Hollow charge liners made of powder metal mixtures

The subject matter of the present invention is liners for hollow charges made of cold-pressed powder metal mixtures that are used for example for the purpose of blasting well drill holes in the oil and gas extraction industry.

For hollow charges that are used for the purpose of blasting well drill holes in the oil and gas extraction industry, the use of liners made of cold-pressed powder metal mixtures is prior art. Here, by powder metal mixtures are meant mixtures of metals and/or mixtures of alloys of metals in powder form. During cold-pressing, the powder metal mixtures are pressed into the final shape by compression under sufficiently high pressure without an additional supply of heat, as is disclosed in DE 19625897 B4. For this purpose, the mixture constituents of the powder metal mixture are previously mixed in accordance with their fractions. Hollow charge liners made of powder metal mixtures during blasting produce a dust jet, the terminal ballistic properties of which differ fundamentally from those of a plastically deforming jet, such as occurs when firing solid material liners. In particular, with hollow charge liners made of powder metal mixtures, even with low stand-off ranges, i.e. short distances between charge and target, it is possible to produce high penetration depths.

The powder metal mixtures that are used to manufacture the liners may vary widely. A mixture may contain for example 10 to 30 % by weight of a soft metal, which serves as a binding agent, while the remaining fraction of the mixture may comprise harder metals. As a binding agent, lead is used in the majority of commercially available liners. Also conceivable are other metals such as for example bismuth, silver, gold, tin, uranium, antimony, zinc, cobalt or nickel. The rest of the mixture often comprises heavy metals such as copper, bronze and/or tungsten in different mixing ratios.

In order to achieve greater penetration depths, in the relevant literature it is proposed to select as high a density as possible for the liner material. From an economic standpoint, therefore, tungsten in particular lends itself as a material for powder-metal hollow charge liners, as is proposed in US 5656791 A and DE 19625897 A1. This leads to powder mixtures of lead and tungsten, the maximum density of which is achieved with a ratio of 20% by weight lead to 80% by weight tungsten. With higher tungsten fractions, the compacts made from the mixture become unstable and can no longer be handled; lower tungsten fractions lead to a reduction of the density.

A problem that arises with liners made from mixtures of tungsten and lead is the formation of slugs. By slugs are meant residual pieces of the jet that block the penetration channels after the blast. In WO 2000/012858 A2 and US 6655291 B2 it is therefore proposed to add molybdenum to the tungsten-lead mixture in order to reduce slug formation.

A further drawback of pure tungsten-lead mixtures is the low hole diameter of the opening-shot holes. In the extraction of fluids from porous geological formations, the hole diameter of the opening-shot channel is however crucial for the hydraulic resistance during extraction. A large hole diameter combined with a high penetration depth is therefore considered advantageous.

An object of the present invention was to provide liners for hollow charges, by means of which a large hole diameter combined with a high penetration depth is achieved.

According to the invention, the object is achieved by the features of the main claim. Advantageous developments are indicated in the sub-claims. In this case, it was discovered that the addition of light-metal powders, for example aluminium powder and/or titanium powder, to

tungsten-lead mixtures or tungsten-copper/bronze-lead mixtures leads to a marked increase of the hole diameter without incurring large losses in terms of the penetration depth.

In addition to or instead of tungsten, tantalum and/or other heavy metals and/or alloys thereof may be used. Furthermore, given the addition of light-metal powders and higher fractions of lead in the mixture, tungsten may be entirely replaced by bronze or copper or a mixture of these. In this case, bronze and copper are usable in any desired mixing ratios.

The subject matter of the present invention is in particular:

Hollow charge liners made of powder metal mixtures that contain 1 to 46% by weight, in a preferred manner 1 to 16% by weight, in a particularly preferred manner 3 to 11% by weight aluminium and/or titanium, as well as lead and one or more substances selected from: one or more heavy metals and/or alloys thereof, in a preferred manner bronze, copper, tungsten, tantalum and/or molybdenum, and/or graphite.

Hollow charge liners made of powder metal mixtures that contain 14 to 30% by weight lead, 70 to 85% by weight tungsten and 1 to 16, in a preferred manner 3 to 11% by weight aluminium.

Hollow charge liners made of powder metal mixtures that contain 14 to 30% by weight lead, 70 to 85% by weight tungsten and 1 to 16, in a preferred manner 3 to 11% by weight titanium.

Hollow charge liners made of powder metal mixtures that contain 14 to 30% by weight lead, 10 to 50; in a preferred manner 10 to 30% by weight tungsten, 30 to 60, in a preferred manner 50 to 60% by weight bronze or copper or a mixture of these and 1 to 46, in a preferred manner 1

to 16, in a particularly preferred manner 3 to 11% by weight aluminium.

