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D. W. KENT ET AL

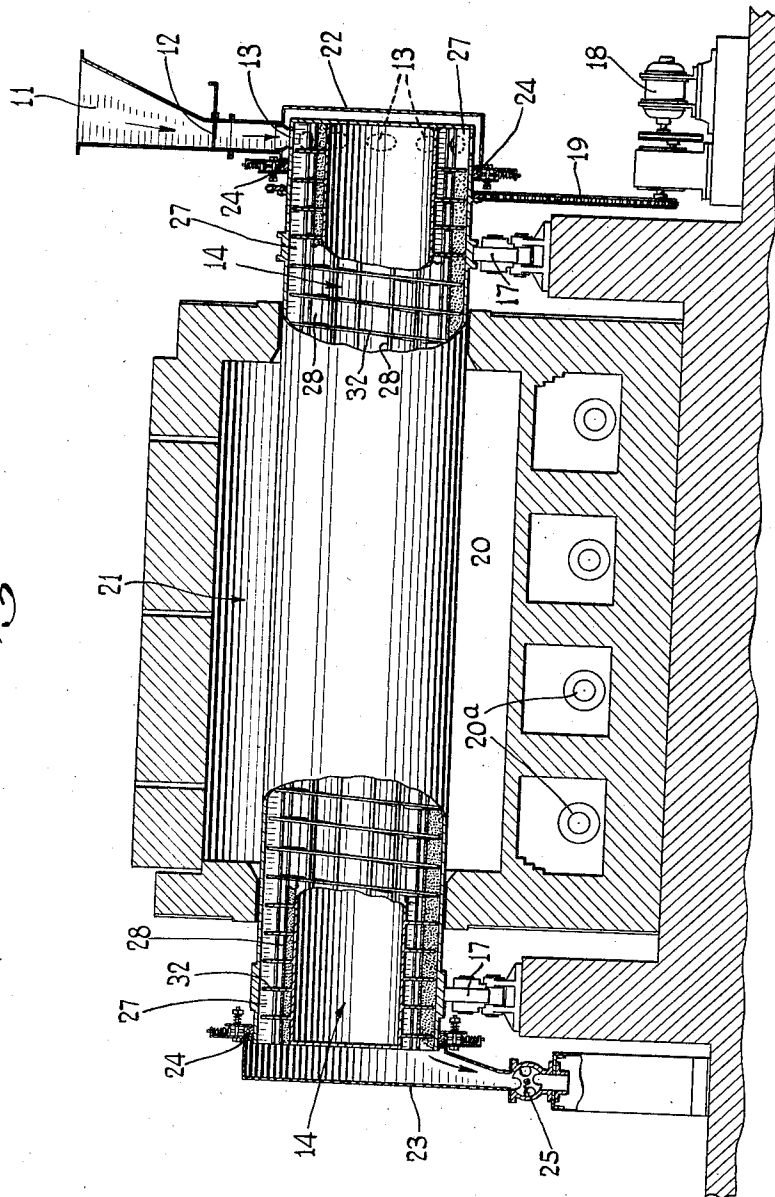
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MATERIAL HANDLING APPARATUS

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3 Sheets-Sheet 1

Fig. 1.



