

March 3, 1964

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3,122,813

FLEXIBLE FORM FOR REPAIRING THE OXYGEN LANCE
HOLES IN OPEN HEARTH FURNACE ROOFS

Filed Dec. 9, 1960

8 Sheets-Sheet 1

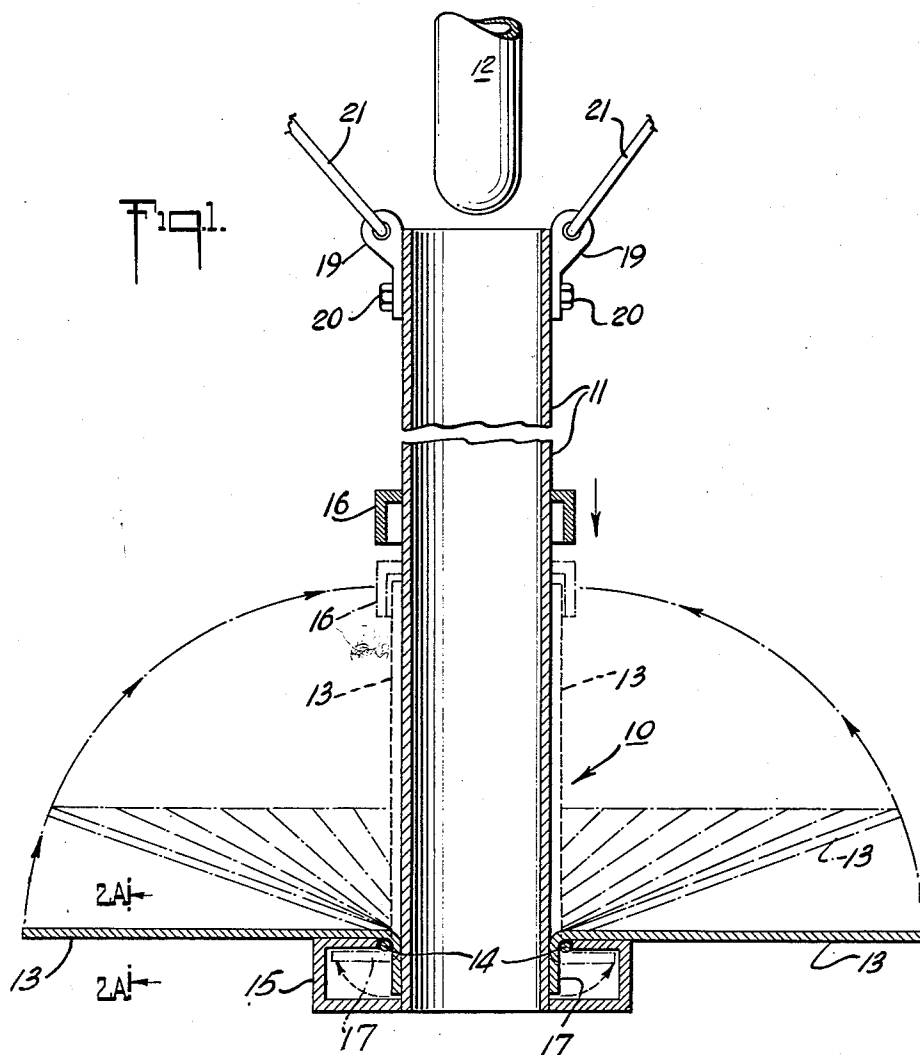


Fig. 2A.



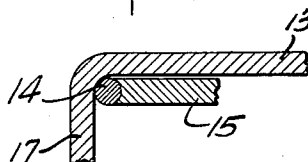
Fig. 2B.



Fig. 2C.



Fig. 3.



