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SHAFT FURNACE FEEDING DEVICE AND METHOD

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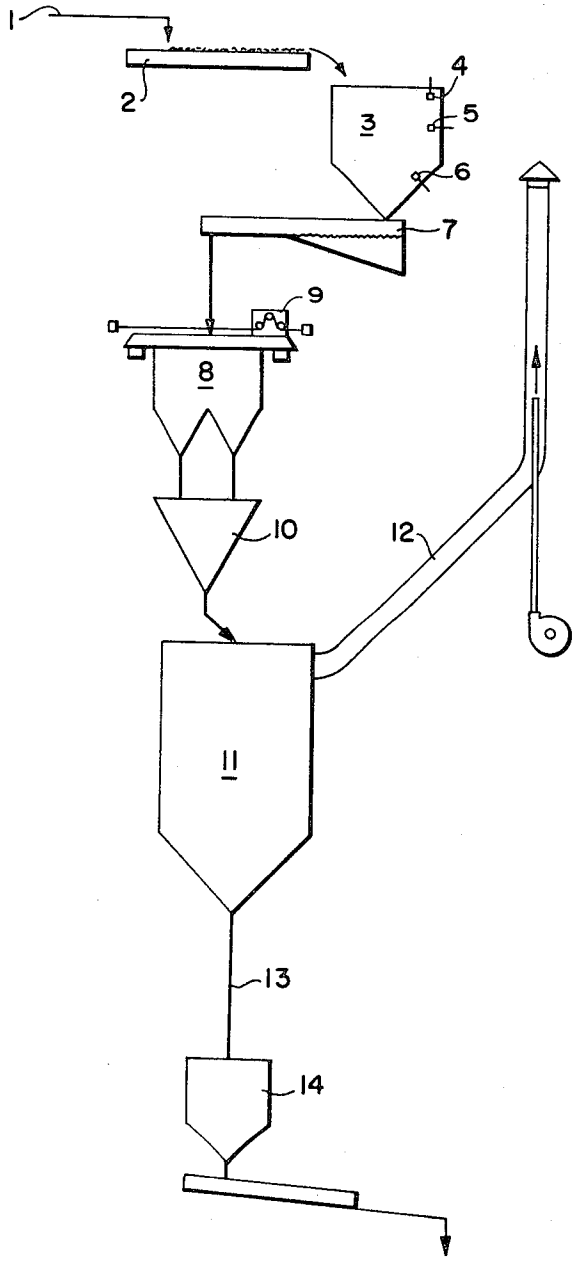


