

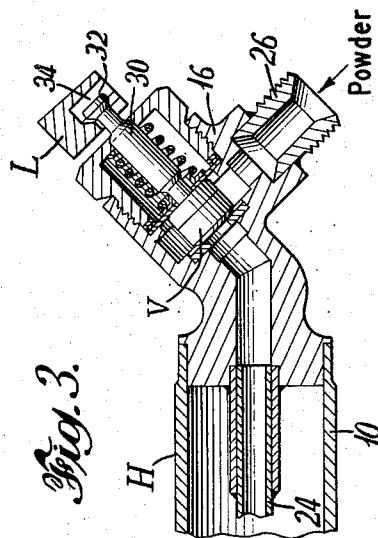
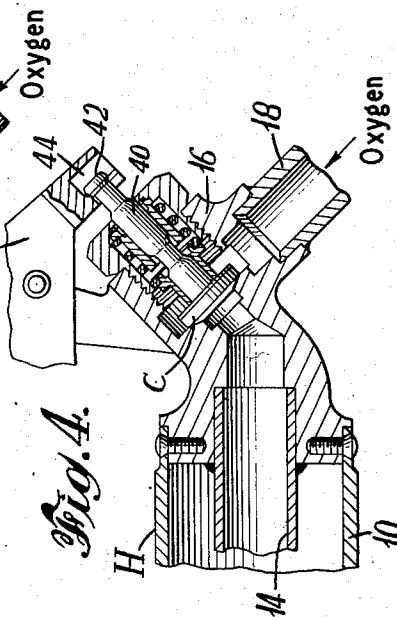
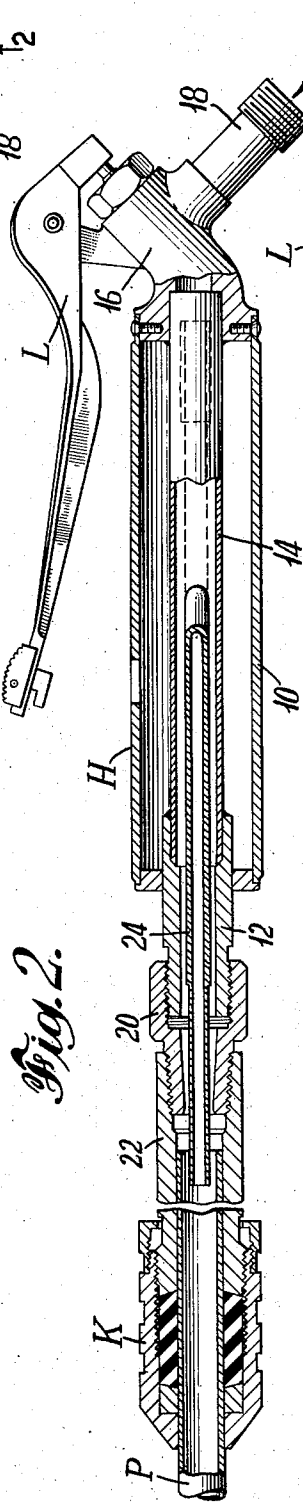
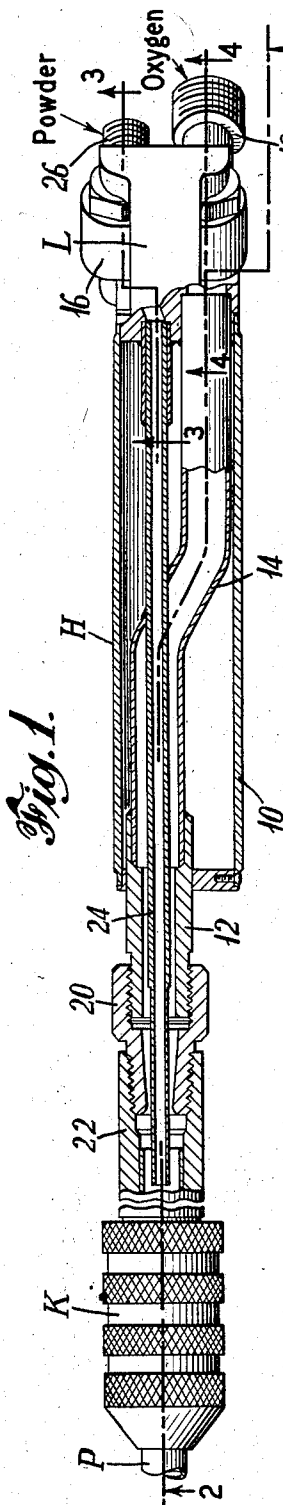
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POWDER LANCE

