

SHEATHED HEATER
BACKGROUND OF THE INVENTION

5 This invention relates to a sheathed heater,
and more particularly to an improvement of a sheathed
heater for use at a higher temperature atmosphere.

10 In the conventional sheathed heater or
cartridge heater, a metal pipe, such as a stainless
steel pipe is used. Accordingly, if the sheathed
heater is used at a high temperature atmosphere
more than 600°C, a leakage current which flows to
the metal pipe from the internal heater coil or
resistance coil is increased, because the insulation
15 resistance of the heat insulating material member,
such as magnesia which is filled in the metal pipe
is decreased according to the elevation of the
temperature. When the leakage current is increased
over a predetermined value, the circuit breaker of
20 the power source for the sheathed heater is energized
to break the power circuit. If a plurality of
sheathed heaters are used at the same time, the
circuit breaker would often be energized to break
the power circuit. Thus, the heating operation
25 cannot be carried out effectively.

This Sheet Has Been Replaced



REPLACED SHEETS		SC
☒	Description : paged1..... to paged10.....	
☒	Claim(s) : paged11..... to paged13.....	
☒	Drawing(s) : paged14..... to paged33.....	
☒	Abstract : paged1A..... to paged1.....	
DATE OF RECEIPT		

Figs. 1 and 2 show a conventional sheathed heater 30 comprising a metal pipe 31, such as stainless steel pipe, a bottom plate 32 covered the metal pipe 31 at the bottom portion thereof, a core of porcelain insulator 33 arranged at the center of said metal pipe 31, a pair of lead pins 34 of which base portions are inserted into small holes formed passing through said core of porcelain insulator 33, a heater coil 35 wound around the core of porcelain insulator 33, and a heat resistive insulation material member 37 filled in a space formed between said metal pipe 31 and said core of porcelain insulator 33.

In such sheathed heater 30, the insulation resistance of the insulation material member 37 filled in the metal pipe 31 is decreased according to the elevation of the temperature, in case that the sheathed heater is used at a high temperature atmosphere more than 600°C. Accordingly, a leakage current which flows to the metal pipe 31 from the internal heater coil 35 through the insulation material member 37 is increased so that the circuit breaker (not shown) inserted between the sheathed heater and the power source thereof is energized to break the heating operation. This causes the heating



operation to be reduced in efficiency. Further, if a plurality of sheathed heaters are used, the operator must find a sheathed heater of which leakage current becomes large and replace it, and then the circuit breaker must be deenergized with much labor and time.

Further, there are given hitherto manufacturing methods of the sheathed heater as disclosed in Japanese Patents Laid-Open Nos. 155690/83, 157080/83 and 157079/83. In the method shown in the Japanese Patent Laid-Open No. 155690/83, a thin metal plate or metal wire is inserted between the metal pipe and the heater coil and after the sheathed heater is assembled heated it to be oxidized in order to prevent the vaporization of the heater coil so that the insulation resistance of the heat insulating material member, such as magnesia is prevented from being reduced.

However, it is insufficient to reduce the leakage current which flows from the heater coil to the metal pipe at a high temperature atmosphere more than 600°C .

In the Japanese Patent Laid-Open No. 157080/83, the inner peripheral surface of the metal pipe is coated with a paint including metal oxide powder in



order to prevent the vaporization of the heater coil
to attain the same purpose of the above. However,
it is also insufficient to reduce the leakage current
at a high temperature atmosphere more than 600 °C and
5 is very difficult to coat uniformly the entire inner
peripheral surface of the metal pipe with the paint.
Further, this method is complex and expensive.

In the Japanese Patent Laid-Open No. 157079/83,
the inner peripheral surface of the metal pipe is
10 coated with a metal and after the sheathed heater is
assembled said metal is oxidized with heat to attain
the same purpose of the above. However, in this
sheathed heater, the leakage current cannot be
reduced sufficiently at a high temperature
15 atmosphere more than 600 °C as mentioned above.

An object of the present invention is to reduce
the leakage current in the sheathed heater, which
flows from the internal heater to the metal pipe,
20 so that the sheathed heater can be used at a high
temperature atmosphere more than 600 °C.

The above object can be attained by a sheathed
heater comprising a metal pipe of which entire inner
peripheral surface has been oxidized previously, an
25 internal heater inserted into said metal pipe,



lead pins connected to both ends of said heater, respectively, and a heat resistive insulation material member filled in a space formed between said metal pipe and said internal heater.

5 The above object can also be attained by a sheathed heater comprising a metal pipe, an internal heater inserted into said metal pipe, lead pins connected to both ends of said heater, respectively, and a heat resistive insulation material member
10 filled in a space formed between said metal pipe and said internal heater, the outer surfaces of said internal heater and lead pins having being oxidized previously.

 According to the sheathed heater of the present
15 invention, the leakage current which flows from the internal heater to the metal pipe can be reduced enough, even if the sheathed heater is used at a high temperature atmosphere more than 600°C, because a sufficient oxide film having a good insulating
20 ability at a high temperature is formed very easily on the entire inner surface of the metal pipe or the outer surfaces of the heater and lead pins by subjecting them at a higher temperature atmosphere in the presence of sufficient oxygen, or subjecting
25 them to the chemicals, such as oxydizing agent.



The other objects and features of the present invention will become apparent from the following description taken in conjunction with the accompanying drawings.

5

Fig. 1 is a sectional side view of a conventional sheathed heater;

Fig. 2 is a vertical sectional view taken along a line 2-2 in Fig. 1

10

Fig. 3 is a sectional side view of a sheathed heater of the present invention;

Fig. 4 is a sectional view taken along a line 4-4 in Fig. 3;

15

Fig. 5 is a sectional side view of a sheathed heater according to another embodiment of the present invention;

Fig. 6 is a sectional view taken along a line 6-6 in Fig. 5;

20

Fig. 7 is a sectional side view of a sheathed heater according to further embodiment of the present invention; and

Fig. 8 is a sectional view taken along a line 8-8 in Fig. 7.

25

Now, one embodiment of this invention will be

This Sheet Has Been Replaced



described by referring to Figs. 3 and 4.

5 A sheathed heater 12 of the present invention comprises a metal pipe 1 made of stainless steel, iron or other heat resistive special steel having a bottom plate 2 made of the same material formed at the bottom portion thereof, a core of porcelain insulator 5 made by compacting magnesia or the like and arranged at the center of said metal pipe 1, a pair of lead pins 7 of which base portions are
10 inserted into small holes 6 formed passing through said core of porcelain insulator 5, a heater coil 8 of nickrome wire wound around the core of porcelain insulator 5, and a heat resistive insulation material member 10 of magnesia or the like filled
15 in a space formed between said metal pipe 1, bottom plate 2 and said core of porcelain insulator 5, said pair of lead pins 7 being connected electrically to both ends of said heater coil 8, respectively, to form a heating element 9.