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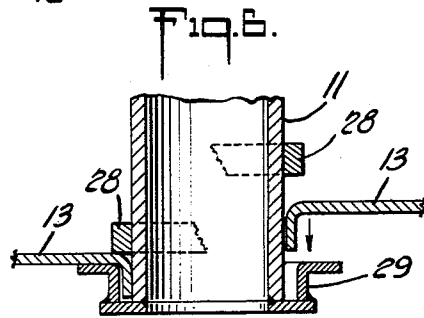
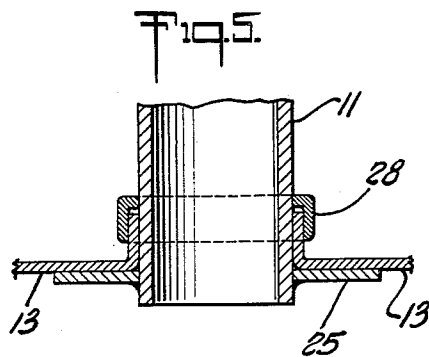
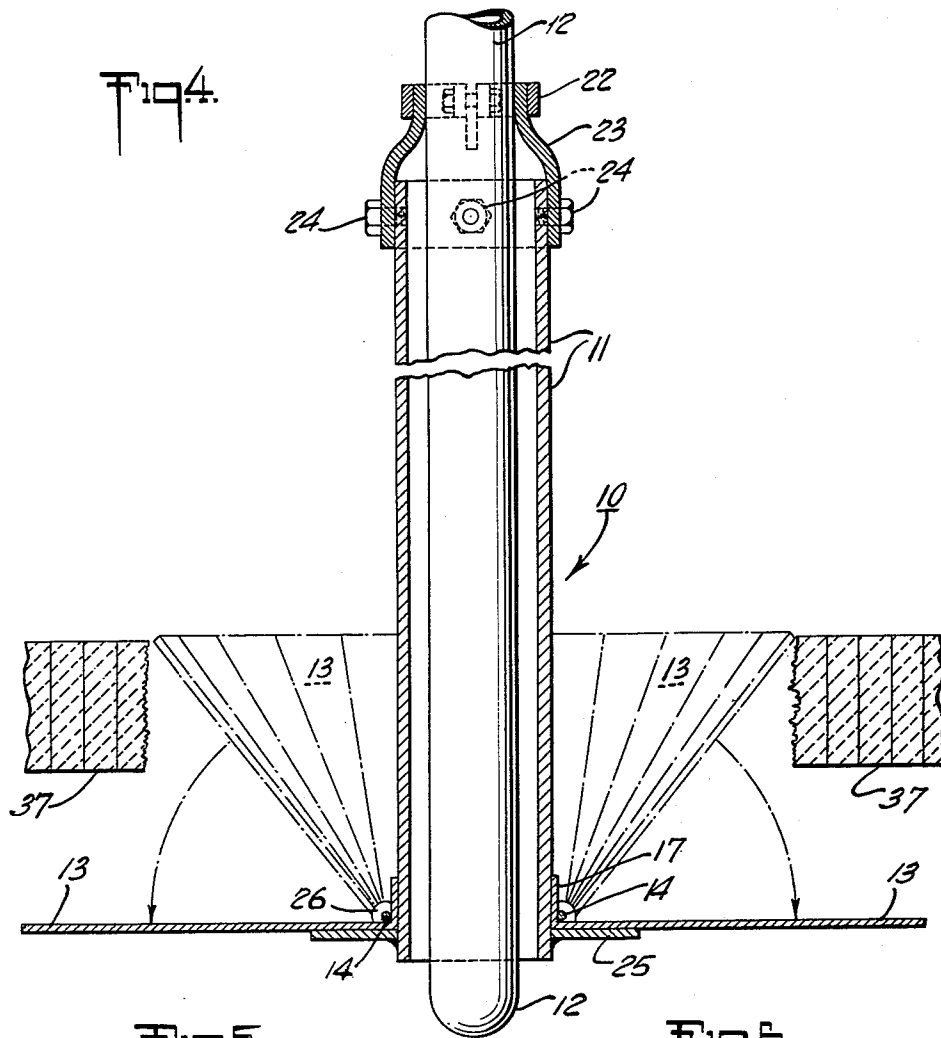
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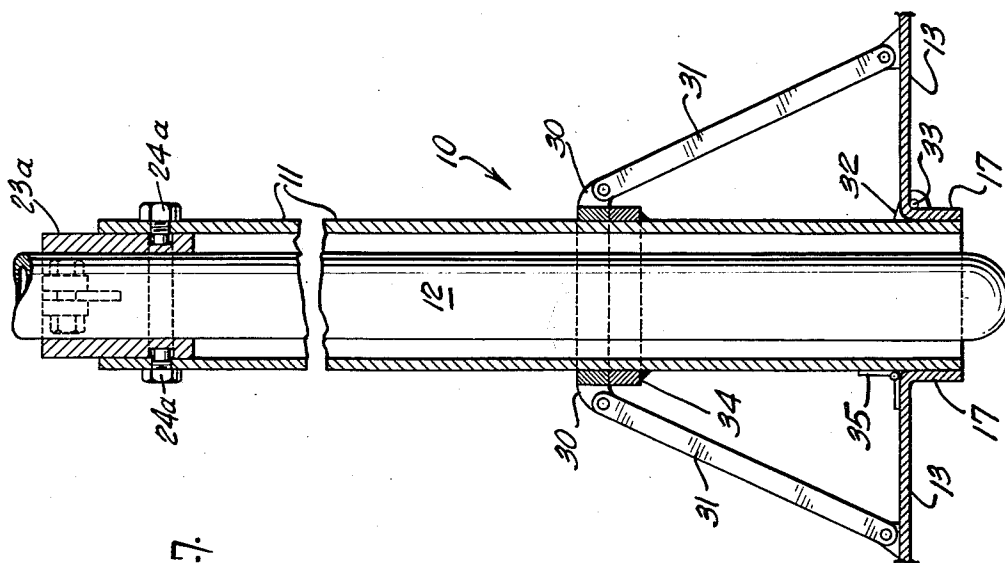
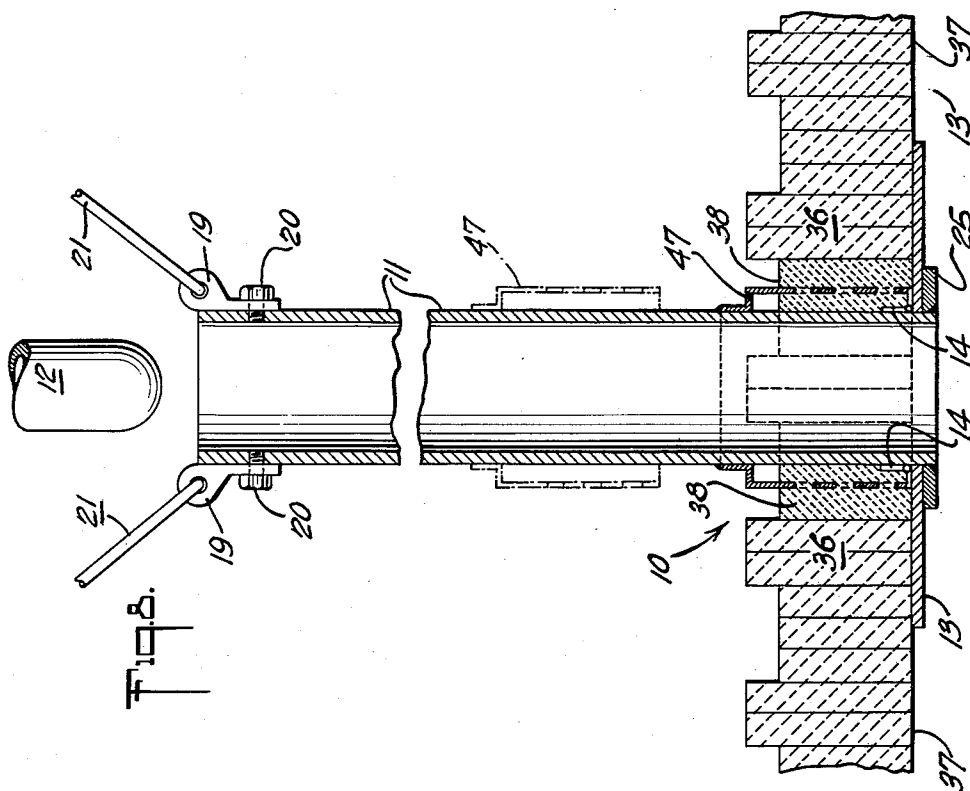
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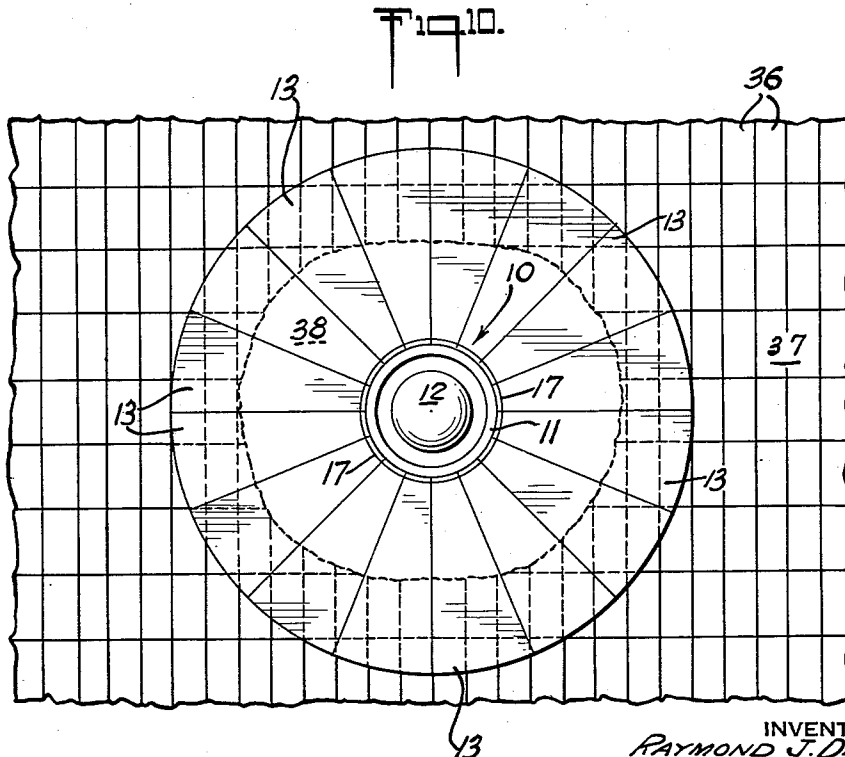
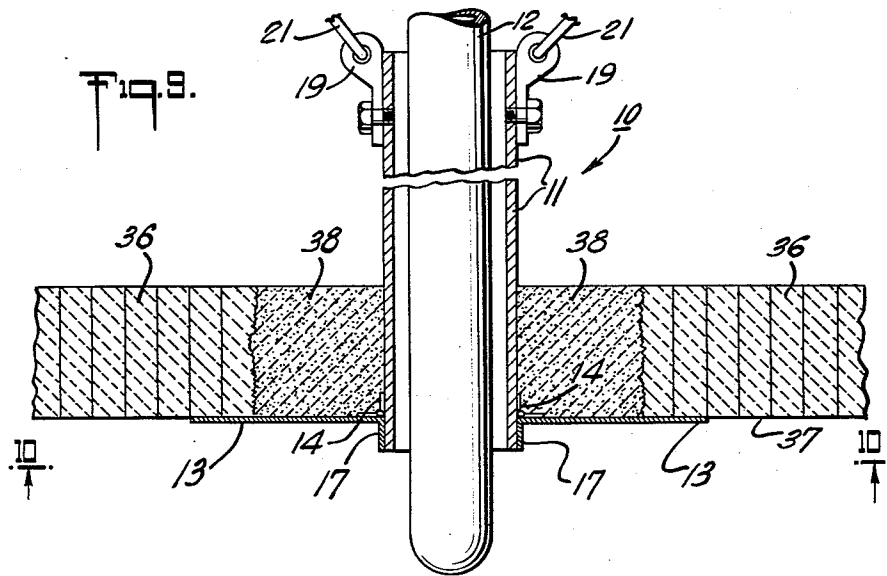
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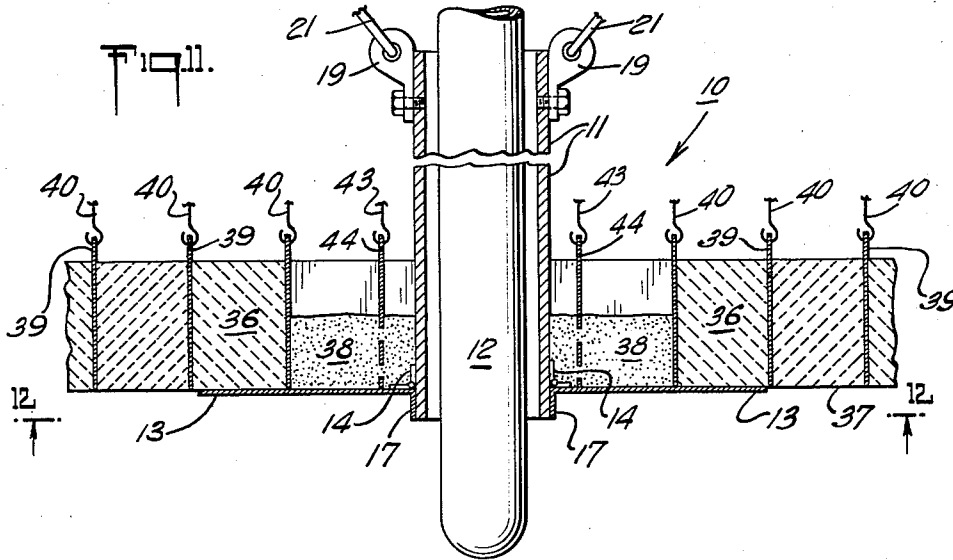
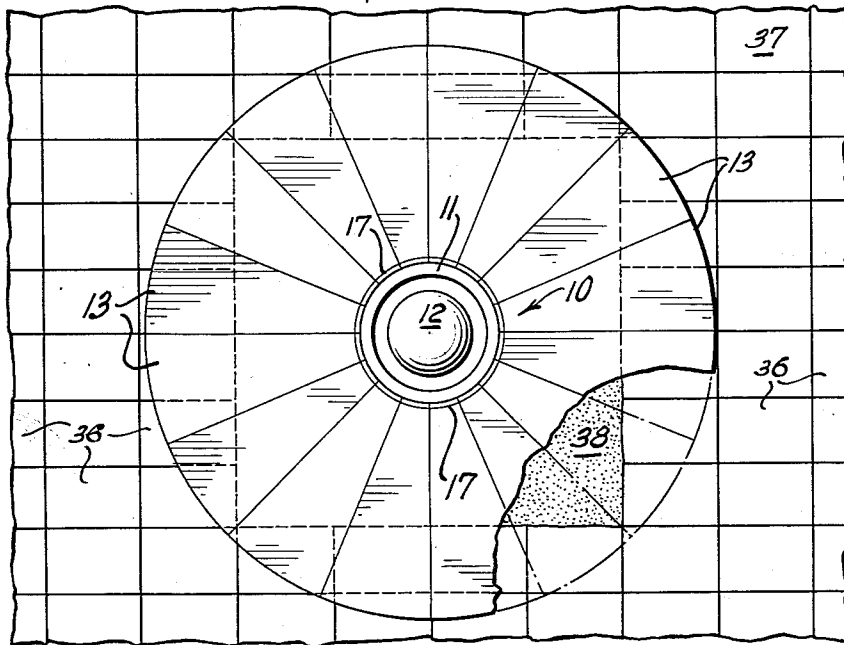