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POWDER LANCE

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This invention relates to powder lances, and more particularly to method and apparatus for thermochemical removal of refractory material from a body thereof.

In the steel industry, the successful maintenance of blast furnaces, reheating furnaces, open hearths and soaking pits depends on the ability to remove damaged components or other sections detrimentally affecting furnace operations. These maintenance operations require the piercing and cutting of oxidation resistant slags, refractories, copper tuyeres, bronze bosh plates, and the cooling jackets of slag run-off openings. Other materials difficult to cut are stainless steels, concrete and brick. Also spills from a steel furnace which on solidification encompass fire brick slag, and other refractories.

In the past, the only available tools for this work were pneumatic hammers, wagon drills, and the conventional oxygen lance. The oxygen lance was ineffective in penetrating copper alloys and refractories, so that most of the work was done mechanically by costly and time consuming operations.

The oxyacetylene blowpipe was not adapted for deep piercing operations, because the nozzle thereof was only a few inches in length, and could not follow the reaction deep into the works. Furthermore, as the depth of the hole increases, the wall of the hole confines the high temperature burnt gases and returns them directly back onto the source, which would melt and burn off the expensive precision machined copper nozzle of the blowpipe.

The conventional oxygen lance incorporated a long section of small diameter pipe which conveyed oxygen to the workpiece. As the cutting reaction progressed, the iron pipe was consumed and the exothermic heat of the cutting reaction aided the operation. The pipe followed the reaction down into the hole at the approximate rate of consumption, so that the returning burnt gases surely increased the rate of cutting. The extension into the hole and the rate of consumption made long lengths of pipe desirable, to decrease down-time for replacing pipe. However, the conventional oxygen lance could not be used effectively to cut refractory materials, particularly the stainless steels of the 18-8 variety, because not enough fuel in the form of iron was added to supply the additional heat and fluxing that was necessary.

In order to enable the oxygen lance to cut more refractory materials, it has been proposed to suspend in the oxygen stream of the lance an adjuvant powder, preferably a mixture of iron and aluminum powders. To carry out this proposal, the conventional powder blowpipe valving sequence was employed, of turning on the powder stream before the oxygen in starting, and cutting off the oxygen stream before the powder stream in stopping. This sequence satisfactory for a blowpipe nozzle a few inches in length, was not satisfactory with a lance pipe up to 63 feet long. Lengths shorter than ten feet were believed to be impractical since the operator was caused to work too close to the reaction. With these long lengths, the powder stream continuing after oxygen cut off, left

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powder distributed along the pipe, so that restarting was hazardous because of pre-ignition within the pipe and subsequent explosion.

It is therefore the main object of the present invention to prevent pre-ignition in the powder lance.

According to the present invention the oxygen-powder sequence of valve opening in starting is exactly opposite from powder blowpipe practice. In starting the powder lance the oxygen valve is opened prior to the opening of the powder valve, and in stopping the powder lance, the powder valve is closed before the oxygen valve. Another important factor is the use of an aluminum powder which has a well defined limit of fines in its composition.

The powder lance according to applicants' invention has the advantage over the conventional oxygen lance that the rate of pipe burn off is up to 75% slower, because the powder supplies the greater part of the fuel supplied by the burning pipe. This allows the job to be done faster because of less time lost on pipe replacement, and allows the use of a shorter pipe, thus making a more maneuverable tool.