Fig. 1

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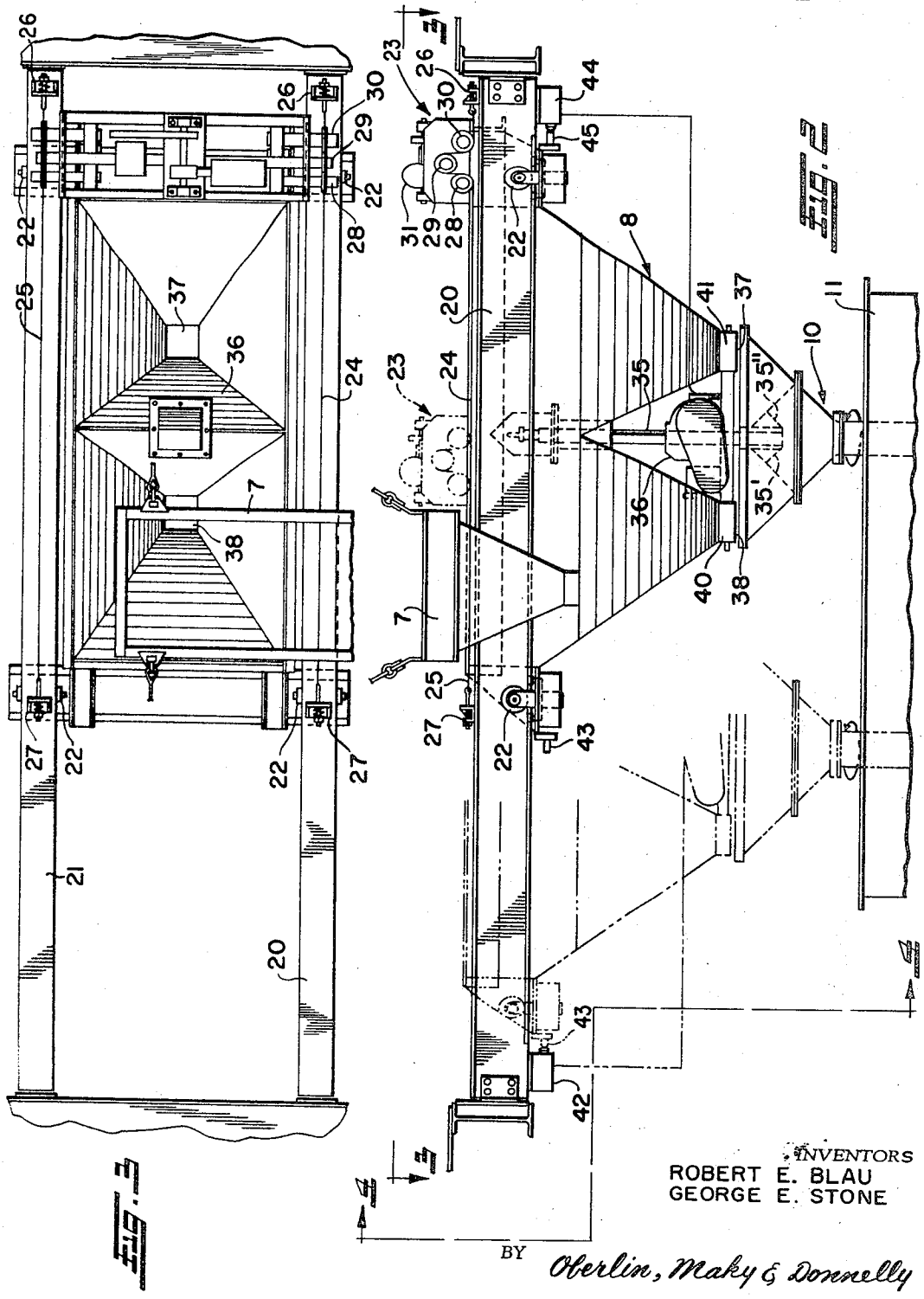


