Oct. 18, 1938. W. E. MOORE ET AL 2,133,329

METHOD FOR HEAT TREATING FURNACE LININGS

Filed Sept. 1, 1936 3 Sheets-Sheet 1

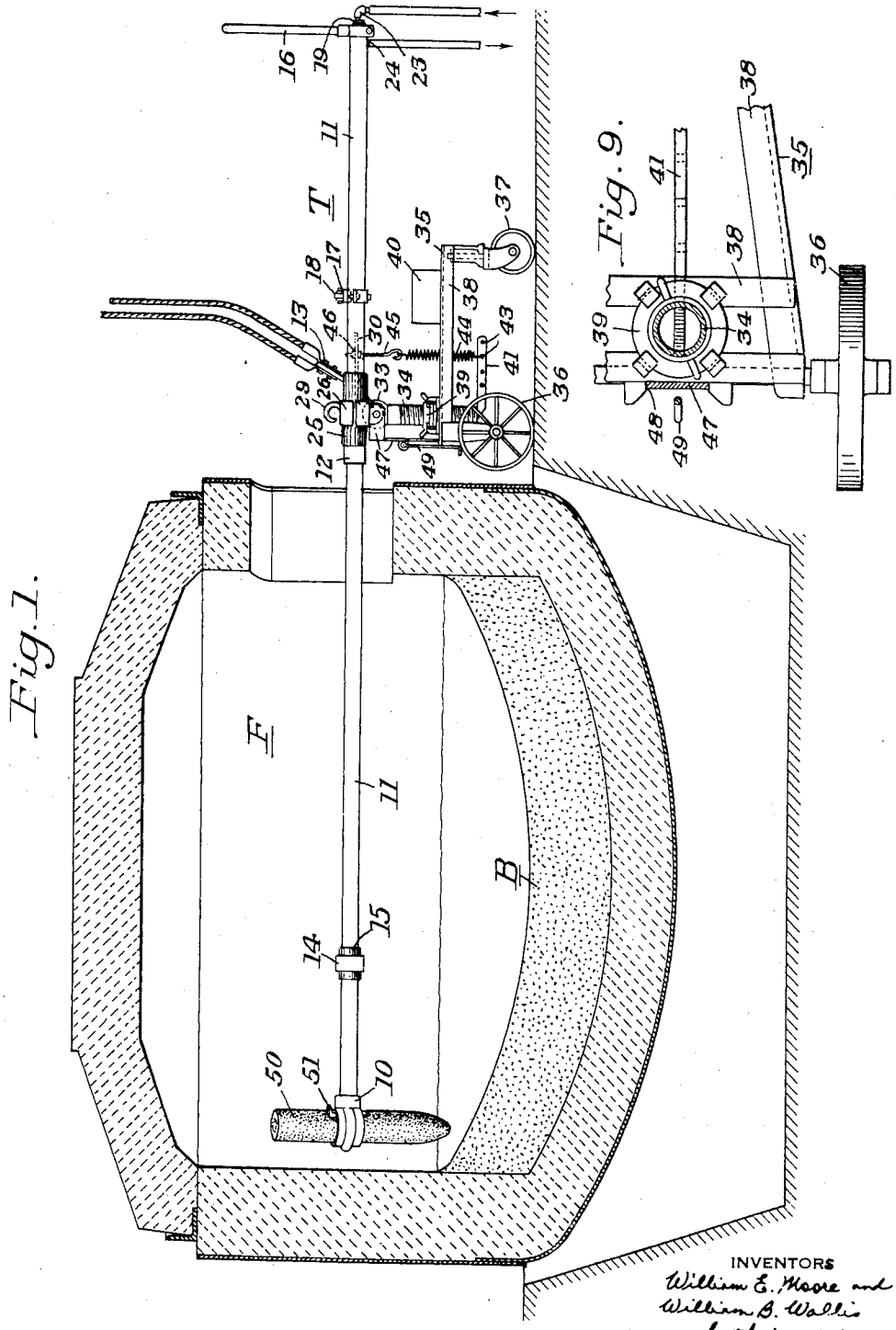


Fig. 1.

