extending groove, and secured in that groove for movement with said peripheral parts of said wheel an annular metal mass;

(b) rotating said wheel about its rotary axis; and

(c) applying to the periphery of said annular metal mass secured in said wheel a tool of predetermined end shape, and progressively advancing said tool in a radial direction as said wheel continues to rotate whereby to machine in the peripheral parts of said annular metal mass a working groove of predetermined desired transverse cross sectional shape;

10 said peripheral parts of said annular metal mass which define said working groove being of a composition which is substantially the same as that of a predetermined feedstock metal that is to be extruded in a said apparatus when equipped with the wheel member so produced; and said predetermined end
15 shape of said tool being substantially the same as that of a predetermined abutment member which is to be used in that apparatus to close the end of an arcuate passageway which is formed in said working groove by a shoe member which when the apparatus is
20 in operation co-operates with said cylindrical peripheral parts of said wheel member.

Preferably, said annular metal mass secured in said wheel groove is in good thermal relationship with said wheel.

25 Said annular metal mass secured in said wheel groove may comprise an annulus of a first predetermined metal lying concentrically with said wheel in said wheel groove and being enveloped within a sheath of a second predetermined metal, said second
30 predetermined metal defining said working groove and being in good thermal relationship with said first predetermined metal.

Said annular metal mass secured in said wheel groove may alternatively comprise an annulus of
35 a first predetermined metal lying concentric with said wheel in the bottom of said wheel groove and

being overlaid by a second annulus of a second predetermined metal, said first predetermined metal being in good thermal relationship with said second predetermined metal, and said second predetermined metal defining said working groove.

Preferably, said first and second predetermined metals each have a product of thermal conductivity and specific heat per unit volume that is greater than that of the material of the wheel.

Advantageously, said product for said first predetermined metal is greater than that for said second predetermined metal.

In carrying out the methods of the present invention, said wheel is preferably mounted for rotation in a said rotary extrusion apparatus, and is rotated therein, and said tool comprises a said abutment member of said apparatus, which abutment member is advanced radially into said annular metal mass as said wheel is rotated, whereby to form said working groove.

The present invention also provides wheel members prepared by methods according to the present invention.

Other features and advantages of the present invention will appear from a reading of the description that follows hereafter, and from the claims appended at the end of that description.

One continuous extrusion apparatus embodying the various aspects of the present invention will now be described by way of example and with reference to the accompanying diagrammatic drawings in which:

Figure 1 shows a medial, vertical cross-section taken through the essential working parts of the apparatus, the plane of that section being indicated in Figure 2 at I-I;

Figure 2 shows a transverse sectional view taken on the section indicated in Figure 1 at II-II;

Figures 3 and 4 show in sectional views similar to that of Figure 2 two arrangements which are alternatives to that of Figure 2;

Figure 5 shows a schematic block diagram of a system embodying the apparatus of the Figures 1 and 2;

Figure 6 shows a graph depicting the variation of a heat extraction rate with variation of a cooling water flow rate, as obtained from tests on one apparatus according to the present invention;

Figures 7 to 9 show, in views similar to that of Figure 2, various modified forms of a wheel member incorporated in said apparatus; and

Figure 10 shows, in a view similar to that of Figure 1, a modified form of the apparatus shown in the Figures 1 and 2.

Referring now to Figures 1 and 2, the apparatus there shown includes a rotatable wheel member 10 which is carried in bearings (not shown) and coupled through gearing (not shown) to an electric driving motor (not shown) so as to be driven when in operation at a selected speed within the range 0 to 20 RPM (though greater speeds are possible).

The wheel member has formed around its periphery a groove 12 whose radial cross-section is depicted in Figure 2. The deeper part of the groove has parallel annular sides 14 which merge with a radiused bottom surface 16 of the groove. A convergent mouth part 18 of said groove is defined by oppositely-directed frusto-conical surfaces 20, 22.

A stationary shoe member 24 carried on a lower pivot pin 26 extends around and cooperates closely with approximately one quarter of the

periphery of the wheel member 10. The shoe member is retained in its operating position as shown in Figure 1 by a withdrawable stop member 28.