Fig. 2

Fig. 3

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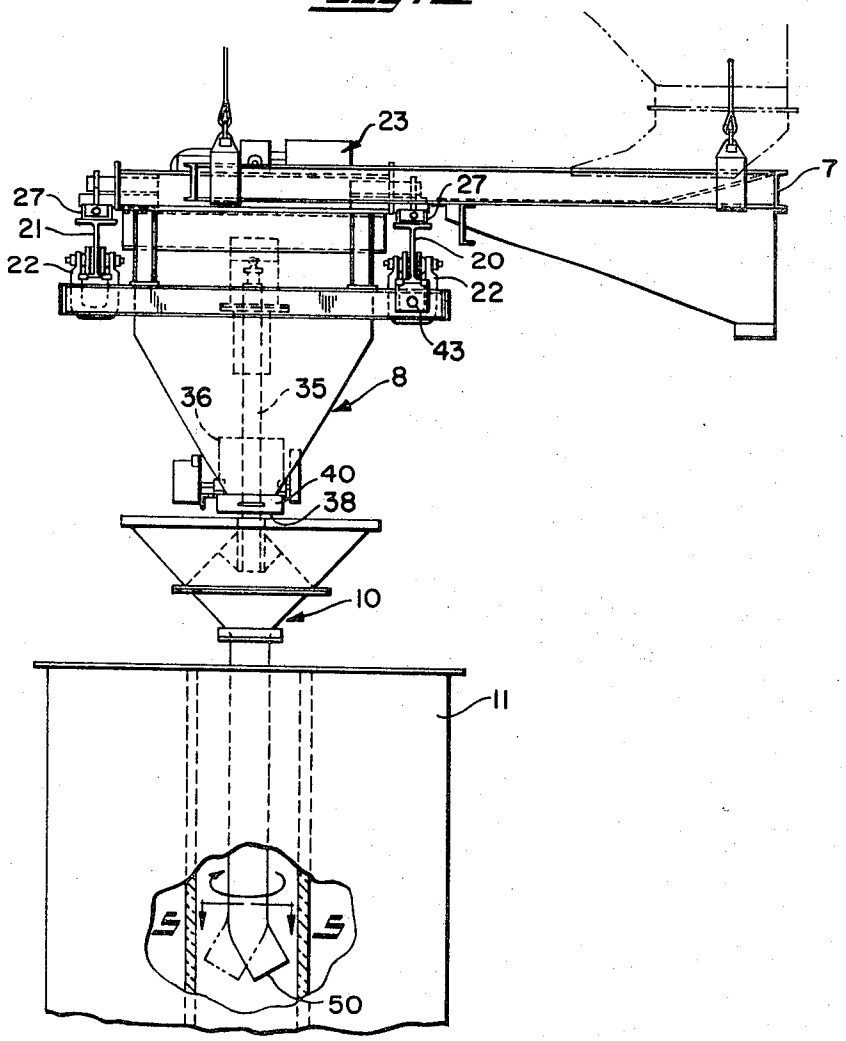
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Fig. 4



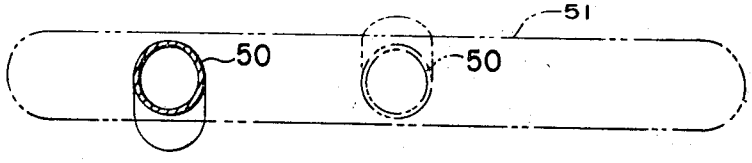


Fig. 5

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SHAFT FURNACE FEEDING DEVICE AND METHOD

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U.S. Cl. 214—35 12 Claims
Int. Cl. F23k 3/00; B65g 65/30, 29/00

ABSTRACT OF THE DISCLOSURE

A feeding device for shaft furnaces and the like including a feed hopper and means for shuttling the hopper along a fixed path. Discharge means are associated with the hopper and adapted to discharge feed material from the hopper into the furnace. The discharge means is rotatable, and there are means associated with the feeding device to correlate the shuttling movement of the hopper and the rotation of the discharge means.

This invention relates generally as indicated to a feeding device for shaft furnaces or the like and more particularly to such a device which includes a unique combination of a shuttling feed hopper and a rotatable discharging mechanism.

In the operation of any shaft furnace or kiln or any other similar apparatus wherein the material being treated continuously moves down a hollow shaft, one of the principal problems encountered is that of obtaining uniform exposure of the downward moving feed material to the upward flowing hot gases which are used to achieve the desired heating of the feed material. In order to accomplish such uniform exposure, it is necessary to provide uniform and continuous interstitial spaces throughout the burden in the shaft of the furnace, or in other words, the porosity of the feed material in the furnace must be maintained as constant as possible across the entire cross-section.

Generally, the prior attempts to obtain such constant or uniform porosity have consisted of presizing the feed material within close dimensional ranges, as for example in shaft kilns for producing high quality lime for structural purposes, the kilns are fed with large lumps of limestone having their maximum dimensions ranging between about 10" and 5". Similarly, in other shaft kilns producing lime, the limestone feed is generally sized between about 5" and 2½" or between about 3" and 1½", and iron oxide pellets, for example, are generally sized from about ⅜" to about ½" for the initial heat treatment in shaft furnaces and for their ultimate use in blast furnaces. Consequently, in all such furnace operations, the feed material is closely sized to the extent possible to provide a maximum of continuous interstitial space between the pieces of feed material to thus permit an unrestricted flow of gases through the burden within the furnace.

