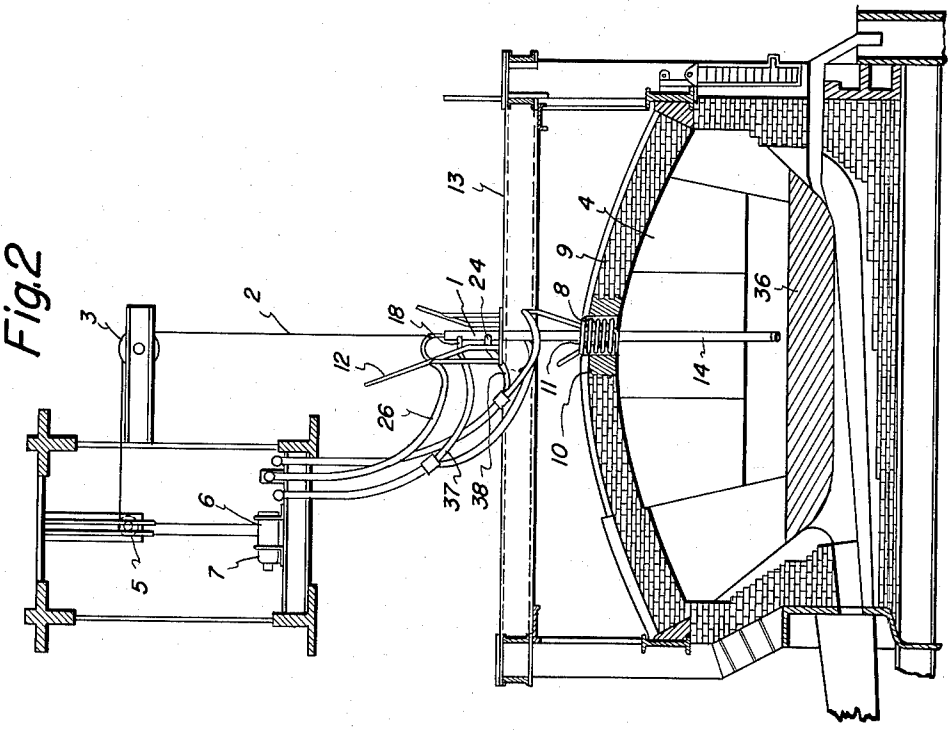
Dec. 20, 1960 A. J. KESTERTON ET AL 2,965,370