INVENTORS
DONALD WETHERALD KENT
FRED VAN DOORNINCK
BY
Hammond
ATTORNEYS

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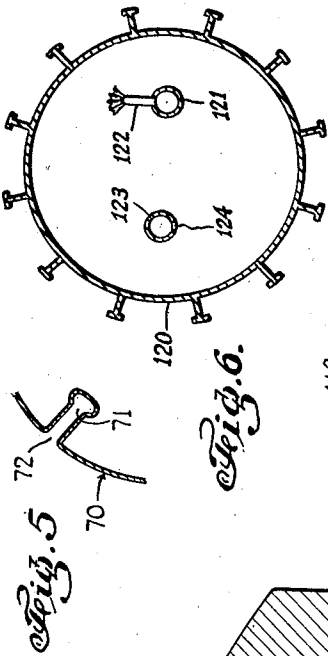
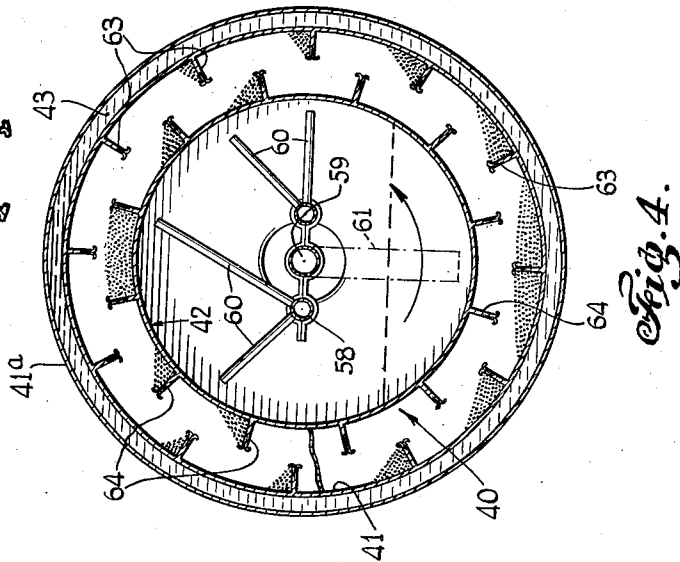
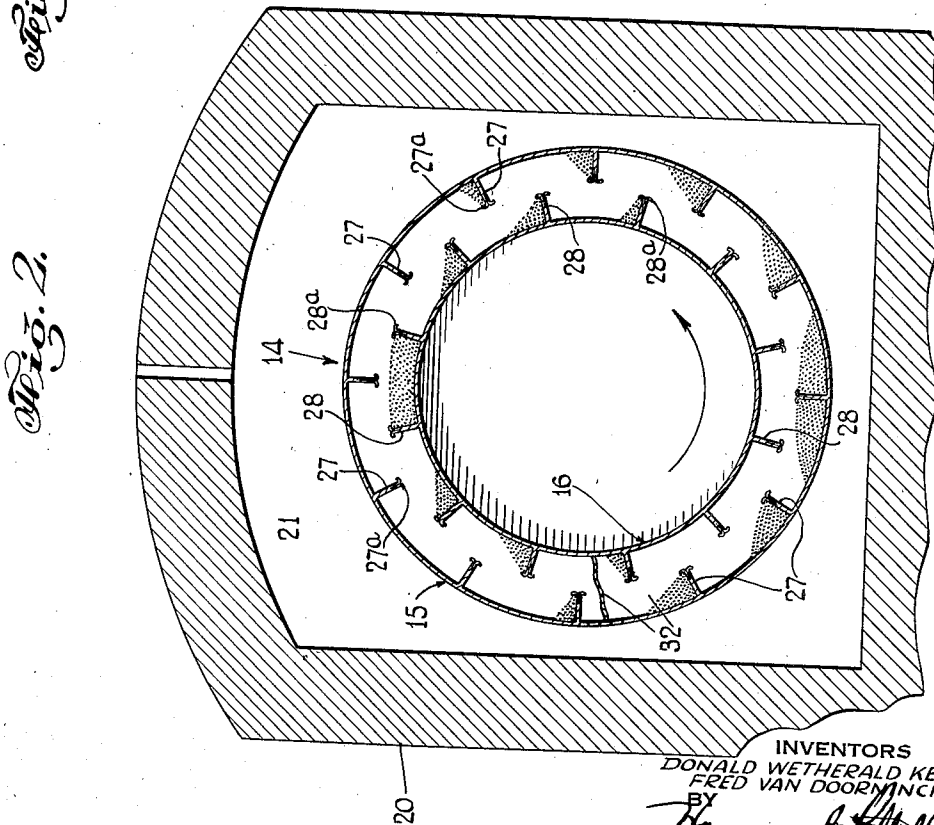
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INVENTORS
DONALD WETHERALD KENT
FRED VAN DOORNINCK
BY
Hammond & Co.
ATTORNEYS

July 16, 1940.