20 Before the sheathed heater is assembled, in the present invention, the entire inner peripheral surface 3 of said metal pipe 1 and the inner surface 3a of said bottom plate 2 are oxidized, respectively, or the outer peripheral surfaces of said heater coil
25 8 and said pair of lead pins 7 are oxidized by



subjecting them at a higher temperature atmosphere in the presence of sufficient oxygen, or subjecting them to the chemicals, such as oxydizing agent.

Another embodiment of the present invention
5 will be explained with reference to Figs. 5 and 6.

In this embodiment, a sheathed heater 12a is composed of a metal pipe 21 made of stainless steel, iron or other heat resistive special steel, an internal heater coil 28 of nickrome wire inserted
10 into said metal pipe 21, lead pins 27 connected to both ends of said heater coil 28 and extending to the outside of said metal pipe 21, respectively, and a heat resistive insulation material member 29 of magnesia or the like filled in a space formed
15 between said metal pipe 21 and said internal heat coil 28.

Before the sheathed heater is assembled, the inner peripheral surface 23 of said metal pipe 21 is oxidized, or the outer peripheral surfaces of
20 said heater coil 28 and lead pins 27 are oxidized by subjecting them at a higher temperature atmosphere in the presence of sufficient oxygen, or subjecting them to the chemicals, such as oxydizing agent.

In the further embodiment of the present
25 invention, an internal heater of a sheathed heater



12b is formed of a straight wire 38.

In said embodiments, a metal pipe having a circular cross section is used. However, it should be understood that a metal pipe having a rectangular cross section, triangular cross section, elliptic cross section or the like may be used.

Said oxidization may be carried out by such a method that the metal pipe etc. is heated in the electric furnace containing sufficient air or oxygen at the temperature of about 300~1300°C during about 5 minutes~ more than 10 hours, or at the temperature of about 1,000~1,300°C during about 5 minutes ~ 1 hour, until the color of the entire inner peripheral surface of said metal pipe etc. is turned to light brown, brown or black.

In the other method, such oxidization is carried out by applying known chemicals, such as oxidizing agent thereto.

By such oxidization, the insulation resistance of the oxide film thus formed becomes large enough.

According to the sheathed heater of the present invention, the leakage current can be reduced to $1/3 \sim 1/10$ of that in the conventional sheathed heater, in case that the sheathed heater is used at a high temperature atmosphere more than 600°C,



because the metal pipe or the heater coil and the lead pins are oxidized fully and uniformly, and the insulation resistance of the oxide film thus formed is very high.

5 Thus, the present invention is effective to reduce the leakage current, thereby precluding the troublesome due to the often energization of the circuit breaker inserted between the sheathed heaters and the power source thereof, and the
10 heating operation using the sheathed heater can be carried out efficiently and economically.

15

20

25

This Sheet Has Been Replaced





CLAIMS

1. A sheathed heater comprising a metal pipe (1, 21) of
5 which entire inner peripheral surface (3, 23) has been
oxidized previously, an internal heater (8, 28, 38)
inserted into said metal pipe (1, 21), lead pins (7,
27) connected to both ends of said heater (8, 28, 38),
respectively, and a heat resistive insulation material
10 member (10, 29) filled in a space formed between said
metal pipe (1, 21) and said internal heater (8, 28,
38).
2. The sheathed heater according to Claim 1, wherein said
oxidization is carried out by subjecting said metal
15 pipe (1, 21) at a high temperature atmosphere in the
presence of sufficient oxygen.
3. The sheathed heater according to Claim 1, wherein said
entire inner peripheral surface (3, 23) of said metal
pipe (1, 21) is oxidized to such a degree that it is
20 colored to at least light brown.
4. A sheathed heater comprising a metal pipe (1, 21), an
internal heater (8, 28, 38) inserted into said metal
pipe (1, 21), lead pins (7, 27) connected to both ends
of said heater (8, 28, 38), respectively, and a heat
25 resistive insulation material member (10, 29) filled
in a space formed between said metal pipe (1, 21) and
said internal heater (8, 28, 38), the outer surfaces
of said internal heater (8, 28, 38) and lead pins (7,
27) having been oxidized previously.





- 12 -

5. The sheathed heater (according to Claim 4, wherein said oxidization is carried out by subjecting said internal heater (8, 28, 38) and said lead pins (7, 27) at a high temperature atmosphere in the presence of sufficient oxygen.
6. The sheathed heater according to Claim 4, wherein the outer surfaces of said internal heater (8, 28, 38) and lead pins (7, 27) are oxidized to such a degree that they are colored to at least light brown.
7. A sheathed heater comprising a metal pipe, (1, 21) an internal heater (8, 28, 38) inserted into said metal pipe (1, 21), lead pins (7, 27) connected to both ends of said heater (8, 28, 38), respectively, and a heat resistive insulation material member (10, 29) filled in a space formed between said metal pipe (1, 21) and said internal heater (8, 28, 38), the entire inner peripheral surface (3, 23) of said metal pipe (1, 21), and the outer surfaces of said internal heater (8, 28, 38) and lead pins (7, 27) having been oxidized previously.
8. The sheathed heater according to Claim 7, wherein said oxidization is carried out by subjecting said metal pipe (1, 21), internal heater (8, 28, 38) and lead pins (7, 27) at a high temperature atmosphere in the presence of sufficient oxygen.

This Sheet Has Been Replaced





- 13 -

9. The sheathed heater according to Claim 7, wherein said entire inner peripheral surface (3, 23) of said metal pipe (1, 21), and the outer surfaces of said internal heater (8, 28, 38) and lead pins (7, 27) are oxidized to such a degree that they are colored to at least light brown.
10. The sheathed heater according to any one of Claims 1, 4 and 7, wherein said oxidization is carried out by applying chemicals.
11. The sheathed heater according to any one of Claims 1, 4 and 7, wherein said internal heater (8, 28) is in the shape of a coil.
12. The sheathed heater according to any one of Claims 1, 4 and 7, further comprising a core of porcelain insulator (5) arranged at the center of said metal pipe (1), wherein said internal heater (8) is a coil wound around said core (5).
13. The sheathed heater according to any one of Claims 1, 4 and 7, wherein said internal heater (38) is a straight wire.