Depending on the job requirements, the powder lance can be used with quarter, three-eighths, and half inch black iron pipe. Once the reaction is started at the end of the lance pipe it is self sustaining. The quarter inch pipe diameter is the most popular size. The burn off rate can be further decreased by substituting stainless steel pipe, the consumption of which varies from one tenths to one quarter of that of iron pipe. In the drawings

Figure 1 is a top plan view of a powder lance according to, and for carrying out the method of, the preferred embodiment of the present invention; parts being broken away and shown in section;

Figure 2 is a side elevation of the same, similarly broken away;

Figure 3 is a section taken along the line 3—3 of Figure 1; and

Figure 4 is a section taken along the line 4—4 of Figure 1.

The powder lance comprises a handle H and a pipe P of ferrous metal such as commercial quarter inch black iron or stainless steel pipe of an initial length of the order of ten to twenty feet. The pipe P is secured to the handle H by a clutch K.

The handle H comprises a shell 10 having a nipple 12 secured in the forward end thereof. The inner end of the nipple 12 is secured to an oxygen tube 14 leading from a valve body 16 at the rear end of the handle H. The valve body contains one oxygen valve C which controls the oxygen supplied to the inlet 18 in the valve body 16.

The nipple 12 at the front of the handle H has secured thereto an adaptor 20 on which is mounted the inner member 22 of the clutch K. Within the shell 10 is mounted a powder tube 24 secured in an aperture in a bend in the oxygen tube 14 so as to pass concentrically through the nipple 12, adaptor 20 and clutch member 22. The rear end of the powder tube 24 leading from the valve body 16. The valve body contains a powder valve V which controls the powder stream supplied by the inlet 26. As shown in Figure 3, the powder valve V has a stem 30 having a head 32 mounted in a socket 34 of a valve control lever L. As shown in Figure 4, the oxygen valve C has a stem 40 having a head 42 mounted in a socket 44 in the valve control lever L. The socket 44 for the oxygen valve stem head is shallower than the socket 34, so that when the lever L is depressed, the oxygen valve C opens before the powder valve V, and when the lever L is released the powder valve V closes before the oxygen valve C.

To prepare the lance for operation the pipe P is installed in the chuck K, oxygen is supplied to the inlet

18, and a powder laden gas stream is supplied to the inlet 26. The powder is adjuvant preferably ferrous material, the optimum being a mixture by weight, 70% iron powder and 30% aluminum powder; although blends of 85% iron and 15% aluminum are frequently employed. This composition can be varied to suit the applications. The addition of the aluminum gives a higher flame temperature, a more stable flame front, greater ease of operation, and superior lancing results. For safety purposes the aluminum powder must be specified to contain less than 45% by weight fines passing through a 325 mesh screen. The powder pressure at the lance handle must be approximately five pounds per square inch greater than the oxygen pressure at this point.

To start the operation, the lever L is depressed to open the oxygen valve C. Oxygen from the inlet 18 passes through oxygen tube 14 along an annular path outside the powder tube 24 but inside the nipple 12, adaptor 20 and clutch member 22, into the pipe P. This initial oxygen purges the pipe of any residual powder from previous operation.

Further depression of the lever L opens the powder valve V. Powder laden gas from the powder inlet 26 passes through the powder tube 24 to the inside of the pipe P. The annular oxygen stream from the chuck number 22 and the central powder stream from the powder tube 24 commingle as they pass along the length of the pipe P to the exit end thereof.

Unlike the conventional oxygen lance which must be started by heating the end of the pipe to kindling temperature, the powder lance according to the invention is started by igniting the oxygen-powder mixture by directing it against a piece of smoldering cloth or wood. The end of the lance pipe should be in contact with the igniting medium for best results. The resultant flame is continued to ignite the cut end of the pipe and progressively consume the pipe as additional fuel for the flame.

A factor not previously known is that the iron pipe burnoff adds a negligible amount of heat to the reaction. This was proven by tests with pipe of very slow consuming material where lancing speeds were equal to that attained with the conventional iron pipe. This was an unexpected result. In starting normal piercing, the end of the lance pipe is positioned two to four inches from the workpiece to prevent too rapid burn off, but after a suitable entrance depression is formed, the pipe is advanced and ultimately enters and follows the reaction into the hole.