Fig. 12.



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Fig. 13.

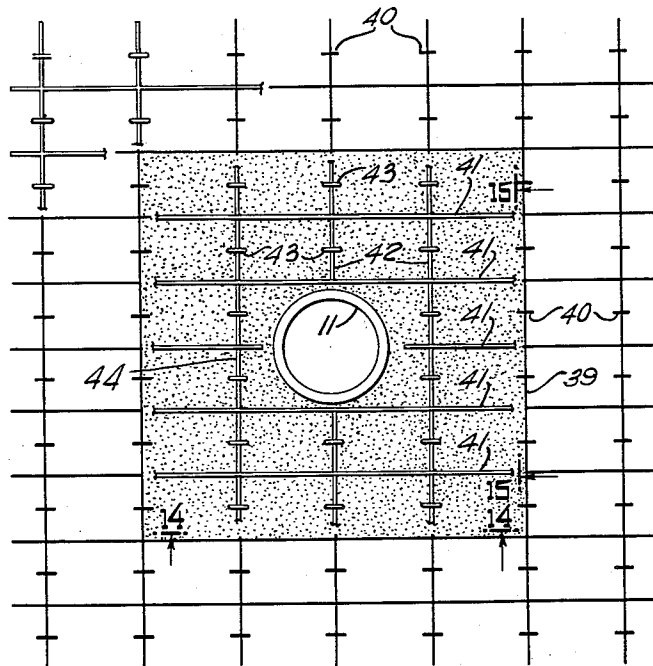


Fig. 14

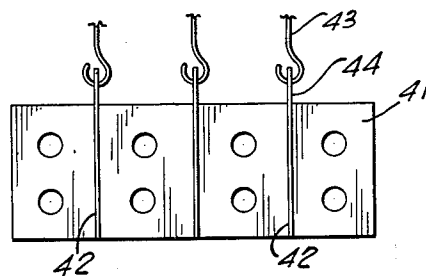
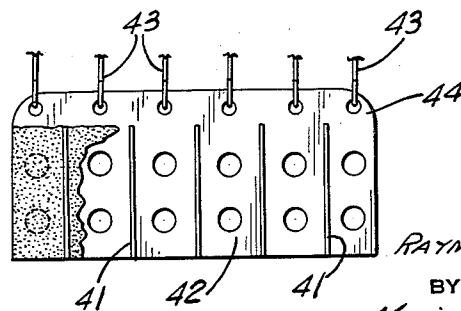


Fig. 15.