This Sheet Has Been Replaced



ABSTRACT:

SHEATHED HEATER

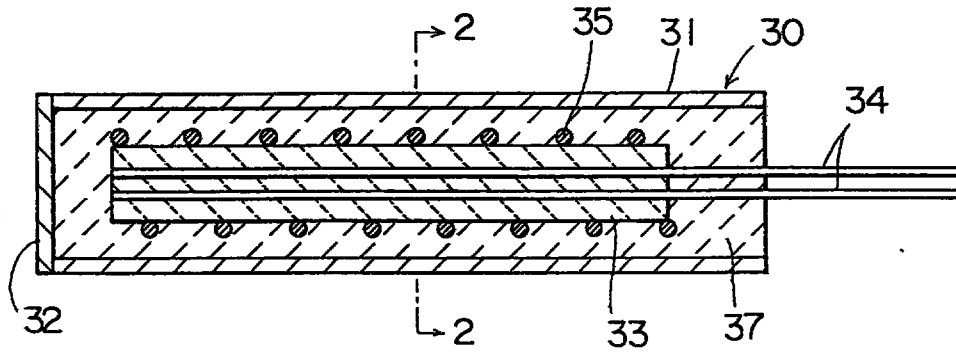
A sheathed heater wherein before the sheathed heater is assembled, an oxide film is formed on the inner peripheral surface (2, 23) of a metal pipe, and/or the outer surfaces of an internal heater (8, 28, 38) and lead pins (7, 27) thereof which are inserted into the metal pipe (1, 21) by heating them in the presence of oxygen or by applying chemicals thereto, and a heat resistive insulation material member (10, 29) is filled in a space formed between the metal pipe (1, 21) and the internal heater (8, 28, 38). The color of the oxide film thus formed is light brown, brown or black.

fig. No 3



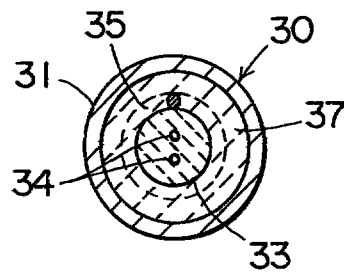
F I G . 1

PRIOR ART

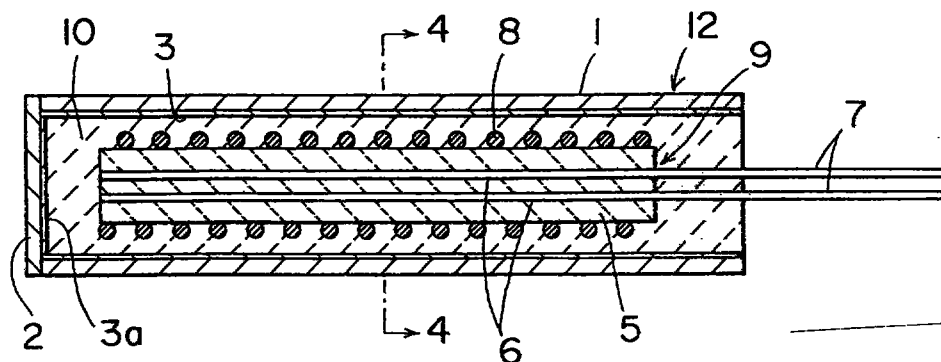


F I G . 2

PRIOR ART



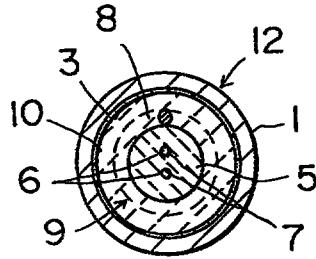
F I G . 3



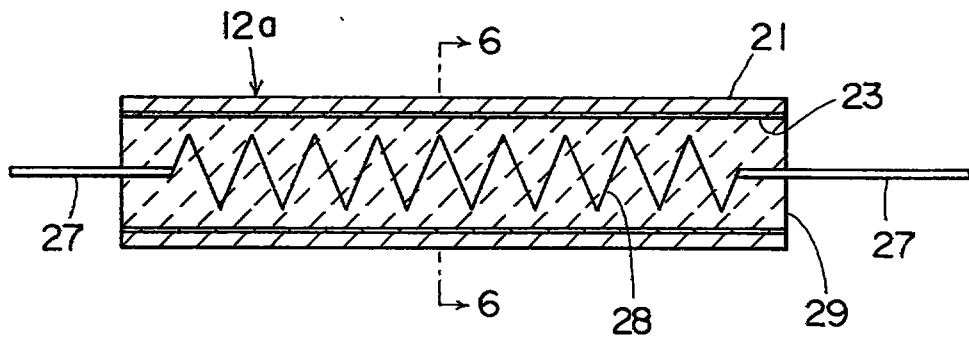
This Sheet Has Been Replaced



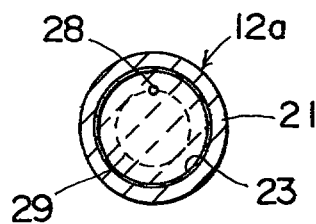
F I G . 4



F I G . 5



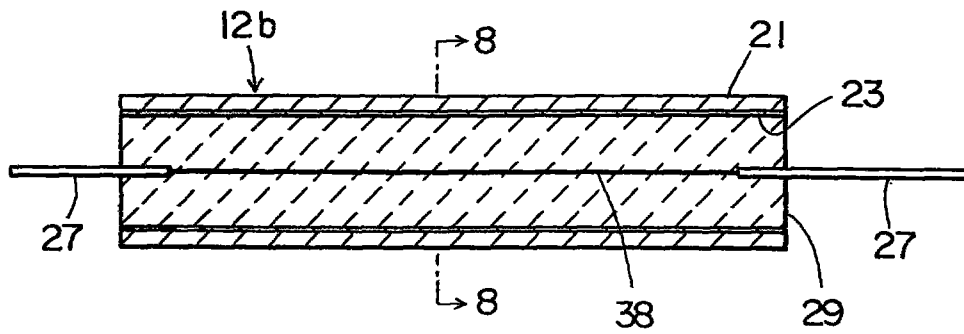
F I G . 6



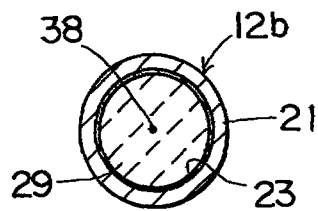
This Sheet Has Been Replaced



F I G . 7



F I G . 8



REPLACED SHEETS	SG
☒ Description : paged 15/1 to paged 16/1	
☒ Claim(s) : paged 11 to paged 12	
☐ Drawing(s) : paged to paged	
☐ Abstract : paged to paged	
DATE OF RECEIPT	

- 1 -

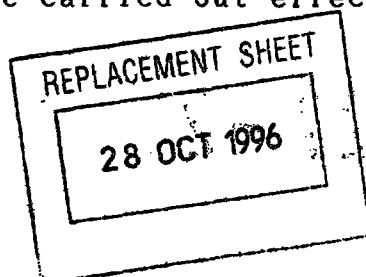
SHEATHED HEATER

REPLACEMENT SHEETS	SG
☒ Description : paged 11 to paged 12	
☒ Claim(s) : paged 11 to paged 12	
☒ Drawing(s) : paged 13 to paged 14	
☒ Abstract : paged 14 to paged 15	
DATE OF RECEIPT 28/10/96	

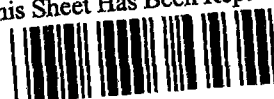
BACKGROUND OF THE INVENTION

This invention relates to a sheathed heater, and more particularly to an improvement of a sheathed heater for use at a higher temperature atmosphere.