Fig. 9.

INVENTORS
William E. Moore and
William B. Wallis
by their atty's
Stebbins, Blenko & Parmelee

Oct. 18, 1938. W. E. MOORE ET AL 2,133,329

METHOD FOR HEAT TREATING FURNACE LININGS

Filed Sept. 1, 1936 3 Sheets-Sheet 2

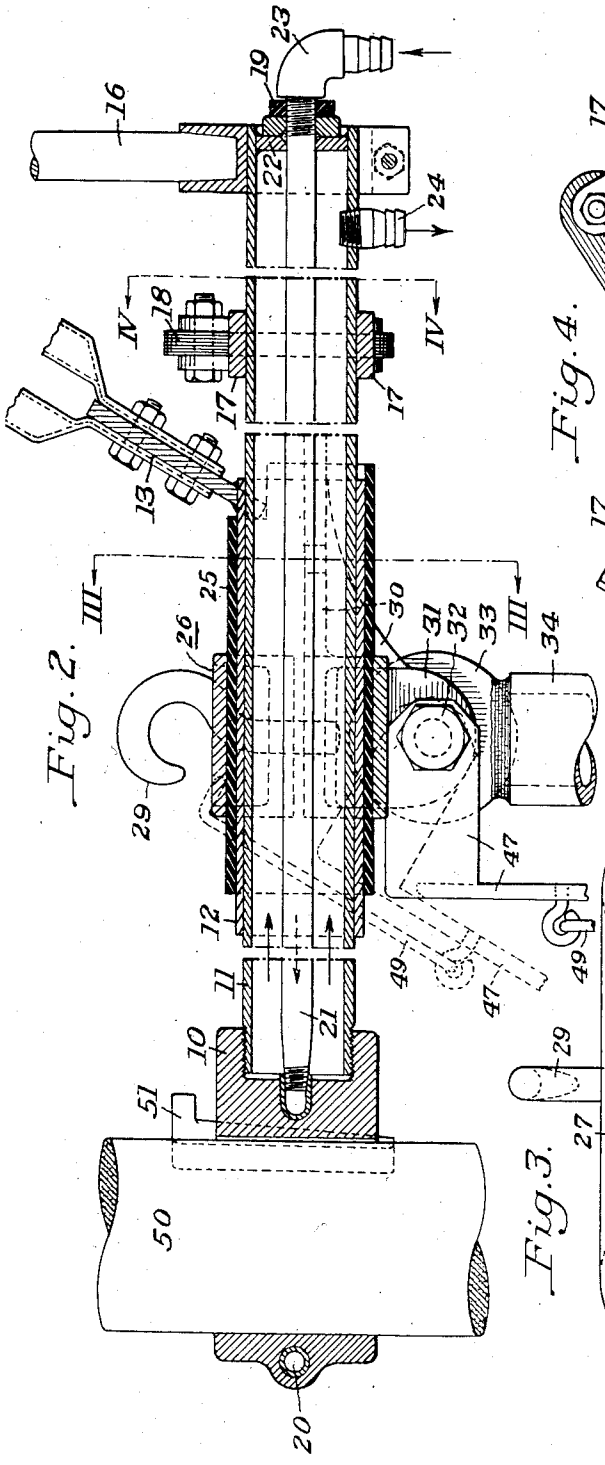


Fig. 2.

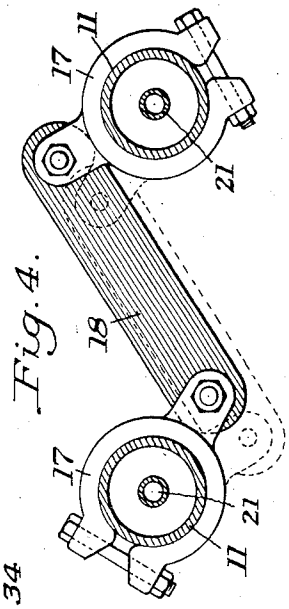


Fig. 4.

