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[11] **3,768,792**

[45] **Oct. 30, 1973**

[54] **CONDENSATION OF METAL VAPOUR**

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Related U.S. Application Data

[63] Continuation of Ser. No. 52,529, July 6, 1970, abandoned.

[52] **U.S. Cl.** .... **266/34 R,** 75/88, 266/15

[51] **Int. Cl.** **C22b 13/06**

[58] **Field of Search** .... 75/88; 266/1 R, 15, 266/16, 34 R

[56] **References Cited**

UNITED STATES PATENTS

2,671,725 3/1954 Robson et al. 75/88

Primary Examiner—Gerald A. Dost

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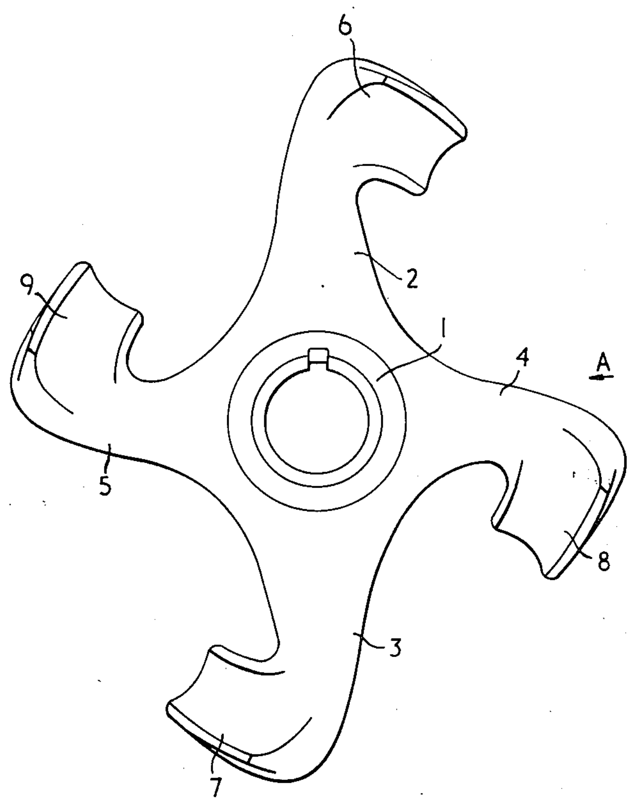
[57] **ABSTRACT**

An impeller suitable to throw up a spray of molten lead in a lead-splash condenser has at least one longer arm and at least one shorter arm, and preferably four arms arranged long-short-long-short, to improve condenser efficiency.