5 The shoe member includes centrally (in an axial direction) a circumferentially-extending projecting portion 30 which projects partly into the groove 12 in the wheel member 10 with small axial or transverse clearance gaps 32, 34 on either side. That projecting portion 30 is constituted in part by
10 a series of replaceable inserts, and comprises a radially-directed abutment member 36, an abutment support 38 downstream of the abutment member, a die block 40 (incorporating an extrusion die 42) upstream of the abutment member, and an arcuate wear-resisting
15 member 44 upstream of said die block. Upstream of the member 44 an integral entry part 46 of the shoe member completes an arcuate passageway 48 which extends around the wheel member from a vertically-oriented feedstock inlet passage 50 disposed below a
20 feedstock hopper 52, downstream as far as the front face 54 of the abutment member 36. That passageway has a radial cross-section which in the Figure 2 is defined by the annular side walls 14 and bottom surface 16 of the groove 12, and the inner surface 56
25 of the said central portion 30 of the shoe member 24.

The said abutment member 36, die block 40, die 42 and arcuate member 44 are all made of suitably hard, wear-resistant metals, e.g. high-speed tool
30 steels.

The shoe member is provided with an outlet aperture 58 which is aligned with a corresponding aperture 60 formed in the die block 40 and through which the extruded output metal product 61 (e.g. a
35 round wire) from the orifice of the die 42 emerges.

On rotation of the wheel member 10,

comminuted feedstock admitted to the inlet end of the said arcuate passageway 48 from the hopper 52 via the inlet passage 50 is carried by the moving groove surfaces of the wheel member in an anti-clockwise direction as seen in Figure 1 along the length of said arcuate passageway 48, and is agglomerated and compacted to form a solid slug of metal devoid of interstices in the lower section of the passageway adjacent said die block 40. That slug of metal is continuously urged under great pressure against the abutment member by the frictional drag of the moving groove surfaces. That pressure is sufficient to extrude the metal of said slug through the orifice of the extrusion die and thereby provide an extruded output product which issues through the apertures 58 and 60 in the shoe member and die block. In the particular case, the output product comprises a bright copper wire produced from small chopped pieces of wire which constitute the said feedstock.

A water pipe 62 secured around the lower end of the shoe member 24 has an exit nozzle 64 positioned and secured on the side of the shoe member that lies adjacent the wheel member 10. The nozzle is aligned so as, when the pipe is supplied with cooling water, to direct a jet of water directly at the downstream parts of the abutment member where it lies in and abuts the groove 12 in the wheel member 10. Thus, the tip of the free end of the abutment member (where in operation most of the heat is generated) and the adjoining surfaces of the wheel member and groove are directly cooled by the flow thereover of water from the jet directed towards them.

The die block 40 is provided with internal water passages (not shown) and a supply of cooling

water for enveloping the output product leaving the die and extracting some of the heat being carried away in that product. But no such internal passages are formed in the abutment member. Thus, the strength of that member is not reduced in the interests of providing internal water cooling for cooling that member.

If desired, the cooling of the apparatus may be enhanced by providing cooling water sprinklers 65 over the hopper 52 so as to feed some cooling water into the said arcuate passageway 48 with the comminuted feedstock.

In the Figure 2, the slug of compacted metal in the extrusion zone adjacent the die block 40 is indicated at 66. From that metal slug, the output product is extruded through the extrusion die 42 by the pressure in that zone. That pressure also acts to extrude some of the metal through the said axial clearance gaps 32 and 34 between the side walls of the groove and the respective opposing surfaces of the die block and abutment member. That extruded metal gradually builds up in a radial direction to form strips 68 of waste metal or "flash". In order to prevent those waste strips growing too large to handle and control, a plurality of transversely-directed teeth 70 are secured on the divergent walls 20, 22 which constitute the said mouth 18 of the groove 12. Those teeth are uniformly spaced around the wheel member, the teeth on one of the walls being disposed opposite the corresponding teeth on the opposite wall. If desired, the teeth on one wall may alternatively be staggered relative to corresponding teeth on the other wall.

