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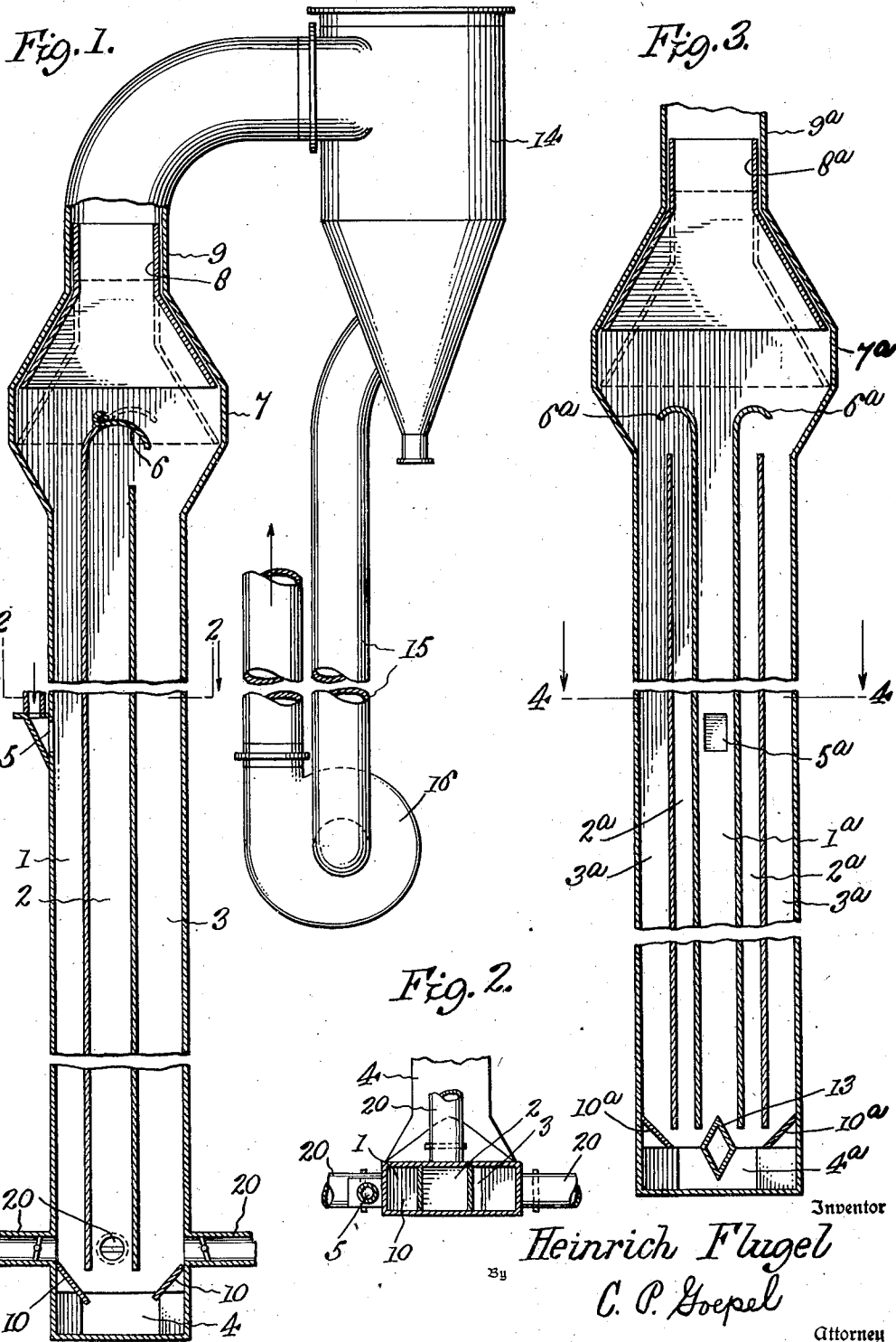
H. FLÜGEL