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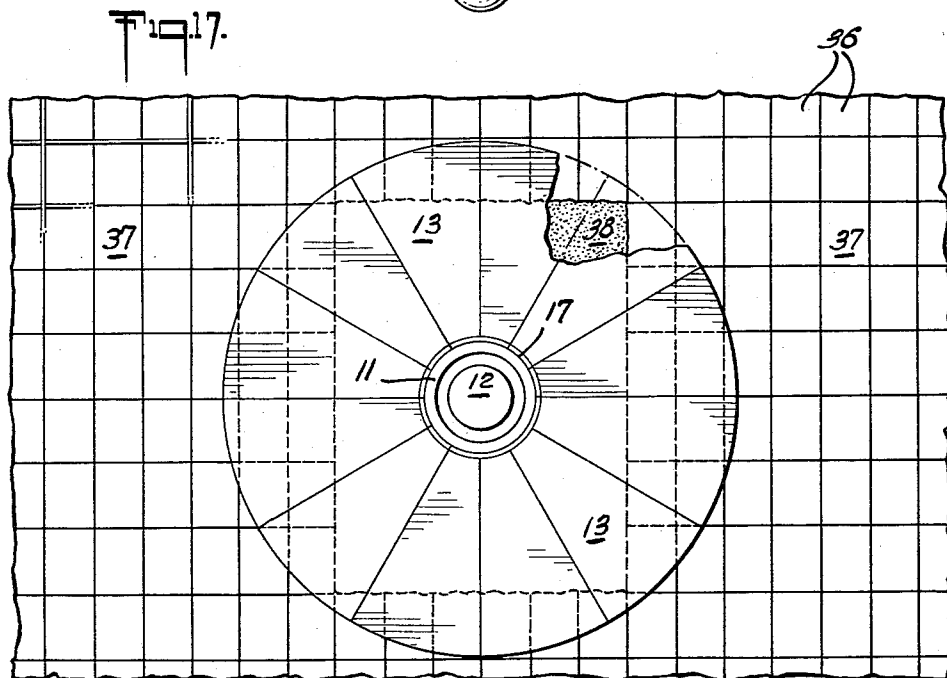
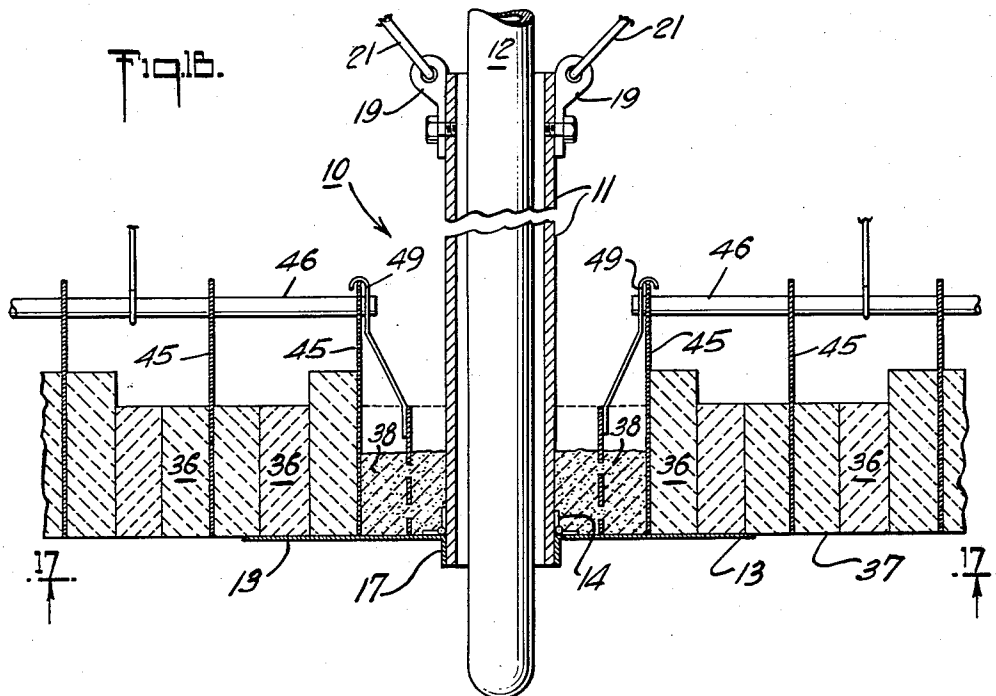
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Fig. 18.

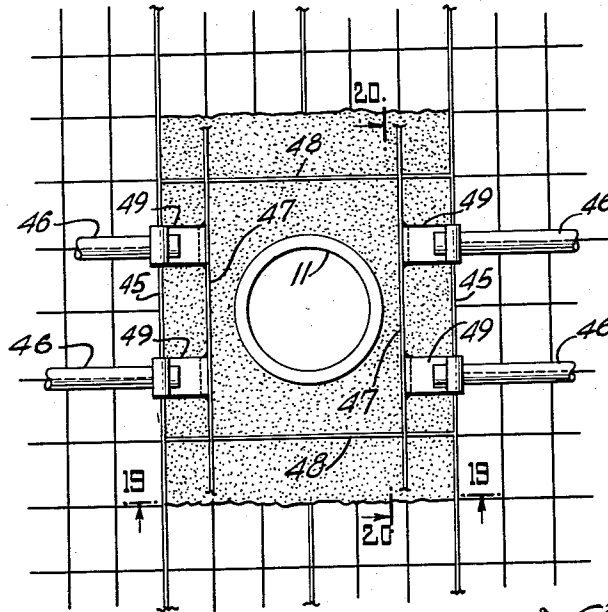


Fig. 19.

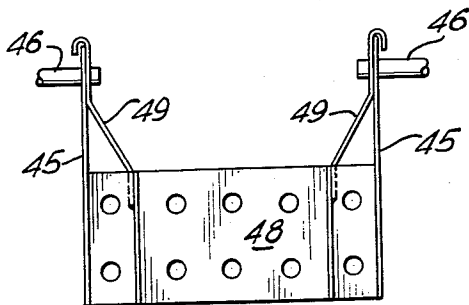


Fig. 20.

