Dec. 10, 1963 J. R. GUINGAND 3,113,766

FORCED CONVECTION, REMOVABLE BELL TYPE FURNACES

Filed July 7, 1960 2 Sheets-Sheet 1

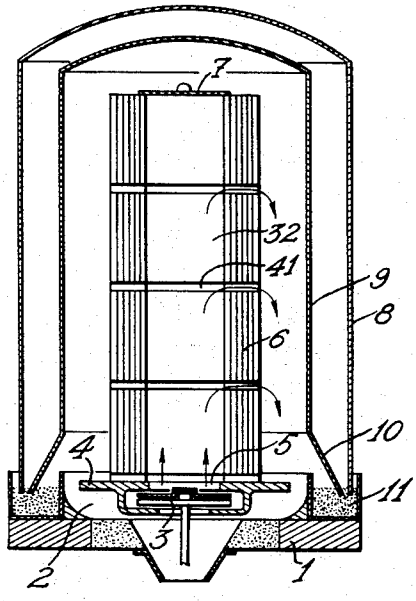


Fig. 1

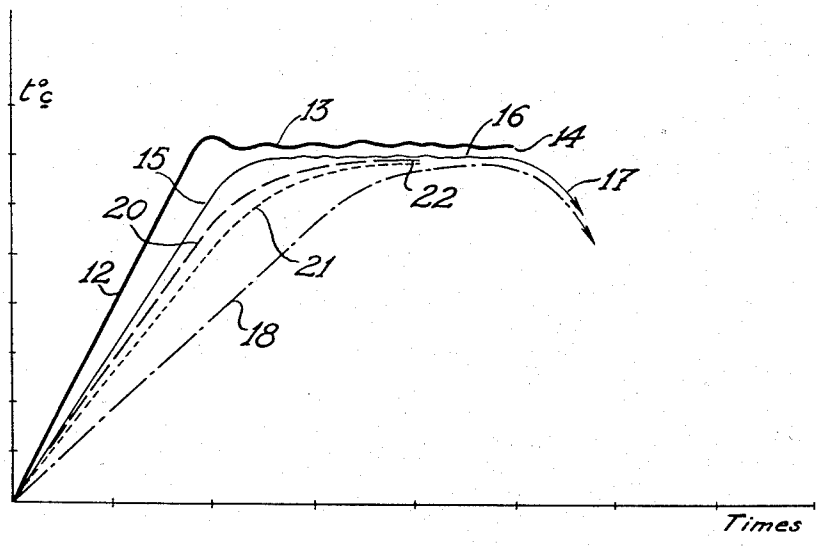


Fig. 2

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FORCED CONVECTION, REMOVABLE BELL TYPE FURNACES

Filed July 7, 1960 2 Sheets-Sheet 2

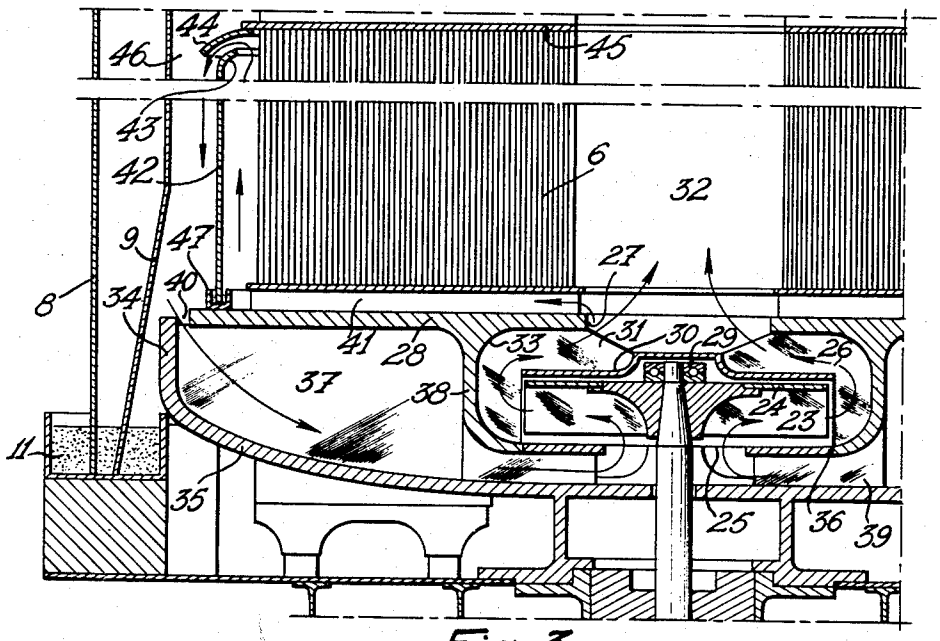


Fig. 3

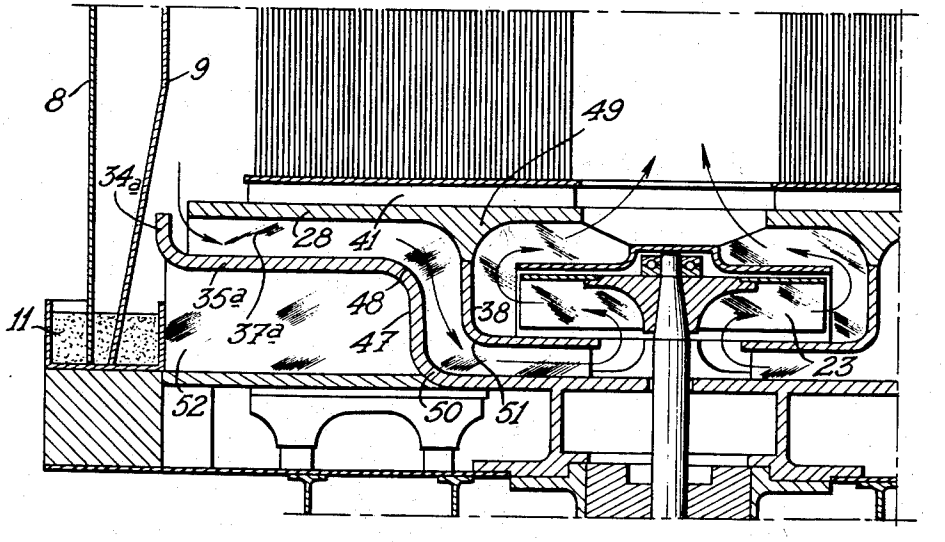


Fig. 4

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FORCED CONVECTION, REMOVABLE BELL TYPE FURNACES

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The present invention relates to improvements in forced convection removable bell type furnaces.

In forced convection, removable bell type furnaces, particularly those used for annealing steel plate reels in a controlled atmoshere, each charge consists of a stack of reels separated from one another by convectors. Beneath each stack is a device chiefly consisting of a fan and a diffuser therefor, the assembly being covered by means of a single or double-walled lid which isolates the charge from the ambient atmosphere.

In such furnaces, the heating is achieved by means of a heating bell which imparts heat to the outer lid, while a gas is caused to circulate in a closed path by the fan, the gas ascending the length of the outer wall of the lid, thereafter flowing over the lid and passing through the convectors, suction being effected via the central flue formed in the stack of reels which open up above the fan intake, the top of the flue being closed by an obturator.

In spite of precautions, it is found that the upper section of the top reel in the stack undergoes a much quicker rise in temperature than the lower section of the reel located at the bottom of the stack. As a result, the charge does not sustain a homogeneous heat cycle and the leg in the temperature rise of the bottom reel is reflected by a lowering of the production capacity of the furnace, since it becomes necessary to wait for the bottom of the charge to reach a minimum temperature close to that reached by the top reel; the uniformity of the mechanical properties of the products treated being likewise affected.

It is an object of the present invention to eliminate the drawbacks referred to above.

According to the invention, the fan diffuser is shaped so that it has a bottom axial intake and a top axial outlet, the overall object being to induce discharging of the gases into the central flue of the stack of reels and to induce a suction in the annular space surrounding the stack.

The direction of gas circulation adopted is therefore the opposite of that used in convention furnaces.

In this way, the gas circulating inside the lid is progressively heated by contact with the latter and is injected into the charge at maximum temperature in the immediate vicinity of the lower portion of the charge, thus ensuring a quicker and more effective heating-up of the coolest point thereof.

