United States Patent [19]

Vollhardt et al.

[11] **3,791,441**

[45] **Feb. 12, 1974**

[54] METHOD OF COOLING CRACKED GAS, SYNTHESIS GAS AND SIMILAR GASES

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[22] Filed: **May 3, 1971**

[21] Appl. No.: **139,878**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 811,746, April 1, 1969, abandoned.

[52] **U.S. Cl.** **165/1,** 165/104, 261/152

[51] **Int. Cl.** **F28d 13/00**

[58] **Field of Search** ..... 165/1, 104, 180, 60 ML; 261/152

[56] **References Cited**

UNITED STATES PATENTS

3,279,441	10/1966	Lippert et al.	261/152
3,364,982	1/1968	Jaffe	165/1

FOREIGN PATENTS OR APPLICATIONS

719,932	12/1954	Great Britain	165/1

Primary Examiner—Charles Sukalo

[57] **ABSTRACT**

A method of cooling gases, especially cracked gas or synthesis gas from hydrocarbons, in which the gas to be cooled is passed under pressure through a metal bath for transferring heat from said gas to said metal bath, said gas being in direct contact with the molten metal, while the temperature of said metal bath is maintained substantially constant by a cooling medium which is variable as to heat absorption.

12 Claims, 5 Drawing Figures