2,118,078

DRYING METHOD AND APPARATUS

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2 Sheets-Sheet 1



Heinrich Flügel
C. P. Goppel

Inventor

Attorney

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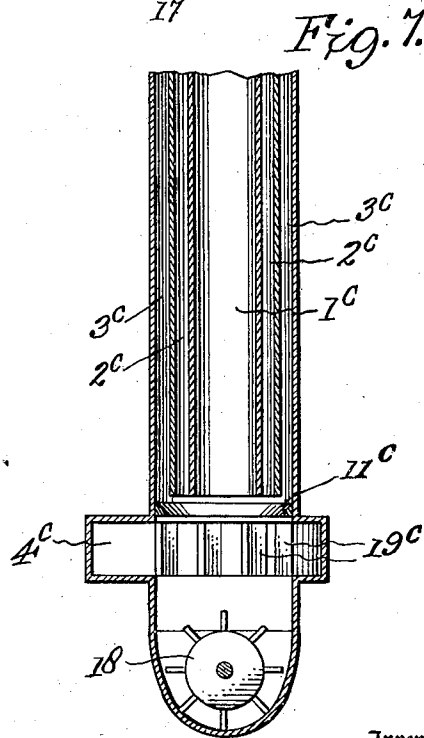
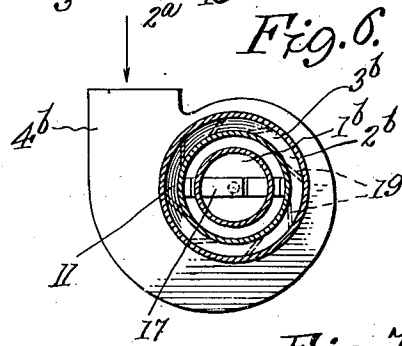
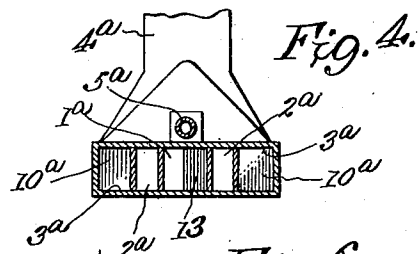
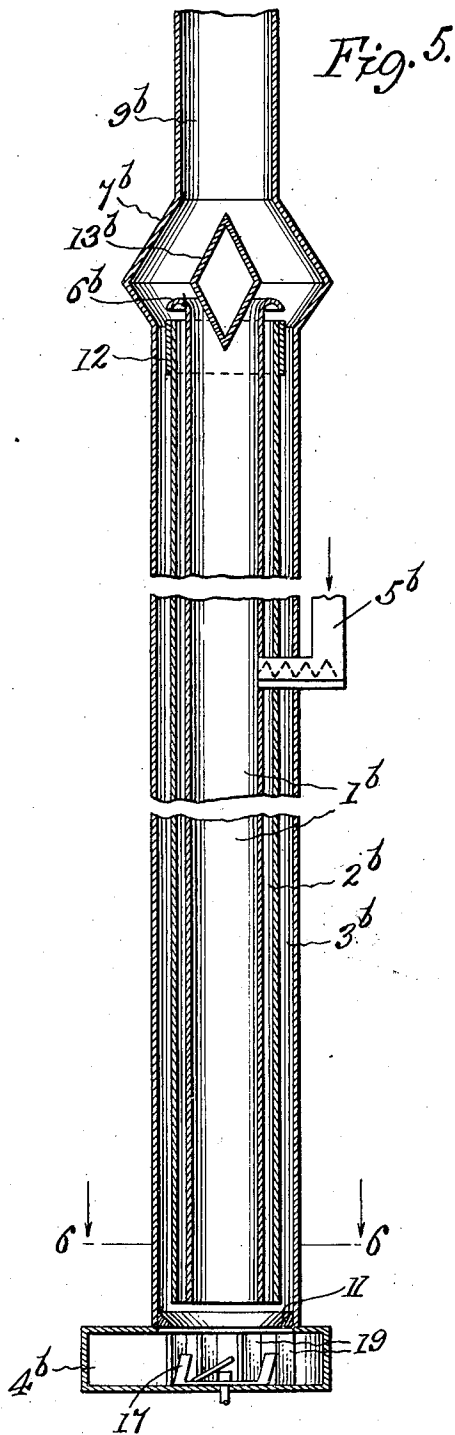
H. FLÜGEL

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DRYING METHOD AND APPARATUS

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2 Sheets-Sheet 2



Inventor

By *Heinrich Flügel*
C. P. Goepel

Attorney

UNITED STATES PATENT OFFICE

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DRYING METHOD AND APPARATUS

Heinrich Flügel, Duisburg, Germany

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4 Claims. (Cl. 34—34)