7 Claims, 3 Drawing Figures



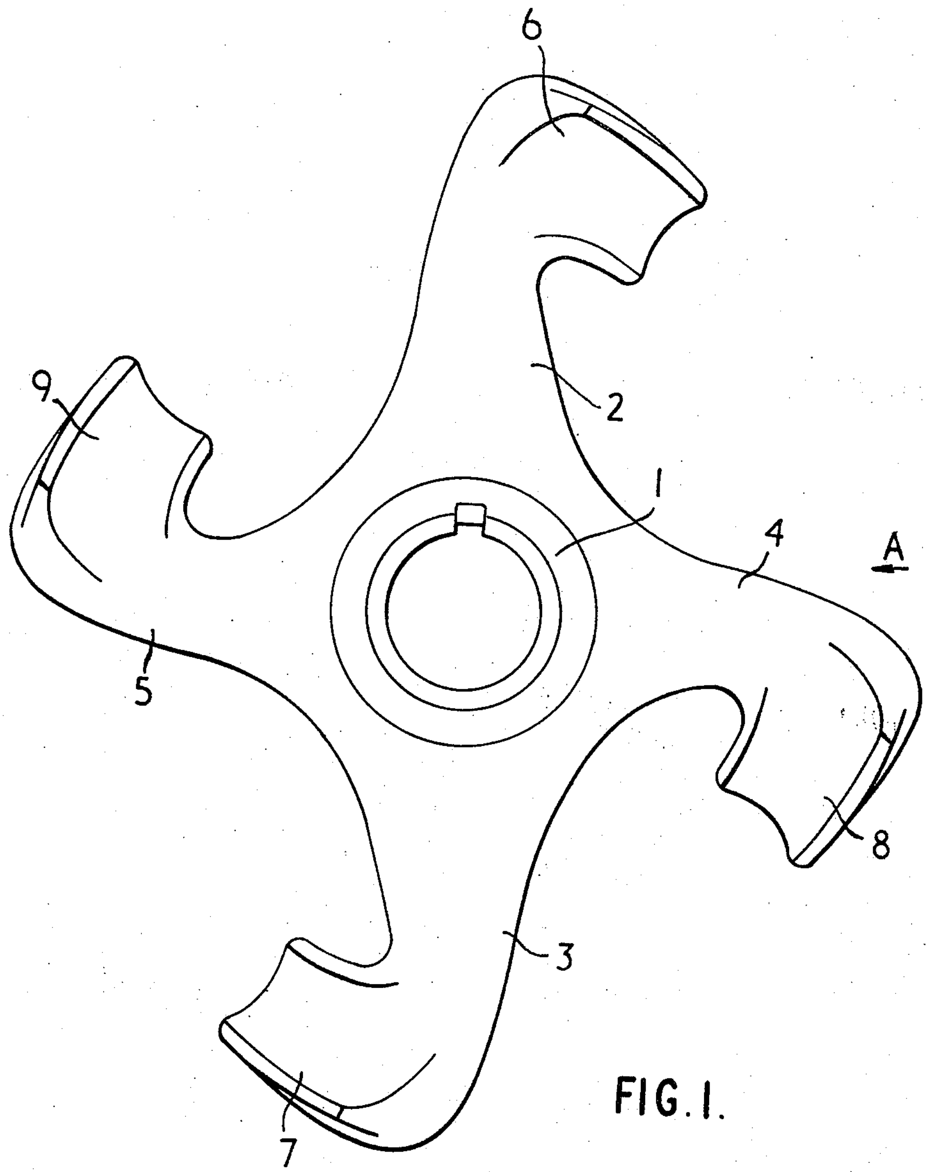


FIG. 1.

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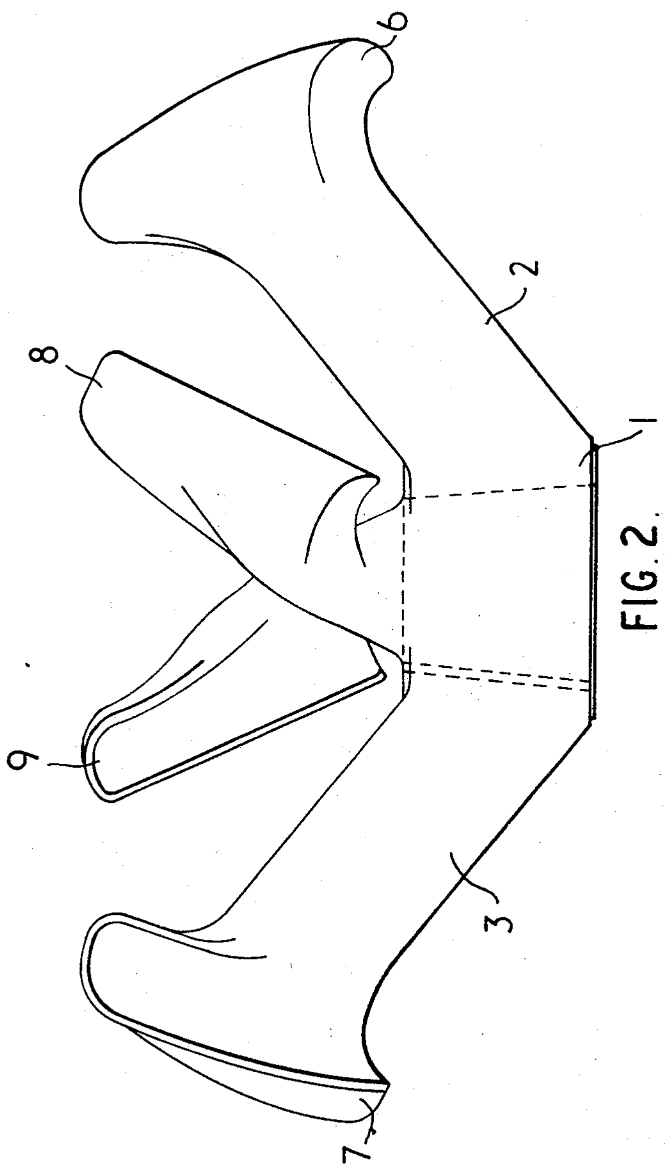

FIG. 2.

