Nov. 20, 1923. 1,474,859

W. G. SWART

SINTERING APPARATUS

Filed Oct. 8, 1919 2 Sheets-Sheet 1

Fig. 1

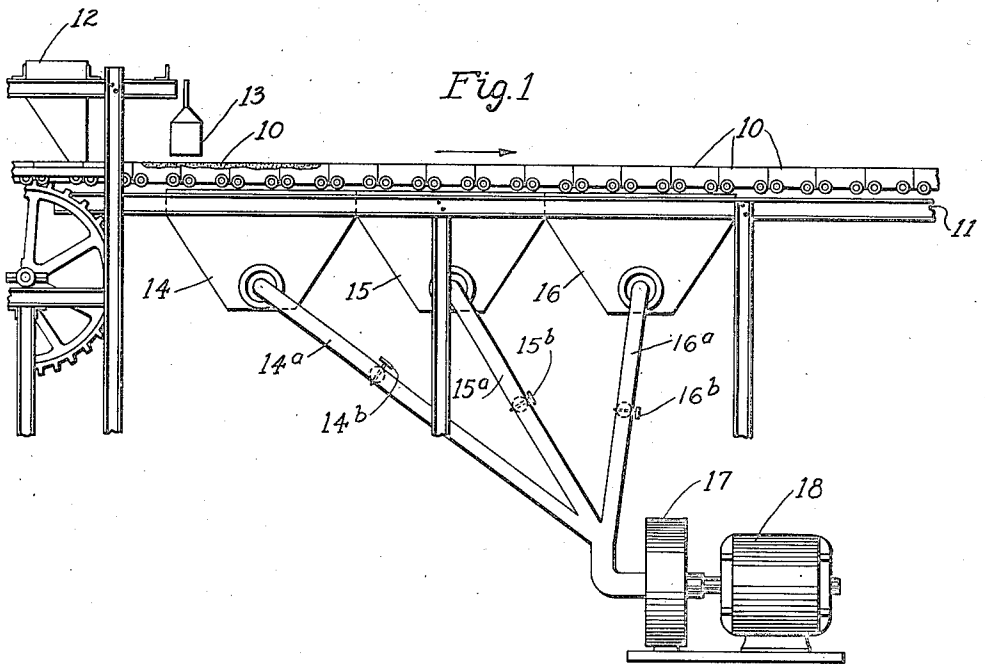


Fig. 2

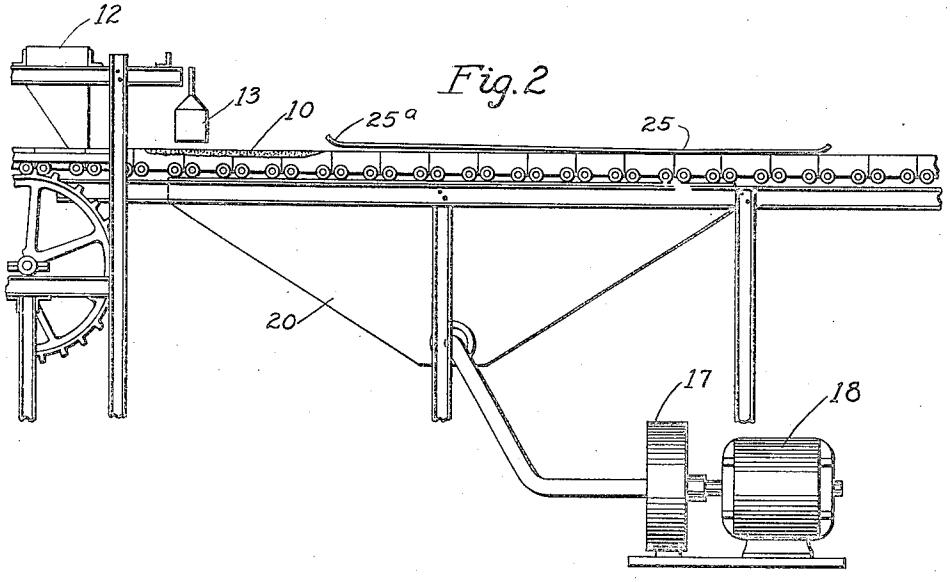


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Fig. 3

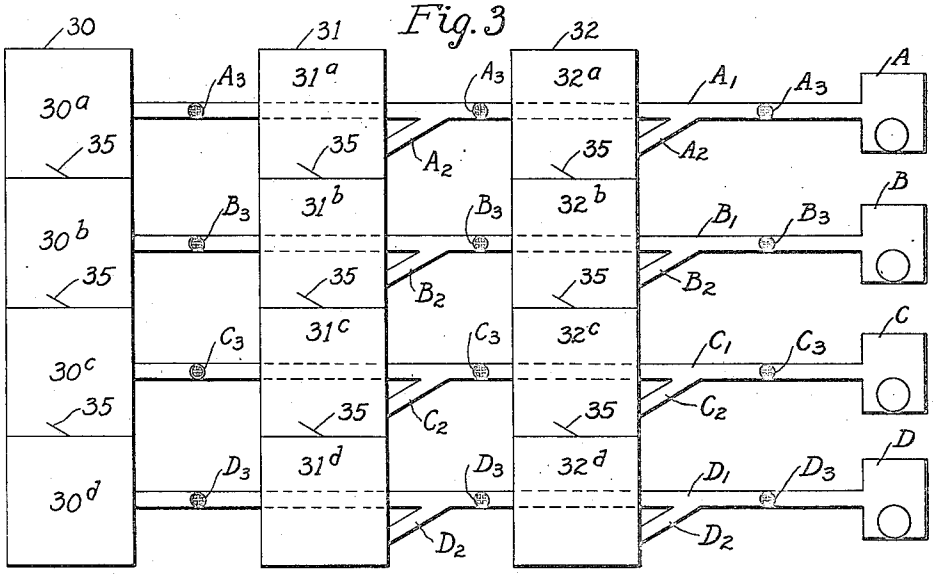
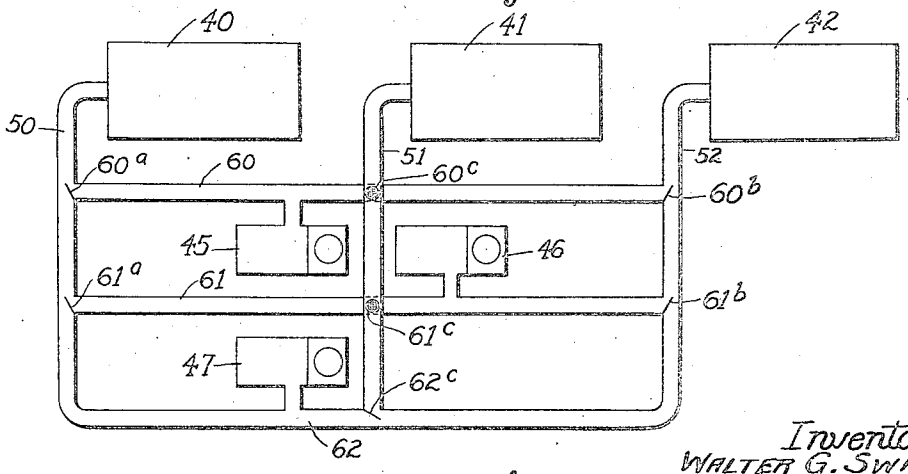



Fig. 4

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Patented Nov. 20, 1923. 1,474,859

# UNITED STATES PATENT OFFICE.

WALTER G. SWART, OF DULUTH, MINNESOTA.

## SINTERING APPARATUS.

Application filed October 8, 1919. Serial No. 329,314.

*To all whom it may concern:*

Be it known that I, WALTER G. SWART, a citizen of the United States, residing at Duluth, in the county of St. Louis and State of Minnesota, have invented certain new and useful Improvements in Sintering Apparatus, of which the following is a specification.

This invention relates to improvements in sintering apparatus and has for its object new and useful improvements for sintering apparatus which may be operated more economically and efficiently than present day apparatus.

