

Oct. 1, 1929.

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1,729,675

TUNNEL DRIER

Filed Dec. 20, 1927

2 Sheets-Sheet 1

Fig. 1

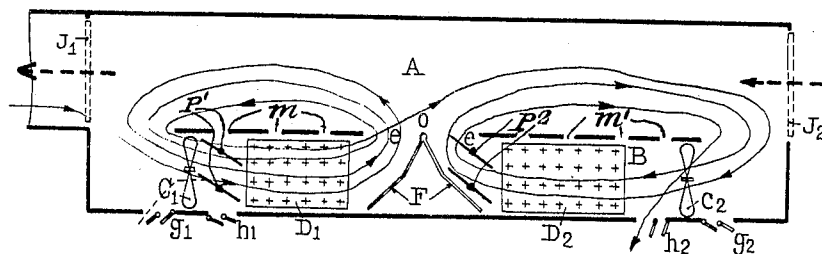


Fig. 2

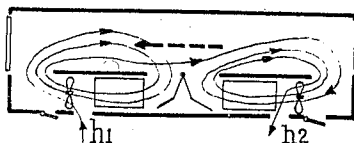


Fig. 3

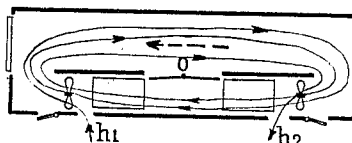


Fig. 4

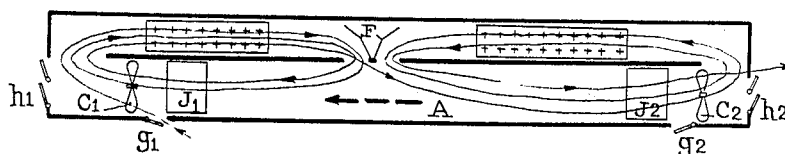
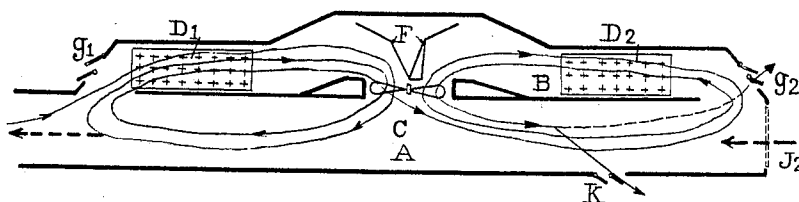


Fig. 5



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Fig. 6

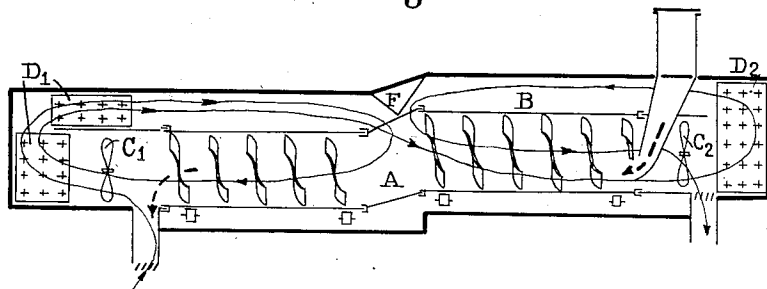


Fig. 7

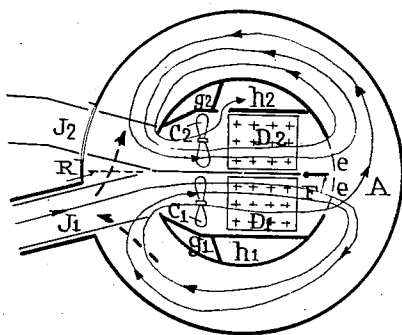


Fig. 8

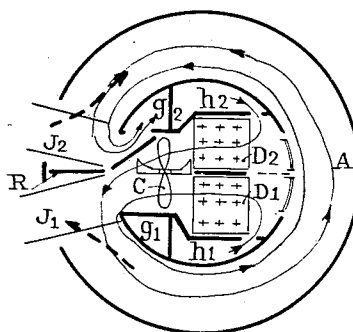
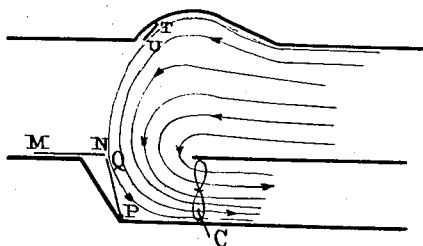