In operation, the inclined surfaces 72 of the die block 40 deflect the extruded waste strips 68

obliquely into the paths of the respective sets of moving teeth 70. Interception of such a waste strip 68 by a moving tooth causes a piece of that strip to be cut or otherwise torn away from the extruded metal in the clearance gap. Thus, such waste extruded strips are removed as soon as they extend radially far enough to be intercepted by a moving tooth. In this way the "flash" is prevented from reaching unmanageable proportions.

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10 The said teeth do not need to be sharp, and can be secured in any satisfactory manner on the wheel member 10, e.g. by welding.

15 In the Figures 3 and 4 are shown other teeth fitted in analogous manners to appropriate surfaces of other forms of said wheel member 10.

20 In those alternative arrangements, the external surfaces of the wheel member 10 cooperate with correspondingly shaped surfaces of the cooperating shoe member 24 whereby to effect control of the flash in a particular desired way. In Figure 3, the flash is caused to grow in a purely transverse or axial direction, until it is intercepted by a radially projecting tooth, whereupon that piece of flash is torn away from the extruded metal in the associated clearance gap.

25 In Figure 4, the flash is caused to grow in an oblique direction (as in the case of Figure 2), but is intercepted by teeth which project radially from the surface of the wheel member 10.

30 Referring now to the Figure 5, the system there shown includes at reference 100 a continuous extrusion apparatus as just described above the output copper wire produced by that apparatus being indicated at 102, and being drawn through a sizing die 104 (for reducing its gauge to a desired lower

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value) by a tensioning pulley device 106 around which the wire passes a plurality of times before passing via an accumulator 108 to a coiler 110.

5 The pulley device 106 is coupled to the
output shaft of an electrical torque motor 112 whose
energisation is provided and controlled by a control
apparatus 114. The latter is responsive to (a) a
10 first electrical signal 116 derived from a wire
tension sensor 118 which engages the wire 102 at a
position between the extrusion apparatus 100 and the
sizing die 104, and which provides as said first
signal an electrical signal dependent on the tension
15 in the wire 102 at the output of the extrusion
apparatus 100; and to (b) a second electrical
signal 120 derived from a temperature sensor 122
which measures the temperature of the wire 102 as it
leaves the extrusion apparatus 100.

 The control apparatus 114 incorporates a
function generator 124 which is responsive to said
20 second (temperature) signal 120 and provides at its
output circuit a third electrical signal
representative of the yield stress tension for the
particular wire 102 when at the particular
temperature represented by the said second
25 (temperature) signal. That third electrical signal
126 is supplied as a reference signal to a comparator
128 (also part of said control apparatus) in which
the said first (tension) signal 116 is compared with
said third signal (yield stress tension). The output
30 signal of the comparator constitutes the signal for
controlling the energisation of the torque motor.

 In operation, the torque motor is energised
to an extent sufficient to maintain the tension in
the wire leaving the extrusion apparatus 100 at a
35 value which lies a predetermined amount below the

yield stress tension for the particular wire at the particular temperature at which it leaves the extrusion apparatus.

5 Whereas in the description above reference has been made to the use of a water jet for cooling the abutment member tip, jets of other cooling liquids (or even cooling gases) could be used instead. Even jets of appropriate liquified gases may be used.

10 Regarding the flash-removing teeth 70 referred to in the above description, it should be noted that:-

(a) the shaping of the leading edge (i.e. the cutting or tearing edge) of each tooth is 15 not critical, as long as the desired flash removal function is fulfilled;

(b) the working clearance between the tip of each tooth 70 and the adjacent opposing surface of the stationary shoe member 24 is not critical, and is 20 typically not greater than 1 to 2 mm, according to the specific design of the apparatus;

(c) the greater the number of teeth spaced around each side of the wheel member 10, the smaller will be the lengths of "flash" removed by each 25 tooth;

(d) the teeth may be made of any suitable material, such as for example, tool steel; and

(e) any convenient method of securing the teeth on the wheel member may be used.

