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EXTRUSION OF METAL

This invention relates to machinery for
extrusion of metal of the kind in which a passageway is
formed between an arcuate first member and a second member
5 in the form of a wheel having a circumferential groove
formed in its peripheral surface into which groove the
first member projects, the wheel being rotatable to urge
material in the passageway towards one end (the exit end)
thereof, an abutment member extending across the
10 passageway at the exit end thereof and at least one die
orifice through the abutment member or through a part of
the arcuate first member adjacent the abutment member.

The abutment member may be large enough to block
the end of the passageway completely (as described in the
15 specification of UK Patent 1370894) but especially when
the material to be extruded is a relatively hard metal,
such as copper, we prefer that the abutment member is of
substantially smaller cross-section than the passageway
and leaves a substantial gap between the abutment member
20 and the groove surface and that the material being
extruded is allowed to adhere to the groove surface,
whereby a substantial proportion of the metal (as distinct
from the inevitable leakage of flash through a working
clearance) extends through the clearance and remains as a
25 lining in the groove to re-enter the passageway while the
remainder of the metal extrudes through the die
orifice(s), as described in our UK Patent No. 2069389B.

Such machinery is commonly known as "Conform" machinery, and will be referred to as such hereinafter.

No doubt because of the extreme assymetry of the die area, we have found that the product of Conform
5 extrusion may differ significantly in shape from the die through which it was produced; for example a round die produces wire of appreciably oval cross-section. It is the object of this invention to eliminate or at least reduce this effect.

10 In accordance with one aspect of the invention, a Conform machine incorporates a die-unit for extrusion apparatus comprising a die and a die holder in which the die is supported but is surrounded over at least a substantial part of its length by a sleeve extending from
15 the working face between the die and the die holder and made of a metal soft compared with the die and the die holder.

The invention includes also an extrusion method in which such a Conform machine is used and products of
20 the method, including round wire made by a Conform machine (as defined).

The die unit is preferably a separate insert, but if desired the die holder could be directly formed in the shoe, or the abutment of the machine.

25 Preferably the sleeve extends to the end of the die at its entry end but stops short of the exit end of the die sufficiently to provide positive location and

pressure-tight engagement.

Preferably the die is held in the die holder by means of a close fitting ring of hard metal or a machined step in the die holder.

5 The sleeve can be formed merely by leaving a clearance which becomes filled with the metal being extruded, or a preformed ring of that metal can be used; but to avoid a risk of damage to the die and/or the die holder when the machine is taken to pieces after use it is
10 preferable to use a sleeve made of another metal (soft compared with the die and the die holder) that will not strongly adhere to the metal to be extruded.

For copper and aluminium and their alloys, and most metals that are commonly extruded, mild steel is a
15 suitable material; others include titanium, nickel and pure iron.

The invention will now be described, by way of example, with reference to the accompanying drawings in which:-

20 Figure 1 is a cross-section of part of a Conform machine (in accordance with our UK Patent 2069389B) suitable for extrusion of copper;

Figures 2 and 3 are mutually perpendicular views of a die unit forming part of the known apparatus shown in
25 Figure 1;

Figures 4 and 5 are mutually perpendicular views of a preferred form of die unit in accordance with the invention; and

Figures 6 and 7 are mutually perpendicular views

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of another form of die unit in accordance with the invention.

In the machine shown in Figure 1, a wheel 1 (the curvature of which is too slight to be visible at this scale) is formed with a rectangular groove 2, that forms three walls of the extrusion passageway 3. The fourth wall is formed by an assembly comprising a shoe 4 (a small portion of which is shown), and an abutment 5 projects into the passageway.

10 A radial extrusion die 6 is formed in a die holder 7 (which is preferably a separate component, though it might be integral with either the abutment or the shoe).

The shoe, abutment and die area are of high-strength materials and are held in position by heavy-duty support members (not shown), and cooling means is provided.

Figures 2 and 3 show a die 6 mounted conventionally in a die holder 7 and providing a cylindrical orifice 8 relieved by a counterbore 9 to provide a clearance around the extruded product.