Fig. 9



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TUNNEL DRIER

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The present invention has for its object improvements in tunnel driers using hot air, which improvements mainly consist in producing in the tunnel two streams of air of which the temperature and the intensity may be adjusted independently and of which the direction of circulation may be modified in certain circumstances; at the same time, if desired, suitable mechanical conveying means for the materials to be dried may be used in the tunnel.

Tunnel driers which are only provided with a single circuit or cycle of air, are of simple construction, but their action on the materials to be dried is not always suitable or their consumption of heat is excessive. Driers with a multiple circuit of air enable a good efficiency to be combined with a suitable treatment of the materials, but they are generally complicated, cumbrous, and expensive. The first are applicable to materials which can be dried easily or without the special precaution, the others to more delicate materials. For drying delicate materials two different circuits of air may suffice in most cases, one for commencing the drying (for example with air sufficiently hot which treats the material on the counter-current principle) the other for completing the operation (for example with air which is less hot, which circulates on the counter-current principle or not). The driers described in the present specification are provided with two circuits of air, each having a fan or fan element and an independent heating battery, which enables the intensity and the temperature to be adjusted at will; the direction of circulation of one of the fans at least may be reversed; and these two circuits of air may be combined into a single one, of increased intensity if desired; these various possibilities enable the drier to be rapidly adapted to the suitable and economical treatment of various materials.

The invention is mainly based on the following principle:

An air intake passage is juxtaposed to the tunnel, this passage being adapted to communicate laterally and at its ends with the tunnel. A single lateral opening thus determines two circuits which are each closed

by one of the two ends of the tunnel. In each circuit and outside the tunnel there is provided a heating battery and a ventilation apparatus. A movable partition, movable in the air intake passage assists in determining at will the paths of the two air circuits or by being removed (or collapsed) permits of combining them into a single one. In this manner it is thus possible to obtain various cycles of ventilation, especially if of two fans, one can turn in two directions.

The invention will be further explained hereinafter with reference to the accompanying drawings showing by way of example various forms of driers based on this principle.

Figures 1, 2 and 3 show the same drier provided with two fans for producing three different cycles of ventilation.

Figure 4 shows a modified construction of this drier.

Figure 5 shows a drier with a single fan.

Figure 6 shows a drier consisting of rotary cylinders.

Figures 7 and 8 show driers of circular shape for facilitating the manipulation of the materials, and

Figure 9 shows a detail of the open ends of a drier.

Figure 1 shows a section of a drier of which the transverse size has been exaggerated for the sake of clearness. A indicates the tunnel through which move the materials to be dried, B is the air intake passage. At C_1 and C_2 are two fans of which at least one (that at the left C_1) is reversible; D_1 and D_2 are two heating batteries or radiators. Towards the middle of the drier the tunnel may communicate with the air intake passage by an opening e, e towards which two deflectors F direct the air from the passage by interrupting this. On opposite sides of each fan openings g_1, h_1, g_2, h_2 communicate with the outside. The materials to be treated leave and enter through the doors J_1 and J_2 provided at the ends of the tunnel.

The operation of the drier is indicated by Figures 1, 2 and 3 in which the arrows in thick broken lines indicate the direction of movement of the material, and the arrows in

thin lines the direction of circulation of the air. In Figure 1 there are used two cycles of air such that the wet material is firstly treated by air on the counter-current principle, then moving in the same direction as the air. This applies to materials which are not capable of withstanding a high temperature when they are almost dried. The air which is sufficiently heated in its first cycle, is no longer so in the second and may be discharged whilst hot or very humid (which is favourable for good efficiency). The degree of intake of air is adjusted by the inlet openings g_1 and the outlet openings h_2 which are provided, for this purpose, with adjustable dampers (the adjustment of one opening is sufficient for this purpose); the temperatures are adjusted by the two radiators.

It is also possible to allow hot air to enter along a portion or the whole length of the tunnel by small openings or slots between this and the passage for compensating for the fall of temperature in the tunnel, and for the purpose of promoting the mixing of the air.