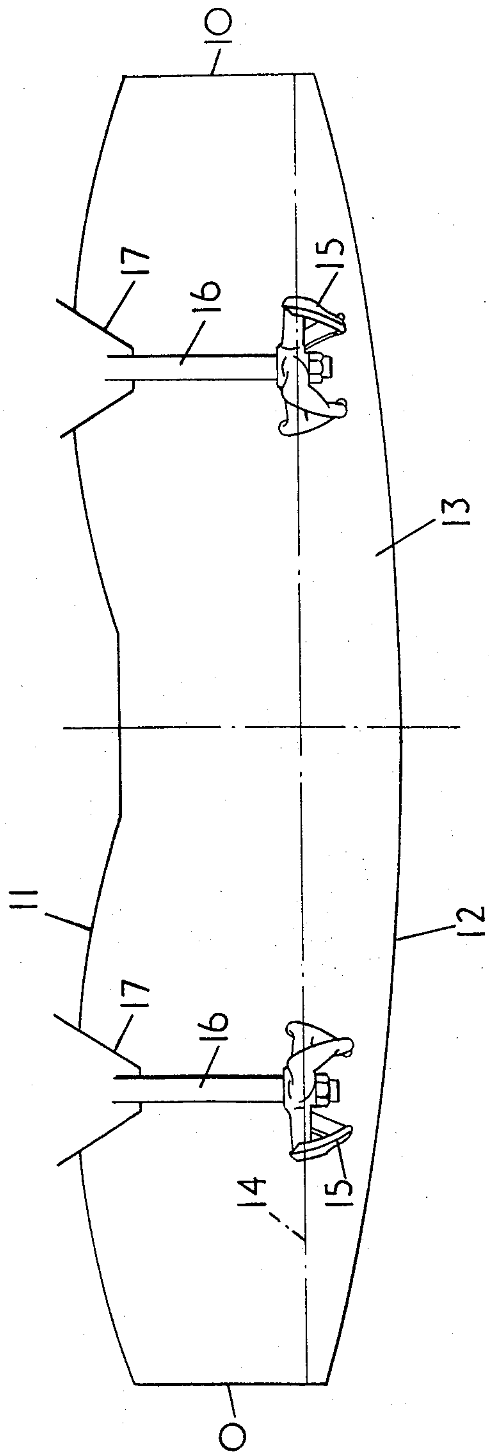

FIG. 3.

CONDENSATION OF METAL VAPOUR

This is a continuation of application Ser. No. 52,529 filed July 6, 1970, and now abandoned.

This invention relates to the condensation of zinc vapour, such as that produced in a zinc blast furnace and to apparatus used to condense zinc vapour.

It is now established that zinc vapour can be condensed by passing it through a condenser containing a pool of molten lead which is impelled as a spray of droplets into the space above the pool by an impeller or a series of impellers. Zinc vapour thus condensed and dissolved in the lead and zinc can subsequently be recovered by circulating the zinc-containing lead through a cooling launder so as to separate a layer of zinc on the surface of the molten metal. This system has the advantage that the zinc vapour is "shock-chilled" from a relatively high temperature (900° – 1,000° C) at which it shows relatively little tendency to revert to zinc oxide due to reaction with carbon dioxide in the gases with which it is associated. Once condensed and dissolved in the molten lead the tendency of the zinc to oxidise is much reduced due to the condensed form of the metal and when separated from the lead the zinc only oxidises slightly on the surface.

In the past the impeller used to throw up the molten lead has generally been in the form of a shaft with four arms of equal length attached to the end thereof, which shaft has been immersed in the lead pool to a suitable depth and rotated by a suitable motor. The arms normally have scoops formed at their ends to throw up molten lead.

The present invention is based upon the surprising discovery that by making impeller arms of unequal length an improvement is obtained in condenser operation and efficiency.

In one aspect, the invention provides an impeller for rotation around a vertical axis and having at least two impeller arms at least one of which differs in length from at least one other, the construction of the impeller being suitable for at least partial immersion and rotation in a body of molten lead to cast up a spray of droplets.

Generally, there will be an even number, and usually four, or possibly six, arms. There are indications that the more arms, the finer the spray. The use of four arms, with two longer arms each of the same length and two shorter arms each of the same length, all generally radially extending and distributed around the vertical axis in a successive long-short-long-short arrangement is particularly advantageous. For convenience the arms may be spaced at essentially 90° between adjacent arms.