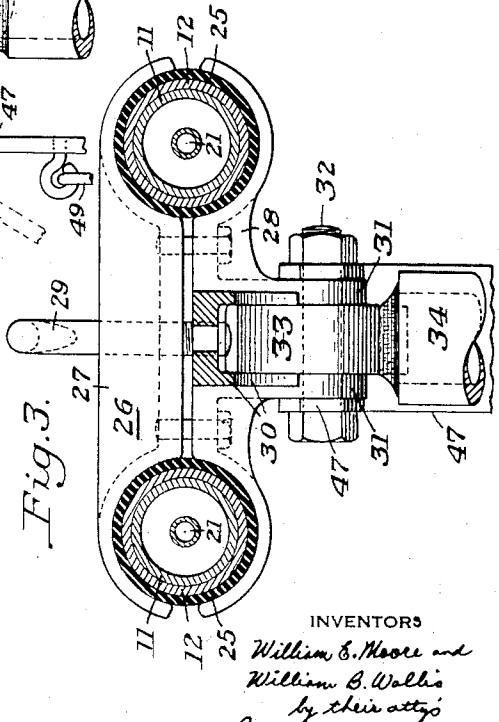


Fig. 3.

INVENTORS
William E. Moore and
William B. Wallis
by their attys
Stebbins, Blenko & Carmelee

Oct. 18, 1938. W. E. MOORE ET AL 2,133,329

METHOD FOR HEAT TREATING FURNACE LININGS

Filed Sept. 1, 1936 3 Sheets-Sheet 3

Fig. 7.

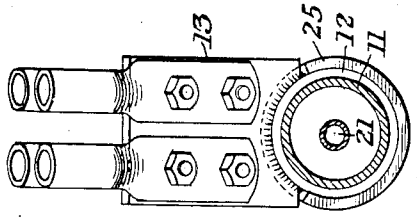


Fig. 6.

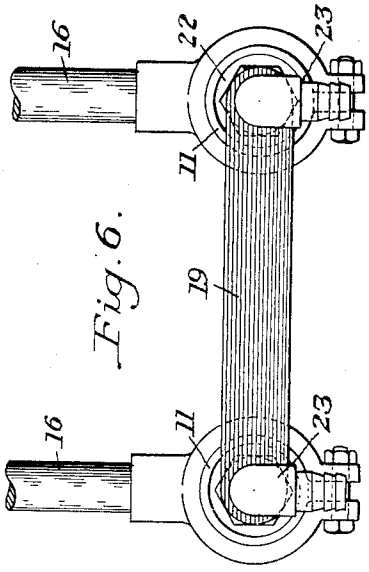


Fig. 5.

