July 2, 1968 S. B. YACURA 3,390,870

PUSHER FOR KILNS AND METHOD OF CHARGING KILNS

Filed June 17, 1966 3 Sheets-Sheet 1

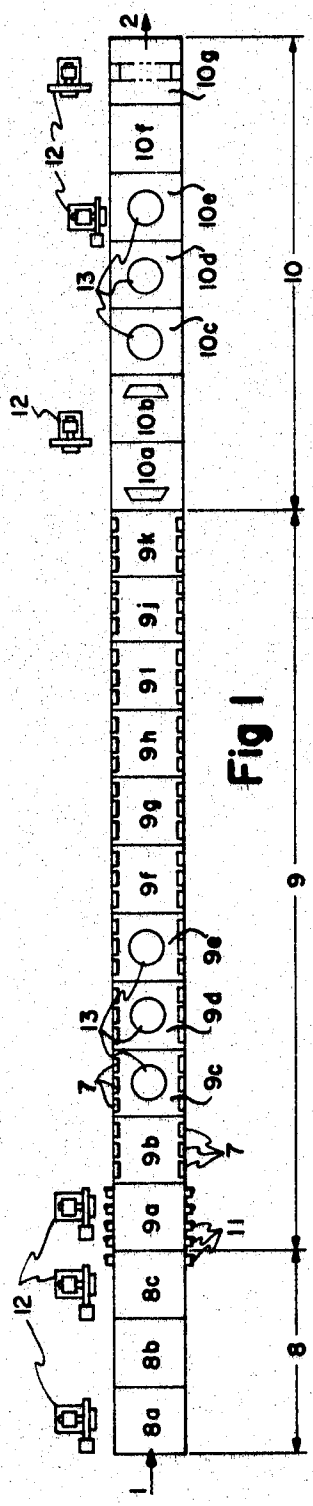


Fig 1

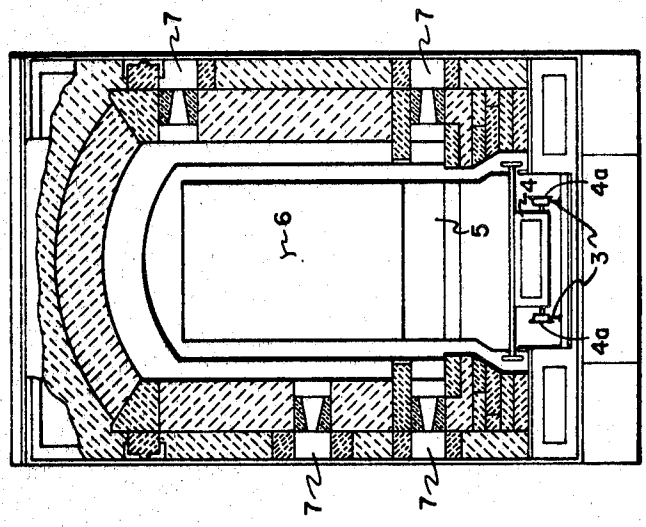


Fig 2

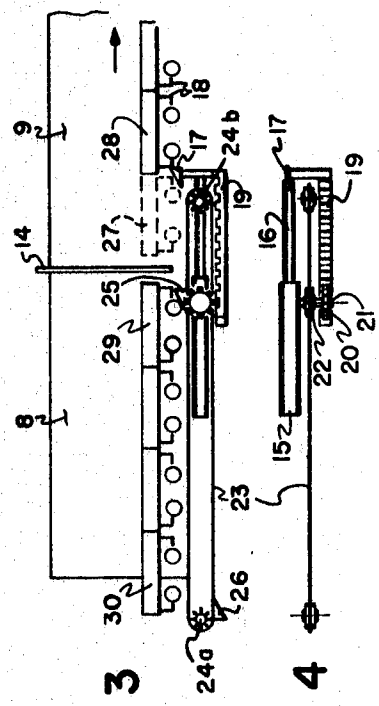


Fig 3

Fig 4

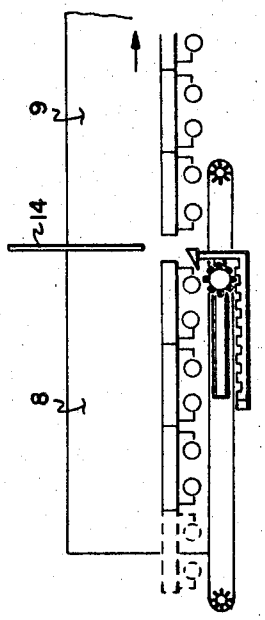


Fig 5

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PUSHER FOR KILNS AND METHOD OF CHARGING KILNS

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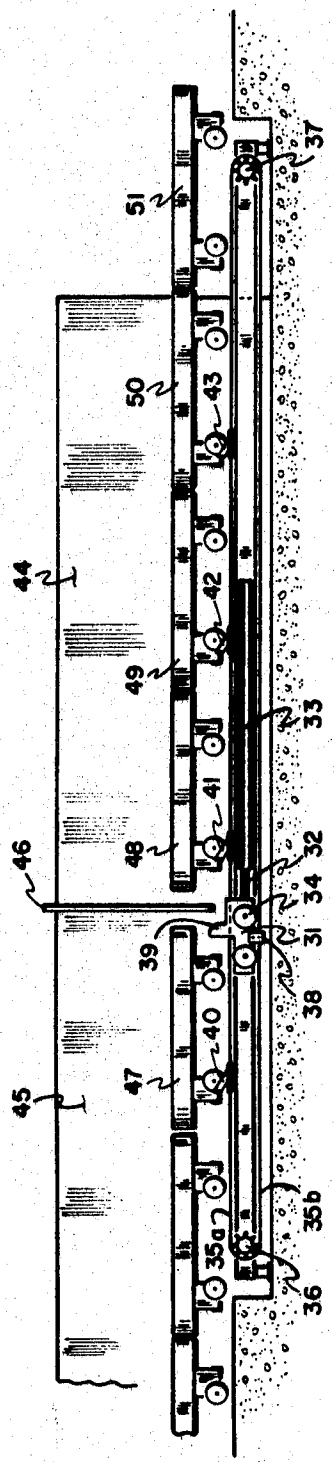