OXYGEN LANCE WITH BENT TIP

Filed May 14, 1956

4 Sheets-Sheet 1

Fig.2



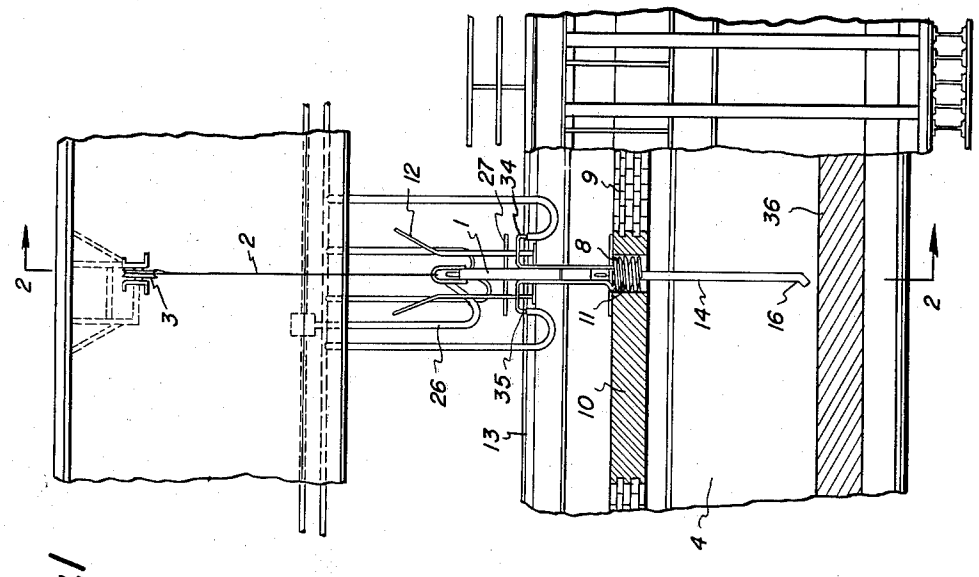


Fig.1

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Fig.6

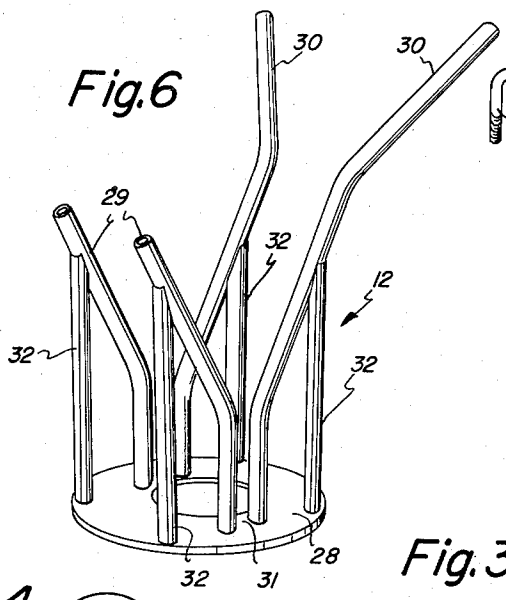

Fig.7

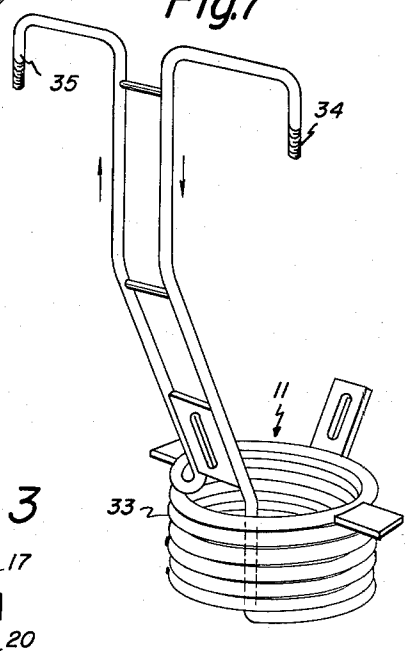

Fig.4

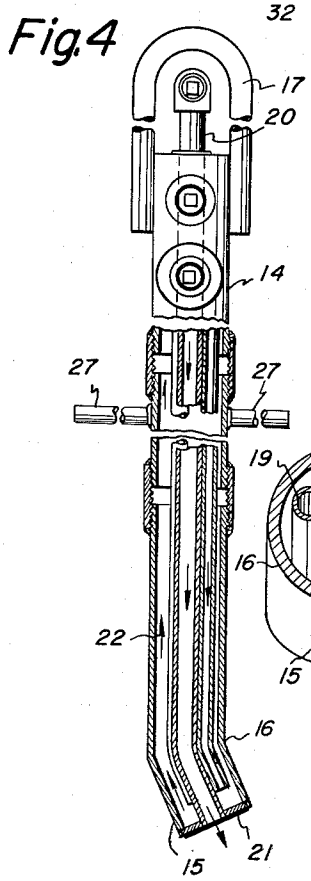

Fig.5

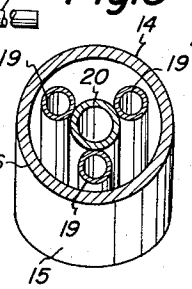

Fig.3