This invention relates to a method and apparatus for drying granular, pulverized and like material of the kind in which the material is dried by hot gas while passing through a conduit through which the hot gas is also flowing. Various forms of apparatus for drying such material in this way have already been proposed. In one of these the material is dried as a result of being conveyed by the hot gases through a conduit, and a regulatable sieve device is incorporated for the purpose of removing the coarse material from the current of gas and delivering it to a disintegrating machine which again delivers the material after disintegration to the hot current of gas at the beginning of the conduit. The pipe of the drier is usually very long and is usually led up and down several times in order to lengthen the path and therefore the duration of drying. It has also been proposed to obtain a correspondingly long drying path by arranging several pipes concentrically one within the other so that the material to be dried and the hot gases follow an up-and-down path from the inside to the outside through the central tube and the annular channels, the coarse material moreover being sieved off between times as in the case of the first-mentioned apparatus, disintegrated and again delivered to the current of hot gas at the beginning of the pipe of the drier. Finally a drier has been suggested which is characterized by a system of parallel or series-connected conduits with several graduated series-connected classifying devices, in which the surplus grain which is removed from the current of gas at any time is transferred to the hot current of gas at the beginning of the following pipe for further drying, either directly or after passing through comminuting apparatus. In all these driers the current of hot gas conveys the material to be dried through the conduit and the hot gas and the material move in the same direction during the whole of the drying process. Accordingly high gas-speeds are necessary in all the pipes in which the material has to be lifted and as, in these apparatus, long conduits and usually several changes of direction are necessary, the blower output and therefore the power consumption is very large.

These disadvantages are overcome by the present invention, according to which the drying is not carried out exclusively during conveying of the material through the conduit in the same direction as that of the gas, but a part of the material, which requires a longer time of drying, is dried in counter-current. The drying apparatus according to the invention consists of two or more channels separated one from the other and provided with a regulating device for adjusting the current of gas and devices for feeding material and effecting changes of direction

that are arranged displaced with respect to one another. The system of conduits or channels is traversed by a uni-directional upward current of hot gas, the speed of flow of which is different in the individual pipes and is such that, in the delivery tube, the light and easily dried portions are immediately carried away by the current of gas from the material fed in, while the coarse constituents of the material which fall down and pass out of the delivery tube, fall into the adjacent pipe at the point of change of direction of the channels and are further dried in them while flowing in the same direction as the gas and in counter-current alternately until they also have become so light that they can be carried off by the current of gas. The speed of the hot gas may be varied by regulating devices or by appropriate dimensioning of the cross-section of the channels. It is also possible to regulate the temperature of the gases in the individual channels by supplying hot, fresh, or led-back gas or cold air in regulated amount. The introduction of the material to be dried into the delivery channel is conveniently effected at various heights corresponding to the quality and moisture of the material. The classification of the material is advantageously effected automatically in the counter-current channels but in the case of the channels in which the material flows in the same direction as the gas as the result of the incorporation of a regulating device at the upper end. A device for whirling up or disintegrating the material may be provided on the bottom of the drier. The advantages which are obtained in this way are to be seen in the reduction in height and space required by the plant, in the avoiding of curves and changes of direction of gas, and above all in the substantially lower power consumption. As a result of the shorter construction and of the better accommodating of the pipes one within the other, the flow-surfaces and therefore the heat losses are smaller. Moreover longer times of drying, which preserve the material to be dried, can be employed as the material falls in opposition to the hot gas several times and reduces its speed. And in addition the heat required is less because the material remains in the current of gas until it is completely dry and no intermediate cooling is able to take place.

Several forms of drying apparatus constructed in accordance with the invention are illustrated by way of example in the accompanying drawings, wherein

Fig. 1 is a vertical sectional view, partly in elevation and partly broken away, of a drying apparatus constructed according to an embodiment of this invention.

Figure 2 is a sectional view taken on the line 2—2 of Fig. 1.

Figure 3 is a vertical sectional view, partly broken away, of a modified form of this invention.

Figure 4 is a sectional view taken on the line 4-4 of Fig. 3.

Figure 5 is a vertical sectional view, partly broken away, of another form of this invention.

Figure 6 is a sectional view taken on the line 6-6 of Fig. 5.

Figure 7 is a fragmentary vertical sectional view of a further modification of this invention.

In the drawings, the reference numerals 1, 2, and 3 indicate the channels or tubes for the hot gases which enter at 4. 5 indicates the point at which the material to be dried is fed in. 6, 7, and 8 form a regulatable classifying device, to which is connected the conduit 9 leading to the separator 14. 10, 11, 12, 13, 19, and 19c are regulating members. The blower 16 is connected with the separator 14 by pipe 15. 17 in Fig. 5 indicates a whirling-up device and 18 in Fig. 7 indicates a disintegrating apparatus.

The hot gas passes through the inlet pipe 4b, which may, for example, take the form of a spiral casing as in Figures 5 and 6, into the drier and traverses the individual channels or pipes 1b-3b upwards. The speed of the gas and therefore the amount in the individual channels may be regulated by known devices, e. g. by displacement of the flaps 10 in Fig. 1, raising and lowering of the ring 11 in Fig. 5, the sleeve 12 or the cone 13b in Fig. 5 or of the double cone 13 in Fig. 3. In addition, hot gas, cold air or fed-back air may be added at the points 20 in Fig. 1 in order to regulate the temperature. On Fig. 1 the feeding of wet material into the drying channel 1 is effected at 5, and the speed of the hot gas in that channel is so adjusted that material of a certain degree of subdivision, which needs only a short time for drying, is taken up, while the coarser material falls down in opposition to the hot gas and is thus pre-dried in the counter-current. The material that is pre-dried in this way is then taken up by the hot gas through the channel 2 as a high speed prevails in the latter, the result of which is that even coarser material—in some cases the coarsest grain present—is lifted. At the upper end of this pipe there is situated a classifying device of known type, by means of which, for example by altering the position of the flaps 6 and of the pipe 8, material of a certain size and weight is caused to separate out, while the finer and lighter is taken up. The separated material then falls through the channel 3 in opposition to the hot gas, as the speed in this pipe is so chosen that the coarse material cannot be taken up and is therefore again dried in the counter-current. On arrival at the lower end it is lifted again through channel 2, it being possible for the procedure described to be repeated until the dry material, on account of its loss of moisture and therefore lower weight, leaves the drier through the connected conduit 9 and is collected in the separator 14.

If necessary, in the form of drier according to Figures 5 and 6, a device for producing turbulence after the manner of a scraper tool may be incorporated in the spiral casing 4b, which device continuously throws the material which has fallen to the bottom into the current of hot gas and thus facilitates its taking-up.

Drying is effected even more satisfactorily if

disintegrating apparatus is provided beneath the drier, as is illustrated by way of example in Figure 7. Any disintegrator is suitable that is able to whirl up the material, e. g. centrifugal and hammer mills, or mills with scrapers, which throw up the ground material, and so on. In this way drying and preliminary disintegration or drying and grinding may be combined. The drier according to the invention is particularly suitable for use in connection with furnaces as the drier is especially suitable for the preparation of the coal, drying or combined drying and disintegration, and therefore has a wide range of application in crude dust or mill furnaces.

I claim:—

1. A method of drying granular, pulverized or like material comprising the steps of feeding it into a vertical channel up which hot gas is passed at such a speed that while lighter particles are carried up by the gas the heavier particles fall down in counter-current to it and causing heavier particles to pass into a second channel up which hot gas is passing at a speed great enough to carry all said heavier particles in parallel flow with it and causing all these particles to pass into a second counter-current channel where the lighter particles are carried up by the gas, the heavier particles falling down in the second counter-current and returning to the second channel, and so on till all the heavy particles are light enough to be carried up by the gas in the second counter-current channel.

2. Apparatus for drying granular, pulverized or like material comprising a plurality of vertically disposed channel members arranged in side by side relation, a common hood above said members, a common bottom chamber below said members, means for discharging a drying agent into said bottom chamber, said drying agent flowing upwardly through said channel members, means for discharging the material into one of said channel members, means below said one channel member for passing the material to another channel member, and means above said other channel member for returning the coarse material to said one channel member.

3. Apparatus for drying granular, pulverized or like material comprising an outer housing member, an inner tubular member disposed within said housing member and spaced from the walls thereof to provide a drying channel therebetween, means for discharging material into said channel, means for discharging a drying agent into the bottom of said housing, said drying agent flowing upwardly within said channel and said tubular member, means for transferring the material from said channel to the lower end of said tubular member, and means at the upper end of said tubular member for returning the coarse material to the upper end of said channel.

4. The method of drying granular or like particles including the discharge of the particles into a relatively low velocity vertically moving current whereby the heavier particles will gravitatingly fall counter to said current, passing the heavier particles to a second vertically moving current having a velocity such as to carry all of the particles therewith, and then delivering all of said particles in a downward direction to a second low velocity vertically moving current whereby the lighter particles will be carried up by said second low velocity current.

HEINRICH FLÜGEL.