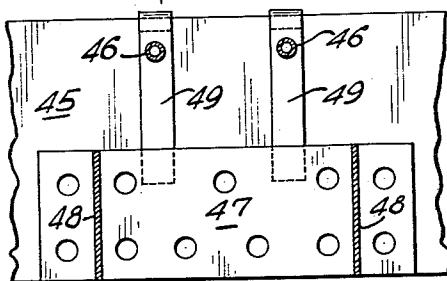
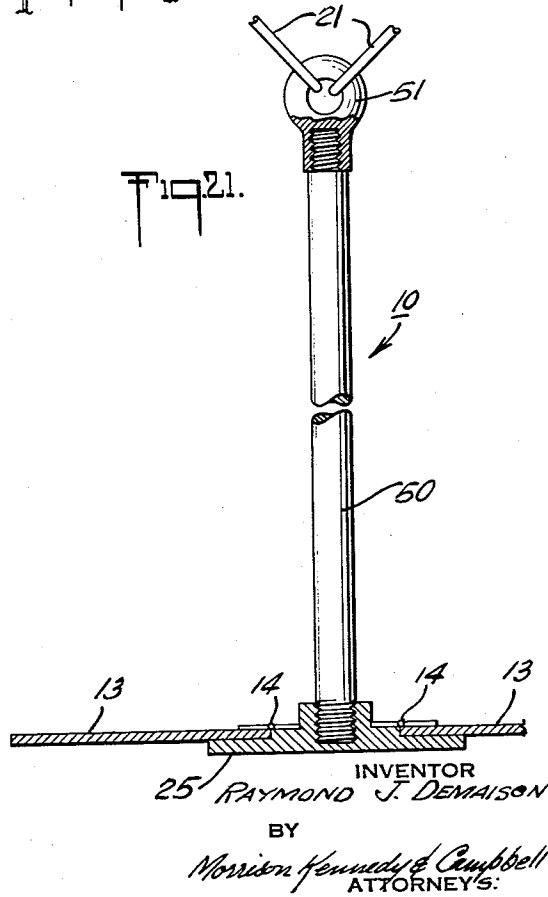


Fig. 21.



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FLEXIBLE FORM FOR REPAIRING THE OXYGEN LANCE HOLES IN OPEN HEARTH FURNACE ROOFS

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5 Claims. (Cl. 25—118)

This invention relates to oxygen lance holes used in open hearth furnace roofs, these holes being usually formed in a water-cooled casting supported in and by the roof structure.

The purpose of this invention is to provide a simple means for repairing the lance holes in the open hearth furnace roofs when the brickwork around and supporting the water-cooled lance hole casting has deteriorated and burned through, making it impossible to use the opening any longer without the danger of a section of the roof falling in. It can readily be understood that under the influence of the extreme temperature, once a small hole opens up in the furnace roof, the heat and flame immediately discharge therethrough if it is not immediately sealed off. It is therefore the prime purpose of this invention to provide a flexible form which can be inserted into the hole, once the lance hole casting is removed, and then opened and suitably placed over the hole to cover the whole area of the opening and thus provide a form for the insertion of a suitable refractory material to form a patch and in addition still provide a new hole at the same location as the old lance hole casting for the insertion of the oxygen lance into the furnace.

Another purpose of this invention is to provide a flexible form which may be used while the furnace is in full heat, thereby obviating the necessity of cooling the furnace down to make the repairs. In addition, the metal of the form will in a short time be burned off the face of the patch to leave the face of the refractory material exposed to the heat of the furnace without the necessity of removing any form whatsoever once the repairs are completed.

The instant invention is therefore predicated on the insertion of a suitably shaped metal form having flexible blades tiltably mounted which may be inserted into the burned out area and then opened to thus form a circular flat symmetrical flexible metal form which may be placed over the opening and then pressed against the inner face of the refractory roof to seal off the opening and allow the insertion of a suitable refractory material from the exterior of the furnace and fill in the area. The stem of the flexible form, upon which the segmentally shaped blades are mounted, is of such diameter as to provide a means for the further insertion of the oxygen lance in the furnace. The form may be inserted and pulled up into position by the use of the oxygen lance operating means or it may be lowered and raised up into position by using the overhead supporting structure and, once it is in place, the form is securely anchored and supported from the overhead structure, thus alleviating the load on the roof at this point. It is not necessary to make the form circular as shown in the instant drawings; the design may be such as to allow almost any shape to be used, such as square or rectangular, to meet the conditions of the opening to be covered. The blades forming the flexible metal form will be melted and burned out by the furnace heat but not before the refractory material which has been inserted into the area behind the form has been caused to set and be self supporting. In larger areas, it may be necessary to insert a suitable reinforcing grid either supported from the overhead structure or by the supporting plates of the brick roofs. After the segmental blades have been burned out or melted, the metal stem

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upon which the blades are mounted will be left securely anchored in place and completely surrounded by the refractory patch and thus form a new opening for the insertion of the oxygen lance for normal furnace operation.

It may be noted that the design of the flexible form is such as to permit the prefabrication of the parts on a production basis and thus insure a form which may be used on any sized opening and still not be too costly. The same form may be used without the hollow stem for making other repairs in the furnace roofs and a design is provided where the stem may be removed if desired.

The instant invention may be used on any one of the standard types of open hearth furnace roofs as follows:

(1) The plain brick roof composed of standard shaped refractory bricks with no supports other than the spring of the arch resting on the brick held in tension by rods or other metal framework.

(2) The tab brick roof in which the cast or pressed bricks are metal-encased and hung from suitable overhead supports.

(3) The plate support brick roof in which the bricks are laid between metal plates held in place by the overhead structure.

A series of specific embodiments of the invention will now be described by way of example and in all instances a round form will be shown for simplicity, it of course being understood that the shape and size may be varied, reference being now made to the accompanying drawings in which:

FIG. 1 is a section through one version of the flexible metal form in opened position ready to be lifted upwardly to cover the hole in the furnace roof and shows the oxygen lance positioned above the form;

FIG. 2A, FIG. 2B and FIG. 2C are a series of typical cross sections through the segmentally shaped blades forming the flat flexible metal form of FIG. 1 at 2—2;

FIG. 3 is a section through the hinge portion of the ends of the segmentally shaped blades of FIG. 1 to clearly show the method of hinging employed;

FIG. 4 is a section through another version of the flexible metal form in opened position and depicts the position the blades assume on passing through the opening in the refractory brick in the roof. In this version, the stem portion of the flexible form is clamped to the oxygen lance and lowered and raised thereby;

FIG. 5 is a partial section through the bottom of the stem and shows another version of the mounting means for the segmental blades;

FIG. 6 is a partial section through the bottom of the stem and shows still another version of the mounting means for the segmental blades;

FIG. 7 is a section through another version of the flexible metal form in opened position ready to be placed over the hole in the furnace roof. Again in this version, the stem portion of the flexible form is clamped to the oxygen lance and lowered and raised thereby;

FIG. 8 is a section through another version of the flexible metal form that may be used in constructing new furnaces, eliminating the water-cooled lance opening casting;

FIG. 9 is a partial section through an open hearth furnace roof composed of plain bricks at the oxygen lance opening and shows the oxygen lance in place and the stem with the flexible form up in place in full open position and supported by the oxygen lance operating and controlling means located above the opening ready to tie in the permanent supports to the overhead roof supports. The filling in of the burned out hole with a suitable refractory material is also shown.

FIG. 10 is a view looking up into the oxygen lance opening from the interior of the furnace along the lines 10—10 of FIG. 9 and clearly shows the flexible form

covering the opening and the stem containing the oxygen lance therein.

FIG. 11 is a partial section through an open hearth furnace roof composed of tab bricks at the oxygen lance opening and shows the oxygen lance in place and the stem with the flexible form up in place in fully open position and supported by the oxygen lance operating and controlling means located above the opening ready to tie in the permanent supports to the overhead roof supports. A partial filling in of the hole with a suitable refractory material is also shown.

FIG. 12 is a view looking up into the oxygen lance opening from the interior of the furnace along the lines 12—12 of FIG. 11 and clearly shows the flexible form covering the opening in the brick and the stem containing the oxygen lance therein.

FIG. 13 is a top view of the open hearth furnace roof shown in FIG. 11 and shows the prefabricated welded reinforcing grid in place in the opening around the stem and supported from the hangers above.