30 It is particularly beneficial in cases where the feestock is in particulate form, that the radial distance of the free planar surface 40A of the die block 40 from the bottom of the wheel groove 12 progressively decreases as th outlet end of the 35 passageway 48 and the abutment member 36 are

approached, since by that means, in a zone immediately ahead of (i.e. upstream of) the abutment member (in which zone the feedstock material has become compacted into a solid mass of feedstock metal) the metal flow pattern achieved in that zone is similar to that achieved in that zone in cases where said feedstock is in solid form.

Whereas in the above description, the wheel member 10 is driven by an electric driving motor, at speeds within the stated range, other like-operating continuous extrusion machines may utilise hydraulic driving means and operate at appropriate running speeds.

As an alternative to introducing additional cooling water into the passageway 48 via the sprinklers 65, hopper 52 and passage 50, such additional cooling water may be introduced into that passageway (for example, via a passage 67 formed in the shoe member 24) at a position at which said passageway is filled with particulate feedstock, but at which said particulate feedstock therein is not yet fully compacted.

It is believed that the high beneficial mode of cooling provided by the present invention, and particularly by the preferred modes of cooling described above with reference to the drawings, arise principally from the fact that the heat absorbed by a part of the wheel member lying temporarily adjacent the hot metal in the confined extrusion zone upstream of the abutment member is conveyed (both by thermal conduction and rotation of the wheel member) from that hot zone to a cooling zone situated downstream of the abutment member, in which cooling zone a copious supply of cooling fluid is caused to flow over relatively large areas of the

wheel member passing through that cooling zone so as to extract therefrom a high proportion of the heat absorbed by the wheel member in the hot extrusion zone.

5 In this cooling zone access to the wheel member is less restricted, and relatively large surfaces of that member are freely available for cooling purposes. This is in direct contrast to the extremely small and confined cooling surfaces that
10 can be provided directly adjacent the extrusion zone in the parts of the said shoe member (i.e. the die block and abutment member) that bound that extrusion zone. As has been mentioned above, the cooling surfaces that can be provided in those parts are
15 severely limited in size by the need to conserve the mechanical strengths of those parts and so enable them to safely withstand the extrusion pressure exerted on them.

 The conveying of heat absorbed by the wheel
20 member to the said cooling zone can be greatly enhanced by the incorporation in said wheel member of metals having good thermal conductivities and good specific heats (per unit volume). However, since the said wheel member, for reasons of providing adequate
25 mechanical strength, is made of physically strong metals, (e.g. tool steels), it has relatively poor heat transmission properties. Thus, the ability of the wheel member to convey heat to said cooling zone can be greatly enhanced by incorporating intimately
30 in said wheel member an annular band of a metal having good thermal absorption and transmission properties, for example, a band of copper.

 Such a thermally conductive band may conveniently be constituted by an annular band
35 secured in the periphery of the said wheel member and

preferably constituting, at least in part, the part of said wheel member in which the said circumferential groove is formed to provide (with the shoe member) the said passageway (48).

5 In cases where the extrusion product of the machine is of a metal having suitably good thermal properties, the said thermally conductive band may be composed of the same metal as the extrusion product (e.g. copper).

10 In other cases, said thermally-conductive band may be embedded in, or be overlaid by, a second annular band, which second band is of the same metal as the extrusion product of the machine and is in contact with the tip portion of the said abutment member, the two bands being of different metals.

15 Metals which may be used for the said thermally-conductive band are selected to have a higher product of thermal conductivity and specific heat per unit volume than tool steel, and include the following (in decreasing order of said product):-

20 Copper, silver, beryllium, gold, aluminium, tungsten, rhodium, iridium, molybdenum, ruthenium, zinc and iron.

25 The rate at which heat can be conveyed by such a thermally-conductive band from the extrusion zone to the cooling zone is dependent on the radial cross-sectional area of the band, and is increased by increasing that cross-sectional area. Thus, for a given cross-sectional dimension measured transversely

30 of the circumference of the wheel member, the greater the radial depth of a said band, the greater the rate at which heat will be conveyed to the cooling zone by the wheel member.