In the conventional sheathed heater or cartridge heater, a metal pipe, such as a stainless steel pipe is used. Accordingly, if the sheathed heater is used at a high temperature atmosphere more than 600°C, a leakage current which flows to the metal pipe from the internal heater coil or resistance coil is increased, because the insulation resistance of the heat insulating material member, such as magnesia which is filled in the metal pipe is decreased according to the elevation of the temperature. When the leakage current is increased over a predetermined value, the circuit breaker of the power source for the sheathed heater is energized to break the power circuit. If a plurality of sheathed heaters are used at the same time, the circuit breaker would often be energized to break the power circuit. Thus, the heating operation cannot be carried out effectively.

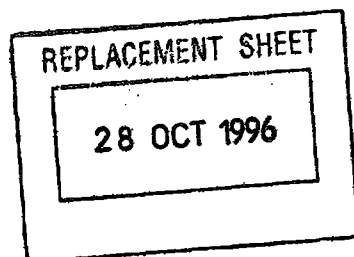


This Sheet Has Been Replaced

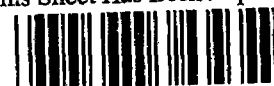


Figs. 1 and 2 show a conventional sheathed heater 30 comprising a metal pipe 31, such as stainless steel pipe, a bottom plate 32 covered the metal pipe 31 at the bottom portion thereof, a core of porcelain insulator 33 arranged at the center of said metal pipe 31, a pair of lead pins 34 of which base portions are inserted into small holes formed passing through said core of porcelain insulator 33, a heater coil 35 wound around the core of porcelain insulator 33, and a heat resistive insulation material member 37 filled in a space formed between said metal pipe 31 and said core of porcelain insulator 33.

In such sheathed heater 30, the insulation resistance of the insulation material member 37 filled in the metal pipe 31 is decreased according to the elevation of the temperature, in case that the sheathed heater is used at a high temperature atmosphere more than 600°C. Accordingly, a leakage current which flows to the metal pipe 31 from the internal heater coil 35 through the insulation material member 37 is increased so that the circuit breaker (not shown) inserted between the sheathed heater and the power source thereof is energized to break the heating operation. This causes the heating



This Sheet Has Been Replaced

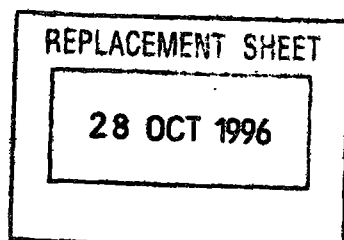


operation to be reduced in efficiency. Further, if a plurality of sheathed heaters are used, the operator must find a sheathed heater of which leakage current becomes large and replace it, and then the circuit breaker must be deenergized with much labor and time.

Further, there are given hitherto manufacturing methods of the sheathed heater as disclosed in Japanese Patents Laid-Open Nos. 155690/83, 157080/83 and 157079/83. In the method shown in the Japanese Patent Laid-Open No. 155690/83, a thin metal plate or metal wire is inserted between the metal pipe and the heater coil and after the sheathed heater is assembled heated it to be oxidized in order to prevent the vaporization of the heater coil so that the insulation resistance of the heat insulating material member, such as magnesia is prevented from being reduced.

However, it is insufficient to reduce the leakage current which flows from the heater coil to the metal pipe at a high temperature atmosphere more than 600°C.

In the Japanese Patent Laid-Open No. 157080/83, the inner peripheral surface of the metal pipe is coated with a paint including metal oxide powder in

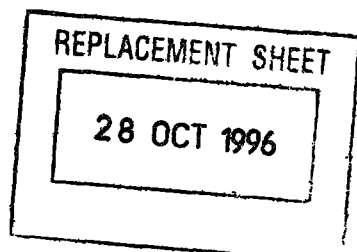


order to prevent the vaporization of the heater coil to attain the same purpose of the above. However, it is also insufficient to reduce the leakage current at a high temperature atmosphere more than 600 °C and is very difficult to coat uniformly the entire inner peripheral surface of the metal pipe with the paint. Further, this method is complex and expensive.

In the Japanese Patent Laid-Open No. 157079/83, the inner peripheral surface of the metal pipe is coated with a metal and after the sheathed heater is assembled said metal is oxidized with heat to attain the same purpose of the above. However, in this sheathed heater, the leakage current cannot be reduced sufficiently at a high temperature atmosphere more than 600 °C as mentioned above.

An object of the present invention is to reduce the leakage current in the sheathed heater, which flows from the internal heater to the metal pipe, so that the sheathed heater can be used at a high temperature atmosphere more than 600 °C.

The above object can be attained by a sheathed heater comprising a metal pipe of which entire inner peripheral surface has been oxidized previously, an internal heater inserted into said metal pipe,



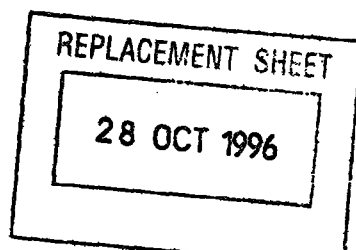
This Sheet Has Been Replaced



lead pins connected to both ends of said heater, respectively, and a heat resistive insulation material member filled in a space formed between said metal pipe and said internal heater.

The above object can also be attained by a sheathed heater comprising a metal pipe, an internal heater inserted into said metal pipe, lead pins connected to both ends of said heater, respectively, and a heat resistive insulation material member filled in a space formed between said metal pipe and said internal heater, the outer surfaces of said internal heater and lead pins having being oxidized previously.

According to the sheathed heater of the present invention, the leakage current which flows from the internal heater to the metal pipe can be reduced enough, even if the sheathed heater is used at a high temperature atmosphere more than 600°C, because a sufficient oxide film having a good insulating ability at a high temperature is formed very easily on the entire inner surface of the metal pipe or the outer surfaces of the heater and lead pins by subjecting them at a higher temperature atmosphere in the presence of sufficient oxygen, or subjecting them to the chemicals, such as oxydizing agent.



This Sheet Has Been Replaced



The other objects and features of the present invention will become apparent from the following description taken in conjunction with the accompanying drawings.