According to a second improvement, in the case where the lid is of the single-walled type, the foot of the charge is surrounded by a ring which is jointed in sealed fashion to the supporting plate. This ring receives the radiation emanating from the protecting lid, at the very point where the latter is at the highest temperature, thus heating the atmosphere gas in the same way as a double-walled lid yet imparting to the gas a shorter and more rapid partial recycling which ensures improved heat exchange conditions at the foot of the charge.

According to a further improvement, by means of a

suitable profile for the diffuser, there is imposed, on the gas stream sucked in by the fan, a circuit such that it closely follows the inner face of the supporting plate, thus improving the heat transfer by conduction through the plate to the bottom face of the charge.

Such a diffuser contour additionally permits taking maximum advantage of the radiation from the protecting lid by the provision, underneath the body of the diffuser proper, of a set of fins whose purpose is also to maintain the charge in the steady state.

Such arrangements, which can be applied singly, or jointly in various combinations, greatly speed up the establishment of the desired temperature at the bottom part of the charge, with an attendant improvement in the uniformity of the treatment and a reduction in the treatment time.

The description which follows with reference to the accompanying drawings given by way of example only and not in a limiting sense will give a clear understanding of how the invention may be performed.

In the drawings:

FIG. 1 is a highly diagrammatic sectional view of a furnace according to the invention and wherein the direction of circulation is shown by the arrows.

FIG. 2 is a diagram giving a set of curves in which temperature is plotted against time for various locations in the furnace according to FIG. 1.

FIG. 3 is a partial sectional view on a larger scale of a gas circulation layout in a bell-type furnace according to the invention; and

FIG. 4 is a sectional view similar to that of FIG. 3 of a modified embodiment of furnace according to the invention.

According to a generally known disposition, as may be seen on FIG. 1, a bell-type furnace is provided with a base **1** on which rests an assembly forming a discharge diffuser **2** for a fan wheel **3** arranged axially beneath a charge supporting plate **4** provided with a central aperture **5**. The charge supporting plate **4** supports a stack of hollow reels **6** separated from one another by convectors **41**, the top of the flue **32** formed by the aligned hollow parts of superposed reels being fitted with an obturator **7**. In certain constructions, the plate supports a skirt forming an internal partition. The charge and eventual partition is covered by a lid **9** the top of which is closed and the bottom edge **10** of which is inserted into a seal **11**. This assembly is ultimately covered over with a heating removable bell **8** surrounded, say, by burners located at the lowermost part of said bell, the inner face of which radiates onto the lid.

In certain types of known constructions, the gases emerge from the fan, pass through the diffuser, are led up between the lid and the skirt where they are heated, and then descend once more between the charge and the skirt, penetrating into the central flue via the convectors.

Thus the hottest gases initially reach the top of the charge thereby subjecting the latter to the most intense radiation. As may be seen from FIG. 2, curve **12** represents a temperature recording for the furnace and includes an ascending section which corresponds to the rise in temperature and a wavy section **13** which is substantially horizontal and which corresponds to the governed temperature, this section **13** being broken off at a point **14**, when the heating bell is removed.

The curve **15** drawn in a thin continuous line represents the temperature recording for the top of the stack **6**. This curve **15** follows curve **12** with but a small gap in between; it indicates a rapid rise in temperature, followed by a level section **16** which is relatively long, and a descending section **17** beyond the point in time corresponding to removal of the heating bell, to the right of the point **14**. Curve **18**, which is drawn in a chain-dotted line and which records the temperature at the foot of the charge, reveals a much slower rise in temperature, a temperature close to that registered at the head of the stack being obtained only close to point **14**.

It can be seen that the treatment time required is entirely dependent upon the curve **18**, since that time must be such that the temperature of the coolest point should generally differ but little from that of the hottest point.

In contradistinction to what is hereinbefore mentioned, if the atmosphere gas is caused to circulate inside the lid **9** in the opposite direction (indicated by the arrows in FIG. 1) by having it first penetrate into the charge **6** via the flue **19** and having it emerge from the charge via the convectors such as **41**, it will be found that the hottest gases, initially contact the lower part of the charge whereas the top of the charge is contacted by cooler gases which have already transferred heat to the charge.

Temperature recordings can then be made, the curve **20** drawn in dashes showing the temperature at the top of the charge and dotted curve **21** showing the temperature at the foot thereof. These curves reveal a slight reduction in the rate of temperature rise at the top of the charge as compared to curve **15**, but a very big increase in the rate of temperature rise at the bottom of the charge, as curve **21** indicates when compared to curve **18**. The equalization point **22** can be located significantly to leftward of point **14**, hence decreasing the treatment duration correspondingly for a given charge, the treatment being in that case applied in much more homogeneous fashion.

With the object of retaining, in furnaces of the type specified and as shown in FIG. 3, the layout involving an axially-located fan, which is of simple construction and which gives reliable operation, the fan wheel **23** is provided on its upper face with a disc **24** placed atop the blading, the intake **25** being beneath the fan wheel in a wall or partition forming the bottom of the wheel case. The periphery of the wheel is surrounded by a duct or diffuser **26** shaped like a half-annulus which is provided with deflector vanes and which reverses the flow by forcing it to pass above the disc **24**, towards the central aperture or outlet means **27** in the charging plate **28**, the central portion of the latter further serving as an envelope for the wheel case.

If necessary, the top **29** of the wheel shaft can be covered by a plate **30** adapted to separate and guide the gas. This plate is joined to the charging plate **28** by vanes **31** acting as bracing struts, these vanes being, if required, chambered in order to impart, to the gas flow discharged from the fan, a gyratory motion.

In order to impart a half-annulus shape to the inner periphery of the fan case, the juncture of the partitioning walls may be suitably rounded as at **33**. The plate **28**, which may, if required, be joined to the vanes **31** and the plate **30**, can be easily dismantled to uncover the fan for maintenance purposes.

On the intake side, plate **28** is spaced from the edge **34** of a bowl **35** which acts as a base supported on the foundations through the medium of suitable legs, said bowl having a dished bottom maintained at a distance from the bottom **36** of the fan case. Guiding vanes **37** secured to the plate **28**, which extend above the bowl **35**, are edge supported on the bowl and latter, acts as supports therefor. The fan case **38** is at a distance from the bottom of the bowl, the central portion of which is provided, beneath the case **38**, with vanes extending up to the inlet port in said case, to extend and supplement the guiding action of vanes **37**, these complementary vanes **39** being shown on the bottom of bowl **35**.

In this way, the gases heated by contact with lid **9** are admitted via the port or inlet means **40** along the periphery of plate **28**, are guided by the vanes **37** and are suitably directed before penetrating into the fan prior to being discharged into the flue **32**.

Thus the bottom part of the stack to be treated is in contact with the hottest part of the circulating gas.

With a view to improving the heating of this bottom part, it is possible to use, instead of the single-walled lid, a double-walled lid. With such a double-walled lid, advantage is taken of the heat imparted by the successive radiations on the walls emanating from the heating bell. A double-walled lid can be used irrespective of whether the charge is supported directly on plate **28** or on a bottom convector **41**.

With a single-walled lid it is also possible to speed up the heat exchange at the base of the stack.

This speeding-up can be achieved by surrounding the bottom reel with a ring or skirt **42** which, in cooperation with the bottom convector **41**, creates a short circulation path about the lower part of the charge. Such a skirt **42** absorbs heat from lid **9**, and transfers it to the recycled gas by contact therewith. Furthermore, the top of the skirt can be provided with an inward-turned edge **43** cooperating with an outwardly formed annular deflector **44**, supported at the periphery of the bottom face **45** of the convector surmounting the last reel, the purpose being to provide, between lid **9** and said deflector **44**, a constriction **46** which provides an accelerated extraction effect of the gases which heat the bottom reel. This circuit is indicated in FIG. 3 by suitable arrows. Naturally, the bottom edge of skirt **42** is provided with an annular seal **47** fitted onto plate **28**.

It should be noted that such a ring or skirt could be used with advantage in a conventional-circulation-type furnace.

Even without this short-circuit, accelerated circulation for the heat gases of the lower portion of the charge, the relatively cool point would be heated in improved fashion by bringing it into direct contact, in the absence of convector **41**, with charging plate **28** which transfers heat absorbed by the vanes **37** to the charge.

To still further improve the heat transfer, the bowl **35** may be shaped so that the ducted gases are made to follow a path which hugs charging plate **28** as closely as possible. To this end, the bottom of the bowl is contoured so that it comprises a rounded edge **34***a* which surrounds the periphery of plate **28** and an annular bottom **35***a* parallel to said plate **28**. This annular bottom is extended by a cylindrical portion **47** which surrounds the wall **38** of the fan case at a distance, rounded edges **48**, **49**, **50** and **51** being provided to ensure non-turbulent flow of the gases. Naturally, the vanes **37***a* are contoured to suit the contour of the bottom of the bowl.

In this way the gases are caused to pass in very close proximity to plate **28**, to improve the heat exchange therewith.

Since the annular section **35***a* of the bowl bottom must be supported mechanically, advantage is taken of this requirement to provide this support in the form of vanes **52** which jointly form externally opened cells.

The heat absorbed by the vanes **52** is transmitted in major part to the walls **35***a* and **47**, and hence to vanes **37***a*, so that the gases receive increased heat before being distributed by the fan.

Clearly, with such a layout, use may be made of the convector **41**, and the skirt **42** or a double envelope.

It is to be clearly understood that many modifications may be made to the embodiments described hereinabove without departing from the scope of the invention as defined in the following claims.

What I claim is:

1. A removable heating bell-type furnace for treating a charge which is constituted by a stack of superposed hollow reels each having a hollow central space, the spaces being in vertical alignment and forming a vertical

flue, and an obturator adapted to be operatively disposed with respect to said flue to obturate the same, each of said reels of said stack being vertically spaced from an adjacent one by a convector adapted to be inserted in the stack of reels, the furnace comprising: lid means for covering the charge in fluid tight relation and defining an annular space therewith, a heating bell surrounding the lid means, supporting means having a flat upper surface for supporting the charge thereon, outlet means in the supporting means adapted for being located below the lower opening of said vertical flue for discharging fluid thereinto, centrifugal means beneath the outlet means for forceably urging said fluid upwardly in said flue and through the spaces between adjacent stacked reels, and inlet means in said supporting means adapted for being in communication with said annular space, said supporting means defining a passageway below said upper surface of the supporting means extending between said inlet means, the centrifugal means, and the outlet means whereby fluid is withdrawn from said space and is charged to the centrifugal means via said inlet means and thereafter discharged through said outlet means to said flue, said centrifugal means comprising a centrifugal fan axially disposed in said supporting means, said supporting means further comprising a curved diffuser for said fan and enveloping the same, said passageway in said supporting means providing communication between said inlet means and the curved diffuser.

2. A removable heating bell-type furnace for treating a charge which is constituted by a stack of superposed hollow reels each having a hollow central space, the spaces being in vertical alignment and forming a vertical flue, and an obturator adapted to be operatively disposed with respect to said flue to obturate the same, each of said reels of said stack being vertically spaced from an adjacent one by a convector adapted to be inserted in the stack of reels, the furnace comprising: lid means for covering the charge in fluid tight relation and defining an annular space therewith, a heating bell surrounding the lid means, supporting means having a flat upper surface for supporting the charge thereon, outlet means in the supporting means adapted for being located below the lower opening of said vertical flue for discharging fluid thereinto, centrifugal means beneath the outlet means for forceably urging said fluid upwardly in said flue and through the spaces between adjacent stacked reels, and inlet means in said supporting means adapted for being in communication with said annular space, said supporting means defining a passageway below said upper surface of the supporting means extending between said inlet means, the centrifugal means, and the outlet means whereby fluid is withdrawn from said space and is charged to the centrifugal means via said inlet means and thereafter discharged through said outlet means to said flue, said centrifugal means comprising a centrifugal fan wheel, said supporting means further comprising a curved casing for said wheel and constituting a diffuser therefor, said casing having an outlet constituting the outlet means in the supporting means, said wheel comprising an upper disc disposed adjacent the outlet in the casing, a radial blading under said disc, and a covering plate over said disc and integral with said casing and supported in spaced relation from the outlet of the casing.

3. A removable heating bell-type furnace for treating a charge which is constituted by a stack of superposed hollow reels each having a hollow central space, said spaces being in vertical alignment and forming a vertical flue, and an obturator adapted to be operatively disposed with respect to said flue to obturate the same, each of said reels of said stack being vertically spaced from an adjacent one by a convector adapted to be inserted in the stack of reels, the furnace comprising: lid means for covering the charge in fluid-tight relation and defining an annular space therewith, a heating bell surrounding the lid means, supporting means having a flat upper surface for supporting the charge thereon, outlet means in

the supporting means adapted for being located below the lower opening of said vertical flue for discharging fluid thereto, centrifugal means beneath the outlet means for forcing a fluid upwardly in said flue and through the spaces between adjacent stacked reels, inlet means in said supporting means adapted for being in communication with said annular space; and duct means between said inlet means, the centrifugal means and the outlet means whereby fluid is withdrawn from said space and is charged to the centrifugal means via said inlet means and thereafter discharged through said outlet means to said flue, said duct means comprising a duct including a first portion coupled to said inlet means and extending parallel to said upper surface of the supporting means, a curved portion extending from the first portion and directed downwardly and a further portion connected to said curved portion and extending to said centrifugal means and coaxial with said outlet means in the supporting means.

4. A removable heating bell-type furnace for treating a charge which is constituted by a stack of superposed hollow reels each having a hollow central space, the spaces being in vertical alignment and forming a vertical flue, and an obturator adapted to be operatively disposed with respect to said flue to obturate the same, each of said reel of said stack being vertically spaced from an adjacent one by a convector adapted to be inserted in the stack of reels, the furnace comprising: lid means for covering the charge in fluid tight relation and defining an annular space therewith, a heating bell surrounding the lid means, supporting means having a flat upper surface for supporting the charge thereon, outlet means in the supporting means adapted for being located below the lower opening of said vertical flue for discharging fluid thereinto, centrifugal means beneath the outlet means for forceably urging said fluid upwardly in said flue and through the spaces between adjacent stacked reels, and inlet means in said supporting means adapted for being in communication with said annular space, said supporting means defining a passageway below said upper surface of the supporting means extending between said inlet means, the centrifugal means, and the outlet means whereby fluid is withdrawn from said space and is charged to the centrifugal means via said inlet means and thereafter discharged through said outlet means to said flue, said furnace further comprising a ring forming a skirt disposed in said lid means and adapted for being adjacent said charge, the skirt being supported in fluid tight relation on said supporting means, the inlet means of the supporting means being located radially outwards of the skirt, said skirt having a height which is adapted to be less than that of said charge whereby the heat exchange at the lower portion of the stack is accelerated.

5. Apparatus as claimed in claim 2 wherein said fan wheel is centered within a plurality of profiled blades integral with said casing and with said cover plate.

6. A furnace as claimed in claim 3 wherein said supporting means further comprises a bowl including a curved portion, guiding vanes on said curved portion and extending interiorly thereof, said vanes having upper edges, an upper plate for said supporting means, said plate and casing being supported by said edges of the vanes, said curved portion having an upper edge in spaced relation with said plate to form an annular space, said space communicating with the space between the lid means and said charge, said guiding vanes being radially disposed and defining therebetween a plurality of ducts which communicate with the curved diffuser for withdrawing fluid from the space between the lid means and the charge and charging the fluid to said fan via said ducts.

7. Apparatus as claimed in claim 3 comprising radially disposed vanes beneath said duct, said vanes constituting open cells opening radially outwardly, for absorbing heat radiated from said lid means.

8. Apparatus as claimed in claim 4 comprising means on the skirt for circulating said fluid through said charge

at an increased rate whereby the heat exchange at the lower portion of the charge is accelerated.

References Cited in the file of this patent

UNITED STATES PATENTS

2,202,424	Hough	May 28, 1940
2,463,222	Vaughan	Mar. 1, 1949
2,686,665	Tauber et al.	Aug. 17, 1954
2,789,808	Blackman	Apr. 23, 1957
2,875,997	Blackman	Mar. 3, 1959
2,878,005	Egge	Mar. 17, 1959

FOREIGN PATENTS

526,270	Belgium	Feb. 27, 1954
755,034	Great Britain	Aug. 15, 1956