For severing and washing operations, the distance of the pipe end from the work should be about six inches. At this distance the pipe stops burning and the lance can be successfully operated as a non-consumable tool. This characteristic is advantageous in that less pipe and shorter pipe can be used.

The powder consumption rates are 30-45 pounds per hour for quarter inch pipe; 60-90 pounds per hour for three eighths inch pipe; and 120-150 pounds per hour for half inch pipe.

For normal operation oxygen pressure of 70-90 pounds per square inch at the inlet of 50 feet of half inch hose is recommended. Corresponding powder dispensing pressures are 75 to 95 pounds per square inch. The higher pressure is for piercing and severing, the lower pressure for washing.

The average piercing rate through cold refractory slag or concrete averages 6-12 inches per minute for one and a quarter inch diameter holes, depending on the powder mixture employed and three inches per minute for three inch diameter holes. Six inch diameter holes have been produced at speeds of an inch and a half per minute.

Other uses of the powder lance are the removal of sand incrustations from large castings, the reduction of spills and buttons in steel mills, and piercing holes in slagaceous and rock like materials. In connection with blast furnaces, the powder lance is used for the tapping of molten

salamanders, and removal of damaged sections, and cleaning of iron and slag runners. In the open hearth furnace, the powder lance is used for the cleaning of slag pockets, removal of metal run outs, cleaning of cinders from the walls, and removal of slag build-up from the banks and the slag run off slot.

In the electric furnace metal run-outs are removed, and top holes cleaned. In one case the electric furnace bottom failed and 16 tons of stainless steel ran into and solidified in the pit beneath. With the powder lance of this invention this breakout was severed into sections and removed in four hours. At least two weeks were saved over the time that would have been required with the conventional oxygen lance or mechanical equipment.

What is claimed is:

1. Method of powder lancing a body of refractory material which comprises directing a stream of oxidizing gas through an elongated ferrous metal pipe to be consumed in the lancing operation, to purge the pipe by blowing out thereof by the force of said stream any powder remaining therein from previous operation thereof, thereafter when said purging operation is completed and while said stream is still flowing, only then supplying adjuvant powder to the entrance end of said pipe to commingle with said oxidizing gas stream and be carried thereby out through the discharge end of said pipe, igniting the mixture of powder and oxidizing gas issuing from the discharge end of said pipe to form a flame, continuing said flame to ignite the discharge end of said pipe and progressively consume the pipe as additional fuel for the flame, and directing the pipe to project the adjuvant powder and pipe metal fueled flame from the exit end thereof against the body of refractory material.

2. Method of powder lancing a body of refractory material which comprises directing a stream of oxidizing gas through a ferrous metal pipe of a length measured in feet to be consumed in the lancing operation to purge the entire length of said pipe by blowing out thereof by the force of said stream any powder remaining therein from previous operation thereof, thereafter when said purging operation is completed and while said stream is still flowing, only then supplying adjuvant powder to the entrance end of said pipe to commingle with said oxidizing gas stream and be carried thereby for the full length of said pipe and on out through the discharge end of said pipe, igniting the mixture of powder and oxidizing gas issuing from the discharge end of said pipe to form a flame, continuing said flame to ignite the discharge end of said pipe and progressively melt and burn off the pipe as additional fuel for the flame, and directing the pipe to project the flame therefrom fueled by said adjuvant powder and the metal of said pipe against the body of refractory material.

3. Method of powder lancing a body of refractory material which comprises directing a stream of oxidizing gas under 70 to 90 pounds per square inch inlet pressure through a ferrous metal pipe of a length to be consumed in the lancing operation to purge the pipe by blowing out thereof by the force of said stream under said pressure any powder remaining anywhere along the length of said pipe from previous operation thereof, thereafter when said purging operation is completed and while said stream is still flowing under said pressure, only then supplying adjuvant powder at an inlet pressure of 75 to 95 pounds per square inch to the entrance end of said pipe at a rate corresponding to 30 to 45 pounds per hour for a quarter inch pipe to commingle with said oxidizing gas stream and be carried thereby for the full length of said pipe and on out through the discharge end of said pipe, igniting the mixture of powder and oxidizing gas issuing from the discharge end of said pipe to form a flame, continuing said flame to ignite the discharge end of said pipe and progressively consume the pipe as additional fuel for the flame, and directing the pipe to project the flame of adjuvant powder and pipe metal burn-

ing in said oxidizing gas against the body of refractory material.