Fig 6

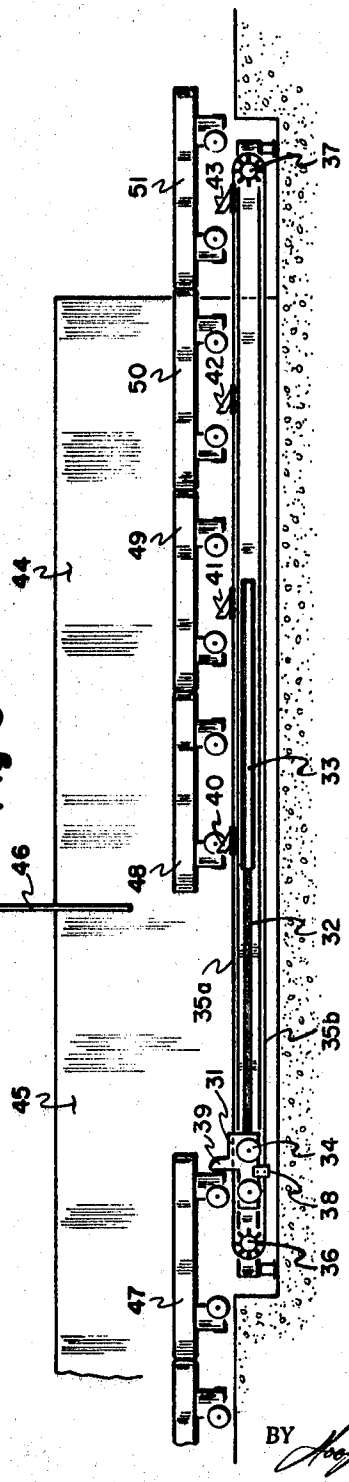


Fig 7

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PUSHER FOR KILNS AND METHOD OF CHARGING KILNS

Filed June 17, 1966 3 Sheets-Sheet 3

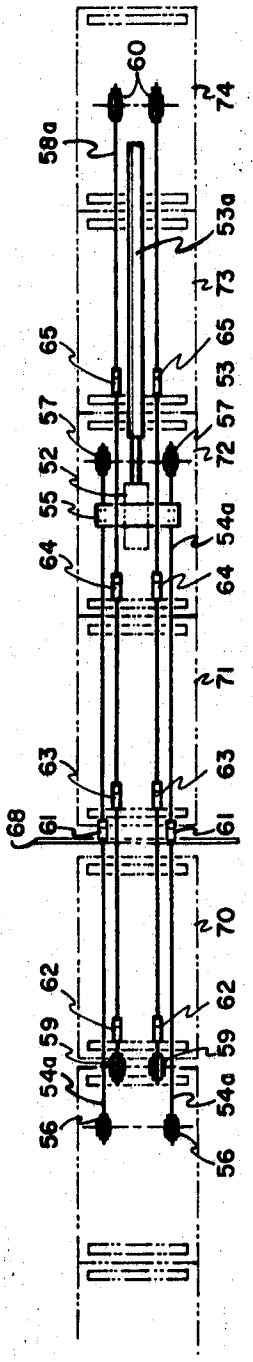


Fig 8

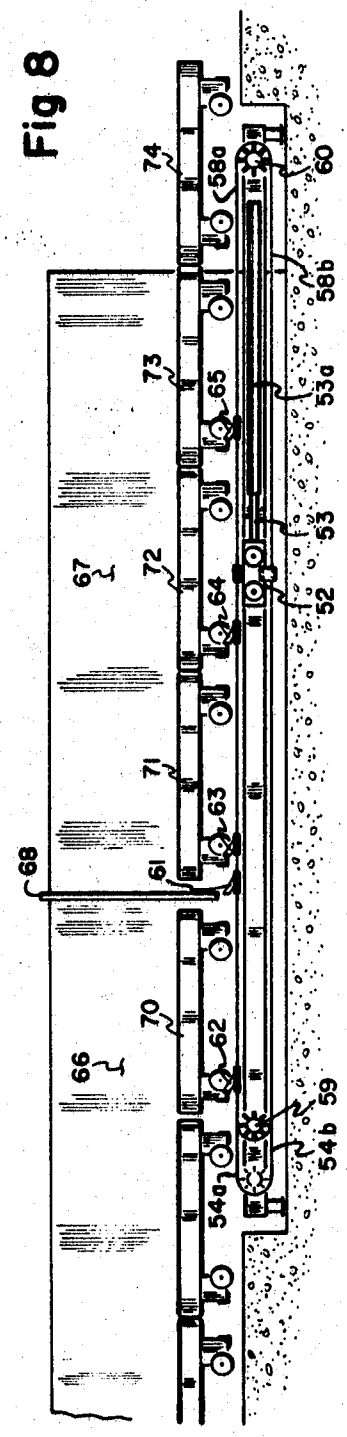


Fig 9

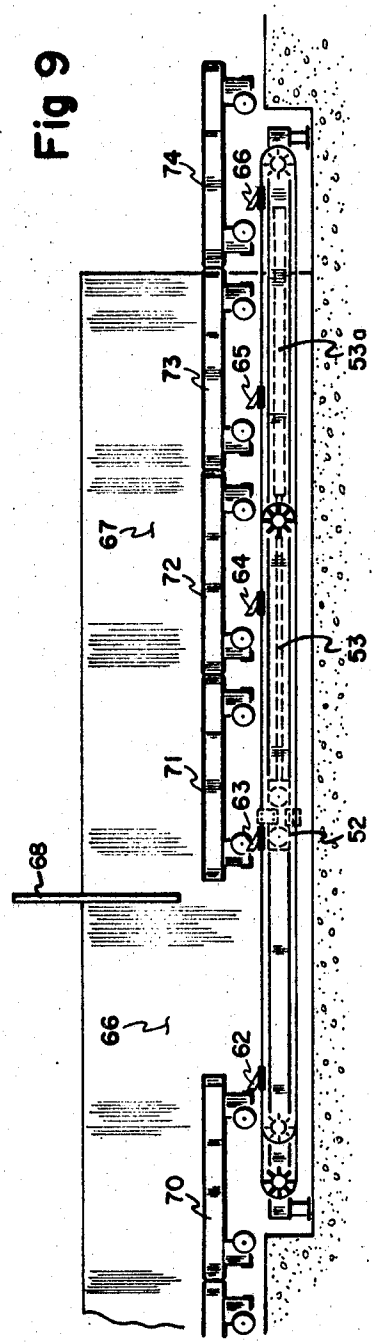


Fig 10

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United States Patent Office 3,390,870 Patented July 2, 1968

3,390,870

PUSHER FOR KILNS AND METHOD OF CHARGING KILNS

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Filed June 17, 1966, Ser. No. 558,325
12 Claims. (Cl. 263—28)

ABSTRACT OF THE DISCLOSURE

This application discloses a continuous tunnel kiln (for ceramic ware etc.) in which a train is slowly pushed through the kiln, and a car is alternately pushed rapidly into the kiln. Separate, connected pusher lugs driven by a reciprocating piston give alternate fast and slow pushes.