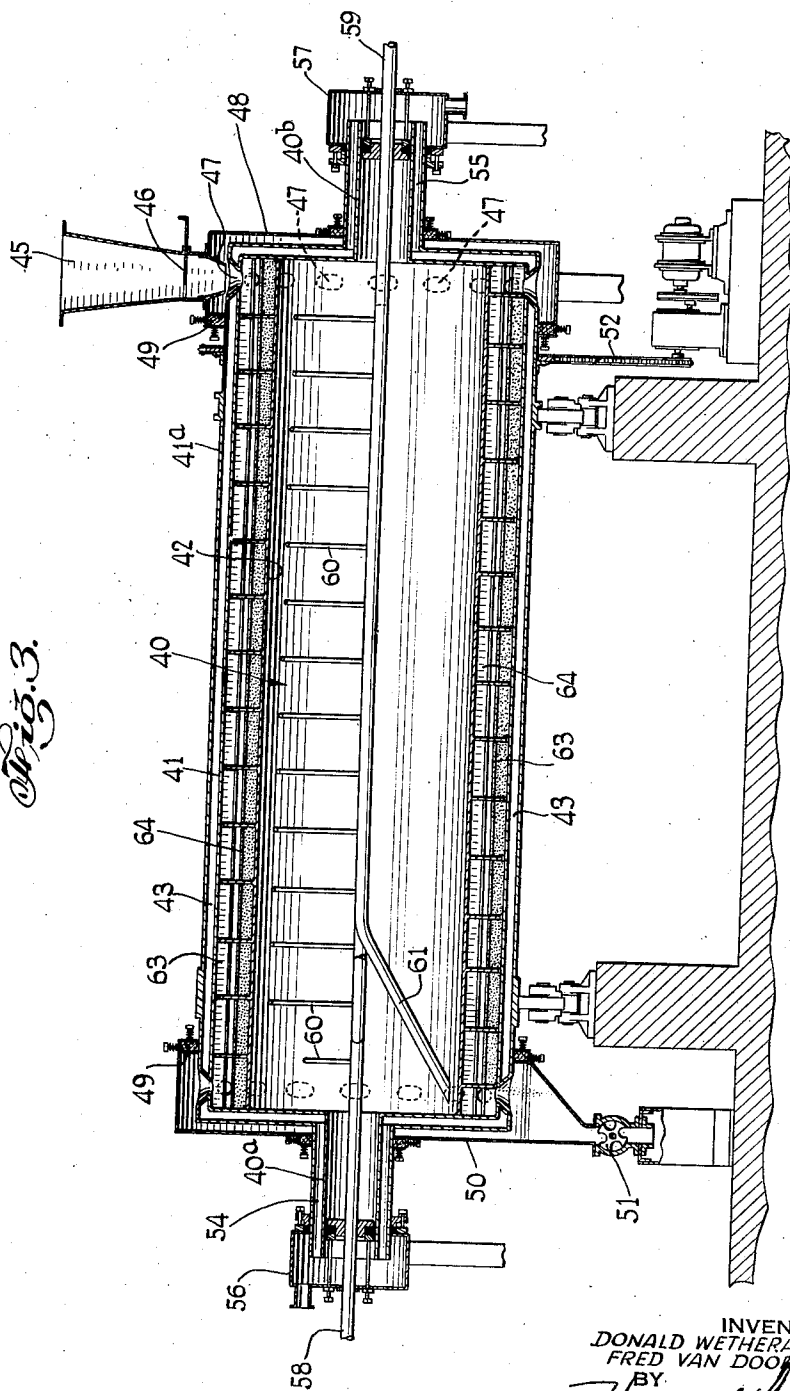
D. W. KENT ET AL

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MATERIAL HANDLING APPARATUS

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3 Sheets-Sheet 3



INVENTORS
DONALD WETHERALD KENT
FRED VAN DOORNINCK
BY
Ammon & Kett
ATTORNEYS

UNITED STATES PATENT OFFICE

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MATERIAL HANDLING APPARATUS

Donald Wetherald Kent, Barron Hill, and Fred
Van Doorninck, Easton, Pa., assignors to C. K.
Williams & Co., Easton, Pa., a corporation of
Pennsylvania

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This invention relates to improvements in heat transfer devices and more particularly to an improved rotary muffle type material handling apparatus which may be adapted either for heating or cooling the materials processed.

The rotary muffle has heretofore been used for the uniform heating of products as required in well known commercial processes because of the evenness of heat transfer due to the overrunning material which constantly exposed new surfaces. As the materials treated only form a shallow layer at the bottom of the drum, however, increase in through-put can only be had by larger drums or higher temperatures, or a greater speed which would normally cause a greater rate of overrunning and therefore greater frequency of formation of new layers for heat treatment. Larger apparatus is of course most expensive, for muffles are not variable in size without also reconstructing the furnace, and temperatures are limited by the materials undergoing treatment.