Usually, the impeller arms will extend at an angle to the horizontal with their lower end farther from the vertical rotation axis. This angle of the arms appears to have less effect on performance than the distribution of the arms as seen in plan view, and, for example, they may all extend downwards at the same angle (whereby arms of different lengths will reach different vertical heights) or may be arranged to reach the same vertical height whatever their length so that arms of different lengths will extend downwards at different angles.

A suitable material of construction for the impeller has been found to be ferritic 3% chromium steel, in which the arms, and any central boss suitable for affixing to a vertical shaft, can be cast in one solid piece.

An advantageous form of impeller according to the invention has a pair of opposed arms on a first diameter and a pair of opposed arms on a second diameter, and scoops on the ends of the arms, the difference in diameters being between ¼ and four times scoop width. In practical embodiments the difference in diameter can be up to 6 inches, but is generally between 2 and 3 inches.

Various expedients can be utilised at the ends of the blades provided that the strength of the blades is not prejudiced. For example, they can be flattened, rounded, or scoop-shaped to throw off molten metal in various trajectories, depending on the nature of the scoop.

A second aspect of the invention consists in a lead-splash condenser fitted with at least one impeller as described above.

Preferably, a rotary shaft extends downwards through a roof portion of the condenser and the impeller is mounted on this shaft. There will usually be a plurality of such impellers within the condenser, the arrangement being basically governed by consideration of the condenser volume which can be irrigated by one impeller, which is typically 150–200 cubic feet. Other possible considerations include a preference for a central position to give adequate spray coverage of condenser walls and roof, close enough positioning of impellers to give mutual irrigation of shafts and seals to prevent accretions, and leaving enough space at the downstream or outlet end of the condenser to minimise lead droplet carry over. This last result can also be achieved by using a conventional impeller, of equal arm lengths, as the last impeller before the outlet.

A third aspect of the invention consists in a method of condensing zinc vapour, for example as present in the offtake gas from a zinc blast furnace, wherein a lead-splash condenser fitted with an impeller as described above is used.

The impeller may be immersed in the body of molten lead to a depth of up to 10.5 inches, preferably 6.75 240.5 inches and be rotated at, say, 200–500 r.p.m.

The invention will be further described with reference to the accompanying drawings in which:

FIG. 1 shows a plan view of an impeller according to the invention, as mounted on a shaft (not shown);

FIG. 2 shows a view on arrow A of FIG. 1 of the demounted and inverted impeller;

FIG. 3 shows a schematic side view through a lead-splash condenser in which are mounted two impellers of the type shown in FIGS. 1 and 2.

As shown in FIG. 1 the impeller according to the invention has a central boss **1** with arms **2, 3, 4, 5**; arms **2** and **3** being longer than **4** and **5**. The arms terminate in scoops **6, 7, 8** and **9** which serve to impel lead into the space above the pool as the impeller is rotated.

FIG. 3 shows a lead-splash condenser having wall members **10**, an over-arching condenser roof **11**, and a floor **12**. A pool **13** of molten lead lies at the bottom of the condenser, the level of the molten lead pool being indicated by reference numeral **14**. Two impellers **15** of the type shown in FIGS. 1 and 2 are mounted on rotary shafts **16** which pass through glands **17** in the condenser roof **11**, the impellers **15** being partially immersed in the pool of molten lead. In use, rotation of the impellers **15** on the shafts **16** gives adequate spray coverage of the condenser walls and roof, the two impellers being positioned for mutual irrigation.

The invention will be further described with reference to the following non-limiting Examples. In the Examples the diameters referred to are measured between the inside tips of the bottom outer edges of the scoop on opposed arms.

EXAMPLE 1

The use of an impeller having unequal arms (namely a 2 inch difference in outside diameter between the long and short pairs of arms with a blade scoop width of 2½ inches) compared with a standard impeller having equal length arms, with 7 inches depth of the impeller immersed in a molten lead pool, gave a 2.46 to 2.92% increase in condenser efficiency over a period of 30 days. There was a 50 to 53% reduction of zinc in "blue powder," (the material condensed by water scrubbing the gases leaving the condenser exit) and a 7 to 18% increase in zinc in dross collected in the sump of of the lead pumps used to circulate the molten lead through the condenser.