This invention relates to apparatus for pushing ware carrying cars into kilns. It is particularly adapted for use in connection with tunnel kilns in which ceramic ware is pushed through the kiln from the entry end to the delivery end of the kiln.

It is common practice to fire ceramic ware by advancing it through a continuous tunnel kiln having a variety of different temperatures at various points within the kiln for the purpose of drying and/or preheating the ware followed by firing and cooling of the ware. A common type of arrangements embodies a tunnel kiln with tracks along which a plurality of cars carrying the ware may be advanced in end-to-end relationship. The unfired green ware is loaded upon the cars which are delivered to the entry end of the kiln, the cars are advanced, and carloads of fired ware exit from the delivery end of the kiln. It is undesirable by reason of the temperatures within such kilns to have apparatus within the kilns to move the cars. Moreover, it is cheaper and simpler to avoid such power transmission equipment. It is desirable, therefore, to advance the cars through the kiln by pushing from the rearward end.

The provision of a drying and preheating section at the entrance end of the kiln in advance of a heating section is desirable, but may also be omitted. The section in advance of the heating (or firing) section of the kiln is referred to herein as the "preheating section" whether the section be used for drying or is simply that section outside a kiln in which cars are placed prior to charging them into the kiln. The preheating section may be employed solely for the purpose of evaporating excess moisture from the green ware, as by the circulation of large volumes of mildy heated gases about the ware. In such cases, the gases are circulated under pressure to obtain optimum heat transfer and to equalize conditions in all portions of the setting from the top to the bottom. In some instances a mild heating may also be provided in the preheating section as may be required by operating conditions.

In the subsequent heating (or firing) section where the ware is raised to firing conditions, a high temperature is required and is progressively approached by ware being pushed from the kiln entrance. The term "heating section" is used herein to denote that section of a kiln where ware advancing through the kiln is heated to firing temperature as distinguished from drying and preheating. Gases in the heating section are commonly withdrawn from ports near the entrance end of the kiln and near the floor so as to advance heated gases counterflow to movement of ware through the kiln and to avoid stratification within the kiln.

A door is commonly provided between the preheating section of the kiln and the heating section of the kiln to

prevent the preheating atmosphere from being drawn into the entrance end of the heating section by the negative pressure therein. Where a preheating section is not provided, a like door is provided at the kiln entrance to prevent atmospheric air from infiltrating into the kiln. The door must, of course, be opened when a car is to be advanced into the heating section. It has, however, been difficult to secure satisfactory door operation with the provision of elaborate interlock equipment and to charge a kiln quickly and to push it slowly without undesirable complications of equipment.

It is desirable that the door be open for only as brief a period as is necessary to move each kiln car from the preheating section to the heating section. In order to obtain uniform firing of all ware it is desirable that the cars in the kiln should be pushed on a substantially continuous basis. Accordingly, it is desired that each car be introduced from the preheating section to the heating section as quickly as possible, but the cars in the heating section be pushed on a virtually continuous basis.

I provide pusher apparatus including power means and lug means in driven relationship to the power means and placed to advance ware in a kiln when the power means are operated. I further provide additional lug means in driven relationship to the power means and positioned to advance ware within the kiln when the power means are operated. I arrange said lug means and said additional lug means to be alternately operable to advance ware within the kiln when the power means are operated. I preferably provide first lug means positioned to advance ware within a heating section of the kiln, second lug means to advance ware from a heating section to the heating section of the kiln and third lug means to advance ware in the preheating section. I prefer to dispose all of said lug means in driven relationship to the power means and arrange said lug means so that the first lug means are operated alternately and oppositely to the second and third lug means when the power means are operated.