Increases of the speed of rotation of the drum or the thickness of layer of the treated material is also limited by practical conditions, especially at high temperatures, and transfer of heat cannot be improved by this means beyond a certain point. In addition, the low rate of heat transfer of many of the materials to be treated is such that layers in excess of two inches have often been found impractical and unsatisfactory. The industry has therefore found that it was necessary to use more muffles, or to use larger ones both in diameter and length for increased production.

It is one of the objects of this invention to increase the capacity of a rotary muffle without changing its size by providing an intermediate tube or muffle and providing inwardly projecting flights to facilitate transfer of the materials handled from one muffle surface to the other.

A further object of this invention is to provide an improved heat treating apparatus consisting of a drum with internally open pockets and having interior transfer means to transfer materials from one upper point on the drum to another upper point on the drum to materially increase the surfaces in active heat transfer operation, and by virtue of the greater volume of material, a greater control of the heat transfer can be obtained.

Another object of this invention is to provide a new method of transferring heat to or from materials to be handled by alternately transferring the materials between generally concentric

drum surfaces by overrunning of the particles on the respective surfaces.

Another and more specific object of this invention is to provide a calcining furnace for heating materials which has an inner core co-operatively arranged within the outer muffle, both having a series of transverse flights to intercept the material flow during rotation of the muffle, and having means to progressively move the material through the muffle.

Another specific object of this invention is to provide a cooling apparatus for continuous surface cooling of materials and having a plurality of rotating, substantially cylindrical surfaces independently cooled.

Another object of this invention is to provide a plurality of substantially drum shaped rotary muffles adapted to progressively move a material to be treated from end to end of the muffle, and also around the diameter in a generally helical path for increasing the effective area contacted by the overrunning material so that the through-put may be materially increased over that of a single unbaffled drum, the speeds, materials and temperatures being the same.

Further objects and advantages of the invention will appear from the following description thereof taken in connection with the attached drawings, which illustrate preferred forms of embodiment of our invention and in which:

Figure 1 is a vertical longitudinal section of a calcining furnace with part in inside elevation showing the improved muffle construction;

Figure 2 is a vertical section transverse to Figure 1 and showing the details of the flights;

Figure 3 is a vertical longitudinal section of a modified form of heat transfer muffle adapted for cooling materials;

Figure 4 is a vertical section, transverse to Figure 3, showing the internal construction, and

Figure 5 is a detail of a modification of hollow flight.

Figure 6 is a cross sectional detail of a modification of the heating arrangement.

The invention is preferably applied to a material handling apparatus of the rotary muffle type in which surface heat transfer takes place to or from materials to be handled, such materials being normally moved from end to end of the drum in any desired manner. It is equally applicable to the muffle structure regardless of whether intended for a uniform heating of the materials or for a cooling of them, or for any variation of the heat transfer as may be found desirable. A preferred form of embodiment of

the invention as applied to a calcining furnace is shown in Figures 1 and 2 and in this embodiment the material to be handled and treated may enter through a suitable hopper 11 mounted on the fixed head 22 which is provided with sealing glands 24. The materials then pass through a valve or gate 12, and suitable openings 13 into the rotary muffle generally indicated at 14, which preferably comprises an outer drum 15 and an inner drum 16.

The muffle 14 is desirably supported for rotation on suitable bearings 17 and is rotated as by a motor 18 through a chain 19 or other well known means. The supports are such that the muffle can be rotated with a portion exposed to a heat transfer medium, in this case the combustion gases, from the furnace 20 which forms a heating chamber 21, surrounding the muffle 14. The manner of heating may be varied to suit conditions but combustion gases are generally circulated for adequate heating, the source being by any well known means such as by fuel burners 20a. Rotation causes a progressive movement to be imparted to the materials, as hereinafter described, so that a continuous discharge of the heated materials takes place through the discharge head 23 which is likewise sealed by glands or other forms of sealing packing 24. As it is desirable that the atmosphere surrounding the materials to be handled be controlled, either for recovery or in order to maintain a desired atmosphere in the muffle, discharge is conveniently through a gas tight sealing apparatus such as a star wheel 25, and the discharge head 23 may have any suitable gas connections found desirable.

