March 31, 1964 K. H. SCHIEREN 3,127,015

HOT DEFORMATION OF METALS

Filed April 29, 1960 2 Sheets-Sheet 1

FIG. 1.

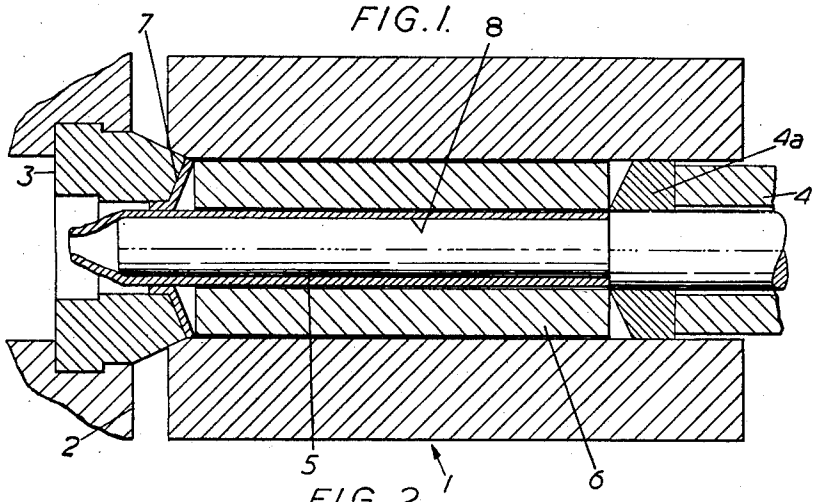


FIG. 2.

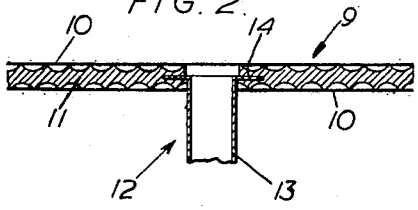
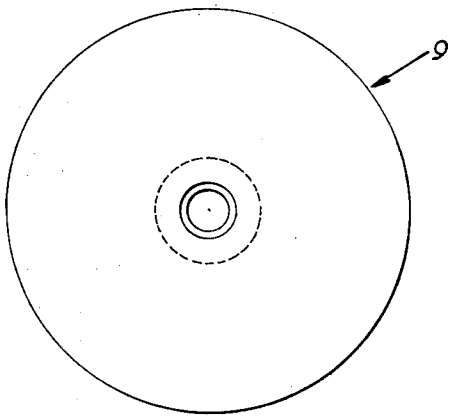


FIG. 3.



Inventor
Karl Heinz Schieren

By Hammond & Littell
Attorneys

March 31, 1964 K. H. SCHIEREN 3,127,015

HOT DEFORMATION OF METALS

Filed April 29, 1960 2 Sheets-Sheet 2

FIG. 4.

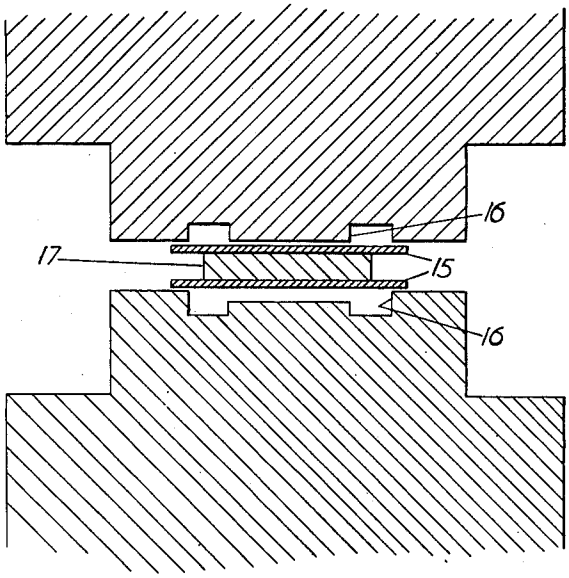
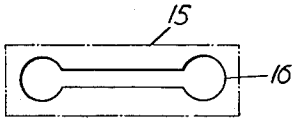


FIG. 5.



Inventor
KARL HEINZ SCHIEREN

By Hammond & Littell
Attorneys

United States Patent Office 3,127,015 Patented Mar. 31, 1964

3,127,015

HOT DEFORMATION OF METALS

Karl Heinz Schieren, Duisburg, Germany, assignor to The Loewy Engineering Company Limited

Filed Apr. 29, 1960, Ser. No. 25,711
5 Claims. (Cl. 207—10)

This invention relates to the hot deformation of metals by extrusion (with or without the use of a mandrel), piercing or die-forging.

The primary object is to prolong the life of the tools, namely the dies, mandrels and punches used in such processes by improving their lubrication and in so doing also to reduce the pressure required to deform a given metal.