I preferably provide piston means having first lug means directly operable with said piston means and endless chain means connected to said second and third lug means and driven by the power means to move the second and third lug means in a direction opposite to the first lug means. I prefer to drive the first lug means forwardly upon a slow stroke of the piston and to retract the first lug means and piston upon a rapid stroke, thereby advancing the second lug means and third lug means rapidly. In the preferred embodiment, the second lug means begin to advance ware from the preheating section to the heating section before the third lug means begins advance of ware in the preheating section. In this manner lost motion is provided as well as space between the cars to permit closing the door after charging. I prefer that the lug means comprise latches or dogs which engage the kilns cars upon a forward movement and which retract beneath the cars upon return movement.

Other details, objects and advantages of the invention will become more apparent as the following description of the present preferred embodiment thereof proceeds.

In the accompanying drawings I have illustrated various present preferred embodiments of the invention in which

FIGURE 1 is a diagrammatic plan view of a tunnel kiln embodying my invention;

FIGURE 2 is a cross-sectional view taken through the heating zone of the kiln;

FIGURE 3 is a diagrammatical side elevation of the entry end of the kiln also showing the pusher apparatus and some kiln cars with unnecessary structural details omitted;

FIGURE 4 is a plan view of the pusher apparatus shown in FIGURE 3;

FIGURE 5 is a view of the structure shown in FIGURE 3 with the pusher apparatus shown at a different point in its operating cycle;

FIGURE 6 is a side view of another form of pusher apparatus with the power piston in retracted position;

FIGURE 7 is a side view of the apparatus shown in FIGURE 6 with the power piston in extended position;

FIGURE 8 is a plan view of still another form of pusher apparatus with the power piston in retracted position;

FIGURE 9 is a side view of the apparatus shown in FIGURE 8; and

FIGURE 10 is a side view of the apparatus shown in FIGURE 9 with the power piston in extended position.

Referring to FIGURES 1–5, a kiln has an entrance end designated at **1** and a delivery end designated at **2**. Ware is advanced through the kiln from entrance end **1** to delivery end **2** on a substantially continuous basis. The kiln has rails **3** in the bottom section upon which kiln cars **4** are adapted to advance through the kiln upon wheels **4***a*. The cars carry pedestals **5** upon which the ware may be placed on setters or in any other manner convenient and satisfactory to the kiln operator. The longitudinal area occupied by the ware is designated by reference number **6**. The heating section is provided with burners **7** which are disposed on each side of the kiln to heat and fire the ware. The burners are preferably in off-set, staggered relationship (FIGURE 2) to promote vigorous circulation of the internal atmosphere, thereby expediting heat transfer to the ware. The kiln may conveniently be considered as divided into a number of units. A preheating zone **8** comprises three units **8***a*, **8***b*, and **8***c* in which the green ware is dried prior to firing.

A heating zone **9** comprises an additional number of units **9***a*, **9***b*, **9***c*, etc. to **9***k*. A cooling zone **10** comprises units **10***a*, **10***b*, **10***c*, etc. to **10***g*. Inspection doors **11** are provided in zones **8***c* and **9***a* and burners **7** are provided in heating zones **9***b* to **9***k*. Fans, generally designated **12**, are provided at various points along the length of the kiln to introduce air into and exhaust air from the kiln structure at appropriate points. Crown fans **13** may also be provided in the kiln roof. Hot gases are generally exhausted at the entrance end of the heating section, and the flow of such gases is counterflow to movement of ware through the kiln. The invention does not reside in the kiln structure which is described in general terms only as an aid to understanding the invention.

In preheating zone **8** substantial volumes of air are circulated by fans to evaporate moisture from the green ware and, perhaps, to aid in supplying mild heat to the ware. Heating zone **9** is maintained as a separate zone with increasing amounts of heat being applied as the ware moves therethrough. Preheating zone **8** and heating zone **9** are separated by a vertically movable door **14** (FIGURES 3 and 5) which can be raised to permit kiln cars to be advanced from preheating zone **8** to heating zone **9**. After a car has been passed through, the door is lowered to prevent excessive gas flow from the preheating zone into the heating zone by reason of the differential in pressures.

It will be appreciated that there is to be no immediate and radical change of temperature from one point to another in the kiln. To the contrary, the ware is to be steadily and evenly brought up to firing temperature as it advances through the kiln.