There is a practical limit, however, as to the accuracy of such pre-sizing operations and also as to the narrowness of the size range which is possible with any feed material. Accordingly, a second requirement in the feeding of shaft furnaces or the like is that the feed be introduced into the furnace in such a manner that segregation of the smaller pieces from the coarse pieces is reduced as much as possible. To achieve such uniform distribution of particle size in the feed material, several devices have been known heretofore including those utilizing a bell type feeding system such as exemplified in U.S. Patents 1,928,039 and 2,408,945. While devices of this type have met with some success, particularly in feeding cylindrical furnaces of circular cross-section, such systems have not

been entirely satisfactory in that they produce an annular heaping of the feed material within the furnace which tends to produce the objectionable segregation of the coarse material from the fines. Moreover, such devices are unsuitable for use with furnaces of other cross-sections as for example rectangular or elliptical as they do not provide a uniform distribution of the feed material over the entire cross-section of the furnace. It is accordingly a principal object of the present invention to provide a feeding device whereby such problems are overcome, and which is particularly suitable for feeding furnaces of rectangular or elliptical cross-section.

It is an additional object of the present invention to provide a feeding device which is capable of providing a uniform and continuous supply of material without segregation of the material into different sizes.

Yet another object of the present invention is to provide a feeding device for shaft furnaces or the like in which a constant and uniform flow of material is maintained from the supply location to such furnace.

An additional object of the present invention is to provide such a device whereby supply material may be fed in briquette form to a shaft furnace or kiln with a minimum of breakage of the briquettes.

Other objects, features and advantages of this invention will become apparent to those skilled in the art after a reading of the following more detailed description.

These and other objects are achieved by this invention in which a feeding device for shaft furnaces is provided which includes a feed hopper which is designed to shuttle along a fixed path above such a furnace and which has a rotatable vertical spout suspended therefrom and adapted to discharge feed material into the furnace. The shuttling movement of the feed hopper and the rotation of the spout are correlated in such fashion that when the shuttling movement is completed, the rotation mechanism of the spout is actuated to rotate the spout, and when this movement is completed, the shuttling mechanism is in turn actuated to resume shuttling of the feed hopper along the fixed path.

To the accomplishment of the foregoing and related ends, the invention, then, comprises the features hereinafter fully described and particularly pointed out in the claims, the following description and the annexed drawing setting forth in detail certain illustrative embodiments of the invention, these being indicative, however, of but a few of the various ways in which the principle of the invention may be employed.

In said annexed drawings:

FIG. 1 is a schematic illustration of an illustrative burning process utilizing a shaft furnace in which the feeding device of this invention may be employed;

FIG. 2 is a view illustrating the feeding device in more detail;

FIG. 3 is a top plan view of the feeding device taken along line 3—3 of FIG. 2;

FIG. 4 is a side view of the feeding device taken along the line 4—4 of FIG. 2; and

FIG. 5 is a schematic view illustrating generally the movement of the shuttling device and the path of movement of the rotary spout, as will be explained in more detail.

Referring to the drawings and more particularly to FIG. 1 thereof, a supply of feed material designated by numeral 1 is taken from a feed preparation plant (not shown) to a moving screen 2 wherein material of unacceptable size is separated out. The acceptable material is taken to a surge bin 3 which, preferably as illustrated has a plurality of level indicating devices 4, 5 and 6 positioned at various heights therein to assist in maintaining a full charge within the bin at all times. The level

indicating devices are also, of course, correlated with control means to maintain a constant supply of material entering and leaving the bin. The supply material is removed from the bottom of the surge bin to a second feeder screen 7 where further classification of the material takes place. After such classification, the supply material is fed into the upper surface of shuttling feed hopper 8, which shuttles back and forth along a fixed path, as illustrated in more detail in the other figures, through a sprocket type drive mechanism shown generally by the numeral 9.