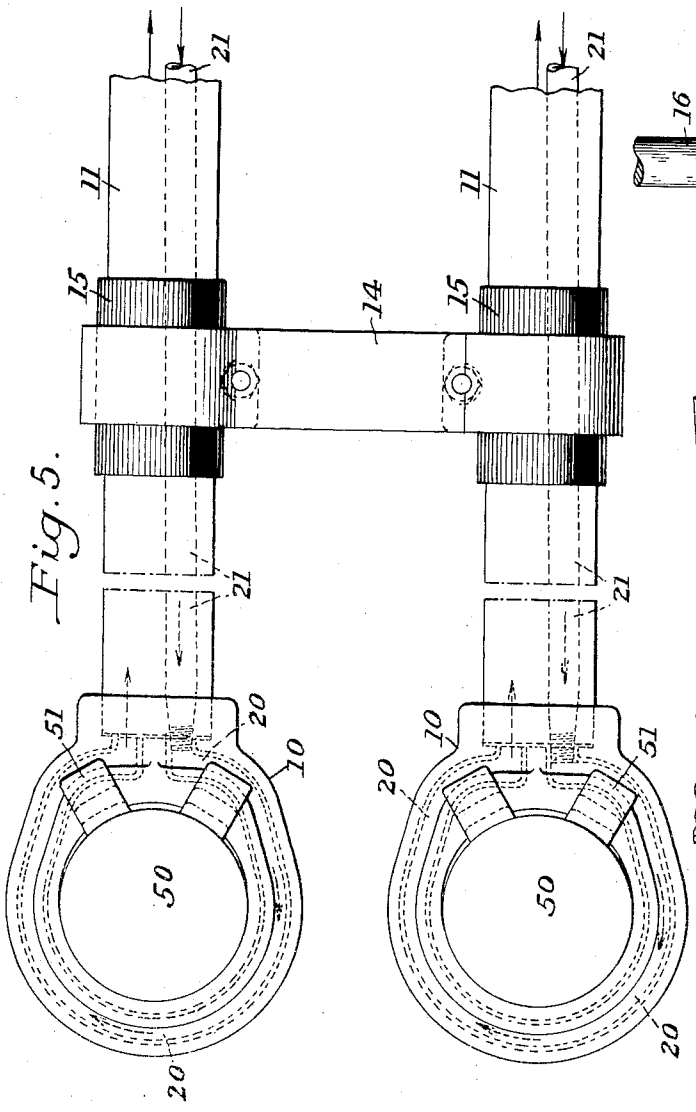
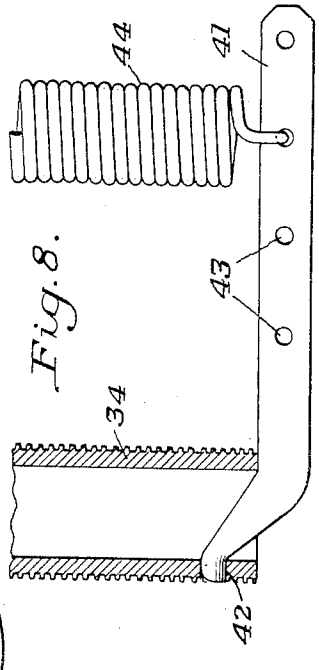


Fig. 8.



INVENTORS
William E. Moore and
William B. Wallis
by their atty's
Stebbins, Henbest & Carmelee

Patented Oct. 18, 1938

2,133,329

UNITED STATES PATENT OFFICE

2,133,329

METHOD FOR HEAT TREATING FURNACE LININGS

William E. Moore, Pittsburgh, Pa., and William B. Wallis, New York, N. Y., assignors to Pittsburgh Research Corporation, Pittsburgh, Pa., a corporation of Delaware

Application September 1, 1936, Serial No. 98,918

2 Claims. (Cl. 13—35)

Our invention relates in general to refractory furnace linings and to the art of heat treating them, and more particularly to methods for burning in the refractory linings of furnaces and like structures and to a lining formed in situ.

Furnaces such as are used for melting, refining or treating metals, glass, or the like, or furnaces for boilers and the like are subject to relatively high temperatures and are usually constructed with highly refractory linings. These linings are commonly made from firebrick aggregates of silica or magnesite sand and the like, cemented or bonded together by a binder, such as, for example, fireclay or hydrocarbons and similar substances. The fusing or maturing point of the binders employed is much lower than that of the refractory material from which the linings and particularly the bottoms are formed, and the use of such a binder impairs the effectiveness of the refractory material in direct proportion to the amount of binder used, as it renders the furnace linings more readily fusible at lower temperatures and more susceptible to disintegration. In the repairs of such furnaces, refractory substances with a binding material such as we mentioned, are usually employed and are subject to the same objections.