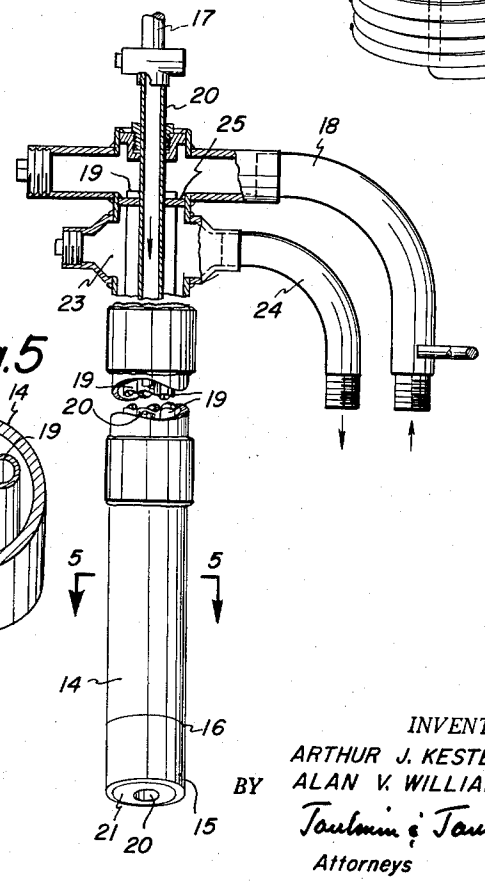

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Fig.8

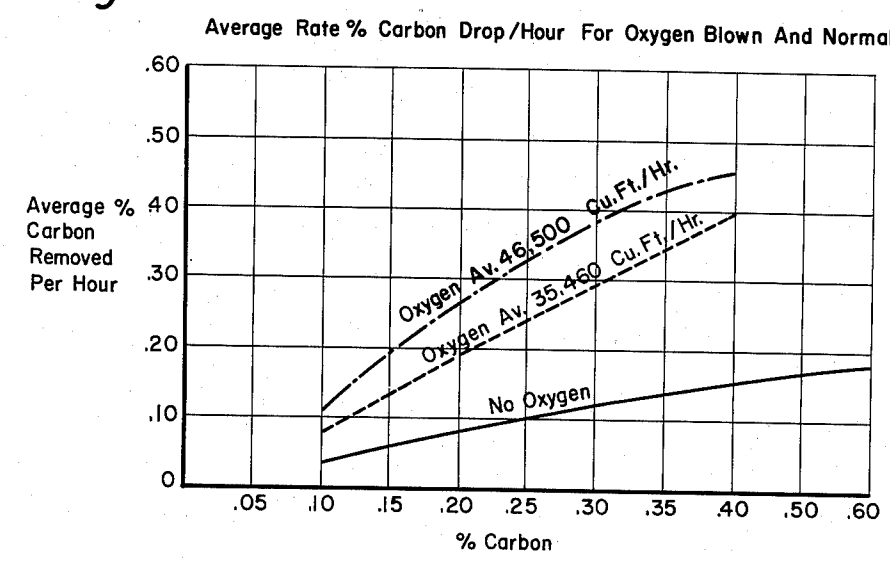
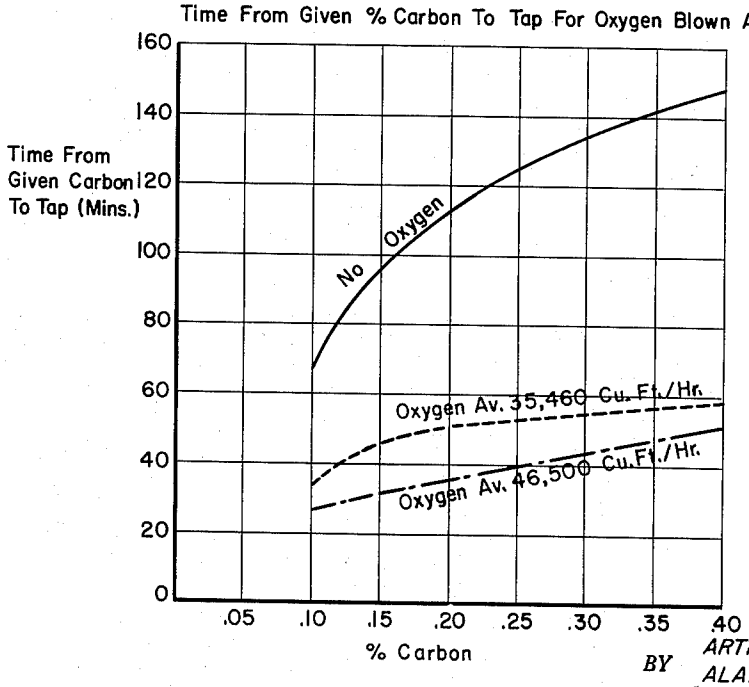


Fig.9



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OXYGEN LANCE WITH BENT TIP

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Fig. 10

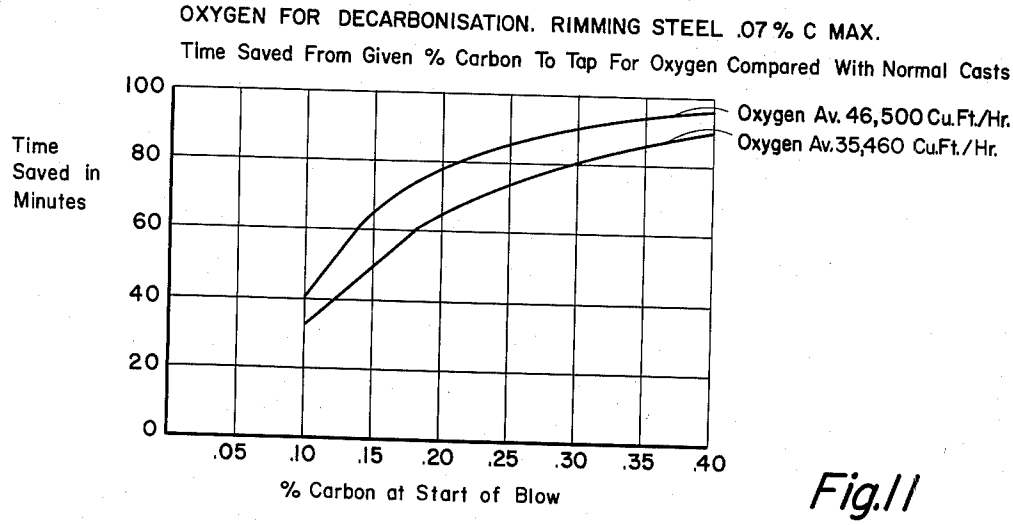
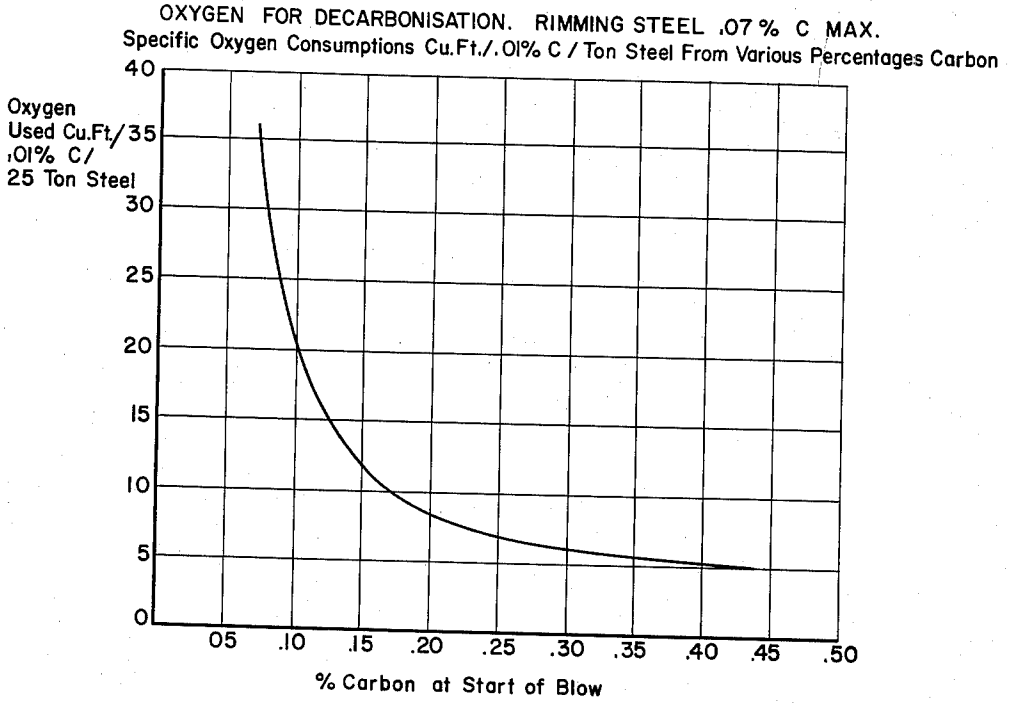