FIG. 14 is a section through the prefabricated reinforcing grid shown in FIG. 13 along the lines 14—14 and shows the lightening holes used to furnish additional support to the patch to prevent fall-in of the area and also shows the ties and supporting wires.

FIG. 15 is a section through the prefabricated reinforcing grid shown in FIG. 13 along the lines 15—15 and again shows the lightening holes and supporting wires.

FIG. 16 is a partial section through an open hearth furnace roof composed of plate support bricks at the oxygen lance opening and shows the oxygen lance in place and the stem with the flexible form up in place in fully open position and supported by the oxygen lance operating and controlling means located above the opening ready to tie in the permanent supports to the overhead roof supports. A partial filling in of the hole with a suitable refractory material is also shown.

FIG. 17 is a view looking up into the oxygen lance opening from the interior of the furnace along the lines 17—17 of FIG. 16 and clearly shows the flexible form covering the opening in the brick and the stem containing the oxygen lance therein.

FIG. 18 is a top view of the open hearth furnace roof shown in FIG. 16 and shows the prefabricated welded reinforcing grid in place in the opening around the stem and supported from the brick support plates on either side.

FIG. 19 is a section through the prefabricated reinforcing grid shown in FIG. 18 along the lines 19—19 and shows the lightening holes used to furnish additional support to the patch to prevent fall-in of the area and also shows the support straps bent over the brick support plates.

FIG. 20 is a section through the prefabricated reinforcing grid shown in FIG. 18 along the lines 20—20 and again shows the lightening holes and support straps.

FIG. 21 is a section through a version of the flexible metal form in open position that may be used on a burned out area or where smaller sized openings are used and where the large stem is not necessary.

In the drawings, the same numbers will be used for the identification of similar parts throughout the description.

In FIG. 1 is shown a section of the complete flexible metal form 10 with its hollow steel stem 11 of sufficient diameter to allow the easy insertion of the oxygen lance 12 and having segmentally shaped blades 13 tiltably mounted and contained on the stem by means of hinges 14. The hinges 14 are contained in an annular cover 15 which, in addition to forming part of the hinge, protects the tab or stop ends 17 of the blades 13 to insure their operation and performance. This type of construction allows ease of assembly and the employment of production line technique for fabrication and assembly. In retracted form for insertion into the opening in the roof, the blades 13 are folded upward and are contained within

and confined by an annular retaining cap 16 which is slidably mounted on the outside of stem 11. The blades 13 are formed as segments of a circle and therefore may be divided up into as many segments as may be deemed necessary to obtain proper hinging and support of the stop ends 17. In this connection, it is deemed desirable to have at least twelve blades (30° each) but it is much better (in order that the blades may be more readily contained in the retaining cap 16) if there are a greater number, say twenty-four which would result in 15° segments. In addition, the use of a greater number of blades permits better operation and better conforming to the contour of the roof. The blades 13 with the stop ends 17 are so formed as to allow the blades to take the initial position on opening as shown in full lines in FIG. 1. In other words, the tabs or end stops 17 are not formed at right angles to the blades 13 but rather at an angle of around 110° or 120° in order to give an upward spring to the flexible form and thus insure its fitting the contour of the refractory face of the underside of the roof for the proper retention of the refractory material when it is inserted in the patch area from above.

The stem 11 is fitted at its top end with two lifting and anchoring ears or lugs 19 which may be either welded permanently on the stem or bolted thereto by means of studs 20 as shown. These two lugs may be used to raise and lower the flexible form, in the absence of a lance, to properly place the form over the burned out area and then used to permanently support the stem in place from the overhead structure by means of rods or wires 21.

In FIG. 2A, FIG. 2B and FIG. 2C there are shown a series of cross sectional views of the flexible blades 13 taken at 2a—2a of FIG. 1 that may be used, such as 13A, 13B or 13C, to insure the retention of the refractory material and in addition give sufficient stiffness to the blades. The blades are formed of metal of sufficient thickness, as for instance of 10—12—14 or 16 gauge or even heavier depending upon the diameter of the form, to insure the resiliency necessary to hold the form in place and support the refractory material until it has had time to set.

In FIG. 3 is shown a partial section through the hinge section of the blades as mounted in FIG. 1. The annular housing 15 is provided with an arc shaped face of the same diameter as the wire 14 which actually forms the hinge and which is welded into the bend of the blades 13 so as thus to be contained within the annular ring 15 upon assembly. After assembly, the ring 15 is welded onto the stem 11 to complete the form. It can readily be seen that this type of construction and design allows for economical production of the component parts as well as ease of assembly and operation and insures ruggedness and protection of parts from the heat long enough to allow insertion and setting of the refractory material.

In FIG. 4 is shown a section of another version of the complete flexible metal form 10 with its hollow steel stem 11 of sufficient diameter to allow the insertion of the oxygen lance 12, which in this instance is used as a means of lowering the flexible form into the furnace. The stem 11 is connected to the lance by means of a reducing fitting 23 provided at its larger end with studs 24 for fastening to said stem 11 and at its smaller end with a suitable clamp 22 to embrace the lance and insure its operation thereby. The blades 13 of this version are supported in a flat position by a ring 25 welded to the stem 11 and are retained in place by means of the wire ring 14 placed in suitably spaced lugs 26 welded to the ring 25. In this manner, the whole circle of blades may be preassembled and slid onto the stem and then welded and contained in place at one time. The blades have a 90° stop 17 which in this instance provides the spring to allow the blades to be inserted into the hole and then returned to their flat position. If it is desired to contour a rough roof, a 30° set may be made in the blades just outside the ring 25.

FIG. 5 shows an alternative method of mounting the

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blades 13 on the stem 11 without the use of any wires or hinges but by simply clamping the preshaped blades in place on the stem 11 by means of an L-shaped retaining ring 28 which has its bottom face suitably chamfered to allow the blades to be displaced upward without difficulty.

FIG. 6 shows still another alternative method of mounting the blades 13 on the stem 11 without the use of any wires or hinges but by simply clamping the preshaped blades in place on the stem 11 by means of a Z-shaped annular ring 29 which has its top face extended to act as a stop when the blades are down in position and which is locked in place by ring 28.

In both FIG. 5 and FIG. 6 the blades may be given an upward set to insure their fitting the contour of the inner refractory furnace face if it is very uneven. In addition, the retaining rings 28 and 29 may be made in halves if so desired and then bolted together or simply made as a split ring and bolted together by one bolt.

In FIG. 7 is shown a sectional view of another alternative method of lowering the flexible form by means of the oxygen lance as well as showing another version of the flexible form in open position.

The stem 11 at its lower end is equipped with lugs 32 welded in place on its periphery and suitably spaced to support a wire 33 upon which the blades 13 will hinge when operated by an actuating ring 30. The actuating ring 30 is directly connected by means of pivotal links 31 to the hinged blades and in its normal raised position retains the blades 13 in retracted position but when lowered operates the blades to full open position, being arrested in its lower position by a stop ring 34 which is permanently welded in place on the stem 11. With this type of construction and operation, the blades may be kept to a minimum in number and made of a maximum thickness to promote stiffness. On the left hand side, at 35, is shown an alternative method of hinging the blades by means of 90° stop hinges welded in place on the blades and the stem.

In this disclosure the blades may also be tilted upward from the links, if the surface of the roof is very irregular, and thus insure a complete sealing of the surface for refractory material insertion.