It is also desirable that the lining have as dense and as homogeneous a surface as possible, so that the content of the furnace, such as molten metal, may not find its way into the body of the lining as the deterioration of the lining depends upon the extent of surface exposed to the corrosive action of the molten charge and the more porous the lining, the greater is the surface exposed. It is, therefore, a great advantage to fuse the lining of the furnace, particularly those parts which come into contact with highly heated metals or highly heated or corrosive products of combustion and to fuse such portions without the use of binders or fluxes which will impair the resistance of the lining material to high temperatures and corrosion.

Heretofore, attempts have been made to burn in the bottoms of electric furnaces having highly refractory bottoms made from materials, such as magnesite, by means of the ordinary electric arc which is generally set up to arc against a delta or T made of carbon electrodes placed across the bottom. While this plan may have some advantages for small furnaces, it becomes less practical as the size of the furnace increases and, even with small furnaces, it has heretofore been essential to reduce the melting temperature of a highly refractory material, such as magnesite, by adding to it a flux such as 8 to 10% of open hearth slag or silica, etc. The same difficulty applies to highly refractory bottoms and linings in open hearth furnaces and the like, as the heat is not available there from combustion of fuel to burn in highly refractory bottoms. Even with such heat as is available, great damage resulting from the overheating thereof is usually done to the roof and other parts of the refractory lining of the furnace when burning in the bottom so that in open hearth furnaces the life of the refractory lining is still further sacrificed by fluxing it more liberally.

The desirable condition, for example, in a metal melting furnace bottom and lining exposed to the action of molten metals and slag, is to have the inner layers thereof thoroughly fused together into a vitreous mass without the use of fluxes or binders. The heat resisting properties of the refractory material need not therefore be impaired by adulteration with fluxes, and we have found that such linings made according to our invention very successfully resist the dissolving action of slag and the boiling action of molten metal and like sources of lining deterioration.

The electric arc has a temperature sufficiently high to melt any known refractory material if the arc be concentrated or blown directly against the material. By means of our invention, we have provided a method and apparatus which utilizes the properties of the electric arc for burning in or fusing the refractory linings, particularly the bottoms, banks or side walls, on all kinds of furnaces, electric, open hearth, or other kinds, but without overheating of other parts of the furnace structure. Furthermore, it is thus possible to provide a lining which is made from unfluxed refractory material which may be formed in situ and fused to the shape of the furnace or like structure. The refractory material may be preformed, if desired, or a loose or granular material of any size particle may be employed, such as granular magnesite. Our device consists of a portable apparatus having supports for two electrodes of suitable material such as carbon or graphite inclinably mounted like a V with the arcing points nearest the bottom of the V. By means of this arrangement, the arc is blown or repelled vigorously by magnetic repulsion away from the bottom of the V and may be directed against the material to be fused or sintered in. The device is portable and is arranged for manipulation of the electrodes to different positions so that the arc may be brought to bear on practically any desired part of the furnace lining and thus fuse the refractory material progressively until the de-

sired portions of the furnace lining are covered with a vitreous mass or to use the expression of the industry "burned in".

By our invention, we provide a simple and convenient arrangement whereby an electric arc can be maintained between the electrodes of a portable apparatus which can be readily manipulated so that the heat therefrom may be directed against any desired point.

In the accompanying drawings, illustrating present preferred embodiments of our invention, and in which like numerals are employed to designate like parts throughout the same;

Figure 1 is an elevation showing our device in position in a furnace;

Figure 2 is a view, partly in section, through one of the holders and to a larger scale than Figure 1;

Figure 3 is a view along the section III—III of Figure 2;

Figure 4 is a view along the section IV—IV of Figure 2;

Figure 5 is a plan view of the electrode end of the apparatus.

Figure 6 is an elevation of the outer end of the control end of the apparatus;

Figures 7, 8, and 9 are detail views of portions of the apparatus.