Fig. 11



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2,965,370

OXYGEN LANCE WITH BENT TIP

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Filed May 14, 1956, Ser. No. 584,772

1 Claim. (Cl. 266—34)

This invention relates to the application of oxygen in the manufacture of steel in steel-refining apparatus, more particularly, to the open-hearth furnace.

It relates in particular to an improved method and apparatus for the injection of oxygen in the form of a jet of nearsonic speed into steel-refining apparatus such as stationary and tiltable open-hearth furnaces, stationary and tiltable "mixers," both of the "inactive" and the "active" type, and the like.

The normal process of steel making includes the removal of impurities from the molten charge in the furnace mainly by oxidation, the oxides of most impurities dissolving in a suitable slag. One impurity, carbon, oxidizes to give a gas.

The rate at which the above oxidation proceeds in the normal manner during the melting and refining period is relatively slow, and may be considerably accelerated by the impingement of an oxygen jet on the surface of the charge.

The methods by which oxygen has previously been applied to open-hearth furnaces have disadvantages in that the apparatus required has been located at positions around the furnace, such as the front or back, where it may seriously interfere with the normal processes of charging and tapping the furnace.

The art of using oxygen or oxygen enriched air for reducing the carbon content in steel manufactured by the open-hearth process is relatively young. In one of the earlier publications of this art it has already been recommended that the introduction of an oxygen jet through the roof of an open-hearth furnace be studied (see "Iron Age" June 19, 1947; pages 75–76): however, the difficulties involved were obviously such that no truly practicable solution has been found so far.

These difficulties did not only involve the necessity of designing a novel type of nozzle, but the resistance of the roof at the opening therein which had to be made for introducing the oxygen jet through the same, and the consequences of a direct impingement of the oxygen jet vertically upon the surface of the bath had also to be taken into account.

We believe we are the first to have made the necessary studies and to have found a practical solution to the problem by taking into account all of the above mentioned factors, and developing a satisfactory method and apparatus for the injection of oxygen jet by way of retractable gears through the roof of an open hearth furnace and related furnaces, impinging the jet onto the surface of the bath.

The introduction of gaseous materials through the roof of an open hearth furnace has been contemplated in the U.S. Patent No. 2,126,272, of Morton, who proposed the introduction of preheated air and gaseous fuel through corresponding openings in the roof of an open-hearth furnace. However, the provisions made for the introduction of a fuel and air mixture for creating a flame impinging at an oblique angle upon the surface of the bath,

were obviously not suitable for adaptation to the task before us.

Various proposals have already been made to introduce oxygen jet lances into the open mouth of a Bessemer converter (British patent to John Miles et al. No. 642,084) and through the upper side walls of a tiltable crucible having a wide roof opening (U.S. Patent to Tenenbaum 2,668,759). None of these publications offers any solution to the specific problem of introducing a substantially vertical oxygen jet through the roof onto the surface of the bath in an open hearth furnace.

In the British Patent No. 623,881 (applied for May 28, 1947), and in a publication in "Journal of Metals" (June 1950, pages 835 to 837), methods and apparatus for directing an oxygen jet or a plurality of jets onto the surface of a bath in an open-hearth furnace are described, which comprise recommendations that the oxygen jet or jets be directed onto the bath surface at an angle, for instance, an angle of incidence of 60° from the horizontal, at a rate of supply of oxygen supply of 30,000 cu. ft. per hour per jet. A water cooled special nozzle having a copper head brazed to the entry end of the water cooled oxygen feeding lance and having a nozzle opening at 45° to the longitudinal axis of the lance which in turn is inclined at an angle of 15° to the bath surface and introduced through the back wall of the furnace, is described in the last-mentioned publication and represents the latest development in the art for this particular kind of use in an open-hearth furnace.

The oxygen jet in the art has already been given a supersonic velocity. Thereby and by pointing the nozzle end toward the center of the hearth splashing of the metal onto the roof and side walls of the furnace was minimized, and so was the creation of excessive amounts of smoke and fumes.