Hollow charge liners made from powder metal mixtures that contain 14 to 30% by weight lead, 10 to 50, in a preferred manner 10 to 30% by weight tungsten, 30 to 60, in a preferred manner 50 to 60% by weight bronze or copper or a mixture of these and 1 to 46, in a preferred manner 1 to 16, in a particularly preferred manner 3 to 11% by weight titanium.

Hollow charge liners made from powder metal mixtures that contain 14 to 50% by weight lead, 50 to 80% by weight bronze or copper or a mixture of these and 1 to 36, in a preferred manner 1 to 16, in a particularly preferred manner 3 to 11% by weight aluminium.

Hollow charge liners made from powder metal mixtures that contain 14 to 50% by weight lead, 50 to 80% by weight bronze or copper or a mixture of these and 1 to 36, in a preferred manner 1 to 16, in a particularly preferred manner 3 to 11% by weight titanium.

In order to avoid slugs, molybdenum may also be added to these powder metal mixtures according to the invention for manufacturing hollow charge liners.

Hollow charge liners made of powder metal mixtures that additionally contain graphite.

Hollow charge liners made of powder metal mixtures that, in addition to or instead of tungsten, contain tantalum and/or other heavy metals and/or alloys thereof.

Method of manufacturing hollow charge liners by cold-pressing powder metal mixtures.

Method of manufacturing hollow charge liners made of powder metal mixtures by mixing of the constituents in the appropriate fractions and subsequent compression into the final shape under sufficiently high pressure without an additional supply of heat.

Hollow charge liners according to the invention made of powder metal mixtures, manufactured by cold-pressing powder metal mixtures.

Use of the hollow charge liners according to the invention made of powder metal mixtures for blasting well drill holes.

The invention is described in detail by means of the following examples without thereby limiting the invention:

Example 1: Hollow charge liner 1

73.5 % by weight bronze
19.5 % by weight lead
7 % by weight titanium

Example 2: Hollow charge liner 2

34.7 % by weight bronze
19.8 % by weight lead
38 % by weight tungsten
7 % by weight aluminium
0.5 % by weight graphite

Claims

1. Hollow charge liners made of powder metal mixtures, characterized in that [they] contain 1 to 46% by weight, in a preferred manner 1 to 16% by weight, in a particularly preferred manner 3 to 11% by weight aluminium and/or titanium, as well as lead and one or more heavy metals and/or alloys thereof, in a preferred manner bronze, copper, tungsten, tantalum and/or molybdenum, as well as optionally graphite.

2. Hollow charge liners made of powder metal mixtures according to claim 1, characterized in that they contain 14 to 30% by weight lead, 70 to 85% by weight tungsten and 1 to 16, in a preferred manner 3 to 11% by weight aluminium.

3. Hollow charge liners made of powder metal mixtures according to claim 1, characterized in that they contain 14 to 30% by weight lead, 70 to 85% by weight tungsten and 1 to 16, in a preferred manner 3 to 11% by weight titanium.

4. Hollow charge liners made of powder metal mixtures according to claim 1, characterized in that they contain 14 to 30% by weight lead, 10 to 50; in a preferred manner 10 to 30% by weight tungsten, 30 to 60, in a preferred manner 50 to 60% by weight bronze or copper or a mixture of these and 1 to 46, in a preferred manner 1 to 16, in a particularly preferred manner 3 to 11% by weight aluminium.

5. Hollow charge liners made of powder metal mixtures according to claim 1, characterized in that they contain 14 to 30% by weight lead, 10 to 50, in a preferred manner 10 to 30% by weight tungsten, 30 to 60, in a preferred manner 50 to 60% by weight bronze or copper or a mixture of these and 1 to 46, in a preferred manner 1 to 16, in a particularly preferred manner 3 to 11% by weight titanium.

6. Hollow charge liners made of powder metal mixtures according to claim 1, characterized in that they contain 14 to 50% by weight lead, 50 to 80% by weight bronze or copper or a mixture of these and 1 to 36, in a preferred manner 1 to 16, in a particularly preferred manner 3 to 11% by weight aluminium.

7. Hollow charge liners made of powder metal mixtures according to claim 1, characterized in that they contain 14 to 50% by weight lead, 50 to 80% by weight bronze or copper or a mixture of these and 1 to 36, in a preferred manner 1 to 16, in a particularly preferred manner 3 to 11% by weight titanium.

8. Method of manufacturing hollow charge liners made of powder metal mixtures according to one or more of claims 1 to 7 by cold-pressing powder metal mixtures.

9. Method according to claim 8, characterized in that the constituents are mixed in the appropriate fractions and pressed into the final shape by compression under sufficiently high pressure without an additional supply of heat.

10. Hollow charge liners made of powder metal mixtures according to one or more of claims 1 to 7, manufactured by a method according to claim 8 or 9.

11. Use of hollow charge liners made of powder metal mixtures according to one or more of claims 1 to 8, characterized in that they are used in the blasting of well drill holes.