The muffle shown in transverse cross section in Figure 2 is provided with flights 27 projecting from the outer drum in accordance with our invention, such flights or vanes preventing an accumulation of material only on the bottom of the drum as is customary in the simple drum structure. A second series of flights 28 project outward from the inner drum, and the flights preferably have angle lips 27a and 28a respectively. These flights are so positioned that material fed into the muffle will be engaged by the flights which will tend to raise the material, still on contact with the drum, until such an elevation is reached that the material falls in overrunning and it will then contact the inner drum. This will appear from Figure 2 in which the material suspended on the flights at the various points in the revolution of the drums is generally shown.

The flights 27 on the outer drum in moving from the bottom to the quarter position carry the materials to be treated with them with certain portions overrunning and forming a new layer. Due to the flights, the material is carried high on the outer drum until some point is reached between the quarter position to the half revolution position, at which the overrunning materials tend to drop onto the flights on the inside drum, reaching a maximum at the top at which point the material has been completely transferred to the inner drum.

Movement of the drums from the half revolution to the three-quarter position starts a transfer to the outer drum. Some of the material will also drop to the bottom in its overrunning movement. During the final quarter revolution of the drums, the materials to be treated are entirely transferred to the outer drums. The material thus contacts with a series of baffles and

with both drums and is entirely transposed so that all parts are subjected to heat transfer. The maximum depth is substantially uniform throughout and careful control can be had.

Considering the areas of the inner drum to give equal heat transfer as do the areas of the outer drum, it will thus be seen that for the same outer drum diameter and length, there is according to our invention, a materially greater area of available surface for material contact as compared with the available area of a single drum, considering the same thickness of layer. The new flights also have a certain area, part of which is in contact with some materials at all times. This increase of effective area is of course variable by virtue of the relative lengths of the flights and their number, but under normal operating conditions, we find that the rate of flow through the improved muffle is of the order of nine times that previously possible.

Heating of the inside of the drum may be accomplished by any desired means such as conduction through the metal surfaces direct from the heat of the combustion chamber 21 or from internal pipes conducting suitable combustible gases. In Fig. 6 there is illustrated a conventional arrangement for heating the interior of the drum 120 comprising a pipe 121 carrying burners 122 with provision for carrying off waste gas, as by a pipe 123 having intake apertures 124. The drum 120 is similar to the drum 16 of Figs. 1 and 2, and the pipes 121 and 123 pass through the end wall. Adequate heating of both the inner and outer drums is readily accomplished and thermocouples placed at 31 and at the other places facilitate accurate control.

The materials to be treated which are usually pulverized or granular materials are moved from end to end of the drum in any desired manner as, for example, by pitch of the muffle, or by the spiral 32 as shown, or by inclining the flights 27 and 28. In the present form of embodiment the spiral 32 extends from end to end of the muffle chamber 14a and the flights 27 and 28 are mounted between the respective threads of the spiral. This is a positive feed construction and forms a pocket relation on both the outer and inner drums of the muffle.

The inner drum 16 need not be either a closed member or a true cylinder. One of its functions of transferring material falling from one point on the outer drum to another point thereon can be accomplished by a series of paddles or a rotating wing shape member. Furthermore, it may be a drum of tapered shape to facilitate feeding if so desired. It may also be separate from the outer drum and independently rotated and heated and, if desired, may have a double lining for a cooling medium. With independently operated drums, separate spirals may be used on each drum or other material advancing means may be used. The pocket relation of the outer drum has the maximum amount of exposed space for contact with the materials handled and will carry the materials to be treated over a substantial range. For maximum efficiency both drums are provided with the flights which extend approximately half way into the muffle chamber and they may be staggered along the periphery of the respective drums. The relationship may be varied however as found desirable.

Another form of embodiment of our invention is shown in the modified apparatus illustrated in Figures 3 and 4, which is more particularly adapted for cooling purposes. In this construc-

tion, the muffle 40 is also of the double drum type having an outer drum 41 and an inner drum 42. The outer drum may preferably be of double wall type having a cooling medium chamber 43 between the inner shell forming the outer drum 41 and the outer shell 41a. Also, in a manner similar to the first form of embodiment, the muffle chamber between the two drums is preferably closed at the end and the material to be handled is confined within the muffle chamber during the cooling.

This type of muffle includes any desired type of feeding hopper 45 from which the materials to be handled pass through a suitable valve or gate 46 and through openings 47 in the outer drum 41 of the muffle. The hopper and fixed head 48 are provided with suitable glands or sealing devices 49 to seal the fixed head during rotation of the muffle. The discharge head 50 is similarly sealed with glands or sealing devices 49 and discharge may be under any form of control found desirable, such as star wheel 51. Rotation of the muffle is conveniently by means of a drive such as shown at 52.