Finally, it has been proposed by Wagstaff (U.S. Patent No. 2,593,505) that oxygen be injected into a molten bath in an open-hearth furnace through an opening in the roof of the latter by way of a lance having a refractory mantle around its lower end, and dipping with the same into the molten bath. In this case the oxygen delivery rate is to be 50,000 cu. ft./hr. The carbon content of the material, which is originally in the order of 2 to 4% by weight is first reduced to somewhat below 60 points. (A "point" is 0.01% carbon content—see for example Heat Treatment of Steel; E. Oberg (1915), page 2, line 2). About two hours and about 100,000 cu. ft. of oxygen are required for a 200 ton charge to reduce the carbon content from 40 points down to the desired range of about 5 points. This second step of the refining process, according to Wagstaff, can be accelerated by injecting powdered iron oxide in the oxygen stream below the surface of the molten bath, thereby reducing the refining time from about 40 points to 5 points from two to one hours, and the oxygen consumption from 100,000 cu. ft. to 50,000 cu. ft. (standard conditions).

However, it must be stated that the time saved by this known method is not worth the amount of oxygen consumed, for a reduction to 60 minutes for decarbonization in the range described has already been achieved in the known art with rates of oxygen delivery as low as about 30,000 cu. ft./hr. (see the above quoted "Journal of Metals") while introducing the oxygen lances through the back wall of the open-hearth furnace and having the oxygen jet impinge at an angle of about 60° from the horizontal upon the bath surface.

Furthermore, the admixture of the iron oxide requires complicated apparatus, and a retraction of the jet lance is made impossible. Also the opening as provided in the roof of the furnace considerably weakens the roof structure and shortens the lifetime of the furnace.

It is, therefore, the principal object of our invention to

provide a novel method of injecting an oxygen jet through the roof of an open-hearth furnace and the like iron refining apparatus onto the surface of the bath and preventing simultaneously interference with the normal operations of the furnace, including tilting the same.

It is a further object of our invention to provide an improved method of injecting an oxygen jet into an open-hearth furnace through the roof of the latter so as to accelerate the rate of carbon reduction in the furnace, and to permit an increase in the performance of the same.

It is another object of our invention to provide apparatus for introducing an oxygen jet through the roof of an open-hearth furnace which will not interfere with the operation of the latter, and which will be in particular adapted to use with fixed open-hearth furnaces and may be easily modified for use with tilting open-hearth furnaces and similar iron refining apparatus wherein the injection of an oxygen jet is desired.

It is still another object of our invention to provide a roof opening through which an oxygen jet can be introduced into an open-hearth furnace, without damaging the roof or shortening the lifetime of the furnace structure.

It is finally an object of this invention to provide an oxygen gun having a jet nozzle which considerably increases the operating life of the gun.

The above objects of this invention are achieved by providing an improved oxygen gun which is lowered through an opening in the roof of an open-hearth furnace to direct a jet of oxygen at an angle upon the surface of the steel bath within the open-hearth furnace. The oxygen gun of this invention essentially comprises a steel body and a copper tip fabricated thereto. Centrally located within the steel body and the copper tip is an oxygen tube. Equally spaced around the oxygen tube is a plurality of pipes through which cooling water is conducted down to the tip of the oxygen pipe. The water then returns in the space between the body wall of the gun and the water and oxygen pipes. This cooling arrangement gives more efficient cooling in the critical zone at the tip of the gun.

The exact structure of the oxygen gun and the many advantages to be derived from the use thereof will be later described at greater length.

It was considered initially that, if a water cooled gun when not in use was situated in such a manner that its end was just level with the lower surface of the roof, the hot gases which issue through the hole would be cooled sufficiently to prevent causing serious damage to the roof. However, it was found that this was only partially true, and that sufficient wear developed to make necessary a patch after about seven weeks. To mitigate this trouble a water cooled annulus through which the gun passes, was built into the hole in the roof. In a roof which at this point is, for instance, 15" thick, a water cooled annulus was introduced to a depth of 6". It has been found that this satisfactorily solved the problem, eliminating serious roof wear at this point without introducing an excessive amount of water cooling, and the roof in this area lasts during the lifetime of the furnace.

We have observed that if properly applied, the use of oxygen at the rate proposed by us does not cause splashes which affect the roof or linings of the furnace.

In fact, indications are to the contrary, in that we apparently obtain an increased lifetime for the roof as a result of the use of oxygen at our rate, resulting from the shorter refining periods, during which the roof is exposed to the highest temperatures, and to the fact that during the oxygen blowing a considerable quantity of fuel is cut off the furnace resulting in lower average roof temperatures.

The above objects and inventions will become readily apparent upon reference to the accompanying description when taken in conjunction with the following drawings wherein:

Figure 1 is a longitudinal vertical cross sectional view of an open-hearth furnace showing the oxygen run in its lowered or operative position;

Figure 2 is a transverse cross section of the open-hearth furnace shown in Figure 1 with the section being taken along the line 2—2;

Figure 3 is an elevational view of the oxygen gun with portions of the wall removed to show the cooling arrangement;

Figure 4 is a vertical sectional view of the oxygen gun in Figure 3;

Figure 5 is a sectional view taken along the lines 5—5 of Figure 3 and showing the arrangement of the coolant pipes about the central oxygen tube.

Figure 6 is a perspective view of the guide for the oxygen gun;

Figure 7 is a perspective view of the water-cooled annulus which is positioned in the opening in the top wall of the open-hearth furnace; and

Figures 8 through 11 are graphs to illustrate the advantages of the present invention over the prior art.