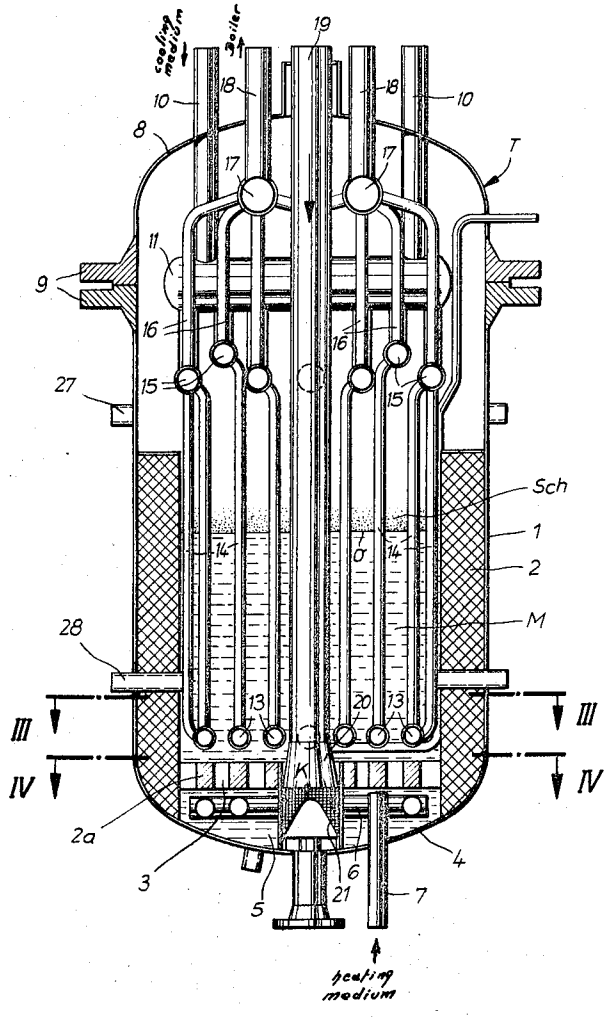

Fig. 1

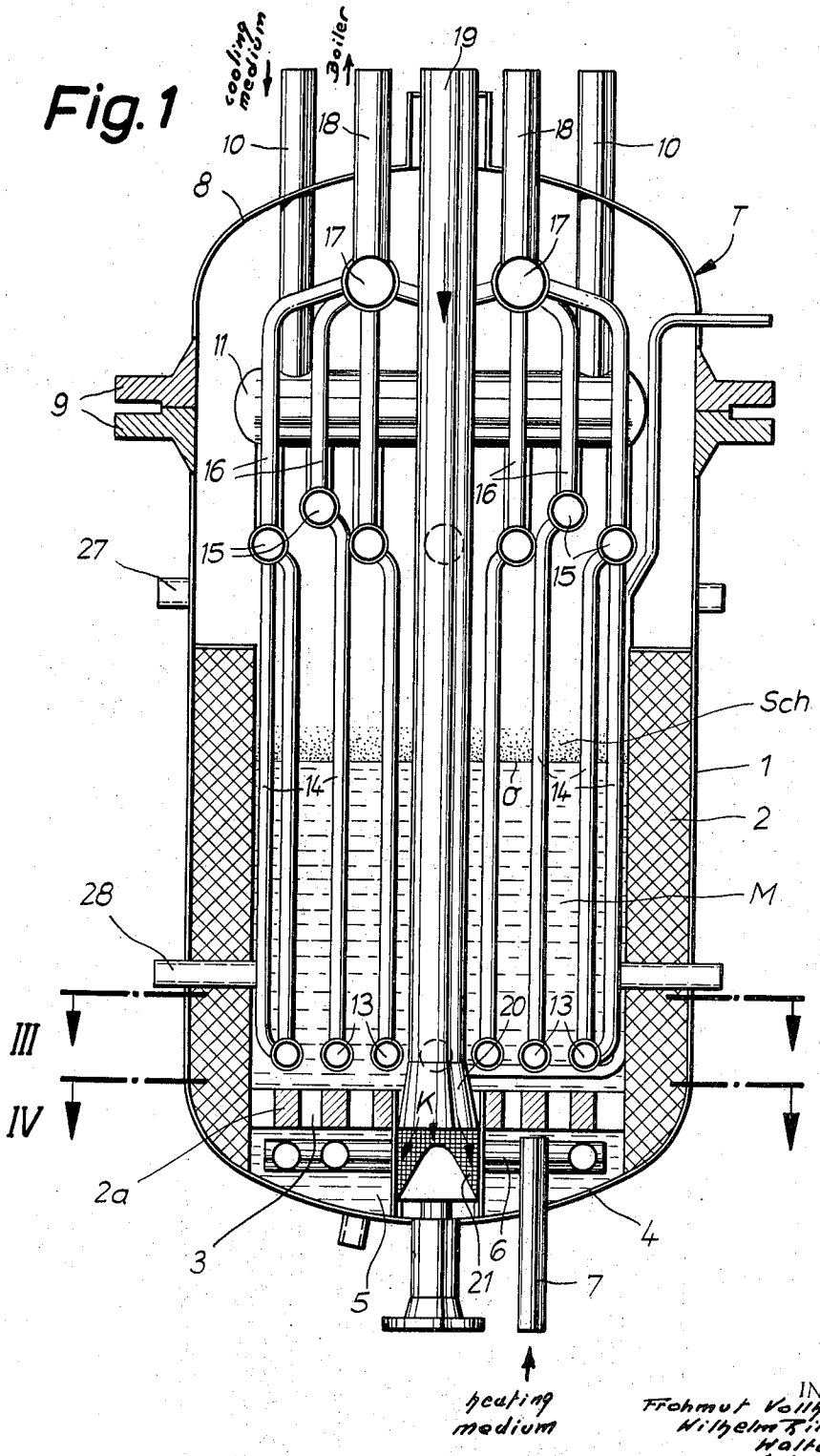

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Fig. 2

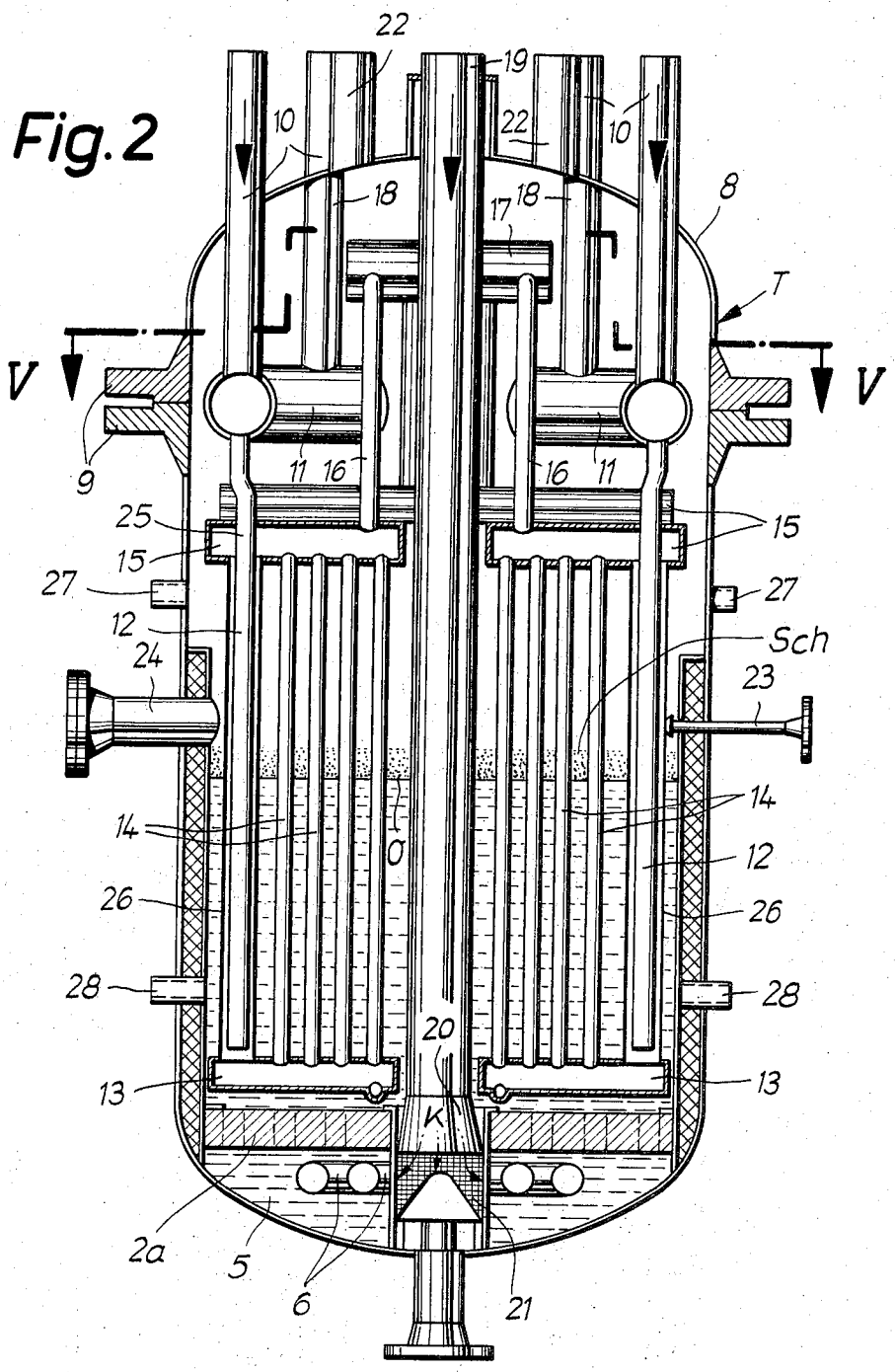

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Fig.3

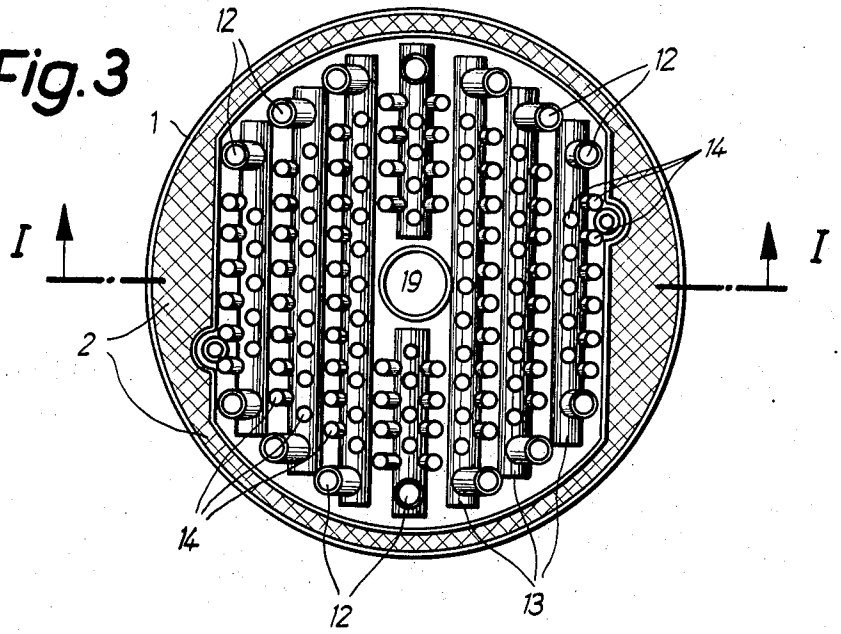

Fig.4

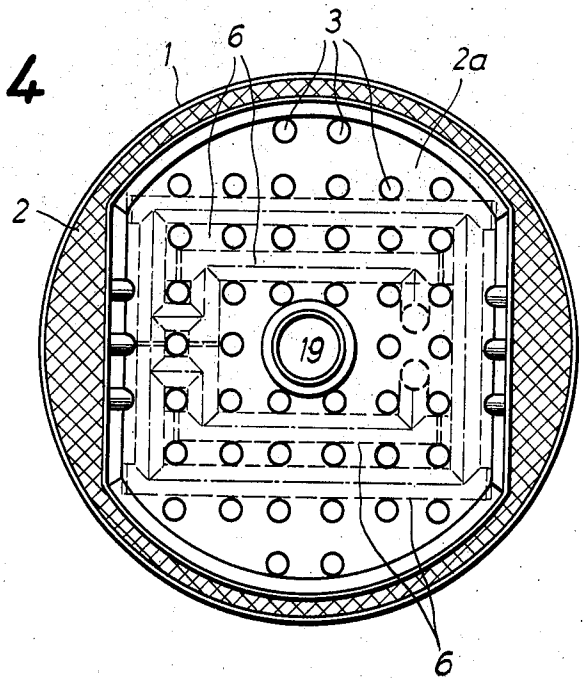

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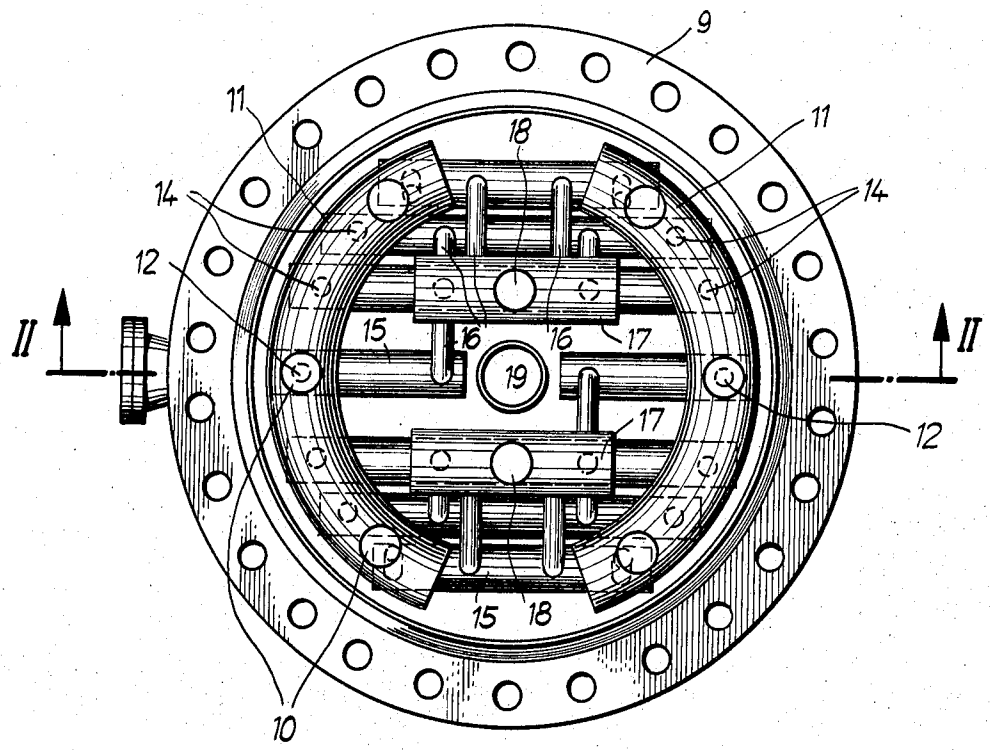
Fig. 5



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METHOD OF COOLING CRACKED GAS, SYNTHESIS GAS AND SIMILAR GASES

This invention is a continuation-in-part application of our application Ser. No. 811,746, filed Apr. 1, 1969, now abandoned.

The present invention relates to a method of cooling cracked gas or synthesis gas from hydrocarbons in which the gas is passed under a pressure through a metal bath to remove heat, said gas being in direct contact with the molten metal. The method according to the invention may also be used in the same manner for cooling gases which during the process have a behavior similar to that of cracked or synthesis gas as, for instance, noble gases, particularly helium from a reactor.