In the drawings, we have shown in Figure 1 a portable water-cooled electric torch T made according to our invention in position to burn in the bottom B of furnace F. It is to be understood that the apparatus is suitable not only for burning in the refractory bottom but by proper manipulation other parts of the lining as well, which are made of refractory material, may be treated.

The torch consists of two copper electrode holders 10, each mounted on an electrode carrying member or arm 11. Each of the electrode arms 11 are slidably and rotatably mounted within a copper contact sleeve 12, to which a suitable terminal 13 for the electric power supply is attached. Adjacent the holder end of the arms 11 is a metal spacing member 14 having ends which embrace an insulated sleeve 15, each sleeve surrounding the arm 11 in such manner that each of the arms 11 may be rotated within its associated sleeve. At the outer end of the electrode arms 11, that is the end distant from the electrode holders 10, suitable adjusting handles 16 are secured. By means of these handles, which are made of insulating material such as wood, fibre, or synthetic resin, etc., the electrode arms can be moved longitudinally and rotated, and the apparatus as a whole can be manipulated. Fixedly mounted on each electrode arm 11, between the handle 16 and contact sleeve 12 is a rock crank 17. The cranks 17 are swivelly connected by an insulating connecting link 18, preferably made of bakelite, fibre, or other physically strong insulating material, so that when one arm is rotated in one direction, the other arm will move simultaneously in the opposite direction and in the same amount. The ends of arm 11 adjacent the handles 16 are rotatably secured together by a spacing link 19 of insulating material.

The electrode arm 11 is preferably made from hollow copper tubing and is attached to the holder 10, in any suitable manner, as, for example, by screw threading. The holder 10 has an internal water passage 20 therearound and to one end of this water passage a pipe 21 is attached. This pipe is smaller in diameter than the inside diameter of the electrode arm 11, and passes therethrough, so that there is an annular space between the pipe 21 and the inner wall of arm 11, into which space the other end of passage 20 leads. Pipe 21 extends through the disc 22 which closes the handle end of the electrode arm 11 and has a connection 23 to a suitable source of water supply (not shown). Cooling water may thus be passed through pipe 21 around passage 20 in holder 10, back through the annular space between the electrode arm and tube 21 and discharged through discharge connection 24.

Contact sleeves 12 are each mounted against movement within an insulating sleeve 25, which is received in a spacing member or support 26. The spacing member consists of an upper portion 27 and a lower portion 28, removably secured together. The ends of both of these portions are shaped to embrace and retain insulating sleeve 25 in a predetermined position. A lifting hook 29 is secured to arm spacing member 26. The lower portion 28 has a rearwardly projecting horizontal arm 30 and a downwardly projecting bifurcated portion 31 which is pivotally secured by bolt 32 to the head 33 of a hollow screw-threaded upright or support 34, which is adjustably fastened to movable truck 35.

Truck 35 has two front wheels 36 and a swivel wheel 37 at the rear supporting a framework 38 through which the hollow upright 34 projects and is supported on the frame 38 by adjusting nut 39, which is in anti-friction engagement therewith. By manipulation of nut 39, the apparatus as a whole may be adjusted to the desired vertical position. A suitable counterweight 40 may be placed, if necessary, on frame 38 to resist the turning movement due to the counterbalance device hereinafter to be described.

In order to counterbalance the weight of the electrode-holders and electrodes so that the apparatus may be readily worked by man power, we provide a counterbalance device. This device consists of a balance arm 41 having an upwardly inclined reduced end portion which is received in an opening 42 in supporting member 34. The arm has various holes 43 along its length into any one of which, one end of a suitable spring 44 may be secured. The other end of spring 44 is fastened to hook member 45 which, in turn, is attached to horizontal arm 30 by an adjustable screw-threaded connection 46. By placing one end of spring 44 in a suitable hole in balance arm 41, the other end in hook member 45, which, in turn, is secured in a suitable position to arm 30, and by adjusting the connection 46, the proper counterbalancing force may be secured. In some installations, counterbalancing may be secured by means of suitably insulated counterweights (not shown) connected to arms 11.