Fig. 1 is a sectional side view of a conventional sheathed heater;

Fig. 2 is a vertical sectional view taken along a line 2-2 in Fig. 1

Fig. 3 is a sectional side view of a sheathed heater of the present invention;

Fig. 4 is a sectional view taken along a line 4-4 in Fig. 3;

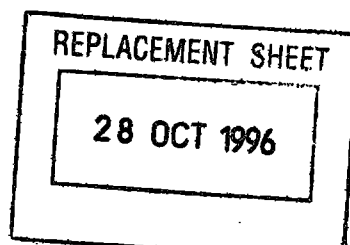
Fig. 5 is a sectional side view of a sheathed heater according to another embodiment of the present invention;

Fig. 6 is a sectional view taken along a line 6-6 in Fig. 5;

Fig. 7 is a sectional side view of a sheathed heater according to further embodiment of the present invention; and

Fig. 8 is a sectional view taken along a line 8-8 in Fig. 7.

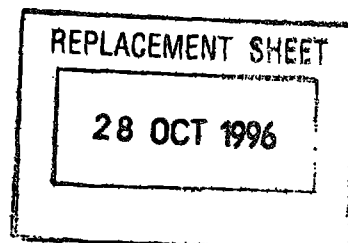
Now, one embodiment of this invention will be



described by referring to Figs. 3 and 4.

A sheathed heater 12 of the present invention comprises a metal pipe 1 made of stainless steel, iron or other heat resistive special steel having a bottom plate 2 made of the same material formed at the bottom portion thereof, a core of porcelain insulator 5 made by compacting magnesia or the like and arranged at the center of said metal pipe 1, a pair of lead pins 7 of which base portions are inserted into small holes 6 formed passing through said core of porcelain insulator 5, a heater coil 8 of nickrome wire wound around the core of porcelain insulator 5, and a heat resistive insulation material member 10 of magnesia or the like filled in a space formed between said metal pipe 1, bottom plate 2 and said core of porcelain insulator 5, said pair of lead pins 7 being connected electrically to both ends of said heater coil 8, respectively, to form a heating element 9.

Before the sheathed heater is assembled, in the present invention, the entire inner peripheral surface 3 of said metal pipe 1 and the inner surface 3a of said bottom plate 2 are oxidized, respectively, or the outer peripheral surfaces of said heater coil 8 and said pair of lead pins 7 are oxidized by



subjecting them at a higher temperature atmosphere in the presence of sufficient oxygen, or subjecting them to the chemicals, such as oxydizing agent.

Another embodiment of the present invention will be explained with reference to Figs. 5 and 6.

In this embodiment, a sheathed heater 12a is composed of a metal pipe 21 made of stainless steel, iron or other heat resistive special steel, an internal heater coil 28 of nickrome wire inserted into said metal pipe 21, lead pins 27 connected to both ends of said heater coil 28 and extending to the outside of said metal pipe 21, respectively, and a heat resistive insulation material member 29 of magnesia or the like filled in a space formed between said metal pipe 21 and said internal heat coil 28.

Before the sheathed heater is assembled, the inner peripheral surface 23 of said metal pipe 21 is oxidized, or the outer peripheral surfaces of said heater coil 28 and lead pins 27 are oxidized by subjecting them at a higher temperature atmosphere in the presence of sufficient oxygen, or subjecting them to the chemicals, such as oxydizing agent.

In the further embodiment of the present invention, an internal heater of a sheathed heater

REPLACEMENT SHEET

28 OCT 1996

12b is formed of a straight wire 38.

In said embodiments, a metal pipe having a circular cross section is used. However, it should be understood that a metal pipe having a rectangular cross section, triangular cross section, elliptic cross section or the like may be used.

Said oxidization may be carried out by such a method that the metal pipe etc. is heated in the electric furnace containing sufficient air or oxygen at the temperature of about 300~1300℃ during about 5 minutes~ more than 10 hours, or at the temperature of about 1,000~1,300℃ during about 5 minutes ~ 1 hour, until the color of the entire inner peripheral surface of said metal pipe etc. is turned to light brown, brown or black.

In the other method, such oxidization is carried out by applying known chemicals, such as oxidizing agent thereto.

By such oxidization, the insulation resistance of the oxide film thus formed becomes large enough.

According to the sheathed heater of the present invention, the leakage current can be reduced to $1/3 \sim 1/10$ of that in the conventional sheathed heater, in case that the sheathed heater is used at a high temperature atmosphere more than 600℃ ,

REPLACEMENT SHEET

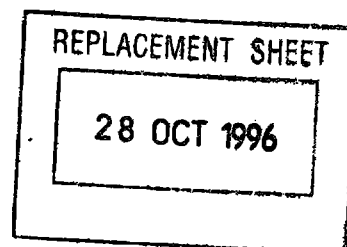
28 OCT 1996

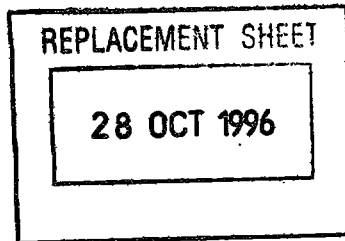
This Sheet Has Been Replaced



because the metal pipe or the heater coil and the lead pins are oxidized fully and uniformly, and the insulation resistance of the oxide film thus formed is very high.

Thus, the present invention is effective to reduce the leakage current, thereby precluding the troublesome due to the often energization of the circuit breaker inserted between the sheathed heaters and the power source thereof, and the heating operation using the sheathed heater can be carried out efficiently and economically.





- 11 -



CLAIMS

1. A sheathed heater comprising a metal pipe (1, 21) of which entire inner peripheral surface (3, 23) has been oxidized previously, an internal heater (8, 28, 38) inserted into said metal pipe (1, 21), lead pins (7, 27) connected to both ends of said heater (8, 28, 38), respectively, and a heat resistive insulation material member (10, 29) filled in a space formed between said metal pipe (1, 21) and said internal heater (8, 28, 38).
2. The sheathed heater according to Claim 1, wherein said oxidization is carried out by subjecting said metal pipe (1, 21) at a high temperature atmosphere in the presence of sufficient oxygen.
3. The sheathed heater according to Claim 1, wherein said entire inner peripheral surface (3, 23) of said metal pipe (1, 21) is oxidized to such a degree that it is colored to at least light brown.
4. A sheathed heater comprising a metal pipe (1, 21), an internal heater (8, 28, 38) inserted into said metal pipe (1, 21), lead pins (7, 27) connected to both ends of said heater (8, 28, 38), respectively, and a heat resistive insulation material member (10, 29) filled in a space formed between said metal pipe (1, 21) and said internal heater (8, 28, 38), the outer surfaces of said internal heater (8, 28, 38) and lead pins (7, 27) having been oxidized previously.