Returning now to the drawings, and more particularly to Figure 1 wherein like reference numerals indicate the same parts throughout the various views, the oxygen gun assembly indicated at 1 is supported by a cable 2 extending over a pulley 3, secured in the roof of a building containing an open-hearth furnace indicated at 4. The cable 2 extends horizontally to another pulley 5 and down to the winding drums 6 of an electrically operated winch 7 secured to girders above the furnace or in any other suitable position.

The gun assembly 1 extends downwardly through an opening 8 in the roof 9 of the open-hearth furnace 4. The opening 8 is in a panel of chrome-magnesite bricks 10 which is inserted in the roof of the furnace 4.

It will be noted that the opening 8 is adjacent one end of the panel 10. This relationship of the opening with respect to the panel will be later described.

Located within the opening 8 is an annulus 11 which surrounds the gun assembly 1.

A guide 12 for the oxygen gun is positioned directly above the opening 8 upon a beam construction indicated at 13. The guide is for the purpose of assisting the cable in supporting the gun in position and to prevent the gun from rotating within the furnace when it is in its operative position. The guide also will be later described in detail.

Proceeding next to Figures 3 and 4 which illustrate the oxygen gun assembly 1 in greater detail, the gun assembly 1 comprises a steel body 14 to which is affixed at the lower end thereof a copper nozzle 15. The extreme lower end of the nozzle 15 is bent at 16 at an angle of the order of 25°. The longer side of the bent portion as seen in Figure 4 is about 4½ inches in length.

Secured to the upper end of the steel body 14 is a U-shaped connecting member 17 to which the cable 2 is attached. Extending from the upper portion of the gun body is a downwardly curved pipe 18 which is the inlet of the cooling water. The pipe 18 is connected to the open top ends of three pipes 19 which extend the length of the oxygen gun and surround a centrally located pipe 20 through which oxygen is passed. The lower end of the oxygen gun is closed by a plate 21 but it will be noticed that the water pipes 19 stop short of the closing plate 21.

As the cooling water emerges from the ends of the pipes 19 it passes upwardly as indicated by the arrows 22 in the space between the walls of the gun and the pipes 19 and 20. When the water reaches a chamber 23, it passes outwardly through a downwardly bent pipe 24. A plate 25 separates the water inlet chamber from the water outlet chamber 23.

As may be best seen in Figure 2, a hose 37 connects

the water inlet pipe 18 to a source of cooling water. A hose 38 connects to the water outlet pipe 24 to convey the heated water to a suitable cooling source.

A hose 26 connects the oxygen pipe 20 to a source of oxygen.

Near the upper end of the gun body 14 there is a pair of radially extending locating bars 27. These bars are of high grade steel and are used to support and locate the gun in the gun guide 12 in a manner which will be presently described.

When the oxygen gun is in its lowered operative position, it is supported in the gun guide 12 which is illustrated in Figure 6. The gun guide 12 comprises an annular base 28. Extending vertically upward from the base 28 are bent front tubes 29 and bent high back tubes 30. It will be noted that the tubes 29 and 30 are bent in such a manner that the lower portions thereof form slots 31. The slots 31 accommodate the locating bars 27 which are mounted on the oxygen gun.

Vertically extending supports 32 connect and brace the tubes 29 and 30 to the base 28. The entire gun guide construction is made of steel.

The guide 12 is positioned upon the roof of the open-hearth furnace in such a position that the axis of the jet of oxygen emitted from the oxygen gun is parallel to the longitudinal axis of the furnace. Since there is considerable splashing of the steel bath by the jet of oxygen, it is desirable to direct the jet along the longitudinal axis of the furnace. The positioning of the locating bars in the slots 31 of the guides will prevent rotating of the oxygen gun during the operation thereof.

The high back tubes 30 are for gathering the various hoses connected to the oxygen gun to prevent fouling of the hoses in any auxiliary equipment which is adjacent to the furnace.

The guide also serves to support the guns above the furnace should there be a failure of the supporting cable.

Proceeding next to Figure 7, there is illustrated in annulus 11 which is used to cool the opening 8 in the roof of the open-hearth furnace. By cooling this opening, the furnace gases escaping from the opening will be cooled and their cutting action on the roof and the position of the hole will be considerably reduced.

The annulus 11 comprises a continuous length of steel tubing which is in the shape of a coil 33. The cooling water enters through the water inlet 34 and circulates through the coil 33 from the bottom upwardly to be exited from the water outlet 35.

The use of a roof cooler in the form of a continuous coil has the outstanding advantage in that there is a constant flow of the cooling water throughout the entire annulus. This results in an equal maximum flow rate throughout the entire coil. By having a constant maximum flow rate, the life of the water-cooled annulus is greatly improved, this improvement being on the order of a fivefold increase in the life of the annulus.

Where it is desired to deliver oxygen to the steel bath within the open-hearth furnace, the gun is lowered to the position as shown in Figures 1 and 2. In this position, the nozzle of the oxygen gun is from four to five inches above the steel bath indicated at 36. Since copper will melt at temperatures encountered within the open-hearth furnace, water is circulated through the gun before the gun is lowered into the furnace. It is desirable to use copper for the tip of the gun, since copper is a good conductor of heat and it is desirable to conduct the heat away from the nozzle of the gun as rapidly as possible.

It has been found that, by circulating the cooling water through the three pipes spaced around the central pipe through which the oxygen is delivered, the life of the gun is greatly increased. This increase is due to the high speed turbulent flow of cooling water at the critical zone of the gun which is the extreme tip of the gun. The high speed turbulent flow results in

greater cooling efficiency at the tip of the gun where this property is most desirable.

When the gun has been lowered into position, oxygen is then passed through the central pipe 20. The oxygen is emitted from the gun at an angle and strikes the steel bath, sending up a spray of molten steel and slag. The angle at which the tip of the gun is bent has been carefully chosen with several considerations in mind. It is desirable that this angle be as near the vertical position as possible. By maintaining the nozzle in as near a vertical position as possible, the distance which the oxygen must travel to penetrate the slag layer on top of the steel is greatly shortened. In addition, the size of the opening in the roof of the open-hearth furnace is decreased, since the tip of the gun is housed within this opening when the gun is not in operation.

The angle at which the tip of the gun is bent is so selected that the slag which is thrown up by the jet of oxygen impinging upon the top of the steel bath just clears the tip of the oxygen gun. Since the oxygen diverges at an angle of approximately 7° when it is emitted from the tip of the oxygen gun, it has been found that an angular bend of approximately 25° will enable the reaction zone of the slag to just clear the tip of the oxygen gun when the tip of the gun is about five inches above the steel bath. As compared with a vertical jet direction, this greatly increases the number of "blows" which may be obtained prior to failure of the gun.

As mentioned previously, the axis of the bent portion of the oxygen gun is parallel to the longitudinal axis of the open hearth furnace. This will prevent steel thrown up by the impinging oxygen from contacting the walls of the open-hearth furnace. To safeguard against the possibility of the splashing slag from damaging the roof of the furnace, the panel of chrome magnesite is positioned in the roof of the furnace with the greater portion of the panel being in the direction of the oxygen discharged from the gun, since the chrome magnesite panel is more resistant to the effects of molten slag than the silica brick of which the furnace is composed, the life of the roof of the furnace will be considerably prolonged.

It is preferred to employ commercial grade undiluted free oxygen, but in actual fact the oxygen used may be an admixture with air or an inert gas. The mixture, if used, should have a high oxygen content in excess of the normal concentration of oxygen in air, i.e. higher than 21% by volume.

As has been stated above, the known art describes an oxygen delivery rate of 30,000 to at the most 35,000 cu. ft. per hr., corresponding to 150 p.s.i. at the gun, and no improvement was rightly expected from a further increase in the supply rate as long as an essentially acute angle of incidence of the jet to the surface of the bath was maintained and considered the best solution.

In contrast thereto, in the present invention, the rate of oxygen delivery per jet is increased to a pressure of approximately 250 p.s.i., which corresponds to an average oxygen delivery in the range of from 42,000 to 50,000 cu. ft./hr. One advantage of this increased delivery rate is that there is no need for a reducing valve if, for instance, oxygen evaporators operating at a pressure of approximately 250 p.s.i. are used.

Furthermore, this increased oxygen delivery rate, which is made possible through the aforesaid introduction of the oxygen jet through the roof to impinge onto the bath surface, was found to lead to a greater area of agitation in the bath; and, as will be shown hereinafter, the rate of decarbonization is also increased. Moreover, it was found that the quicker rate of carbon removal, and consequently shorter refining time has had no adverse effect on either the attainment of the

correct tapping temperature, or the final removal of sulphur or phosphorus.

It is preferred in our method of injecting oxygen at an increased supply rate and through the roof of the furnace to commence the use of oxygen as soon as the bath is clear melted or virtually so, at a range of approximately 40 points carbon content.

Above this level of carbon it has been found that the reaction becomes violent in the bath, producing a good deal of flame, which even with the oil completely off may nevertheless raise the roof temperature locally high enough to melt the silica bricks. Also the fume issuing from the stack is heavy.

However, below 0.4% C the whole process in the furnace is entirely manageable and the discharge from the stack is not excessive, and in fact is usually very much less than that following the introduction of hot metal during normal operation. Fume formation rapidly tails off and below 0.2% C is very light.

It is found that splash varies both with the distance between the jet orifice and the bath, and with the percentage of carbon in the steel. Splash and agitation are greater the higher the carbon in the bath, and splash increases as the distance between the jet orifice of the bath is increased above about 4". If the jet is lifted 9/10" above the bath a good deal of splash occurs in droplet form which can and does reach the roof. If properly located, therefore, we find that the reaction is not responsible in any way for splash causing damage to either the roof or front and back linings.

It is usual, depending on the condition of the bath to feed either oxide or lime, or both, just prior to the commencement of the oxygen blow, since it is found that the agitation produced by the jet is an excellent means for causing rapid reaction between these reagents and the bath.

It has also been found that the delivery of a volume of oxygen proportional to the carbon content of the bath at the commencement of the blow will reduce it to that required to meet the 0.07% carbon upper limit usually desired.

The following further simplification of operation is made possible by our method:

A sample is sent to the laboratory at the same time as the oxygen blow is commenced. When the carbon analysis is available the quantity of oxygen required is calculated from this, and as soon as this amount has been delivered the furnace is prepared for tapping. No other samples are required so far as carbon removal is concerned, and unless there is any difficulty with sulphur or phosphorus, which however is not usually the case, no further sample is sent to the laboratory until the tapping sample is taken when the bath is running out.

This not only relieves the laboratory of a good deal of analytical work, but there is no delay in tapping while the final bath carbons are being checked to ensure that the requirements as to carbon content will be met as is the case with normal charges.

While the oil input is normally reduced during the oxygen blow, the air/oil ratio is, however, appreciably increased in order that the considerable volume of combustible gas generated at the reaction zone around the jet may be provided with sufficient air for burning as a supplementary fuel.

Decarbonization rates

The major effect of oxygen introduced into the bath at the rate according to our invention is to cause a considerable increase in the rate of elimination of carbon.

The effect on the furnace is conveniently summarized in the graphs shown in Figure 8. Each graph shows the average rate of carbon removal in percent per hour from various carbon levels to that which is required to secure a specification of 0.07% C, i.e. approximately 0.07% for the last bath sample on normal casts, and 0.06% for the last bath sample with oxygen blown casts.

The lower curve shows the average rate of carbon removal for normal non-oxygen blown casts. The curve above this shows the average rate of carbon removal for oxygen blown casts with an average rate of oxygen input of 35,460 cu. ft. per hr. and the top curve shows the average rate of carbon removal for oxygen blown casts in which the average rate of oxygen input is 46,500 cu. ft. per hr.

The beneficial results of using oxygen at the rate proposed by us for decarbonization are immediately apparent from these graphs when comparing our rate with the non-oxygen rate. Taking two samples only and starting from 0.35% C, which is a typical starting level for oxygen blowing, the average rate of removal is 0.42% C per hr., oxygen delivery averaging 46,500 cu. ft. per hr. as compared to 0.14% C per hour at no-oxygen.

It may be deduced, therefore, that throughout normal range within which oxygen will be used for decarbonization, a threefold increase in the rate of removal is obtained thereby.

In Figure 9 two curves are given, showing the time from a given carbon to tap for both the non-oxygen and the oxygen blown casts, the latter at our preferred blowing rate.

From 0.35% C, for example, the use of oxygen at our rate reduces the time to tap from 142 to 48 mins. From 0.15% C the corresponding time to tap is down to 33 mins., while the non-oxygen rate heats required 95 minutes.

Figure 10 shows the considerable increase in time saved by oxygen blown at a rate according to our invention as compared with the non-oxygen rate and is graphed over the full range of carbon levels, and varies from 40 mins. saved at 0.10% C to 95 mins. at 0.40% C, which is the carbon range within which oxygen is likely to be applied.

Figure 11 shows the specific consumption of oxygen in cu. ft. per 0.01% C per ton of steel, plotted against percent C at start of blow. From this it is quite clear that there is a rapid reduction in the efficiency of the use of oxygen as percent C at start of blow declines. The reduction in efficiency is at a spectacular rate below 0.15% C.

This fact, together with the increase in time saved the higher the percent of carbon at which oxygen blowing is commenced, suggests that the higher the carbon at which blowing is commenced the greater is the net gain from all points of view. This is counterbalanced by the physical fact that above 0.45% C the reaction is too violent, and accordingly we have selected a value from that limit down to 0.35% C as the best compromise at which to commence oxygen blowing for full rates. However, O_2 may be used from a higher C level satisfactorily if the rate of flow is initially reduced, until the C is below about 0.40%.

Operation of the oxygen injection according to our invention by the melter is extremely simple, lowering and withdrawal of the gun being effected by push button control from the panel, and the oxygen supply being controlled by the operation of a single valve.

By the delivery of oxygen in accordance with the invention through the roof of the furnace and providing means for retracting the gun or guns, other operations essential to the open-hearth furnace, such as charging and tapping the furnace, are not interfered with in any way and the invention may thus be easily applied to existing furnaces. The manipulation of the delivery pipe assembly is extremely simple and the operation requires very little manual attention.

It is found in practice that contrary to expectation very little slag or metal attaches itself in a solidified form to the part of the delivery pipe assembly entering the furnace.

It will be understood that this invention is susceptible to modification in order to adapt it to usage with different types of steel refining apparatus, such as in particular, tiltable open-hearth furnaces and so-called "mixers," and, accordingly, it is desired to comprehend such modifications within this invention as may fall within the scope of the appended claim.

This application is a continuation-in-part of application Number 454,246, filed September 7, 1954.

We claim:

In an open-hearth furnace for use in the manufacture of steel from a suitable charge, an elongated hearth having a roof with an opening therein, an oxygen delivery lance retractably mounted above said hearth for lowering through said opening to direct a stream of oxygen upon the surface of a charge within the furnace and comprising an elongated body having a tubular member within said body for the passage of oxygen therethrough, the end of said tubular member being flush with the end of said body, an annular plate in the space between the lower end of said tubular body and the elongated body for supporting the lower end of said tubular member, a plurality of pipes in said body spaced around said tubular member the lower ends of said pipes terminating short of said annular plate so that a coolant introduced through said pipes produces a high turbulent flow at the tip of the lance for cooling thereof, the lower end of said lance

being bent at an angle from the vertical so that the charge thrown up by the stream of oxygen will just clear the tip of the lance body, there being locating bars on said lance body, and a guide mounted above said roof opening and having slots to receive said lance-locating bars non-rotatably holding said lance when the lance is lowered into the furnace in its operative position and to position the lance so that the bent end thereof will direct a stream of oxygen in a direction substantially parallel to the longitudinal axis of said furnace.

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