In sintering hitherto in the continuous process it has been customary to pass the pans, or pallets, continuously over a suction compartment during substantially the entire sintering operation, this suction being maintained substantially constant. In the operation of the intermittent process, so-called because the pans, or pallets, are intermittently sintered and then discharged, it has also been customary to utilize a substantially uniform suction during the entire sintering operation. In both instances, this entails the operation of the suction pump, or fan, at or near its maximum load.

When a mass of ore and fuel is ignited at the top and begins to sinter, it is usually in its best condition for good sintering results. After any portion of such mass has become sintered, it has lost its fuel and its moisture and becomes a porous coke-like mass, which allows air to pass much more freely than before the sintering action took place. It will, therefore, be obvious that whenever any given mass is being sintered, the amount of air passing through it steadily increases because of the increasing porosity of the mass. If the amount of air used at the beginning of the re-action is just sufficient, then there is an enormous excess of air passing through towards the end of the re-action. Not only does this excess of air do no good in the process itself, but it adds very greatly to the work done by the fan.

It is well known to those skilled in the art that other conditions being uniform, the power required to operate a centrifugal suction fan, or the like, is approximately proportional to the amount of air which is passing through said fan; consequently, in sintering, as the porosity of the mass increases, the power utilized by the fan will increase owing to the excess of air, although, the passage of this air through the sintering mass is a detriment rather than an advantage as stated above.

It is my object in this invention to provide apparatus in which the maximum suction may be applied at the beginning of the sintering operation and such suction be decreased as the sintering operation approaches its completion.

The means in which I accomplish these objects and others will be more fully set forth and described in the following specification and shown in the accompanying drawings, in which:—

Figure 1 is a partially diagrammatic side elevation of apparatus embodying one form of my invention, as applied to present-day sintering apparatus;

Fig. 2 is a similar view showing a modification of my invention;

Fig. 3 is a plan view, showing diagrammatically my invention as applied to the process for intermittent sintering;

Fig. 4 is a modification showing my invention also applied to apparatus for intermittent sintering.

Like numerals refer to like elements throughout the drawings, in which, 10 designates sintering pallets mounted to move longitudinally upon suitable track work 11. Adjacent the left-hand end of the apparatus, which moves in the direction indicated by the arrow in Fig. 1, is a charging hopper 12 having its delivery end adjacent the pallets 10 and an igniting member 13 is located above the pallets to the right of the charging hopper 12. The pallets are charged from the hopper as they pass beneath, the charge, as is well-known, comprising a moist well-mixed mixture of powdered fuel and ore. This mixture is ignited at its upper surface by the igniter 13. A plurality of suction boxes 14, 15, and 16, which, in the form shown, are three in number, but which number may be varied to produce the desired results, are located beneath the path of travel of the pallets 10, the first suction box 14 being located beneath the igniter 13. Pipes, or ducts, $14^a$, $15^a$, $16^a$, lead from the suction boxes 14, 15, and 16, respectively, to an exhaust fan 17 driven by an electric motor 18, or the like. Suitable dampers, or valves $14^b$, $15^b$, and $16^b$, are located in the pipes $14^a$, $15^a$ and $16^a$,

respectively, these dampers permitting control of the flow of air through the respective pipes when the fan 17 is in operation.

As the mixture of ore and fuel is ignited, during its passage beneath the igniter 13, passage of the zone of combustion through the pallets is effected by the suction in the suction boxes.

The damper $14^b$ will normally be regulated to permit a relative maximum of suction to obtain in suction box 14, since during the passage of the pallets thereover, the sintering has progressed only a portion of the way through the pallet charges and a comparatively small amount of air is passing through such pallets since the porosity of the mass is mostly at the top. Suction in the suction box 15 will be reduced by the damper $15^b$, relative to that obtaining in box 14, since the zone of combustion has traveled farther and, consequently, there is greater permeability in the pallet charges and reduction of the suction results in the passage of less air through the sinter mass, or, to state the action otherwise, cutting down of the effective flow by means of the valve $15^b$ results in less air travelling through the mass and into the suction box 15, thereby permitting more thorough sintering and reducing the load upon the fan from what it would be were full flow of air possible through pipe $15^a$. Also, under normal conditions, the flow of air through the pipe $16^a$ will be reduced below the rate of flow through pipe $15^a$ by suitable regulation of the valve $16^b$, since the zone of combustion is approaching its limit; i. e., the bottom of the pallet, and the porosity of the mass is such that the flow of air therethrough is much less impeded.