An alternative form of lance clamp is also shown in this disclosure. A clamp sleeve 23a is secured by tightening the clamp thereon to thus secure the sleeve to the lance by bolts to the lance 12 and is connected to the stem 11 by means of step studs 24a which have no threads on their inner ends but are left plain so as to engage freely in an annular groove cut in the outer face of the split sleeve. In this way, the lance and stem may be rotated with reference to each other if necessary.

There is inherently another alternative method of operation of the form which can be spoken of at this time and which is predicated on the section shown in FIG. 7. It can readily be seen, by looking at this section, how the links 31 could be lengthened to allow reverse operation of the blades in a downward or retracted position for insertion into the burned out hole and then moved upward into their normal open position as shown in the figure by moving the actuating ring 30 upward on the stem 11. In this instance, the stop ring 34 would be located to keep the blades in retracted position and a pin would be supplied which could be inserted into and through the actuating ring and into a hole suitably placed in the stem 11 to thus lock the blades in proper position. In this instance, the hinging means shown at 35 would have to be used and the stop tabs 17 could be dispensed with, as they would not be necessary.

In FIG. 8 is shown a section through still another alternative design which may be used in constructing new furnaces, thereby eliminating the water-cooled lance opening casting. The stem 11 is fitted at its bottom end with an annular flat ring 25 welded in place thereon and the

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blades 13 are hinged at 14 by use of flat welded 90° stop hinges, thereby allowing the retracting of the blades for insertion into the hole and then opening them up to result in the form which is then placed over the opening. In this version, due to the fact that new bricks are being used, it is not necessary to have recourse to bent blades as the underside of the roof will be fairly smooth and even. The use of a welded prefabricated reinforcing grid 47 held up in place on stem 11 which may be used as a form retaining means until the form is opened and then dropped down into place and welded onto the stem is shown in this version and is therefore supported from the stem 11 rather than from the roof supports. The form is shown supported by the two tie rods 21 from the overhead structure and is of a permanent nature, requiring no changing until a repair is made, at which time the new form is installed on the old hangers. The hole formed by the bricks 36 into which the reinforcing grid 47 is placed is then filled with a suitable refractory material 38 to thus form a monolithic structure.

FIG. 9 is a partial section through an open hearth furnace roof composed of plain bricks at the oxygen lance opening and shows the oxygen lance in place, it having been used to lower and raise the flexible form into its full open position and to tie in the permanent supports to the overhead structure. The bricks 36 on the edges of the burned out hole have been cleaned to insure a good bond and now form the opening which must be repaired and into which the stem 11 mounted on the lance 12 has been properly positioned and the repairing refractory material 38 has been inserted. The lugs 19 will be used to support the flexible form from the overhead structure and will thus form a permanent support therefor. It will be noted that the blades 13 on the hinges 14 have been fully sprung against the stops 17 to insure sufficient pressure to seal against the underside of the roof 37 and prevent leakage of the refractory material 38. It might also be mentioned that, if the patch is of sufficient area, it may be necessary to use one of the various types of prefabricated reinforcing grids shown in the following disclosures.

FIG. 10 is a view looking up into the oxygen lance opening from the interior of the furnace along the lines 10—10 of FIG. 9 and shows the flexible form 10 over the cleaned burned out opening in the refractory brick and in addition show the lance 12 in the stem 11.

FIG. 11 is a partial section through an open hearth furnace roof composed of tab bricks at the oxygen lance opening and shows the oxygen lance in place, having been used to lower and raise the flexible form into its operating position in full open position ready to tie in the permanent supports to the overhead structures. The bricks 36 on the edges of the burned out hole have been removed to form a suitable opening into which the stem 11 mounted on the lance 12 has been properly positioned and a portion of the refractory material 38 has been inserted. The lugs 19 will be used to support and position the flexible form from the overhead structure and will thus form a permanent support therefor. Here again it will be noted that the blades 13 on the hinges 14 have been fully sprung against the stop tabs 17 to insure sufficient pressure to seal against the underside of the roof 37 and prevent leakage of the refractory material 38. In this type of roof the bricks 36 are supported individually by metal tabs 39 extending up and beyond the bricks by means of wires 40 which are looped over the roof supporting and retaining steel members. It is only natural therefore that a prefabricated reinforcing grid (later to be described) be used in the hole area supported by means of tabs 44 and wires 43, as the bricks normally are to insure the retention of the patched area in the roof and its normal movement with and in accordance with the movement of the roof structure. It will be noted that, in this roof design, the bricks are

metal covered and individually suspended, thereby necessitating the removal of bricks to form a square or rectangular hole. The refractory material 38 may only be inserted to a suitable depth, as shown, depending on the size of the patched area and the thickness of the roof.

FIG. 12 is a view looking up into the lance opening from the interior of the furnace along the lines 12—12 of FIG. 11 and shows the flexible form 10 over the cleaned burned out area in the refractory brick and in addition shows the lance 12 in the stem 11.

FIG. 13 is a top view of the open hearth furnace roof shown in FIG. 11 and shows the welded prefabricated reinforcing grid in place in the cleaned burned out area. The reinforcing grid is composed of plates 41 and 42 suitably fitted and welded together and fitted to the area as shown. The thickness of the metal to be employed will be dependent upon a number of variables such as the size of the furnace, the size of the bricks, and the size of the burned out area to be supported. As a rule a thickness of $\frac{1}{16}$ " to $\frac{1}{8}$ " will suffice.

FIG. 14 is a section through the prefabricated reinforcing grid shown in top view in FIG. 13 along the lines 14—14 and clearly shows the plates 42 forming the tabs 44 for the wires 43 and the transverse plates 41 fitted thereto to make up the complete grid. It will be noted that lightening holes are used to not only lighten the grid but in addition provide a method of tying the patched area in more securely to the grid in order to preclude a fall-in of the patched area and in addition provide a cooling medium in the refractory patch.

FIG. 15 is a section through the prefabricated reinforcing grid shown in top view in FIG. 13 along the lines 15—15 and again clearly shows the plates, supporting wires and lightening holes.

FIG. 16 is a partial section through an open hearth furnace roof composed of plate support bricks at the oxygen lance opening and shows the oxygen lance in place, having been used to lower and raise the flexible form into its full open position ready to tie in the permanent supports to the overhead structure. The bricks 36 at the edges of the burned out hole have been removed to form a suitable opening into which the stem 11 mounted on the lance 12 has been properly positioned and a portion of the refractory material 38 has been inserted. The lugs 19 will be used to support and position the flexible form from the overhead structure and will thus form a permanent support therefor. Here again it will be noted that the blades 13 in the hinges 14 have been fully sprung against the stop tabs 17 to insure sufficient pressure to seal against the underside of the roof 37 and prevent leakage of the refractory material 38. In this type of roof, the bricks 36 are held by the support plates 45 which in turn are held by the overhead structure by means of rods or bars 46 threaded through holes at their top area. It is again only natural that a prefabricated reinforcing grid be placed in the hole area, as by means of holding straps 49 placed over the holding rods 46 and adjacent holding plates 45 to thus confine the refractory material 38 contained in the patched area. In this manner, it is possible to insure the retention of the patched area in the roof and its normal movement with and in accordance with the movement of the complete overhead structure. It will be noted that, in this roof construction, the bricks are not individually suspended but rather are suspended by the holding plates contained between every three courses of brick, so that it is obviously necessary to remove the bricks between the holding plates in one direction in order to provide retention of the reinforcing means while in the other direction it is only necessary to go to good solid brick for proper bonding. The refractory material 38 may only be inserted to a suitable depth, as shown, depending on the size of the patched area and the thickness of the roof but care must be taken to provide a sufficient depth to preclude a hot spot forming which can result in another burn out or still worse a fall in.