4. Method of powder lancing a body of refractory material which comprises directing a stream of oxidizing gas through a ferrous metal pipe of a length of between ten and twenty feet to purge the entire length of said pipe by blowing out thereof by the force of said stream any powder remaining therein from previous operation thereof, thereafter when said purging operation is completed and while the stream is still flowing, only then supplying adjuvant powder to the entrance end of said pipe to commingle with said oxidizing gas stream and be carried thereby for the full length of said pipe and on out through the discharge end of said pipe, igniting the mixture of powder and oxidizing gas issuing from said pipe to form a flame, continuing said flame to ignite the discharge end of said pipe and progressively consume the metal thereof as additional fuel for said flame, and directing the pipe to project the flame from the exit end thereof against the body of refractory material.

5. Method of powder lancing a body of refractory material which comprises directing a stream of oxidizing gas through a stainless steel pipe to purge said stainless steel pipe by blowing out thereof by the force of said stream any powder remaining therein from previous operation thereof, thereafter when the purging of said stainless steel pipe is completed and while said stream is still flowing in said stainless steel pipe, only then supplying adjuvant powder to the entrance end of said stainless steel pipe to commingle with said oxidizing gas stream and be carried thereby for the full length of said stainless steel pipe and out through the discharge end of said stainless steel pipe, igniting the mixture of powder and oxidizing gas issuing from said pipe to form a flame, continuing said adjuvant powder fueled flame to ignite the discharge end of said stainless steel pipe and progressively consume the metal thereof as additional fuel for said flame, and directing the pipe to project the stainless steel fueled flame from the exit end thereof against the body of refractory material.

6. Method of powder lancing a body of refractory material which comprises directing a stream of oxidizing gas through a ferrous metal pipe to purge the pipe by blowing out thereof by the force of said stream any powder remaining therein from previous operation thereof,

thereafter when said purging operation is completed and while said stream is still flowing, only then supplying adjuvant powder to the entrance end of said pipe to commingle with said oxidizing gas stream and be carried thereby out through the discharge end of said pipe, said powder comprising a mixture of the order of by weight 70% iron powder and 30% aluminum powder, the aluminum powder containing less than 45% by weight of fines which pass through a 325 mesh screen, igniting the mixture of powder and oxidizing gas issuing from said pipe to form a flame, continuing said flame to ignite the discharge end of said pipe and progressively consume the metal thereof as additional fuel for said flame, and directing the pipe to project the iron-aluminum powder-pipe metal fueled flame from the exit end thereof against the body of refractory material.

7. Method of powder lancing a body of refractory material which comprises directing a stream of oxidizing gas through a metal pipe, supplying adjuvant powder to said pipe to commingle with said oxidizing gas stream, igniting the mixture of powder and oxidizing gas issuing from said pipe to form a flame, continuing said flame to ignite the discharge end of said pipe and progressively consume the metal of said pipe as additional fuel for said flame, directing the pipe to project the flame from the exit end thereof against a body of refractory material, discontinuing the supply of adjuvant powder while continuing the oxidizing gas stream to at least partially purge the pipe by blowing out thereof by the force of said steam at least part of the powder supplied thereto before such discontinuation thereof, and thereafter discontinuing the oxidizing gas stream.

References Cited in the file of this patent

UNITED STATES PATENTS

968,350	Harrison	Aug. 23, 1910
1,494,003	Malcher	May 13, 1924
2,407,972	Aitchison	Sept. 24, 1946
2,444,899	Meincke et al.	July 6, 1948
2,632,721	Meincke	Mar. 24, 1953
2,643,622	Meincke et al.	June 30, 1953