It will be apparent that if no means for regulating the flow of air through the pipes $14^a$, $15^a$, and $16^a$, were provided, the capacity of the fan 17 would have to be much larger than that required in the operation of my apparatus, since the increasing porosity of the mass as it travels over the successive suction boxes, would permit increasing flow of air and the tendency of such flow to follow the path of least resistance, would result in too great flow and interference with the proper sintering of the mass, while the suction obtaining in suction box 14 at the initiation of the ignition would be decreased resulting in imperfect sintering. This same detrimental effect is present in the use of a single suction box where the porosity resulting from the sintering is frequently increased to such an extent that the sintering is imperfect and bodies of the unsintered mass are mixed with the sintered portions, the sintering being confined to the immediate neighborhood of the relatively large air ducts in the mass.

It will be obvious that in the embodiment shown in Fig. 1, the flow of air from each of the suction boxes may be regulated, as described above, so that relatively great suction and relatively small flow will be present in box 14 during the early stage of sintering, while suction in box 15 may be reduced while obtaining the same, or slightly greater, flow and in box 16, the suction may be still further reduced and the flow thereby maintained constant or varied as desirable in the treatment of different ores and mixtures. By this regulation, the maximum efficiency and economy of operation of the fan may be obtained, since it will not be necessary to employ a fan handling more air than is absolutely necessary for the proper sintering and the same may be run at a constant efficient speed.

In Fig. 2, I have shown another embodiment of my invention as applied to the continuous process, in which the same charging hopper 12 and igniter 13 are provided in conjunction with the pallets 10, but in lieu of the plurality of suction boxes, I provide a single suction box 20 extending beneath the pallets for a distance sufficient to produce proper and thorough sintering of the charges on the pallets. Suction is obtained, for example, by the fan 17 and motor 18, as in the construction shown in Fig. 1. To decrease the flow of air as the sintering progresses, I provide a damper plate or cover 25, located above the surface of the pallets, being spaced from the top of the pallet at its forward end $25^a$, the space decreasing in the line of progress of the pallets toward the point at which sintering has been practically completed; the decrease in such spacing resulting in the gradual reduction of flow of air during the progress of the pallet charges as will be obvious. This apparatus accomplishes the same purpose as that shown in Fig. 1, but utilizes a different means as will be obvious.

In Fig. 3, I have shown my invention as applied to the intermittent, or stationary type of sintering apparatus in which stationary rows of suction boxes 30, 31, and 32, are provided, the suction boxes of each row being designated as $30^a$, $30^b$, $30^c$, $30^d$, $31^a$, $31^b$, $31^c$, $31^d$, $32^a$, $32^b$, $32^c$, $32^d$, respectively, as illustrated in the drawings. It is, of course, to be understood that a removable sintering pan of conventional type is to be mounted upon each of these suction boxes, the sintering of the mass in such pans being effected by the suction of the respective boxes. Gates diagrammatically illustrated and designated by the numeral 35 connect each of the suction boxes with its adjacent neighbor so that one, or more, suction boxes of a row may be thrown into communication for a purpose to be described below.

A plurality of exhaust fans A, B, C, and D, are provided, as shown, and ducts $A_1$, $B_1$,

$C_1$, and $D_1$, extend transversely of the rows 30, 31, and 32, from each of said fans respectively, such pipes, or ducts, terminating in communication with the suction boxes of the first row 30, being in communication with the suction boxes of rows 31 and 32 by branch pipes $A_2$, $B_2$, $C_2$, and $D_2$, respectively. Flow from the suction boxes through said pipes is regulated by means of the valves $A_3$, $B_3$, $C_3$, and $D_3$, respectively.