One of the problems to be dealt with when cracking naphtha, for instance, is the coking in coolers for quenching cracked gases which causes stoppages after comparatively short periods of time. This coking increases when starting materials having a higher boiling range are used. It would not be possible to control the quenching of cracked gases from gas oil with conventional coolers for indirect cooling in which water is employed as the heat transfer medium.

It is an object of the invention to provide a process for the cooling of cracked gas or synthesis gas from hydrocarbons in which the risk is avoided.

It is another object of the present invention to provide a process by which high pressure steam can be produced.

This and other objects and advantages are achieved by passing the gas to be cooled under pressure through a metal bath in order to transfer heat from said gas to said metal bath, said gas being in direct contact with the molten metal, and maintaining the temperature of the said metal bath substantially constant by a cooling medium which is variable as to heat absorption, said cooling medium being passed into or through said metal bath.

The invention will appear more clearly from the following description and the accompanying drawings, in which:

FIG. 1 illustrates a longitudinal section through the heat exchanger according to the invention, said section being taken along the line I—I of FIG. 3.

FIG. 2 illustrates a section taken along the line II—II of FIG. 5, which section is taken at a right angle with regard to the section of FIG. 1.

FIGS. 3, 4 and 5 respectively illustrate cross sections through the heat exchanger of the invention, said sections being, taken along the lines III—III, IV—IV and V—V of FIG. 2.

Hydrocarbons from which the cracked gas or the synthesis gas are produced are preferably natural gas, naphtha or higher boiling hydrocarbons such as light oil or crude oil.

A suitable temperature range for the quenching of the gas to be cooled is from 330°C to 450°C, preferably from 340°C to 400°C.

The method according to the present invention for cooling cracked gas or synthesis gas from hydrocarbons, in which the gas is passed under pressure through a metal bath for purpose of heat removal, is characterized in that for purposes of maintaining the temperature of the metal bath constant, a cooling medium variable as to heat absorption is introduced into or passed

through the metal bath. This cooling medium preferably consists of water or steam.

Maintaining constant the bath temperature and the gas exit temperature may be realized by varying the temperature and/or quantity and/or flow rate of the cooling medium.

According to a further feature of the invention, the metal bath level may be raised or lowered in order to change the metal bath temperature and thus the gas exit temperature.

Soiling particles collecting at the surface of the metal bath may be removed by overlfowing or blowing, either continuously or intermittently, in spite of the cooling medium being introduced or passed through the metal bath.

Preferably, metals or alloys are used for the metal bath which are inert to the gases to be cooled, whose steam pressures at 400°C. are less than 10^{-3} and whose melting points are less than 350°C. Such metals are, for instance, bismuth, tin and thallium. Suitable alloys are, for instance, lead alloys containing various quantities of silver, bismuth, thallium or tin and the melting points of which are below 350°C. Particularly suitable are lead alloys with up to approximately 20 percent by weight of bismuth or silver.

The heat exchanger for carrying out the method according to the present invention has a gas feed conduit which is equipped with a screen-like exit end and extends into the vicinity of the exchanger bottom. The gas feed conduit in the exchanger is surrounded by pipes of the type conventionally used in heat exchangers for water or steam. These pipes form a pipe nest or cylinder and are connected to an upper and lower distributing and collecting chamber while being parallel to the gas feed line.

For purposes of withdrawing soiling particles from the surface of the metal bath, the exchanger jacket is provided in about the middle with at least one blow nozzle and a dirt discharge opening.

Referring now to the drawings in detail, the heat exchanger according to the present invention is formed by an upright pressure vessel T which may rest on the furnace foundation by means of legs (not shown). Additional steel supports are not necessary and the vessel may be connected to the connecting lines leading to the cooling surface.