The improvement in condensation efficiency is apparently due to the impeller producing a more dense and uniform "curtain" of lead droplets within the condenser although this is not certain.

EXAMPLE 2

A comparison was carried out between an impeller having four arms with a diameter of 16.8 inches and an impeller having two arms with a diameter of 16.8 inches and two with a diameter of 19 inches arranged as shown in the drawings.

This test was carried out in a water test tank. Such tests carried out with water give a good analogy to the lead-splash condenser, because;

a. molten lead has similar physical properties to mercury at room temperature, and experimental comparisons between mercury and water sprays from identical nozzles and under similar conditions, reported in the literature, show a similarity of drop size.

b. there is a good correspondence between plant experience with new impellers and under different operating conditions (i.e., of immersion and speed) with that predicted from test tank work, with respect to such factors as power consumption and condenser roof irrigation.

The advantages of the unequal arm length impeller were as follows, at the normal speed of operation of 300 r.p.m.

1. A total rate of splashing which is higher by approximately 30%.
2. A more even spray distribution across the condenser chamber space at higher immersions, within the range of immersion normally experienced in a lead-splash condenser. This advantage may alternatively be expressed as a spray distribution which is less adversely affected by the variation of immersion, i.e., between 7 and 9 inches, normally encountered.
3. Better roof irrigation resulting in a cleaner condenser and a greater intensity of spray resulting from rebound from the roof.

EXAMPLE 3

A lead-splash condenser was operated with the impeller in the first stage, i.e., the impeller nearest the gas inlet, having two arms at a diameter of 19 inches and two arms at a diameter of 16.8 inches, at right angles to the first two. It was found that this led to reduced accretion on the shaft, and lower temperatures at the roof tiles and condenser offtake. This implies improved irrigation of the condenser space and is consistent with the water test tank results.

EXAMPLE 4

Similar impellers to those of Example 3 but with arm diameters of 19 and 16.8 inches were used (*a*) to substitute two conventional impellers and (*b*) to substitute four conventional impellers. Results are shown in Table I.

TABLE I

Configuration	Zinc loss to blue powder (lb./ton zinc vol.)	Lead loss to blue powder (lb./ton zinc vol.)
Normal	103.2	66.7
2 unequal arm length impellers	89.8	64.5
4 unequal arm length impellers, 1 in. extra impeller immersion	71.9	54.2

"Blue powder" is the oxidised metal recovered as powder from the outlet gases from the condenser. This decrease in "blue powder" signifies a considerable increase in condenser efficiency and consequently in economic performance of the process. It was also observed that accretion was generally reduced and roof temperature decreased.

We claim:

1. A lead-splash condenser for the condensation of zinc vapour having wall members, an over-arching condenser roof, at least one rotary shaft extending downwards through the said condenser roof, and an impeller on the said shaft so as to give adequate spray coverage of the condenser walls and roof, and wherein the impeller has a plurality of impeller arms extending generally radially from the said vertical shaft, adjacent impeller arms being of unequal lengths.

2. A lead-splash condenser as claimed in claim **1**, wherein the impeller has two longer impeller arms each of the same length and two shorter impeller arms each of the same length, the said arms being distributed around the said vertical shaft in a successive long-short-long-short arrangement.

3. A lead-splash condenser as claimed in claim **1**, wherein the said impeller arms are spaced at essentially 90° between the arms of each adjacent pair.

4. A lead-splash condenser as claimed in claim **1**, wherein the said impeller arms extend at an angle to the horizontal with their lower ends further from the vertical rotation axis.

5. A lead-splash condenser as claimed in claim **1**, wherein the impeller has a pair of opposed impeller arms on a first diameter and a pair of opposed impeller arms on a second diameter, and scoops on the ends of the impeller arms, the difference in diameters being between one-quarter and four times the scoop width.

6. A lead-splash condenser as claimed in claim **5**, wherein the said difference in diameters is between 2 and 3 inches.

7. A lead-splash condenser as claimed in claim **1**, having at least two rotary shafts each carrying an impeller and positioned for mutual irrigation.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,768,792 Dated October 30, 1973

Inventor(s) Frank George Simmon Benatt et al

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Col. 2, line 41, "240.5" should read -- ± 0.5 --.

Signed and sealed this 23rd day of April 1974.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents