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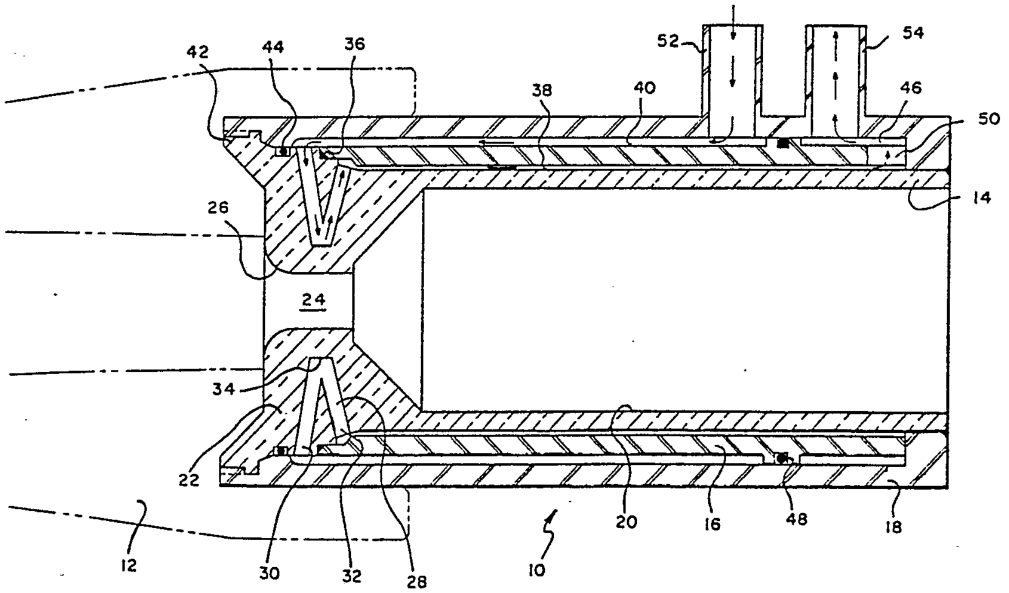
(54) Title: ULTRAHIGH VELOCITY WATER COOLING



(57) Abstract

A cooling system for devices utilized with a melting furnace for producing mineral wool including tapholes (10), troughs (110) and spinners (210) provides protection from wear of such devices. The system allows a film of solid material of predictable, constant thickness to freeze on the working surface (20) of the device. Each device is comprised of a copper shell (14) and includes a coolant guide (16) having a surface which is closely spaced from the nonworking surface of the device to from a highly restrictive, narrow flow passage therebetween. A liquid coolant is supplied to the passage where the velocity of the same is made to accelerate to an ultrahigh velocity of at least 10 feet per second across the inner surface of the shell to thereby sweep away steam generated upon the surface.

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Description

ULTRAHIGH VELOCITY WATER COOLING

Technical Field

This invention is directed toward the production of mineral wool fibers for thermal insulation. More particularly, the invention provides a means for effectively cooling various elements of a mineral wool production system.

Background Art

In the production of mineral wool fibers, molten material from a furnace flows through a taphole into a trough and is directed onto the surface of a fiberizing spinner. Because of the extremely high heat generated by the molten material flowing through the taphole, it has been known for sometime that provisions must be made for cooling such tapholes. This has been conventionally accomplished by constructing the taphole from steel and water cooling the steel. However, this approach has been less than effective and results in an unpredictable, varying buildup or "skull," of solid material at the working surface of the cooled metal and a correspondingly uneven discharge of molten material.

Troughs for delivery of molten material have been one of the banes of designers for years. Refractory construction is expensive and short-lived in air, builds up unpredictable accretions as the "system" attempts to reach thermal steady state and therefore corrupts an otherwise steady delivery into an unsteady, wavering flow. Essentially the same criticism applies to water-cooled metal troughs, particularly since these have invariably been made of carbon or stainless steel, cooled in a conventional manner. To date, no one has been able to produce a trough capable of providing a constant, unwavering flow of material from the discharge end thereof.

The function of a fiberizing spinner is to impart kinetic energy to the stream of molten material so that high velocity air, steam or other vapor, impinging on the rapidly moving stream of molten material, can force that stream into a multiplicity of small diameter fibers of considerable length.

For the long fiber, low density mineral wool in general use in the United States for attic insulation, single wheel spinners have proved quite effective. For higher density fiber for cavity wall retrofit or industrial pipe covering, ceiling tiles, etc., it is more customary worldwide to use the so-called "four-wheel" spinner.

This four-wheeled spinner consists of 4 parallel, powered spindles each terminating in a water-cooled wheel of 10 to 14 inches in diameter with a 4 to 5 inch rim width, all 4 wheels being mounted in the same plane so that molten material dropping onto the top wheel is given velocity and slung onto the second wheel, and so on. Past the lowest, or third and fourth wheels, high velocity air or steam pushes the now highly energetic molten material laterally with such force that it separates into fibers.

These 4 spinner wheels have in the past been constructed of steel, conventionally water-cooled. As a result, the wheels are worn out by approximately one week's work and have to be refaced at considerable expense.

As explained more fully in Applicant's United States Patent No. 4,032,705 (the entire subject matter thereof being included herein by reference), Applicant has discovered that the rapid, consistent removal of large quantities of energy (in the range of 1 BTU per square inch per second) through a water-cooled metal barrier, without damage to that barrier, requires that the metal have excellent thermal conductivity and a reasonably high melting point, and be force-cooled at a constant temperature by the creation and efficient removal of steam at its back face.

Converting 1 pound of water into steam requires 967 BTU's of heat at 212^{o}F (or 536 calories per gram at 100^{o}C).

If water can be made to present itself consistently to the area to be cooled and there to turn into steam, and then to leave the area immediately to make room for more water to arrive, a highly efficient and predictable cooling system results. The area to be cooled must, of course, be kept free of accretion to obviate the film effects which are adverse to efficient thermal transfer.

Experimentation has shown that the best way to remove the steam film as rapidly as it forms is by applying ultrahigh velocity cooling water to the back surface of the metal barrier. A cooling water velocity of at least 10 feet per second has proved to be required, and this velocity must be at the surface of the metal, not merely at the center of a substantial cooling passage of which the metal barrier is one of the walls. The preferred water cooling velocity is at least 20 feet per second. It should be readily apparent that such velocities require high flow rates through small passages, thereby generating pressure drops of the order of 20 to 60 psi, depending on the surfaces, shapes and length of the area to be cooled.

To enhance the effectiveness of this cooling, a readily workable metal of reasonable cost and melting point and high thermal conductivity is required. From a table of the physical properties of the elements, a selection of an easily workable, relatively inexpensive material with a melting point about 1,000^{o}C and good thermal transfer capability results in the following list:

ELEMENT	MELTING POINT (^{o}C)	CONDUCTIVITY (calgmcm/sqcm/sec/^{o}C)
Chromium (Cr)	1875	0.16
Copper (Cu)	1083	0.943
Iron (Fe)	1537	0.18
Molybdenum (Mo)	2610	0.34
Nickel (Ni)	1453	0.22
Silver (Ag)	960	1.00 (for comparison)

Chromium, molybdenum and nickel are not really easily workable and they are relatively expensive. Furthermore, these materials have thermal conductivities which are from 3 to 5 times poorer than that of copper.

Because of the relatively low melting point of copper and the corresponding higher melting point of iron, the automatic and quite incorrect choice in the past for a water-cooled taphole, trough or spinner has been steel. This has been true even though it has a thermal transfer ability less than 1/5 that of copper. Furthermore, for a number of reasons, the water-cooled steel has a tendency to form films thereon of a highly insulating nature.

Compounding this technical felony is the fact that, to Applicant's knowledge, no attempt has been made to ensure the efficient removal of heat energy from the back face of a taphole orifice, a trough or a spinner by the encouragement of steam formation, against a clean surface, made effective by the immediate removal of that steam by new cooling water moving at "ultrahigh velocity." It should be pointed out that the use of stainless steel only makes matters worse since stainless steel grades have thermal transfer abilities 16 to 24 times poorer than copper.

Disclosure of Invention

The present invention overcomes the problems of the prior art and provides a taphole, trough or spinner which is protected from wear and which allows a film of solid material or "skull" of predictable, constant thickness to freeze on its working surface. The taphole, trough or spinner is comprised of a copper shell and includes a coolant guide having a surface which is closely spaced from the nonworking surface of the taphole, trough or spinner to form a highly restrictive, narrow flow passage therebetween. A liquid coolant is supplied to the passage where the velocity of the same is made to accelerate to an ultrahigh velocity of at least 10 feet per second across the inner surface of the shell to thereby sweep away steam generated upon the surface.

Brief Description of Drawings

For the purpose of illustrating the invention, there are shown in the accompanying drawings forms which are presently preferred; it being understood that the invention is not intended to be limited to the precise arrangements and instrumentalities shown.

Figure 1 is a cross-sectional view of an ultrahigh velocity water-cooled copper taphole constructed in accordance with the principles of the present invention;

Figure 2 is a lengthwise cross-sectional view of an ultrahigh velocity water-cooled copper trough;

Figure 3 is a cross-sectional view taken along the lines 3-3 of Figure 2, and

Figure 4 is a cross-sectional view of an ultrahigh velocity water-cooled copper spinner.

Best Mode for Carrying Out the Invention

Referring now to the drawings in detail wherein like reference numerals designate like elements, there is shown in Figure 1 a longitudinal cross-sectional view of an ultrahigh velocity water-cooled copper taphole constructed in accordance with the principles of the present invention and designated generally as 10. The forward end of the taphole 10 (the left side as shown in the figure) is secured to a graphite nozzle 12 in a known manner. The nozzle 12 is not part of the present invention per se and is shown in phantom merely to show the environment of the present invention. The nozzle 12 is, in turn, fitted in the crucible wall of a melting furnace in a manner known to those skilled in the art.

The taphole 10 is comprised essentially of three major parts: an inner copper member 14, an intermediate coolant guide 16 and an outer jacket 18. Except for the forward portion of the copper member 14 which will be explained in more detail hereinafter, each of the elements 14, 16 and 18 is relatively thin-walled tubularly shaped and preferably cylindrically shaped, i.e. having a circular cross section. The inner copper member 14, coolant guide 16 and jacket 18 are also arranged to be coaxial with each other.

The inner surface 20 of the copper member 14 is the working surface of the taphole 10 and defines the opening through which molten material from a furnace passes (from left to right in the figure). The thickness of the wall of the copper member 14 is increased at the forward end thereof as shown at 22 so as to produce a reduced inner diameter portion defining an orifice 24. The orifice 24 includes an inner working surface 26 which is continuous with the inner working surface 20 of the copper member 14.

In order to effectively cool the working surface of the orifice in the manner described hereinabove, a plurality of holes are drilled into the thickened wall portion 22 to form a plurality of passageways such as shown at 28. Each passageway is formed by drilling a first hole 30 from the outer surface of the copper member 14 toward the working surface 26 of the orifice 24. A second hole 32 starting at a position which is axially offset from the first hole 30 is also drilled inwardly toward the working surface 26 of the orifice 24 so as to intersect the inner end of the first hole 30.

Each passageway 28 is, therefore, substantially V-shaped and includes wall surfaces 34 which lie behind the working surface 26 of the orifice. The surface 34 is in relatively close proximity to the working surface 26 but is isolated therefrom. Each of the holes 30 and 32 forming the passageways 28 is only approximately 5/32 of an inch thereby defining a highly restrictive narrow flow passage for a liquid coolant. It should be readily apparent that while only two such passageways 28 are shown in the figure, any desired number of such passageways may be utilized and are preferably equiangularly spaced around the axis of the orifice 24. In the preferred embodiment, twelve such passages are utilized.

As stated above, the coolant guide 16 is coaxially disposed around the copper member 14. The forward most end of the coolant guide 16 is welded or otherwise secured to the outer surface of the copper member 14 at a position 36 which is located between the openings 30 and 32. A narrow annular space 38 remains between the inner copper member 14 and the coolant guide 16 and extends substantially the entire length of the taphole 10. This space 38 forms a part of the highly restrictive narrow flow passage and is in communication with the passageways 28 through the holes 32.

An annular space 40 also remains between the coolant guide 16 and the outer jacket 18. This annular space 40 extends from a point near the forward end of the taphole 10 to a point adjacent the discharge end of the taphole but spaced therefrom. Adjacent the forward end of the taphole 10, the jacket 18 is secured to the copper member 14 such as shown at 42. An O-ring 44 provides a liquid seal between the two elements. The forward most end of the annular space 40 is in communication with the passageways 28 through the holes 30.

The annular space 46 between the coolant guide 16 and the jacket 18 at the rear of the taphole 10 is isolated from the major portion of the annular space 40 by an O-ring seal 48 located between the coolant guide 16 and jacket 18. The annular space 46 communicates with the annular space 38 through a plurality of openings 50 located in the rearward most end of the coolant guide 16. These openings 50 can be formed by either castellating the end of the coolant guide 16 or by drilling a plurality of holes therethrough. An inlet port 52 communicates with the annular space 40 and an outlet port 54 communicates with the annular space 46.

The taphole 10 functions in the following manner. Molten material such as molten slag, for example, flows from the furnace and nozzle 12 through the orifice 24 and thence along the working surface 20 of the copper member 14 until it is discharged from the discharge end of the taphole. As the molten material flows through the taphole, intense heat is transferred to the copper member 14. Water or other desired liquid coolant is forced into the inlet port 52, through the annular space 40 and thence into the passageways 28 through openings 30. The liquid coolant flows out of the passageways 28 through the openings 32 and through the annular space 38. At the rearward end of the taphole 10, the liquid coolant flows through the openings 50 into the annular space 56 and out the outlet port 54. Because of the highly restrictive narrow flow passage in the passageways 28 and in the annular space 38, in combination with the pressure of the incoming liquid coolant, the coolant is forced across the surfaces 34 and the outer surface of the copper member 14 at an ultrahigh velocity of at least 10 feet per second to sweep away steam generated upon these surfaces, thereby effectively cooling the copper member 14.

As a result of the effective cooling provided by the present invention, a skin or "skull" of solid slag material of predictable, constant thickness freezes on the working surfaces 26 and 20 of the orifice and taphole so that the discharge of further molten material is smooth and consistent. Furthermore, this skull is thermally insulating thereby protecting the copper from excessive temperatures. The skull also protects the copper working surface from physical wear.

There is shown in Figure 2 a lengthwise cross-sectional view of an ultrahigh velocity water-cooled copper trough constructed in accordance with the principles of the present invention and designated as 110. Trough 110 is shown located beneath taphole 10 so that molten material such as molten slag 114 flowing from the taphole 10 may be guided along the upper surface of the trough to a spinning station or to any other desired location.

Except for the end wall 116, the entire trough 110 is substantially semicylindrically shaped as is shown most clearly in Figure 3. The trough is comprised of an elongated substantially semicylindrically shaped upper copper member 118 having an upper working surface 120 which supports the molten material 114. A complementary shaped coolant guide 122 is mounted below the lower surface 124 of the copper member 118 and is closely spaced therefrom defining a highly restrictive narrow flow passage 126. The flow passage 126 extends substantially the entire length of the trough 110.

Located beneath the coolant guide 122 and spaced therefrom so as to define a return path or space 128 is a lower jacket 130. The shape of the jacket 130 is substantially the same as the shape of the upper copper member 118 and the coolant guide 122. As shown most clearly in Figure 3, the extreme side edges of the members 118, 122 and 130 are sealed together such as shown at 132 and 134. A plurality of holes 136, however, are formed in the coolant guide adjacent the discharge end of the trough 110 (the right side as viewed in Figure 2) so as to provide communication between the passage 126 and the return path 128.

The end wall 116 of the trough 110 includes an inlet port 138 and an outlet port 140. Inlet port 138 is in communication with a channel 142 which extends substantially the width of the trough and which communicates with the passage 126. Similarly, the outlet port 40 is in communication with channel 142 which, in turn, communicates with the return path 128.

The trough 110 functions in the following manner. Molten material such as molten slag 114, for example, flows through taphole 10 onto the working surface 120 of the copper member 118 and thence to a spinner or the like. As the molten slag 114 flows along the surface 120, intense heat is transferred to the copper member 118. Water or other desired liquid coolant is forced into the inlet port

138, through the channel 142 and into the passage 126. From there, the liquid coolant passes through the openings 136 and back up through the return path 128 to channel 142 and out the outlet port 140. Because of the highly restrictive narrow flow passage 126 in combination with the pressure of the incoming liquid coolant, the coolant is forced across the undersurface 124 of the copper member 118 at an ultrahigh velocity of at least 10 feet per second to sweep away steam generated upon this surface, thereby effectively cooling the copper member 118.

As a result of the effective cooling provided by the present invention, a skin or "skull" of solid slag material of predictable, constant thickness freezes on the working surface of the trough thereby permitting a constant, unwavering flow of material from the discharge end of the trough. Furthermore, this skull is thermally insulating thereby protecting the copper from excessive temperatures. The skull also protects the copper working surface from physical wear.

Figure 4 shows a cross-sectional view of an ultrahigh velocity water-cooled copper spinner designated generally as 210. Spinner 210 is comprised essentially of a substantially cylindrically shaped copper shell 212 having an outer working surface 214 upon which molten material such as molten slag 114 impinges to receive kinetic energy so that it may be formed into fibers. The copper shell 212 also includes an inner cylindrical surface 216 and an end wall 218 which is integral with the cylindrically shaped portion 212.

Located within the shell 212 and securely fastened thereto through a plurality of bolts 220 is a coolant guide 222. Coolant guide 222 is substantially cylindrically shaped and has an outer cylindrical wall 224. The coolant guide 222 is coaxially arranged within the shell 212 with the surface 224 closely spaced from the inner surface 216 of the shell 212 so as to define a highly restrictive annularly shaped narrow flow passage 226.

Passing axially through the center opening 228 of the guide 222 is an inner conduit 230. The forward end of the conduit 230 is rotatably mounted with respect to the guide 222 but is provided with a liquid seal by the use of O-ring 232. The rearward end of the conduit 230 (the left side as viewed in Figure 4) terminates in a fixed inlet port 234.

An outer conduit 236 is coaxially disposed around the inner conduit 230 so as to define an annular space 238 therebetween which functions as a return path as will be explained more clearly hereinafter. The forward end of the conduit 236 is secured to the back face of the guide 222 through a plurality of bolts 240 and is sealed thereto by O-ring 242.

The other end of the outer conduit 236 is secured to a first part 244 of a rotating union 246. The other half 248 of the rotating union 246 which is the fixed half therof is secured to the inner conduit 230 and the inlet port 234. The rotating union 246 is also provided with an outlet port 250 which, as can be seen, is in communication with the annular space or return path 238.

Located within the interior of the guide 222 and adjacent the rearward end thereof (the left side as shown in Figure 4) is a substantially disc-shaped cavity 252. This cavity 252 is in communication with the annular space or return path 238. The cavity 252 is also in communication with the narrow flow passage 226 through a plurality of holes 254 which pass radially through the guide 222 from the outer surface 224 thereof into the cavity 252. In the preferred embodiment, there are twelve such holes 254 which are equiangularly spaced around the circumference of the guide 222.

The front face 256 of the guide 222 is substantially dish-shaped. That is, the distance between the face 256 and the end wall 218 narrows as the radius increases. As should be recognized by those skilled in the art, this is done to provide constant flow velocity in the space between the surface 256 and the end wall 218. The spinner may be rotated in a conventional manner around its axis by a gear or pulley fixedly secured to the outer conduit 236.

The spinner 210 functions in the following manner. The combined shell 212, guide 222 and outer conduit 236 are rotated at the desired speed and molten material such as molten slag 114, for example, is made to impinge on the working surface 214 of the copper shell 212 to be formed into fibers. As the molten material contacts the surface 214, intense heat is transferred to the copper shell 212. Water or other desired liquid coolant is forced into the inlet port 234, through the conduit 230 and into the space between the face 256 of the guide 222 and the end wall 218. From there, the liquid coolant passes through the passage 226, through the openings 254 into the cavity 252 and through the return path 238 to the outlet port 250. Because of the highly restrictive narrow flow passage 226 in combination with the pressure of the incoming liquid coolant, the coolant is forced across the inner surface 216 of the copper shell 212 at an ultrahigh velocity of at least 10 feet per second to sweep away steam generated upon this surface, thereby effectively cooling the copper shell 212.

As a result of the effective cooling provided by the present invention, a skin or "skull" of solid slag material of predictable, constant contour freezes on the working surface of the spinner thereby permitting closer control of the fiberization process. Furthermore, this skull is thermally insulating thereby protecting the copper from excessive temperatures. The skull also protects the copper working surface from physical wear.

It should be noted with respect to each of the above embodiments, that while some ports have been referred to as inlet ports and others as outlet ports, these can be reversed. The liquid coolant can be made to flow in the opposite direction entering the "outlet" ports and leaving the "inlet" ports with the same cooling effect. Furthermore, it should be pointed out that the coolant guides, conduits and jackets may also be made from copper or may be made from stainless steel or any other desired material.

The present invention may be embodied in other specific forms without departing from the spirit or essential attributes thereof and accordingly, reference should be made to the appended claims rather than to the foregoing specification as indicating the scope of the invention.

Claims

1. In a device utilized in a process for converting molten material into mineral wool fibers and which includes a working surface which is contacted by said molten material, the improvement in cooling means for said device including:

a coolant guide closely spaced from the nonworking surface of such device so as to define a highly restrictive narrow flow passage between said guide and said nonworking surface, and

liquid coolant supply means in communication with said passage for supplying coolant thereto whereby the velocity of the coolant will be accelerated to an ultrahigh velocity across the surface of the passage walls as it passes through the passage.

2. A taphole for a melting furnace comprising:

a metallic member having an inner working surface defining an orifice through which molten material from a furnace can pass;

a highly restrictive narrow flow passage in the area around said orifice, said passage being in relatively close proximity to but being isolated from said working surface, and

liquid coolant supply means in communication with said passage for supplying coolant thereto whereby the velocity of the coolant will be accelerated to an ultrahigh velocity across the surface of the passage walls as it passes through the passage.

3. The taphole as claimed in Claim 2 wherein said passage is formed in said metallic member.

4. The taphole as claimed in Claim 3 wherein said passage surrounds said orifice.

5. The taphole as claimed in Claim 2 wherein said passage includes a tunnel-like passageway formed in the metallic member adjacent said orifice and including first and second openings in the outer wall of said member, one of said openings being an inlet for said coolant and the other functioning as an outlet therefor.

6. The taphole as claimed in Claim 5 wherein said passage includes a plurality of said passageways, each including first and second openings, all said first openings being in communication with each other and all said second openings being in communication with each other.

7. The taphole as claimed in Claim 6 wherein said metallic member includes a substantially tubular portion.

8. The taphole as claimed in Claim 7 further including a coolant guide disposed coaxially around at least part of said tubular portion and closely spaced therefrom thereby defining an annular space therebetween forming part of said highly restrictive flow passage and being in communication with said passageways through said first openings.

9. The taphole as claimed in Claim 8 further including an outer tubular jacket coaxially arranged around said coolant guide and being spaced therefrom to provide a path for said liquid coolant, said path being in communication with said passageways through said second openings.

10. The taphole as claimed in Claim 2 wherein said metallic member is comprised of copper.

11. A method for effectively cooling a taphole comprising the step of directing liquid coolant across a surface thereof behind the working surface of said taphole at an ultrahigh velocity of at least 10 feet per second to sweep away steam generated upon said surface.

12. A trough for delivering molten material flowing from a furnace comprising:

an elongated upper member having an upper surface for supporting said material and a lower surface;

a coolant guide having a shape complementary to said upper member and being closely spaced from the lower surface thereof defining a highly restrictive narrow flow passage, and

liquid coolant supply means in communication with said passage for supplying coolant thereto whereby the velocity of the coolant will be accelerated to an ultrahigh velocity across the lower surface of said member as it passes through the passage.

13. The trough as claimed in Claim 12 further including a lower member complementary to said coolant guide and being spaced from the bottom thereof to provide a return path for said liquid coolant, a plurality of transfer ports adjacent one end of the trough providing communication from said passage to said return path.

14. The trough as claimed in Claim 12 wherein said upper member is comprised of copper.

15. A method for effectively cooling a trough comprising the step of directing liquid coolant across the lower surface thereof at an ultrahigh velocity of at least 10 feet per second to sweep away steam generated upon said surface.

16. A fiberizing spinner for converting a stream of molten material into a plurality of fibers comprising:

a substantially cylindrically shaped metallic shell having an outer surface upon which the molten material impinges, said shell further including an inner cylindrical surface;

a coolant guide having an outer cylindrical surface coaxially disposed within said shell and closely spaced from the inner surface thereof so as to define a highly restrictive narrow flow passage, and

liquid coolant supply means in communication with the passage for supplying coolant thereto whereby the velocity of the coolant will be accelerated to an ultrahigh velocity across the inner cylindrical surface of said shell as it passes through said passage.

17. The spinner as claimed in Claim 16 wherein said liquid coolant supply means includes a centrally disposed inner conduit extending from an opening in the center of said coolant guide outwardly to the exterior of the spinner.

18. The spinner as claimed in Claim 17 further including an outer conduit coaxially arranged around said inner conduit and being sapced therefrom to provide a return path for said liquid coolant, a plurality of transfer ports providing communication from said passage to said return path.

19. The spinner as claimed in Claim 16 wherein said shell is comprised of copper.

20. A method for effectively cooling a spinner comprising the step of directing liquid coolant across the inner surface thereof at an ultrahigh velocity of at least 10 feet per second to sweep away steam generated upon said surface.

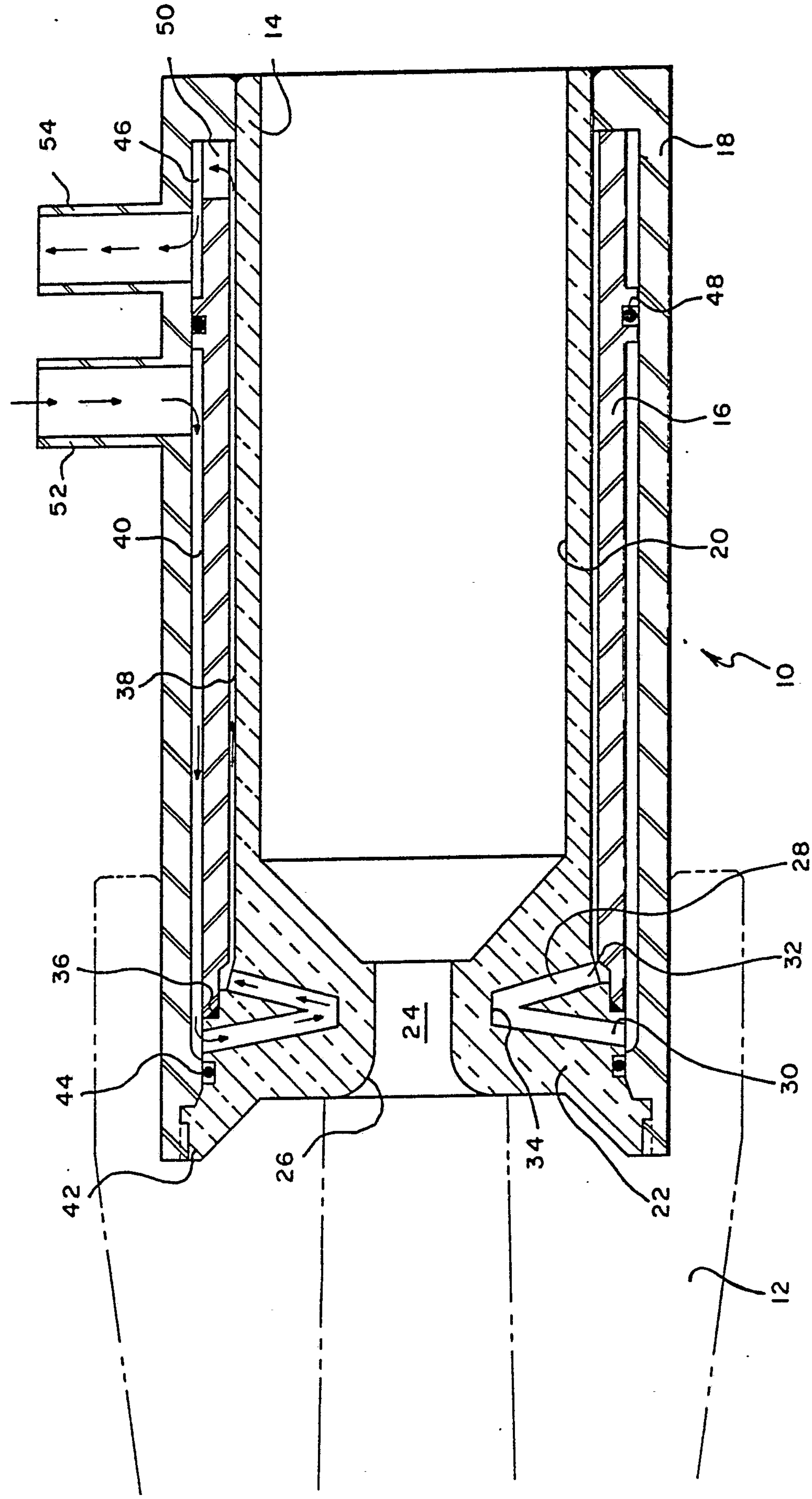

Fig. 1

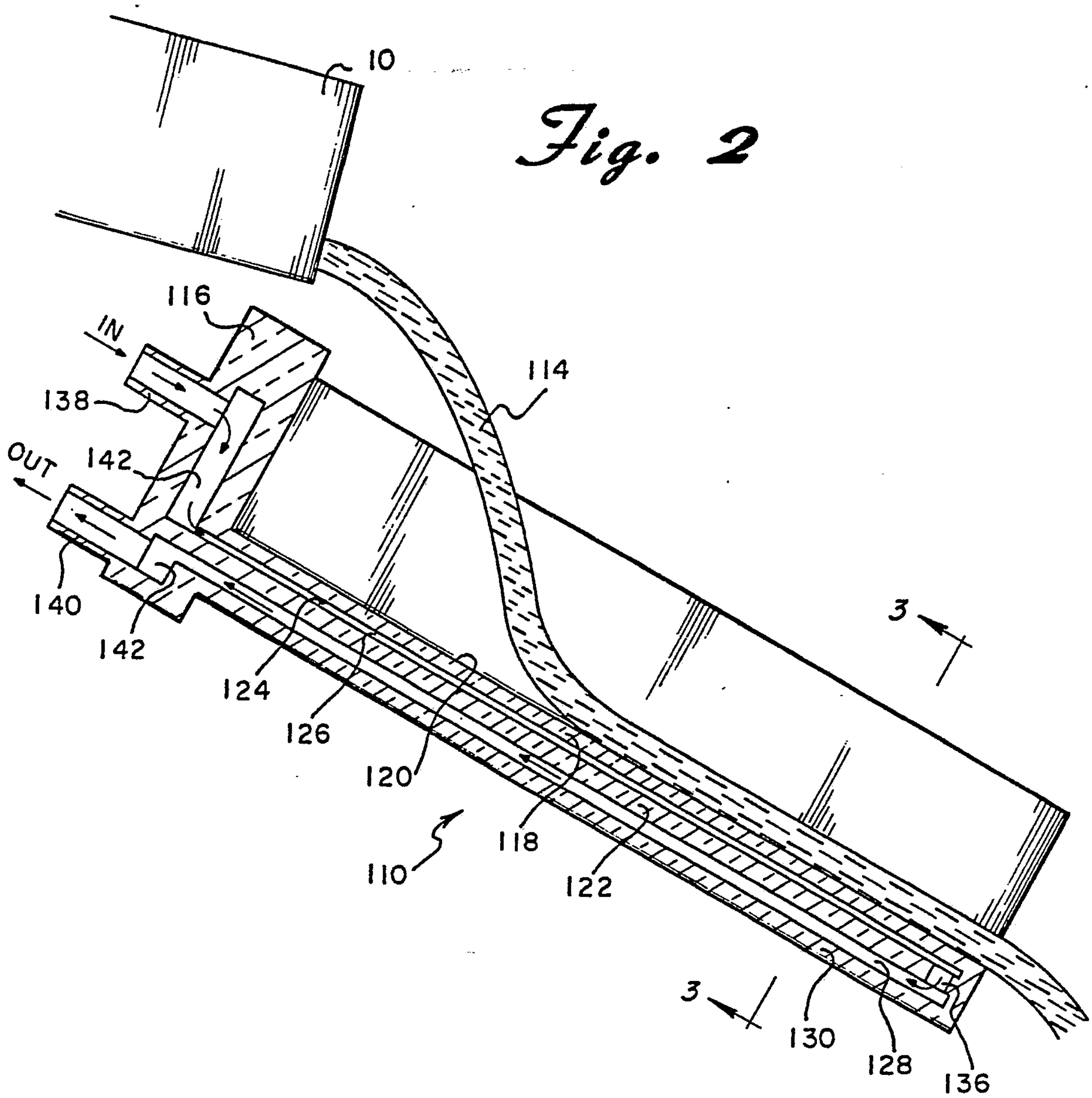
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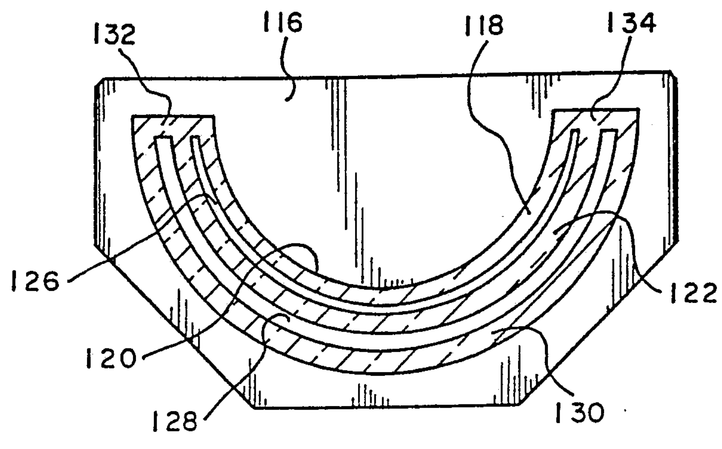
Fig. 2

Fig. 3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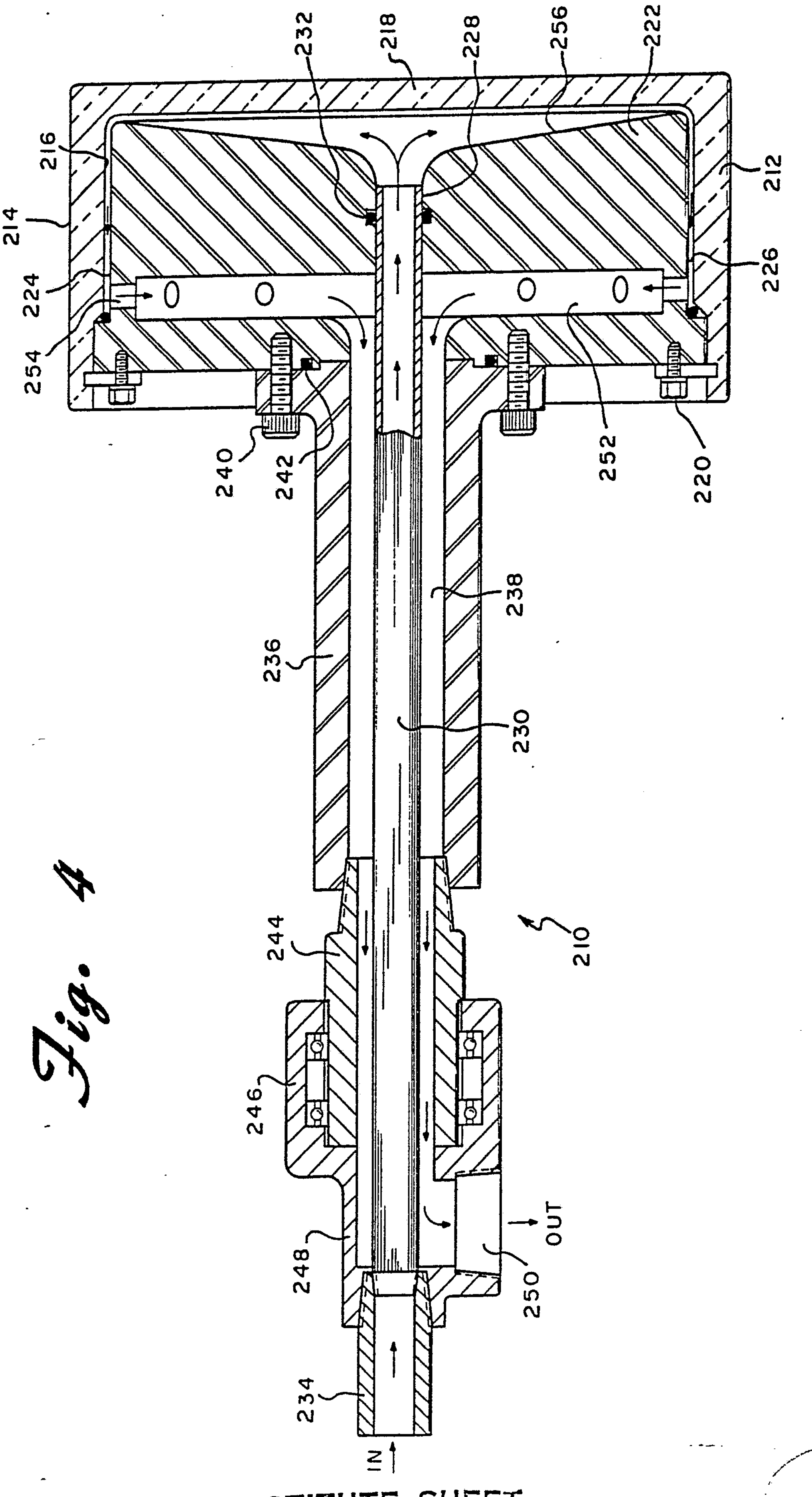
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Fig. 4

INTERNATIONAL SEARCH REPORT

International Application No PCT/US8201393

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

INT. CL[3] B62D 41/08, C03B 37/05
U.S. CL. 222/592, 65/8,15

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
U.S.	222/146C, 592, 593, 606, 607 65/6,8,12,15 164/303,309,316,337 266/46,241,270

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
X	US, A, 2,827,279, Published 18 March 1958, Cox.	1
X	JP, B, 48-8363, Published 14 March 1973, Nippon Kokan, see figure 4 for claim 6.	2-20
Y	SE, A, 85,432, Published 04 February 1936	12-15
Y	US, A, 2,944,284, Published 12 July 1960, Tillotson et al.	16-20
A	US, A, 399,263, Published 12 March 1889, Hartman.	1-15
A	US, A, 4,106,921, Published 15 August 1978, Porter.	16-20

* Special categories of cited documents: [15]

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

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"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search [2]	Date of Mailing of this International Search Report [2]
10 January 1983	21 JAN 1983
International Searching Authority [1]	**Signature of Authorized Officer** [20]
ISA/US	DA Scherbel

Form PCT/ISA/210 (second sheet) (October 1981)