According to the invention a material interposed between the metal and the surface of a die, mandrel or punch for the purpose of lubricating the surface consists wholly or substantially wholly of normally solid organic material which burns or volatilises when trapped between the hot metal and the surface and subjected to the operating pressure.

The organic material is preferably polyethylene or polyvinyl chloride but it may be any other material which will be converted completely or substantially completely into gas under the stated conditions. Broadly speaking all synthetic polymers will be so converted.

A lubricant that is in use at the present time consists of a mixture of substances including graphite, carbonaceous materials and a source of oxygen, the graphite being the predominating constituent. This lubricant partially vapourises under the working temperature and pressure. The lubrication in this case is mainly effected by the graphite, but the gases evolved are said to contribute to the lubrication.

It is of the essence of the present invention that no graphite or other lamellar lubricant is used to lubricate the die or mandrel and I believe that in fact all or substantially all the lubrication of the tool is effected by a film of gas produced from the organic material at the operating pressure and temperature. However this may be, the result is increased tool life in comparison with that obtained when the graphite-containing lubricant referred to above is used.

The organic material may be used as a moulding, which can easily be preformed to fit a given die and can very easily be put in position. However the organic material preferably is in the form of a powder or granules, bound to or enclosed in a combustible carrier, since then the expense of converting the material into a moulding is avoided.

The invention can be applied with advantage to the extrusion of tubing with the use of a mandrel that passes through the die. In this case the mandrel may be covered or coated with the organic solid material and lubricated by the gases evolved from it. However the mandrel may be lubricated only by gases evolved from organic solid material interposed between the hot metal and the die, that is to say, the mandrel need not itself be covered or coated with the organic material, though when it is so covered or coated the inner surface of the extruded tubing is of better quality than that obtained by normal methods of lubrication.

This invention will be more clearly understood by reference to the accompanying drawings, in which:

FIGURE 1 diagrammatically shows part of one extrusion press just before extrusion begins;

FIGURE 2 is a section through one carrier of powdered organic material;

FIGURE 3 is a plan of this carrier; and

FIGURES 4 and 5 illustrate a die-forging operation.

The press shown in FIGURE 1 is of the kind in which there is a container 1 and a movable die-carrier 2 which brings dies successively into register with the outlet of the container, one die being shown at 3. The press is intended for the production of tubing from steel, and it includes an annular pressing stem 4 with a pressing disc 4*a* and a mandrel 5 which after entering the container move as a unit during the extrusion operation.

The press is shown at the moment when an annular billet 6 is in the container and the pressure is about to be applied.

The die 3 has a frusto-conical mouth, and before it is brought into register with the end of the container 1 a moulding 7 of polyethylene which mates with the frusto-conical face of the die and has a hollow spigot that extends into the die opening proper is inserted in it. The reason for using a moulding with a cylindrical spigot is that the die carrier 2 turns at high speed to bring the die 3 into position, and it is necessary that the moulding 7 should be held in the die during this movement by the frictional engagement of the spigot in the die.

FIGURE 1 also shows a paper sleeve 8, to which powdered organic material is bound, in position on the mandrel 5. This sleeve is pushed over the mandrel before the introduction of the mandrel into the container. The powdered organic material may be bound to the paper by a mixture of trichloroethylene and polystyrol or by cold glue.

When the hot billet 6 is initially brought into contact with the moulding 7 a little smoke is evolved but there is substantially no development of gas until the billet is subjected to the extrusion pressure. Immediately after the pressure is applied there is intense developement of gas, and provided that the polyethylene or polyvinyl chloride is present in adequate amount the gas serves to lubricate the surface during the whole of the extrusion process. The polyethylene or polyvinyl chloride is not wholly converted into gas, and surprisingly a small tarry residue of the combustion is found to adhere to the leading end of the extruded tubing.

As an example, in the extrusion of a hollow billet of stainless steel to tubing over an uncovered mandrel through a die with an entrance angle of 27°, the die being made of 9% tungsten steel, I have found that a moulding 7 of polyvinyl chloride 2 mm. thick serves to lubricate completely a billet 380 mm. long, 164 mm. in outside diameter to produce tube of 62 mm. outside diameter and 50 mm. inside diameter, the extrusion ratio being 18:1 and the length of the tube being over 6 meters. In this example the inner wall of the extrusion container was lubricated with a mixture of oil and graphite in the usual way.

A particularly convenient way of using an organic material in the form of powder or granules is to mix these with a binder and enclose the mixture between two pieces of paper. A unit so formed is shown at 9 in FIGURES 2 and 3 and consists of two pieces 10 of corrugated paper of the desired size and shape, with the mixture of the organic material and binder 11 enclosed between them as in a sandwich. For use in a unit of 170 mm. external diameter and 65 mm. internal diameter the mixture may consist, for example, of 60 grams of polyethylene, 35 grams of polystyrol and ¼ litre of trichlorethylene, and it hardens when put between the pieces of paper.