The shuttling feed hopper is equipped with a rotatable vertically suspended discharge means 10 which discharges the material into a shaft type kiln 11. The kiln is equipped with an exhaust duct 12 for exit of the upward flowing heating gases. After passing downwardly through the shaft kiln, the material is removed therefrom at 13 and fed into a clinker bin 14, after which it will be removed and subjected to further processing as is necessary.

Referring more particularly now to FIGS. 2–4 inclusive, the feeding device 8 and the rotatable discharge mechanism 10 are shown in more detail. The feed hopper is shown as being suspended from a pair of support beams 20 and 21 by hanger rollers 22 which are generally U-shaped (see FIG. 4) and have rollers on opposite sides of the supporting beams. Also associated with the hopper is a drive mechanism indicated generally by numeral 23 and which comprises a pair of drive chains 24 and 25 which are anchored to the beams 20 and 21 respectively by means 26 and 27 positioned on the support beams at the opposite ends of the path of movement of the hopper as it shuttles from side to side. The chains are trained over sprockets 28, 29 and 30. The drive mechanism is actuated by a motor 31 to cause the hopper to shuttle from one side of the track to the other.

Also associated with the feed hopper is the rotatable discharge mechanism, indicated generally by the numeral 10, which is in the form of a rotatable vertical spout suspended from the bottom of the feed hopper. The spout is thus in communication with the feed hopper and is adapted to discharge material from the hopper into the furnace 11. The spout has a vertical shaft 35 attached thereto through bars 35′ and 35″ which extends upwardly therefrom for assisting in suspending and stabilizing the spout. The rotation means for the spout is designated generally by numeral 36; since this is a conventional mechanical means and is not per se a part of the invention, it will not be described in detail herein.

To accommodate the drive mechanism for the rotatable spout, the feed hopper 8 is preferably designed so that it has a pair of discharge openings 37 and 38 at the bottom thereof which communicate with the spout to feed material thereto on opposite sides of the drive mechanism. Such construction has the advantage that it tends to assist in providing a uniform and constant flow of supply material to the spout and also to avoid clogging or bridging of material within the hopper. The discharge openings also preferably have means 40 and 41 positioned therein to control the flow of material to the spout, which are preferably in the form of shutoff gates or gate valves.

A preferred mode of operation of the feeding device will now be described. After the feed material has been supplied to the feed hopper, as for example in the manner shown in FIG. 1, the feed hopper is actuated so that it traverses the fixed path along the support beams 20 and 21 and material is discharged into the furnace from the discharge end of the spout. When the hopper reaches the end of its traverse in one direction, as shown by the phantom line in FIG. 2, a limit switch 42 positioned on the beam 20 is contacted by means 43 associated with hanger roller 22 to stop the movement of the feed hopper in that direction. The switch 42 is correlated with the drive mechanism for the rotatable spout by standard means, preferably electrical, (as shown diagrammatically in FIG. 2), although it may alternatively be mechanical, pneumatic or hydraulic if desired, whereby when the shuttling action is stopped, the drive mechanism for the spout is actuated to cause the spout to rotate through a predetermined rotation movement. When the rotation movement has been completed, it will in turn actuate the shuttling mechanism to cause the feed hopper to reverse its direction of travel and to return to its original position adjacent the opposite end of beams 20 and 21 (the FIG. 2 position). A limit switch 44 and stop means 45 are also, of course, positioned at this end of the beam so that the shuttling movement will be stopped and the rotation movement of the spout actuated when the hopper reaches this position in its fixed path of travel.

As shown more clearly in FIG. 4, the discharge end 50 of the spout is offset at an angle with respect to the longitudinal axis of the spout so that the feed material will not be discharged centrally of the spout, which will assist in preventing a build up or heaping of the material within the furnace as would occur if a central discharge were provided. Thus, as shown in FIG. 5, the discharge end 50 revolves through an approximate elliptical path as the spout rotates. The phantom line 51 represents the path of movement of the center line of the discharge end of the spout as the feed hopper shuttles along its fixed path. The phantom illustration on the righthand side of the figure, of course, illustrates the path of rotation movement of the angular discharge when the feed hopper and spout have moved to the opposite end of the path.