35 Calculations have shown that for a said wheel member having an effective diameter of 233 mm,

and a speed of rotation of 10 RPM, and a said thermally-conductive band of copper having a radial cross-section of U-shape, the rate "R" of conveying heat from the extrusion zone to the said cooling zone by the wheel member, by virtue of its rotation alone, varies in the manner shown below with variation of the radial depth or extent to which a said abutment (36) cooperating with the wheel member penetrates into that copper band, that is to say, with variation of the radial thickness "T" of the copper band that remains at the bottom of the said circumferential groove (12). These calculations were based on a said copper band having with the adjacent parts (tool steel) of the wheel member an interface of generally circular configuration as seen in a radial cross section. Hence, the radial cross-sectional area "A" of the copper band varies in a non-linear manner with the said radial thickness "T" of copper at the bottom of said groove (12).

20	<u>T (mm)</u>	<u>A (sq. mm)</u>	<u>R (kW)</u>
	1.0	18.0	5.1
	1.5	22.7	6.4
	2.0	27.4	7.7
	2.5	32.1	9.1
25	3.0	36.8	10.4

In one practical arrangement having such a wheel member and a 2 mm radial thickness T of said copper band at the bottom of said groove (12), when operating at said wheel member speed and extruding copper wire of 1.4 mm diameter at a speed of 150 metres per minute, heat was extracted from the wheel member and abutment member in said cooling zone at a rate of 10 kW by cooling water flowing at as low a rate of 4 litres per minute and providing at the surfaces to be cooled in said cooling zone a jet

velocity of approximately 800 metres per minute.

This heat extraction rate indicates that heat was reaching the cooling zone at a rate of some 2.3 kW as a result of the conduction of heat through the said conductive band, the adjacent wheel member parts, and the abutment member, induced by the temperature gradient existing between the extrusion zone and the cooling zone.

This measured rate of extracting heat by the cooling water flowing in the cooling zone compares very favourably with a maximum rate of heat extraction of some 1.9 kW that has been found to be achievable by flowing cooling water in the prior art manner through internal cooling passages formed in the abutment member.

Figure 6 shows the way in which the rate of extracting heat from the wheel member and abutment member in said cooling zone was found to vary with variation of the rate of flow of the cooling water supplied to that zone.

The extrusion machine described above with reference to the drawings was equipped for the practical tests with a said thermally-conductive band of copper, which band is shown at reference 74 in Figure 10, and indicated, for convenience only, in dotted-line form in Figure 2. (It should be noted that Figure 2 also depicts, when the copper band 74 is represented in full-line form, the transverse sectional view taken on the section indicated in Figure 10 at II-II.) As will be understood from reference 74 in Figure 2, the said copper band had a radial cross section of U-shape, which band lined the rounded bottom 16 of the circumferential groove 12 and extended part-way up the parallel side walls of that groove.

Figure 7 shows in a view similar to that of Figure 2 a modification of the wheel member 10. In that modification, a solid annular band 76 of copper having a substantially rectangular radial cross-section is mounted in and clamped securely between cooperating steel cheek members 78 of said wheel member, so as to be driven by said cheek members when a driving shaft on which said cheek members are carried is driven by said driving motor. The band 76 has, at least initially, a small internal groove 76A spanning the tight joint 78A between the two cheek members 78. That groove prevents the entry between those cheek members of any of the metal of said band 76 during assembly of the wheel member 10. Complementary frusto-conical surfaces 76B and 78B on said band and cheek members respectively permit easier assembly and disassembly of those parts of the wheel member 10.

The circumferential groove 12, is formed in the copper band by pivotally advancing the shoe member 24 about its pivot pin 26 towards the periphery of the rotating wheel member 10, so as to bring the tip of the abutment member 36 into contact with the copper band, and thereby cause it to machine the copper band progressively deeper to form said groove 12 therein.

Figure 8 shows an alternative form of said modification of Figure 7, in which alternative the thermally-conductive band comprises instead a composite annular band 80 in which an inner core 82 of a metal (such as copper) having good thermal properties is encased in and in good thermal relationship with a sheath 84 of a metal (for example, zinc) which is the same as that to be extruded by the machine.