Figures 4 and 5 show a die unit, in accordance with the invention, comprising a die 10, a die holder 11 and a sleeve 12 of mild steel (which is soft compared with the die and die holder and does not strongly adhere to copper) surrounding the die over its whole length.

The alternative die unit of Figures 6 and 7 differs in that the sleeve 12 is replaced by a hard metal ring 13 (which positions the die) and a clearance 14 in

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which a copper sleeve will be formed as extrusion commences. This die unit is effective, but is less satisfactory than the die unit of Figures 4 and 5 as there is a risk of damage when the copper discard is pulled from the die unit when the machine is taken to pieces after use.

We believe that during extrusion a hydrostatic stress, governed by the pressure of metal at the die face, exists in the steel or copper (as the case may be) surrounding the die.

In a particular group of examples, the die holder had overall dimensions 20 x 15 x 15 mm and the dies used had a length of 4 mm (of which the parallel part of the bore was 3 mm) and a diameter of 7 mm.

The first three dies were conventionally mounted, as Figures 2 and 3. The first had a bore whose maximum and minimum diameters were 2.500 and 2.496 mm and produced wire of consistently oval cross-section with maximum and minimum diameters of 2.481 and 2.460 mm respectively ($2.47 \pm 0.6\%$); the second had a bore whose maximum and minimum diameters were 2.502 and 2.497 mm and produced wire of consistently oval cross-section with maximum and minimum diameters of 2.488 and 2.455 mm respectively ($2.47 \pm 0.8\%$); the third had a bore whose maximum and minimum diameters were 2.550 and 2.547 mm and produced wire of consistently oval cross-section with maximum and minimum diameters of 2.517 and 2.482 mm respectively ($2.50 \pm 0.8\%$).

The fourth and fifth dies were mounted as shown

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in Figures 4 and 5 using a mild steel sleeve 0.5 mm thick. The fourth had an almost perfectly round bore with a diameter of 2.280 mm and produced wire that was substantially round with a diameter of 2.2245 ± 0.0021 mm (better than $\pm 0.1\%$). The fifth had a bore with maximum and minimum diameters of 3.120 and 3.118 mm and produced wire that was substantially round with a diameter of 3.0580 ± 0.0028 mm (again better than $\pm 0.1\%$).

The sixth die was mounted as shown in Figures 6 and 7 using a preformed copper sleeve 0.5 mm thick and 2.5 mm long, the hard steel sleeve 13 correspondingly being 1.5 mm long. The sixth die had maximum and minimum diameters of 2.500 and 2.496 mm (substantially identical with the first die) and produced copper wire that was substantially round with diameters in the range 2.480 to 2.476 mm ($2.478 \pm 0.1\%$).



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CLAIMS

1. A Conform machine incorporating a die unit comprising a die and a die holder in which the die is supported but is surrounded over at least a substantial
5 part of its length by a sleeve extending from the working surface between the die and the die holder and made of a metal soft compared with the die and the die holder.
2. A Conform machine incorporating a die unit comprising a die and a die holder in which the die is
10 supported but is surrounded over at least a substantial part of its length by a sleeve extending from the working surface between the die and the die holder and made of a metal soft compared with the die and the die holder that
15 is different from and will not strongly adhere to the metal to be extruded.
3. A Conform machine as claimed in Claim 2 in which the sleeve is of mild steel.
4. A Conform machine as claimed in any one of
20 Claims 1 to 3, wherein the sleeve extends to the end of the die at its entry end.
5. A Conform machine as claimed in Claim 1, wherein the sleeve is made of the material that is to be extruded.
6. A Conform machine as claimed in Claim 5, wherein
25 the sleeve stops short of the exit end of the die sufficiently to provide positive location and pressure-tight engagement between the die and the die holder.
7. A Conform machine substantially as hereinbefore

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described and with reference to and as shown in Figures 4 and 5.

8. A Conform machine substantially as hereinbefore described and with reference to and as shown in Figures 6 and 7.

9. A method of Conform extrusion distinguished by using a die unit as claimed in any one of Claims 1 to 8.

10. An elongate body extruded by the Conform machine claimed in any one of Claims 1-8 or the method claimed in Claim 9.