The spout is preferably designed such that one complete rotation movement will rotate the spout through 180° thus to provide a more uniform distribution of the feed material across the top of the kiln. The spout may, of course, be designed to undergo any selected degree of rotation, but it has been found that 180° is a preferred movement as better distribution of the feed material is obtained. Similarly, because of this same objective, the rotation movement of the spout is preferably designed to occur when the feed hopper has reached the permissible limit of its travel in one direction, but it is to be understood that the rotation could be caused to occur at any position along the path of travel and that such variation is within the scope of this invention.

As mentioned previously, the present invention is suitable for general utility in supplying material to any hollow shaft, as for example, shaft furnaces or kilns, but it may also be used in similar environments as in supplying materials to silos, drying shafts, gas generators or the like. The invention is particularly suitable, however, for use with shaft furnaces such as blast furnaces, lime kilns and the like.

Other modes of applying the principle of the invention may be employed, change being made as regards the details described, provided the features stated in any of the following claims, or the equivalent of such, be employed.

We therefore particularly point and distinctly claim as our invention:

1. A feeding device for shaft furnaces or the like comprising a feed hopper, means for shuttling said hopper along a fixed path, a vertical spout suspended from said hopper into a furnace or the like, means to rotate said spout, and means correlating the shuttling movement of said hopper with the rotation of said spout whereby completion of shuttling movement actuates said rotation meass to rotate said spout and completion of rotation of said spout actuates said shuttling means to again shuttle said hopper.

2. The feeding device of claim 1 in which said spout rotates 180° in one rotation movement.

3. The feeding device of claim 1 in which said spout has an angular opening at its discharge end.

4. The feeding device of claim 1 in which said hopper has a plurality of discharge openings at its lower end communicating with said spout to feed material thereto.

5. The feeding device of claim 4 in which the means

for rotating said spout are positioned vertically above said spout and said discharge openings are positioned on opposite sides of said rotation means to feed material to said spout.

6. The feeding device of claim 1 including means in said feeder hopper to control the flow of material to said spout.

7. A feeding device for shaft furnaces or the like comprising a feed hopper, means for shuttling said hopper along a fixed path, a vertical spout suspended from said hopper adapted to discharge feed material from said hopper into a furnace or the like, means associated with said spout for rotation of said spout, and means correlating the shuttling movement of said hopper with the rotation of said spout whereby completion of the shuttling movement of said hopper to one end of said fixed path actuates said rotation means to rotate said spout through one complete rotation movement and completion of such rotation movement of said spout in turn actuates said shuttling means to shuttle said hopper to the opposite end of said fixed path.

8. The feeding means of claim 7 in which said spout rotates through 180° in one rotation movement.

9. A feeding device for shaft furnaces or the like comprising a feed hopper, means for shuttling said hopper along a fixed path, a rotatable discharge means connected to said hopper adapted to discharge feed material from said hopper into a furnace or the like, and means associated with said hopper and said discharge means to correlate the shuttling movement of said hopper with the rotation of said discharge means whereby completion of shuttling movement actuates the rotation of said discharge means and completion of rotation of said discharge means actuates said shuttling means to again shuttle said hopper.

10. In a process of feeding a uniform supply of material to a shaft furnace or the like, the steps comprising shuttling a feed hopper having a discharge means connected thereto along a fixed path, interrupting such shuttling movement of such hopper when such hopper is positioned adjacent one end of such fixed path, rotating such discharge means during such interruption, and subsequently resuming shuttling of such hopper upon completion of rotation of such discharge means.

11. The process of claim 10 in which the spout discharges material at an angle with respect to the longitudinal axis thereof.

12. The process of claim 10 in which such spout is rotated through 180° during one rotation movement.

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