Figure 9 shows a further alternative form of said modification of Figure 7, in which alternative the thermally-conductive band comprises instead a composite band 86 in which a radially-inner annular part 88 thereof is made of a metal (such as copper) having good thermal properties and is encircled, in good thermal relationship, by a radially-outer annular part 90 of a metal which is the same as that to be extruded by the machine. Said circumferential groove is machined by said abutment member wholly within said radially-outer part 90 of said band.

Metals which can be extruded by extrusion machines as described above include:-

Copper and its alloys, aluminium and its alloys, zinc, silver, and gold.

It should be noted that various aspects of the present disclosure which are not referred to in the claims below have been made the subjects of the respective sets of claims of other British patent applications, namely, No. 8309836 (publication No. 2 134 428) from which this application is divided; and Nos. 8402415, 8402416 and 8402417 (publication Nos. 2 134 828, 2 135 616, and 2 134 829 respectively), all three of which were filed on the 30th January 1984 and claimed priority from application No. 8309836 and the earlier-filed, now-abandoned application No. 8302951, filed 3rd February, 1983.



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CLAIMS

1. A method of producing a rotary wheel member adapted for use in a rotary, friction type, continuous extrusion apparatus, which method comprises the steps of:

(a) producing a rotary wheel having formed in its cylindrical peripheral parts a continuous, radially-extending groove, and secured in that groove for movement with said peripheral parts of said wheel an annular metal mass;

(b) rotating said wheel about its rotary axis; and

(c) applying to the periphery of said annular metal mass secured in said wheel a tool of predetermined end shape, and progressively advancing said tool in a radial direction as said wheel continues to rotate whereby to machine in the peripheral parts of said annular metal mass a working groove of predetermined desired transverse cross sectional shape;

said peripheral parts of said annular metal mass which define said working groove being of a composition which is substantially the same as that of a predetermined feedstock metal that is to be extruded in a said apparatus when equipped with the wheel member so produced; and said predetermined end shape of said tool being substantially the same as that of a predetermined abutment member which is to be used in that apparatus to close the end of an arcuate passageway which is formed in said working groove by a shoe member which when the apparatus is in operation co-operates with said cylindrical peripheral parts of said wheel member.

2. A method according to Claim 1, wherein said annular metal mass secured in said wheel groove



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is in good thermal relationship with said wheel.

3. A method according to Claim 1 or Claim 2,
wherein said annular metal mass secured in said wheel
groove comprises an annulus of a first predetermined
5 metal lying concentrically with said wheel in said
wheel groove and being enveloped within a sheath of a
second predetermined metal, said second predetermined
metal defining said working groove and being in good
thermal relationship with said first predetermined
10 metal.

4. A method according to Claim 1 or Claim 2,
wherein said annular metal mass secured in said wheel
groove comprises an annulus of a first predetermined
metal lying concentric with said wheel in the bottom
15 of said wheel groove and being overlaid by a second
annulus of a second predetermined metal, said first
predetermined metal being in good thermal
relationship with said second predetermined metal,
and said second predetermined metal defining said
20 working groove.

5. A method according to Claim 3 or Claim 4,
wherein said first and second predetermined metals
each have a product of thermal conductivity and
specific heat per unit volume that is greater than
25 that of the material of the wheel.

6. A method according to Claim 5, wherein
said product for said first predetermined metal is
greater than that for said second predetermined
metal.

7. A method according to any preceding Claim,
wherein said wheel is mounted for rotation in a said
rotary extrusion apparatus, and is rotated therein,
and said tool comprises a said abutment member of
said apparatus, which abutment member is advanced
35 radially into said annular metal mass as said wheel
is rotated, whereby to form said working groove.



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8. A wheel member prepared by a method according to any preceding claim.

9. A wheel member according to Claim 8, substantially as hereinbefore described with reference to and as illustrated by any single figure or group of associated figures of the accompanying diagrammatic drawings.

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10. A method according to any one of the Claims 1 to 7, substantially as hereinbefore described with reference to and as illustrated by any single figure or group of associated figures of the accompanying diagrammatic drawings.

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