When placing the apparatus in position and at other times during the operation of the apparatus, it may be desirable to move the torch itself and the truck 35 as a unit. To prevent the torch T from swinging in a horizontal plane with respect to the truck 35, we provide a lock member or latch 47 which is pivotally secured to the bifurcated portion 31 of spacing member 26 so that when the torch is to be locked to truck 35, latch 47 will be in the position shown in Figures 1, 2 and 9, where the depending portion of the latch is received in groove 48 formed in the framework 38. Secured to member 47 is a hook 49, which when connected to spacing member 26, will hold latch 47 out of engagement with groove 48 and thus permit the torch to freely

swivel on the truck **35**. In Figure 2, the latch **47** is shown in dotted lines out of locking engagement.

The electrodes **50** of a suitable size and formed from a suitable material such as carbon or graphite, are secured in the electrode holder or clamp **10** by any suitable means such as clamping wedges **51**, preferably made of copper, which are driven in from the upper side of the holder.

Operation of the apparatus

A layer of refractory material is rammed in on the elementary bottom layers of the furnace lining which are usually of brick. The electrode end of the torch is projected through a door or other suitable opening into the furnace and the water cooling circulation is established. An arc is then struck by rocking the arms **11** by means of handle **16** until the tips of the electrodes **50** contact, after which they are rocked back slightly to draw the arc to the desired length, whereupon the free-burning arc is blown or projected against the lining at the desired point until the refractory lining is burned in or sintered. The arc is then moved from place to place on the lining until the desired area is burned in or sintered. Due to the construction of the torch, the arms may be moved backwards or forward tilted and rotated, and the truck may be manipulated so that all the desired area of the furnace lining may be processed.

It is also possible to disconnect the torch from the truck by removing bolt **32**. The torch may then be suspended by means of hook **29** from an overhead crane or the like, or from a convenient part of the structure to be treated, in which circumstances, the electrode end of the torch may be inserted into the furnace by first removing the roof or it may be introduced through any other convenient opening. In case the torch is suspended from a convenient support, the rock cranks **17** may be adjusted in position along the arms, so that sliding movement of the arms in the contact sleeves **21** is restricted. Many modern furnaces, especially electric furnaces, are of the tilting type and have removable roofs and the overhead suspension of the torch is particularly applicable when treating such furnaces.

It will be observed that we have invented a flux free lining and a convenient and wholly satisfactory method and apparatus for heat treating the refractory lining of any type of furnace and which may be used for heat treating other refractory vessels, such as ladles, launders, spouts, etc., which require some kind of refractory lining. Linings so prepared and treated show pronounced economies and advantages in furnace operation. By our invention, not only can new linings be satisfactorily treated, but repairs can be expeditiously made to defective linings. Furthermore, the desirable refractory material may be burned in or fused without the use of fluxes, thus retaining unimpaired the maximum refractory and other desirable qualities of the lining.

While we have illustrated and described certain preferred embodiments of our invention, it will be understood that the invention is not limited thereto and that various changes in the shape, size and arrangement of parts may be resorted to without departing from the spirit of our invention or the scope of the following claims.

We claim:

1. The process of heat treating the refractory lining of a furnace or like structure, which consists in subjecting a limited area of said lining to the action of a mobile electric arc blown against it and thereafter subjecting other areas of the lining to the action of the electric arc until the desired area of the lining has been treated.

2. The process of preparing furnace linings for use which comprises applying and shaping lining material to the interior of a furnace chamber of the ultimate desired contour and thickness and thereafter burning in the shaped refractory by progressively subjecting successive small areas of the lining to the fusing action of an electric arc projected against the surface of the lining.

WILLIAM E. MOORE.
WILLIAM B. WALLIS.