A hydraulic fluid cylinder **15** is provided adjacent the entrance end of the kiln and has a piston rod **16**. Cylinder **15** is valved so that piston **16** has a slow extending stroke and a rapid retracting stroke. Lug **17** is provided upon the end of piston rod **16** and engages angle irons **18** fitted crosswise upon the under side of the kiln cars. Lug **17** is hinged so that when it is retracted it will go beneath angle irons **18** without engaging them. When it is advanced, however, it does engage the kiln cars. A rack **19** is connected to piston rod **16** and moves with it. Rack **19** engages a pinion **20** mounted upon a rotatable shaft **21**. A sprocket **22**, also mounted upon shaft **21**, engages the lower reach of an endless chain **23** which extends over idler sprockets **24***a* and **24***b*. A second lug **25** is positioned upon the upper reach of chain **22** adjacent cylinder **15**. A third lug **26** is positioned upon chain **22** adjacent idler sprocket **23**. Lugs **25** and **26** are similar to lug **17**. That is, they will engage the kiln cars upon forward movement but will drop beneath and will not engage the cars upon a rearward movement.

When the kiln is being operated, the fans **12** and **13** and burners **7** are placed into operation to give a desired heat balance and air circulation. Such operating procedures are well-known, and are variable with the firing requirements. Where the kiln is in operation and is fully loaded, door **14** will ordinarily be in lowered position. When it is desired to advance ware through the kiln, hydraulic pressure is applied to piston **15** causing lug **17** to move in a forwardly direction (to the right in FIGURES 3 and 5) engaging a kiln car in position **27** and moving it forwardly to position **28**. The stroke is a slow, deliberate one and the entire train of cars in the kiln is slowly advanced, pushing a loaded car from the delivery end for unloading. The stroke may, for example, take fifty-five minutes for completion. When the stroke is completed and the pusher apparatus is in the position, shown in FIGURE 3, car position **27** will be vacant. Door **14** is thereupon raised and piston **16** immediately makes a rapid return stroke, taking perhaps one minute in a total cycle of sixty minutes. The door may be operated from a limit switch (omitted from the drawings for convenience) or other type of switch associated with the reversing valve upon the power piston. A timer is commonly provided to sequence each cycle, allowing for irregularities in the pushing and charging speeds.

When piston **16** makes its return stroke, lug **25** engages the kiln car in position **29**, advancing it past open door **14** into kiln car position **27**. Door **14** is then closed by further switch action which may be of conventional form. By reason of the rapid advance of a kiln car from position **29** to position **27**, door **14** is open for only a minimum time and the disruption of temperatures and gas flow in the heating zone is held to a minimum.

During the initial portion of the return stroke of piston **16**, lug **26** travels around idler sprocket **24***a*. After the kiln car in position **29** has advanced an appreciable distance, lug **26** will engage the kiln car in position **30** and advance it and those ahead of it to door **14** in a solid train. A small space is left between a kiln car in position **29** and a kiln car at position **30** by reason of the idle travel of lug **26** around idler sprocket **24***a*. Door **14** is lowered into that empty space.

Advance of the train of cars to door **14** leaves kiln car position **30** empty and ready to receive a new car of green ware which can be pushed into position whenever convenient.

After firing has proceeded to the extent necessary, the cycle is repeated. In this manner ware is advanced through the preheating zone and thence through the heating and cooling zones.

Referring now to FIGURES 6 and 7, a dolly **31** is mounted upon the end of a piston rod **32** operable in a hydraulic piston **33**. Dolly **31** moves from side-to-side (as shown in FIGURES 6 and 7) upon wheels **34**. An endless chain having an upper reach **35***a* and a lower reach **35***b* passes over sprockets **36** and **37**. The bottom reach of the chain **35***b* is attached to a bracket **38** upon dolly **31**. A lug **39** is retractably positioned on top of dolly **31**. It will retract when dolly **31** is moved to the right. A series of lugs **40**, **41**, **42** and **43** are attached to the upper reach **35***a* of the endless chain and likewise retract when moved to the right. When the lugs move in the opposite direction they will engage kiln cars and advance them into the kiln. If desired, several chains may be provided in parallel arrangement and operation.

The dolly and chain arrangement is located beneath a kiln preheating section **44** and kiln heating section **45** of the type previously described. A vertically movable door **46** is positioned between the preheating and heating sections to prevent gas flow from the preheating section to the heating section.