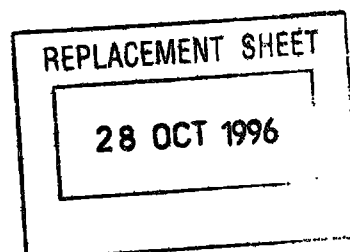
This Sheet Has Been Replaced





- 12 -

5. The sheathed heater (according to Claim 4, wherein said oxidization is carried out by subjecting said internal heater (8, 28, 38) and said lead pins (7, 27) at a high temperature atmosphere in the presence of sufficient oxygen.
6. The sheathed heater according to Claim 4, wherein the outer surfaces of said internal heater (8, 28, 38) and lead pins (7, 27) are oxidized to such a degree that they are colored to at least light brown.
7. A sheathed heater comprising a metal pipe, (1, 21) an internal heater (8, 28, 38) inserted into said metal pipe (1, 21), lead pins (7, 27) connected to both ends of said heater (8, 28, 38), respectively, and a heat resistive insulation material member (10, 29) filled in a space formed between said metal pipe (1, 21) and said internal heater (8, 28, 38), the entire inner peripheral surface (3, 23) of said metal pipe (1, 21), and the outer surfaces of said internal heater (8, 28, 38) and lead pins (7, 27) having been oxidized previously.
8. The sheathed heater according to Claim 7, wherein said oxidization is carried out by subjecting said metal pipe (1, 21), internal heater (8, 28, 38) and lead pins (7, 27) at a high temperature atmosphere in the presence of sufficient oxygen.



This Sheet Has Been Replaced





- 13 -

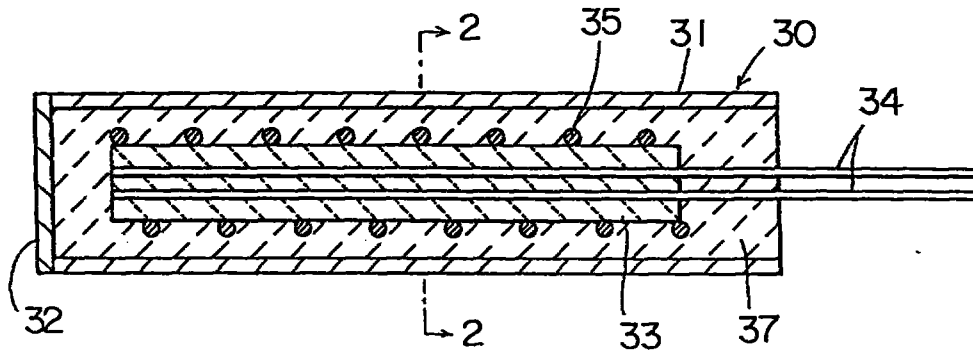
9. The sheathed heater according to Claim 7, wherein said entire inner peripheral surface (3, 23) of said metal pipe (1, 21), and the outer surfaces of said internal heater (8, 28, 38) and lead pins (7, 27) are oxidized to such a degree that they are colored to at least light brown.
10. The sheathed heater according to any one of Claims 1, 4 and 7, wherein said oxidization is carried out by applying chemicals.
11. The sheathed heater according to any one of Claims 1, 4 and 7, wherein said internal heater (8, 28) is in the shape of a coil.
12. The sheathed heater according to any one of Claims 1, 4 and 7, further comprising a core of porcelain insulator (5) arranged at the center of said metal pipe (1), wherein said internal heater (8) is a coil wound around said core (5).
13. The sheathed heater according to any one of Claims 1, 4 and 7, wherein said internal heater (38) is a straight wire.

REPLACEMENT SHEET

28 OCT 1996

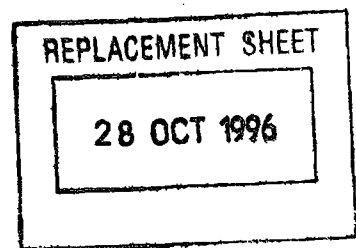
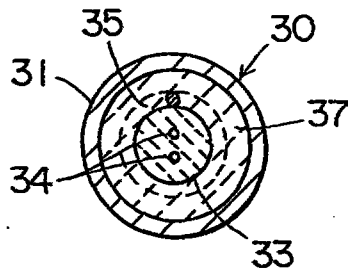
F I G . 1