The two doors being placed near the suction of each of the two fans there will not be a discharge of moist air into the surrounding chamber when these doors are opened. Air may be drawn in through the opening g_1 or through the opening of the door J_1 (as in Figure 1) as may be desired and the door J_1 may be omitted. By extending the tunnel from this door, as indicated at the left of Figure 1, there is obtained the double advantage of cooling the dried product and recovering its heat and that of the supports by the fresh air which is drawn in.

It is also possible to arrange for the pressure of the air to be the same on both sides of the door J_2 . For this purpose the resistance offered to the streams of air in the tunnel or in the air intake passage is acted upon by adjustable dampers such as p_1 and p_2 provided in this passage. The pressure at the opening J_1 being the atmospheric pressure, the pressure at the middle point is greater by a quantity which may be made to vary as said above by means of the dampers p_1 disposed in the first stream of air; the dampers indeed cause the total amount and velocity of air running through the first cycle to vary, and in consequence, the drop of pressure through a part of such, the difference in pressure on the two sides of J_2 being adapted to change inside according as to whether the losses of the charge or of the pressure are greater or less in the tunnel than in the air intake passage. It is thus also possible to omit the door J_2 without destroying the effective operation of the drier or disturbing the atmosphere of the chamber. A tunnel open at both ends enables the materials to be dried to be manipulated extremely easily.

If the direction of rotation of the fan C_1 is reversed so as to draw in air through h_1

instead of through g_1 , a different arrangement is obtained as shown in Figure 2. In this case the drying is effected throughout on the counter-current principle and it is also possible to adjust at will the temperature of each of the two cycles of air.

If the middle communication between the tunnel and the air intake passage is obstructed, the continuity of the latter is re-established (for example by tilting the deflectors F about their hinging point o as in Figure 3) and a drier is obtained with a single intake of air. It is easily possible to prevent the intake of air by interrupting the air intake passage, whilst heating the air if this is desired.

The construction of such a drier may be effected in a number of different forms. The air intake passage may be arranged at the bottom of the tunnel as shown in Fig. 1, or at the top, as shown in Fig. 4 or at any desirable position. The length of each section may be modified simply by displacing the deflectors F in the passage and at the same time also the openings e, e . The relative positions of the fans and the radiators may also be changed or even reversed. The manipulation of conveyance of the materials into the drier may be of any suitable known character, such as by trucks running on rails, by suspended, sliding or rolling hoppers, or by chains or otherwise.

In Figure 4, for example there are shown different arrangements of radiators and fans, which are more suitable for materials which are easily dried as the direct drying without intake of air is facilitated. The doors are provided on one side. For manipulation, for example, trucks are mounted or suspended from rails on which they run. Opposite the doors, these rails are interrupted and may themselves leave the drier, supporting trucks, rolling themselves on transverse rails which from a travelling bridge. The trucks which leave through one door J_1 may be thus discharged, recharged, and again brought in front of the door J_2 for the purpose of being reintroduced into the tunnel.

The drier illustrated in Figure 5 is only provided with a single fan capable of causing two different streams of air to circulate. For this purpose this single fan C is disposed at the point of meeting of the two circuits of air between the tunnel and the intake passage. The deflectors F of a curvature converge towards the axis of the fan in such a manner as to suitably divide the mass of air which passes through it. For adjusting these two circuits of air a deflector, shaped in such a manner as not to produce any eddy, is movably and radially mounted about the centre of the fan. The air may be introduced through a separate opening g_1 or through the outlet opening for the materials. The inlet opening for the materials may also be left continuously open without disturbing

the atmosphere of the chamber, if instead of discharging the air through the opening g_2 it is discharged (only slightly humid) through a separate opening k situated at some distance from the end of the tunnel.

the partition R extended towards the fan as shown in the figure so as to keep the air in this case all on one side.

In the case of driers having open ends, as in Figure 1, in spite of the average internal and external pressures which prevent the mixture of the internal and external air, it is possible for a small amount of hot air to escape from the top of the drier through the opening in the tunnel whilst a small amount of cold air may enter the bottom, this being due to the differences between the densities of the hot and cold air.

Figure 9 indicates means for overcoming this drawback which are applied to each of the two openings.