The respective heads 48 and 50 are adapted to receive the rotatable ends 40a and 40b, of the muffle which desirably project through the same and have conduits 54 and 55 respectively, for the cooling medium. Manifolds 56 and 57 cooperate with these ends of the muffle and act as distributors for the cooling medium. Other conduits 58 and 59 may also extend into and out of the core of the muffle to cool the interior of the muffle, conduit 58 having extending spray arms 60 for cooling, and conduit 59 having a suction end 61 to remove the cooling medium at the greatest distance from the inlet.

In operation of this form of apparatus, the material which is to be cooled passes into the muffle chamber 40a and is moved by rotation of the muffle toward the discharge end of the apparatus. This is accomplished by a spiral 62 although other means could be provided as heretofore mentioned. During the movement of the materials to be handled, the flights 63 and 64 projecting from the drum engage the material and as before mentioned, it is transferred from one drum to the other, both of which are independently heated or cooled as desired. In this form, the cooling chamber for the outer drum is represented at 43 as shown in Figure 4, and the inner cooling chamber is represented at 40. The internal cooling pipes may spray or expand either a gas such as a refrigerant or a cold liquid which can be removed as it collects at the bottom of the respective drums and in the liquid discharge heads 57.

A modified form of flight is shown in Figure 5 in which the drum 70 has a hollow projecting flight member 71 which is cooled or heated by gases entering the aperture 72 at the base. This will facilitate heat transfer under certain conditions.

The apparatus by which new surfaces of material become exposed to new surfaces of a rotating drum at a greater frequency without increase of speed for improved heat exchange is the particular advantage of our invention. The term heat exchange is to be understood to include either heating or cooling the materials handled. It is possible, however, that exposure of new surfaces of materials to gases within the muffle chamber would be advantageous with or without heat transfer.

While we have shown preferred forms of embodiment of our invention, we are also aware that many modifications can be made thereto, and we therefore desire a broad interpretation of our invention within the scope and spirit of the description herein and of the claims appended hereinafter.

We claim:

1. A calcining furnace of the class described including a muffle, said muffle having a plurality of concentric drums forming a muffle chamber therebetween and having means to raise material within the muffle chamber alternately and to spread said material over parts of both drums alternately during rotation, said raising means including a plurality of flights projecting into said muffle from both drums and engaging the material to be treated, each flight being secured to one drum and spaced from the other drum and means to rotate the muffle and means to heat said drums from without the muffle chamber.

2. A calcining furnace of the class described including a muffle having an inner drum and an outer drum forming a muffle chamber therebetween, means to rotate the muffle, means to apply heat to the inner surface of the inner drum and the outer surface of the outer drum, means to introduce material to be calcined into the muffle chamber and to remove material therefrom including means to prevent contact of the contents of the muffle chamber with exterior gas or air, said muffle chamber having means to raise material therein during rotation of the muffle and to spread said material over parts of both drums during rotation comprising flights alternately secured to the inner and outer drums and projecting into said muffle chamber.

3. A heat exchange apparatus of the class described for treating granular and pulverulent material comprising a muffle having concentric drums with a muffle chamber therebetween, spiral vane means for advancing material from one end of said muffle to the other, means for distributing the material over the surfaces of both drums comprising flights secured to the outer drum and projecting radially inward but spaced from the inner drum and flights secured to the inner drum and extending radially outward but spaced from the outer drum and means for heating the material while excluding the heating medium from contact with the material.

4. A calcining furnace as defined in claim 2, wherein the outer drum is formed with a plurality of feed openings and having means for feeding material by gravity through said openings into the muffle chamber.

5. In an apparatus of the character described having outer and inner drums forming a muffle chamber therebetween, a plurality of pickup vanes projecting from the outer surface of the inner drum and the inner surface of the outer drum adapted to raise a material to be treated, said vanes being of T-shape to provide pockets for material handled and being so spaced as to alternately transfer said material between said drums during a single revolution and means to revolve the drums.

6. A calcining furnace as described in claim 1, wherein the flights are of T-shape to provide material holding pockets on both sides of each flight.

DONALD W. KENT.
FRED VAN DOORNINCK.