By means of the apparatus just described, it is possible to throw the suction boxes of any row into communication with any of the fans, thereby preventing shutting down of the apparatus should one or more fans be thrown out of operation. Furthermore, close regulation of the sintering in each pan or each row of pans is possible, as will be obvious. Furthermore, the regulation and determination of the proper size and speed of the fan is possible by the use of a battery of fans and suction boxes, as shown and described, and it is desirable in some instances to utilize a plurality of relatively small capacity fans in lieu of one or more fans of relatively large capacity. The main advantage of this construction, however, consists in the fact that during the initial stage of the sintering, proper suction may be obtained in the different suction boxes by the use of less than the entire battery of fans, proper adjustment of the valves and gates, ensuring communication of the different suction boxes with the fans which are in operation. As the porosity of the mass increases, the volume of air to be handled may increase and additional fans may be thrown into communication with the suction boxes to take care of such increased flow, thereby permitting, during the entire sintering operation, the use of fans running at their maximum efficiency cutting in additional fans to compensate for the increased volume of air to be handled.

In Fig. 4, I have shown a plurality of suction boxes 40, 41, and 42, and a corresponding number of suction fans 45, 46, and 47, respectively, and three pipes, or ducts, 50, 51, and 52, lead from the respective suction boxes. A cross-pipe, or duct, 60, extends between ducts 50 and 52, its communication therewith being regulable by dampers $60^a$ and $60^b$, respectively. This duct 60 passes beneath duct 51 but is in communication therewith by means of the valved duct $60^c$, the duct 60 being in communication with the fan 45, the duct 61, similar to 60, also extends between ducts 50 and 52, the valves, or dampers, $61^a$ and $61^b$ controlling communication therewith and a valved duct $61^c$, providing communication with the duct 51. The duct 61 is in communication with fan 46. A third cross duct 62, in communication with fan 47, provides a continuation of ducts 50 and 52, and duct 51 also terminates in communication with said cross duct 62, such communication being regulable by the damper $62^c$.

By this construction, it will be apparent that the suction of the boxes 40, 41, and 42, may be regulated as desired and at the beginning of the sintering operation, for example, when the flow of air is relatively small, proper suction in each of the suction boxes may be obtained by the use of a single fan operating at its most efficient rate of speed. As in the case of the apparatus shown in Fig. 3, as the porosity of the sinter mass increases, a second fan may be thrown into communication with the suction boxes, while during the final stages of sintering the third fan may be cut in and each of the boxes operated on a separate fan, by proper regulation of the valves and dampers. This construction also permits the use of the apparatus even though one of the fans should break down, when such fan may be cut out of communication with the suction boxes, and the latter thrown into communication with the remaining fans.

It will be obvious that sintering may be regulated throughout the entire process by regulation of the flow of air through the mass overcoming the defects present in connection with the operation of present-day apparatus. It will also be obvious that my invention is susceptible of numerous modifications and improvements and I do not wish to be restricted to the form shown, except as defined in the appended claims.

What I claim is:

1. In an apparatus of the class described, a plurality of travelling charge carrying members, draft creating means to circulate combustion supporting air through the charges on said members, and means to gradually reduce such draft during the travel of said members.

2. In apparatus of the class described, travelling pallets, a suction box located adjacent thereto, air-exhausting means in communication with said suction box, and means to vary the flow of air through the charge carried by each pallet during the progress thereof over said suction box.

3. In apparatus of the class described, travelling pallets, a suction box located adjacent thereto, air-exhausting means in communication with said suction box, and means to vary the flow of air through a charge carried by said pallets during the progress thereof over said suction box, said means comprising a plate located adjacent said pallets.

4. In apparatus of the class described, travelling pallets, a suction box located adjacent thereto, air-exhausting means in communication with said suction box, and means to vary the flow of air through a charge car-

ried by said pallets during the progress thereof over said suction box, said means comprising a plate located adjacent said pallets, said plate being spaced a distance from said pallets decreasing in the direction of movement of the latter.

5. A method of sintering ore consisting in depositing a body of ore and fuel in a suitable receptacle, igniting such body at the surface thereof and thereafter subjecting the same to a draft to circulate combustion supporting gas through the body, and decreasing such draft as combustion progresses.

In testimony whereof, I have subscribed my name.

WALTER G. SWART.