PRIOR ART

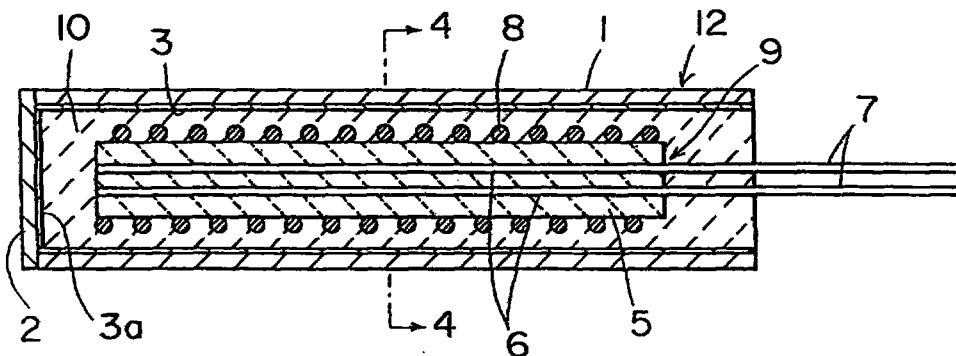


F I G . 2

PRIOR ART

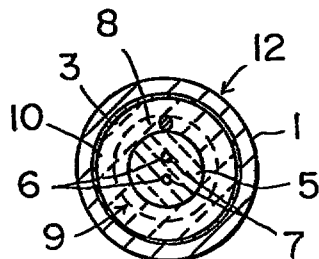


F I G . 3

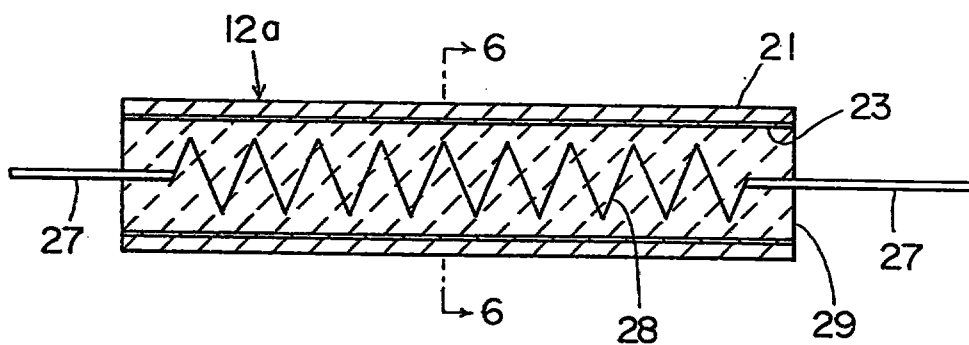


2-1111

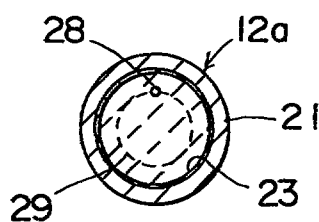
F I G . 4



F I G . 5



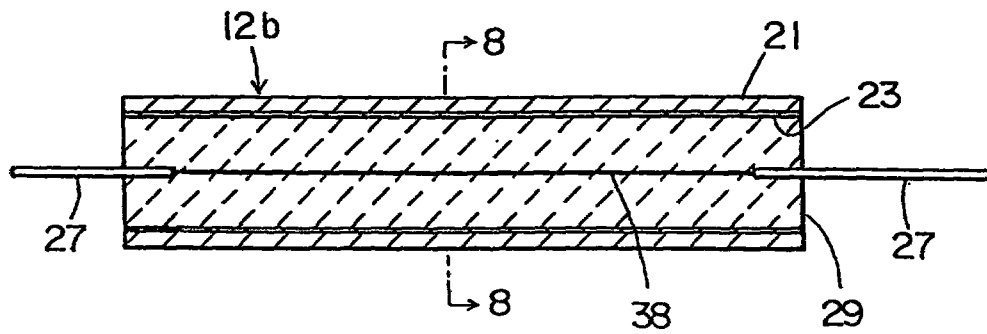
F I G . 6



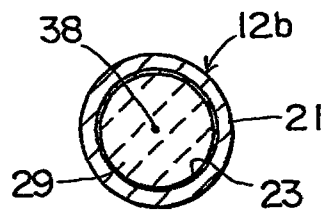
REPLACEMENT SHEET

28 OCT 1996

F I G . 7



F I G . 8



REPLACEMENT SHEET

28 OCT 1996

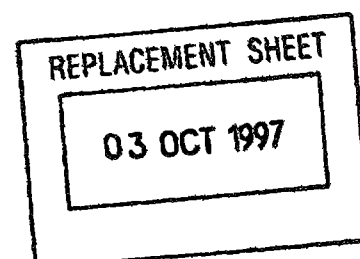
-1-

SHEATHED HEATER**BACKGROUND OF THE INVENTION**

This invention relates to a sheathed heater, and more particularly to an improvement of a sheathed heater for use at a higher temperature atmosphere.

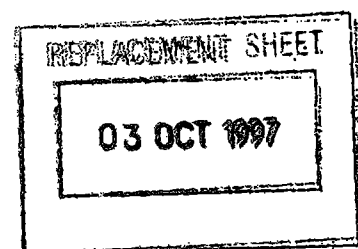
In the conventional sheathed heater or cartridge heater, a metal pipe, such as a stainless steel pipe is used. Accordingly, if the sheathed heater is used at a high temperature atmosphere of more than 600°C, a leakage current which flows to the metal pipe from the internal heater coil or resistance coil is increased, because the insulation resistance of the heat insulating material member, such as magnesia which is filled in the metal pipe is decreased according to the elevation of the temperature. When the leakage current is increased over a predetermined value, the circuit breaker of the power source for the sheathed heater is energized to break the power circuit. If a plurality of sheathed heaters are used at the same time, the circuit breaker would often be energized to break the power circuit. Thus, the heating operation cannot be carried out effectively.

REPLACEMENT SHEETS		SC
☒	Description : paged 151 to paged 152	
☒	Claim(s) : paged 151 to paged 152	
☐	Drawing(s) : paged to paged	
☐	Abstract : paged to paged	
RECEIPT		3/10/97



Figs. 1 and 2 show a conventional sheathed heater 30 comprising a metal pipe 31, such as stainless steel pipe, a bottom plate 32 covering the metal pipe 31 at the bottom portion thereof, a core of porcelain insulator 33 arranged at the center of said metal pipe 31, a pair of lead pins 34 of which base portions are inserted into small holes formed passing through said core of porcelain insulator 33, a heater coil 35 wound around the core of porcelain insulator 33, and a heat resistive insulation material member 37 filled in a space formed between said metal pipe 31 and said core of porcelain insulator 33.

In such sheathed heater 30, the insulation resistance of the insulation material member 37 filled in the metal pipe 31 is decreased according to the elevation of the temperature, in case that the sheathed heater is used at a high temperature atmosphere of more than 600°C. Accordingly, a leakage current which flows to the metal pipe 31 from the internal heater coil 35 through the insulation material member 37 is increased so that the circuit breaker (not shown) inserted between the sheathed heater and the power source thereof is energized to break the heating operation. This causes the heating

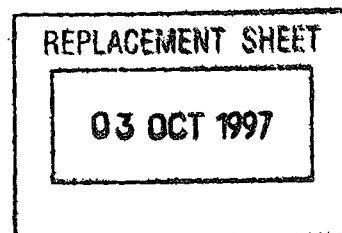


operation to be reduced in efficiency. Further, if a plurality of sheathed heaters are used, the operator must find a sheathed heater of which leakage current becomes large and replace it, and then the circuit breaker must be deenergized with much labor and time.

Further, there are given hitherto manufacturing methods of the sheathed heater as disclosed in Japanese Patents Laid-Open Nos. 155690/83, 157080/83 and 157079/83. In the method shown in the Japanese Patent Laid-Open No. 155690/83, a thin metal plate or metal wire is inserted between the metal pipe and the heater coil and after the sheathed heater is assembled heated it to be oxidized in order to prevent the vaporization of the heater coil so that the insulation resistance of the heat insulating material member, such as magnesia is prevented from being reduced.

However, it is insufficient to reduce the leakage current which flows from the heater coil to the metal pipe at a high temperature atmosphere of more than 600°C.

In the Japanese Patent Laid-Open No. 157080/83, the inner peripheral surface of the metal pipe is coated with a paint including metal oxide powder in

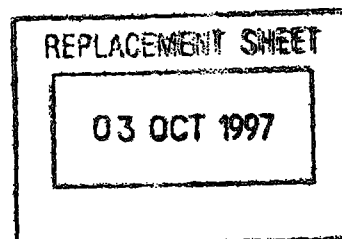


order to prevent the vaporization of the heater coil to attain the same purpose of the above. However, it is also insufficient to reduce the leakage current at a high temperature atmosphere more than 600°C and is very difficult to coat uniformly the entire inner peripheral surface of the metal pipe with the paint. Further, this method is complex and expensive.

In the Japanese Patent Laid-Open No. 157079/83, the inner peripheral surface of the metal pipe is coated with a metal and after the sheathed heater is assembled said metal is oxidized with heat to attain the same purpose of the above. However, in this sheathed heater, the leakage current cannot be reduced sufficiently at a high temperature atmosphere of more than 600°C as mentioned above. GB 1101275 discloses a sheathed heater in accordance with the precharacterising portion of Claim 1.

An object of the present invention is to reduce the leakage current in the sheathed heater, which flows from the internal heater to the metal pipe, so that the sheathed heater can be used at a high temperature atmosphere of more than 600°C.