More specifically, jacket 1 is lined partially with an insulating ramming mix 2 which at its lower end has a bridge 2*a* which is provided with bores 3 and consists of ceramic or other heat-resistant material. Between the bottom of this bridge and the bottom 4 of the pressure vessel there is an intermediate space 5 in which a labyrinth-like heat conveying line 6 is provided which receives a heating medium through a pipe 7 so that the contents of chamber 5 is heated and the metal is made liquid or remains liquid. A number of downcomers 10 for the cooling medium extend into the interior of vessel T through the hood 8 which by means of flanges 9 is connected to the jacked 1. These downcomers lead in threes to two semi-circular collecting chambers 11. From these collecting chambers pipes 12 (FIGS. 2, 3 and 5) extend vertically in downward direction. The said pipes 12 lead into horizontal distributing chambers 13 from which extend upwardly directed further pipes 14 which lead to tubular collecting chambers 15. From these chambers the steam is passed through conduits 16 to further collecting chambers 17 and from there

through risers **18** to a boiler drum (not shown). The cracked gas or synthesis gas to be cooled is conveyed from a gas feed pipe **19** extending through hood **8** and centrally through drum T, while the conical end **20** of the pipe **19** is located in the vicinity of the bottom **4.** The gas leaving the conical end of pipe **19** enters the chamber **5** directly or through the screen **21** in the direction of the arrows K where it is deflected upwardly and passes through the bores **3** of the bridge **2a**, thus penetrating the metal bath in the lower section of the pressure vessel which is lined with ramming mix. The gas gives off its heat to the said bath, leaves the gas outlet **22** (FIG. **2**) and may then be put to other uses.

The soiling particles Sch which collect at the surface **0** of the metal M preferably of the lead bath are forced toward the dirt discharge **24** by means of steam from a nozzle **23.** Preferably, a plurality of these nozzles are directed radially or toward the discharge **24** so that in spite of the arrangement of the pipes **12,14** the dirt or soiling particles can be removed from the vessel.

The pipes **12,** the upper sections of which extend at **25** through the tubular collecting chambers **15,** are surrounded by a jacket **26.**

In order to maintain the temperature of the metal bath and thus of the effluent gas constant, the cooling medium in conduits **14** may be varied and the metal bath level may be raised or lowered. Outlets and inlets **27, 28** from and to a metal melting furnace are provided to this end.

It is, of course, to be understood that the present invention is by no means limited to the particular method and heat exchanger set forth above, but may also comprise any modifications within the scope of the appended claims.

We claim:

1. A method of cooling cracked gases or synthesis gases from hydrocarbons whereby the problem of coking is substantially eliminated which comprises: passing said cracked gases or synthesis gases from hydrocarbons to be cooled under pressure through a lower temperature molten metal bath which does not undergo external circulation and under conditions such that no substantial evaporation of metal takes place, said gas being in direct contact with the molten metal, and maintaining the temperature of said metal bath substantially constant by indirect heat exchange by passing water and/or steam as a cooling medium through said metal bath.

2. A method according to claim **1,** which includes the step of selectively lowering and raising the level of said metal bath to thereby vary the gas exit temperature.

3. A method according to claim **1,** which includes the step of varying the temperature of the cooling medium to vary the gas exit temperature.

4. A method according to claim **1,** which includes the step of varying the quantity of the cooling medium to vary the gas exit temperature.

5. A method according to claim **1,** which includes the step of varying the speed at which the cooling medium is passed through the metal bath.

6. A method according to claim **1,** which includes the step of collecting soiling particles from the surface of the metal bath while said cooling process is in operation.

7. A method according to claim **1,** in which said metal bath comprises at least one metal which is inert to the cooling gas used, which at 400°C has a vapor pressure less than 10^{-3} mm Hg and which has a melting point of less than 350°C.

8. A method according to claim **7,** in which said metal bath comprises at least one alloy which is inert to the cooling gas used, which at 400°C has a vapor pressure less than 10^{-3}, and which has a melting point of less than 350°C.

9. A method according to claim **7,** in which said metal bath includes at least one metal of the group consisting of bismuth, tin and thallium.

10. A method according to claim **8,** in which said bath comprises a lead alloy.

11. A method according to claim **1,** in which the temperature of the metal bath to be maintained substantially constant is from 330°C to 450°C.

12. A method according to claim **1,** in which the temperature of the metal bath to be maintained substantially constant is from 340°C to 400°C.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,791,441 Dated February 12, 1974

Inventor(s) Fronhmut Vollhardt et al.

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

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First page, left-hand column, tenth line,"Badische Anilin & Soda Fabrik Akteingesellschaft" should read -- Badische Anilin- & Soda-Fabrik Akteingesellschaft --.

Signed and sealed this 17th day of December 1974.

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

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