If the unit 9 is to be used with a die held in a rotary carrier, it is put into position when the die is out of register with the container and must be frictionally held in position. For this purpose a spigot 12 is provided and consists of a tube 13 with a flange 14 which is pushed into the mixture 11 before this hardens. The tube 13 may be

of sheet metal, cardboard or any other convenient material.

The unit 9 can be handled with ease, and the corrugated paper acts as thermal insulation to prevent premature combustion or volatilisation of the organic material when the unit comes into contact with a hot surface.

A sleeve to be put over a mandrel may also be made as a sandwich.

In the die-forging process illustrated by FIGURES 4 and 5 flat discs 15 are used and overlap the effective area of dies 16 as shown in FIGURE 5. One disc 15 is put in the bottom die, the hot metal 17 is then put on it and another disc 15 is put on top of the hot metal immediately before the upper die is brought down.

I find that in an extrusion process the air available in the container of the press is adequate for the production of the gases by chemical reaction with the polyvinyl chloride or other material, but if necessary additional oxygen may be supplied. For example the moulding 7 may be covered with a layer of an oxidising agent or a material containing excess oxygen may be incorporated in the mixture 11. An example of a suitable oxidising agent in manganese dioxide. The oxidising agent will not be completely converted into gas and accordingly its presence is undesirable. If such an oxidising agent is used, therefore, it should be present in only a small amount, say not more than 5% by weight of the organic solid material.

The great advantage obtained by means of the invention is shown by tests made with one extrusion press used for the production of tubing of stainless steel containing about 18% chromium and 9% nickel with a small amount of titanium, the die being normally lubricated by a mixture of graphite and combustible materials. The average life of the dies in this particular press is 35 extrusions. The quality of the surface of the extruded stainless steel is such that from 50 to 70% of the tubes must be ground to remove surface blemishes. The average pressure required during the extrusion is about 84,000 p.s.i. measured on the cross-section of the billet.

On replacing the graphite lubricant by polyvinyl chloride in the form of mouldings 2 mm. thick, but making no other change, the average die life went up to 54 extrusions, the average number of tubes that needed grinding fell to below 50% and the average extrusion pressure fell to about 78,500 p.s.i.

When a more heat-resistant steel, containing about 18% chromium, 11.5% nickel and 2.2% molybdenum, was extruded with an extrusion ratio of 18:1 the average life of the dies with the graphite lubricant was 11 extrusions and the average pressure during the extrusion was

about 97,500 p.s.i. On replacing the lubricant by mouldings of polyvinyl chloride 2 mm. thick the average life rose to 24 extrusions and the average pressure fell to about 89,700 p.s.i.

The work normally carried out on a 1700 ton press requires only a 1530 ton press. Or conversely a 1700 ton press in which a lubricant according to the invention is used can extrude at a higher extrusion ratio than was heretofore possible, so that the output which can be obtained from the press is increased. These advantages are additional to the increase in tool life.

I claim:

1. In a method of producing a shaped metal body by subjecting a metal work-piece heated to a plastic condition to a metal shaping operation using shaping dies and pressure, the steps which comprise interposing between said heated work-piece and said shaping dies a lubricant layer consisting of a wholly solid organic material which becomes gaseous when under operating pressures between the hot metal work-piece and the shaping dies and applying pressure and vaporizing the wholly solid organic material whereby the vapor acts as the lubricant.

2. The method of claim 1 wherein the said organic material is a solid polymer selected from the group consisting of polyethylene and polyvinyl chloride.

3. The method of claim 1 wherein the organic material is in the form of a moulding.

4. The method of claim 1 wherein the organic material is retained in a combustible carrier.

5. The method of claim 1 wherein the organic material is a hardened mixture of polyethylene and polystyrol between sheets of corrugated paper.

References Cited in the file of this patent

UNITED STATES PATENTS

1,168,050	Benbow	Jan. 11, 1916
2,356,367	Wright	Aug. 22, 1944
2,459,164	Holst et al.	Jan. 18, 1949
2,757,138	Clato et al.	July 31, 1956
2,932,390	Edgecombe	Apr. 12, 1960
2,946,437	Edgecombe	July 26, 1960

FOREIGN PATENTS

1,191,503	France	Apr. 13, 1959

OTHER REFERENCES

Paper Number 57–LUB–1, Oct. 7–9, 1957, pub. by ASME, 29 W. 39th St., New York 18, N.Y., pp. 1–13.

"The Extrusion of Metals," by Claude E. Pearson, 1953, John Wiley and Sons, Inc., 440 4th Ave., New York, p. 120.