In FIGURE 6 a kiln car **47** is shown at the end of a train being pushed through the heating section of the kiln. Additional kiln cars **48**, **49** and **50** are shown in the preheating section and a car **51** is located just outside the preheating section prior to entry into that section. FIGURE 7 shows the same cars at the completion of a pushing cycle.

When dolly **31** and the kiln cars are in the position shown in FIGURE 6, dolly **31** is then pushed by hydraulic pressure applied in piston **33**. When pressure is first applied there is virtually no resistance to movement and dolly **31** is caused to advance promptly until lug **39** engages kiln car **47**. The advance is then adjusted to a much slower speed for pushing. Such speed changes are provided by conventional equipment which need not be described here. The entire train is pushed slowly until the piston has reached the end of its stroke, as shown in FIGURE 7. A limit switch (omitted from the drawings for clarity) then opens door **36** and reverses pressure to piston **33** to move dolly **31** backwardly toward the preheating section. As the dolly moves to the right (FIGURE 7) the upper reach **35***a* of the endless chain will advance to the left. Lug **41** will immediately engage car **48** and advance it rapidly into heating section **45**. After lug **41** and car **48** have advanced a short distance (perhaps 10 or 12 inches) lugs **42**, **43** and **44** will engage cars **49**, **50** and **51**, respectively, and those cars will also be advanced maintaining a gap between cars **48** and **49**. When the piston has fully retracted so that it is again in the position shown in FIGURE 6, car **48** will be inside the heating section **45**. Door **46** is then automatically lowered by another limit switch. The apparatus then again slowly pushes the train in the kiln in the manner previously described.

Referring now to FIGURES 8, 9 and 10 a dolly **52** is mounted upon the end of a piston rod **53** operable in a hydraulic piston **53***a*. An endless chain having an upper reach **54***a* and a lower reach **54***b* passes over sprockets **56** and **57**. The upper reach **54***a* is attached to dolly **52**. It will be noted from FIGURE 8 that two side-by-side chains are provided. For convenience they are given the same reference numbers. A second endless chain (also in duplicate) having an upper reach **58***a* and a lower reach **58***b* passes over sprockets **59** and **60**. Lower chain reach **58***b* is attached to dolly **52**. Accordingly, upper chain reaches **54***a* and **58***a* will move in opposite directions upon movement of dolly **52**. In like manner, lower chain reaches **54***b* and **58***b* will move in opposite directions.

The pushing apparatus is positioned outside a kiln in which a heating section **66** and a preheating section **67** are provided. Dolly **52** and the associated piston and piston rod **53** and **53***a* are, however, located outside of the heating zone of the kiln and are not exposed to its temperatures. A door **68** is provided between the heating and preheating sections and is vertically movable responsive to limit switches. Those are conventional and have been omitted from the drawings for simplicity.

A lug **61** is attached to each upper chain reach **54***a*, and lugs **62**, **63**, **64** and **65** are attached to each upper reach **58***a*. A kiln car **70** is shown in the heating section of the kiln (FIGURES 8 and 9) and a series of additional kiln cars **71**, **72**, **73**, and **74** are shown in preheating section **67**. When dolly **52** is in the position shown in FIGURES 8 and 4 door **68** is closed. Hydraulic pressure is admitted to piston **53***a* to begin pushing dolly **52** to the left, as shown in the figures. As dolly **52** moves toward heating section **66**, each upper chain reach **54***a* will move forwardly with it, moving each lug **61** toward the heating section. After movement of perhaps a foot, each lug **61** will engage kiln car **70** and will begin moving forward the entire train of cars in the heating section of the kiln. Movement of dolly **52** will be rapid until lugs **61** engage kiln car **70**. Thereafter the movement will be slowed to provide a deliberate push. At the same time that the dolly **52** is moving toward heating section **66**, upper chain reach **58***a* and lugs **62**, **63**, **64** and **65** move away from the heating section **66**. When piston **53** has completed a full stroke dolly **52** will be in the position shown in FIGURE 10. By means of a conventional limit switch, movement of dolly **52** is reversed and it is rapidly retracted causing lug **62** to move away from the heating section and lugs **63**, **64**, **65** and **66** to move toward the heating section. At the time movement of dolly **52** is reversed, door **68** is opened. Lug **63** will promptly engage kiln car **71** and advance it into heating section **66**. After further movement of dolly **52**, lugs **64**, **65** and **66** will engage kiln cars **71**, **72** and **73**. Thus, all of cars **71**, **72**, **73** and **74** will be advanced, but there will be a gap between cars **71** and **72**. When dolly **52** has completed its reverse movement, door **68** is closed by a further limit switch. The kiln cars at that point are again in the position shown in FIGURES 8 and 9, but with kiln car **71** at the end of the train in heating section **66**. The cycle is then repeated with a slow pushing stroke and a rapid return stroke, thus enabling almost continuous movement to be maintained upon the train in the kiln and allowing a new car to be introduced into the kiln without disrupting heating within the kiln.