In the stream of hot air in the tunnel, opposite the opening, there is caused to exist a pressure slightly below the external atmospheric pressure. For this reason the outer air tends to enter the tunnel. The dynamic action of the hot air, moving in the direction of the arrows, tends to drive it out; moreover this hot air is drawn in laterally by the fan C.

Under these various conditions the films of air take a curved path as is indicated in Figure 9.

All these films of hot air, thus deviated, are recovered there exactly in the lateral intake passage by limiting the opening of communication of this passage at the joint N against which the last film of deviated hot air strikes.

For the purpose of obtaining this result with greater certainty there is disposed on the separating partition a sheet or sliding shutter M, N which is advanced or drawn back as desired. If advanced too much into the drier this partition will cause the deviated films of hot air to be drawn outwardly whereas when it is drawn back too much it allows the cold air to enter. When in a well selected position it prevents both these actions. It is also possible to use for this purpose a partition such as P, Q oscillating about P.

In Figure 9 will also be seen an enlargement of the tunnel on the side opposite to that of the intake for air. This enlargement causes and deviates the outermost films of air to assist in the deviation of the entire stream. In this manner there is also prevented any liability of small films of hot air which are not separated from the roof of the tunnel, of passing along its roof to the outside. It is also possible to adjust the inclination of the wall of this enlargement as indicated for example in Figure 9, by means of a wall T, U, pivoting on the point T.

I claim:—

1. A hot air drier comprising a tunnel through which the materials to be dried are passed and provided with air intake passages, means forming at will one or more air circuits, each of said circuits being provided

5 Figure 6 shows a section of a tunnel drier consisting of two rotary cylinders for the treatment of heavy materials. The movement of the materials is promoted by the inclination of the cylinders or by the provision of these cylinders with radial helices, as shown in this figure. The hot air is directed into the cylinders by means of a non-rotary junction collar, of which the lower portion is solid for the purpose of directing the material from one cylinder to the other, but open at the sides or at the top so as to enable the tunnel to communicate with a lateral or upper intake passage. The charging and discharging of the material to be dried may be effected by means of hoppers with sieves so as to prevent the passage of air, as is shown for the charging, or by open hoppers as shown at the discharge point for the material where fresh air also enters.

15 The tunnel drier may be of circular shape as shown in Figure 7. The same parts are indicated by the same references as the corresponding members described in connection with the drier shown in Figure 1. The fans, radiators, passages for the admission and discharge of air are in the central portion of the drier. All the properties of this drier and its different methods of operation remain. Thus, for example, it is possible to combine the circuits of air into a single circuit by closing the openings e, e and omitting or folding back the partition F of the passage, the single partition R limiting the two ends of the tunnel. When operating with two circuits of air it is easy to arrange for the two doors J_1 and J_2 to be always open or omitted. It is even possible as shown in the figure to have the same pressure on the two sides of the partition R so that this partition may be omitted and the drier operated through a single opening without the door J_1 . A circular rolling track, either supported on the ground or suspended, enables the material to be dried to circulate without the rolling trucks or carriages moving whilst empty. The air enters through a short tunnel arranged in front of the opening where it cools the dry and hot material, then flows along its double course through the drier before being discharged by the central portion of the drier.

25 Figure 8 shows a modification of the circular drier in which there is only a single fan C. This is capable of producing the circulation of two streams of air as has been described in connection with Figure 5. It also permits of the operation as will be described with reference to Figure 8. The fan causes a single stream of air to circulate in the tunnel which is limited at its two ends by

with a heating battery and a fan or ventilating element, said heating battery and fan or ventilating element being adapted for controlling the temperature and intensity of the air, said air circuits being adapted under
5 certain conditions of being reversed or combined so as to form a single circuit.

2. A drier according to claim 1, the tunnel being of straight line shape and provided
10 with two fans adapted to operate either with a double circuit of air and the ends of the tunnel open or with a single circuit of air.

3. In combination with a drier according to claim 1 an adjustable deviating device
15 adapted to cause the outer films of air at the open ends of the tunnel or chamber to follow a predetermined path so as to prevent the air of the tunnel mixing with the outer air unless this is desired.

4. A drier according to claim 1, the tunnel
20 being constituted by two rotating cylinders.

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