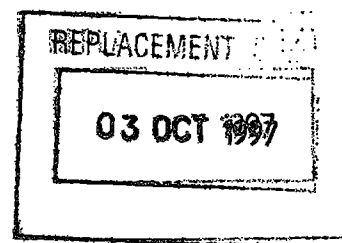
The above object can be attained by a sheathed heater in accordance with the appended claims and comprising, in one embodiment, a metal pipe of which entire inner peripheral surface has been oxidized previously, an internal heater inserted into said metal pipe,



lead pins connected to both ends of said heater, respectively, and a heat resistive insulation material member filled in a space formed between said metal pipe and said internal heater.

The above object can also be attained by a sheathed heater comprising a metal pipe, an internal heater inserted into said metal pipe, lead pins connected to both ends of said heater, respectively, and a heat resistive insulation material member filled in a space formed between said metal pipe and said internal heater, the outer surfaces of said internal heater and lead pins having being oxidized previously.

According to the sheathed heater of the present invention, the leakage current which flows from the internal heater to the metal pipe can be reduced enough, even if the sheathed heater is used at a high temperature atmosphere of more than 600°C, because a sufficient oxide film having a good insulating ability at a high temperature is formed very easily on the entire inner surface of the metal pipe or the outer surfaces of the heater and lead pins by subjecting them at a higher temperature atmosphere in the presence of sufficient oxygen, or subjecting them to the chemicals, such as oxidizing agent.



12b is formed of a straight wire 38.

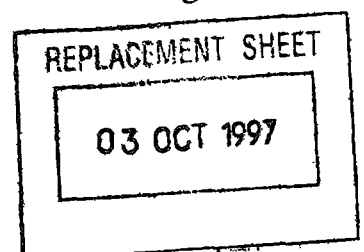
In said embodiments, a metal pipe having a circular cross section is used. However, it should be understood that a metal pipe having a rectangular cross section, triangular cross section, elliptic cross section or the like may be used.

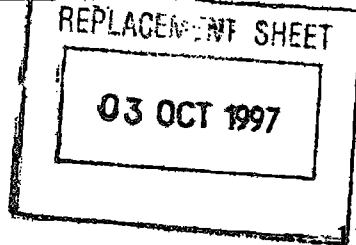
Said oxidization may be carried out by such a method that the metal pipe etc. is heated in the electric furnace containing sufficient air or oxygen at the temperature of about 300- 1300°C during about 5 minutes- more than 10 hours, or at the temperature of about 1,000- 1,300°C during about 5 minutes- 1 hour, until the color of the entire inner peripheral surface of said metal pipe etc. is turned to light brown, brown, or black. The weight of the metal surface being oxidized is increased by about 0.01 mg/cm² of oxidized surface by oxidation when the oxidized surface turns light brown.

In the other method, such oxidization is carried out by applying known chemicals, such as oxidizing agent thereto.

By such oxidization, the insulation resistance of the oxide film thus formed becomes sufficiently large to reduce the leakage current even at temperatures above 600°C.

According to the sheathed heater of the present invention, the leakage current can be reduced to 1/3- 1/10 of that in the conventional sheathed heater, in case that the sheathed heater is used at a high temperature atmosphere of more than 600°C.





11 -



CLAIMS

1. A sheathed heater comprising a metal pipe (1, 21) an internal heater (8, 28, 38) inserted into said metal pipe (1, 21), lead pins (7, 27) connected to both ends of said heater (8, 28, 38), respectively, and a heat resistive insulation material member (10, 29) filled in a space formed between said metal pipe (1, 21) and said internal heater (8, 28, 38), characterised by the entire inner peripheral surface (3, 23) of said metal pipe (1, 21) having been oxidized previously.
2. A sheathed heater comprising a metal pipe, (1, 21) an internal heater (8, 28, 38) inserted into said metal pipe (1, 21), lead pins (7, 27) connected to both ends of said heater (8, 28, 38), respectively, and a heat resistive insulation material member (10, 29) filled in a space formed between said metal pipe (1, 21) and said internal heater (8, 28, 38), characterised by the outer surface of said internal heater (8, 28, 38) and lead pins (7, 27) having been oxidised previously.
3. A sheathed heater according to Claim 2 the entire inner peripheral surface (3, 23) of said metal pipe (1, 21) having been oxidised previously.
4. The sheathed heater according to either one of Claims 1, 2 and 3 wherein said internal heater (8, 28) is in the shape of a coil.
5. The sheathed heater according to either one of Claims 1, 2 and 3, further comprising a core of porcelain insulator (5) arranged at the center of said metal pipe (1), wherein said internal heater (8) is a coil wound around said core of porcelain insulator (5).
6. The sheathed heater according to either one of Claims 1, 2 and 3,



- 12 -

wherein said internal heater (38) is a straight wire.

7. A method of forming a sheathed heater exhibiting reduced current leakage under high temperature operation, comprising the steps of:

providing

- 1) a metal pipe (1, 21) having an inner peripheral surface (3, 23), and
- 2) a heater having (8, 28, 38) lead pins (7, 27) attached to ends thereof;

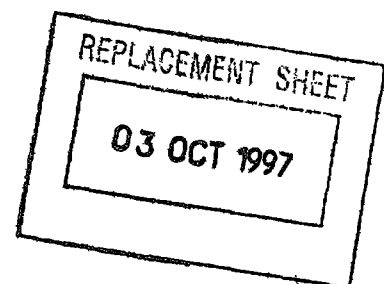
inserting said heater (8, 28, 38) and said lead pins (7, 27) into said metal pipe (1, 21);

filling a space formed between said heater (8, 28, 38) and lead pins and said metal pipe with a member formed from heat resistant insulation material (10, 29),

the method characterised by oxidising directly in a high temperature atmosphere containing sufficient air or oxygen to at least one of

- 1) all of said inner peripheral surface (3, 23) of said pipe (1, 21) and
- 2) outer surfaces of said heater (8, 28, 38) and said lead pins (7, 27) prior to said insertion step.

8. The method of forming the sheathed heater according to Claim 7, wherein said oxidation is such a degree that it is colored to at least light brown.



ABSTRACT:

SHEATHED HEATER

A sheathed heater wherein before the sheathed heater is assembled, an oxide film is formed on the inner peripheral surface (2, 23) of a metal pipe, and/or the outer surfaces of an internal heater (8, 28, 38) and lead pins (7, 27) thereof which are inserted into the metal pipe (1, 21) by heating them in the presence of oxygen or by applying chemicals thereto, and a heat resistive insulation material member (10, 29) is filled in a space formed between the metal pipe (1, 21) and the internal heater (8, 28, 38). The color of the oxide film thus formed is light brown, brown or black.

Figure 3