FIG. 17 is a view looking up into the lance opening from the interior of the furnace along the lines 17—17 of FIG. 16 and shows the flexible form 10 over the cleaned burned out area in the refractory brick and in addition shows the lance 12 in the stem 11.

FIG. 18 is a top view of the open hearth furnace roof shown in FIG. 16 and clearly shows the welded prefabricated reinforcing grid in place in the cleaned burned out area. The reinforcing grid is composed of plates 47 and 48 suitably fitted and welded together and fitted to the area as shown. The thickness of the metal to be employed will again be dependent upon the same variables as previously stated.

FIG. 19 is a section through the prefabricated reinforcing grid shown in top view in FIG. 18 along the lines 19—19 and clearly shows the plates 47 and 48 with the holding straps 49 welded thereto and hung onto the holding rods 46 and bent over the holding plates 45. Due to the construction in this type of roof, it is necessary that the plates 48 be cut to exact length to exactly fill in the space between holding plates 45 and thus prevent these two holding plates from closing in and crushing the patched area and the bricks on either side. Hence, in this instance, the plates will have to be individually fitted to each opening. It will be noted that lightening holes are used to not only lighten the grid but in addition provide a method of tying in the patched area more securely to the grid in order to preclude a fall-in of the patched area but in addition provide a cooling medium in the refractory patch.

FIG. 20 is a section through the prefabricated reinforcing grid shown in the top view in FIG. 18 along the lines 20—20 and again clearly shows the plates, holding straps and lightening holes. In this view, it will also be noted that the prefabricated reinforcing grid plates 47 must again be fitted to the opening to preclude crushing of the patched area in this direction and also the possibility of the dropping out of the bricks in the adjacent bays.

FIG. 21 is a section of still another version of the complete flexible metal form 10 with a solid stem 50 and segmentally shaped blades 13 mounted on the stepped annular ring 25 which is screw mounted on said stem 50. The blades 13 in this version are mounted by means of narrow hinges 14 welded in place on the blades and on the ring 25. A supporting and mounting eye 51 is screw mounted on stem 50 to thus provide a means for permanently supporting the form in place. Here again the form is used as before but is lowered and placed over the opening by suitable means and fastened to the overhead supporting steel work. It is possible to provide and use a water-cooled stem 50 in this instance, if deemed necessary, to preclude too rapid a deterioration of the form and then remove the stem if it is not necessary for support. This same technique may be employed on the solid stem if so desired. If the burned out area is of sufficient size, a reinforcing grid suitable for the type of roof as disclosed herein may be employed in order to insure the retention of the patch in the roof.

From the foregoing disclosure, it can readily be seen that a new era has been reached in the art of repairing burned out holes in refractory roofs of open hearth furnaces while they are in full heat and operating without any cooling down whatsoever and without any consequent loss of production. The design of the repair form also makes it possible to mass produce the parts in order to provide an economically feasible background for its use in furnace repair. In some instances, where the holes are rather large, it may be necessary to provide a covering of corrugated iron inside the hole in the roof to keep the heat off until the area can be cleaned but, beyond this, the form is so designed to take care of all the steps necessary without any other assistance.

In inserting the refractory material into the burned out area, the technique most generally used is to spray

in a material that is compatible with the existing bricks composing the roof in sufficient thicknesses to preclude hot spotting and burn outs which would eventually end up with serious fall-ins or cave-ins "so called." The refractory material may also be trowelled into place if desired but under no consideration should ramming be attempted as this would tend to loosen or distort the form and force the refractory material into the furnace.

The ideal material that has been found to work perfectly (as it does in spraying on the inside walls and roofs of the open hearth furnace) is a refractory material which is known in the art as Roofchrome and is made in different compositions, each of which is compatible with different types of brick and which in this particular instance is just what is necessary in order to get a good bond to the parent refractory still remaining in the roof and still have a material which will set and bond together layer on layer as it is applied by spraying to result in a perfect monolithic patch bonded to the parent refractory material surrounding it. The compositions of the Roofchrome materials are such as to be compatible with the various types of refractories in use today and are in addition able to react with the slags and iron oxides deposited thereon to result in a composition that is of higher refractoriness than the original compositions. Roofchrome is a material manufactured and sold by The Quigley Company, Inc., 415 Madison Avenue, New York City, N.Y., and its composition is set forth in Patent No. 2,809,126, dated October 8, 1957.

The instant invention can be used to construct new furnaces as well as repair old ones and it is readily seen that it is possible to provide a standard type unit which can be readily replaced as it becomes necessary and reuse existing supports and simply tie these in to the new form. By standardizing on designs, the units may be manufactured in lots and thereby reduce costs considerably, resulting in a very economical system for the repair of lance openings and burnt-outs in furnace roofs.

It must be remembered that the flexible forms may be inserted by either lowering into and raising onto the underside of the roof by the use of the oxygen lance or by recourse to the overhead structure. Eventually the form is tied in to the roof structure for permanent support.

It is also possible to precast and prefabricate a complete patch which could be inserted into the square or rectangular hole in the roof and the cracks or seams then filled with suitable refractory cement if so desired. In this instance, the form could be made to fit the contour of the hole and inserted therethrough without the necessity of collapsing.

In the foregoing description the reference to an oxygen lance is intended to apply not only to its use with oxygen alone, but also to its use with any other medium such as

fuels or solids in fine grain or any combination thereof that may be injected into the furnace.

The disclosures contained herein are only some of the embodiments of the instant invention and it is therefore understood that the invention is not to be limited to any particular disclosure except insofar as such limitations are contained in the appended claims.

What is claimed is:

1. A flexible form for repairing with refractory material a damaged hole in an open hearth furnace roof composed of refractory bricks while the furnace is in operation, said form comprising a plurality of separate and distinct flexible resilient metal blades decreasing in width from one end to the other, and a stem upon which the blades are individually mounted at their narrow ends for movement from a nested collapsed position into a fully expanded position, said blades in their collapsed position being insertable by means of the mounting stem through the damaged hole in the furnace roof from the outside and then movable into their fully expanded position after insertion to cover the damaged roof hole on the inside of the furnace from the stem outwardly, said blades in their fully expanded position acting as a temporary support for the refractory material used in filling the cavity created by the stem and the refractory wall of the damaged hole.

2. A flexible form according to claim 1, wherein the mounting stem for the metal blades is hollow and remains in place after the repairing of the damaged hole for the insertion of an oxygen lance into the furnace for a normal operation.

3. A flexible form according to claim 2, wherein the stem is provided with means for attaching it to the oxygen lance for positioning thereby and for subsequently supporting the form from the overhead structure.

4. A flexible form according to claim 1, wherein the stem is provided with means for positioning the form by the use of the overhead structure and for subsequently supporting the form thereby.

5. A flexible form according to claim 1, wherein the metal blades are biased upwardly with reference to the stem to insure their sealing against an uneven roof section.

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