If desired, dolly **52**, piston rod **53** and piston **53***a* may be located entirely outside of the kiln heating and preheating sections. All that is required is to extend the lengths of chains **54** and **58** sufficiently to locate them away from the heated kiln portions.

From the foregoing it will be seen that a kiln can be pushed on a substantially continuous basis introducing new cars to the kiln at intervals and maintaining a door at the entrance end to prevent infiltration of cold air at the kiln entrance and disruption of gas flow within the kiln. At the same time elaborate interlock systems previously required are completely avoided and the need for them is obviated.

While I have illustrated and described a present preferred embodiment of my invention, it is to be understood that I do not limit myself thereto and that the invention may be otherwise variously practiced within the scope of the following claims.

I claim:

1. Pusher apparatus adapted for use in a continuous tunnel kiln and the like, said pusher apparatus comprising power means, first lug means in driven relationship to the power means and placed to advance ware in the kiln when the power means are operated, and additional lug means in driven relationship to the power means and driven in opposite direction to the first lug means and placed to advance ware in the kiln, said lug means and said additional lug means being operable by said power means alternately to advance ware in the kiln.

2. Pusher apparatus as set forth in claim **1** in which the first lug means engage kiln car means at a position within the kiln intermediate the entrance end and delivery end of the kiln, and the additional lug means engage kiln car means adjacent to the entrance end of the kiln.

3. Pusher apparatus as set forth in claim **2** in which the additional lug means are fitted to endless chain means driven by the power means in opposite direction to the first lug means.

4. Pusher apparatus as set forth in claim **3** in which the power means include a fluid power piston and having rack and pinion means in driving connection between the piston means and the endless chain means.

5. Pusher apparatus as set forth in claim **1** in which the power means is removed from the heated sections of the kiln.

6. Pusher apparatus adapted for use in a continuous tunnel kiln having a preheating zone and a heating zone,

said pusher apparatus comprising power means, first lug means in driven relationship to the power means and placed to advance ware in the heating zone when the power means are operated in one direction, second lug means in driven relationship to the power means and placed to advance ware from the preheating zone to the heating zone, third lug means in driven relationship to the power means and placed to advance ware in the preheating zone, the first lug means being advanced by operation of the power means in one direction and the second and third lug means being advanced by operations of the power means in the opposite direction.

7. Pusher apparatus as set forth in claim **6** in which the first lug means are connected to a piston and the second and third lug means are connected to endless chain means and are driven thereby in opposite direction to the piston by operation of the piston.

8. Pusher apparatus as set forth in claim **6** in which the lug means engage ware-carrying kiln cars and advance the same through the kiln.

9. The method of charging a continuous tunnel kiln having a preheating section and a heating section which comprises slowly advancing ware in the heating section and thereafter rapidly advancing ware from the preheating section to the heating section and simultaneously

rapidly retracting pusher means used to slowly advance the ware in the heating section.

10. The method of claim **9** which includes opening door means intermediate the preheating section and heating section after advancing ware in the heating section and during rapid advance of ware from the preheating section to the heating section and then closing the door means.

11. The method of claim **10** which includes rapidly advancing ware into the preheating section substantially concurrently with rapid advance of ware from the preheating section into the heating section.

12. Pusher apparatus as set forth in claim **8** in which the second lug means engage a kiln car before the third lug means engages a kiln car.

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JOHN J. CAMBY, *Acting Primary Examiner.*

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,390,870 July 2, 1968

Stephen B. Yacura

It is certified that error appears in the above identified patent and that said Letters Patent are hereby corrected as shown below:

Column 2, line 33, "heating" should read -- preheating --.
Column 5, line 70, "4" should read -- 9 --.

Signed and sealed this 13th day of January 1970.

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents